AGARD-AR-211

AGARD-AR-211

AGARD

ADVISORY GROUP FOR AEROSPACE RESEARCH & DEVELOPMENT

7 RUE ANGELLE 92200 NEUILLY SUR SEINE FRANCE

AD-A162 128

AGARD ADVISORY REPORT No.211

Test Cases for Inviscid Flow Field Methods

DTIC
ELECTE
OCT 28 1985
S D
E

NORTH ATLANTIC TREATY ORGANIZATION

DISTRIBUTION AND AVAILABILITY
ON BACK COVER

85 10 28 070

REPRODUCED AT GOVERNMENT EXPENSE

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

NORTH ATLANTIC TREATY ORGANIZATION

ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT

(ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD)

AGARD Advisory Report No.211

TEST CASES FOR INVISCID FLOW FIELD METHODS

REPORT OF FLUID DYNAMICS PANEL WORKING GROUP 07

Accession For
NTIS GRA&I
DTIC TAB
Unannounced
Justification
By
Distribution/
Availability Codes
Dist | Avail and/or Special
A-1 | 23

QUALITY INSPECTED

DTIC ELECTE OCT 2 8 1985 D E

This Advisory Report was prepared at the request of the AGARD Fluid Dynamics Panel.

THE MISSION OF AGARD

The mission of AGARD is to bring together the leading personalities of the NATO nations in the fields of science and technology relating to aerospace for the following purposes:

— Exchanging of scientific and technical information;

— Continuously stimulating advances in the aerospace sciences relevant to strengthening the common defence posture;

— Improving the co-operation among member nations in aerospace research and development;

— Providing scientific and technical advice and assistance to the North Atlantic Military Committee in the field of aerospace research and development;

— Rendering scientific and technical assistance, as requested, to other NATO bodies and to member nations in connection with research and development problems in the aerospace field;

— Providing assistance to member nations for the purpose of increasing their scientific and technical potential;

— Recommending effective ways for the member nations to use their research and development capabilities for the common benefit of the NATO community.

The highest authority within AGARD is the National Delegates Board consisting of officially appointed senior representatives from each member nation. The mission of AGARD is carried out through the Panels which are composed of experts appointed by the National Delegates, the Consultant and Exchange Programme and the Aerospace Applications Studies Programme. The results of AGARD work are reported to the member nations and the NATO Authorities through the AGARD series of publications of which this is one.

Participation in AGARD activities is by invitation only and is normally limited to citizens of the NATO nations.

The content of this publication has been reproduced
directly from material supplied by AGARD or the authors.

Published May 1985

Copyright © AGARD 1985
All Rights Reserved

ISBN 92-835-1497-1

Printed by Specialised Printing Services Limited
40 Chigwell Lane, Loughton, Essex IG10 3TZ

PREFACE

The escalating costs and the continuing limitations of wind tunnel testing together with the growing imperative to achieve the "optimal" design have rapidly increased the importance of computational fluid dynamics in the design of military aircraft. At relevant Reynolds numbers, inviscid flow methods continue to play an essential role in this design process.

In recognition of this, the AGARD Fluid Dynamics Panel established Working Group 07 to specify relevant reference test cases to serve as validation bases for those developing new methods with improved accuracy and cost-effectiveness. These cases further serve as check cases for those learning to use existing production codes.

This report presents the recommendations of the Working Group.

H.Yoshihara
Chairman, WG07

P.Sacher
Co-chairman, WG07

CONTENTS

	Page
PREFACE	iii
	Reference
OBJECTIVES AND SCOPE OF THE WORKING GROUP 07 by H.Yoshihara	1
FORMULATION OF THE EULER BOUNDARY VALUE PROBLEM by H.Norstrud	2
NUMERICAL METHODS by J.W.Boerstoel	3
EXACT SOLUTIONS TO TRANSONIC AND SUPERSONIC FLOWS by G.Chiocchia	4
REFERENCE TEST CASES AND CONTRIBUTORS by D.J.Jones	5
NUMERICAL SOLUTIONS OF TWO-DIMENSIONAL REFERENCE TEST CASES by H.Viviand	6
NUMERICAL SOLUTIONS FOR THREE-DIMENSIONAL CASES – SWEPT WINGS by P.Sacher	7
NUMERICAL SOLUTIONS FOR THREE-DIMENSIONAL CASES – DELTA WINGS by J.H.B.Smith	8
CONCLUDING REMARKS by H.Yoshihara	9
APPENDIX A1: NUMERICAL DATA RELATING TO THE SOLUTIONS FOR THE TWO- AND THREE-DIMENSIONAL TEST CASES	A1*

*The data relating to Appendix A1 has been prepared in the form of microfiche which accompany this publication.

1. OBJECTIVES AND SCOPE OF THE WORKING GROUP 07 (H. YOSHIHARA)

In real flows over configurations at full scale Reynolds numbers, the viscous effects are confined primarily to a thin boundary layer wetting the configuration surface and its downstream wake extension. In the familiar fashion the problem is then divided into the outer equivalent inviscid flow problem and the thin viscous layer problem. The accurate computation of inviscid flow therefore continues to be an essential requirement.

In recognition of this, at the suggestion of Dr. John Green, former Head of the Aerodynamics Department, RAE (Farnborough), the AGARD Fluid Dynamics Panel (FDP) established Working Group (WG) 07 "Test Cases for Inviscid Flow Field Methods." The objective and scope of this WG are described succinctly in the proposal to the National Delegates Board composed by Dr. Green; that is,

OBJECTIVE:

"To assist the development of numerical methods for steady, transonic and supersonic flows in two and three dimensions, by specifying relevant test cases for inviscid calculations and presenting either exact or definitive numerical results where these can be made available. The exact and definitive results will be solutions of the Euler equations with Rankine-Hugoniot shock relations. The benefits will arise in the development of methods for solving the Euler equations and the equations of potential flow, either alone, or in conjunction with other methods for treating viscous effects."

SCOPE:

"The Group will seek solutions which are exact, in the sense of not depending on the numerical solution of partial differential equations. Secondly, it will review existing numerical solutions from the viewpoint of relevance and accuracy, and encourage supplementary calculations if appropriate. Thirdly, it will review the features of aircraft shapes which are envisaged as being represented in numerical calculations, and define shapes which embody these features as test cases for future calculations. Test cases will be proposed based on these approaches. Each will be fully defined in the Group's report, together with exact or definitive numerical solutions where available."

In the above it is intended that "exact solutions" cover not only solutions as the Ringleb hodograph solutions which are in a true sense exact, but also more complex hodograph solutions, for example planar shock-free airfoil flows, for which error assessment is difficult. "Definitive solutions" on the other hand are numerical solutions as finite difference iterative solutions, for example for transonic airfoil or wing flows with shocks. In such numerical solutions, an absolute assessment of the numerical errors is not possible. To reflect this uncertainty, we shall refer to these solutions as "reference test cases" rather than "definitive solutions."

In Figure 1.1 is sketched the discretization and solution procedure, for example, for a finite difference method, identifying the sources of error at various stages. the evaluation of the Reference Test Cases, of primary importance will be the assessment of the "truncation errors" since the "residual errors" can be readily calculated.

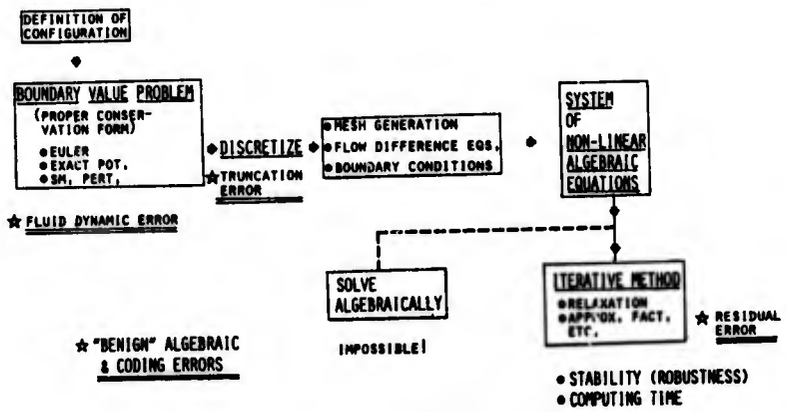


FIGURE 1.1. ANATOMY OF A FINITE DIFFERENCE METHOD -- SOURCES OF NUMERICAL ERROR.

Due to possible numerical instabilities and certainly to computer costs, the mesh is rarely adequately refined. As a consequence, different codes of the same nominal order of accuracy can yield significantly different absolute truncation errors even with the identical mesh. Of particular concern here is the accuracy in the fulfillment of the flow equations and the boundary condition at the configuration surface which unfortunately is seldom verified. Assessment of the contributed reference test cases in this uncertain environment will be a challenging task for the Working Group.

The Euler solutions have been selected since they represent the most general class of inviscid solutions, encompassing flows with varying total pressure and temperature and therefore varying entropy and vorticity. Relative to exact potential codes, the state of Euler codes is less mature, but the recent rapid development should shortly close this gap.

As mentioned above, Euler codes, in contrast to exact potential codes, can treat directly flows containing strong curved shock waves, vortex sheets as springing from sharp edges of wings, and regions of varying total pressure and temperature as occurring in a jet engine exhaust plume. In an important class of flows over wings at high subsonic freestream Mach numbers with shocks, the exact potential code however continues to be a viable code. Here shock waves are usually sufficiently swept or made sufficiently oblique by the shock/boundary layer interactions that the shock total head losses are insignificant.

In the future with the development of improved Euler codes and the availability of advanced computers with increased memory capacity, more accurate results for the selected test cases must follow. The Reference Test Cases presented herein must therefore be considered as interim results to be possibly updated in the future. This is particularly true of the three dimensional cases.

The achievements of the WG contained herein have been fully responsive to the Objectives and Scope as given above with one exception, the third item under the Scope paragraph. An exhaustive consideration of "shapes embodying practical aircraft features" was deemed premature at this stage due to the expected inadequate state of mesh generation in the near future.

The Working Group was composed of the following members.

FDP PANEL MEMBERS

Dr. Ing. G. Bucciantini
Aeritalia S.P.A.
Corso Marche 41
10146 Torino - Italy

Professor H. Norstrud
The University of Trondheim
N-8034 Trondheim - NTH - Norway

Dr. L. Roberts
Stanford University
Stanford, CA 94305 - U.S.A.

Dipl. Ing. P. Sacher (Co-chairman)
Messerschmitt-Bolkow-Blohm GmbH, UF
Postfach 80 11 60
D-8000 Munchen 80 - West Germany

Dr. H. Yoshihara (Chairman)
Boeing Military Airplane Company
Mail Stop 41-16
P. O. Box 3707
Seattle, Washington 98124 - U.S.A.

NON-PANEL MEMBERS

Dr. Ir. J. W. Boerstoel
Nationaal Lucht-En
Ruimtevaartlaboratorium
P. O. Box 90502
1006 BM Amsterdam - Netherlands

Mr. D. J. Jones
National Aeronautical
Establishment
Montreal Road,
Ottawa, Ontario K1A OR6 - Canada

Mr. J. H. B. Smith
Royal Aircraft Establishment
Farnborough, Hants GU14 6TD
United Kingdom

Dr. H. Viviand
Office National D'Etudes et de
Recherches Aerospatiales
29 Avenue de la Div. Leclerc
92320 Chatillon - France

Assisting the Working Group were several invited unofficial observers. These include the following:

Prof. Dr. G. Chiocchia (1982-1983)
Corso Duca D. Abruzzi 24
Politecnico Di Torino
I-10129 Torino - Italy

Dr. A. Rizzi (1982-1983)
F.F.A. P. Box 11021
S-16111 Bromma 11 - Sweden

Dr. W. Schmidt (1983)
Dornier Gmb H
Postfach 1420
D-7990 Friedrichshafen 1 - West Germany

Meetings of the WG were held usually over two days, twice a year, preceding the FDP symposium and business meeting. The term of the WG was two years, 31 October 1981 to 31 October 1983. Much of the early preparatory effort was however organized and carried out between the formal meetings by the following three committees for consideration and approval by the Working Group:

Committee A (Chairman: Dr. W. Boerstoel)
Select and define exact solutions as the existing hodograph solutions.

Committee B (Chairman: Dr. H. Viviand)
Establish procedures and criteria to assess the reference test cases and identify potential contributors.

Committee C (Chairman: Dipl. Ing. P. Sacher)
Suggest two and three dimensional reference test cases.

The remainder of the report is organized as follows with the primary authors noted in parenthesis. The chapter contents, particularly of chapters 6, 7, 8, and 9, reflect the consensus of the Working Group.

Chapter 2. Formulation of the Euler Problem (Prof. Norstrud)

Chapter 3. Numerical Methods: General Considerations (Dr. Ir. Boerstoel assisted by Dr. Rizzi)

Chapter 4. Exact Solutions (Prof. Chiocchia)

Chapter 5. Reference Test Cases (Mr. Jones)

Chapter 6. 2D Reference Test Cases (Dr. Viviand)
(Assisted by Dr. Boerstoel, Prof. Chiocchia, Mr. Jones, and Dr. Schmidt)

Chapter 7. 3D Reference Test Cases - Swept Wings (Mr. Sacher)
(Assisted by Dr. Bucciantini, and Dr. Roberts)

Chapter 8. 3D Reference Test Cases - Delta Wings (Mr. Smith)
(Assisted by Prof. Norstrud and Dr. Rizzi)

Chapter 9. Concluding Remarks (Dr. H. Yoshihara)

2. FORMULATION OF THE EULER BOUNDARY VALUE PROBLEM (H. NORSTRUD)

2.1 Fluid dynamic background

The Swiss mathematician Leonard Euler (1707-1783) is remembered through the equations of motion which describes rotational, but inviscid compressible flow. Most of the obtained solutions to such fluid flow problems are based on irrotational motion and, hence, can be grouped together as potential flow solutions.

In many practical cases such potential approximations[1,2] yields satisfactory results as compared to a rotational flow solution[3,4]. This is e.g. illustrated in figure 2.1 which shows the Mach number contours around an airfoil at supersonic speed. For flows with strong entropy variation in the flow field the situation, however, is changed. This is especially true for embedded shocks as can be seen from figure 2.2. Here figure 2.2a shows the Mach number contour around a cylinder for $M_\infty < 1$, whereas 2.2b shows the corresponding streamlines.

The major reason behind the discrepancy between a rotational and irrotational solution lies in the fact that the potential flow solution does not satisfy the Rankine-Hugoniot jump condition across a shock, see figure 2.3. As it can be seen, an irrotational solution like the full potential solution or the transonic small perturbation solution (TSP), will yield a larger Mach number jump across the shock as compared to the equivalent rotational or Euler solution. Furthermore, the shock location will differ between a rotational and irrotational solution, and this is depicted in figure 2.4.

Finally, it must be stated that for flows with complex shock patterns and for flows with inherent vorticity the method of solution adopted must be based on the Euler equations. The flow field around a modern combat aircraft is well suited to serve as an example to this, see figure 2.5 which shows the calculated pressure distribution around an aircraft forebody at $M_\infty > 1$.

2.2 Integral form of the Euler equations

We will follow the formulation given by Rizzi[6] and can write the integral form of the Euler equations in a higher-dimensional space as

$$\frac{\partial}{\partial t}\int_V q\, dV + \int_A Q\cdot n\, dA = 0 \tag{2.1}$$

where $q = [\rho, \rho u, \rho v, \rho w]$ refers to the fluid density ρ and to the components of the translational momentum $\rho v = (\rho u, \rho v, \rho w)$ in a Cartesian coordinate system x,y,z. The closed area A bounds the volume V and n designates the outward unit normal on the elemental area dA.

Furthermore, the flux vector $Q = [qv + (0, e_x, e_y, e_z)p]$ is a function of the static pressure p acting on dA with the unit directional vectors given as e_x, e_y and e_z. Time is denoted by t and for steady flows the first integral in (2.1) will be identical zero.

With the definition of enthalpy h as

$$h = e + p/\rho$$

where e denotes the internal energy per unit mass, we can write for the stagnation enthalpy

$$h_0 = h + \tfrac{1}{2}(u^2 + v^2 + w^2)$$

and for isoenergetic flow (i.e. globally constant h_0) we obtain the relation

$$p = \rho\,\frac{\gamma-1}{\gamma}\left[h_0 - \tfrac{1}{2}(u^2 + v^2 + w^2)\right] \tag{2.2}$$

where γ designates the ratio of specific heats.

The integral formulation is the basis for various finite volume techniques adopted for the solution of the Euler equations, but is not necessarely associated with constant stagnation enthalpy.

2.3 Differential form

The differential form of the Euler equations can be found in many papers, see e.g. reference 7-10 for different applications. In three space-dimensions these equations can be written in conservation form as

$$\frac{\partial U}{\partial t} + \frac{\partial F}{\partial x} + \frac{\partial G}{\partial y} + \frac{\partial H}{\partial z} = 0 \tag{2.3}$$

where the vector U of the conservative variables(ρ, ρu, ρv, ρw and E) and the flux vectors F, G and H are

$$U = \begin{bmatrix} \rho \\ \rho u \\ \rho v \\ \rho w \\ E \end{bmatrix} \quad F = \begin{bmatrix} \rho u \\ \rho u^2+p \\ \rho uv \\ \rho uw \\ u(E+p) \end{bmatrix} \quad G = \begin{bmatrix} \rho v \\ \rho uv \\ \rho v^2+p \\ \rho vw \\ v(E+p) \end{bmatrix} \quad H = \begin{bmatrix} \rho w \\ \rho uw \\ \rho vw \\ \rho w^2+p \\ w(E+p) \end{bmatrix}$$

Here the total energy E is given as

$$E = \frac{p}{\gamma-1} + \frac{\rho}{2}(u^2 + v^2 + w^2) = \rho[e + \frac{1}{2}(u^2 + v^2 + w^2)]$$

see e.g. equation (2.2). For two-dimensional, unsteady flows equation (2.3) reduces to

$$\frac{\partial U}{\partial t} + \frac{\partial F}{\partial x} + \frac{\partial G}{\partial y} = 0 \tag{2.4}$$

where

$$U = \begin{bmatrix} \rho \\ \rho u \\ \rho v \\ E \end{bmatrix} \quad F = \begin{bmatrix} \rho u \\ \rho u^2+p \\ \rho uv \\ u(E+p) \end{bmatrix} \quad G = \begin{bmatrix} \rho v \\ \rho uv \\ \rho v^2+p \\ v(E+p) \end{bmatrix}$$

A transformation of (2.4) to curvilinear coordinates is in many application mandatory and will be given in the following section.

2.4 General curvilinear transformation

The system of Euler equations (2.3) will not alter its conservation form when subjected to an arbitrary coordinate transformation such as

$$\xi = \xi(x, y, z, t)$$
$$\eta = \eta(x, y, z, t)$$
$$\zeta = \zeta(x, y, z, t)$$
$$\tau = \tau(t)$$

where ξ, η, ζ are the transformed space coordinates and J is the Jacobian of the transformation

$$J = \frac{\partial(\xi,\eta,\zeta)}{\partial(x,y,z)} = \begin{vmatrix} \frac{\partial \xi}{\partial x} & \frac{\partial \xi}{\partial y} & \frac{\partial \xi}{\partial z} \\ \frac{\partial \eta}{\partial x} & \frac{\partial \eta}{\partial y} & \frac{\partial \eta}{\partial z} \\ \frac{\partial \zeta}{\partial x} & \frac{\partial \zeta}{\partial y} & \frac{\partial \zeta}{\partial z} \end{vmatrix}$$

This will transform equation (2.3) to

$$\frac{\partial \bar{U}}{\partial \tau} + \frac{\partial \bar{F}}{\partial \xi} + \frac{\partial \bar{G}}{\partial \eta} + \frac{\partial \bar{H}}{\partial \zeta} = 0$$

where the following transformed vectors are introduced

$$\bar{U} = IU$$
$$\bar{F} = I\,\xi_t U + \xi_x F + \xi_y G + \xi_z H$$
$$\bar{G} = I\,\eta_t U + \eta_x F + \eta_y G + \eta_z H$$
$$\bar{H} = I\,\zeta_t U + \zeta_x F + \zeta_y G + \zeta_z H$$

Here $I = 1/J$ denotes the Jacobian of the inverse mapping, i.e.

$$I = x_\xi(y_\eta z_\zeta - y_\zeta z_\eta) - x_\eta(y_\xi z_\zeta - y_\zeta z_\xi) + x_\zeta(y_\xi z_\eta - y_\eta z_\xi)$$

and where

$$J = \xi_x(\eta_y\zeta_z - \eta_z\zeta_y) - \xi_y(\eta_x\zeta_z - \eta_z\zeta_x) + \xi_z(\eta_x\zeta_y - \eta_y\zeta_x)$$

For the two-dimensional unsteady case, see equation (2.4), we will obtain

$$\frac{\partial \bar{U}}{\partial \tau} + \frac{\partial \bar{F}}{\partial \xi} + \frac{\partial \bar{G}}{\partial \eta} = 0 \tag{2.5}$$

where

$$\begin{aligned} \bar{U} &= IU \\ \bar{F} &= I(\xi_t U + \xi_x F + \xi_y G) \\ \bar{G} &= I(\eta_t U + \eta_x F + \eta_y G) \end{aligned} \tag{2.6}$$

Again $I = 1/J$ denotes the Jacobian of the inverse mapping, i.e.

$$I = x_\xi y_\eta - x_\eta y_\xi$$

and

$$J = \xi_x \eta_y - \xi_y \eta_x$$

The metrics of the mapping to the metrics of the inverse mapping are related as follows

$$\begin{aligned} I\xi_t &= y_\tau x_\eta - x_\tau y_\eta \\ I\xi_x &= y_\eta \\ I\xi_y &= -x_\eta \end{aligned}$$

and

$$\begin{aligned} I\eta_t &= x_\tau y_\xi - y_\tau x_\xi \\ I\eta_x &= -y_\xi \\ I\eta_y &= x_\xi \end{aligned}$$

and these relations rewrites equations (2.6) to yield

$$\begin{aligned} \bar{U} &= IU \\ \bar{F} &= (y_\tau x_\eta - x_\tau y_\eta)U + y_\eta F - x_\eta G \\ \bar{G} &= (x_\tau y_\xi - y_\tau x_\xi)U - y_\xi F + x_\xi G \end{aligned} \tag{2.7}$$

Hence, equation (2.5) together with (2.7) forms the transformed system of equations for the non-steady, planar case.

2.5 Alternative form of the differential equations

The conservation form of the energy equation, as embedded in eq. 2.3, reads explicitely

$$\frac{\partial E}{\partial t} + \frac{\partial u(E+p)}{\partial x} + \frac{\partial v(E+p)}{\partial y} + \frac{\partial w(E+p)}{\partial z} = 0$$

or

$$\frac{\partial}{\partial t}[\rho(e + \tfrac{1}{2}V^2)] + \text{grad}[\rho(e + \tfrac{1}{2}V^2)\vec{V}] + \text{grad}(p\vec{V}) = 0 \tag{2.8}$$

where $V = (u^2 + v^2 + w^2)^{1/2}$ is the modulus of the velocity vector $\vec{V}$. Equation (2.8) is valid for the unsteady flow of a compressible, inviscid fluid with the absence of body forces and heat transfer. Hence, it relates to adiabatic flow and in terms of the total enthalpy h_0 eq. (2.8) can be transferred to the non-conservation form

$$\frac{Dh_0}{Dt} = \frac{1}{\rho}\frac{\partial p}{\partial t} \tag{2.9}$$

where $D/Dt = \partial/\partial t + \text{div}\,\vec{V}$ denotes the substantial derivative. Furthermore, for steady flows eq. (2.9) reduces to $H_0 = \text{const}$, i.e. constant total enthalpy along a streamline.

Similarely, the momentum equations can be stated in a non-conservation form as

$$\frac{D\vec{V}}{Dt} = -\frac{1}{\rho}\text{grad}\ p \tag{2.10}$$

which will lead to the Crocco's theorem

$$T\ \text{grad}\ s = \text{grad}\ h_0 - \vec{V} \times \text{curl}\ \vec{V} + \partial\vec{V}/\partial t \tag{2.11}$$

This equation relates the entrophy gradient to the vorticity (curl $\vec{V}$) in the flow field along with the gradient of the total enthalpy and the unsteady velocity term. For steady, homentropic flows eq. (2.11) yields a direct correspondance between the entropy gradient and the vorticity since grad $h_0 = \partial\vec{V}/\partial t = 0$.

In calculating flow fields with strong entropy gradients (e.g. across shocks), Moretti[11] made use of an entropy function as a dependent variable in solving the Euler equations and thus incorporated eq. (2.11) in his analysis of supersonic, steady flows. The relation between circulation and vorticity flux should also be pointed out.

2.6 Nature of equations for steady and unsteady flows

The steady state solution is frequently found on the basis of an iteration process involving the unsteady Euler equations, i.e. in many applications only the limiting state of time-independancy is of interest. This means that the physical time scale is adopted for numerical purposes only and that the introduction of a surrogate time could serve the same purpose.

Such a solution technique, however, is not a simple one since any iteration process involves a communication scheme between the numerical grid points which must satisfy the physics of the flow.

The physical unsteady flow equations says that it requires initial data to approach the steady state condition. This is due to the hyperbolic nature of the partial differential equations with respect to time and a time-dependent technique requires special criterions for stability purposes. Furthermore, it puts emphasis on the different utility of implicit and explicit iteration schemes.

Similarely, the steady-state equations are of a elliptic and/or hyperbolic type and due to this mixed flow behaviour the solution of the time-independent equations are inherently more difficult to solve.

2.7 Formulation of boundary conditions

The Euler equations, as presented in the previous sections, are subject to certain boundary conditions in order to render a desired unique solution. These conditions applies to a physical fluid region and can in general be specified[12] or listed in relation to

a) physical objects
b) inflow
c) outflow
d) internal surfaces
e) artificial surfaces

The physical objects (profiles, wings etc.) constitutes single or multiple body surfaces which internally bounds the fluid region and, hence, give rise to the tangential flow condition. Since the computational space is often a truncated part of the physical space, these objects have a distinct influence on the inflow/outflow conditions (e.g. the Sommerfeld radiation conditions). The inflow condition is usually identical to the free-stream condition, which again can be specified in terms of constant total enthalpy.

The term internal surfaces refers to singular areas in the flow field which are caused by the geometric representation of the physical objects or by flow phenomena such as vorticity sheets or shock waves. The Rankine-Hugoniot condition is associated with the latter type surface and relates the flow properties across a shock. The classical Kutta condition, however, seems at present to be under doubt as a necessary supplementary condition.

Artificial surfaces are normally constructed as an integral part of the computational space and, hence, bears no physical significance. Nevertheless, the use of artificial surfaces for the purpose of convergence improvements[13] should be noted.

2.5 References

1. Murman, E.M. and Cole, J.D., "Calculation of Plane Steady Transonic Flows", AIAA Journal, Vol. 9, No. 1, January 1971, pp. 114-121.

2. Yoshihara, H. and Spee, B.M., "Applied Computational Transonic Aerodynamics", AGARDograph No. 266, August 1982.

3. Hafez, M. and Lovell, D., "Numerical Solution of Transonic Stream Function Equation", AIAA Journal, Vol. 21, No. 3, March 1983, pp. 327-335.

4. Ecer, A. and Akay, H.U., "A Finite Element Formulation for Steady Transonic Euler Equations", AIAA Journal, Vol. 21, No. 3, March 1983, pp. 343-350.

5. Arlinger, B.G., "Computation of Supersonic Flow around Bodies", AIAA Paper No. 84-0259, January 1984.

6. Rizzi, A., "Damped Euler-Equation Method to Compute Transonic Flow Around Wing-Body Combinations", AIAA Journal, Vol. 20, No. 10, October 1982, pp. 1321-1238.

7. Ni, R.H., "A Multiple-Grid Scheme for Solving the Euler Equations", AIAA Journal, Vol. 20, No. 11, November 1982, pp. 1565-1571.

8. Atkins, H.L. and Hassan, H.A., "Transonic Flow Calculations Using the Euler Equations", AIAA Journal, Vol. 21, No. 6, June 1983, pp. 842-847.

9. Salas, M.D. et al, "Shock-Fitted Euler solutions to shock-vortex interactions", in Lecture Notes in Physics, No. 170 (ed. E.Krause), Springer-Verlag, Berlin Heidelberg, 1982, pp. 461-467.

10. Weiland, C., "Vortex flow simulations past wings using the Euler-equations", AGARD Conference Proceedings CP-342, July 1983, pp. 19-1 to 19-12.

11. Moretti, G., "Calculation of Three-Dimensional, Inviscid Supersonic, Steady Flows", NASA Contractor Report 2573, Washington D.C., June 1982.

12. Turkel, E., Progress in computational physics", Computers and Fluids, Vol. 11, No. 2, 1983, pp. 121-144.

13. Chakravarthy, S.R., "Euler Equations - Implicit Schemes and Boundary Conditions", AIAA Journal, Vol. 21, No. 5, May 1983, pp. 699-706.

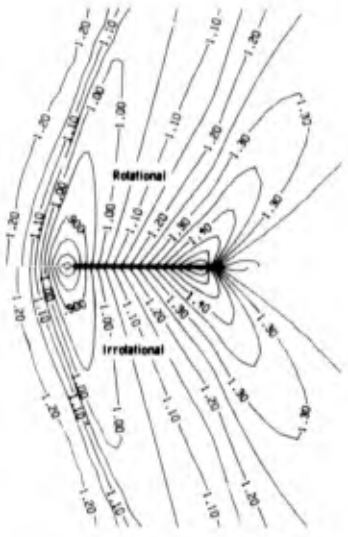


Fig. 2.1 Mach number contours around a 10 % thick parabolic arc airfoil at M_∞ = 1.2 (from ref.3)

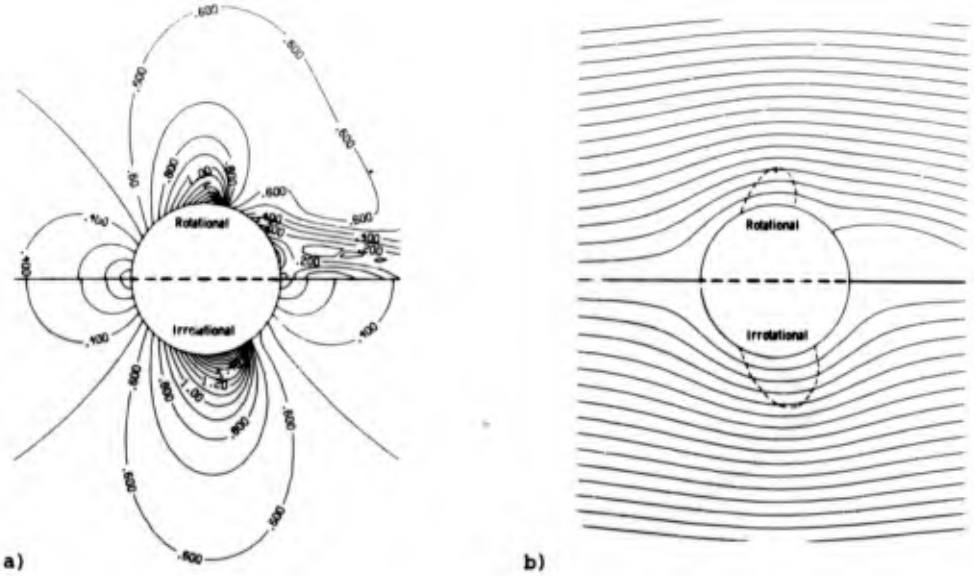


Fig. 2.2 Mach number contours (a) and streamlines (b) around a cylinder at M_∞ = 0.51 (from ref.3)

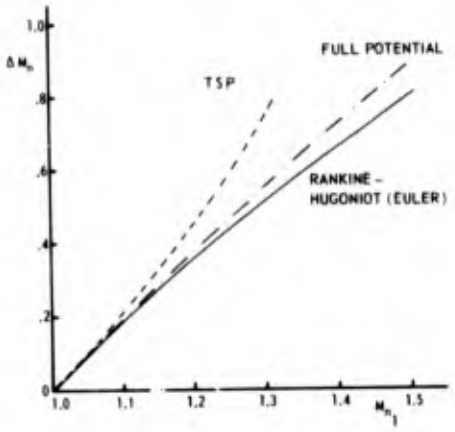


Fig. 2.3 Mach number jump ΔM_n in terms of normal Mach number (ref.2)

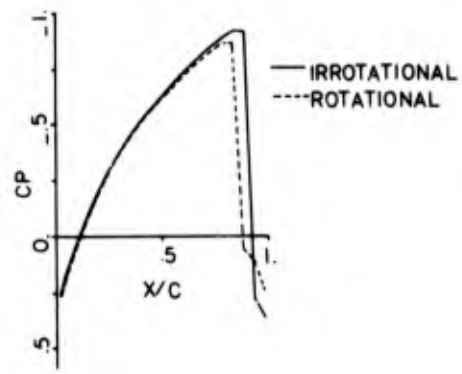


Fig. 2.4 Pressure distribution over a circular arc bump in a channel at $M_\infty = 0.85$ (from ref.4)

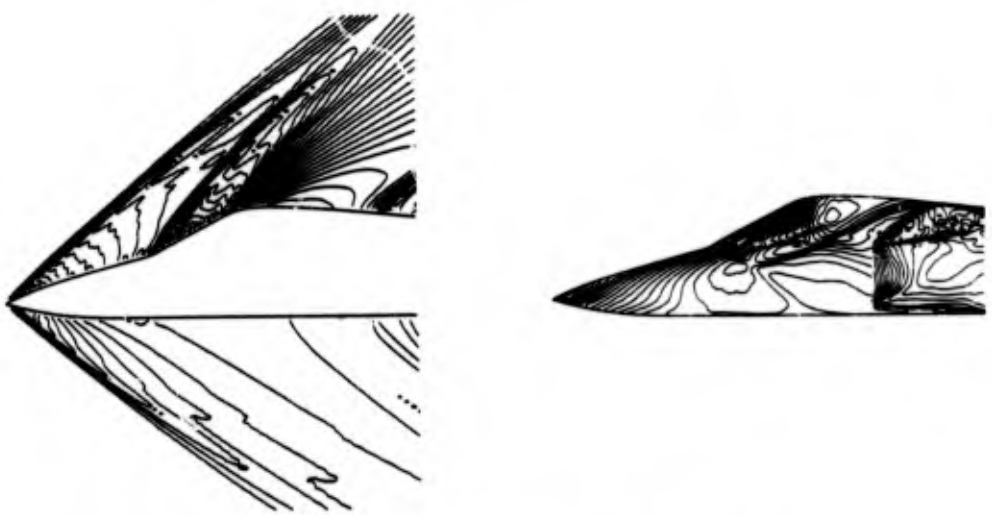


Fig. 2.5 Isobar pattern in the symmetry plane around aircraft forebody at $M_\infty = 1.8$ (from ref. 5)

3. NUMERICAL METHODS (J.W. BOERSTOEL)

SUMMARY

A survey of numerical techniques used in computational simulations of Euler flows is presented. The number of techniques reported in literature is so large that a detailed description of all of them is out of scope. Therefore, this survey is concentrated to sketching only the more important numerical topics, and pointing out differences in possible approaches.

3.1 General requirements for numerical methods; general approach

From the point of view of aeronautical applications, numerical methods for the solution of the initial-boundary-value problem of the Euler equations should satisfy a number of primary requirements. The following list is expected to cover many specific application fields.

- The numerical method should be able to compute Euler flows around a specified, sufficiently wide class of aeronautical configurations (aerofoils, wings, aircraft configurations, air intakes, etc.), and for a specified suitably wide range of free-stream conditions, incidences, in- and outflux conditions, etc. The desired flow should be specified to be steady or unsteady, if possible.
- For a given desired accuracy level, the calculation results should be obtained with minimal computational effort.
- The desired accuracy levels should be specified. This may be done in terms of overall quantities, like c_l, c_d, c_m, and in terms of distributions of functions on the configuration or in the flow field, like c_p, M, total pressure, entropy, and vorticity.
- C^o-discontinuities, like shocks and vortex sheets, should be as sharp as possible, with a minimum of smearing and dispersion (wiggles). The best resolution is obtained when C^o-discontinuities have a thickness of one mesh.
- Unphysical phenomena (like expansion shocks) have to be rigorously suppressed.

Lists of primary requirements are seldom explicity specified. However, they are needed to objectively evaluate the quality of a numerical method, because they specify the criteria that should be met by a numerical method.

Starting from such lists of requirements, the general approach to the numerical solution of the initial-boundary-value problem of the Euler equations consists of two major steps. In the first step the flow equations, the boundary conditions, and the initial conditions of the continuum-model formulation of the problem are replaced by a large system of algebraic equations (discretisation). In the second step the resulting system of algebraic equations is solved (solution), see figure 3.1. The discretisation process reduces to splitting the (t,x,y,z)-space into small elementary volumes called cells (grid generation, section 3.2), and writing down, for each cell, algebraic approximations of the conservation equations (section 3.3), of the initial conditions (section 3.5), and of boundary conditions (section 3.4). The solution of the algebraic equation system is discussed in section 3.7, and the topic of well-posedness of the numerical problem is briefly discussed in section 3.8.

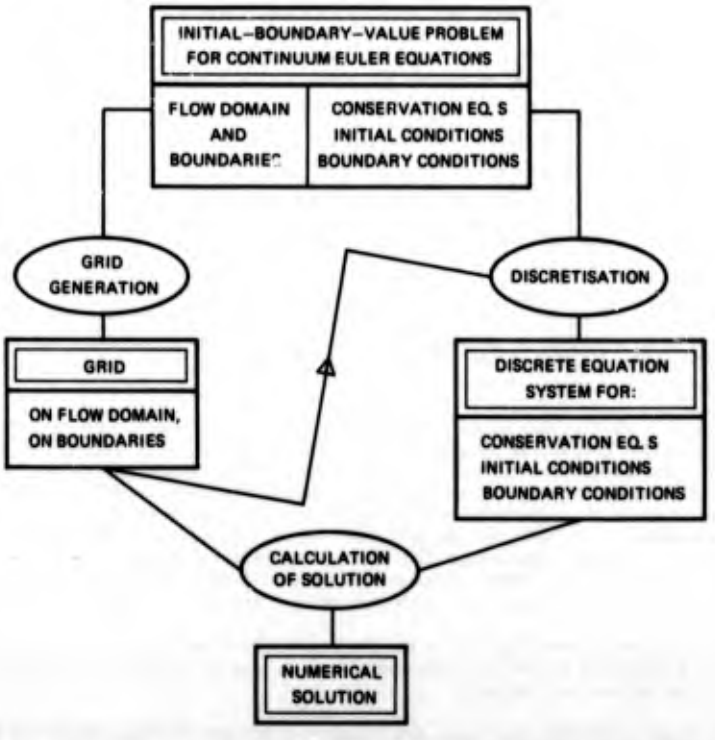


Fig. 3.1 General approach to numerical solution of initial-boundary-value problem for Euler-equation flows

3.2 Grid generation

The first step in a numerical technique is the choice of a grid in (t,x,y,z)-space. Most existing grid generation procedures produce grids for ultimately steady flows. These grids should be designed such that:

- adequate resolution is obtained: high resolution where the flow has large gradients (leading and trailing edges, side edges of wing tips, leading edges of nacelles, etc.), low resolution in regions with small flow gradients;
- the grid is preferably solid-boundary conforming, so that boundary conditions may be simply incorporated;
- data bases are well-ordered.

Such grids are technically realized by designing a mapping

$$x = x(\xi,\eta,\zeta),\ y = y(\xi,\eta,\zeta),\ z = z(\xi,\eta,\zeta), \tag{3.1}$$

such that a uniform mesh in (ξ,η,ζ) generates a mesh with desired resolution in (x,y,z)-space, with the boundaries corresponding to surfaces ξ,η, or ζ = constant. The main burden of the grid generation then becomes the design of a mapping from some rectangular box in (ξ,η,ζ)-space onto the flow domain with its boundaries. Topological questions (O,C,H type meshes, and combinations of these for threedimensional flows around wings), mesh singularities, and their effect, and practical engineering questions, like sizes of computational domains are discussed by Eriksson (3-1) and Rizzi-Eriksson (3-2). They describe in detail a technique based on transfinite interpolation. Mesh generation techniques based on the solution of elliptic solvers and other techniques are reviewed by Thompson e.a. (3-3).

It is generally expected that the construction of a single mapping from one rectangular box to the flow domain becomes impractical, when complicated aeronautical configurations have to be dealt with (for example, a wing with flaps, engines and pylons). In such cases, the mapping problem may be alleviated by resorting to domain-splitting (= zonal = composite grid = subdomain) techniques. The flow domain is thereby split into a few subdomains, and each subdomain is mapped onto a rectangular box in (ξ,η,ζ)-space by its own mapping. For examples, see e.g. Hessenius-Pulliam (3-4) and Cambier-Ghazzi-Veuillot-Viviand (3-5). The mapping problem is avoided if rectangular grids are used; exploratory research in this direction has been reported by Wedan (3-6), using potential-flow theory.

For steady-flow solutions, the grids may be defined time-independent, and the grid may be generated prior to flow calculations. This becomes impossible when the solid surfaces move in time, and the grid is required to be boundary conforming. Practical experience with time-dependent grids seems to be limited, however.

3.3 Discretisation of conservation equations

For each cell in a grid, algebraic equations representing approximations of the conservation equations over the cell have to be defined. (When the cell is adjacent to a boundary, the boundary conditions have also to be discretized, see below.) The discretisation process leads to difference schemes for the continuum equations.

Most authors follow certain numerical guidelines that should lead to meeting primary requirements like those presented in section 3.1. These guidelines, and some major related topics are briefly discussed.

- A major topic is the choice between the following differencing alternatives:

  1st-order accurate / 2nd-order accurate } { in space: central or upwind / in time : explicit or implicit }

  Combining these alternatives, eight major ways for differencing may be identified, and of several of them examples may be found in literature. There are two main approaches, however.

  a. In most older techniques (3-2, 7 to 14), 2nd-order accurate explicit, central schemes are used. In order to suppress odd-even decoupling effects and unphysical expansion shocks (3-9, 11,15), artificial viscosity (AV) is explicitly added. See below for more remarks about the AV-issue.

  b. In many recent computation techniques (3-16, 36) explicit schemes are also used, but they are 1st- or 2nd-order upwind in space. The upwinding is based on flux-vector or flux-difference splitting (3-16, 18 - 29) or on wave splitting according to characteristics theorie (λ and SCM methods) (3-17, 30-36), and introduces implicit AV of desired nature; so the addition of explicit AV may be dispensed with.

  Many explicit schemes may be viewed as implicit, whereby the differences between the solutions at the new and the old time levels are linearized in terms of the solution at the old time level (Newton-like iteration, (3-2, 7), Runge-Kutta-like time stepping (3-9, 10), ADI approximate factorization (3-11, 14, 16, 18, 32, 33).

- Semi-discretisation (method of lines) is a discretisation technique that some authors like to follow to derive their final difference scheme in (t,x,y,z)-space. They first discretize in the spatial variables (x,y,z), and obtain then a system of first-order, coupled, nonlinear, ordinary differential equations of the form $\partial\bar{U}/\partial t = A\bar{U}$, where $\bar{U}$ is a vector of unknowns at cell centres, and $A = A(\bar{U})$ a sparse matrix. Subsequently, this system is further discretized in time; the vast body of knowledge for integrating numerically such ordinary differential-equation systems may then be used.

- Major properties of a difference-equation system may be judged from its AV (artificial viscosity). This concept is useful within the context of an analogy consideration: when the difference scheme behaves analogously to a continuum model with a small viscosity, which has smooth solutions due to that viscosity, then the difference scheme may be expected to have also smooth discrete solutions. This analogy is usually arrived at as follows. Assume the dependent variables on a grid to be smooth in a certain region, then the differences may be replaced by derivatives using Taylor series expansions. As the difference scheme is consistent, the difference between the scheme and the corresponding differential expression is a partial-differential operator of $O(h^m)$, $m \geq 1$. When in the continuum model this partial-differential operator may be identified to simulate a viscosity, the difference scheme is said to have AV, and the $O(h^m)$ operator is a viscosity operator.

  The applicability of the AV analogy hinges on the assumption that the discrete solutions must be smooth, so that Taylor series expansions are valid approximations. It may be used then to explain why discrete solutions in smooth flow regions are smooth.

- Flux-vector and flux-difference splitting are concepts that are used to construct (fully-conservative) upwind schemes having in smooth flow regions appropriate implicit AV, so that discrete solutions are smooth

away from C^0-discontinuities.

The construction of these schemes is based on the theory of characteristic manifolds in (t,x,y,z)-space. In continuous flow regions in continuum flow, the theory of characteristic manifolds describes, how the data at a given time level at both sides of given plane-segments P in (x,y,z)-space (e.g. cell boundaries in finite-volume discretisations) may be separated in different types of waves, and how the initial data of each wave at both sides of the plane-segments P are convected with time with their own characteristic speed in the direction of the corresponding threedimensional characteristic manifold (3-37). For each given initial plane-segment P, and for each type of wave, we may then determine domains of dependence and of determinacy, and ranges of influence. The wave types and characteristic propagation speeds associated with the waves may be determined with eigenvalue-eigenvector analyses of hyperbolic partial-differential equations, applied to the Euler equations or their first-variations. In fact, numerical simulations should properly account for these wave propagation processes, with their complex relations between various domains of dependence and of determinacy, and ranges of influence.

The concepts of flux-vector splitting (3-18 to 24, 38) and flux-difference splitting (3-16, 25-29) rely on characteristics theory as follows. In order to construct the upwinding, it is necessary to detect the signs of the eigenvalues and the corresponding eigenvectors of certain Jacobian matrices, because these signs define the direction of upwinding. The corresponding eigenvectors define how to split flux vectors or flux-difference vectors. For details about these techniques c.f. (3-16, 18-29, 38-40). Because the eigenvalue-eigenvector decomposition of the Jacobians is also the basis of the theory of characteristic manifolds, there is a close relation between: characteristic theory; splitting techniques; construction of appropriate implicit AV; tuning of numerical domains of dependence, determinacy, and ranges of influence to those of the continuum model; separation of convection effects in different propagation directions; generation and evaluation of C^0-discontinuities; etc.

- λ-schemes and SCM (split-coefficient methods) are also based on the theory of characteristic manifolds, and are thus related to flux-vector and flux-difference splitting-based schemes. However, the schemes are usually nonconservative, so that differencing over C^0-discontinuities (in particular shocks) should be avoided. See further (3-31 to 35).

- A major problem encountered in discretisation processes of the continuum model is the discretisation at and over C^0-discontinuities. Nearly everywhere in the flow, we may assume that the dependent variables $(\rho,\rho u,\rho v,\rho w,E)$ are smooth functions of the coordinates (t,x,y,z). This is not true, however, for the following types of C^0-discontinuities:
  - shock waves
  - contact discontinuities, slip discontinuities } contact-slip discontinuities (vortex sheets)

In time-dependent problems, the formation and evolution of these discontinuities have to be traced. The differential form of the conservation equations are not valid over C^0-discontinuities. Hence, the discrete conservation equations over C^0-discontinuities should simulate numerical analogs of the generalized Rankine-Hugioniot relations (see Jeffrey, (3-37)), describing the conservation of mass, momentum, and energy over (unsteady) C^0-discontinuities.

The numerical treatment of these discontinuities is based on two basically different approaches.

- Differencing over C^0-discontinuities (= shock capturing in the case of shock waves) is accepted, and the associated large consistency errors arising at the discontinuities are (partially) compensated for using so-called fully conservative schemes. Such schemes should prevent the build-up of large errors at discontinuities in quantities to be conserved (mass, momentum, energy).
- Differencing over C^0-discontinuities is (effectively) avoided, and the scheme needs only to be conservative within a certain approximation error $O(h^n)$, $n>1$. (For example, shock-fitting permits to follow this approach.)

Fully conservative difference schemes are characterized by the fact that, at each cell face, and for each quantity to be conserved, the outflux at the one side of the cell face is exactly equal to the influx at the other side; differencing over C^0-discontinuities may or may not be accepted in this concept.

Most authors in literature use fully-conservative capturing schemes, because these are considered simpler. Such schemes are usually found to give rise to smearing or dispersion effects (wiggles) at shocks, however. For that reason some authors advocate schemes avoiding differencing over C^0-discontinuities, e.g. Moretti, (3-30).

- Elimination of AV at C^0-discontinuities. The concepts of λ-schemes, flux-vector or flux-difference splitting leads in many cases to schemes producing steep shocks (over one to three meshes at most), without a sign of smearing or dispersion (wiggles) near the shocks (see, for example, Sells (3-16), Hancock-Van Leer (3-23), Chakravarthy-Osher (3-27)), Lombard-Oliger-Yang (3-28), and shocks over one mesh in Pandolfi-Zanetti (3-17), Dadone-Napolitani (3-32, 33)). In such schemes, AV is effectively switched off or reduced between two cells where an eigenvalue (characteristic speed) changes sign. Over the shocks, the schemes act as approximate algebraic Rankine-Hugoniot relations allowing discontinuity jumps between adjacent cell centres. The eigenvalue-sign change implies that the upstream differencing changes from $\pm$ direction into the opposite $\mp$ directions. Such switches reduce or eliminate at isolated points AV, and C^0-discontinuities tend to concentrate at such points.

- An important issue arising in connection with the proper numerical modelling of C^0-discontinuities is the use of limiters. Limiters may be defined to be procedures that limit gradients computed from grid functions, so that effectively the $O(h^{-1})$ gradients over C^0-discontinuities are not used in the conservation equations. At such discontinuities, one-sided differencing is in fact applied. Examples are the algebraic limiters proposed by Van Leer (3-20, 23), and Leonard (3-41), and the limiters introduced at shocks by eigenvalue-sign changes in upwind schemes. The use of these limiters seems thus to be more or less equivalent to avoiding differencing over C^0-discontinuities.

- Maintaining free-stream accuracy is of importance in flows where a coarse grid is used in regions where the ultimately steady flow is a slight perturbation of a uniform parallel flow. By this is meant that the difference schemes are designed such that the discrete steady uniform flow is an exact solution of the schemes. When the schemes do not have this property, substitution of the uniform flow may give rise to relatively large errors due to coarseness of the mesh. It is known how to design schemes maintaining free-stream accuracy, see for example Thomas-Lombard (3-42), Buning-Steger (3-18), Rizzi (3-7). The discrete steady-state solution should also be independent of the time discretisation; this requirement is sometimes overlooked.

- Stiffness is a property of an algebraic (non)linear equation system, that is of importance for the efficient solution of the system. It is generally associated with the ratio between the largest and the smallest moduli of eigenvalues of the Jacobian of the (non)linear equation system.
  It is usually possible to characterize stiffness in equivalent other notions involving large scale differences. In Euler-flow calculations, at least two major causes of stiffness may be identified: large ratios between largest and smallest cell sizes or mesh sizes, limiting via the CFL numbers the time step (in explicit methods, stability; in implicit methods, accuracy); and secondly, the sensitivity of many shock-capturing conservation equations to the interior numerical structure of smeared shocks.

- Steady-flow equations. In a few recent publications, the steady-flow equations are discretized to be solved by a time-independent iterative technique. Examples: Atkins-Hassan (3-15)(Newton iteration and Douglass-Gunn ADI approximate factorization), Johnson (3-43) ("Surrogate"-equation technique), Jespersen (3-44), Ni (3-45) (Newton and multigrid), and Bruneau e.a. (3-46).

- Padé difference operators. In a few recent papers (3-41, 47), 2nd-order accurate two-point upstream difference operators were used, that are known as rational Padé difference operators; for an extensive list of such operators, see Kopal in (3-48). These operators combine higher-order accuracy with smaller stencil sizes.

- Expansion shocks over sonic lines are usually prevented by applying proper switching or AV. Hence, the entropy inequality of the continuum equations is not explicitly used to enforce continuous flow over sonic lines. It is known, that the continuum Euler equations satisfy an entropy condition which can be formulated in integral form suitable for fully conservative numerical approximation: there exist scalar entropy functions

$$f(S) \,, \tag{3.2}$$

$$S = \rho\, \rho^{-\gamma} \,, \tag{3.3}$$

with $f(S)$ satisfying only very mild restrictions (see Harten, (3-39)), such that a conservation integral of $f(S)$ is always nonnegative, independent of time and space coordinates. The continuum conservation equations allow expansion shocks as solutions; however, the entropy integral inequality rules out these shocks.
  In some recent mathematical studies of continuum Euler flows, the entropy inequality is explicitly used, see e.g. (3-29) and (3-39).

3.4 Discretisation of boundary conditions

The discretisation of the conservation equations has to be modified at the boundaries, to incorporate discretisations of the boundary conditions.
The boundary conditions may be divided in three classes (broadly speaking):

- Conditions at solid walls (like aerofoils, wings, fuselages, windtunnel walls etc.). Usually, the normal velocity is put equal to zero, but when a boundary layer has to be matched, one would like to specify transpiration fluxes for mass, tangential momentum, and/or energy. When a steady flow has to be determined, the boundary conditions have ultimately to become steady.
  At solid surfaces with zero normal fluxes, various techniques are applied. In flux-vector and flux-difference methods, the waves are reflected against the wall in such a way that the boundary condition becomes satisfied, see Chakravarthy (3-34), Dadone-Napolitano (3-33), and Pandolfi-Zanetti (3-17), in particular. Special attention is sometimes needed to evaluate the pressure in the boundary condition, because it is unknown; the pressure may be evaluated using locally the unsteady normal momentum equation, see Rizzi (3-2, 7). Higher-order accuracy in the boundary conditions may be realized by using the known derivatives of the boundary conditions with respect to time, Chakravarthy (3-34).
- Conditions far away from the configuration, where free-stream conditions have to be approached when going to infinity, except possibly at downstream infinity behind shock waves, near convected vortex sheets, etc.. Asymptotic theory should be applied to evaluate the perturbation of the uniform flow. For super-sonic and subsonic free-stream flows, this theory leads to different types of results. In current applications, three different approaches may be identified.
  - The first few terms of an asymptotic expansion are explicitly used (see, for example, Sells (3-16), flow around aerofoil, far-field flow uniform plus circulation perturbation).
  - Differential operators are used to simulate the far-field flow (Bayliss-Turkel (3-43), Rudy-Strikwerda (3-50), Engquist-Mayda (3-51), Gustafsson-Kreiss (3-52)). These differential operators act as radiation conditions, selecting acceptable asymptotic expansions that represent only the physically relevant outgoing disturbances.
  - Characteristic theory is applied. When using flux-vector or flux-difference splitting or a λ-scheme, waves coming into the computational domain over the boundary are separated from the outgoing waves, and the incoming waves are prescribed to be those of the unperturbed far-field flow, see e.g. Chakravarthy (3-34).
- At influx and outflux boundaries, various types of boundary conditions are encountered depending on the problem (inlets, channels). Characteristic theory is usually applied to determine what boundary conditions should be applied to prevent over- or under-specification of the boundary conditions.

The theory of characteristics provides much insight how to specify well-posed boundary conditions. At each time level t on a boundary surface, there are two different types of characteristic manifolds: those carrying waves arriving at the boundary from previous times from the interior of the flow, and those carrying waves leaving the boundary to future times into the flow. Boundary conditions have to be such that waves leaving the boundary can be uniquely and stably defined from incoming waves and the boundary conditions. This approach can be applied at solid boundaries as well as boundaries with influx and outflux. See further in particular Chakravarthy (3-34), and Rai-Chaussee (3-35).

3.5 Initial conditions

Initial conditions for time-dependent approaches are often taken to be that of a uniform flow, see e.g. (3-2, 7 to 14, 16), or an approximation corresponding to a steady potential flow see e.g. (3-9).

When initial and boundary conditions are contradictory, (like in the case of an initial uniform parallel flow, and time-independent zero-flux boundary conditions on solid surfaces,) strong transient effects arise. When these effects have to be convected out of the desired final results, like in final steady states, such strong transient effects can better be avoided to obtain a faster convergence to a steady state. This may be realized by making initial and boundary conditions compatible. For example, the time-independent zero-flux boundary conditions may be replaced by compatible, initially time-dependent boundary conditions, see the "expanding-configuration" method and the "leaky-boundary" condition methods of Sells, (3-16).

3.6 Kutta conditions

The application of Kutta conditions at sharp edges of configurations is a matter of debate. Usually, a special boundary condition is not explicitly enforced at such edges (trailing edges of aerofoils and wings, sharp leading edges of delta wings), but it is not clear that this is appropriate, because in the continuum model the Kutta condition cannot be dispensed with, see the continuing discussions in e.g. (3-7, 10, 15, 16, 57). An appropriate numerical model is presented by e.g. Pandolfi-Zanetti in (3-17), and by Cambier-Ghazzi-Veuillot-Viviand in (3-5).

3.7 Numerical solution, (pseudo-)time evolution

The numerical (pseudo-)time evolution of the discrete model, if possible to a steady state, involves various numerical issues. Issues already mentioned are: 1st/2nd-order accuracy, explicit/implicit schemes, Newton(-like) iteration on implicit schemes, Runge-Kutta(-like) time stepping.

A much used technique is ADI approximate factorization. This technique is based on the use of sequences of time integrations, that are implicit at all grid points in one space-coordinate direction, and explicit in the other ones. The implicitly treated space-coordinate direction is cyclically exchanged with the other directions to achieve higher-order accuracy. ADI is usually considered to be a technique reducing an in-all-space-directions implicit scheme to a sequence of schemes implicit in only one space direction per iteration step; the associated sparse equation system of the overall implicit scheme is thereby simplified to small-banded systems, allowing simplified solution algorithms. For examples of ADI approximate factorization, see (3-11, 14-15, 18, 32,33).

For unsteady calculations aiming at a steady-state solution, a true time-evolution simulation is not necessary, and convergence speed-up is an important issue. The following techniques may be considered for improving the convergence rate.

- Local time stepping: at each cell, the local CFL-value is used to compute a local time-step value as large as stability and/or accuracy criteria allow. For applications, see e.g. (3-2, 7 to 10, 16). This is, in the continuum formulation, equivalent to the introduction of a new pseudo-time, depending on spatial coordinates and on the solution.
- Change from explicit to implicit schemes to increase or remove the CFL stability limits.
- Make initial conditions (often: uniform parallel flow) and ultimately steady boundary conditions compatible to avoid strong transient effects that are hard to convect and/or dissipate out of the computation (leaky-boundary concept, Sells (3-16), expanding-aerofoil concept, Sells (3-16)).
- Use a grid sequence, with grids arranged from coarse to fine, and apply successive grid refinement: precompute the numerical solution on progressively finer grids (see e.g. Sells (3-16), Rizzi (3-2)).
- Try multigrid ideas. Promising preliminary results have been reported by Jesperson (3-44), Stubbs (3-53)), Chima-Johnson (3-54), and Schmidt-Jameson (3-58).
- Replace the energy equation by its steady state solution. This reduces the size of the equation system. Examples of the use of this assumption are (3-2, 7,8). A review of such techniques has been presented by Viviand (3-55).

3.8 Consistency, stability, and convergence

The difference schemes should satisfy three major well-known criteria: consistency, stability, and convergence. These notions may be roughly described as follows. Consistency implies that each difference expression tends to a corresponding (differential) expression of the continuum model, when the mesh is decreased to zero. A difference equation system is stable if the linear first-variation problems of the equation system are well-posed (nonsingular), independent of the mesh size. A sequence of solutions of difference equation systems is convergent for decreasing mesh size, if the sequence of solutions tends to a solution of the continuum model. Consistency and stability may be shown to imply convergence, under certain general conditions (3-24).

These issues presuppose that the continuum analog of the numerical initial-boundary-value problem for the discrete Euler equations is well-posed: a solution should exist, and should be stable against (first-variation) perturbations in the initial data, boundary data, and the solution itself. Stability of the first-variation of the solution implies uniqueness of the solution, and thus e.g. absence of bifurcation problems.

What this requirement means for the problems encountered in aeronautical applications, where discontinuous features like vortex sheets, shock waves, and contact discontinuities occur, seems to be not clear. It is even not clear, that asymptotically steady solutions always exist in problems where the boundary conditions become time-independent. See the instabilities with vortex sheets in the analysis of (3-56), the various numerical stability experiments discussed by Salas (3-40) (stability of transonic flow over circular cylinder), and the stability of vortex cores, discussed by Hitzel e.a. in (3-13), and by Krause-Shi in (3-57). The well-posedness of many aeronautical initial-boundary-value problems for the Euler conservation equations is thus evidently an area of concern.

In view of this situation, it is difficult to present for numerical methods rigorous results about stability and convergence. For this reason, authors often resort to extensive numerical experimentation to analyse the stability and convergence issues; for example, solutions on successively finer grids are compared to each other, computational-domain sizes are varied, time steps are varid, AV coefficients are varied, etc..

3.9 Literature

3-1. Eriksson, L.E.: Practical three-dimensional mesh generation using transfinite interpolation, VKI Lecture Series 1983-04 (1983).
3-2. Rizzi, A., Eriksson, L.E.: Transfinite mesh generation and damped Euler equation algorithm for transonic flow around wing-body configuration, AIAA-81-0999 (1981).
3-3. Thompson, J.F., Warsi, Z.U.A., Mastin, C.W.: Boundary fitted coordinate systems for numerical solution of partial differential equations, a review, J. Comp. Phys. 47 (1982) 1-108.
3-4. Hessenius, K.A., Pulliam, T.H.: A zonal approach to the solution of the Euler equations, AIAA-82-0969 (1982).
3-5. Cambier, L., Ghazzi, W., Veuillot, J.P., Viviand, H.: Une approche par domaines pour le calcul d'écoulements compressibles, Comp. Methods Appl. Sc. and Eng., V, North Holland Publ. Comp. (1982) 423-446.
3-6. Wedan, B., South, J.C. jr: A method for solving the transonic full-potential equation for general configurations, AIAA-83-1889 (1983).
3-7. Rizzi, A.: Explicit multistage finite volume procedure to solve the Euler equations for transonic flow, VKI Lect. Series Notes 1983-04, VKI Inst., Brussels (1983).
3-8. Eriksson, L.E., Rizzi, A.: Computation of vortex flow around wings using the Euler equations, in: Proc. IV-th GAMM Conf. Num. Meth.s in Fluid Mech.s, Paris, Oct. 1983, Vieweg Verlag (1982).
3-9. Jameson, A., Schmidt, W. Turkel, E.: Numerical solutions of the Euler equations by finite-volume methods using Runge-Kutta time-stepping schemes, AIAA-81-1259 (1981).
3-10. Schmidt, W., Jameson, A., Whitfield, D.: Finite-volume solution for the Euler equations for transonic flow over airfoils and wings including viscous effects, AIAA-81-1265 (1981), Journ. Aircraft (Febr. 1983).
3-11. Pulliam, T.H., Jesperson, D.C., Childs, R.E.: An enhanced version of an implicit code for the Euler equations, AIAA-83-0344 (1983).
3-12. Chattot, J.J.: Numerical methods for three-dimensional inviscid flow computations, Proc. 10th IMACS Congr. Syst. Simulation and Sc. Comp. (1982) 185-188.
3-13. Hitzel, S.M., Schmidt, W.: Slender wings with leading-edge vortex separation, a challenge for panel methods and Euler codes, AIAA-83-0562 (1983).
3-14. Lerat, A., Sides, J., Daru, V.: An implicit finite-volume method for solving the Euler equations, ONERA rep. TP 1982-59 (1982), Lect. Notes Phys., vol. 170, Springer Verlag (1982) 343-349.
3-15. Atkings, H.L., Hassan, H.A.: Transonic flow calculations using Euler's equations, AIAA-82-0106 (1982).
3-16. Sells, C.C.L.: Solution of the Euler equations for transonic flow past a lifting aerofoil, RAE TR 80065 (1980).
3-17. Pandolfi, N., Zanetti, L.: A physical approach to solve numerically complicated hyperbolic flow problems.
3-18. Buning, P.G., Steger, J.L.: Solution of the two-dimensional Euler equations with generalized coordinate transformation using flux vector splitting, AIAA-82-0971 (1982).
3-19. Deese, J.E. : Numerical experiments with the split-flux-vector form of the Euler equations, AIAA-83-0122 (1983).
3-20. Van Leer, B.: Computational methods for ideal compressible flow, VKI Lect. Series Notes 1982-04, VKI Inst., Brussels (1983).
3-21. Van Leer, B.: Upwind differencing for hyperbolic systems of conservation laws, in: Numerical methods for engineering, ed.s. E. Absi, e.a. Durand, Paris (1980).
3-22. Van Leer, B.: Flux vector splitting for the Euler equations, Lect. Notes Phys., vol. 170, Springer Verlag (1982).
3-23. Van Albeda, G.D., Van Leer, B., Roberts jr., W.W.: A comparitive study of computational methods in cosmic gas dynamics, Astron. Astrophys. 108 (1982) 76-84.
3-24. Harten, A.: On a class of high-resolution total-variation-stable finite-difference schemes, DOE/ER/03077-176 rep., New York Univ. (1982).
3-25. Roe, P.L.: Approximate Riemann solvers, parameter vectors, and difference schemes, J. Comp. Phys., 43 (1981) 357-372.
3-26. Osher, S.: Numerical solution of singular perturbation problems and hyperbolic systems of conservation laws, in: Anal. and num. approaches to asympt. probl. anal., North-Holland Publ. Comp (1981) 179-204.
3-27 Chakravarthy, S.R. Osher, S.: Numerical experiments with the Osher upwind scheme for the Euler equations, AIAA-82-0975 (1982).
3-28. Lombard, C.K., Oliger, J. Yang, J.Y.: A natural conservative flux-difference splitting for the hyperbolic systems of gasdynamics, Lect. Notes Phys., vol. 170, Springer Verlag (1982).
3-29. Harten, A., Lax, P.D., van Leer, B.: On upstream differencing and Godunov-type schemes for hyperbolic conservation laws, ICASE rep. 82-5 (1982).
3-30. Moretti, G.: λ-scheme, Comp.s and Fluids 7 (1979) 191-205.
3-31. Daywitt, J.E., Srostowski, D.J.: A split coefficient/locally monotonic scheme for multishocked supersonic flow, AIAA-82-0289 (1982).
3-32. Dadone, A., Napolitani, M.: An implicit lambda scheme, AIAA-82-0972 (1982).
3-33. Dadone, A., Napolitani, M.: Efficient transonic flow simulation to the Euler equations, AIAA-83-0258 (1983).
3-34. Chakravarthy, S.R.: Euler equations, implicit schemes and implicit boundary conditions, AIAA-82-0228 (1982).
3-35. Rai, M.M., Chaussee, D.S.: New implicit boundary procedures: theory and applications, AIAA-83-0123 (1983).
3-36. Chakravarthy, S.R., Osher, S.: High resolution applications of the Osher upwind scheme for the Euler equations, AIAA-83-1943 (1983).
3-37. Jeffrey, A.: Quasilinear hyperbolic systems and waves, Pitman Publ., London (1976).
3-38. Yee, H.C., Warming, R.F., Harten, A.: A high resolution numerical technique for inviscid gasdynamic weak solutions, Lect. Notes Phys., vol. 170, Springer Verlag (1982).
3-39. Harten, A.: On the symmetric form of systems of conservation laws with entropy, ICASE Rep. 81-34 (1981), J. Comp Phys. 49 (1983) 151-164.
3-40. Salas, M.D.: Recent developments in transonic Euler flow over a circular cylinder, Proc. Vol. 1 10-th IMACS World Congres Syst. Sim. Sc. Comp (1982) 175-177.
3-41. Leonard, B.P.: A survey of finite differences with upwinding for numerical modelling of the incompressible convective diffusion equation, Ch. 1 in: Computational techniques in transient and turbulent flow, Pineridge Press Ltd. Swansea, U.K. (1981) 1-35.
3-42. Thomas, P.D., Lombard, C.K.: Geometric conservation law and its application to flow computations on moving grids, AIAA Journ. 17, 10 (1979) 1030-1037.
3-43. Johnson, G.M.: Relaxation solution of the full Euler equations, Lect. Notes Phys., vol. 170, Springer Verlag (1982).
3-44. Jespersen, D.C.: A multigrid method for the Euler equations, AIAA-83-0124 (1983).
3-45. Ni, R.H.: A multiple grid scheme for solving the Euler equations, AIAA-81-1025 (1981).
3-46. Bruneau e.a., in Lect. Notes Phys., vol. 170, Springer Verlag (1982) 161-166.

3-47. Warming, R.F., Beam, R.M.: Upwind second-order difference schemes and applications in aerodynamic flows, AIAA J. 14, 9 (1976) 1241-1249.
3-48. Kopal, Z.: Operational methods in numerical methods based on rational approximations, in On numerical approximation, Univ. Wisconsin Press (1959) 25-44.
3-49. Bayliss, A., Turkel, E.: Far-field boundary conditions for compressible flows, in: NASA CP 2201 (1981) 1-21.
3-50. Rudy, D., Strikwerda, J.C.: Boundary conditions for subsonic compressible Navier-Stokes calculations, J. Comp. Ph. 9 (1981) 327-338.
3-51. Engquist, B., Mayda, A.: Absorbing boundary conditions for the numerical simulation of waves, Math. Comp. 31 (1977) 629-651.
3-52. Gustafsson, B., Kreiss, H.-O.: Boundary conditions for time-dependent problems with an artificial boundary, J. Comp. Ph. 30 (1979) 333-351.
3-53. Stubbs, R.M.: Multiple-gridding of the Euler equations with an implicit scheme, AIAA-83-1945 (1983).
3-54. Chima, R.V., Johnson, G.M.: Efficient solution of the Euler and Navier-Stokes equations with a vectorized multiple-grid algorithm, AIAA-83-1893 (1983).
3-55. Viviand, H.: Pseudo-unsteady methods for transonic flow computations, Lect. Notes Phys., vol. 141, Springer Verlag (1981) 44-54.
3-56. Masaru Kiya, Mikio Arie: Helmholtz instability of a vortex sheet in uniform shear flow, Phys. Fl. 22(2) (1979) 378-379.
3-57. Krause, G., Shi, X.G., Hartwich, P.M.: Computation of leading-edge vortices, AIAA-83-1907 (1983).
3-58. Schmidt, W., Jameson, A.: Euler solvers as an analysis tool for aircraft aerodynamics, in: Advances in Comp. Transonics, ed. W.G. Habashi, Pineridse Press, Swansea, U.K. (to be published).

N.B. DESCRIPTION OF NUMERICAL METHODS OF CONTRIBUTORS
A description of the methods of the contributors to this AGARD report may be found in the appendices.

ACKNOWLEDGMENT The author is indebted to dr. A. Rizzi, FFA The Aeronautical Research Institute of Sweden, S-161 11 Bromma, Sweden, for discussions about a draft of this survey, and adding topics to be noticed.

4. EXACT SOLUTIONS TO TRANSONIC AND SUPERSONIC FLOWS (G. CHIOCCHIA)

INTRODUCTION

In this chapter a survey of the most important analytical solutions for transonic and supersonic flows is presented. Particular attention is paid to the transonic cases, where the presence of embedded supersonic regions of "a priori" unknown extension causes considerable difficulties to the numerical computations and raises the need for reference test cases.
Unfortunately, exact analytical transonic solutions are rare and not always adequate for checking practical cases. For this reason some approximate analytical solutions are also presented; in this case, however, the approximations must be well known in advance and their numerical effects must be limited. As a general standard of judgement, we exclude from this survey solutions in which the approximation consists in the replacement of partial differential equations by finite difference equations. We accept however closed form or series solutions for two or three cases of approximate equations whose validity fields are well established.
For a more extensive review of cases and methods, ref. [1] [14] [40] are suggested.

1. EXACT SOLUTIONS FOR TRANSONIC FLOWS

1.1 General considerations

Analytical solutions for compressible flows are particular integrals of the systems of equations (normally called Euler equations):

$$\begin{aligned} &\mathrm{div}(\rho\vec{q}) = -\frac{\partial\rho}{\partial t} \\ &-\frac{1}{\rho}\mathrm{grad}\,p = \frac{\partial\vec{q}}{\partial t} + \frac{1}{2}\mathrm{grad}\,q^2 + \mathrm{rot}\,\vec{q}\times\vec{q} \\ &\frac{\partial h_o}{\partial t} + \vec{q}\cdot\mathrm{grad}\,h_o = \frac{1}{\rho}\frac{\partial p}{\partial t} \end{aligned} \qquad (1.1.1)$$

completed by the state equation:

$$p = R\rho T \qquad (1.1.2)$$

In the (1.1.1) and (1.1.2) t is the time, $\vec{q}$ the velocity vector with (u,v,w) as cartesian components referred to a (x,y,z) reference frame, R the specific gas constant, ρ the density, p the pressure and h_o the total enthalpy per unit mass defined as:

$$h_o = c_p T + \frac{q^2}{2} \qquad (1.1.3)$$

c_p being the specific heat at constant pressure per unit mass and T the static temperature. Eqs. (1.1.1) and (1.1.2) are a system of six equations for the six unknowns u,v,w,ρ,p,h_o (or T); if suitable initial and boundary conditions are also assigned, the problem of the motion of a perfect gas with given geometrical constraints could be, at least from a theoretical standpoint, defined.
Unfortunately, we do not even know any approximate analytical solution to the full Euler equations, so that some restrictions must be accepted.
The first restriction is the steady flow assumption; then the local time derivatives $\partial/\partial t$ disappear from the (1.1.1).
The second restriction consists in assuming everywhere in the flow field:

$$\mathrm{rot}\,\vec{q} = 0 \qquad (1.1.4)$$

i.e. that the flow is irrotational. As it is well known, an important consequence of this assumption is that if h_o is assumed to be uniform in the whole flow field, the entropy must also be uniform. This conclusion is not compatible with the presence of finite extension shocks, or curved shock waves which, on the contrary are so often detected in actual transonic flows; as a consequence, any analytical solution based on the (1.1.4) in which shock waves are present must be considered as being only approximate.
However, if the component M_n normal to the shock of the upstream Mach number is sufficiently close to unity, the approximation can be very good, the typical error being of the order of $(M_n^2-1)^3$ (see p.e. ref. [1]).
If the (1.1.4) is satisfied, a potential function $\Phi(x,y,z)$ can be introduced:

$$\Phi_x = u \; ; \qquad \Phi_y = v \; ; \qquad \Phi_z = w \tag{1.1.5}$$

so that Eqs. (1.1.1) and (1.1.2) can be condensed in an unique second order non linear partial differential equation:

$$(1 - \frac{u^2}{c^2})\Phi_{xx} + (1 - \frac{v^2}{c^2})\Phi_{yy} + (1 - \frac{w^2}{c^2})\Phi_{zz} - 2\frac{uv}{c^2}\Phi_{xy} - 2\frac{vw}{c^2}\Phi_{yz} - 2\frac{uw}{c^2}\Phi_{xz} = 0 \tag{1.1.6}$$

where c is the local sound speed.
It is not encouraging to observe that even this simplified equation is untractable because of its non linearity; on the other hand no transformation has been developed at this date to reduce the (1.1.6) to a linear equation in the general 3-D case. A consequence is the almost absolute absence of 3-D analytical solutions for potential flows; the case quoted later in sect. 1.4 is not in contradiction to this, this case to be regarded more as a superposition of known 2-D solutions than a true 3-D flow extracted from Eq. (1.1.6).
The third restriction consists therefore in the limitation to two-dimensional flow fields. In this case a stream function $\Psi(x,y)$ can be easily defined so that:

$$\Psi_x = -\frac{\rho}{\rho_r}v \qquad\qquad \Psi_y = \frac{\rho}{\rho_r}u \tag{1.1.7}$$

where ρ_r is an arbitrary reference value for ρ.
Eq. (1.1.6) reduces then to its 2-D form:

$$(1 - \frac{u^2}{c^2})\Phi_{xx} - 2\frac{uv}{c^2}\Phi_{xy} + (1 - \frac{v^2}{c^2})\Phi_{yy} = 0 \tag{1.1.8}$$

and an identical equation can be written for $\Psi(x,y)$:

$$(1 - \frac{u^2}{c^2})\Psi_{xx} - 2\frac{uv}{c^2}\Psi_{xy} + (1 - \frac{v^2}{c^2})\Psi_{yy} = 0 \tag{1.1.9}$$

Eqs. (1.1.8) and (1.1.9) are simpler than Eq. (1.1.6) but still non-linear. Their reduction to a linear form can only be performed if the flow field is not only two-dimensional but also planar, and this is the case we choose to start.

1.2 2-D planar potential flows

1.2.1 The hodograph transformation method

If the velocity q and its deviation θ with respect to a reference direction are assumed as independent variables instead of x and y, Eqs. (1.1.8) and (1.1.9) can be linearized in the planar case. This is tantamount to solving the problem in the (q,θ) plane instead of in the (x,y) one; since the first is known as "hodograph plane" this procedure is called "hodograph method".
Two ways can be followed to apply it. The first one is the classical Legendre transformation [2]. If it is applied to (1.1.8) the Legendre potential transform is defined as:

$$\Omega(u,v) = xu + yv - \Phi \tag{1.2.1}$$

Then (1.1.8) takes the linear form:

$$q^2\Omega_{qq} + q\,(1 - \frac{q^2}{c^2})\Omega_q + (1 - \frac{q^2}{c^2})\Omega_{\theta\theta} = 0 \tag{1.2.2}$$

in which the change from (u,v) to (q,θ) has been already accounted for, so that the sought function is now $\Omega(q,\theta)$.
A fully similar equation can also be obtained from Eq. (1.1.9). The main shortcoming of the Legendre transformation method is that the boundary conditions for Ω cannot be easily identified. For this reason the Molenbrock - Tschapligin [3][4] transformation is more frequently used, in which the original functions Φ and Ψ are retained.
Applying it to Eq. (1.1.9) leads to the equation:

$$q^2\Psi_{qq} + q(1 + \frac{q^2}{c^2})\Psi_q + (1 - \frac{q^2}{c^2})\Psi_{\theta\theta} = 0 \tag{1.2.3}$$

Eqs. (1.2.2) and (1.2.3) are similar to each other, so we can concentrate our attention solely to (1.2.3). The most general known solutions are obtained by separation of the variables q and θ. By introducing the quantity:

$$\tau^* = (\frac{q}{q_{lim}})^2 \tag{1.2.4}$$

where q_{lim} is the limiting speed of the stream, a class of solutions of Eq. (1.2.3) is:

$$\psi_\nu(\tau^*,\theta) = \tau^{*\nu/2}\, F_\nu(a_\nu, b_\nu; \nu+1; \tau^*)e^{i\nu\theta} \tag{1.2.5}$$

where only the real or the imaginary part of the right hand side is retained and F_ν is the hypergeometric function.
The parameters a_ν and b_ν are given by:

$$a_\nu + b_\nu = \nu - \frac{1}{\gamma-1} \; ; \qquad a_\nu b_\nu = -\frac{\nu(\nu+1)}{2(\gamma-1)} \tag{1.2.6}$$

with $\gamma = c_p/c_v$. The quantity ν is the variable separation constant and can be arbitrarily chosen (only negative integer values of ν must be separately considered).
Because of the linearity of Eq. (1.2.3), solutions like (1.2.5) can be summed to build more general solutions. The F_ν's are convergent series for $q<q_{lim}$, i.e. on the whole flow field (only for $q = q_{lim}$ the convergence is not assured); the idea to obtain general solutions by considering the infinite series:

$$\psi = \sum_\nu c_\nu \psi_\nu \qquad (1.2.7)$$

was developed by Lightill [5]. The goal is to find proper values of the coefficients c_ν, so that the conditions imposed to the flow can be satisfied. In some cases (profile flows are the most important ones) singularities in the hodograph plane must be considered: then one or more functions satisfying (1.2.3) and displaying these singularities have to be added to (1.2.7).
Unfortunately, the convergence of the single series (1.2.5) does not imply that of the (1.2.7), which has to be proved each time; analytical continuations can then result to be necessary in certain flow regions. Moreover, the convergence of (1.2.7), even if proved, can be very slow; this causes numerical difficulties which can more than offset the advantage of the theoretical exactness.
To find a solution of Eq. (1.2.3) is only one of the necessary steps: the next step is the transfer of the solution from the hodograph to the physical plane. This transfer can be unsuccessful, at least in the supersonic region, if two "limit lines" appear on the (x,y) plane, separating a region in which the streamlines turn back and cross themselves. This is usually represented by means of a three - folded Riemann surface. This behaviour is physically unrealistic, and the solution must be rejected (see Fig. 1). However, if allowed by the nature of the problem, a part of the solution can be retained by choosing a particular streamline as rigid wall, so that the limit lines fall in the region occupied by the body.
This approach is called the "indirect method" and consists in solving the equations on the hodograph plane and obtaining the flow field on the physical plane together with the shape of the boundaries (which are therefore part of the solution itself).
In contrast to this, the "direct method" consists in imposing the physical constraints on the physical plane and determining the related flow. As it can be expected, most exact solutions have been found by means of the indirect method, which is basically simpler.

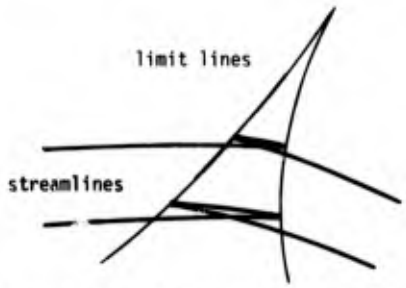


Fig. 1 - Limit lines on the physical plane

1.2.2 Exact solutions and fictitious gas models

To avoid the difficulties of solutions like (1.2.7), some modifications have been introduced into Eqs. (1.2.2) or (1.2.3) so that a solution in closed form becomes possible.
Let us work with Eq. (1.2.3). By referring q and ρ to their critical values, a new independent variable can be defined:

$$\sigma = \int_q^1 \rho \frac{dq}{q} \qquad (1.2.8)$$

Eq. (1.2.3) can then be shown to take the form [1]:

$$k(\sigma)\psi_{\theta\theta} + \psi_{\sigma\sigma} = 0 \qquad (1.2.9)$$

where:

$$k(\sigma) = \frac{1}{\rho^2}\left(1 - \frac{q^2}{c^2}\right) \qquad (1.2.10)$$

The behaviour of $k(\sigma)$ depends on the pressure - density relationship, which, for a real gas is given by the Poisson adiabatic law. The fictitious gas method consists in substituting $k(\sigma)$ through a suitable approximate function, so that Eq. (1.2.9) can be solved in closed form. The resulting solution can be interpreted as describing the motion of a fictitious gas whose adiabatic law is not that of Poisson, but the one which can be derived from the chosen approximated form of $k(\sigma)$. A comparison of the adiabatic behaviour of the real and of the fictitious gas provides a test for the validity of the method.
The advantage of this procedure is that only the error in $k(\sigma)$ is introduced, which is well known in advance; on the other hand, this is only justified if the remainder of the computation is rigorously analytical, so that additional numerical error generation is avoided.
Two approximate forms for $k(\sigma)$ are most widely used.
The Tricomi approximation is linear [6]:

$$k_T(\sigma) = (1 + \gamma)\sigma \qquad (1.2.11)$$

An equivalent form for (1.2.11) can be determined in the physical plane (see p.e. [1] pp. 54 to 59) and leads to the approximate equation:

$$[1 - M_\infty^2 - (\gamma + 1)\phi_x]\phi_{xx} + \phi_{yy} = 0 \qquad (1.2.12)$$

where ϕ is the perturbation potential given by $\phi = \Phi - q_\infty x$. Eq. (1.2.12) has been independently derived [8] assuming that the deviation of the local Mach number from the unit value is everywhere small; for this reason Eq. (1.2.12) is also called the "transonic perturbation" equation.
The Tomotika - Tamada approximation is exponential [7]:

$$k_{TT}(\sigma) = \left(\frac{2}{\gamma+1}\right)^{\frac{2}{\gamma-1}} \cdot (1 - e^{-2\delta\sigma}) \qquad (1.2.13)$$

with

$$\delta = \left(\frac{\gamma+1}{2}\right)^{\frac{\gamma+1}{\gamma-1}}$$

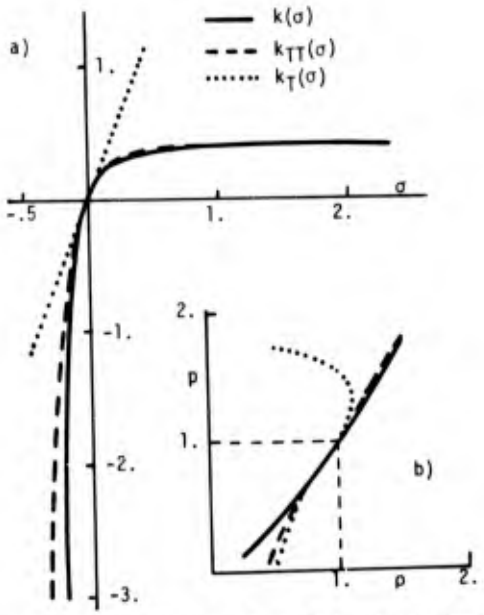


Fig. 2 - Comparison of the Tricomi and Tomotika-Tamada approximate gas laws to the real one; 2a): functions $k(\sigma)$; 2b): pressure-density relationship.

The comparison of $k_T(\sigma)$ and $k_{TT}(\sigma)$ to the real gas function $k(\sigma)$ is given in Fig. 2a. It can be seen that all three functions give the same (exact) value at $\sigma = 0$, i.e. at the sonic conditions. However, whereas $k_T(\sigma)$ is a good approximation of $k(\sigma)$ only in a small neighbourhood of $\sigma = 0$, $k_{TT}(\sigma)$ approximates $k(\sigma)$ closely in the whole subsonic region ($\sigma > 0$) and also in part of supersonic region. It can be evaluated that the Tomotika - Tamada law provides a good approximation if the local Mach number is everywhere lower than 1.2 ÷ 1.3.
A further comparison is given in Fig. 2b where the curves $p = p(\rho)$ are plotted for the two quoted approximations and for the real case $p = \rho^\gamma$.
Fictitious thermodynamic laws relating the pressure to the density and to the internal energy, that is to say in the form required for the full Euler equations, can be associated to a given $k(\sigma)$ law in such a way that the solution of Eq. (1.2.9) is also a solution of the full Euler equations for these fictitious thermodynamic laws [9].

1.2.3 Cases of fully exact analytical solution

As already mentioned (sect. 1.1) these cases can only be related to smooth transonic flows, i.e. shockless flows. A consequence is that the undisturbed stream Mach number M_∞ must be less than one to avoid the bow wave in front of the leading edge of the body.
It should, however, be recalled here that even the existence of a stable steady smooth transonic flow around an obstacle is still a matter of discussion and no definitive answer to this question has been given as yet in spite of the contributions of many Authors [10] [11] [1] [12] [13] [14]. The smooth flow cases , quoted here, therefore, can be unstable if small disturbances (as numerical errors) are introduced. These flows can also be regarded as exceptional cases in which a favorable interference prevents the reflection of the waves at the sonic line to form a shock [15].

1.2.3.1 Source, vortex and doublet flows

These flows have been exactly solved in [16] [17] [18]. Their utility as test cases for computer codes is limited, but more complicated flows can be constructed via superposition starting from them: an example is the Greitzer flow, see sect. 1.4.
A characteristic feature of a compressible source, vortex or doublet is a circular central region (not present in the incompressible case) in which no flow is possible.

1.2.3.2 Ringleb's flow [18]

When ν in the (1.2.5) is a negative integer, F_ν is a logarithmically modified hypergeometric function. The case $\nu = -1$ is notable in that F_{-1} is an elementary function; in this case the streamlines on the hodograph plane have the simple form:

$$\psi = \frac{1}{\bar{q}} \cdot \sin\theta \qquad (1.2.14)$$

In this and in the following relations, $\bar{q}$, $\bar{c}$ and $\bar{\rho}$ are referred to the stagnation values of sound speed and density respectively.
The flow on the physical plane corresponding to the (1.2.14) has streamlines given by the simple relations:

$$x = \frac{1}{2}\,\frac{1}{\bar{\rho}}\left(\frac{1}{\bar{q}^2} - \frac{2}{k^2}\right) + \frac{J}{2}$$

$$y = \pm \frac{1}{k\bar{\rho}\bar{q}}\sqrt{1 - \left(\frac{\bar{q}}{k}\right)^2} \qquad (1.2.15)$$

where:

$$k = 1/\psi \qquad \text{constant on every streamline}$$

$$J = \frac{1}{\bar{c}} + \frac{1}{3\bar{c}^3} + \frac{1}{5\bar{c}^5} - \frac{1}{2}\lg\frac{1+\bar{c}}{1-\bar{c}}$$

$$\bar{c} = \sqrt{1 - \frac{\gamma-1}{2}\bar{q}^2} \qquad (1.2.16)$$

$$\bar{\rho} = \bar{c}^{\,2/(\gamma-1)}$$

The constant velocity lines are circles given by:

$$\left(x - \frac{J}{2}\right)^2 + y^2 = \frac{1}{4\bar{\rho}^2\bar{q}^2} \qquad (1.2.17)$$

where the sonic line is also obtained if the critical values of $\bar{\rho}$, $\bar{q}$ and J are used.
The flow pattern is shown in Fig. 3: a curved stream around an obstacle is envisaged. The streamlines are symmetrical with respect to the x-axis and their shape tends to become parabolic far from the body. By choosing two streamlines and regarding them as rigid walls, the flow in a curved duct with and without a supersonic region can also be obtained.
If $k > 4/(\gamma+1)$, limit lines appear and no realistic streamlines are described by the (1.2.15) and (1.2.16); for $k = 4/(\gamma+1)$ the streamline has two points with infinite curvature. The regular flow is therefore only possible if $k < 4/(\gamma+1)$.

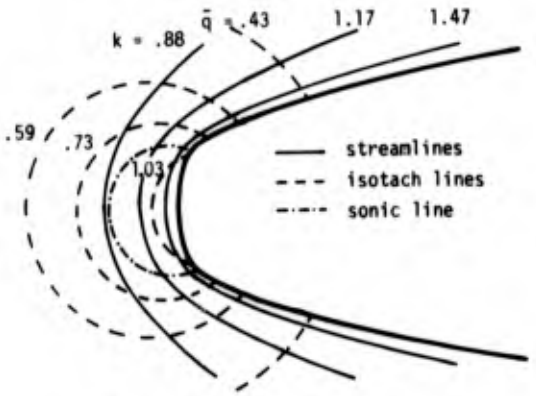


Fig. 3 - Ringleb's flow

1.2.3.3 Cherry's cylinder flow [19] [20] [21]

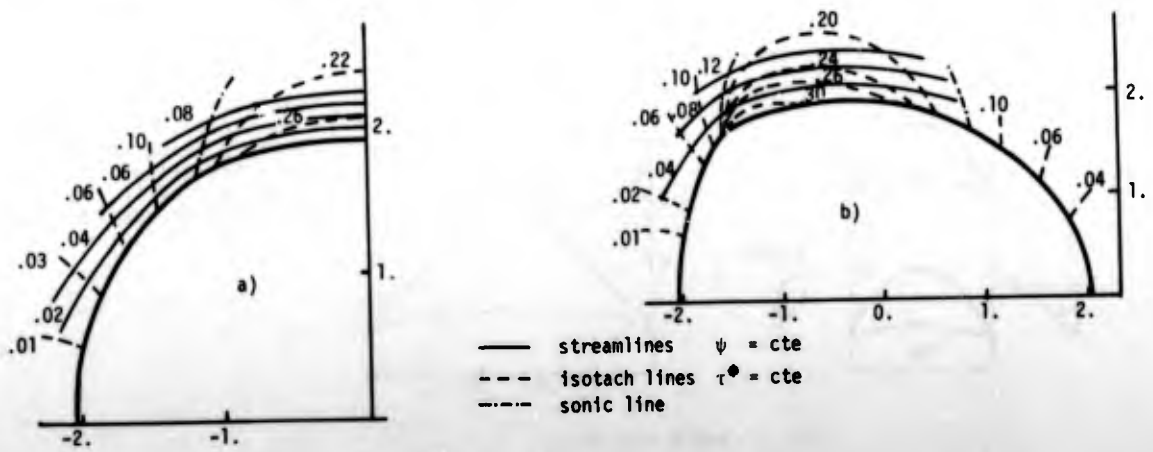


Fig. 4 - Cherry's cylinder flow, $M_\infty = 0.509$. a) symmetric; b) unsymmetric

T.M. Cherry determined a solution of the same kind as (1.2.7) to Eq. (1.2.2) by transforming the well known incompressible flow around a circular cylinder into a compressible flow around a cylindrical body whose section is no longer circular. The work of Cherry involves complex analysis and no detailed formulae can be given here. The solution is given in the form of series: their convergence is proved, but it becomes slower and slower as the line $q = q_\infty$ is approached.
The results of Cherry for $M_\infty = 0.509$ are reproduced in Fig. 4a. By superposing other solution like (1.2.5) to them, different flow patterns can be obtained: one is reported in Fig. 4b, also for $M_\infty = 0.509$. If the value of M_∞ is increased, limit lines appear; in addition to this, the series become difficult to compute because of the growing extension of the slow convergence region.

1.2.3.4 The NLR airfoils

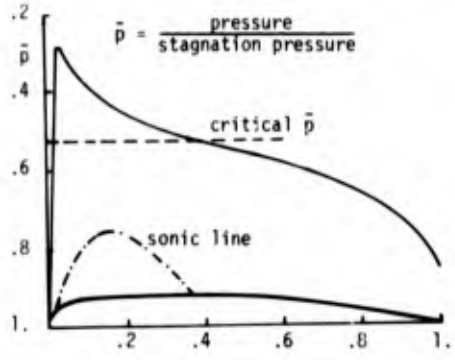


Fig. 5 - Niewland's airfoil 0.1-.675-1.6
$M_\infty = 0.745$

By developing the basic methods outlined in Sect. 1.2.1, the Dutch school was able to produce a set of transonic airfoils which can also have the property (rare in exact transonic solutions) of producing lift.
Two techniques have been used. Niewland's quasi-elliptical profiles [22] were obtained by transforming incompressible flow patterns where some parameters could be varied to a certain extent, so that an airfoil shape resulted. Fig. 5 shows one of these cases.
In the technique of Boerstoel-Huizing [23] a hodograph image transformation method was adopted, where the starting point was the image of the airfoil on the hodograph plane (see also [25]). The NLR 7301 airfoil extensively described in Chapt. 5 belongs to this family. Other NLR airfoils can be found also in [24][26].
Both Niewland's and Boerstoel-Huizing's methods develop convergent series solutions and combine them, so satisfying our requirement for analytical solutions. Other well known reliable examples of profile flows exist, where a large amount of analytical work is present, as those of Bauer-Garabedian-Korn [27][28]; however, unlike the NLR airfoils, a significant part of the design procedure is performed by means of numerical finite difference methods and therefore they are not considered in this survey.

1.2.3.5 An inner flow: Cherry's nozzle [29][30][31]

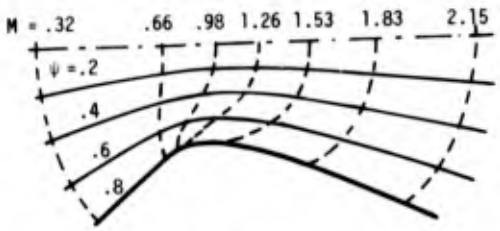


Fig. 6 - Cherry's nozzle

Some particular nozzle flows have been exactly computed by T.M. Cherry, who used similar procedures as those quoted in Sect. 1.2.3.3. A result is given in Fig. 6.

1.2.3.6 A cascade flow: the Hobson cascade [32]

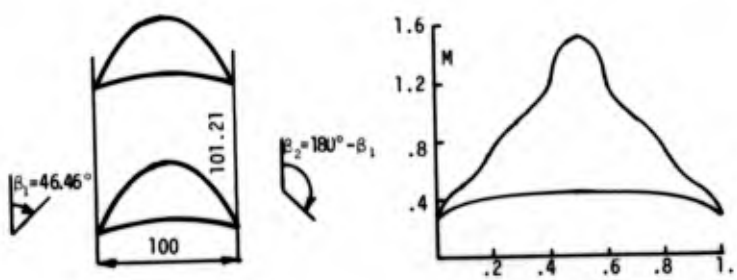


Fig. 7 - Hobson cascade

Two cascade flows have been computed by D.G. Hobson applying a hodograph image transformation method; one of them is reproduced in Fig. 7, but more details can be found in Chapt. 5.

1.2.3.7 A flow with shock: Chattot's double wedge [33]

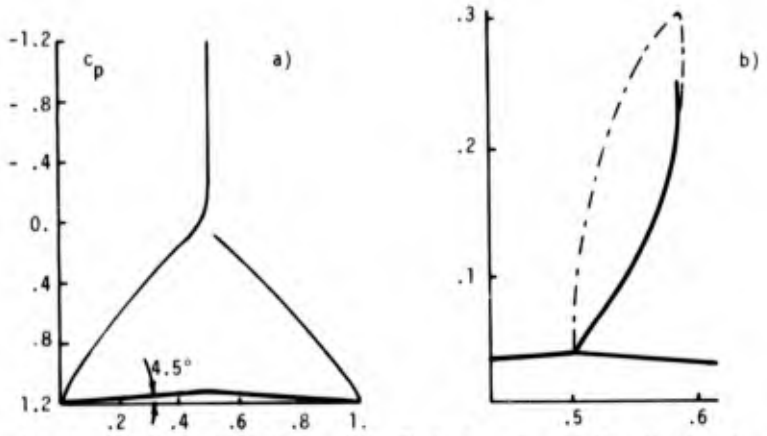


Fig. 8 - Double wedge with shock by Chattot. a) c_p - distribution for M_∞ = 0.89; b) detail of the shock region

Although it is not rigorously exact (the shock is assumed to be isentropic), this solution is considered here because no approximate gas law is used. Moreover, the value of the Mach number in front of the shock is 1.05, i.e. close enough to unity, so that the error can be neglected.
Chattot obtained this solution by reducing Eq. (1.2.3) to a system of ordinary differential equations; to do this, solutions of Eq. (1.2.3), suitably transformed, were examined in the form of trigonometric polynomials. The results shown in Fig. 8a,b are for a 4.5° half-wedge angle and for M_∞ = 0.89

1.2.4 Cases of fictitious gas analytical solutions

Cases are quoted in this section for which no exact real gas solution exists. As a rule, the Tomotika-Tamada cases are first given, followed by those based on the Tricomi (or equivalent) gas law.
If shock waves are present, the same considerations as in Sect. 1.1 and 1.2.3.7 hold, i.e. M_n must be close to unity, so that no meaningful additional error source affects the solution. In some cases an overall error assessment across the shock has also been performed.

1.2.4.1 Subsonic upstream flow ($M_\infty < 1$)

Two profile flows are considered here, both based on the Tomotika-Tamada approximation: the first one is smooth, the second displays a shock wave.

1.2.4.1.1 The profiles of Tomotika and Tamada [7]

Eq. (1.2.9) through the substitution of $k(\sigma)$ by $k_{TT}(\sigma)$ leads to exact solutions. By superposing two of them, Tomotika and Tamada derived a family of symmetrical profiles at zero incidence, whose shapes depend slightly on the value of M_∞. One case is given in Fig. 9; two features characterize these airfoils:
- a sharp leading edge with a fixed half-angle of 19.2°;
- a cusped trailing edge with smooth outflow.

If the limiting value M_∞ = 0.752 is exceeded, limit lines appear and the regular flow is no longer possible.

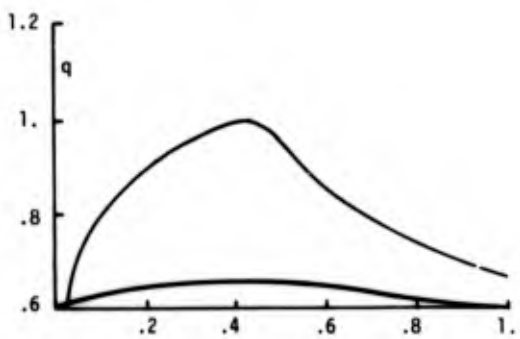


Fig. 9 - Tomotika-Tamada profile for M_∞=0.717: velocity distribution and profile shape

1.2.4.1.2 The profiles of Chiocchia and Nocilla [36]

These profiles are the extension of those of Tomotika and Tamada to the case $M_\infty > 0.752$. A first effort was made by Nocilla [34][35] by means of a local use of the Tricomi approximation confined to the shock region; separate streamfunctions to be matched to each other were also sought. The method has been simplified in [36] where the shock was suitably inserted at the locus of the self-intersections of the stream-lines to avoid the multivalued region produced by the limit lines. An independent test on the fulfillment of the Rankine-Hugoniot conditions across the shock shows errors not exceeding 1÷2% in the meaningful cases.

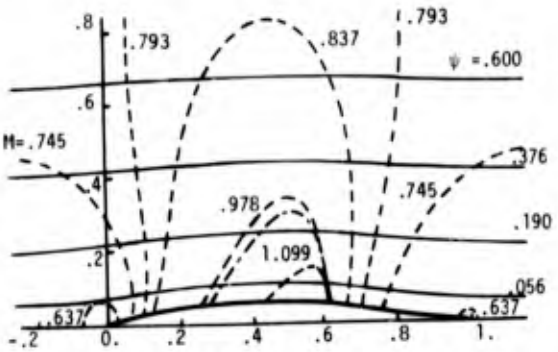


Fig. 10 - Chiocchia-Nocilla profile for M_∞=0.769: flow field and profile contour

An example is given in Fig. 10: the profile features are the same as in Sect. 1.2.4.1.1, but also a slope discontinuity is now present; the corresponding angle amounts to 1÷3°.

1.2.4.2 Sonic upstream flow (M_∞ = 1.)

When the undisturbed stream is precisely sonic some important simplifications take place. From the mathematical standpoint, if the Tricomi approximation is used Eq. (1.2.12) takes a simpler form for M_∞ = 1; more generally, however, the whole flow structure becomes easier to handle. This is due to the existence of a "limiting Mach wave", i.e. a characteristic line starting on the body and meeting the sonic line at infinity. The downstream flow is supersonic and cannot influence the region in front of the limiting Mach wave; it can therefore be solved independently (p.e. by means of the standard method of the characteristics) for different shapes of the tail of the body.
At the trailing edge a shock wave must be expected; however, this does not influence the already computed pressure distribution on the profile.

1.2.4.2.1 Nocilla's sonic profiles

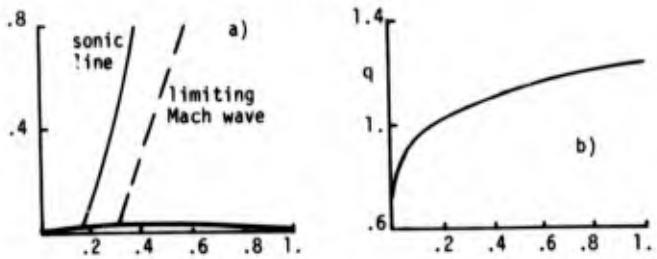


Fig. 11 - Sonic airfoil by Nocilla: a) flow field; b) velocity distribution on the profile

By extending the class of the exact solutions in the Tomotika-Tamada approximation, S. Nocilla [37][38] derived a family of profiles for M_∞ = 1 with a free parameter. One case is reported in Fig. 11; detailed results can be found in [39].

1.2.4.2.2 Guderley's sonic profiles [40]

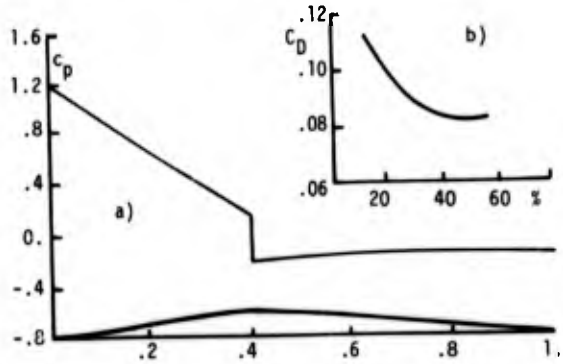


Fig. 12 - Guderley sonic profile 10% thick; a) c_p - distribution with maximum thickness at 40% of the chord; b) variation of the drag coefficient with the position of max. thickness

This family of profiles, whose leading edges are cusped and whose maximum thickness position along the chord can be chosen, have been obtained in the Tricomi approximation. Working with the method of the characteristics, Guderley determined also the tail shape giving the minimum drag; Fig. 12 shows a result. Owing to the necessity of a Prandtl-Meyer expansion to minimize the drag, the obtained shapes present a slope discontinuity at the junction of the front and the rear part (i.e. at the startpoint of the limiting Mach wave).

1.2.4.2.3 Sobieczky's sonic profiles

Both Nocilla's and Guderley's cases are not able to produce lift. By rearranging the hodograph equation as previously suggested by Busemann [41], H. Sobieczky [42][43] obtained a Beltrami equation which could be solved through the consideration of certain special curves called "rheographs". A family of profiles, which can also be lifting, was then derived in an approximation fully equivalent to the Tricomi one. Fig. 13 shows the profile shape, characterized by a cusped leading edge and by a sharp trailing edge. Thickness, camber and incidence can be changed but not independently from one another; the direction of the free stream coincides with the tangent to the cusped leading edge (something like the "ideal incidence" of the theory of the thin airfoils in incompressible flow). In [43] very simple closed form relations are given, so that the profile shapes, the pressure coefficient distributions and the lift coefficients can be easily worked out.

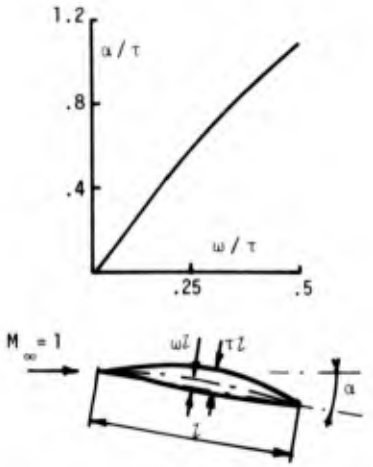


Fig. 13 - Sonic profile by Sobieczky: geometry

1.2.4.2.4 The double wedge at incidence of Guderley and Yoshihara [45]

The flow over a double wedge has been studied by Guderley and Yoshihara [44] in the Tricomi approximation neglecting the shock wave which necessarily occurs at the shoulder of the profile (see p.e. Fig. 8). This second assumption is a significant one, but if $M_\infty = 1$, it does not invalidate the computation of the flow over the upstream wedge because the limiting Mach wave arises also at the shoulder. At zero incidence [44] these results are overcome by the more exact ones of Chattot (see Sect. 1.2.3.7), which, moreover, are not limited to the sonic upstream case. However, the quoted authors were able in a later work [45] to extend their results to the case in which a small angle of incidence is present. This was done by means of a perturbation procedure; the results without incidence and the correction due to an angle of 1° are shown in Fig. 14 for a 10% thick profile.

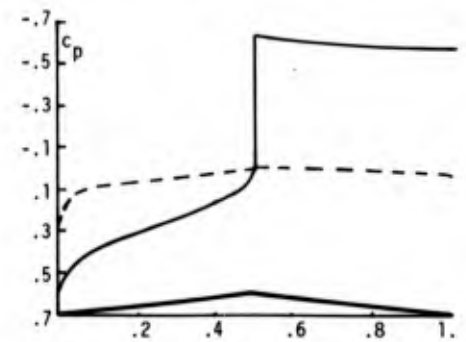


Fig. 14 - Double wedge by Guderley and Yoshihara. Full line: without incidence; dashed line: c_p-correction due to $\alpha = 1°$

1.2.4.3 Supersonic upstream flow ($M_\infty > 1$)

Only cases where a bow wave occurs, followed by a subsonic region and, further downstream, by a recompression, are considered in this section. Cases without a subsonic region pertain to the fully supersonic flows (Sect. 2).
These flows are difficult to study; there is still, however, a limiting Mach wave, so that the downstream flow cannot influence the subsonic region and can be separatly studied.

1.2.4.3.1 Nocilla's airfoil flow [46]

The profile belongs to the family quoted in Sect. 1.2.4.2.1 but with $M_\infty = 1.11$, where the Tomotika-Tamada approximation is still retained. The results are given in Fig. 15a,b: the computations have been terminated when the limiting Mach wave on the profile was reached. The given solution is rigorous if a very slight non uniformity in the undisturbed flow is accepted; if not, a small error in the fulfillment of the shock conditions (which have been rederived for the Tomotika-Tamada gas) occurs. The evaluation of this possible error is also performed in [46].

1.2.4.3.2 Sobieczky's extension to $M_\infty > 1$ of Guderley's airfoils [47]

By further exploiting the methods developed in [42][43], the flow past a Guderley profile (see Sect. 1.2.4.2.2) was computed in an approximation equivalent to the Tricomi one and for a $M_\infty > 1$ given by:

$$M_\infty = 1. + .836[(\gamma + 1)\tau]^{-2/3} \qquad (1.2.18)$$

where τ is the thickness ratio and the factor 0.836 refers only to the presented results. These are given in Fig. 16: they have been scaled for a 10% thick profile, so that $M_\infty = 1.15$.

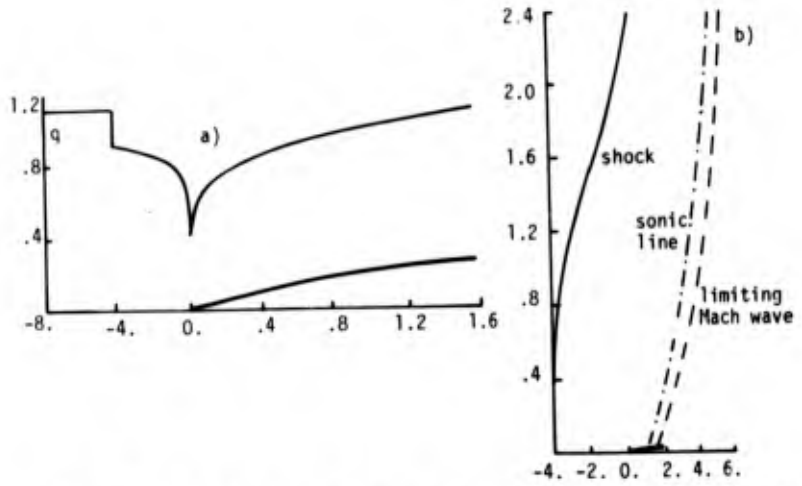


Fig. 15 - Nocilla's airfoil for $M_\infty = 1.11$; a) detail of the leading edge with velocity distribution (pay attention to the different scales for and behind the leading edge!); b) flow field

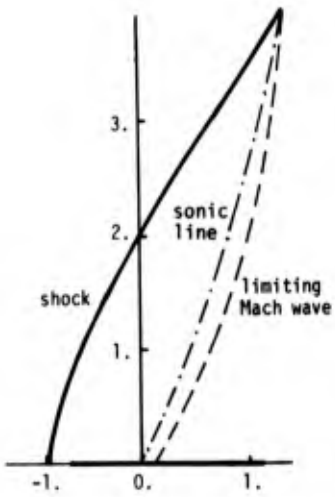


Fig. 16 - Sobieczky's profile for $M_\infty > 1$: flow field for $\tau = 0.10$ ($M_\infty = 1.15$)

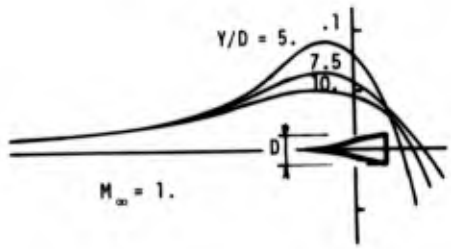


Fig. 17 - Body of revolution by Guderley and Yoshihara: c_p-distribution for three different distances from the axis

1.3 2-D axisymmetric flows

If the 2-D flow is not planar, the hodograph method can still be used but it no longer leads to the linearisation of Eq. (1.1.6) and its main advantage is lost.
Guderley and Yoshihara [48] determined the flow with $M_\infty = 1$ past a revolution body by means of the Tricomi approximation and looking for a perturbation potential in the form:

$$\phi(X,Y) = Y^{3n-2} f(\zeta) \qquad (1.3.1)$$

where $\zeta = (\gamma + 1)^{-1/3} X Y^{-n}$

In (1.3.1) X and Y are the coordinates in a meridian plane.
Such a flow has been called "homogeneous" by Guderley [40]; its assumption reduces the potential equation to an ordinary differential equation for $f(\zeta)$. In [47] this equation was numerically solved and solutions were found for $n = 4/7$; some results are in Fig. 17. This value of n was later confirmed by Fal'kowich and Chernow [49], by Müller and Matschat [50] and by Randall [51]: all Authors derived simple closed form solution for $f(\zeta)$.

1.4 3-D transonic flows: Greitzer's swirling flow [52]

This solution has been obtained by superposing a uniform strem to a vortex-source as shown in Fig. 18. The result is a swirling flow in an annular duct; the projection of a streamline on a meridian plane is also represented in Fig. 18 for two cases, i.e. with a certain amount of swirl and without it. A minimum distance from the axis exists, at which the radial Mach number (due to the source) reaches unity; nearer to the axis no flow is possible.
The Greitzer flow, owing to its construction, is irrotational. It is however possible to use its streamlines to describe a rotational flow in which the stagnation enthalpy varies from streamline to streamline but remains constant along each of them; as a consequence the velocity field is altered. This possibility is a very interesting feature of this flow.
The formulae given in [52] have been obtained in closed form for $\gamma = 1.4$, but other values of γ should also allow this.

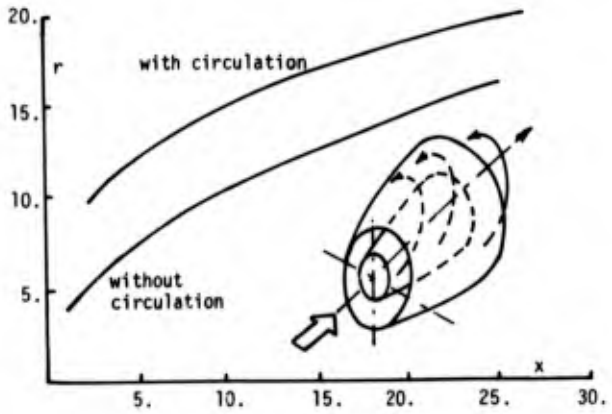


Fig. 18 - Greitzer's swirling flow: streamline shape in a meridional plane

2. EXACT SOLUTIONS FOR SUPERSONIC FLOWS

Fully supersonic flow fields have the advantage, if compared to the transonic ones, to be everywhere hyperbolic and therefore, in principle at least, can be solved by means of the method of the characteristics.
However, curved shock waves occur frequently, p.e. when an expansion fan from a wedge meets an already existing shock. In these cases an amount of rotationality is introduced in the flow field, which cannot be neglected when the Mach numbers are high. Although the exact computation is also possible (see p.e. [53] Chapt. V), it is much more complicated.
We quote here only some cases whose construction is simple; similar flows can be found in textbooks as [53][54].

2.1 2-D supersonic flows

We recall all flows consisting of simple wave regions. Examples are flows over simple wedges, double wedges (so far the expansion fan does not meet the shock wave), expansions around corners, etc..
Also duct flows can belong to this family; they may also have a curved axis as the one reproduced in Fig. 19 (from [54]).

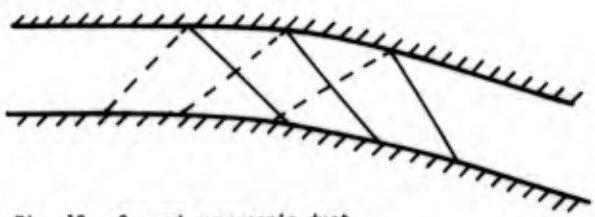


Fig. 19 - Curved supersonic duct

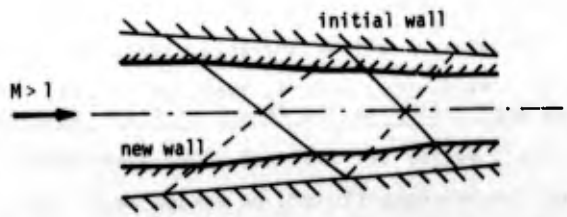


Fig. 20 - Construction of a new duct flow starting from an assigned analytical one

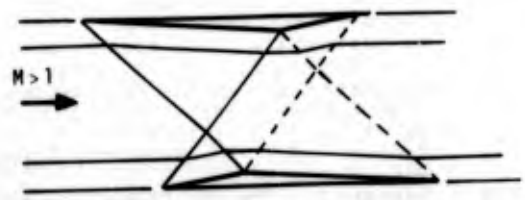


Fig. 21 - Busemann's biplane

By choosing two streamlines as new physical boundaries (i.e. as rigid walls) different flows can be obtained: an example is given in Fig. 20 [55].
A very particular flow pattern is provided by the Busemann biplane [56] and it is represented in Fig. 21. The flow structure in the region between the profiles is complicated but can be exactly computed for a special configuration; it can therefore be very useful as a test case.

2.2 2-D axisymmetric supersonic flows

The theory of the flow over a circular cone without incidence is well developed, owing to the irrotationality of the flow behind the shock. The results have been tabulated by Sims [57] and can be used for testing of codes.

2.3 3-D supersonic flows

Three-dimensional fields are in general difficult to study and analytical solutions are mostly based on approximate assumptions (linearized theories, perturbation methods, ...).
An exception are the special body shapes of Nonweiler [58] and Flower [59], where the flow field was determined by means of an indirect method, i.e. the body shape was obtained by selecting known streamlines.
In these cases the flow in every plane parallel to the symmetry one is two-dimensional, so that it can be easily studied through elementary techniques. No irrotationality is introduced in the flow if the design conditions are assumed. An example is offered by Nonweiler's "caret wing" shown in Fig. 22.

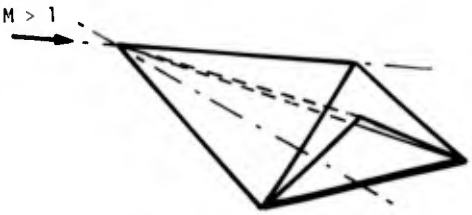


Fig. 22 - The "caret wing" by Nonweiler

Other shapes, based on axisymmetric flows obtained by characteristic calculations, have been derived by Pike [60] and can be very interesting as test cases, owing to their resemblance to aircraft configurations.
Finally, let us mention the tabulations of Sims [61] which extend the results for the supersonic flow over a circular cone to the case where the incidence angle is not zero.

REFERENCES

1. Ferrari C., Tricomi F., "Transonic Aerodynamics", New York and London, Academic Press, 1968
2. Courant R., Hilbert D., "Methoden der mathematischen Physik", Bd. II, Berlin, Springer Verlag, 1937, pp. 26-31
3. Molenbroek P., "Über einige Bewegungen eines Gases bei Annahme eines Geschwindigkeitspotentials", Arch.d.Math.u.Phys., Grunert Hoppe, Reihe 2, Bd.9, 1890, p. 157 (see also[40])
4. Tschaplygin S.A., "On Gas Jets", Sci.Ann.Imperial Uni. of Moscow, Otd.Fiz.Mat.Uch. Zap., vol. 21, 1904, pp. 1-121. English translation in: NACA TM No. 1063, Washington, 1944 (see also[40])
5. Lightill M.J., "The Hodograph Transformation in Transonic Flows - Part I. Symmetrical Channels"; id. "Part II. Auxiliary Theorems on the Hypergeometric Function $\psi_n(\tau)$"; id. "Part III. Flow around a Body", Proc. Roy.Soc. of London, A 191, 1947, pp.323-369
6. Tricomi F.G., "Sulle equazioni lineari alle derivate parziali di secondo ordine di tipo misto", Mem. Reale Acc. dei Lincei, Classe Sci.Fis.Mat.Nat., vol. 14, 1923, pp. 133-247. English translation: Brown Univ. Transl., A9-T-26, Providence, Rhode Island, 1948
7. Tomotika S., Tamada K., "Studies on Two Dimensional Transonic Flows of Compressible Fluid" Pt. III, Quart.Appl.Math., vol. 9, 1951, pp. 129-147
8. Von Karman T., "The Similarity Law of Transonic Flows", J.Math. and Phys., vol. 26, 1947, pp. 182-190
9. Viviand H., "Approximate Compressibility Relations and Solutions of the Euler Equations", Rech. Aérosp., n. 6, 1981, pp. 405-406
10. Friedrichs K.O., "On the non Occurrence of a Limiting Line in Transonic Flow", Comm. Pure Appl.Math., vol. 1, 1948, pp. 287-308
11. Morawetz C.S. "On the non Existence of Continuous Transonic Flows past Profiles", Comm.Pure Appl.Math.; Part I: vol. 9, 1956, pp. 45-68; Part II: vol. 10, 1957, pp. 107-131; Part III: vol. 11, 1958, pp. 129-144
12. Manwell A.R., "The Hodograph Equation", Edingburgh, Oliver and Boyd, 1971, pp. 426-466
13. Ferrari C., "On the Transonic Controversy", Meccanica, vol. 1, 1966, pp. 37-44
14. Manwell A.R., "The Tricomi Equation with Application to the Theory of Plane Transonic Flow", Pitman Publ., 1979, pp. 135-169
15. Cole J.D., "Twenty Years of Transonic Flow", Boeing Sc. Res. Lab. Doc. D1-82-0878, 1969, pp. 33-37
16. Taylor G.J., "Recent Work on the Flow of Compressible Fluid", J. London Math. Soc., vol. 5, 1930, p. 224
17. Ferrari C., "Campi di moto in fluidi compressibili", L'Aerotecnica, vol. 18, 1938, pp. 400-411
18. Ringleb F., "Exakte Lösungen der Differentialgleichungen einer adiabatischen

Gasströmung", ZAMM, vol. 20, Pt. 4, 1940, pp. 185-198
19. Cherry T.M., "Flow of a Compressible Fluid about a Cylinder", Proc.Roy.Soc. London, A 192, 1947, pp. 45-79
20. Cherry T.M., "Numerical Solutions for Transonic Flow", Proc.Roy.Soc. London, A 196, 1949, pp. 32-36
21. Cherry T.M., "Numerical Solutions for Compressible Flow past a Cylinder", Rep. A 48 C.S.I.R., Div. of Aeron., Fishermen's Bend, Melbourne, Australia, 1948
22. Niewland G.Y., "Transonic Potential Flow round a Family of Quasi-elliptical Airfoil Sections", NLR-TR T-172, 1967
23. Boerstoel J.W., Huizing G.H., "Transonic Shockfree Airfoil Design by an Analytical Hodograph Method" AIAA Paper 74-539, 1974. Also: NLR MP 74025 U, 1974
24. Lock R.C., "Test cases for Numerical Methods in Two-dimensional Transonic Flows", AGARD R-575-70, 1970
25. Boerstoel J.W., "Review of the Applications of Hodograph Theory to Transonic Airfoil Design and Theoretical and Experimental Analysis of Shock-free Airfoils", IUTAM Symposium Transsonicum II, Göttingen 8-13.9.75, Springer Verlag, 1976
26. Boerstoel J.W., "A Survey of Symmetrical Transonic Potential Flows around Quasi-elliptical Aerofoil Sections", NLR TR-T-136, 1967
27. Bauer F., Garabedian D., Korn A., "Supercritical Wing Sections", Springer Ed., 1972
28. Bauer F., Garabedian D., Korn A., Jameson A., "Supercritical Wing Sections II", Springer Ed., 1975
29. Cherry T.M., "A Transformation of the Hodograph Equation and the Determination of Certain Fluid Motions", Phil. Trans. Roy.Soc. London, Sez. A, vol. 245, 1953, pp. 583-624
30. Cherry T.M., "Some Nozzle Flows Found by the Hodograph Method", J. Austral.Math.Soc., vol. 1, 1959-60, pp. 80-94
31. Cherry T.M., "Nozzle Flows Found by the Hodograph Method II", J. Austral.Math.Soc., vol. 1, 1959-60, pp. 357-367
32. Hobson D.G., "Shock-free Transonic Flow in Turbomachinery Cascades", Univ. of Cambridge, Dept. of. Eng., Rep. CUED/A TURBO/TR65, 1974
33. Chattot J.J., "Symmetrical Flow past a Double Wedge at High Subsonic Mach Numbers", J.Fl.Mech., vol. 86, part 1, 1978, pp.161-177
34. Nocilla S., "Flussi transonici attorno a profili alari simmetrici con onda d'urto attaccata ($M_\infty < 1$)", Atti Acc.Sc. Torino, Classe Sci.Mat.Fis.Nat., vol. 92, 1957-58, pp. 282-307. English translation in: Techn. Note no. 4, Lab.Mecc.Appl., Politecnico di Torino, Torino 1957
35. Nocilla S., "Flussi transonici attorno a profili alari simmetrici con onda d'urto attaccata ($M_\infty < 1$). Parte II", Atti Acc.Sci.Torino, Classe Sci.Mat.Fis.Nat., vol. 93, 1958-59, pp. 124-148. English translation in: Tech.Note No.9, Lab.Mecc.Appl., Politecnico di Torino, Torino 1958
36. Chiocchia G., Nocilla S., "Transonic Flows past Symmetrical Airfoils with Attached Shock Wave and Discontinuous Slope: a Simplified Analytical Procedure and Results". To be printed in: Atti Acc.Sci.Torino, Classe Sci.Fis.Mat.Nat., vol. 117, 1982-83
37. Nocilla S., "Campi di moto transonici attorno a profili alari simmetrici, senza incidenza, con numero di Mach 1", Atti Acc.Sci.Torino, Classe Sci.Fis.Mat.Nat., vol. 90, 1955-56, pp. 46-52. See also[1], pp. 436-442
38. Nocilla S., "Die Transsonische Strömung um Flügelprofile mit einer Machzahl der ungestörten Strömung gleich Eins',WGL Jahrbuch 1955,Brauschweig, Vieweg, 1955,pp.186-192
39. Nocilla S., "Campi di moto transonici attorno a profili alari: applicazioni", Atti Acc.Sci.Torino, Classe Sci.Fis.Mat.Nat., vol. 90, 1955-56, pp. 311-331. See also[1], pp. 436-442
40. Guderley G., "Theorie schallnaher Strömungen", Springer Verlag, 1957
41. Busemann A., "Hodographenmethode der Gasdynamik", ZAMM, Bd. 17, Heft. 2, 1937, pp. 73-79
42. Sobieczky H.E., "Exakte Lösungen der ebenen Gasdynamischen Gleichungen in Schallnähe", Zeitschr.f.Flugwiss., Bd. 19, Heft 5, 1971, pp. 197-214
43. Sobieczky H.E., "Tragende Schnabelprofile in stossfreier Shallanströmung", ZAMP, vol. 26, 1975, pp. 819-830
44. Guderley G., Yoshihara H., "The Flow over a Wedge Profile at Mach Number 1", J. Aero. Sci., vol. 17, 1950, pp. 723-735
45. Guderley G., Yoshihara H., "Two-dimensional Unsymmetric Flow Patterns at Mach Number 1", J.Aeron.Sci., vol. 20, 1953, pp. 757-768
46. Nocilla S., "Flussi transonici intorno a profili alari simmetrici con onda d'urto staccata", Atti Acc.Sci.Torino, Classe Sci.Fis.Mat.Nat., vol. 91, 1956-57, pp. 353-385. See also[1] pp. 448-457
47. Sobieczky H.E., "Die abgelöste transsonische Kopfwelle", Zeitschr.f.Flugwiss., Bd. 22, Heft 3, 1974, pp. 65-73
48. Guderley G., Yoshihara H., "An Axial-symmetric Transonic Flow Pattern", Quart.Appl. Math., vol. 8, 1951, pp. 333-339
49. Fal'kovich S.V., Chernov I.A., "Flow of a Sonic Gasstream past a Body of Revolution", PMM, vol. 28, No.2, 1964, pp. 280-284
50. Müller E., Matschat K., "Ähnlichkeitslösungen der transsonischen Gleichungen bei der Anstrom-Machzahl 1", Proc. 11th Int. Congr.Appl.Mech.,München 1964, Springer 1966
51. Randall D.G., "Some Results in the Theory of Almost Axisymmetric Flow at Transonic Speed", AIAA J., vol. 3, No. 12, 1965, pp. 2339-2341
52. Greitzer E.M., "A New Exact Solution for Compressible Swirling Flow", Aeron.Quart., 1975, pp. 297-303
53. Ferri A., "Elements of Aerodynamics of Supersonic Flows", New York, The MacMillan Co., 1949
54. Sears W.R., "High Speed Aerodynamics and Jet Propulsion", vol. VI, Princeton Univ. Press, 1954

55. Grümmer K., "Die numerische Verhandlung supersonischer Einlaufströmungen in zweidimensionalen Kanälen", ZAMM 61 (Sonderheft GAMM-Tagung 1980), T157-T158, 1981
56. Busemann A., Walchner O., "Profileigenschaften ben Überschallgeschwindigkeit", Forsch. aus. d.Geb.des Ing. Wesens, vol. 4, 1933, p. 87
57. Sims J.L., "Tables for Supersonic Flow Around Right Circular Cones at Zero Angle of Attack", NASA SP 3004, 1964
58. Nonweiler T., "Delta Wings of Shapes Amenable to Exact Shock-Wave Theory", J.Roy. Aer.Soc., vol. 67, 1963, pp. 39-40
59. Flower J.W., "Configurations for High Supersonic Speeds Derived from Simple Shock-Waves and Expansions", J.Roy.Aer.Soc., vol. 67, 1963, pp. 287-290
60. Pike J., "Wing-Body Shapes from Known Flow Fields", RAE TR 70235, 1970
61. Sims J.L., "Tables for Supersonic Flow Around Right Circular Cones at Small Angle of Attack", NASA SP 3007, 1964.

5. REFERENCE TEST CASES AND CONTRIBUTORS (D.J. JONES)

5.1. Two Dimensional Airfoils and Cascades

5.1.1. Specification of 2-D Reference Test Cases

(1) NACA0012 M=0.8, α=1.25°

This airfoil is the NACA0012 foil with trailing edge extended to a position such that the new trailing edge is closed. This gives a new thickness/chord ratio of 11.8938%. This closing of the TE was carried out so that contributors would not close the TE in a manner of their own choice. This had been a problem in the GAMM workshop [5.1]. The profile is shown in Fig. 5.1(a).

The NACA0012 foil is symmetrical. Its upper surface is defined by

$$\bar{y}(\bar{x}) = 5\,t\,(0.2969\,\bar{x}^{\frac{1}{2}} - 0.126\,\bar{x} - 0.3516\,\bar{x}^2 + 0.2843\,\bar{x}^3 - 0.1015\,\bar{x}^4), \qquad (5.1)$$

where

$\bar{x}$ = the chordwise distance from the leading edge at $\bar{x} = 0$,
$\bar{y}$ = the upper-surface coordinate,
$t = 0.12$ (value of thickness parameter for NACA0012).

The airfoil has a finite thickness of about 0.0025 at $\bar{x}=1$, the trailing edge used in reference 5.2. In order to avoid ambiguities with this open trailing edge, the airfoil should be made closed ,so that there is a well-defined trailing-edge point. For the test cases, the trailing-edge coordinate $\bar{x}_{te}$ is defined to be the $\bar{x}$-value, where $\bar{y}=0$:

$$\bar{y}(\bar{x}) = 0 \leftrightarrow \bar{x} = \bar{x}_{te} = 1.008930411365 \leftrightarrow |\bar{y}| < 10^{-13}.$$

This means that the chord length is equal to the value $\bar{x}_{te}$, and slightly exceeds the unit value.

For the test calculations, the coordinates $(\bar{x},\bar{y})$ obtained from (5.1) have to be divided by $\bar{x}_{te}$ to new coordinates (x,y), to be used when presenting computational results:

$$(x,y) = (\bar{x}/\bar{x}_{te},\ \bar{y}/\bar{x}_{te})$$

This rescales the airfoil to unit chord.

Results of inviscid computations for this case (NACA0012) were given in the Rizzi-Viviand GAMM Workshop [5.1].

Experimental data for NACA0012 were presented in AGARD AR-138 (Working Group 04), Reference 5.3.

(2) NACA0012 See (1) above. M=0.85, α=1°

(3) NACA0012 See (1) above. M=0.95, α=0°

Both cases 2 and 3 were included in the Rizzi-Viviand GAMM Workshop. The latter case has a strong shock at the trailing edge as well as a secondary shock downstream of the trailing edge.

(4) NACA0012 See (1) above. M=1.2, α=0°

(5) NACA0012 See (1) above. M=1.2, α=7°

These cases were not included in the GAMM workshop but are included here to define reference solutions for supersonic airfoil calculations. Of particular interest are the upstream and downstream pressure jumps.

(6) RAE2822 M=0.75, α=3°

A table of coordinates is given as Table 5.1. The profile is shown in Fig. 5.1(b).

Results of inviscid computations are given in the GAMM Workshop [5.1] and experimental data are presented in AGARD AR-138 [5.3].

(7) NLR7301 M=0.720957, α=-0.194°

This airfoil is obtained from hodograph theory [5.4] at the above design condition. This condition produces shock free supercritical flow from a peak local Mach number of about 1.27.

The coordinates are given in Table 5.2. These should be scaled by 1.0152284 to give a unit chord length. Also for completeness the Mach number and C_p distributions obtained from hodograph theory are given in Table 5.3. The profile is shown in Fig. 5.1(c).

Note that in this case (as well as in 8, 9, 10 below) we already have a definitive solution. However these cases are included so that an assessment of contributor's solutions relative to the known solution can be made.

Experimental results for this airfoil are given in AGARD AR-138 [5.3].

(8) CHIOCCHIA-NOCILLA profile. M=0.769041, α=0°

This symmetrical profile is designed in the hodograph plane using the Tomotika-Tamada approximation to the Chaplygin equation.

The profile has a sharp leading edge and a small discontinuity in slope (~3°) at about 60% chord at which point the shock Mach number is about 1.16. Further information on the derivation can be found in Reference 5.5.

This case is considered interesting as it is the only known (reference) airfoil solution with a shock wave. One drawback is that the Tomotika-Tamada gas law differs slightly from the real gas law and it is difficult to incorporate this difference into an Euler code.

The coordinates and design pressure distribution can be found in Table 5.4. The sonic line and the shock line are tabulated in Tables 5.5 and 5.6 respectively.

Figs. 5.2 - 5.5 show some details of the flow.

5.1.2. 2-D Cascade Reference Solutions

(9) HOBSON-1. M=0.476, α=43.544° Spacing s/c=1.0121

(10) HOBSON-2. M=0.575, α=46.123° Spacing s/c=0.5259

These geometries are obtained by a hodograph solution to the transonic flow equations [5.6]. They produce shockless flow at the above design conditions with peak Mach numbers of 1.52 and 1.132 respectively.

Their coordinates and Mach number distributions are given in Tables 5.7 and 5.8 respectively, while their profiles are shown in Figs. 5.6(a) and 5.6(b) respectively.

These profiles are included so that one can see how well internal flows are handled by the various Euler codes.

5.1.3. 2-D Test Case Contributors

This sub-section gives a list of contributors for the 2-D test cases. The numeral is used to identify the contributor in the assessments made later.

1. J.P. Veuillot and A.M. Vuillot
   ONERA
   29 Av. de la Div. Leclerc
   Chatillon F-92320
   France

2. J. Sides
   ONERA (see 1)

3. C.C. Lytton
   Royal Aircraft Establishment
   Farnborough, Hants
   England

4. J.L. Jacocks
   A.E.D.C., A.R.O. Inc.
   Tennessee 37389
   U.S.A.

5. T.H. Pulliam and J.T. Barton
   NASA Ames
   N215-1 Moffet Field
   California 94035
   U.S.A.

6. M.D. Salas and J.C. South Jr.
   NASA Langley
   Hampton, Va
   U.S.A.

7. A. Eberle
   Postfach 801160
   MBB UF-FE122
   8000 Muenchen 80
   Germany

8. A. Rizzi
   F.F.A., P.O. Box 11021
   S-16111 Bromma 11
   Sweden

9. W. Schmidt (Dornier) and A. Jameson (Princeton Univ.)
   Postfach 1420
   Dornier
   7990 Friedrichshaffen
   Germany

   Aeronautical Dept.
   Princeton
   New Jersey 08540
   U.S.A.

10. R.H. Ni
Pratt Whitney A/C Group
East Hartford
Connecticut 06108
U.S.A.

11. A. Dadone
University of BARI via re David 200
Istituto di Macchine
Italy

12. G. Meauze and P. Lesaint
ONERA (see 1 above).

13. B. Fortunato
University of Bari (see 11).

5.2. Three Dimensional Cases

5.2.1. Specification of 3-D Reference Test Cases

(11) ONERA M-6 M=0.84, α=3.06°

(12) ONERA M-6 M=0.92, α=0°

The pertinent points of this swept back conical wing are its trapezoidal planform, 5% thickness/chord, 30° leading edge sweep, symmetry, aspect ratio 3.8 and taper ratio 0.56.

Note that the present definition differs very slightly from that of the real M6 wing given in Ref. 5.3, by the fact that the ONERA-D profile is extended to the point of strictly zero thickness. This corresponds to an extension in chord of about 0.6%. Also the wing tip is rounded in a slightly different manner from the real M6 wing.

Experimental results for this wing are given in AGARD AR-138.

A complete definition of the wing now follows.

i) Planform

The planform is shown on Fig. 5.7. The point A, with coordinates:

$$x_A = 1578.7 \text{ mm} \qquad y_A = 2734.5 \text{ mm}$$

is the apex of the conical surface to which the wing belongs.

The root-chord is:

$$x_B = 810.5 \text{ mm}$$

(instead of 805.9 mm for the real wing; see note above)

The semi-span, excluding the rounded wing tip, is:

$$b = 1196.3 \text{ mm}$$

For dimensionless quantities, use the semi-span b as reference length.

ii) "Extended" ONERA-D Profile

The intersection of the wing by a vertical plane inclined at an angle - θ with respect to the x-axis (Fig. 5.7) is the symmetrical ONERA-D profile. The angle θ is given by its tangent:

$$\tan\theta = 0.45891$$

Here we consider the ONERA-D profile extended to the point of exactly zero thickness. Let c be the chord of the extended profile, and ξ=x'/c the reduced abscissa along the chord. The equation of the upper surface can be written:

$$z = c\, g\,(k\xi)/k, \qquad 0 < \xi < 1$$

with $k = 1.00638425$

and where the function g(X) is given by the following set of equations:

a) $0 < X < 0.044$

$$g(X) = \sqrt{X} \sum_{n=0}^{7} A_n X^n$$

$A_0 = -0.1898087584379$ D+00
$A_1 = +0.31813568315041$ D-01
$A_2 = -0.79875599950822$ D+02
$A_3 = +0.19826412221164$ D+04
$A_4 = -0.17124203429644$ D+05
$A_5 = -0.83765417234613$ D+04
$A_6 = +0.89884596073744$ D+06
$A_7 = -0.35691922706000$ D+07

b) $0.044 \leq X \leq 0.945$

$$g(X) = \sum_{n=0}^{8} B_n X^n$$

B_0 = +0.20511700000000 D-01
B_1 = +0.27338051499795 D+00
B_2 = -0.12221782415231 D+01
B_3 = +0.38864797060892 D+01
B_4 = -0.75862963116995 D+01
B_5 = +0.68359355107744 D+01
B_6 = -0.73185676985056 D+00
B_7 = -0.27540347977852 D+01
B_8 = +0.12790983175276 D+01

c) $0.945 \leq X \leq 1.00638425$
$g(X) = -0.127\ (X-0.945) + 0.0077958$

iii) Root Section

Let $\bar{x}$ be the reduced abscissa along the chord of the root section (intersection of wing by plane y=0): $\bar{x}=x/x_B$.

The upper surface of the root section is given by the equation:

$$\frac{z}{x_B} = \frac{y_A}{y'_A} \bar{x}\xi \frac{1}{k} g(k\xi)$$

with

$$y'_A = x_A \sin\theta + y_A \cos\theta$$

$$\mu = x_B \sin\theta / y'_A = 0.10753067$$

$$\xi = \frac{1-\mu}{1-\mu\bar{x}} \bar{x}$$

i.e.,

$$\frac{z}{x_B} = 0.96843983\ (1-\mu\bar{x})\ g(X)$$

with

$$X = k\xi = 0.89816708\ \frac{\bar{x}}{1-\mu\bar{x}}$$

iv) Tip Section

The tip of wing M6 is not completely defined by analytical expressions. It is based on the half body of revolution formed by rotating the tip section around its symmetry axis. However a smoothing is necessary to ensure the continuity of the tangent plane; in particular, the upstream part of the half body of revolution is modified over a distance of about 3% of the tip chord.

Another wing tip, with a simple definition, is to be used for calculations. This theoretical wing tip is generated by circular arcs in the vertical planes going through the apex A of the conical surface of the wing. Each arc is completely defined by the condition of tangency with the generators of the wing surface in the vertical plane (see Fig. 5.8).

An explicit equation for the rounded wing tip in the form z=function of x,y can be found as follows.

For given x,y on the wing tip make the substitutions

$$P = \frac{x_A - x}{y_A - y} \qquad \text{and} \qquad x_0 = x_A - y_A P$$

where x_0 is the x value of S_0 (see Fig. 5.7). Then letting $z_0=F(x_0)$ be the equation of the root section, we can compute the z value on the tip as given by

$$z^2 = (y-y_A)^2 \frac{z_0^2}{y_A^2} - C_1^2 (y-b)^2$$

where $C_1^2 = 1+P^2 + \frac{z_0^2}{y_A^2}$.

Also a parametric representation of the section of the wing tip in the plane z=0 in terms of the above mentioned variable x (Fig. 5.9) can be written as follows.

$$y = y_A \frac{z_0 + C_1 b}{z_0 + C_1 y_A}$$

$$x = x_0 + Py \quad .$$

(13) BUTLER WING. M=2.5, α=0°

This wing (see Ref. 5.7) has a delta planform with sonic leading edge at M=3.5. It has elliptic cross sections with aspect ratio decreasing from unity (circular up to 20%) to zero at the trailing edge.

Experimental results for this wing are reported in Ref. 5.8.

The complete wing description is given on Fig. 5.10.

(14) DILLNER WING. M=1.5, α=15°

(15) DILLNER WING. M=0.7, α=15°

This wing has a delta planform with 70° sweep and a sharp leading edge. The surface is specified by spanwise sections of bi-convex circular arc profiles whose maximum thickness (at midchord) is 6% of the local chord (see Fig. 5.11).

Experimental results are reported in FFA Report No. AU-295.

(16) NASA Ames Swept Wing. M=0.833, α=1.75°

This is an arrow type wing with 36°/27° leading edge sweep, 14% thickness at root, 12% at the break and 9.7% at the tip. The aspect ratio is 7.2, it has 4.34° of twist and 1.293°/2.93° dihedral.

Fig. 5.12 shows the planform, twist (ε) and leading edge dihedral for this wing while Fig. 5.13 shows the defining sections 1, 4, 6 and 11 (the surface is lofted linearly between sections 1, 4, 6 and 11).

Table 5.9 contains values of the leading edge coordinates, local chord length and twist at each of the sections 1 through 11. All units are in metres. Finally Table 5.10 gives the coordinates of sections 1 through 11.

This wing is considered typical of the type on modern supercritical transport aircraft.

(17) AGARD B. M=1.5, α=0°

(18) AGARD B. M=1.5, α=2°

(19) AGARD B. M=2.0, α=0°

(20) AGARD B. M=2.0, α=2°

This wing-body configuration has been the model for several wind tunnel tests. In particular results are reported in References 5.9 and 5.10.

Fig. 5.14 gives a complete definition of the model. It shows a delta wing mounted on a cylindrical body of revolution. The wing has a 4% thick bi-convex section with exposed aspect ratio 2.31 and 60° leading edge sweep.

5.2.2. 3-D Test Case Contributors

Dr. D.S. Chaussee
MS 202A-14
NASA-Ames Research Center
Moffett Field
California 94035
USA

Prof. G. Moretti
P.O. Box 184
Freeport
New York 11520

Dr.-Ing. K. Weiland
Postfach 801160
MBB UF-FE122
8000 Muenchen
W. Germany

MM. M. Fenain* and J. Lordon
Aérospatiale
Division des Engins Tactiques
92320 Chatillon
France
*now retired

Dr. A. Rizzi
(address as in 5.1.3)

Dr.-Ing. W. Schmidt and Prof. A. Jameson
(address as in 5.1.3)

Prof. F. Walkden
Dept. of Mathematics
Salford M54WT
England

Dr. M. Neron
29 Av. de la Div Leclerc
O.N.E.R.A.
France
F-92320 Chatillon

and

J. Koeck
37 Av. L. Breguet
MATRA
FRANCE
F-78140 Velizy

5.3. References

5.1. Rizzi A. and Viviand H. Numerical Methods for the Computation of Inviscid Transonic Flows with Shock Waves in Notes on Numerical Fluid Mechanics (Vol. 3). GAMM Workshop 1981.

5.2. Abbott I.H. and von Doenhoff A.E. Theory of Wing Sections. Dover Publ. Inc., 1959.

5.3. AGARD AR-138. Experimental Data Base for Computer Program Assessment. 1979.

5.4. Boerstoel J.W. and Huizing G.H. Transonic Shock Free Aerofoil Design by Analytic Hodograph Methods. NLR MP 73023U also AIAA Paper 74-539.

5.5. G. Chiocchia, S. Nocilla: "Transonic Flows past symmetrical Airfoils with attached Shock Wave and discontinuous Slope: a simplified analitical Procedure". Atti dell'Acc. delle Scienze di Torino, Classe di Scienze Fis., Mat. e Nat., Vol. 117, Torino, 1983.

5.6. Hobson D.E. Shock Free Transonic Flow in a Turbomachinery Cascade. Cambridge Univ. Eng. Dept. CUED/A Turbo/TR65 (1974).

5.7. Butler D.S. Proc. Roy. Soc. London A Vol. 255, pp. 232-252 (1960).

5.8. Squire L.C. Dept. Eng., Cambridge Univ. CUED/A-AERO/TR9 (1979).

5.9. AGARD Wind Tunnel Calibration Models. AGARD Spec 2 (1958).

5.10. AGARDOGRAPH 64. pp. 35-136 (1961).

TABLE 1

Coordinates of RAE 2822 Aerofoil

X/C	DESIGN ORDINATES Z/C UPPER	LOWER
0.00000	0.00000	0.00000
0.00060	0.00316	0.00316
0.00241	0.00631	0.00631
0.00541	0.00942	0.00944
0.00961	0.01248	0.01256
0.01498	0.01549	0.01565
0.02153	0.01844	0.01871
0.02923	0.02135	0.02172
0.03806	0.02422	0.02469
0.04801	0.02706	0.02759
0.05904	0.02987	0.03042
0.07114	0.03264	0.03317
0.08427	0.03536	0.03584
0.09840	0.03801	0.03843
0.11349	0.04059	0.04093
0.12952	0.04307	0.04333
0.14645	0.04546	0.04561
0.16422	0.04773	0.04777
0.18280	0.04987	0.04981
0.20215	0.05188	0.05169
0.22221	0.05375	0.05343
0.24295	0.05547	0.05499
0.26430	0.05703	0.05638
0.28622	0.05841	0.05755
0.30866	0.05963	0.05846
0.33156	0.06066	0.05905
0.35486	0.06150	0.05924
0.37851	0.06213	0.05897
0.40245	0.06256	0.05822
0.42663	0.06278	0.05698
0.45099	0.06277	0.05526
0.47547	0.06253	0.05310
0.50000	0.06203	0.05056
0.52433	0.06125	0.04772
0.54901	0.06019	0.04464
0.57336	0.05885	0.04140
0.59754	0.05722	0.03804
0.62149	0.05534	0.03463
0.64514	0.05326	0.03121
0.66845	0.05099	0.02781
0.69134	0.04857	0.02449
0.71378	0.04603	0.02129
0.73570	0.04338	0.01823
0.75705	0.04064	0.01536
0.77778	0.03785	0.01269
0.79785	0.03502	0.01024
0.81720	0.03218	0.00803
0.83578	0.02935	0.00605
0.85355	0.02655	0.00431
0.87048	0.02382	0.00283
0.88651	0.02115	0.00159
0.90160	0.01858	0.00060
0.91574	0.01611	-0.00016
0.92886	0.01377	-0.00069
0.94096	0.01156	-0.00103
0.95200	0.00951	-0.00120
0.96194	0.00762	-0.00121
0.97077	0.00592	-0.00111
0.97847	0.00440	-0.00093
0.98502	0.00309	-0.00072
0.99039	0.00200	-0.00050
0.99459	0.00114	-0.00030
0.99759	0.00051	-0.00014
0.99940	0.00013	-0.00004
1.00000	0.00000	0.00000

TABLE 5.2 Coordinates of NLR7301 Aerofoil

$\bar{x}$	$\bar{y}$	$\bar{x}$	$\bar{y}$	$\bar{x}$	$\bar{y}$	$\bar{x}$	$\bar{y}$
1.0152284	.0	.4297667	.0880434	.0108218	-.0280297	.5516579	-.0609873
1.0130394	.0004144	.4204592	.0881775	.0127561	-.0298946	.5545499	-.0605234
1.0108504	.000832	.4111518	.0882789	.0154631	-.0321417	.5636167	-.0590373
1.0086614	.001253	.4018445	.0883475	.0179506	-.0339548	.5726834	-.0575037
1.0064723	.0016772	.3925373	.0883833	.0197713	-.0351686	.5821558	-.0558514
1.0042833	.0021046	.3834053	.0883867	.0219376	-.036506	.591628	-.0541483
1.0020942	.0025354	.3742734	.0883584	.0245498	-.0379864	.6011052	-.0523934
.9999052	.0029695	.3651416	.0882986	.0268947	-.0392137	.6105822	-.0505882
.9977161	.0034069	.3560099	.0882071	.0323335	-.0417721	.6197243	-.0487996
.9928541	.0043901	.3473354	.088091	.035881	-.0432701	.6288662	-.0469661
.9879921	.0053884	.338701	.0879641	.0376546	-.0439771	.6376225	-.0451694
.98313	.0064005	.3300467	.0877723	.0394281	-.0446591	.6463786	-.0433366
.978268	.0074251	.3213925	.087569	.0423271	-.0457248	.6550535	-.0414889
.9734058	.008461	.31352	.0873584	.045226	-.0467344	.6637283	-.0396149
.9685437	.0095069	.3056476	.0871229	.0481247	-.047693	.6727886	-.0376348
.9636815	.0105616	.2977752	.0868622	.0510232	-.0486058	.6818488	-.0356373
.9588193	.0116237	.2899029	.0865757	.0565381	-.050231	.6915939	-.0334759
.9442415	.014844	.2827236	.0862918	.0620525	-.0517267	.7013389	-.0313082
.9340827	.0171138	.2755442	.0859859	.0675667	-.053111	.7118449	-.0289698
.9239238	.0193996	.268365	.0856577	.0730805	-.0544013	.7223508	-.0266371
.9137649	.0216968	.2611858	.0853068	.0771059	-.0552931	.7279285	-.025403
.900792	.0246399	.2546944	.0849698	.0811312	-.0561467	.7335062	-.0241734
.8906331	.0269475	.248203	.0846135	.0851564	-.0569652	.7390839	-.0229494
.8804741	.0292535	.2417117	.0842377	.0891816	-.0577513	.7446616	-.0217322
.8703152	.0315545	.2352205	.0838418	.0929399	-.0584584	.7506223	-.0204404
.8604179	.033788	.2293459	.0834659	.0966982	-.0591412	.7565831	-.0191598
.8505207	.03601	.2234714	.0830729	.1004565	-.059801	.7625439	-.0178924
.8406234	.0382174	.217597	.0826623	.1042147	-.0604391	.7685048	-.0166403
.8307263	.0404068	.2117226	.0822338	.1078915	-.0610431	.7752698	-.0152405
.8217815	.0423675	.2063608	.0818267	.1115683	-.0616267	.7820349	-.0138661
.8128369	.0443086	.2009991	.081404	.1152451	-.0621901	.7888	-.0125201
.8038922	.0462276	.1956374	.0809654	.1189218	-.0627346	.7955653	-.0112058
.7949477	.0481221	.1902757	.0805103	.126463	-.0638076	.804048	-.0096069
.7867346	.0498382	.1830136	.0798669	.134004	-.0648412	.8125308	-.0080674
.7785316	.0515298	.1757516	.0791914	.1417023	-.0658428	.8210139	-.0065919
.7703087	.0531951	.1709103	.0787225	.1494005	-.0667871	.8294972	-.0051848
.7620959	.0548323	.1620297	.0778222	.1581394	-.0677937	.8396449	-.0035977
.7543987	.0563396	.1531492	.0768871	.1668782	-.0687354	.8497929	-.0021236
.7467015	.0578191	.1451619	.0759587	.1756167	-.0696163	.8599413	-.0007717
.7390044	.0592694	.1371749	.0750008	.1843551	-.0704393	.8700901	.0004496
.7313074	.0606892	.1298374	.0740738	.189524	-.0708995	.8763318	.0011324
.7239965	.0620082	.1225001	.0730979	.1946928	-.0713408	.8864812	.0021265
.7166857	.0632973	.1174463	.0723954	.1998615	-.0717636	.896631	.0029712
.709375	.0645558	.102879	.070215	.2050302	-.0721684	.9067813	.0036605
.7020644	.0657827	.0926554	.0685253	.2110365	-.0726163	.9169321	.0041886
.6951093	.0669196	.0848828	.0671354	.2170428	-.0730405	.9270833	.0045505
.6881543	.0680263	.0764002	.0654949	.2230491	-.0734416	.9372351	.0047413
.6811995	.0691019	.0661071	.0632814	.2290552	-.07382	.9473873	.0047565
.6742447	.0701454	.0566824	.0609237	.2363154	-.0742478	.9575401	.0045921
.6674601	.0711318	.047259	.0581064	.2435754	-.0746437	.9676934	.0042446
.6606756	.072086	.0378375	.0546577	.2508353	-.0750084	.9748111	.00389
.6539319	.0730023	.0316879	.0519702	.2580952	-.0753426	.9839296	.0032994
.6470765	.0739003	.030451	.051385	.2673729	-.0757257	.988489	.002945
.6401197	.0747768	.0296602	.0510052	.2766505	-.0760604	.9930485	.0025507
.6329293	.0756458	.0285818	.0504716	.285928	-.0763472	.9971651	.0021591
.625404	.0765152	.0279647	.0501553	.2952053	-.0765865	.9999096	.0018774
.6174218	.0773934	.0276023	.0499651	.3053582	-.0767948	1.0026541	.0015787
.6130854	.0778517	.0265278	.0493759	.3155109	-.0769474	1.0040264	.0014231
.6087491	.0782972	.024055	.0478651	.3256635	-.0770445	1.007327	.0010317
.6040016	.0787704	.021127	.0457913	.3358159	-.0770861	1.0106277	.0006148
.5992541	.0792287	.0194052	.0443882	.3460392	-.0770716	1.0143956	.0001129
.5938567	.0797321	.0175319	.0426834	.3561913	-.0770007	1.0152284	.0
.5884593	.0802173	.0153049	.0404096	.3663432	-.076872		
.5822243	.0807557	.0131194	.0378449	.376495	-.0766837		
.5759893	.0812713	.010753	.0346503	.3866465	-.0764334		
.5686577	.0818492	.0081862	.0305312	.3967979	-.0761186		
.5613261	.0823976	.0056121	.0254172	.4069491	-.0757362		
.5525071	.0830196	.0028314	.0179878	.4171001	-.0752827		
.5436882	.083602	.0022988	.0160878	.4272508	-.0747544		
.5383319	.0839369	.0017468	.0138934	.4374014	-.0741469		
.5302975	.0844136	.0011758	.0112217	.4475517	-.0734558		
.5222632	.0848603	.000587	.0076768	.4594475	-.0725326		
.5157191	.0852026	.0000012	-.0004162	.4688157	-.0717156		
.509175	.085526	.0004787	-.0076027	.4745806	-.0711708		
.502631	.0858307	.0009431	-.0102206	.4856332	-.0700287		
.496087	.0861171	.0014054	-.0121076	.4933971	-.0691512		
.488345	.0864327	.0017744	-.0133248	.5001765	-.0683376		
.480603	.0867235	.0021625	-.0144608	.5067021	-.0675108		
.4728611	.0869899	.0031756	-.0169046	.5133493	-.0666367		
.4651193	.0872324	.0046153	-.0197634	.5202298	-.0656939		
.4562811	.0874805	.0059313	-.0219728	.5274553	-.0646685		
.4474429	.0876982	.0073992	-.0240599	.5351272	-.0635414		
.4386048	.0878857	.0091007	-.0261667	.5431744	-.0623191		

N.B. Rescale coordinates to unit chord as specified in section 5.1.1.

TABLE 5.3 Technical Tables, including Mach Number and C_p, for NLR7301 as Obtained from Hodograph Theory

Mach INF = 0.720957
Incidence = -0.358998 DEG
CL = 0.594936
CN = 0.594924
CT = 0.003728
CP(MACH=0) = 1.136786
CP(MACH=1) = -0.695936

UPPER PART OF AEROFOIL

X	Z	THETA	1/R	M	CP
-0.00000	-0.00041	89.7175	1.841,+1	0.0002	1.137
0.00119	0.01105	78.9392	1.373,+1	0.2008	1.029
0.00422	0.02171	68.9825	1.634,+1	0.3932	0.744
0.00943	0.03217	57.7134	1.817,+1	0.6135	0.265
0.01519	0.03976	47.4163	2.124,+1	0.8257	-0.265
0.02005	0.04434	39.0787	2.535,+1	1.0120	-0.725
0.02722	0.04909	27.9208	2.199,+1	1.2221	-1.192
0.03278	0.05173	23.5938	8.307,+0	1.2738	-1.296
0.06994	0.06306	12.1222	2.751,+0	1.2738	-1.296
0.08380	0.06584	10.3503	1.778,+0	1.2652	-1.279
0.09548	0.06778	9.2952	1.386,+0	1.2566	-1.262
0.10759	0.06963	8.4118	1.138,+0	1.2479	-1.244
0.12087	0.07153	7.6114	9.641,-1	1.2393	-1.227
0.13533	0.07334	6.8614	8.341,-1	1.2307	-1.210
0.15107	0.07521	6.1473	7.337,-1	1.2221	-1.192
0.16857	0.07699	5.4501	6.536,-1	1.2135	-1.174
0.18765	0.07872	4.7675	5.888,-1	1.2048	-1.156
0.20878	0.08033	4.0870	5.352,-1	1.1962	-1.138
0.23193	0.08211	3.4060	4.910,-1	1.1875	-1.120
0.25751	0.08337	2.7129	4.542,-1	1.1789	-1.102
0.28580	0.08456	2.0029	4.243,-1	1.1702	-1.083
0.31682	0.08535	1.2693	4.014,-1	1.1616	-1.065
0.35092	0.08578	0.5038	3.861,-1	1.1529	-1.046
0.38690	0.08585	-0.2843	3.798,-1	1.1442	-1.027
0.42357	0.08551	-1.0827	3.838,-1	1.1355	-1.008
0.45839	0.08454	-1.8614	3.988,-1	1.1268	-0.989
0.48889	0.08334	-2.5809	4.237,-1	1.1180	-0.969
0.51467	0.08203	-3.2298	4.562,-1	1.1093	-0.950
0.53577	0.08074	-3.8041	4.939,-1	1.1005	-0.930
0.55314	0.07951	-4.3156	5.347,-1	1.0918	-0.910
0.56758	0.07836	-4.7739	5.744,-1	1.0830	-0.890
0.57986	0.07712	-5.1915	6.114,-1	1.0742	-0.870
0.59049	0.07628	-5.5757	6.457,-1	1.0653	-0.850
0.59984	0.07534	-5.9334	6.745,-1	1.0565	-0.829
0.60838	0.07443	-6.2704	6.968,-1	1.0476	-0.809
0.61624	0.07355	-6.5898	7.119,-1	1.0388	-0.788
0.62365	0.07267	-6.8961	7.201,-1	1.0299	-0.767
0.63073	0.07179	-7.1910	7.216,-1	1.0209	-0.746
0.63758	0.07091	-7.4761	7.176,-1	1.0120	-0.725
0.64433	0.07000	-7.7545	7.091,-1	1.0030	-0.703
0.65097	0.06908	-8.0250	6.970,-1	0.9940	-0.682
0.65765	0.06812	-8.2916	6.827,-1	0.9850	-0.660
0.66433	0.06714	-8.5519	6.666,-1	0.9759	-0.638
0.69172	0.06276	-9.5556	5.958,-1	0.9393	-0.549
0.72061	0.05786	-10.4899	5.191,-1	0.9022	-0.457
0.75082	0.05183	-11.3298	4.285,-1	0.8644	-0.362
0.78316	0.04514	-12.0395	3.204,-1	0.8257	-0.265
0.81838	0.03745	-12.5775	2.014,-1	0.7861	-0.164
0.85735	0.02864	-12.8939	7.612,-2	0.7454	-0.061
0.90012	0.01878	-12.9145	-6.232,-2	0.7032	0.045
0.94447	0.00870	-12.5279	-2.496,-1	0.6594	0.153
0.98276	0.00049	-11.6106	-6.649,-1	0.6135	0.265
1.00000		-9.4533		0.5686	0.372

LOWER PART OF AEROFOIL

X	Z	THETA	1/R	M	CP
0.00090	-0.01007	-78.1070	-2.815,+1	0.2008	1.029
0.00380	-0.01817	-63.2287	-2.379,+1	0.3932	0.744
0.00973	-0.02674	-47.4469	-2.386,+1	0.6135	0.265
0.01514	-0.03170	-37.8363	-1.911,+1	0.7245	-0.009
0.02032	-0.03528	-31.8854	-1.487,+1	0.7861	-0.164
0.03173	-0.04119	-23.7468	-7.879,+0	0.8452	-0.314
0.03871	-0.04403	-20.7632	-6.086,+0	0.8644	-0.362
0.05012	-0.04794	-17.1851	-4.338,+0	0.8834	-0.410
0.07183	-0.05373	-13.0435	-2.390,+0	0.8928	-0.433
0.08768	-0.05710	-11.1493	-1.751,+0	0.8959	-0.441
0.10248	-0.05982	-9.7987	-1.406,+0	0.8991	-0.449
0.11696	-0.06217	-8.7150	-1.186,+0	0.9002	-0.457
0.13181	-0.06430	-7.7675	-1.028,+0	0.9053	-0.464
0.14697	-0.06626	-6.9198	-9.116,-1	0.9084	-0.472
0.16344	-0.06814	-6.1020	-8.174,-1	0.9115	-0.480
0.18139	-0.06997	-5.2977	-7.407,-1	0.9146	-0.488
0.20175	-0.07172	-4.4710	-6.763,-1	0.9177	-0.495
0.22541	-0.07338	-3.5902	-6.225,-1	0.9208	-0.503
0.25401	-0.07492	-2.6068	-5.792,-1	0.9239	-0.511
0.29056	-0.07620	-1.4290	-5.503,-1	0.9270	-0.518
0.34063	-0.07674	0.1428	-5.534,-1	0.9301	-0.526
0.45235	-0.07265	4.4299	-9.293,-1	0.9301	-0.526
0.46726	-0.07139	5.2831	-1.057,+0	0.9239	-0.511
0.47815	-0.07032	5.9586	-1.084,+0	0.9146	-0.488
0.48580	-0.06950	6.4272	-1.029,+0	0.9053	-0.464
0.49891	-0.06793	7.1442	-8.612,-1	0.8865	-0.418
0.50546	-0.06709	7.4549	-7.864,-1	0.8771	-0.394
0.51936	-0.06521	8.0380	-6.740,-1	0.8580	-0.346
0.52692	-0.06411	8.3230	-6.347,-1	0.8484	-0.322
0.53485	-0.06293	8.6082	-6.048,-1	0.8387	-0.297
0.54321	-0.06164	8.8955	-5.826,-1	0.8290	-0.273
0.54606	-0.06119	8.9913	-5.767,-1	0.8257	-0.265
0.56393	-0.05827	9.5760	-5.540,-1	0.8061	-0.215
0.58260	-0.05502	10.1729	-5.456,-1	0.7861	-0.164
0.60128	-0.05158	10.7615	-5.353,-1	0.7659	-0.113
0.61930	-0.04806	11.3087	-4.973,-1	0.7454	-0.061
0.63656	-0.04454	11.7694	-4.062,-1	0.7245	-0.009
0.65366	-0.04090	12.1112	-2.719,-1	0.7032	0.045
0.67152	-0.03702	12.3224	-1.356,-1	0.6815	0.099
0.69073	-0.03283	12.4071	-1.826,-2	0.6594	0.153
0.71144	-0.02826	12.3602	+9.588,-2	0.6367	0.209
0.73343	-0.02348	12.1462	+2.442,-1	0.6135	0.265
0.75693	-0.01851	11.6662	+4.631,-1	0.5896	0.322
0.78360	-0.01321	10.7331	+7.284,-1	0.5649	0.380
0.81704	-0.00733	9.0608	+9.821,-1	0.5394	0.439
0.86319	-0.00121	5.9425	+1.386,+0	0.5130	0.498
0.96020	0.00109	-3.5723	+1.846,+0	0.5130	0.498
0.97816	-0.00032	-5.5151	+1.938,+0	0.5264	0.469
0.98897	-0.00145	-6.7713	+2.111,+0	0.5394	0.439
0.99547	-0.00225	-7.5880	+2.162,+0	0.5523	0.409
0.99918	-0.00275	-7.9294	+2.891,-1	0.5649	0.380
1.00000		-9.4533		0.5686	0.372

COORDINATES OF SONIC LINE

X	Z
0.01953	0.03685
0.01957	0.03899
0.02006	0.04234
0.02107	0.04632
0.02236	0.05165
0.02389	0.05877
0.02612	0.06767
0.03006	0.07841
0.03697	0.09241
0.04823	0.11389
0.06577	0.15016
0.08293	0.18694
0.10739	0.23590
0.14366	0.29554
0.19795	0.35670
0.25361	0.39100
0.29768	0.40149
0.34585	0.39832
0.39593	0.38024
0.44531	0.34851
0.49159	0.30641
0.53311	0.25819
0.58503	0.18263
0.63623	0.08834
0.67200	0.00866

TABLE 5.4

Coordinates and design pressure distribution for the CHIOCCHIA-NOCILLA profile

MACH	X	Y	THETA(DEG)	CP	1-P/P1inf
0.0	0.0	0.0	19.107422	1.000000	
0.488612	0.003894	0.001247	17.756042	0.630514	0.138896
0.572144	0.014612	0.004553	16.411728	0.434157	0.196483
0.636718	0.030045	0.008914	15.079749	0.284291	0.240436
0.693529	0.049502	0.013927	13.766672	0.158597	0.277299
0.745445	0.072377	0.019268	12.477856	0.048691	0.309532
0.793323	0.098087	0.024669	11.218925	-0.049519	0.338335
0.837438	0.126071	0.029916	9.994726	-0.138393	0.364400
0.877884	0.155786	0.034842	8.809763	-0.219400	0.388158
0.914741	0.186713	0.039325	7.667740	-0.293531	0.409899
0.948112	0.218365	0.043283	6.571787	-0.361497	0.429832
0.978129	0.250283	0.046668	5.524612	-0.423803	0.448105
STARTPOINT OF THE SONIC LINE					
1.004969	0.282055	0.049466	4.528163	-0.480840	0.464833
1.028830	0.313312	0.051685	3.583742	-0.532949	0.480115
1.049926	0.343733	0.053355	2.692245	-0.580383	0.494027
1.068479	0.373049	0.054520	1.853807	-0.623383	0.506638
1.084706	0.401037	0.055235	1.068211	-0.662165	0.518012
1.098819	0.427519	0.055561	0.334760	-0.696922	0.528205
1.111020	0.452367	0.055559	-0.347706	-0.727856	0.537277
1.121493	0.475490	0.055291	-0.980638	-0.755145	0.545281
1.130408	0.496834	0.054817	-1.565775	-0.778965	0.552267
1.137921	0.516377	0.054191	-2.105159	-0.799505	0.558291
1.144170	0.534127	0.053462	-2.600936	-0.816945	0.563406
1.149277	0.550114	0.052672	-3.055461	-0.831445	0.567658
1.153352	0.564388	0.051859	-3.471148	-0.843194	0.571104
1.156489	0.577015	0.051051	-3.850451	-0.852350	0.573689
1.158776	0.588075	0.050273	-4.195918	-0.859082	0.575763
1.160284	0.597652	0.049544	-4.509984	-0.863553	0.577074
1.161077	0.605840	0.048878	-4.795117	-0.865915	0.577767
1.161214	0.612740	0.048283	-5.053729	-0.866321	0.577886
1.160742	0.618448	0.047767	-5.288099	-0.864911	0.577473
1.159946	0.621982	0.047433		-0.860927	-
SHOCK POSITION					
0.927877	0.621982	0.047433		-0.318653	
0.921246	0.624244	0.047096	-8.526827	-0.306666	0.413751
0.911580	0.628011	0.046529	-8.582439	-0.286704	0.407896
0.901474	0.632205	0.045894	-8.634891	-0.266726	0.402038
0.891538	0.636832	0.045189	-8.683694	-0.246746	0.396178
0.881583	0.641900	0.044413	-8.728315	-0.226765	0.390318
0.871618	0.647415	0.043564	-8.768196	-0.206791	0.384460
0.861653	0.653383	0.042642	-8.802744	-0.186836	0.378607
0.851697	0.659809	0.041645	-8.831294	-0.166900	0.372761
0.841761	0.666698	0.040574	-8.853209	-0.146993	0.366922
0.831853	0.674054	0.039427	-8.867702	-0.127123	0.361095
0.821982	0.681883	0.038205	-8.874045	-0.107291	0.355278
0.812156	0.690188	0.036908	-8.871398	-0.087510	0.349477
0.802385	0.698972	0.035538	-8.858867	-0.067782	0.343691
0.792675	0.708240	0.034096	-8.835476	-0.048112	0.337922
0.783034	0.717993	0.032583	-8.800179	-0.028510	0.332174
0.773469	0.728237	0.031001	-8.751842	-0.008980	0.326446
0.763988	0.738973	0.029355	-8.689221	0.010473	0.320741
0.754595	0.750204	0.027646	-8.610911	0.029841	0.315061
0.745298	0.761935	0.025880	-8.515388	0.049120	0.309407
0.736100	0.774167	0.024061	-8.400879	0.068306	0.303779
0.727007	0.786904	0.022195	-8.265397	0.087389	0.298183
0.718023	0.800147	0.020290	-8.106626	0.106365	0.292618
0.709151	0.813901	0.018354	-7.921855	0.125229	0.287085
0.700395	0.828170	0.016396	-7.707864	0.143975	0.281588
0.691758	0.842954	0.014427	-7.460680	0.162599	0.276126
0.683240	0.858259	0.012462	-7.175355	0.181092	0.270702
0.674846	0.874090	0.010515	-6.845499	0.199453	0.265317
0.666573	0.890449	0.008607	-6.462562	0.217675	0.259973
0.658424	0.907342	0.006761	-6.014545	0.235752	0.254671
0.650400	0.924774	0.005006	-5.483386	0.253683	0.249412
0.642498	0.942749	0.003383	-4.839442	0.271457	0.244200
0.634718	0.961273	0.001948	-4.026045	0.289074	0.239033
0.627061	0.980350	0.000794	-2.900028	0.306528	0.233914
0.619523	1.000000	0.0	-0.019028	0.323816	0.227844

PROFILE SLOPE DISCONTINUITY DTHETA = 3.036777 DEGREES
CRITICAL CP = -0.470166
CD = 0.000914

TABLE 5.5 Sonic line in flow around CHIOCCHIA-NOCILLA profile

XS	YS	THETAS(DEG)	XS	YS	THETAS(DEG)
0.275917	0.048967	4.717499	0.521865	0.301182	-1.490753
0.278843	0.053360	4.617150	0.525557	0.300302	-1.598593
0.285491	0.063377	4.395081	0.529152	0.299160	-1.706409
0.292113	0.073387	4.181582	0.532650	0.297767	-1.814238
0.298710	0.083369	3.975973	0.536052	0.296127	-1.922112
0.305280	0.093303	3.777692	0.539359	0.294249	-2.030080
0.311822	0.103168	3.586191	0.542571	0.292140	-2.138209
0.318336	0.112946	3.400987	0.545688	0.289807	-2.246512
0.324820	0.122618	3.221618	0.548713	0.287259	-2.355025
0.331272	0.132164	3.047688	0.551645	0.284502	-2.463828
0.337690	0.141567	2.878806	0.554486	0.281545	-2.572921
0.344071	0.150810	2.714645	0.557237	0.278394	-2.682361
0.350415	0.159878	2.554858	0.559898	0.275057	-2.792172
0.356717	0.168753	2.399165	0.562470	0.271541	-2.902390
0.362975	0.177421	2.247267	0.564956	0.267854	-3.013061
0.369187	0.185868	2.098929	0.567356	0.264002	-3.124219
0.375350	0.194081	1.953910	0.569672	0.259993	-3.235898
0.381461	0.202047	1.811987	0.571904	0.255834	-3.348111
0.387518	0.209754	1.872941	0.574056	0.251532	-3.460939
0.393517	0.217192	1.536599	0.576124	0.247091	-3.574335
0.399456	0.224351	1.402751	0.578116	0.242519	-3.688405
0.405331	0.231221	1.271257	0.580027	0.237823	-3.803122
0.411141	0.237796	1.141956	0.581864	0.233009	-3.918571
0.416883	0.244068	1.014650	0.583626	0.228081	-4.034763
0.422554	0.250030	0.889271	0.585315	0.223047	-4.151700
0.428151	0.255677	0.765643	0.586931	0.217912	-4.269445
0.433673	0.261005	0.643639	0.588476	0.212678	-4.388004
0.439116	0.266010	0.523166	0.589952	0.207355	-4.507409
0.444479	0.270689	0.404085	0.591361	0.201946	-4.627696
0.449759	0.275040	0.286304	0.592702	0.196454	-4.748887
0.454955	0.279063	0.169718	0.593978	0.190887	-4.870984
0.460066	0.282756	0.054233	0.595192	0.185248	-4.994067
0.465088	0.286120	-0.060231	0.596341	0.179539	-5.118114
0.470020	0.289156	-0.173766	0.597432	0.173767	-5.243181
0.474862	0.291866	-0.286466	0.598461	0.167934	-5.369289
0.479612	0.294252	-0.398401	0.599432	0.162044	-5.496442
0.484268	0.296316	-0.509640	0.600347	0.156102	-5.624691
0.488831	0.298064	-0.620275	0.601205	0.150109	-5.754058
0.493298	0.299498	-0.730354	0.602010	0.144071	-5.884557
0.497670	0.300622	-0.839957	0.602760	0.137987	-6.016201
0.501945	0.301443	-0.949131	0.603459	0.131864	-6.149041
0.506124	0.301964	-1.057933	0.604105	0.125703	-6.283085
0.510205	0.302193	-1.166445	0.604703	0.119506	-6.418339
0.514189	0.302135	-1.274726			
0.518075	0.301795	-1.382797			

TABLE 5.6 Shock line in flow around CHIOCCHIA-NOCILLA profile

MACH1	MACH2	XU	YU
1.159946	0.927877	0.621982	0.047433
1.158066	0.930135	0.621263	0.050124
1.156225	0.932479	0.620561	0.052846
1.154204	0.934736	0.619890	0.055573
1.152234	0.937072	0.619199	0.058311
1.150295	0.939429	0.618505	0.061059
1.148203	0.941740	0.617828	0.063811
1.146109	0.944179	0.617147	0.066573
1.144050	0.946703	0.616462	0.069342
1.141891	0.949205	0.615782	0.072117
1.139658	0.951670	0.615111	0.074899
1.137474	0.954146	0.614432	0.077687
1.135197	0.956757	0.613760	0.080480
1.132822	0.959417	0.613095	0.083277
1.130518	0.962094	0.612418	0.086081
1.128042	0.964651	0.611759	0.088888
1.125535	0.967541	0.611099	0.091698
1.123078	0.970382	0.610434	0.094515
1.120347	0.973129	0.609780	0.097332
1.117719	0.976218	0.609127	0.100153
1.114854	0.979151	0.608481	0.102976
1.112018	0.982321	0.607834	0.105801
1.108968	0.985530	0.607191	0.108628
1.105914	0.988880	0.606550	0.111457
1.102553	0.992341	0.605916	0.114286
1.099241	0.996053	0.605284	0.117117
1.095469	0.999702	0.604656	0.119947
1.091509	1.004012	0.604031	0.122778
1.087328	1.008581	0.603408	0.125607
1.082674	1.013508	0.602793	0.128437
1.077170	1.019155	0.602185	0.131265
1.070333	1.025985	0.601578	0.134092
1.062473	1.041033	0.600961	0.136918

TABLE 5.7 Coordinates of Hobson-1 Cascade. (Profile symmetric w.r.t. the line x=0.5)

Suction surface

x/c	y/c	M	θ
0	0	0	1.0600
.0043	.0074	0.299	1.0430
.0283	.0481	0.394	1.0372
.0883	.1487	0.491	1.0285
.1206	.2018	0.540	1.0210
.1469	.2440	0.590	1.0088
.1747	.2869	0.667	.9766
.1980	.3193	0.746	.9200
.2158	.3414	0.800	.8624
.2560	.3828	0.883	.7396
.2918	.4124	0.941	.6417
.3310	.4387	1.000	.5400
.3750	.4618	1.096	.4200
.3937	.4695	1.158	.3600
.4072	.4741	1.239	.3000
.4167	.4767	1.330	.2400
.4318	.4800	1.401	.1800
.4503	.4827	1.458	.1200
.4843	.4847	1.502	.0600
.5000	.4854	1.520	.0000

Pressure surface

x/c	y/c	M	θ
0	0	0	.5003
.0282	.0112	0.323	.3479
.1343	.0434	0.394	.2502
.2103	.0608	0.418	.1987
.3312	.0803	0.439	.1200
.3612	.0838	0.442	.0996
.4179	.0873	0.444	.0600
.5000	.0909	0.447	.0000

$\theta_1 = -\theta_2 = .7600$

$M_1 = M_2 = .476$

$s/c = 1.0121$

Blade is symmetrical about mid chord
c chord
s spacing
θ flow direction

TABLE 5.8 Coordinates of Hobson-2 Cascade. (Profile symmetric w.r.t. the line x=0.5)

Suction surface

x/c	y/c	M	θ
0	0	0	.981
.0064	.0096	0.466	.980
.0167	.0249	0.515	.978
.0342	.0506	0.565	.972
.0562	.0824	0.615	.957
.0803	.1156	0.667	.928
.1069	.1496	0.719	.886
.1350	.1822	0.773	.833
.1651	.2132	0.827	.764
.1833	.2299	0.855	.719
.2063	.2488	0.883	.661
.2347	.2693	0.912	.591
.2642	.2876	0.941	.522
.2906	.3018	0.970	.462
.3174	.3141	1.005	.400
.3393	.3225	1.031	.350
.3608	.3299	1.057	.300
.3828	.3361	1.080	.250
.4054	.3413	1.100	.200
.4286	.3453	1.114	.150
.4521	.3483	1.123	.100
.4759	.3501	1.130	.050
.5000	.3507	1.132	0

Pressure surface

x/c	y/c	M	θ
0	0	0	.614
.0072	.0045	0.418	.542
.0265	.0154	0.466	.499
.0456	.0256	0.491	.471
.0727	.0387	0.515	.437
.1062	.0534	0.540	.399
.1460	.0692	0.565	.359
.1943	.0861	0.590	.313
.2087	.0906	0.596	.300
.2602	.1053	0.615	.251
.2872	.1118	0.624	.225
.3124	.1171	0.630	.200
.3371	.1217	0.635	.175
.3778	.1280	0.641	.132
.4088	.1316	0.644	.100
.4321	.1337	0.646	.075
.4550	.1351	0.647	.050
.4777	.1360	0.647	.025
.5000	.1362	0.647	0

$\theta_1 = -\theta_2 = .805$

$M_1 = M_2 = .575$

$s/c = .5259$

TABLE 5.9 Definition of leading edge coordinates x,y,z, local chord length and twist

No.	y**	x	z	c	ε[°]	
1*	0	0	0	0.40927	2.69	root
2	0.03081	0.02212	0.00069	0.38893	2.54	
3	0.06162	0.04425	0.00139	0.36861	2.37	
4*	0.12324	0.08850	0.00299	0.32794	1.97	
5	0.22964	0.16490	0.00573	0.25776	0.72	
6*	0.25504	0.18314	0.00639	0.24136	0.31	break
7	0.28044	0.19626	0.00715	0.23628	0.25	
8	0.39749	0.25674	0.01222	0.21287	-0.03	
9	0.68021	0.40284	0.02544	0.15501	-0.99	
10	0.77429	0.45145	0.03016	0.13605	-1.39	
11*	0.82162	0.47590	0.03258	0.12652	-1.65	tip

*surface is lofted linearly between defining stations 1, 4, 6 and 11

**x,y,z - coordinates in meters

TABLE 5.10b NASA SWEPT WING. LOWER SURFACE COORDINATES.

SECTION	1	2	3	4	5	6	7	8	9	10	11
$x/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
.000200	-.003547	-.003476	-.003397	-.003206	-.002958	-.002879	-.002866	-.002797	-.002541	-.002409	-.002328
.000500	-.005608	-.005496	-.005371	-.005069	-.004676	-.004553	-.004532	-.004422	-.004018	-.003810	-.003680
.001000	-.007931	-.007773	-.007596	-.007169	-.006613	-.006438	-.006410	-.006253	-.005682	-.005387	-.005205
.002000	-.011212	-.010987	-.010735	-.010129	-.009322	-.009063	-.009021	-.008793	-.007960	-.007528	-.007261
.005000	-.017291	-.016939	-.016548	-.015614	-.014195	-.013743	-.013672	-.013302	-.011933	-.011218	-.010775
.010000	-.023483	-.022964	-.022382	-.020985	-.019359	-.018848	-.018738	-.018163	-.016072	-.014999	-.014342
.020000	-.032259	-.031390	-.030407	-.028049	-.025523	-.024702	-.024570	-.023880	-.021374	-.020089	-.019300
.030000	-.038766	-.037633	-.036369	-.033349	-.029799	-.028642	-.028488	-.027681	-.024739	-.023229	-.022302
.040000	-.043880	-.042560	-.041103	-.037614	-.033208	-.031771	-.031602	-.030720	-.027513	-.025868	-.024859
.050000	-.048264	-.046801	-.045172	-.041291	-.035948	-.034202	-.034022	-.033082	-.029664	-.027909	-.026832
.060000	-.051967	-.050389	-.048634	-.044463	-.038415	-.036448	-.036257	-.035256	-.031613	-.029740	-.028590
.070000	-.055073	-.053425	-.051593	-.047250	-.040635	-.038480	-.038278	-.037221	-.033374	-.031399	-.030185
.080000	-.057807	-.056120	-.054247	-.049808	-.042507	-.040123	-.039914	-.038823	-.034856	-.032820	-.031572
.090000	-.060275	-.058555	-.056646	-.052120	-.044148	-.041550	-.041336	-.040221	-.036163	-.034078	-.032799
.100000	-.062461	-.060707	-.058761	-.054149	-.045697	-.042949	-.042730	-.041583	-.037405	-.035256	-.033937
.110000	-.064380	-.062599	-.060622	-.055939	-.047159	-.044308	-.044082	-.042898	-.038585	-.036365	-.035002
.120000	-.066088	-.064286	-.062288	-.057556	-.048499	-.045558	-.045326	-.044109	-.039677	-.037397	-.035999
.150000	-.070273	-.068462	-.066454	-.061707	-.051711	-.048467	-.048227	-.046968	-.042384	-.040028	-.038581
.200000	-.073979	-.072242	-.070317	-.065777	-.055562	-.052265	-.052006	-.050651	-.045705	-.043157	-.041592
.250000	-.074981	-.073407	-.071667	-.067562	-.057958	-.054864	-.054591	-.053168	-.047971	-.045297	-.043655
.300000	-.074187	-.072800	-.071265	-.067651	-.058994	-.056212	-.055941	-.054519	-.049336	-.046667	-.045027
.350000	-.071886	-.070726	-.069444	-.066429	-.059144	-.056810	-.056533	-.055088	-.049814	-.047096	-.045427
.400000	-.068295	-.067375	-.066360	-.063978	-.058127	-.056258	-.055989	-.054578	-.049434	-.046786	-.045160
.450000	-.063793	-.063093	-.062321	-.060511	-.056168	-.054787	-.054530	-.053187	-.048287	-.045766	-.044217
.500000	-.058481	-.057903	-.057353	-.056066	-.052991	-.052014	-.051770	-.050491	-.045832	-.043436	-.041965
.550000	-.052688	-.052273	-.051815	-.050742	-.048168	-.047346	-.047129	-.045995	-.041873	-.039759	-.038462
.600000	-.046539	-.046109	-.045653	-.044512	-.041789	-.040912	-.040739	-.039833	-.036547	-.034864	-.033833
.650000	-.040423	-.039856	-.039227	-.037740	-.034100	-.032921	-.032791	-.032105	-.029618	-.028347	-.027569
.700000	-.034424	-.033642	-.032774	-.030720	-.025668	-.024033	-.023948	-.023502	-.021890	-.021071	-.020570
.750000	-.028441	-.027410	-.026267	-.023556	-.016888	-.014730	-.014693	-.014505	-.013832	-.013495	-.013289
.800000	-.022629	-.021392	-.020019	-.016766	-.008763	-.006173	-.006173	-.006169	-.006166	-.006174	-.006179
.850000	-.017036	-.015722	-.014263	-.010809	-.002316	.000433	.000417	.000334	.000020	-.000148	-.000253
.900000	-.011728	-.010559	-.009262	-.006194	.001350	.003794	.003773	.003664	.003252	.003035	.002901
.950000	-.006746	-.006020	-.005216	-.003312	.001364	.002883	.002871	.002811	.002584	.002463	.002388
.970000	-.004949	-.004494	-.003991	-.002801	.000122	.001071	.001067	.001042	.000946	.000895	.000863
.980000	-.004064	-.003769	-.003442	-.002669	-.000771	-.000154	-.000152	-.000149	-.000137	-.000132	-.000129
.990000	-.003252	-.003125	-.002986	-.002655	-.001843	-.001580	-.001573	-.001543	-.001431	-.001374	-.001338
.995000	-.002893	-.002853	-.002808	-.002702	-.002443	-.002359	-.002351	-.002311	-.002166	-.002090	-.002044
1.000000	-.002555	-.002600	-.002650	-.002769	-.003064	-.003160	-.003151	-.003104	-.002932	-.002843	-.002787

TABLE 5.10a NASA SWEPT WING. UPPER SURFACE COORDINATES.

SECTION	1	2	3	4	5	6	7	8	9	10	11
$x/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$	$z/c(y)$
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
.000200	.003600	.003542	.003479	.003328	.003001	.002894	.002879	.002806	.002537	.002397	.002311
.000500	.005692	.005600	.005500	.005262	.004744	.004576	.004553	.004437	.004011	.003789	.003654
.001000	.008049	.007919	.007778	.007442	.006709	.006471	.006439	.006275	.005672	.005359	.005167
.002000	.011253	.011068	.010863	.010382	.009397	.009072	.009027	.008799	.007957	.007519	.007250
.005000	.017358	.017043	.016696	.015875	.014297	.013780	.013707	.013326	.011922	.011192	.010740
.010000	.023488	.023010	.022483	.021244	.019315	.018656	.018560	.018061	.016207	.015234	.014632
.020000	.031736	.030856	.029885	.027610	.025891	.025298	.025172	.024518	.022087	.020812	.020022
.030000	.037727	.036540	.035226	.032128	.030213	.029559	.029411	.028641	.025777	.024273	.023339
.040000	.042240	.040853	.039316	.035679	.033554	.032829	.032668	.031823	.028683	.027032	.026008
.050000	.046024	.044484	.042776	.038725	.036459	.035689	.035513	.034596	.031184	.029392	.028281
.060000	.049136	.047496	.045673	.041338	.038861	.038025	.037840	.036871	.033267	.031371	.030196
.070000	.051706	.050010	.048122	.043624	.040929	.040020	.039828	.038821	.035073	.033102	.031880
.080000	.053860	.052147	.050239	.045684	.042850	.041893	.041694	.040649	.036761	.034719	.033452
.090000	.055684	.053987	.052095	.047572	.044640	.043651	.043443	.042362	.038337	.036222	.034911
.100000	.057246	.055589	.053740	.049313	.046275	.045252	.045038	.043922	.039772	.037591	.036240
.110000	.058580	.056980	.055194	.050911	.047768	.046711	.046491	.045344	.041082	.038842	.037455
.120000	.059718	.058187	.056475	.052366	.049138	.048052	.047827	.046654	.042293	.040002	.038583
.150000	.062228	.060930	.059474	.055973	.052659	.051543	.051307	.050073	.045490	.043083	.041590
.200000	.064421	.063541	.062552	.060154	.057102	.056064	.055814	.054502	.049629	.047073	.045489
.250000	.065019	.064494	.063900	.062447	.060257	.059496	.059231	.057840	.052679	.049973	.048296
.300000	.064513	.064272	.063995	.063297	.062143	.061718	.061444	.060005	.054671	.051873	.050141
.350000	.062712	.062742	.062767	.062790	.063094	.063140	.062858	.061387	.055926	.053064	.051291
.400000	.059904	.060210	.060542	.061295	.063278	.063872	.063590	.062112	.056635	.053763	.051986
.450000	.056203	.056815	.057486	.059052	.062740	.063893	.063607	.062110	.056561	.053654	.051855
.500000	.051998	.052852	.053796	.056010	.061335	.063025	.062747	.061290	.055887	.053055	.051300
.550000	.047415	.048504	.049709	.052548	.059438	.061642	.061374	.059969	.054757	.052027	.050336
.600000	.042583	.043865	.045286	.048643	.056842	.059479	.059221	.057870	.052858	.050231	.048604
.650000	.037778	.039196	.040769	.044489	.053608	.056551	.056311	.055055	.050390	.047943	.046427
.700000	.032775	.034281	.035951	.039908	.049635	.052784	.052566	.051419	.047163	.044931	.043548
.750000	.027797	.029304	.030979	.034947	.044723	.047895	.047704	.046702	.042980	.041025	.039811
.800000	.022669	.024103	.025694	.029468	.038781	.041658	.040868	.037931	.036385	.036385	.035426
.850000	.017679	.018927	.020314	.023604	.031731	.034377	.034263	.033669	.031453	.030285	.029560
.900000	.012578	.013543	.014614	.017755	.023440	.025489	.025414	.025020	.023550	.022775	.022293
.950000	.007555	.008135	.008779	.010205	.014083	.015316	.015279	.015093	.014594	.014024	.013794
.970000	.005553	.005941	.006372	.007394	.009922	.010746	.010727	.010626	.010246	.010044	.009919
.980000	.004552	.004839	.005059	.005917	.007790	.008401	.008385	.008300	.007982	.007815	.007711
.990000	.003552	.003727	.003922	.004384	.005526	.005899	.005885	.005812	.005544	.005403	.005316
.995000	.003051	.003163	.003288	.003583	.004311	.004549	.004538	.004476	.004251	.004134	.004061
1.000000	.002551	.002597	.002648	.002768	.003064	.003160	.003152	.003104	.002932	.002843	.002787

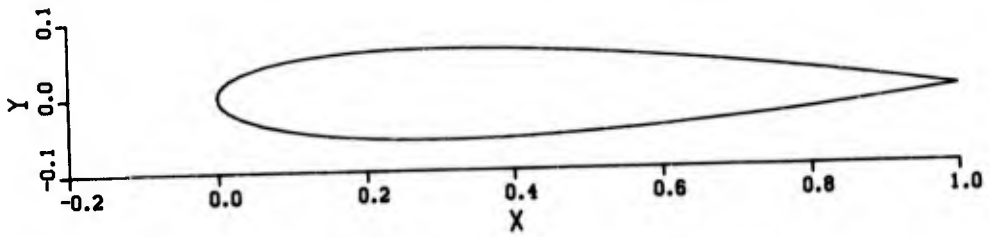


FIG. 5.1(a): AIRFOIL NACA0012, USED FOR TEST CASES (1) – (5)

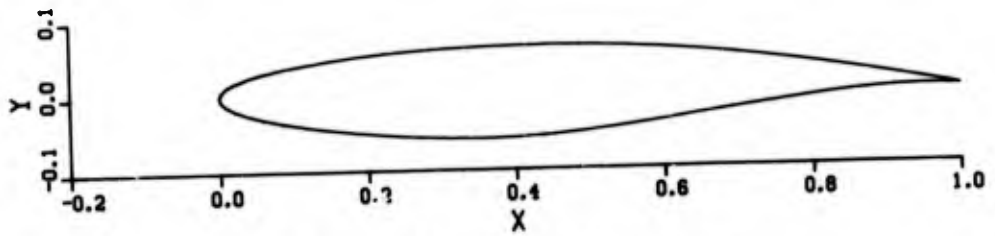


FIG. 5.1(b): AIRFOIL RAE2822, USED FOR TEST CASE (6)

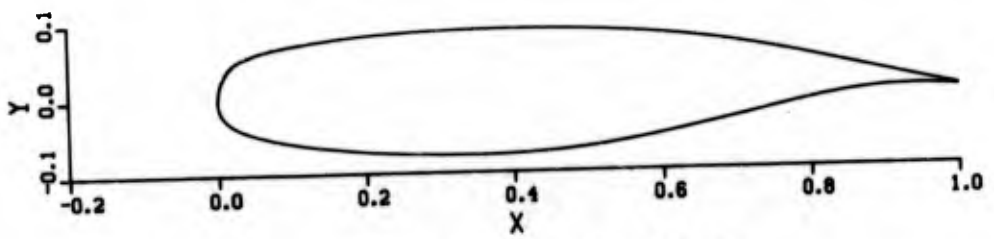


FIG. 5.1(c): AIRFOIL NLR7301, USED FOR TEST CASE (7)

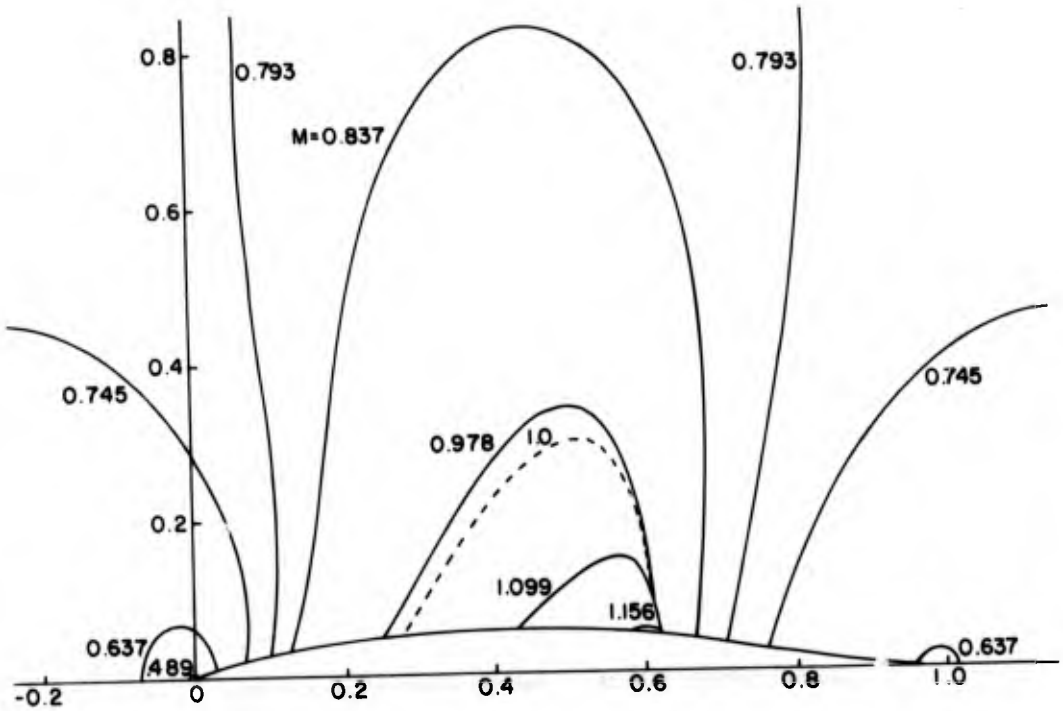


FIG. 5.2: ISOMACH LINES, M_∞ = 0.769, CHIOCCHIA-NOCILLA PROFILE

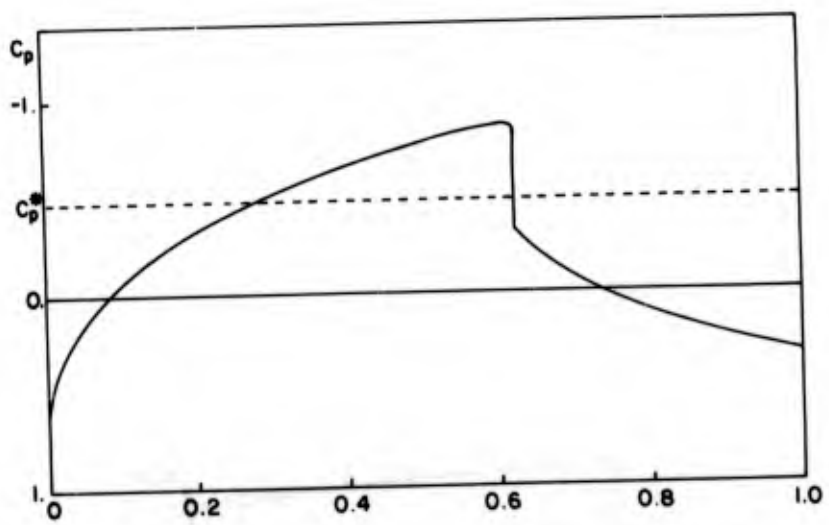


FIG. 5.3: PRESSURE COEFFICIENT, M_∞ = 0.769, CHIOCCHIA-NOCILLA PROFILE

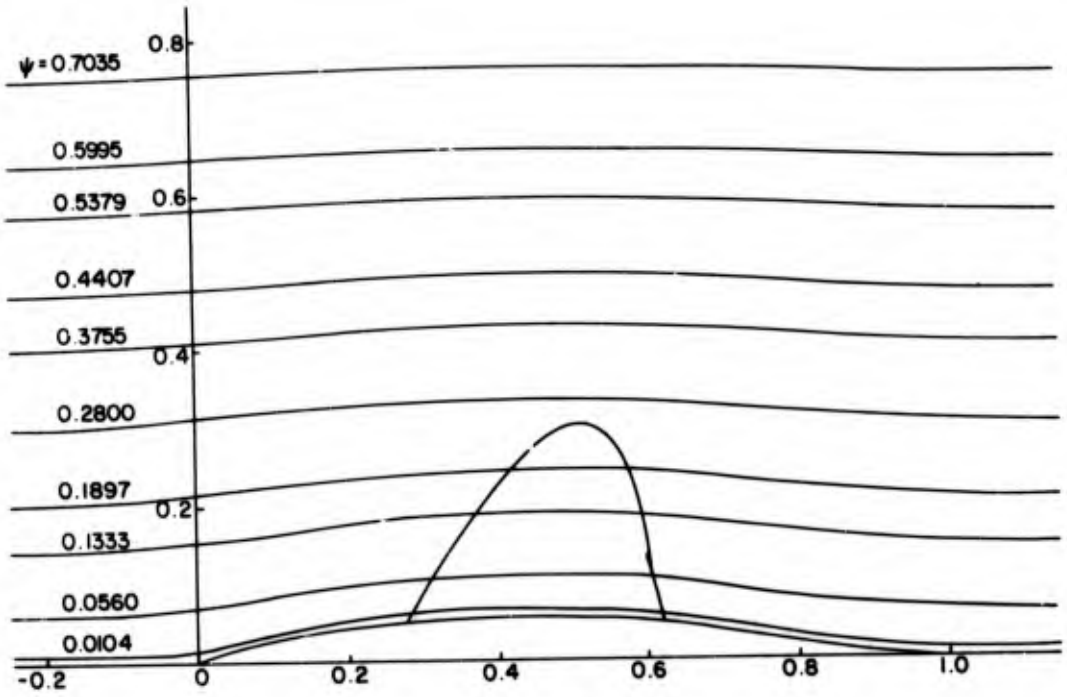


FIG. 5.4: STREAMLINES, M_∞ = 0.769, CHIOCCHIA-NOCILLA PROFILE

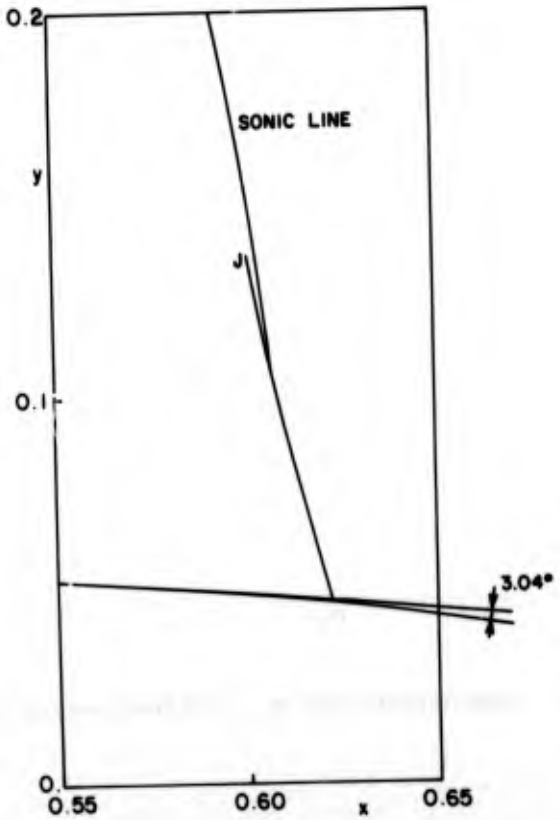


FIG. 5.5: SHOCK REGION, M_∞ = 0.769, CHIOCCHIA-NOCILLA PROFILE

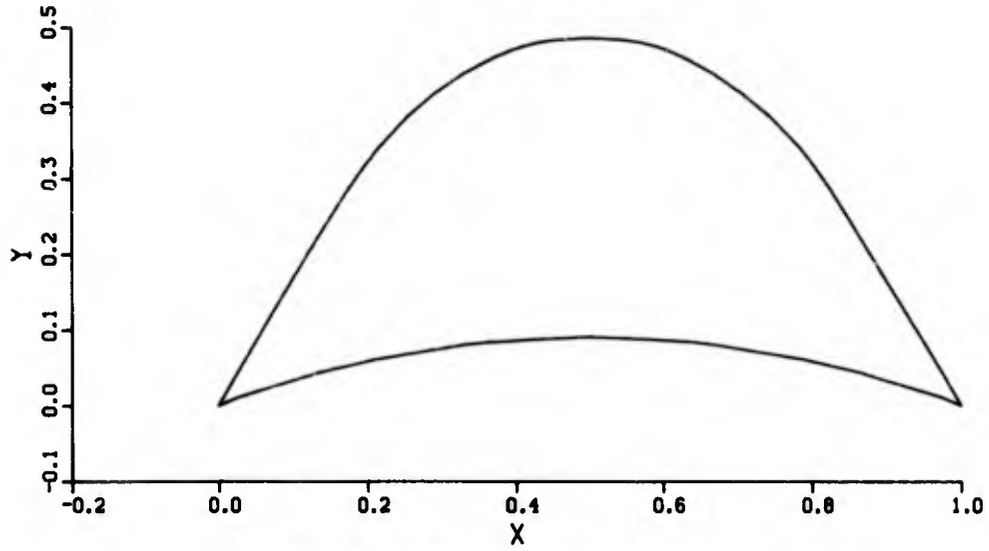


FIG. 5.6(a): HOBSON CASCADE-1, TEST CASE (9)

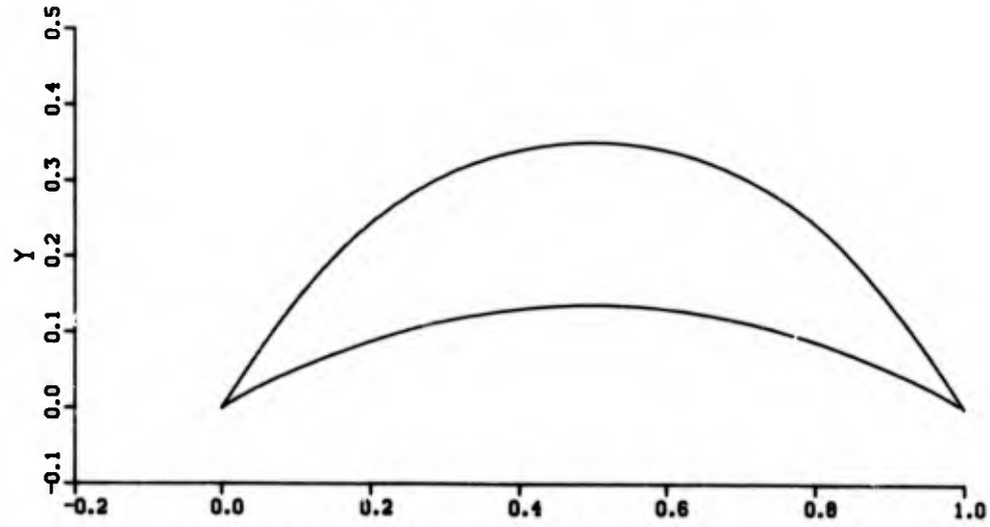


FIG. 5.6(b): HOBSON CASCADE-2, TEST CASE (10)

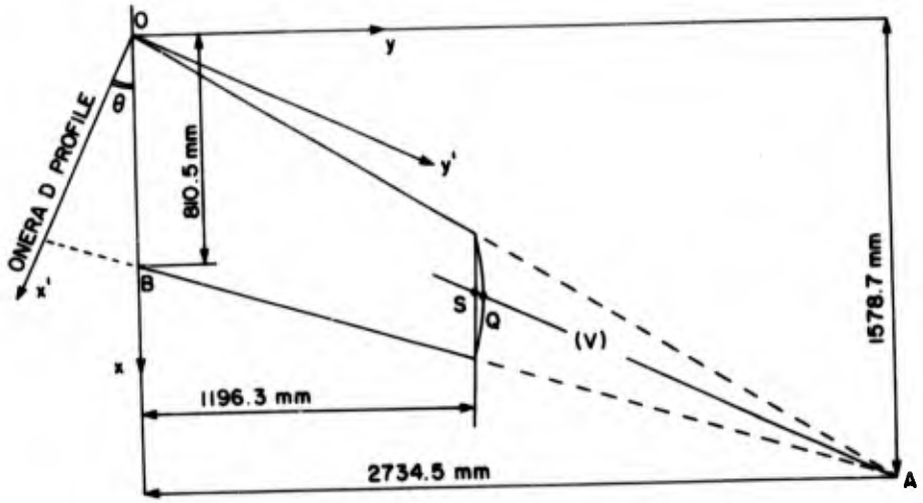


FIG. 5.7: PLANFORM OF WING M6 (With Extended Profile D)

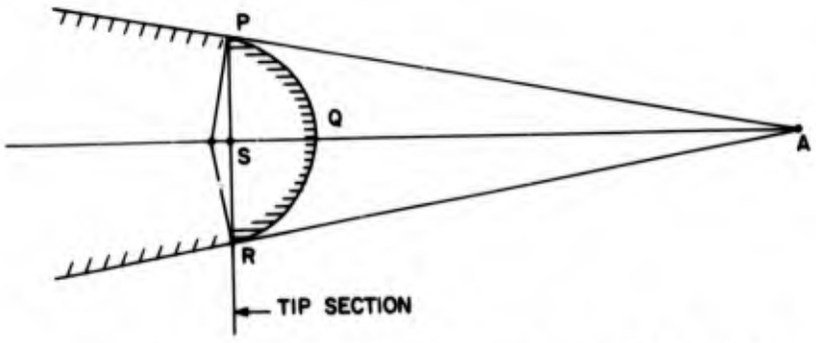
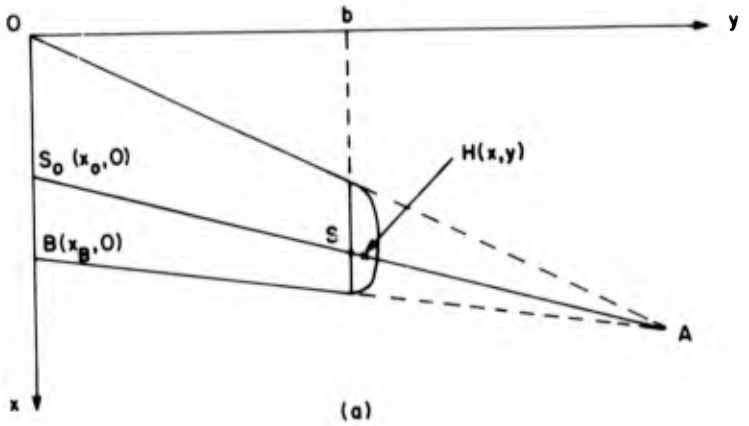
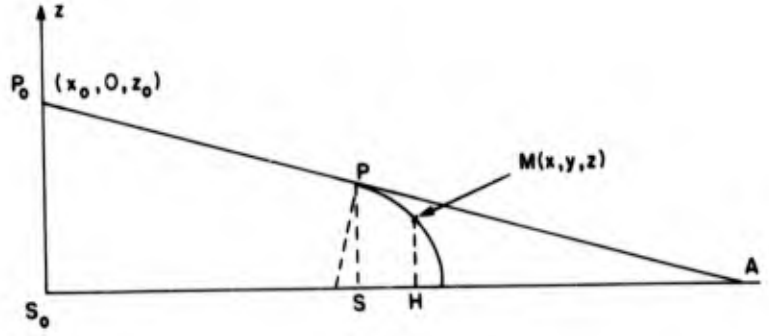


FIG. 5.8: DEFINITION OF THEORETICAL ROUNDED TIP: CIRCULAR ARC PQR IN VERTICAL PLANE(V) (Not to Scale)

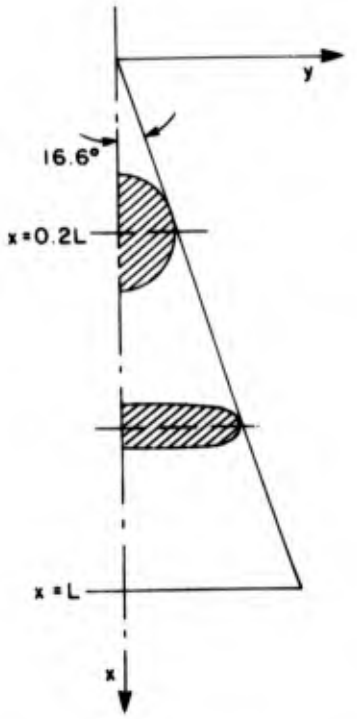


(a)



(b)

FIG. 5.9: SKETCHES TO DETERMINE EQUATIONS FOR ROUNDED WING TIP OF ONERA-M6 (Not to Scale)



SURFACE DEFINITION:

$$\frac{y^2}{a^2(x)} + \frac{z^2}{b^2(x)} = 1$$

$$a(x) = \frac{x}{\beta}$$

$$\beta^2 = M_\infty^2 - 1 \text{ for } M_\infty = 3.5$$

$$b(x) = \begin{cases} \frac{x}{\beta} & \text{for } 0 < x \leq 0.2L \\ \frac{x}{\beta}\left(1 - \left(\frac{x - 0.2L}{0.8x}\right)^4\right) & \text{for } 0.2L < x \leq L \end{cases}$$

FIG. 5.10: TEST CASE 13. BUTLER WING

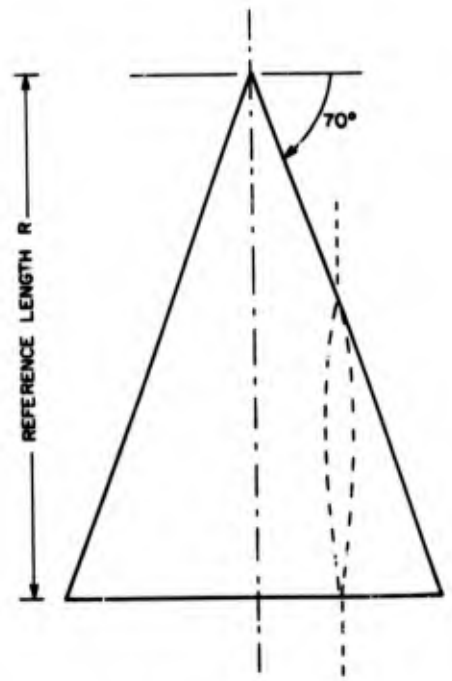


FIG. 5.11: TEST CASES 14 AND 15. DILLNER WING

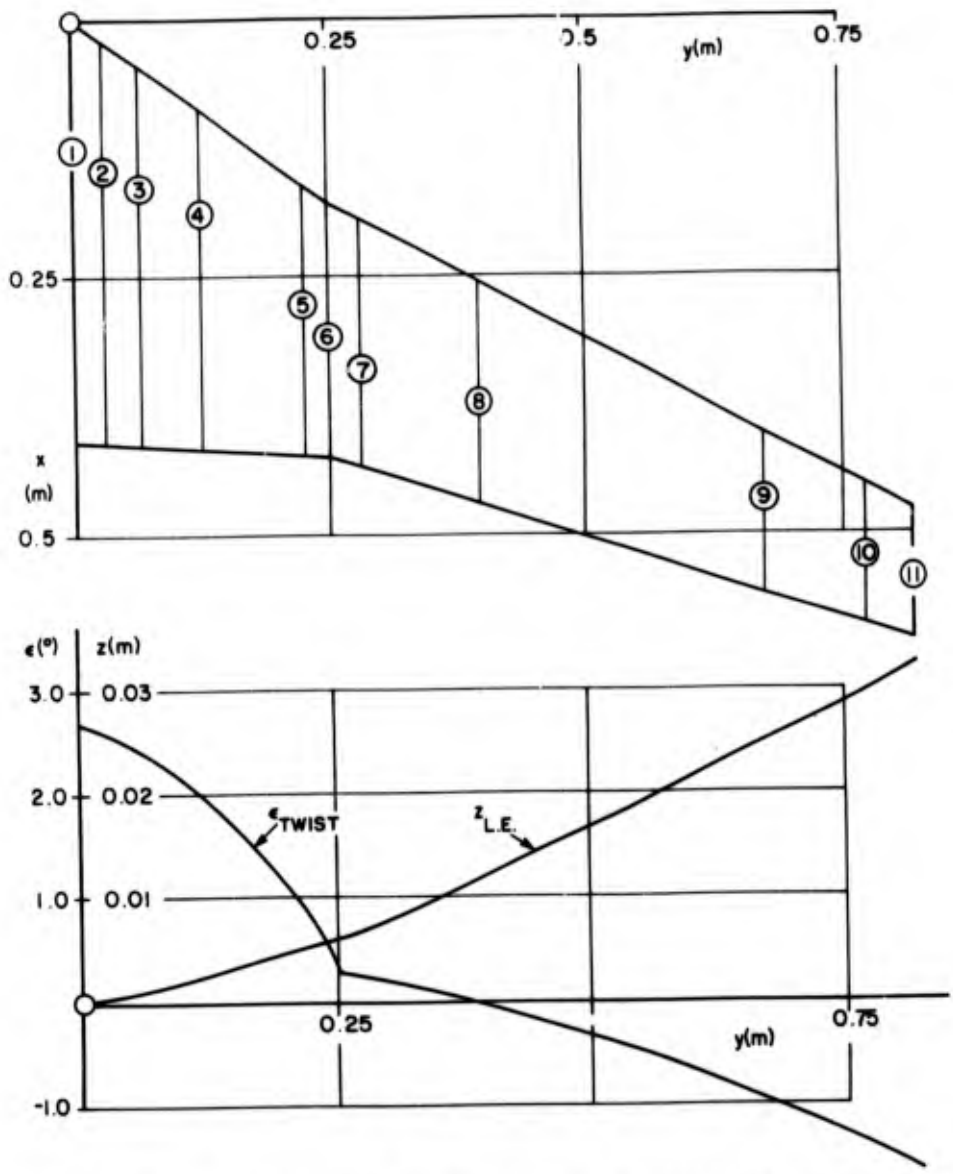


FIG. 5.12: NASA AMES SWEPT WING. PLANFORM, TWIST AND LEADING EDGE DIHEDRAL

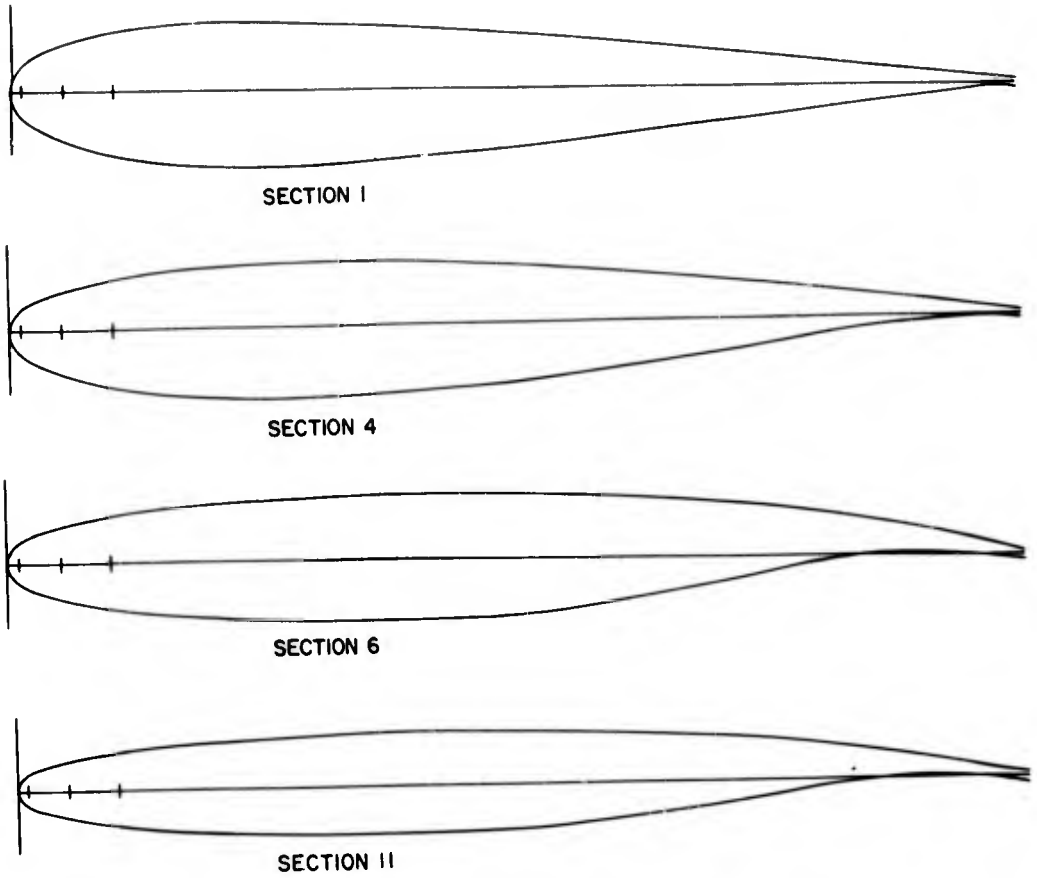
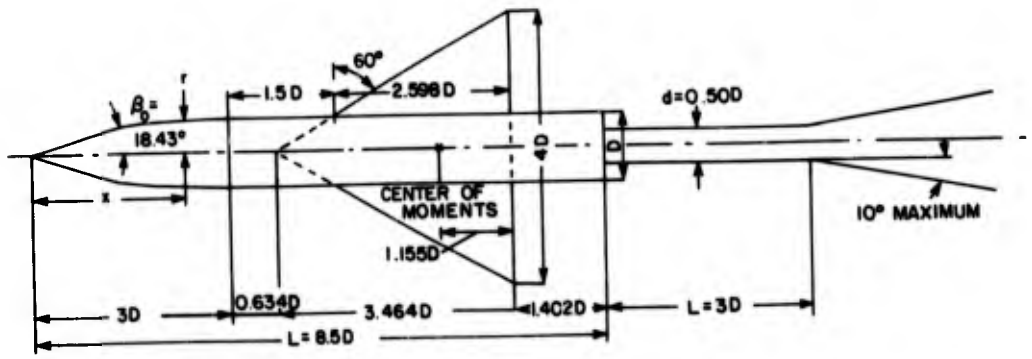


FIG. 5.13: NASA AMES SWEPT WING. PLOTS OF DEFINING SECTIONS 1, 4, 6, 11



Wing profile: symmetrical circular arc section. Thickness ratio = 0.04

Nose profile: length 3D. Equation of curve: $r = \frac{x}{3}\left[1 - \frac{1}{9}\left(\frac{x}{D}\right)^2 + \frac{1}{54}\left(\frac{x}{D}\right)^3\right]$

FIG. 5.14: TEST CASES 17-20. AGARD CALIBRATION MODEL B

6. NUMERICAL SOLUTIONS OF TWO-DIMENSIONAL REFERENCE TEST CASES (H. VIVIAND)

Nomenclature

c : chord length, used as reference length
C_D : drag coefficient
C_L : lift coefficient
C_M : pitching moment coefficient with respect to the 1/4 chord-y-axis.
C_p, or CP : pressure coefficient
M, or MACH : Mach number
p, or P : local static pressure
p_i, or PI : local total pressure defined from p and M by : $p_i = p\left[1 + (\gamma - 1)M^2/2\right]^{\gamma/(\gamma-1)}$
$p_{i\infty}$, or PIINF : free-stream total pressure
T : local absolute temperature
T_i, or TI : local total temperature, $T_i = T\left[1 + (\gamma - 1)M^2/2\right]$, ($T_i = T_{i\infty}$ for the exact solutions)
$T_{i\infty}$, or TIINF : free-stream total temperature
$\vec{U}$: velocity vector
x, y, z : cartesian coordinates ; the plane of the flow is (x, z)
ρ : density
γ : specific heat ratio, taken equal to 1.4

6.1. Introduction

The objective of this chapter is to present selected numerical solutions of the two-dimensional reference test cases, and to attempt to assess the quality if not the absolute accuracy of these solutions.

In the cases when an exact solution is known, direct comparison is possible, but these cases either are shockless flows, or present certain peculiarities. For typical transonic flow with shocks past a profile, no exact solution is known, and the assessment of the quality and accuracy of a numerical solution rests largely upon physical or empirical criteria.

The numerical methods used to solve the Euler equations are not taken into consideration in the present discussion, and the numerical solutions available for a given test case are evaluated essentially through cross-comparisons of these solutions and by taking into account some known features of the exact (unknown) solution.

Ideally, the objective could be considered as achieved only if i) perfect agreement were found between several numerical solutions obtained by different methods and using fine enough meshes, and ii) the reasons for disagreement of other numerical solutions were clearly shown. The present evaluation, based on a significant number of numerical solutions, can be considered as a first step toward this objective.

6.2. Data used for assessment of solutions

The contributors were asked to provide the following information and data concerning their numerical solutions :

a) Computational domain and mesh

- mesh topology (C, O or H type).
- number of mesh points (or cells) in each mesh direction.
- number of mesh points (or cells) on the body.
- views of the mesh showing mesh size variations from the wall to the far field.
- partial views of the mesh showing mesh refinements.
- distance of outer boundary in appropriate directions.

b) Convergence of the numerical solution

All the numerical solutions made available to the Working Group for the 2D test cases have been obtained by time-marching methods. The degree of convergence toward a steady state is a possible source for discrepancies between solutions. To check this, we asked the following data :

- plots of the root-mean-square values and maximum absolute values of the residuals for each of the equations solved, as functions of the iterations. Residuals are understood as measuring the accuracy with which the steady discrete equations are satisfied and, in some sense, are equivalent to time-derivatives.

- plots of the lift, drag and pitching moment coefficients versus iterations.

c) Global quantities

- lift coefficient
- drag coefficient
- pitching moment coefficient (with respect to the 1/4 chord axis).

These coefficients are to be obtained from integration of wall pressure.

- dimensionless circulation around the airfoil or the blade (referred to U_∞, c).

d) Surface values

- tabulated values of the following quantities :

$1 - p/p_{i\infty}$, C_p, M, $1 - p_i/p_{i\infty}$, $1 - T_i/T_{i\infty}$ (if relevant)

- plots of the same quantities versus x/c and versus z/c.

e) Flow field (if possible)

- contour maps of the following quantities :

$$M,\ p/p_{i\infty},\quad p_i/p_{i\infty},\quad T_i/T_{i\infty}\quad \text{(if relevant)}$$

- local contour maps with enlarged scales in regions of large gradients such as the leading-edge region.

- for test case 03, plots of $1 - p/p_{i\infty}$, M, $1 - p_i/p_{i\infty}$, versus x/c on the downstream x-axis.

- for test cases 04 and 05, plots of the same quantities versus x/c on the upstream x-axis.

- calculations of the resulting aerodynamic force and moment on the body based on momentum flux balance across various closed contours surrounding the body. Such calculations provide an accuracy check for the flow field. Another global check can be made on the mass flux (which must be zero) across such a contour. Unfortunately, these checks require much work and in fact were not carried out by any of the contributors.

6.3. Solution assessment procedure

We now describe the general approach which has been followed to compare and evaluate the various numerical solutions available for each test case.

Two kinds of criteria or checks can be distinguished. The first one is that of rigorous criteria which result from known properties of the exact (unknown) solution and which provide a quantitative partial measure of the error with respect to this exact solution. The second kind of criteria group all those which are based on cross-comparisons of numerical solutions, with the underlying hypothesis that the scatter of a large enough number of seemingly good solutions is representative of the uncertainty on the error with respect to the exact solution.

For criteria of the first kind, the most obvious properties of the exact solution which can be used are the following :

a) The total enthalpy is uniform over the the whole flow field (Bernoulli's relation). This property provides a criterion only if the numerical method does not use the Bernoulli relation directly to eliminate the energy equation, as it is most often the case (pseudo-unsteady method). Only three contributors do not use the Bernoulli relation in the flow field, and one of the three uses it at the wall. Therefore this property has been of limited interest in the present evaluation.

b) Upstream of shocks, the total pressure $p_{i\infty}$ is equal to its free-stream value $p_{i\infty}$. It is important to clearly state how this property has been used practically, because in some of the solutions obtained by finite-volume methods the given wall value of p_i has been (or seems to have been) extrapolated from values at inner points close to the wall. Here we have determined the wall value of p_i as a function of the given wall values of p and M according to the formula given in the nomenclature ; comparing this value of p_i to $p_{i\infty}$ then provides a check on the consistency of the wall values of p and M. The plots and tabulated values of $(1 - p_i/p_{i\infty})$ given in the following sections correspond to the value of p_i calculated in this way, and therefore may differ from the values of p_i given by the author.

c) The shock which terminates a supersonic region in transonic flow past a smooth airfoil is normal to the wall (except if the shock is at the trailing-edge), and we can compare the pressure and Mach number jumps at the wall in the numerical solution with the Rankine-Hugoniot jumps for a normal shock. More precisely, taking the numerical value of the Mach number just upstream of the shock, M_1, as given upstream value in the Rankine-Hugoniot relations, we compute the downstream value of the Mach number, M_2, and the ratio of downstream static pressure to upstream total pressure, p_2/p_{i_1}, and we compare these values to the corresponding ones from the numerical solution. One must be careful of the fact that, whereas for the exact solution $p_{i_1} = p_{i\infty}$, in the numerical solution p_{i_1} differs more or less from $p_{i\infty}$ due to numerical errors (numerical gain or loss of entropy). Therefore, in order to separate the error in pressure jump from the error in upstream total pressure, we have determined the value of p_2/p_{i_1} for the numerical solution as :

$$p_2/p_{i_1} = (p_2/p_{i\infty})\ (p_{i\infty}/p_1)\ \left[1 + (\gamma - 1)M_1^2/2\right]^{-\gamma/(\gamma-1)}$$

This point was overlooked at the beginning ; for those results which have a rather large error on p_i upstream of shocks, the pressure jump was found more accurate after the correction was made.

The upstream and downstream points of the shock in the numerical solution are defined as the local true maximum and minimum values of the Mach number, even if oscillations are present. If a local minimum does not exist, we take the point at which a break occurs in the Mach number distribution.

For a shock arising normally on a smooth curved wall, the flow properties at the wall just downstream of the shock exhibit the so-called Zierep singularity. This singularity, corresponding to infinite derivatives in the tangential direction, is a source of difficulty, and it is not clear how the errors in the numerical representations of the shock itself on the one hand and of the Zierep singularity on the other hand interfere. No attempt has been made to separate these two sources of errors in the evaluation of shock quality.

d) As already mentioned, the resulting force and moment can be evaluated from momentum flux balance across arbitrary closed contours surrounding the body. Variations in the values obtained with different contours provide a measure of error in the flow field.

Practically, it has not been possible to make use of all these criteria, and in particular no check using criterion d) was made. We essentially considered the total pressure at the wall upstream of shocks and the shock jumps.

The second kind of criteria groups all those which are based on cross-comparisons of numerical solutions. These comparisons allow to see the influence of various factors which characterize a particular numerical solution, besides the numerical scheme itself : mesh size, mesh variations in space, artificial

viscosity (nature and amount), location of outer boundary, numerical treatment at boundaries. Features we looked at for such comparisons were essentially the aerodynamic coefficients of lift, drag and pitching moment, the circulation around the airfoil, the shock position and shock quality (sharpness, absence of oscillations), and more generally the pressure and Mach number distributions at the wall. In the second kind of criteria, we can also include the convergence of the numerical solution towards a steady state.

Based on these two kinds of criteria, the assessment procedure can be developed by stages, going from the more obvious global or local features to more detailed examination of pressure, Mach number and total pressure distributions. However, owing to the large number of test cases, it was not materially possible to take full advantage of all the material available concerning the numerical solutions ; in particular detailed comparisons of flow fields through the contour maps of isobars and of iso-Mach lines were not carried out, nor detailed comparisons of the meshes.

In the general case, the assessment procedure can be decomposed into three successive stages described below.

Stage 1 : The aerodynamic coefficients C_L, C_D, C_M, and the circulation Γ (when available) are plotted for all the numerical solutions, the contributor's number being used as abscissa. These plots allow to quickly see how the solutions group together. In general, there exists a homogeneous group made of the majority of the solutions, and only a few isolated points clearly standing apart from this main group (although not necessarily the same on all the plots). Then we try to find out whether these singular points can be explained by simple reasons, and firstly by the mesh coarseness and by the closeness of the outer boundary.

Concerning the influence of the distance of the outer boundary, one must distinguish broadly between two types of conditions applied on the inflow part of this boundary :

i) all the flow properties are imposed equal to their free-stream values,

ii) Only some of the flow properties are imposed equal to their free-stream values, or some asymptotic representations of the flow field are used, while the additional necessary informations are obtained from some compatibility relations or some non-reflective type relations.

It is not possible in this evaluation to make a finer discrimination between different treatments of the second type, although it could be of interest. The essential point here is that, with conditions of type i), the outer boundary must be located much further away from the body than with conditions of type ii) for an equivalent accuracy. A numerical study by Pulliam and Barton (see their contribution in Appendix A1) gives indications on the sensitivity of the solution to outer boundary distance with conditions i).

In general, we find a clear correlation between these few singular points and the two following factors : mesh coarseness,and closeness of outer boundary taking into account the above remark. On the contrary, the degree of convergence towards a steady state does not seem to play a role for explaining these points.

Thus, stage 1 of the evaluation aims only at uncovering these singular solutions, so as to be left with a more homogeneous group of results which hereafter shall be called group 1.

Stage 2 : For some test cases (but not for all), group 1 includes more than one solution from some contributors. These multiple solutions are of interest to evaluate the effects of factors such as mesh size, mesh refinements, outer boundary distance, amount of artificial viscosity...

Stage 2 of the evaluation consists in comparing these multiple solutions furnished by the same contributor and in determining the best one using the criteria discussed above. By selecting only one solution per contributor in the solutions of group 1, we obtain group 2.

We noticed, as a general trend, that the variations on the aerodynamic coefficients and on local features (shock positions...) between the multiple solutions coming from the same contributor were generally smaller than the global scatter of group 1. This means that the global scatter of group 1 is due to solutions coming from different contributors, and that the global scatter is about the same for group 1 and for group 2.

A general conclusion which can be drawn from stage 2 is that, although we do get indications on the sensitivity of the numerical solutions to some of the numerical parameters, the number of these multiple solutions is not yet sufficient to quantitatively assess the effects of these parameters and to be able to conclude definitively, just from numerical experiments, as to the convergence towards the exact solution. It is clear that we do not have yet a real control over all the numerical parameters, and more systematic and costly studies are necessary.

Stage 3 : In this last stage, we try to discriminate more sharply between the solutions of group 2, and to see whether one or several of them stand out as best solutions constituting group 3. In particular, we look at the error on total pressure upstream of shocks, and at the shock quality (sharpness, absence of oscillations, shock jumps).

The convergence to a steady state, evaluated from the convergence histories of the aerodynamic coefficients (not always available) and from the residuals, appears to be almost always satisfactory. However, we do not know in a quantitative way the influence on the solution of a small defect of convergence. When the maximum residuals are reduced below 10^{-6}, there is no doubt on the steadiness of the numerical solution ; but in many cases the final maximum values of residuals are of the order of 10^{-3}, and we cannot be sure that the influence on the solution is completely negligible. All we can say is that, except for one or two instances where convergence was suspect, we did not notice any correlation between degree of convergence on the one hand and accuracy of the solution, as deduced from other features, on the other hand.

The following sections relate to the assessment of the solutions to the different test cases. It is not possible, because of space limitation, to give all the details of these evaluations and still less to

present all the numerical solutions. Rather we try to give a summary presentation starting with the solutions of group 2. The list of these solutions is given in a table together with the main features of the mesh and the values of the aerodynamic coefficients and of the circulation (when available). Plots of the wall distributions of pressure p, Mach number M and total pressure p_i are shown for all the solutions of group 2. Tabulated values of these quantities are given for one solution of group 3 only except for test cases 07 and 05 for which two solutions of group 3 are tabulated. Moreover the complete sets of the data supplied by the contributors are given in microfiche form in Appendix A1 for all the solutions of group 2.

Exceptions are made for the presentation of test cases 07 to 10, which are the test cases for which exact (or almost exact) solutions are known. For test cases 08 to 10, there are only a few numerical solutions available so that the general assessment procedure does not really apply in the form described above, and we give all these solutions. As to test case 07, we choose it as an example for a more complete presentation of the numerical solutions (in particular listing all the solutions available), and we present it first in the next section.

In the following sections, the numerical solutions will be referred to by numerals ; the correspondence between the author(s) and this numeral has been given in section 5.1.3.

6.4. Reference test case 07 (NLR 7301, $M_\infty = 0.720957$, $\alpha = -0.194°$)

This is a special test case corresponding to a supercritical shockless flow for which the exact solution is known. A physical picture of the flow is given by the maps of iso-Mach lines shown on Fig. 6.11 and taken from the numerical solution N° 9.2.

This case is chosen as example for a more complete presentation of the evaluation and of the comparison of the numerical solutions. All the numerical solutions supplied for this test case are listed in table 6.1. Each solution is referred to by a number, the integer part being the contributor's number and the digit following the decimal point being used to distinguish between the multiple solutions from the same contributor. The distance of the outer boundary (measured in chords) is characterized either by three numbers a/b/c for C-type meshes, where a and c are respectively the upstream and downstream distances from the leading-edge and b is the lateral distance, or, for O-type meshes, by one number representing the mean distance from the airfoil. The symbol "FS" following these numbers means that the conditions on the inflow part of the outer boundary are of type i) (§ 6.3), namely all the flow properties imposed equal to free-stream values (this is the case for solutions N° 4 and 5 only).

It should be noted that solution N° 10 has been calculated with a value of the incidence different from the design value, namely $\alpha = 0.244°$ instead of $\alpha = -0.194°$, which is an important variation.

On the bottom line of table 6.1., we give the values of the aerodynamic coefficients for the exact solution, calculated by numerical integration of wall values. The drag coefficient is not found to be strictly zero, but is equal to 0.5×10^{-3} ; therefore values of this order of magnitude given by the numerical solutions should be considered as quite satisfactory.

The plots of the aerodynamic coefficients and of the circulation are given on Figs. 6.1 to 6.4. The exact value is shown by the horizontal line, but we wish to evaluate the numerical solutions without using the exact solution, except for a posteriori comparisons.

On each of the plots of the aerodynamic coefficients (Figs. 6.1 to 6.3), we can distinguish between the main group of results, and some isolated points apart from this main group which are :

solutions N° 4, 5, 7 for C_L,
solutions N° 4, 7, 10 for C_D,
solution N° 5 for C_M.

On the plot of the circulation (Fig. 6.4), many points are missing, nevertheless solution N° 5 can be considered as a singular point. Thus we define group 1 as made of all the solutions except N° 4, 5, 7 and 10. An additional reason for not including N° 10 in group 1 is the fact it corresponds to an incidence quite different from the design incidence. The global scatters of C_L and C_M in group 1 are :

$\Delta C_L = 0.084$, $\Delta C_L/C_L = 14\ \%$
$\Delta C_M = 0.007$, $\Delta C_M/|C_M| = 5\ \%$

and the maximum value of C_D in group 1 is 2.8×10^{-3}.

Solutions N° 10, 7 and 4 are those with the coarsest meshes at the airfoil, and solution N° 7 has the closest outer boundary. For solutions N° 4 and 5, the outer boundary (at least the inflow part for N° 5) is not very far, and we can suspect that this is the main reason why these solutions stand apart in view of the conditions of type i) (see discussion in § 6.3.) which are applied on the inflow boundary. Many other solutions of group 1 involve outer boundaries which are also rather close to the airfoil but they use conditions of type ii).

As to the effect of the mesh size, we see that solutions N° 8.1 and 8.2 do not use many more points on the airfoil than solutions N° 4 and 7. However, we must look more closely at the distribution of points on the airfoil ; in particular the mesh fineness in the leading-edge region could play an important role due to the bluntness of the leading-edge. Solutions N° 8.1 and 8.2 have the same total number of points on the airfoil, but their distributions are quite different, with a finer mesh in the leading-edge region for solution N° 8.2. To characterize the mesh fineness in this region, we look at the number of meshes in this part of the leading-edge approximately defined by $-0.041 \leq z/c \leq 0.056$; let N_{LE} be this number, we find

Solution N°	10	7	4	8.1	8.2
N_{LE}	13	17	22	25	38

Table 6.1 — Numerical solutions for test case 07 (NLR 7301, $M_\infty = 0.721$, $\alpha = -0.194°$)

Solution	MESH			outer boundary (chords)	C_L	Γ	C_D	C_M
	type	points or cells						
		total	on airfoil					
1	C	251 x 35	195	4/6/7	0.5878	0.2900	0.0016	-0.1347
2.1	C	250 x 34	194	4/6/7	0.6035	0.2958	0.0014	-0.1345
2.2	C	298 x 34	230	4/6/7	0.6015	0.3012	0.0011	-0.1333
3.1	O	159 x 23	159	16	0.5591	0.2709	0.0028	-0.1290
3.2	O	159 x 23	159	16	0.5587	0.2717	0.0024	-0.1290
3.3①	O	319 x 47	319	?	0.5722	0.2834	0.0027	-0.1303
4	O	121 x 34	121	6 FS	0.4792		0.0065	-0.1298
5	C	249 x 41	181	8/12/12 FS	0.4497	0.2230	0.0017	-0.1135
6	O	192 x 39	192	50	0.6431		0.0013	-0.1350
7	C	150 x 25	120	4/5/4	0.4369		0.0104	-0.1240
8.1	O	128 x 28	128	5	0.578	0.282	0.0012	-0.128
8.2	O	128 x 32	128	5	0.591	0.288	0.0014	-0.130
8.3	O	160 x 32	160	5	0.587	0.287	0.0007	-0.129
8.4	O	160 x 32	160	5	0.597	0.298	0.0002	-0.130
8.5	O	160 x 32	160	5	0.598	0.300	0.0001	-0.130
9.1	O	162 x 34	160	50	0.592		0.0019	-0.132
9.2	O	322 x 66	320	50	0.594		0.0005	-0.132
10②	C	129 x 25	105	9	0.5964		0.0055	-0.1236
"exact"					0.5939	0.2967	"0.0005"	-0.1298

(① : aerodynamic coefficients only, ② : $\alpha = 0.244°$)

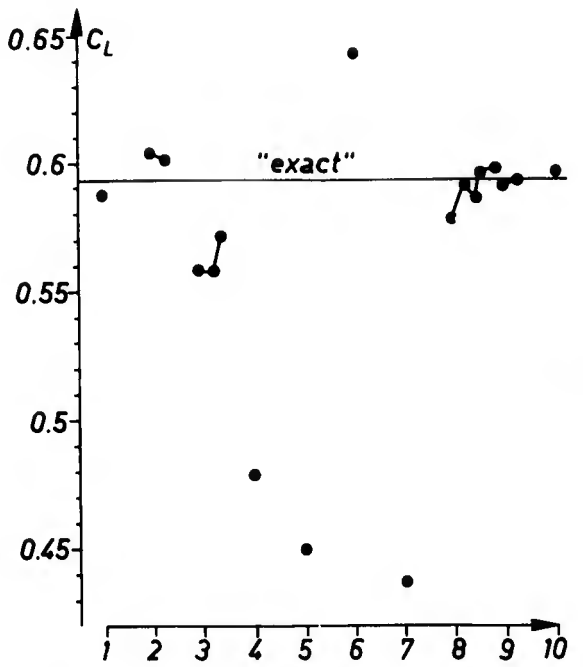


Fig. 6.1 — Lift coefficient for test case 07.

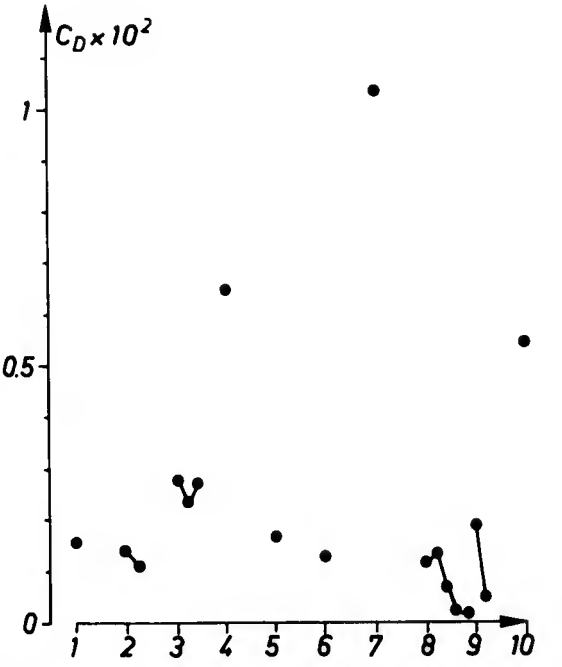


Fig. 6.2 — Drag coefficient for test case 07.

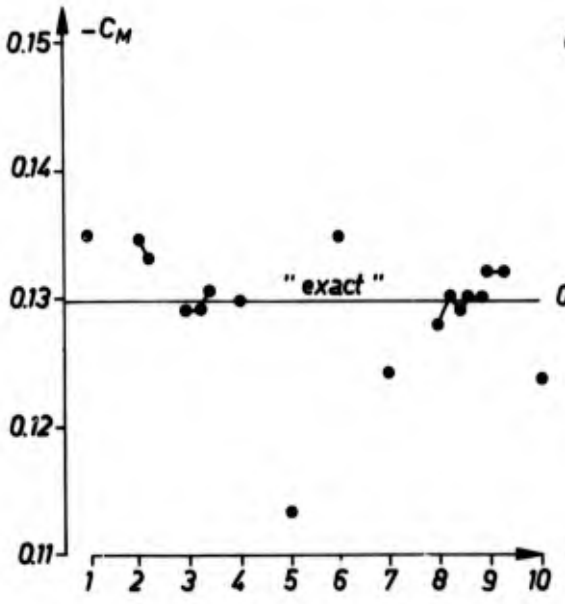


Fig. 6.3 — Pitching moment coefficient for test case 07.

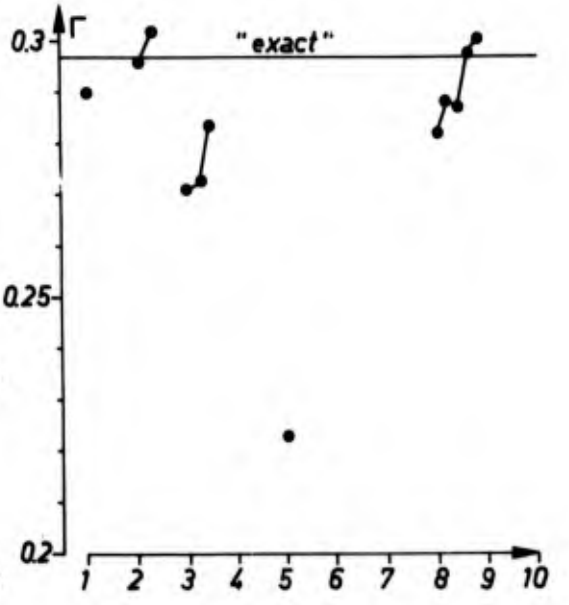
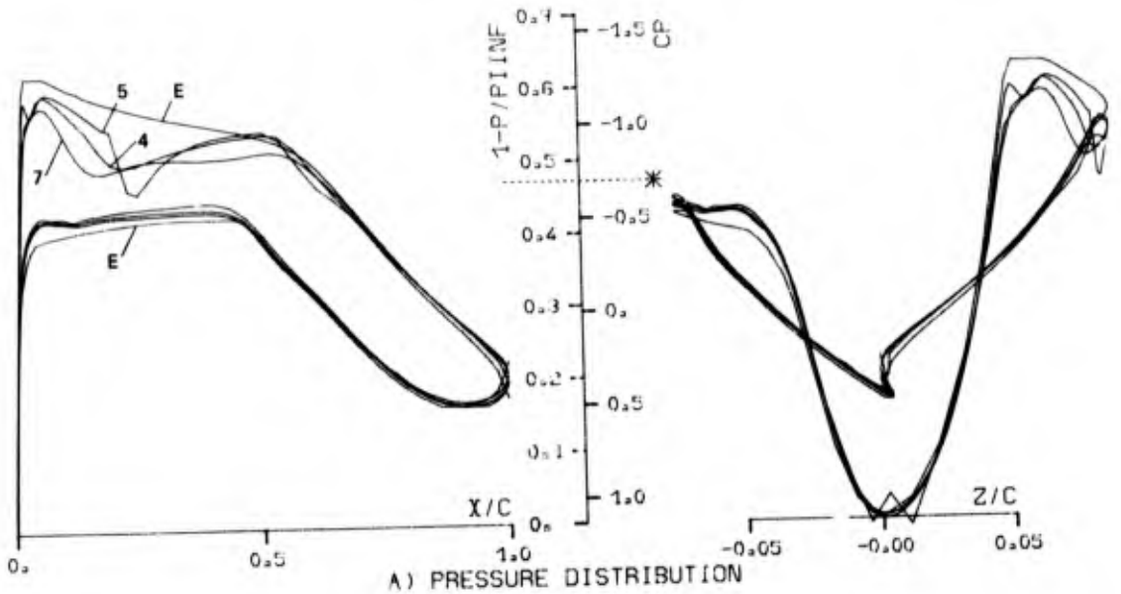


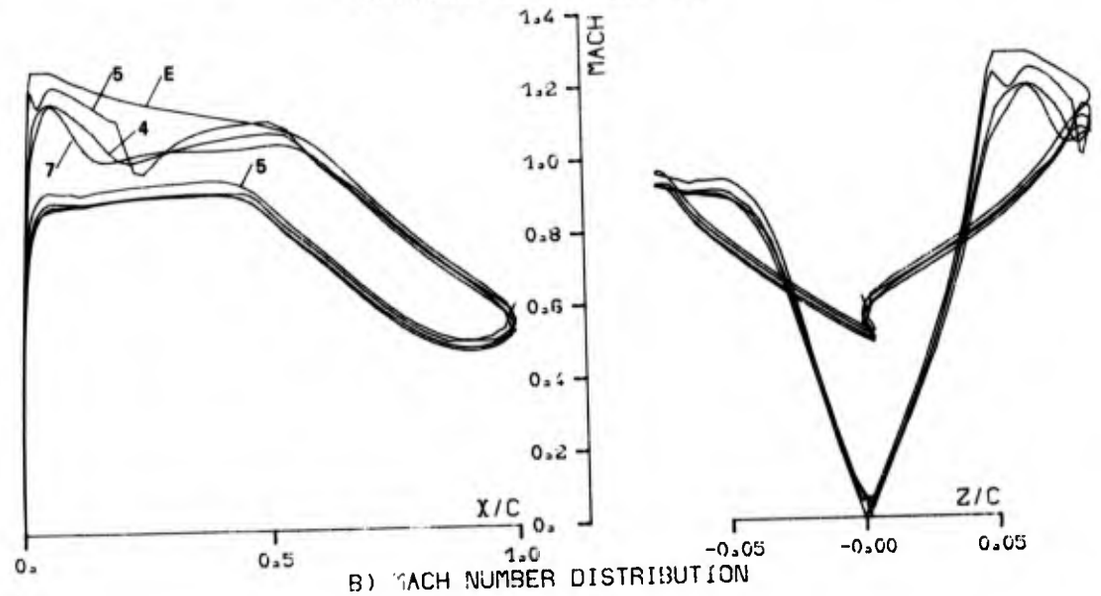
Fig. 6.4 — Circulation around airfoil for test case 07.

The difference in mesh fineness at the leading-edge between solution N° 7 and solution N° 8.1 appears significant enough to explain the difference in these two solutions; despite the fact that the total numbers of points on the airfoil are not much different.

The pressure, Mach number and total pressure distributions are shown, and compared with the exact solution, on Fig. 6.5 for solutions N° 4, 5, 7, and on Fig. 6.6 for solution N° 10. The dotted line with a star on the pressure axis indicates the sonic value (for $p_i = p_{i\infty}$). The pressure and the Mach number are plotted not only versus x/c, but also versus z/c to get a clearer representation of the leading-edge region. The total pressure is plotted versus x/c only, but in two parts separately for the upper surface (on the left) and for the lower surface (on the right).

The solutions N° 4, 5 and 7 are characterized by an under-expansion on the upper surface at the leading-edge (compared to the exact solution), followed by a rapid compression, or even a shock for N° 5, in the fore part of the airfoil. The total pressure is very good for solution N° 5, but is quite in error for solutions N° 4 and 7.





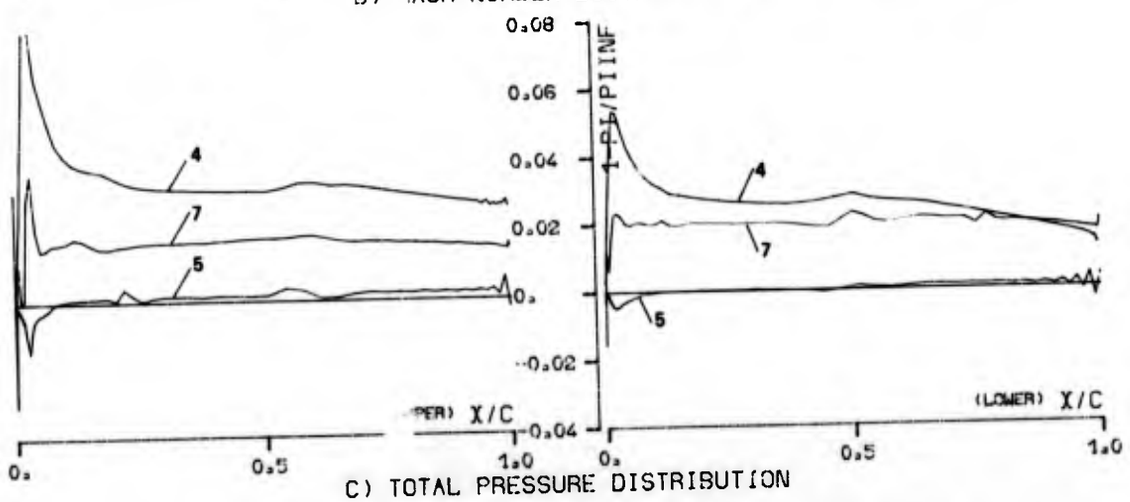
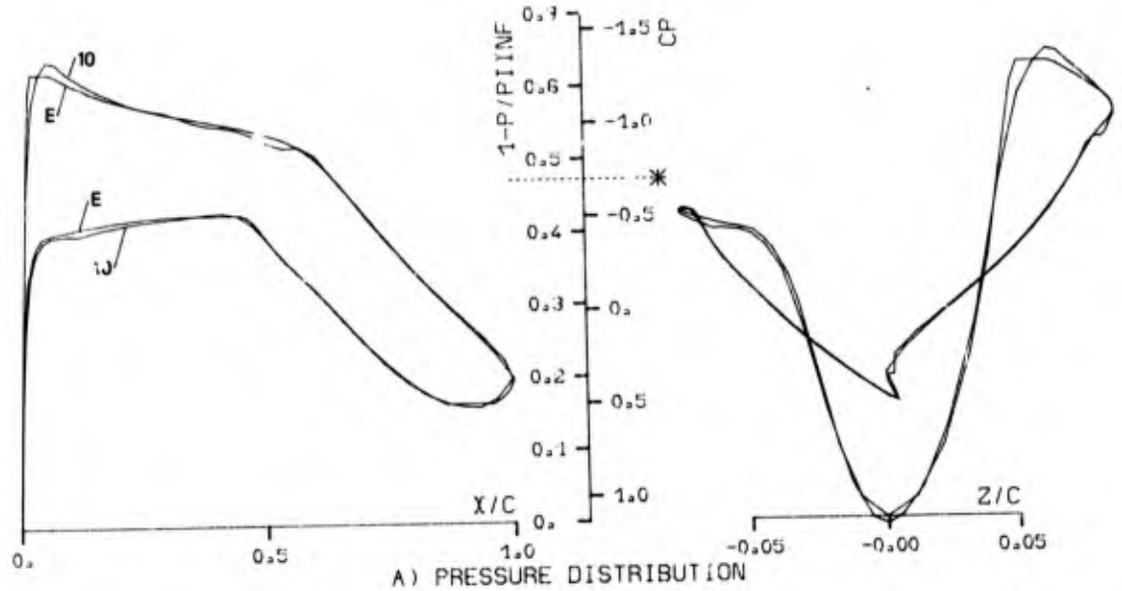
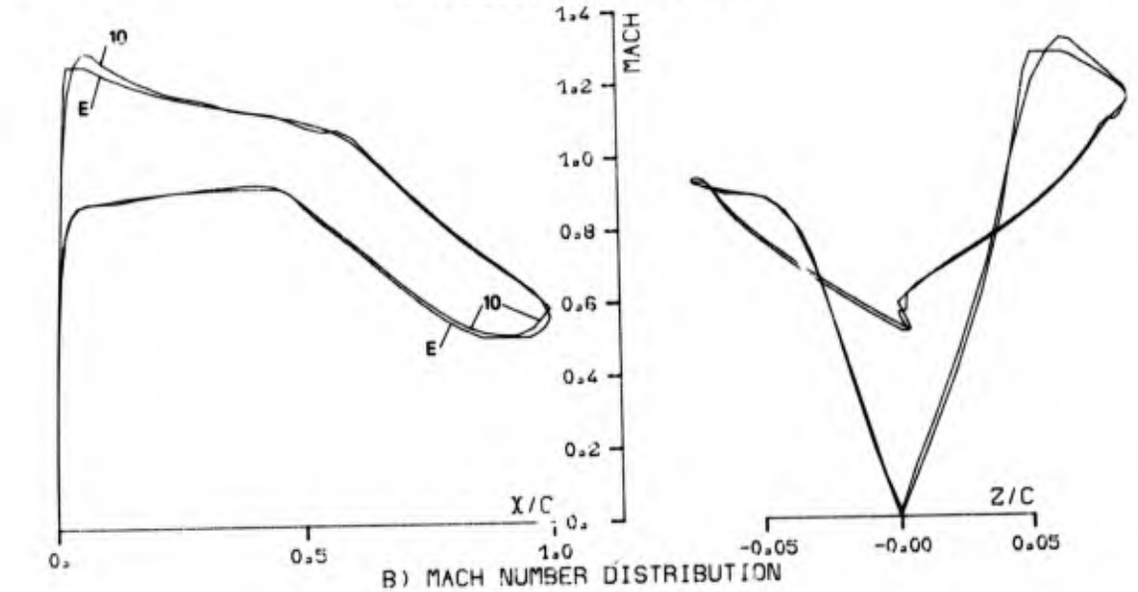


Fig. 6.5 – Solutions 4/5/7 and exact for test case 07 (NLR 7301, Mach = 0.721, α = - 0.194).





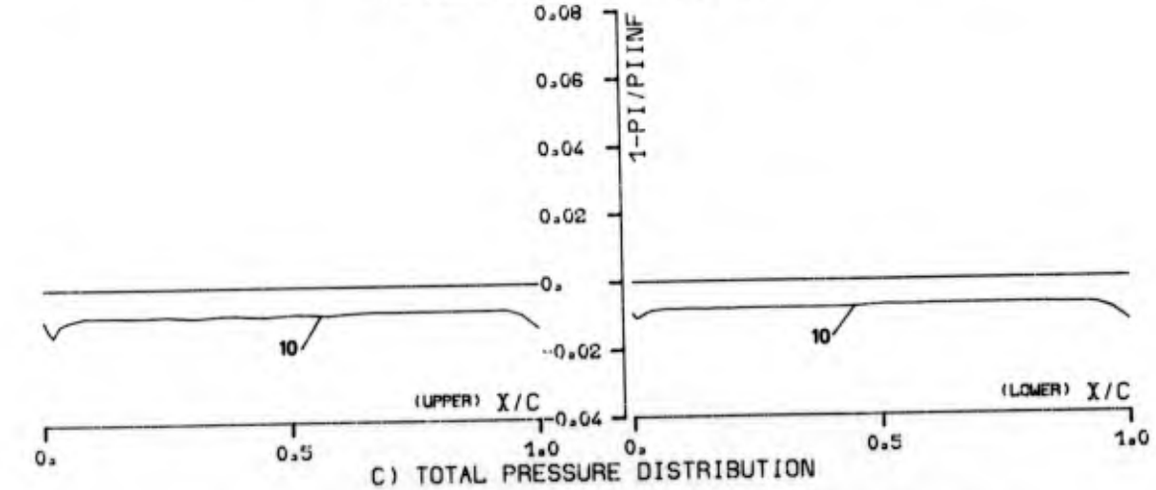


Fig. 6.6 -- Solutions 10 and exact for test case 07 (NLR 7301, Mach = 0.721, α = 0.244/ - 0.194).

Despite the coarse mesh used, solution N° 10 (Fig. 6.6) follows rather well the exact solution, except in the suction peak region, but it shows undulations on part of the upper surface. This solution gives an almost exact value of lift, but an important drag (since the numerical solution is shockless, the drag reveals the truncation error). The existence of this numerical solution tends to prove that it is possible to obtain a good approximation of the exact shockless solution by adjusting the incidence so as to match the lift with the exact value, the modified incidence depending on numerical parameters (mesh, artificial viscosity...)

In stage 2 of the assessment, we compare the multiple solutions given by the same contributor. It is not possible here to show the full data on which these comparisons are based (in particular total pressure plots), and we present only a summary of this stage 2.

Solutions N° 2.1 and 2.2 differ by the mesh which is finer in the direction around the airfoil for N° 2.2. The differences in the aerodynamic coefficients are very small ; solution N° 2.2 is better than N° 2.1 (smaller drag, more accurate total pressure).

Solutions N° 3.1 and 3.2 differ by the numerical treatment at the wall, with N° 3.2 giving a smaller error on p_i and a lower drag than 3.1. Solution N° 3.3, obtained in a much finer mesh, cannot be retained since the full data are not available.

The discussion of the five solutions N° 8.1 to 8.5 is more complex. Between the solutions N° 8.1 to 8.3, only the meshes differ ; the mesh at the leading-edge is finer for N° 8.2 than for N° 8.1, not only in the direction along the airfoil surface as already seen, but also in the transverse direction ; compared to N° 8.2, the mesh of N° 8.3 is refined in the middle of the airfoil. We would expect solution N° 8.3 to be the best one of the three since it uses the finest mesh. Indeed solution N° 8.3 has the smallest drag, but curiously enough it also has a slightly higher error on the total pressure. The solutions N° 8.1 and 8.3 show a very weak rear shock, whereas solution N° 8.2 shows no shock at all and (referring to the exact solution) gives better values of C_L, Γ and C_M (although the variations remain small between the three solutions). Looking at the convergence of the aerodynamic coefficients and of the circulation for solutions N° 8.1 to 8.3, it appears to be very good for C_L, but only good or sometimes doubtful for the other coefficients, with an oscillatory behaviour. A possible explanation is that the solution is not strictly converged, but exhibits slight oscillations possibly localized upstream of the rear sonic point where this very weak shock forms and disappears in time. If this is so, solution N° 8.2 would correspond exactly at a time when this shock has vanished.

Solution N° 8.4 is obtained using the same mesh as solution N° 8.3 but a reduced artifical viscosity. It gives a much better total pressure and shows no shock on the rear part of the upper surface (see Fig. 6.9). The above remark on the oscillatory convergence applies here too. The values of C_L, C_D, C_M and Γ are seen to be excellent.

Solution N° 8.5 corresponds to a further important reduction of artificial viscosity compared to N° 8.4. The accuracy on the total pressure is not improved, and the solution now shows a compression bump at the rear of the airfoil.

Based on the total pressure criterion, solutions N° 8.4 and 8.5 are much better than solutions N° 8.1 to 8.3, but it is necessary to appeal to the exact solution to make a choice between the two and to retain solution N° 8.4 as the best one. A remarkable feature of all the solutions N° 8 is the small distance (5 chords) at which the outer boundary is placed.

Solutions N° 9.1 and 9.2 differ only by the mesh which is twice finer in each direction for solution N° 9.2. The accuracy on the total pressure is good for both solutions, and, as it should be expected, is better for solution N° 9.2. If we now refer to the exact solution, the values of the aerodynamic coefficients are seen to be very good, solution N° 9.2 giving practically the exact values for C_L and C_D, but the same value of C_M (in error of 1.7 %) as solution N° 9.1. So, were it not for this slight discrepancy, we could consider that the convergence of the numerical solution with respect to mesh refinement was achieved for solution N° 9.2.

Thus, stage 2 leads to the selection of solutions N° 1, 2.2, 3.2, 6, 8.4 and 9.2 to form group 2. It is interesting to note that the global scatters on C_L and C_M in group 2 are exactly (for C_L) or practically (for C_M) the same as in group 1.

The full sets of data, as given by the contributors, for the solutions of group 2 are presented in Appendix A1 in microfiche form.

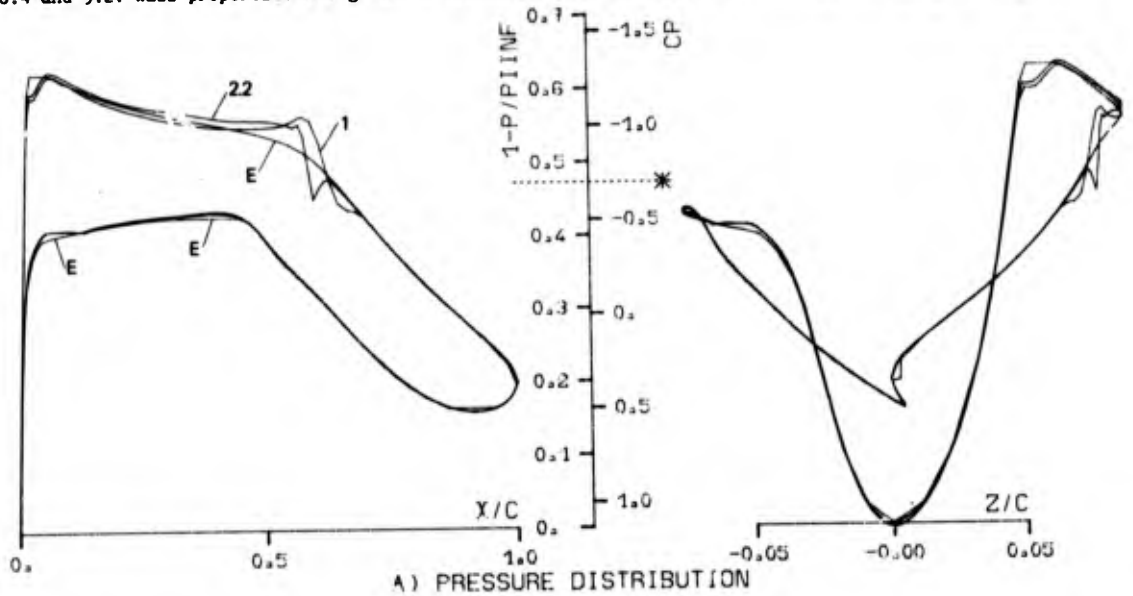
Of the six solutions of group 2, four of them, namely N° 1, 2.2, 3.2 and 6, give a rear shock of weak intensity. Figures 6.7 and 6.8 show the cross-plots of p, M and p_i for these solutions and compare them to the exact solution. The solutions N° 8.4 and 9.2, which give no shock, are plotted on Figs. 6.9 and 6.10 respectively, together with the exact solution.

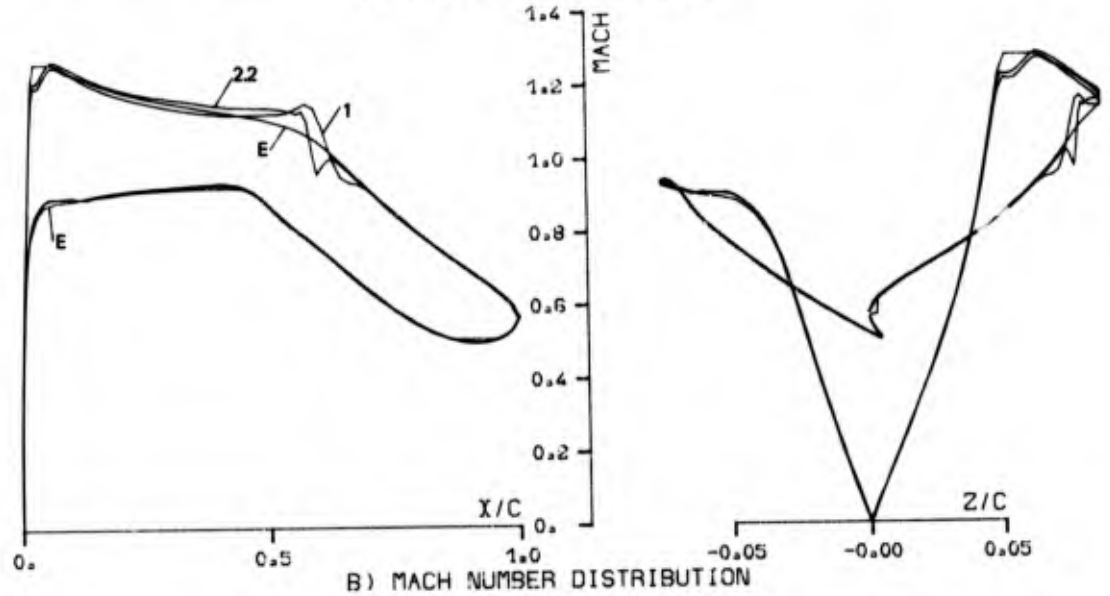
Comparing the solutions of group 2 from these plots (and using the exact solution just as a common reference), one can see that the solutions N° 8.4 and 9.2 are in very good agreement, and furthermore that the solutions N° 1 and 2.2 are in rather good agreement with N° 8.4 and 9.2 except of course in the neighborhood of the weak rear shock. On the contrary, solutions N° 3.2 and 6 differ appreciably from the four other solutions on the upper surface from the minimum pressure point to the rear shock. For solution N° 3.2, we can relate this observation to the high error on total pressure (Fig. 6.8 c); for solution N° 6 the above discussion is insufficient to reveal reasons for this discrepancy. Among the four solutions N° 1, 2.2, 8.4 and 9.2, the preference clearly goes to N° 9.2 because of its very fine mesh and of the large distance of the outer boundary ; these criteria do not allow to distinguish between the three others and we have to appeal to the exact solution (or to a comparison with solution N° 9.2) to see that, in spite of its coarser mesh, solution N° 8.4 is better than N° 1 and 2.2.

This discussion of solutions of group 2 shows the limits of this type of evaluation. However the

special character of this test case, due to the flow being shockless, should also be kept in mind.

Finally, making use of our knowledge of the exact solution, we restrict group 3 to the solutions N° 8.4 and 9.2. Wall properties are given in tabulated form for these two solutions in tables 6.2. and 6.3.





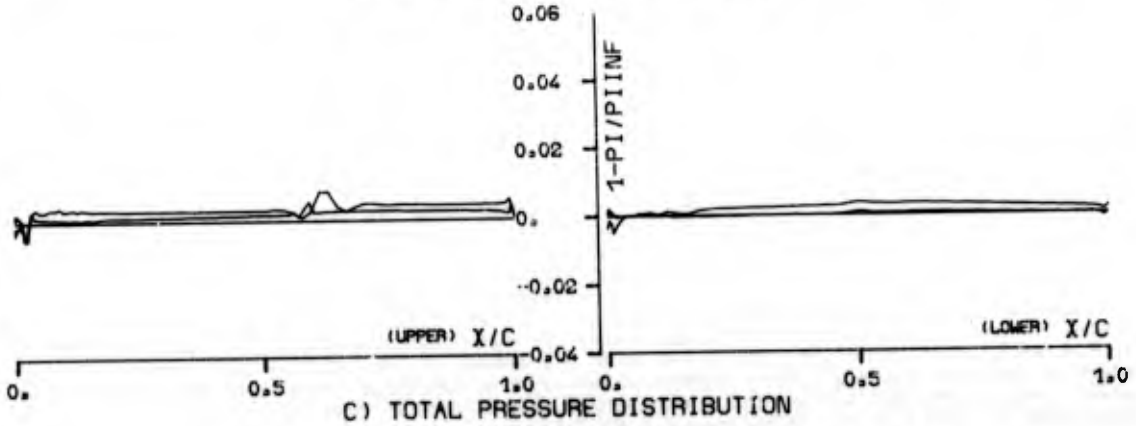


Fig. 6.7 – Solutions 1/2.2 and exact for test case 07 (NLR 7301, Mach = 0.721, α = - 0.194).

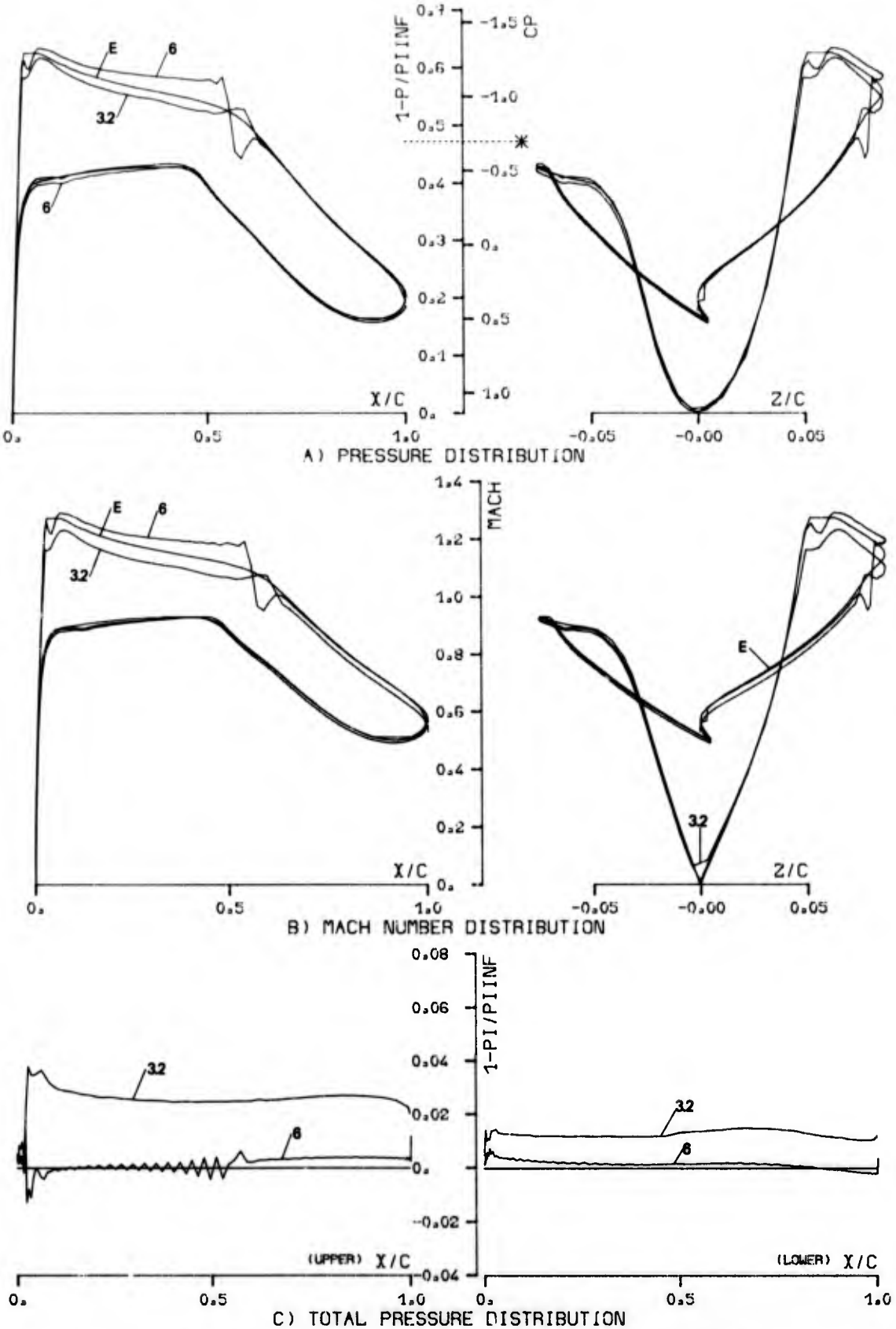


Fig. 6.8 – Solutions 3.2/6 and exact for test case 07 (NLR 7301, Mach = 0.721, α = - 0.194).

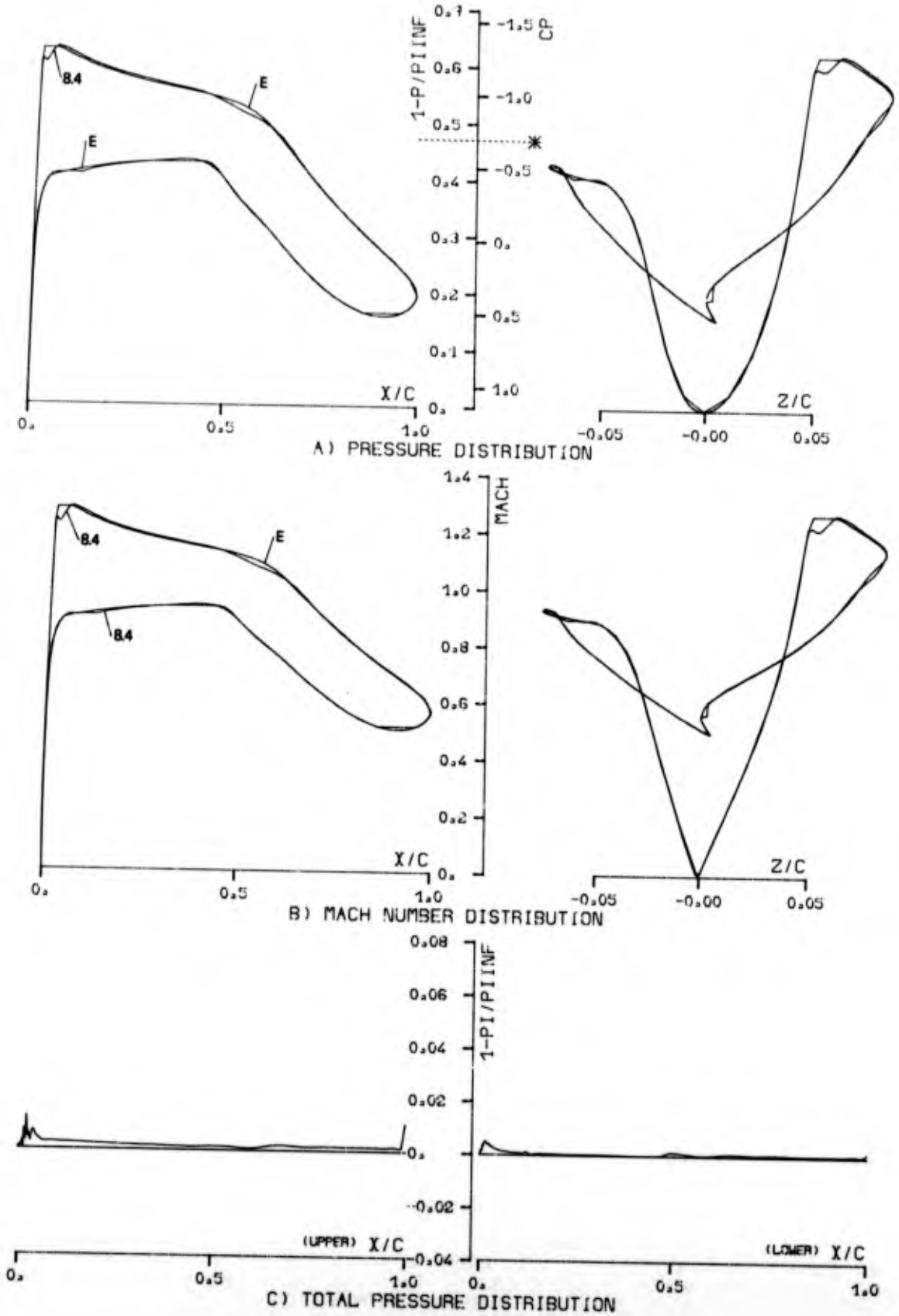


Fig. 6.9 – Solutions 8.4 and exact for test case 07 (NLR 7301, Mach = 0.721, α = - 0.194).

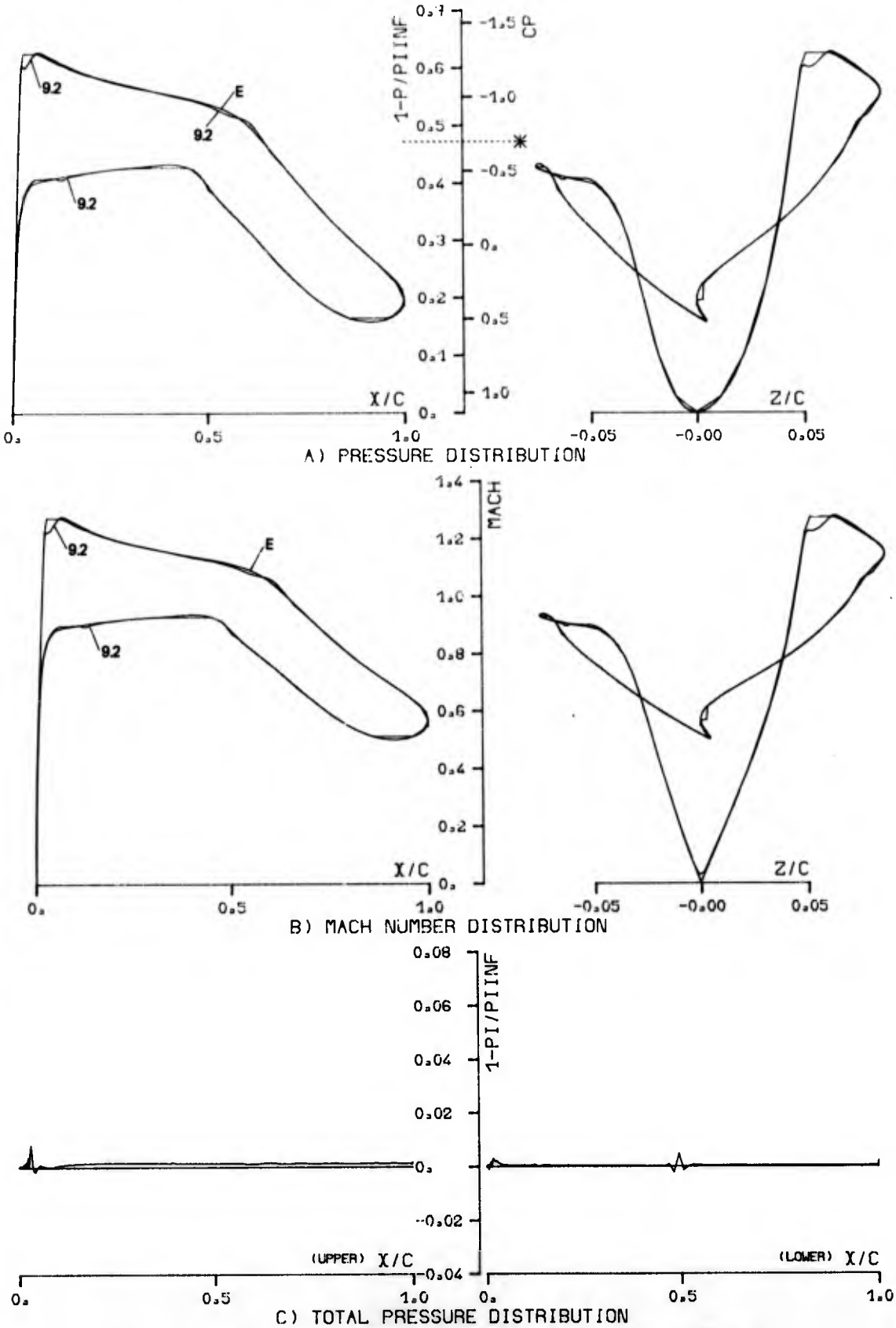


Fig. 6.10 – Solutions 9.2 and exact for test case 07 (NLR 7301, Mach = 0.721, α = - 0.194).

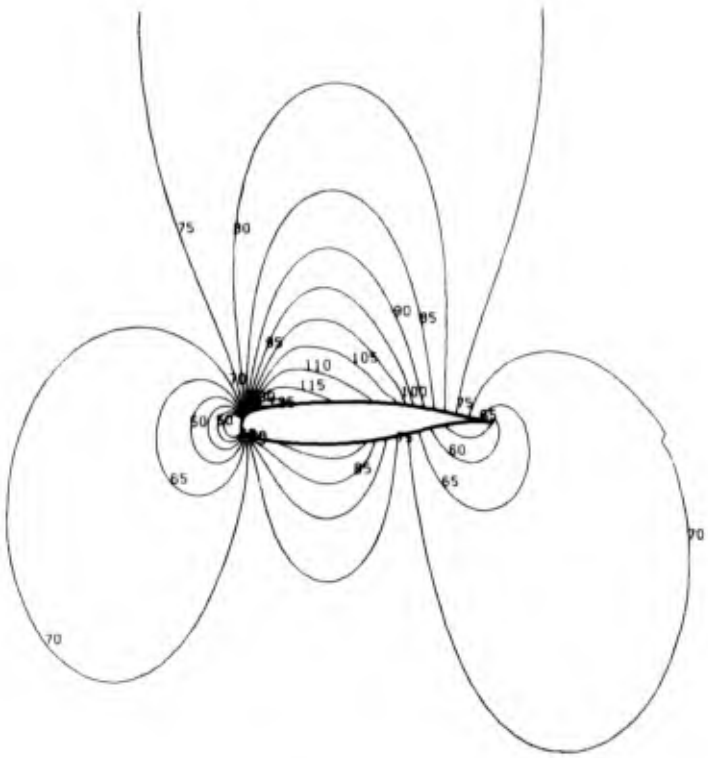


Fig. 6.11 – Iso-Mach lines of solution n° 9.2 for test case 07 (ΔM = 0.05, curve parameter = 100 M).

Table 6.2 – Wall values of solution n° 8.4 for test case 07 (NLR 7301, $M_\infty = 0.720957$, $\alpha = -0.194°$).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF	N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.999233	.000104	.193388	.305511	.560502	.001630	51	.069112	-.052906	.405719	-.439373	.894034	.001356
2	.996220	.000503	.187820	.407112	.552144	.000882	52	.062353	-.051250	.404811	-.435846	.892563	.001416
3	.990341	.001227	.181230	.432743	.541449	.000526	53	.056113	-.049577	.402371	-.426366	.888605	.001584
4	.981774	.002143	.174255	.459840	.529691	.000361	54	.050363	-.047890	.398602	-.411724	.882526	.001812
5	.970706	.003099	.168474	.482299	.519314	.000627	55	.045075	-.046192	.393540	-.392059	.874468	.002015
6	.957323	.003937	.163876	.500162	.511323	.000587	56	.040224	-.044487	.387108	-.367071	.864287	.002229
7	.941815	.004494	.160634	.512757	.505747	.000492	57	.035782	-.042779	.379777	-.338591	.852608	.002571
8	.924371	.004608	.158978	.519190	.502861	.000460	58	.031724	-.041071	.371649	-.307015	.839742	.002882
9	.905179	.004128	.159094	.518739	.503092	.000443	59	.028025	-.039364	.362554	-.271682	.825228	.003366
10	.884424	.002931	.161189	.510601	.506802	.000442	60	.024662	-.037654	.351559	-.228967	.807807	.003835
11	.862287	.000929	.165500	.493853	.514339	.000474	61	.021611	-.035937	.337324	-.173666	.785541	.004155
12	.838944	-.001917	.172182	.467894	.525899	.000528	62	.018850	-.034212	.319862	-.105828	.758589	.004173
13	.814566	-.005591	.181100	.433248	.541272	.000494	63	.016357	-.032482	.301762	-.035511	.730013	.004712
14	.789318	-.010027	.192522	.388875	.560457	.000591	64	.014114	-.030747	.282104	.040856	.699049	.005050
15	.763357	-.015119	.206562	.334331	.583609	.000730	65	.012100	-.028994	.257954	.134679	.661331	.004838
16	.736836	-.020707	.222546	.272235	.609804	.000653	66	.010299	-.027218	.230303	.242100	.617803	.004279
17	.709895	-.026606	.239979	.204510	.637903	.000563	67	.008692	-.025430	.201709	.353185	.572291	.003211
18	.682672	-.032645	.259303	.129438	.668247	.000755	68	.007266	-.023644	.176411	.451465	.528674	.003702
19	.655293	-.038664	.280479	.047171	.701148	.000928	69	.006004	-.021858	.151044	.550013	.484734	.003014
20	.627876	-.044485	.301763	-.035515	.734329	.000728	70	.004895	-.020059	.124328	.653802	.436563	.001831
21	.600533	-.049949	.321513	-.112242	.765123	.000368	71	.003925	-.018271	.101173	.743756	.390558	.001485
22	.573365	-.054971	.340262	-.185079	.794027	.000264	72	.003084	-.016528	.083033	.814228	.350334	.001806
23	.546467	-.059524	.360096	-.262133	.824189	.000579	73	.002362	-.014814	.066072	.880120	.310676	.001435
24	.519925	-.063584	.382757	-.350168	.858446	.001290	74	.001749	-.013090	.050780	.939528	.269637	.001587
25	.493815	-.067093	.405161	-.437205	.893117	.001407	75	.001238	-.011323	.036228	.986061	.227301	.000920
26	.468209	-.069947	.420306	-.496042	.918098	-.000010	76	.000823	-.009491	.024094	1.043200	.183587	.000875
27	.443168	-.072116	.428295	-.527079	.930583	.000069	77	.000498	-.007583	.014284	1.081311	.140234	.000648
28	.418748	-.073692	.431416	-.539203	.935493	.000080	78	.000257	-.005592	.006988	1.109655	.096560	.000492
29	.394996	-.074782	.431735	-.540443	.935999	.000077	79	.000099	-.003534	.002467	1.127219	.053298	.000482
30	.371952	-.075470	.430759	-.536651	.934368	.000179	80	.000021	-.001452	.000258	1.135801	.011352	.000168
31	.349652	-.075823	.429397	-.531360	.932171	.000233	81	.000021	.000621	.000422	1.135164	.014804	.000269
32	.328124	-.075894	.428102	-.526329	.930074	.000296	82	.000099	.002682	.002411	1.127437	.054079	.000367
33	.307389	-.075720	.426877	-.521570	.928138	.000304	83	.000257	.004762	.006367	1.112068	.092059	.000460
34	.287465	-.075331	.425641	-.516768	.926172	.000327	84	.000498	.006897	.012078	1.089881	.129406	.000449
35	.268363	-.074751	.424306	-.511582	.924066	.000334	85	.000823	.009114	.019876	1.059587	.167492	.000493
36	.250089	-.074002	.422887	-.506069	.921804	.000370	86	.001238	.011408	.029844	1.020862	.207565	.000269
37	.232646	-.073105	.421356	-.500121	.919386	.000385	87	.001749	.013757	.042612	.971260	.247833	.000813
38	.216033	-.072076	.419693	-.493661	.916758	.000406	88	.002362	.016169	.057004	.915348	.290283	.000200
39	.200242	-.070934	.417937	-.486839	.913980	.000434	89	.003084	.018629	.076011	.841508	.336694	.000587
40	.185266	-.069693	.416200	-.480091	.911194	.000505	90	.003925	.021087	.097125	.759482	.382893	.001021
41	.171091	-.068368	.414401	-.473102	.908341	.000546	91	.004895	.023546	.119339	.673183	.428361	.000938
42	.157702	-.066973	.412345	-.465114	.905071	.000606	92	.006004	.026038	.144632	.574923	.476510	.000783
43	.145083	-.065518	.409398	-.453666	.900621	.000440	93	.007266	.028571	.175034	.456814	.530669	.000637
44	.133213	-.064014	.406197	-.441230	.895819	.000234	94	.008692	.031120	.210491	.319067	.588762	.001736
45	.122070	-.062489	.406555	-.442621	.895412	.001276	95	.010299	.033660	.248502	.171399	.650645	.001228
46	.111632	-.060952	.407526	-.446293	.897496	.000661	96	.012100	.036183	.290755	.007258	.714457	.003317
47	.101873	-.059385	.407191	-.445092	.896885	.000746	97	.014114	.038676	.337934	-.176035	.769889	.000818
48	.092769	-.057790	.406560	-.442640	.895700	.000874	98	.016357	.041106	.393169	-.390618	.868841	.007339
49	.084292	-.056176	.406045	-.440640	.894914	.000956	99	.018850	.043446	.448867	-.606999	.960575	.003031
50	.076415	-.054547	.405771	-.439575	.894322	.001133	100	.021611	.045660	.511574	-.850609	1.055562	.012368

Table 6.2 (continued).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
101	.024662	.047719	.565665	-1.060747	1.156540	.004221
102	.028025	.049613	.603698	-1.208501	1.225854	.005824
103	.031724	.051410	.606509	-1.219421	1.233612	.002700
104	.035782	.053199	.602548	-1.204033	1.223113	.006536
105	.040224	.054975	.602870	-1.205284	1.223453	.006896
106	.045075	.056717	.607049	-1.221519	1.232746	.005210
107	.050363	.058415	.613184	-1.245353	1.245399	.004158
108	.056113	.060063	.619810	-1.271094	1.258793	.003564
109	.062353	.061658	.625546	-1.293378	1.270771	.002701
110	.069112	.063209	.628637	-1.305386	1.277014	.002584
111	.076415	.064730	.628229	-1.303801	1.276110	.002704
112	.084292	.066239	.626109	-1.295565	1.271849	.002755
113	.092769	.067741	.623468	-1.285305	1.266638	.002720
114	.101873	.069232	.620381	-1.273313	1.260623	.002620
115	.111632	.070713	.616921	-1.259871	1.253848	.002608
116	.122070	.072178	.613183	-1.245349	1.246610	.002549
117	.133213	.073625	.609291	-1.230229	1.239092	.002532
118	.145083	.075048	.605301	-1.214728	1.231465	.002477
119	.157702	.076440	.601408	-1.199605	1.224097	.002394
120	.171091	.077794	.597676	-1.185106	1.217073	.002322
121	.185266	.079099	.594070	-1.171097	1.210333	.002245
122	.200242	.080346	.590609	-1.157652	1.203905	.002167
123	.216033	.081526	.587306	-1.144820	1.197816	.002077
124	.232646	.082626	.584132	-1.132489	1.191987	.002001
125	.250089	.083635	.581013	-1.120372	1.186282	.001932
126	.268363	.084540	.577924	-1.108372	1.180668	.001853
127	.287465	.085329	.574830	-1.096352	1.175064	.001784
128	.307389	.085986	.571634	-1.083936	1.169281	.001739
129	.328124	.086498	.568294	-1.070960	1.163261	.001700
130	.349652	.086849	.564901	-1.057779	1.157181	.001652
131	.371952	.087022	.561590	-1.044916	1.151307	.001566
132	.394996	.087000	.558390	-1.032484	1.145674	.001460
133	.418748	.086765	.555023	-1.019404	1.139775	.001348
134	.443168	.086296	.550854	-1.003208	1.132430	.001308
135	.468209	.085571	.545067	-.980726	1.122212	.001364
136	.493815	.084564	.537211	-.950206	1.108378	.001540
137	.519925	.083244	.527758	-.913482	1.092042	.001578
138	.546467	.081573	.518171	-.876237	1.075882	.001337
139	.573365	.079500	.508365	-.842027	1.061337	.000941
140	.600533	.076966	.500198	-.806414	1.046154	.000758
141	.627876	.073910	.487540	-.757239	1.024834	.001196
142	.655293	.070305	.468662	-.683900	.993359	.001960
143	.682672	.066179	.444393	-.589618	.954175	.002197
144	.709895	.061601	.419071	-.491244	.914476	.001838
145	.736836	.056653	.395976	-.401523	.878646	.001596
146	.763357	.051432	.375087	-.320371	.846304	.001591
147	.789318	.046044	.355630	-.244783	.816265	.001643
148	.814566	.040596	.337356	-.173790	.788155	.001648
149	.838944	.035195	.320377	-.107828	.762075	.001612
150	.862287	.029939	.304774	-.047212	.738063	.001578
151	.884424	.024920	.290477	.008330	.715993	.001537
152	.905179	.020217	.277363	.059277	.695602	.001546
153	.924371	.015902	.265251	.106330	.676717	.001504
154	.941815	.012034	.254061	.149802	.659177	.001448
155	.957323	.008663	.243612	.190396	.642507	.001540
156	.970706	.005830	.233790	.228553	.626583	.001729
157	.981774	.003560	.224603	.264244	.612371	.001258
158	.990341	.001858	.216215	.296830	.598344	.001574
159	.996220	.000719	.209042	.324697	.578447	.007764
160	.999233	.000145	.201497	.354008	.561871	.010593

Table 6.3 – Wall values of solution n° 9.2 for test case 07 (NLR 7301, $M_\infty = 0.720957$, $\alpha = -0.194°$).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.999890	.000015	.186418	.412588	.547894	.002169
2	.999454	.000074	.189420	.400926	.554577	.001077
3	.998589	.000191	.188761	.403486	.554641	.000219
4	.997298	.000364	.187096	.409955	.551606	.000383
5	.995578	.000590	.184662	.419410	.547433	.000421
6	.993435	.000864	.181953	.429935	.542862	.000397
7	.990867	.001177	.179314	.440187	.538288	.000439
8	.987874	.001523	.176622	.450645	.533808	.000351
9	.984460	.001893	.174118	.460373	.529464	.000375
10	.980627	.002277	.171937	.468846	.525591	.000447
11	.976375	.002666	.169811	.477105	.522013	.000370
12	.971710	.003052	.167767	.485046	.518486	.000348
13	.966636	.003423	.165890	.492338	.515171	.000372
14	.961155	.003769	.164160	.499058	.512158	.000358
15	.955275	.004078	.162593	.505146	.509426	.000342
16	.949000	.004337	.161231	.510437	.507021	.000344
17	.942338	.004533	.160094	.514854	.505020	.000338
18	.935296	.004654	.159211	.518285	.503465	.000332
19	.927882	.004687	.158612	.520612	.502403	.000331
20	.920104	.004617	.158316	.521762	.501880	.000330
21	.911973	.004433	.158345	.521649	.501936	.000327
22	.903498	.004124	.158714	.520216	.502595	.000324
23	.894691	.003679	.159448	.517364	.503899	.000322
24	.885564	.003086	.160572	.512997	.505884	.000322
25	.876129	.002338	.162098	.507069	.508590	.000317
26	.866398	.001428	.164058	.499455	.512037	.000319
27	.856386	.000351	.166481	.490042	.516274	.000325
28	.846105	-.000897	.169386	.478756	.521335	.000328
29	.835572	-.002316	.172789	.465536	.527218	.000340
30	.824798	-.003903	.176659	.450501	.533887	.000340
31	.813798	-.005654	.180954	.433816	.541263	.000322
32	.802590	-.007564	.185715	.415320	.549350	.000325
33	.791186	-.009625	.191004	.394772	.558249	.000340
34	.779600	-.011830	.196861	.372019	.568024	.000360
35	.767848	-.014164	.203275	.347101	.578655	.000371
36	.755943	-.016615	.210200	.320198	.590044	.000379
37	.743901	-.019164	.217573	.291555	.602064	.000394
38	.731733	-.021794	.225271	.261649	.614556	.000376
39	.719455	-.024485	.233238	.230698	.627377	.000364
40	.707079	-.027223	.241475	.198698	.640530	.000360
41	.694618	-.029993	.250056	.165361	.654124	.000370
42	.682086	-.032780	.259048	.130428	.668275	.000387
43	.669494	-.035569	.268515	.093650	.683068	.000424
44	.656854	-.038344	.278370	.055365	.698420	.000435
45	.644180	-.041083	.288477	.016100	.714085	.000456
46	.631484	-.043769	.298554	-.023048	.729701	.000428
47	.618775	-.046385	.308372	-.061190	.744880	.000392
48	.606067	-.048915	.317825	-.097914	.759453	.000368
49	.593371	-.051355	.326929	-.133282	.773460	.000354
50	.580697	-.053698	.335773	-.167640	.787061	.000336
51	.568057	-.055944	.344531	-.201664	.800523	.000323
52	.555462	-.058090	.353465	-.236372	.814226	.000345
53	.542922	-.060134	.362868	-.272901	.828541	.000491
54	.530447	-.062073	.372615	-.310768	.843382	.000668
55	.518048	-.063902	.381923	-.346928	.858278	.000116
56	.505733	-.065574	.388622	-.372053	.869995	-.001320
57	.493513	-.067156	.405355	-.437959	.890358	.004695
58	.481394	-.068626	.414302	-.472717	.910731	-.002237
59	.469389	-.069895	.421497	-.500669	.919284	.000741
60	.457505	-.071007	.426201	-.518944	.927160	.000209
61	.445749	-.071973	.429444	-.531542	.932279	.000196
62	.434130	-.072806	.431515	-.539588	.935487	.000261
63	.422654	-.073517	.432653	-.544009	.937276	.000269
64	.411327	-.074118	.433103	-.545757	.937902	.000275
65	.400157	-.074618	.433062	-.545598	.937903	.000290
66	.389148	-.075024	.432681	-.544118	.937284	.000299
67	.378305	-.075347	.432092	-.541829	.936352	.000312
68	.367634	-.075591	.431382	-.539071	.935228	.000314
69	.357136	-.075765	.430642	-.536196	.934052	.000325
70	.346819	-.075874	.429935	-.533490	.932927	.000336
71	.336684	-.075921	.429305	-.531002	.931918	.000353
72	.326734	-.075913	.428729	-.528765	.931011	.000353
73	.316972	-.075853	.428189	-.526667	.930157	.000356
74	.307400	-.075743	.427667	-.524639	.929333	.000358
75	.298020	-.075586	.427150	-.522630	.928513	.000360
76	.288833	-.075386	.426629	-.520606	.927687	.000371
77	.279839	-.075145	.426074	-.518450	.926818	.000366
78	.271042	-.074865	.425482	-.516150	.925885	.000368
79	.262440	-.074549	.424876	-.513796	.924922	.000379
80	.254033	-.074199	.424247	-.511352	.923936	.000376
81	.245823	-.073818	.423611	-.508882	.922929	.000384
82	.237806	-.073407	.422972	-.506399	.921922	.000387
83	.229984	-.072969	.422308	-.503820	.920877	.000389
84	.222355	-.072506	.421673	-.501353	.919849	.000423
85	.214917	-.072018	.420864	-.498210	.918654	.000341
86	.207670	-.071508	.420105	-.495261	.917379	.000434
87	.200610	-.070978	.419292	-.492103	.916154	.000379
88	.193737	-.070429	.418503	-.489036	.914880	.000419
89	.187047	-.069864	.417714	-.485972	.913647	.000416
90	.180539	-.069283	.416878	-.482725	.912352	.000400
91	.174206	-.068687	.416014	-.479368	.910998	.000401
92	.168054	-.068078	.415201	-.476210	.909706	.000422
93	.162071	-.067459	.414455	-.473312	.908531	.000431
94	.156258	-.066827	.413752	-.470580	.907414	.000450
95	.150610	-.066187	.413003	-.467671	.906221	.000474
96	.145125	-.065538	.412014	-.463829	.904678	.000471
97	.139797	-.064880	.410528	-.458056	.902440	.000380
98	.134624	-.064214	.408499	-.450173	.899441	.000199
99	.129589	-.063542	.406564	-.442656	.896437	.000185
100	.124720	-.062871	.406216	-.441304	.895493	.000618
101	.119978	-.062201	.407530	-.446402	.897423	.000747
102	.115370	-.061531	.409062	-.452360	.900026	.000517
103	.110895	-.060854	.409795	-.455208	.901300	.000376
104	.106546	-.060168	.409730	-.454955	.901209	.000364
105	.102321	-.059474	.409350	-.453479	.900566	.000418
106	.098212	-.058773	.408994	-.452096	.899978	.000454
107	.094215	-.058066	.408692	-.450923	.899520	.000439
108	.090324	-.057351	.408457	-.450010	.899138	.000456
109	.086532	-.056629	.408284	-.449338	.898862	.000462
110	.082836	-.055898	.408096	-.448608	.898590	.000439
111	.079227	-.055158	.407896	-.447831	.898283	.000434
112	.075703	-.054406	.407743	-.447236	.898036	.000443
113	.072257	-.053643	.407755	-.447283	.898001	.000501
114	.068881	-.052866	.407885	-.447788	.898169	.000539
115	.065572	-.052071	.407853	-.447663	.898133	.000524
116	.062325	-.051257	.407434	-.446036	.897478	.000526
117	.059133	-.050420	.406503	-.442419	.896031	.000521
118	.055991	-.049557	.405064	-.436829	.893775	.000535
119	.052896	-.048666	.403197	-.429575	.890822	.000584
120	.049842	-.047743	.400995	-.421021	.887317	.000668
121	.046824	-.046784	.398348	-.410738	.883170	.000702
122	.043840	-.045785	.395016	-.397783	.878005	.000692
123	.040888	-.044742	.391007	-.382219	.871717	.000766
124	.037966	-.043649	.386496	-.364694	.864601	.000902
125	.035074	-.042503	.381430	-.345013	.856663	.001009
126	.032214	-.041295	.375824	-.323234	.847751	.001271
127	.029392	-.040023	.369465	-.298530	.837641	.001578
128	.026617	-.038675	.361638	-.268123	.825354	.001806
129	.023901	-.037248	.351519	-.228812	.809643	.001940
130	.021260	-.035732	.338126	-.176781	.789185	.001799
131	.018712	-.034122	.322018	-.114203	.763984	.002202
132	.016272	-.032418	.304446	-.045938	.736040	.002986
133	.013960	-.030618	.283001	.037374	.703825	.002041
134	.011813	-.028715	.253562	.151741	.660137	-.000036
135	.009840	-.026716	.223826	.267262	.610590	.001675
136	.008044	-.024633	.192052	.390701	.559887	.000430
137	.006431	-.022473	.161034	.511203	.506219	.000650
138	.005012	-.020244	.127643	.640923	.447660	-.000897
139	.003776	-.017959	.099748	.749292	.389077	.000686
140	.002705	-.015633	.075911	.841897	.336341	.000642
141	.001819	-.013268	.053238	.929979	.281447	-.000307
142	.001137	-.010871	.033914	1.005061	.223222	-.000205

Table 6.3 (continued).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF	N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
143	.000641	-.008455	.019320	1.061747	.166781	.000092	232	.279032	.085017	.573797	-1.092339	1.173262	.001679
144	.000303	-.006031	.009395	1.100304	.114637	.000252	233	.286199	.085299	.572666	-1.087945	1.171207	.001674
145	.000100	-.003608	.003369	1.123715	.066915	.000242	234	.293498	.085563	.571534	-1.083547	1.169155	.001668
146	.000018	-.001192	.000806	1.133672	.027930	.000260	235	.300931	.085809	.570380	-1.079064	1.167061	.001668
147	.000043	.001213	.001188	1.132188	.036275	.000268	236	.308498	.086036	.569191	-1.074445	1.164909	.001667
148	.000169	.003602	.004154	1.120665	.074637	.000265	237	.316197	.086243	.567970	-1.069701	1.162704	.001663
149	.000390	.005974	.009449	1.100085	.114864	.000270	238	.324030	.086429	.566719	-1.064841	1.160457	.001649
150	.000700	.008327	.016869	1.071269	.154715	.000297	239	.331994	.086593	.565428	-1.059826	1.158126	.001656
151	.001093	.010660	.026212	1.034972	.194232	.000253	240	.340090	.086734	.564084	-1.054605	1.155712	.001652
152	.001567	.012969	.037576	.990824	.233563	.000321	241	.348318	.086852	.562717	-1.049294	1.153266	.001643
153	.002118	.015257	.050839	.939299	.272846	.000449	242	.356674	.086944	.561326	-1.043890	1.150774	.001643
154	.002743	.017519	.066088	.880058	.314304	-.000104	243	.365161	.087010	.559919	-1.038424	1.148259	.001642
155	.003453	.019756	.084411	.808875	.356611	.000281	244	.373775	.087049	.558546	-1.033090	1.145794	.001661
156	.004256	.021965	.103358	.735268	.397074	.000435	245	.382515	.087059	.557215	-1.027919	1.143573	.001471
157	.005147	.024141	.123669	.656362	.437551	.000498	246	.391379	.087039	.555826	-1.022523	1.140821	.001828
158	.006117	.026288	.146103	.569208	.479900	.000334	247	.400366	.086987	.554189	-1.016164	1.138136	.001550
159	.007169	.028401	.171396	.470947	.524918	.000263	248	.409473	.086906	.553005	-1.011564	1.136016	.001579
160	.008308	.030478	.199093	.363347	.571735	.000363	249	.413699	.086789	.551722	-1.006580	1.133727	.001605
161	.009542	.032516	.228592	.248747	.619847	.000423	250	.428040	.086638	.550421	-1.001525	1.131432	.001603
162	.010870	.034509	.259747	.127713	.669063	.000654	251	.437494	.086450	.549062	-.996246	1.129054	.001582
163	.012298	.036457	.292706	-.000329	.719959	.001071	252	.447057	.086225	.547626	-.990667	1.126530	.001579
164	.013823	.038353	.328787	-.140500	.776654	.000024	253	.456728	.085961	.546062	-.984591	1.123784	.001580
165	.015459	.040192	.368502	-.294789	.836675	.001046	254	.466502	.085656	.544361	-.977983	1.120815	.001566
166	.017210	.041965	.408299	-.449396	.897547	.001910	255	.476376	.085309	.542522	-.970839	1.117614	.001549
167	.019079	.043668	.450923	-.614986	.966212	.000361	256	.486346	.084916	.540504	-.962999	1.114106	.001535
168	.021082	.045287	.495494	-.788140	1.037245	.002064	257	.496407	.084478	.538244	-.954219	1.110189	.001518
169	.023222	.046813	.535964	-.945361	1.104372	.003828	258	.506556	.083991	.535662	-.944188	1.105705	.001526
170	.025494	.048242	.572459	-1.087141	1.171906	.000292	259	.516787	.083453	.532682	-.932611	1.100542	.001542
171	.027896	.049565	.598913	-1.189912	1.216405	.006262	260	.527097	.082862	.529340	-.919628	1.094767	.001567
172	.030392	.050797	.604723	-1.212483	1.225887	.008352	261	.537480	.082216	.525789	-.905833	1.088653	.001596
173	.032923	.051968	.602651	-1.204433	1.225173	.004092	262	.547930	.081511	.522315	-.892336	1.082719	.001596
174	.035476	.053084	.601415	-1.199632	1.225689	.000314	263	.558441	.080742	.519272	-.880515	1.077599	.001524
175	.038055	.054146	.601791	-1.201092	1.227671	-.001359	264	.569009	.079909	.516900	-.871300	1.073610	.001480
176	.040662	.055157	.603550	-1.207926	1.231072	-.001427	265	.579625	.079006	.515082	-.864237	1.070719	.001252
177	.043295	.056117	.606017	-1.217510	1.235313	-.000799	266	.590285	.078030	.513315	-.857372	1.067738	.001247
178	.045953	.057031	.608852	-1.228524	1.240212	-.000075	267	.600980	.076974	.510364	-.845908	1.062754	.001260
179	.048637	.057900	.611902	-1.240373	1.245741	.000403	268	.611704	.075838	.505289	-.826192	1.054125	.001394
180	.051346	.058729	.615044	-1.252579	1.251664	.000639	269	.622449	.074617	.497472	-.795824	1.040929	.001586
181	.054079	.059520	.618069	-1.264331	1.257502	.000729	270	.633208	.073310	.487248	-.756105	1.023912	.001718
182	.056839	.060276	.620848	-1.275127	1.262989	.000684	271	.643972	.071917	.475790	-.711592	1.005169	.001695
183	.059625	.061001	.623345	-1.284828	1.268000	.000568	272	.654733	.070440	.464515	-.667789	.987020	.001533
184	.062439	.061696	.625463	-1.293056	1.272270	.000466	273	.665486	.068883	.454351	-.628303	.970797	.001388
185	.065282	.062367	.627090	-1.299376	1.275568	.000379	274	.676219	.067249	.445346	-.593320	.956445	.001348
186	.068155	.063014	.628132	-1.303425	1.277707	.000294	275	.686926	.065543	.437000	.560897	.943168	.001369
187	.071061	.063643	.628473	-1.304749	1.278424	.000245	276	.697599	.063772	.428772	-.528932	.930090	.001450
188	.074000	.064255	.628061	-1.303149	1.277579	.000276	277	.708228	.061939	.420343	-.496186	.916796	.001484
189	.076975	.064854	.627123	-1.299505	1.275755	.000216	278	.718807	.060050	.411753	-.462815	.903323	.001500
190	.079988	.065442	.626064	-1.295391	1.273705	.000141	279	.729326	.058111	.403131	-.429319	.889874	.001492
191	.083042	.066021	.625039	-1.291409	1.271675	.000135	280	.739775	.056127	.394634	-.396309	.876676	.001474
192	.086142	.066590	.624044	-1.287543	1.269624	.000243	281	.750150	.054105	.386345	-.364107	.863827	.001470
193	.089290	.067151	.623010	-1.283526	1.267462	.000401	282	.760439	.052052	.378268	-.332729	.851333	.001471
194	.092490	.067706	.621908	-1.279245	1.265169	.000560	283	.770634	.049974	.370399	-.302159	.839183	.001474
195	.095744	.068254	.620743	-1.274719	1.262774	.000696	284	.780728	.047878	.362732	-.272373	.827362	.001478
196	.099056	.068795	.619551	-1.270088	1.260365	.000785	285	.790710	.045770	.355271	-.243[illegible]88	.815881	.001474
197	.102429	.069332	.618338	-1.265376	1.257928	.000863	286	.800573	.043656	.348033	-.215269	.804746	.001476
198	.105866	.069864	.617071	-1.260454	1.255387	.000946	287	.810307	.041543	.341011	-.187989	.793949	.001476
199	.109369	.070392	.615762	-1.255368	1.252780	.001016	288	.819904	.039437	.334212	-.161576	.783504	.001471
200	.112942	.070915	.614450	-1.250271	1.250195	.001056	289	.829355	.037344	.327643	-.136056	.773400	.001472
201	.116589	.071435	.613145	-1.245202	1.247623	.001104	290	.838651	.035270	.321289	-.111371	.763625	.001472
202	.120310	.071951	.611829	-1.240089	1.245026	.001166	291	.847783	.033219	.315147	-.087510	.754171	.001471
203	.124110	.072464	.610516	-1.234988	1.242455	.001208	292	.856740	.031198	.309214	-.064461	.745025	.001473
204	.127991	.072974	.609223	-1.229973	1.239942	.001237	293	.865517	.029211	.303480	-.042185	.736178	.001473
205	.131956	.073480	.607923	-1.224915	1.237402	.001281	294	.874100	.027264	.297945	-.020682	.727631	.001468
206	.136007	.073983	.606579	-1.219693	1.234788	.001324	295	.882483	.025360	.292604	.000067	.719358	.001475
207	.140147	.074483	.605193	-1.214309	1.232102	.001363	296	.890656	.023504	.287434	.020152	.711342	.001475
208	.144379	.074979	.603779	-1.208816	1.229372	.001398	297	.898610	.021701	.282438	.039561	.703584	.001473
209	.148704	.075473	.602362	-1.203311	1.226645	.001430	298	.906333	.019952	.277603	.058344	.696054	.001477
210	.153127	.075962	.600961	-1.197868	1.223950	.001468	299	.913819	.018263	.272918	.076545	.688743	.001479
211	.157648	.076448	.599582	-1.192511	1.221308	.001500	300	.921057	.016637	.268389	.094140	.681670	.001472
212	.162272	.076929	.598220	-1.187219	1.218700	.001537	301	.928037	.015076	.264018	.111121	.674820	.001472
213	.166998	.077406	.596864	-1.181952	1.216114	.001567	302	.934752	.013585	.259785	.127565	.668169	.001472
214	.171830	.077879	.595527	-1.176757	1.213580	.001584	303	.941190	.012164	.255664	.143575	.661677	.001473
215	.176771	.078346	.594209	-1.171637	1.211087	.001601	304	.947343	.010815	.251638	.159216	.655308	.001481
216	.181822	.078807	.592905	-1.166571	1.208627	.001615	305	.953203	.009542	.247695	.174534	.649054	.001489
217	.186985	.079263	.591623	-1.161591	1.206223	.001617	306	.958759	.008346	.243862	.189425	.642976	.001480
218	.192261	.079712	.590361	-1.156688	1.203857	.001625	307	.964002	.007229	.240194	.203674	.637141	.001474
219	.197655	.080154	.589102	-1.151797	1.201494	.001642	308	.968924	.006193	.236688	.217295	.631543	.001471
220	.203166	.080590	.587849	-1.146929	1.199160	.001642	309	.973516	.005238	.233328	.230348	.626164	.001468
221	.208796	.081016	.586620	-1.142155	1.196868	.001652	310	.977769	.004365	.230096	.242904	.620971	.001467
222	.214548	.081436	.585409	-1.137450	1.194619	.001654	311	.981676	.003573	.226967	.255060	.615938	.001459
223	.220422	.081846	.584219	-1.132827	1.192413	.001657	312	.985226	.002862	.223925	.266878	.611042	.001443
224	.226422	.082246	.583036	-1.128231	1.190216	.001670	313	.988412	.002232	.220919	.278556	.606165	.001446
225	.232547	.082635	.581857	-1.123651	1.188042	.001667	314	.991227	.001681	.217844	.290502	.601193	.001423
226	.238798	.083014	.580691	-1.119121	1.185887	.001677	315	.993663	.001210	.214634	.302972	.595939	.001436
227	.245178	.083381	.579524	-1.114587	1.183743	.001674	316	.995711	.000816	.211150	.316507	.590197	.001464
228	.251687	.083736	.578366	-1.110089	1.181612	.001681	317	.997365	.000499	.207226	.331752	.583951	.001305
229	.258326	.084078	.577206	-1.105582	1.179485	.001683	318	.998619	.000261	.202701	.349331	.576835	.001030
230	.265096	.084406	.576059	-1.101126	1.177391	.001677	319	.999464	.000101	.197477	.369625	.567008	.001884
231	.271998	.084719	.574927	-1.096729	1.175324	.001677	320	.999891	.000021	.188343	.405110	.551610	.001913

6.5 Reference test case 01 (NACA 0012, $M_\infty = 0.8$, $\alpha = 1.25°$)

The seven solutions of group 2 are listed in table 6.4 below with mesh characteristics and values of the aerodynamic coefficients and of the circulation. A star indicates the maximum or the minimum value in the corresponding column, while the absolute and relative corresponding scatters are given on the bottom line.

The full sets of data for the solutions of group 2, as given by the contributors, can be found, in microfiche form in Appendix A1.

A physical picture of the flow field is given by the map of iso-Mach lines shown on Fig. 6.15 and taken from solution N° 9.

Table 6.4 – Solutions of group 2 for test case 01 (NACA 0012, $M_\infty = 0.8$, $\alpha = 1.25°$).

Solution	MESH			outer boundary (chords)	C_L	Γ	C_D	C_M
	type	points or cells						
		total	on airfoil					
1	C	189 x 25	147	4/6/7	0.3642	0.1692	0.0225	- 0.0376
2	C	188 x 24	146	4/6/7	0.3736*	0.1733*	0.0244*	- 0.0411
3	O	158 x 23	158	16	0.3463*	0.1534*	0.0223	- 0.0358*
5	C	249 x 67	181	48/96/96	0.3661	0.1723	0.0229	- 0.0430*
6	O	192 x 39	192	50	0.3474		0.0221*	- 0.0374
8	O	128 x 28	128	5	0.350	0.161	0.0221*	- 0.037
9	O	320 x 64	320	25	0.3632		0.0230	- 0.0397
					0.0273	0.0199	0.0023	0.0072
				scatter :	± 7.6 %	± 12 %	± 9.9 %	± 18 %

The overall scatter of the solutions of group 2 can be evaluated from Fig. 6.12 which gives cross-plots of the pressure, Mach number and total pressure distributions. Enlarged plots of pressure and Mach number in the shock regions, on the upper surface and on the lower surface, are shown on Fig. 6.13. A characteristic shock jump, computed from the Rankine-Hugoniot relations for a given value of the upstream Mach number M_1 and assuming $pi_1 = pi_\infty$, is given by the dashes marked "RH", just as an example and not for precise comparisons with the numerical solutions since the values of M_1 and pi_1 vary from one solution to another.

From table 6.4, we see that the solutions can be separated into two sub-groups, according to the distance of the outer boundary. For solutions N° 1, 2 and 8, this distance varies from 4 to 7 chords, while for the other solutions, it is at least of 16 chords and goes up to 96 chords for solution N° 5. As discussed in § 6.3, the distance of the outer boundary should not be considered alone but in relation to the type of boundary condition used. It is only in solution N° 5 that all the flow properties are imposed equal to their free-stream values on the inflow part of the boundary ; for all other solutions, some compatibility or non-reflective type relations are used, which allows the outer boundary to be taken much closer to the airfoil. However, whether a distance of the order of 5 chords, as in solutions N° 1, 2 and 8 is sufficient or not is not clear and, from this point of view, we have to give a preference to the other solutions.

This preference is strengthened by the consideration of the mesh size at the wall. It turns out that the solutions N° 1, 2 and 8 are also those with the coarsest meshes at the wall, while solution N° 9 has the finest mesh, followed by solutions N° 6 and 5.

Looking now at the error on the total pressure at the wall upstream of shocks (Fig. 6.12 c), it can be seen that the relative error is of the order of or smaller than 10^{-2} for all the solutions except solution N° 5 for which the error reaches 6×10^{-2} ; the error is by far the smallest for solution N° 9 since it is below 10^{-3}.

If we consider the quality of the shocks, (Fig. 6.13), and firstly the jumps through the shock on the upper surface, we find that all solutions give very good jumps in Mach number, but only good jumps in pressure, with solution N° 5 slightly not as good as the others. As to the shock on the lower surface, this is a weak shock located much more upstream than the upper shock, hence in a region of higher wall curvature, and we find that neither the pressure jump nor the Mach number jump are good for any of the solutions : they are appreciably smaller than the Rankine-Hugoniot jumps (discrepancies are of the order of 0.05 in the jumps of M and of $p/p_{i\infty}$). Here, there is a possibility that the error comes as much from the Zierep singularity as from the shock itself.

As to the sharpness of the upper shock, solution N° 5 comes first, followed by solutions N° 3, 9 and 6 in this order. Solutions N° 1, 2 and 8 have rather thick shocks due to mesh coarseness. Solutions N° 3 and 9 show no oscillation at the shock ; solution N° 5 has post-shock oscillations, and solution N° 6 shows very small ripples in the pressure and Mach number distributions on the upper surface upstream of the shock (probably related to the saw-tooth distribution of p_i).

So, considering the accuracy on the total pressure and the shock quality, we class solution N° 9 first, solution N° 3 second and solution N° 6 third, and these three solutions constitute the group 3. Despite the fine mesh used, solution N° 5 suffers from a large error on the total pressure at the wall. Looking again at the aerodynamic coefficients in table 6.4, we see that the solutions N° 3 and 6 agree very well on C_L and on C_D, while solution N° 9 gives slightly higher lift and higher drag ; the agreement on C_M is not as good.

Figure 6.14 gives the cross-plots of p, M and p_i for the solutions of group 3 (N° 3, 6, 9). Tabulated wall values from solution N° 9 are given in table 6.5, and Fig. 6.15 shows the map of iso-Mach lines for this solution.

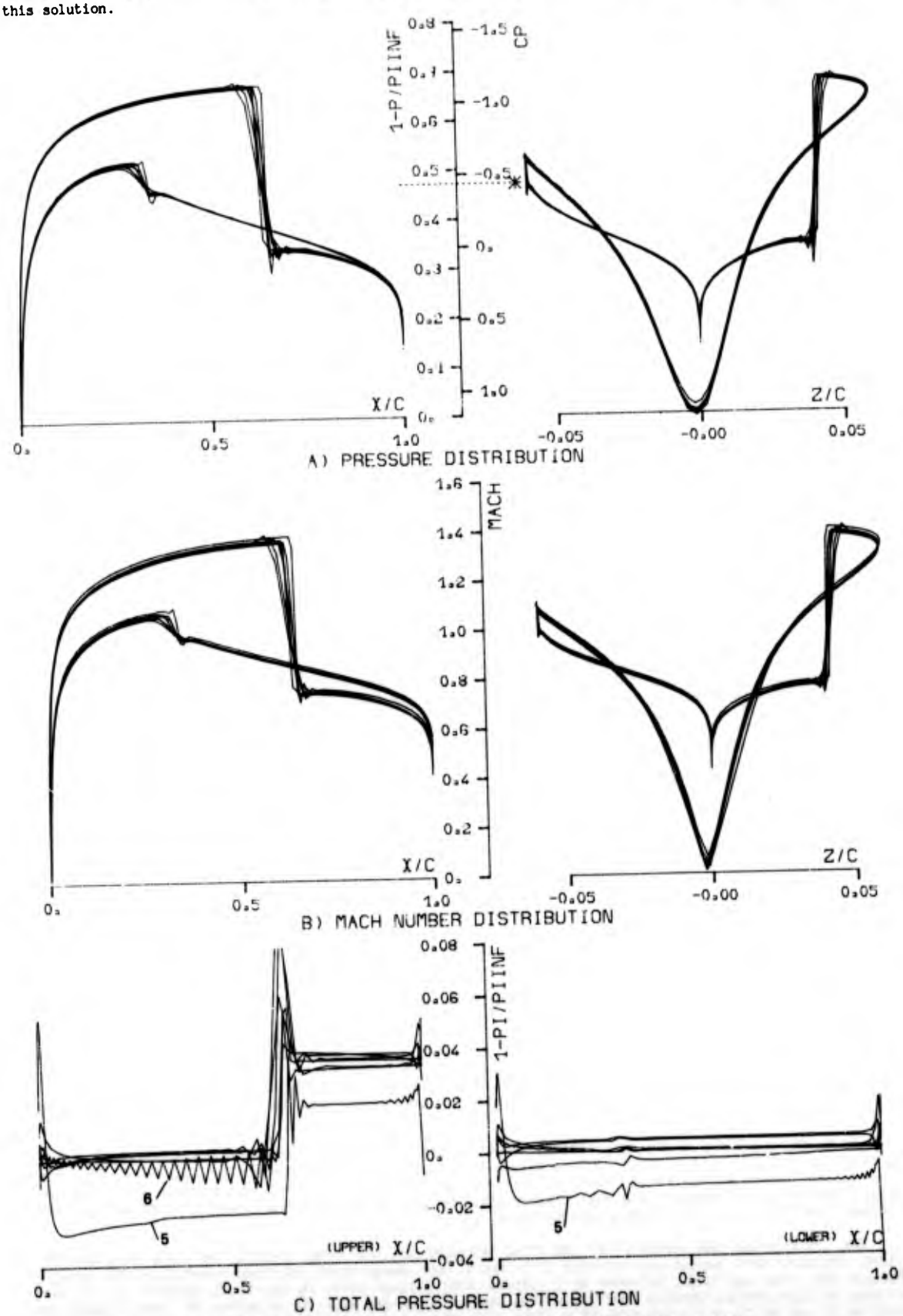


Fig. 6.12 – Solutions of group 2 for test case 01 (NACA 0012, Mach = 0.80, α = 1.25).

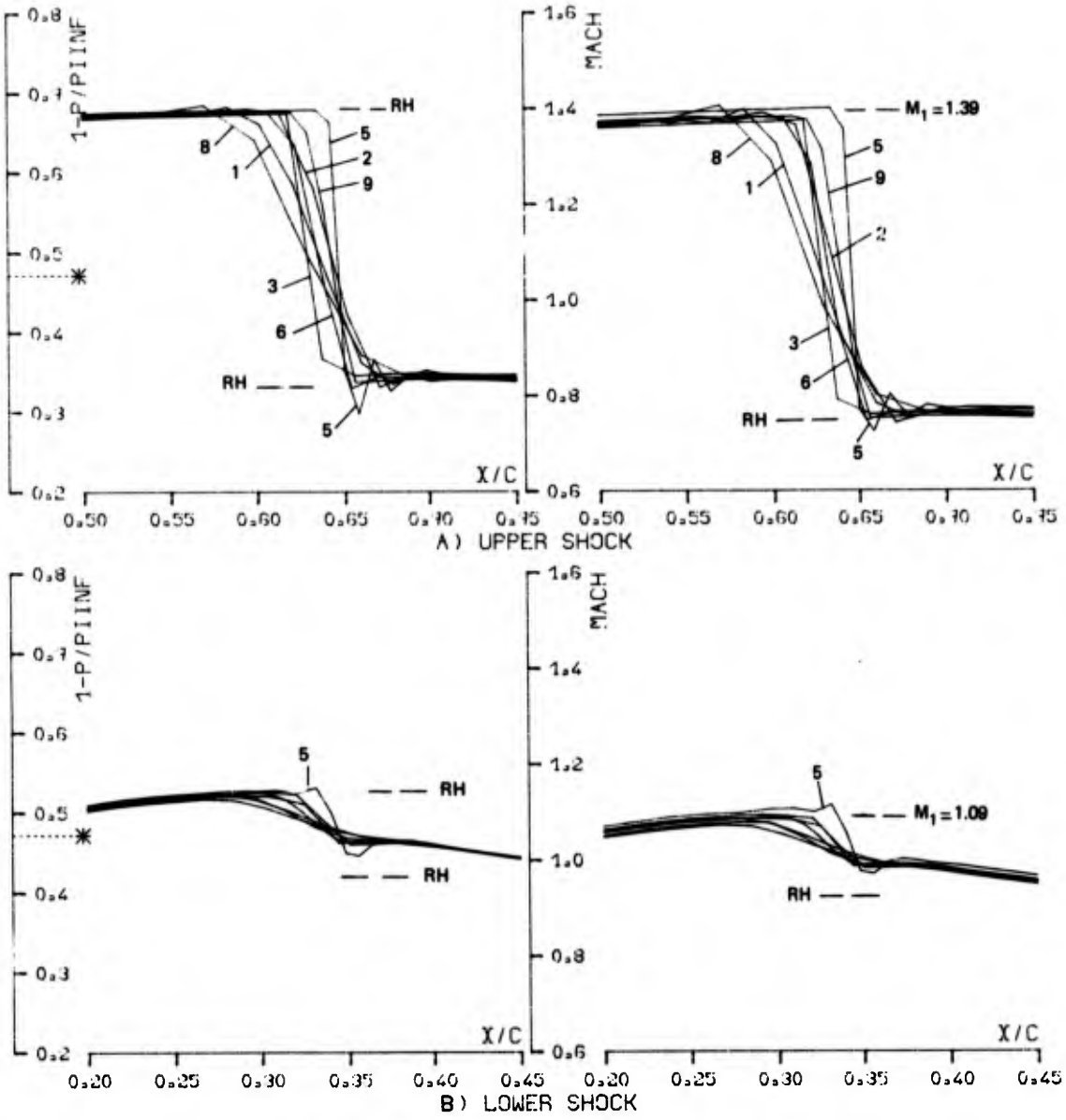


Fig. 6.13 – Shock profiles for solutions of group 2. Test case 01.

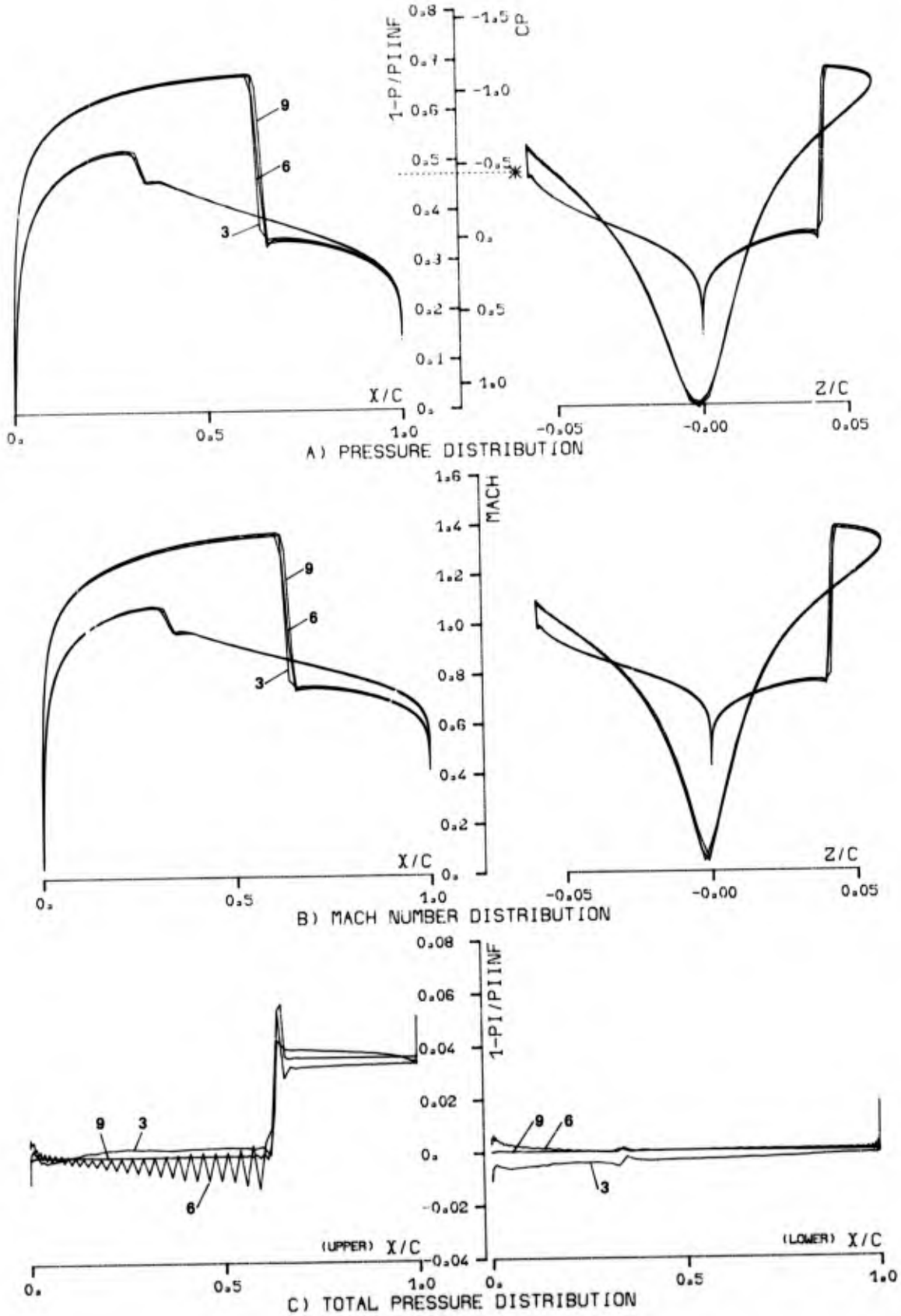


Fig. 6.14 — Solutions of group 3 for test case 01 (NACA 0012, Mach = 0.80, α = 1.25).

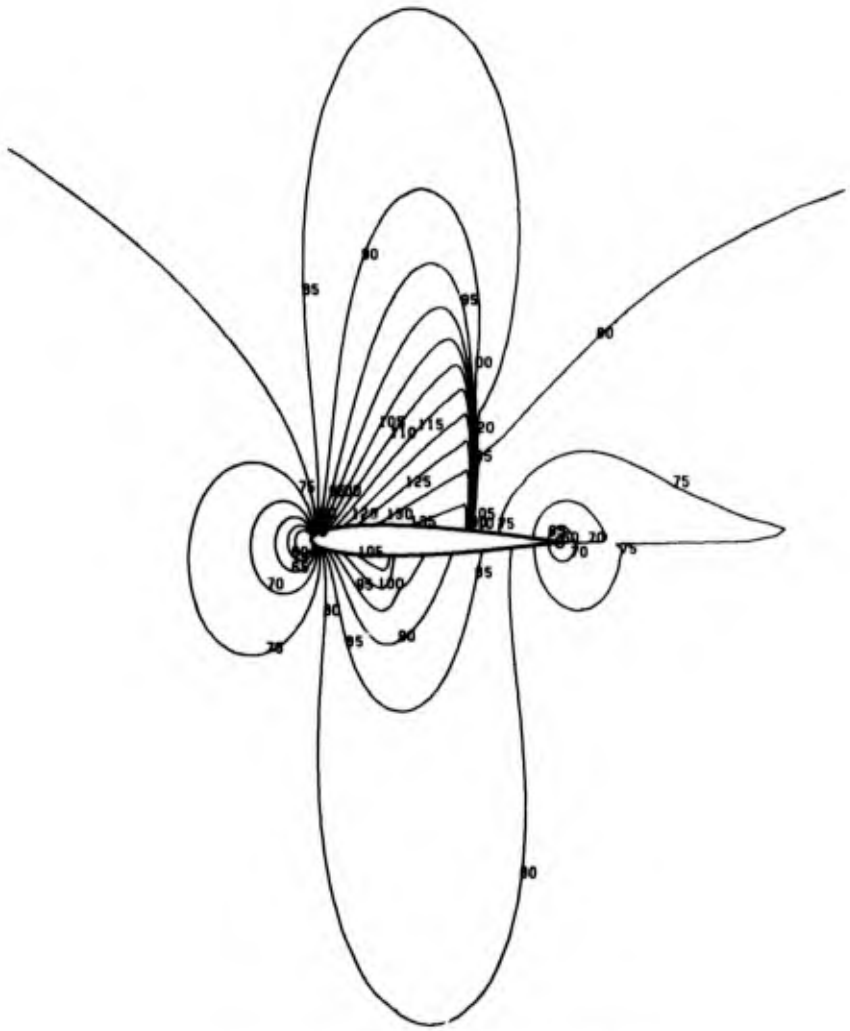


Fig. 6.15 — Iso-Mach lines of solution n° 9 for test case 01 (ΔM = 0.05, curve parameter = 100 M).

Table 6.5 — Wall values of solution n° 9 for test case 01 (NACA 0012 $M_\infty = 0.8$, $\alpha = 1.25°$).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.999928	-.000010	.139552	.695536	.466564	-.000094
2	.999659	-.000048	.170725	.569502	.522552	.001097
3	.999147	-.000121	.184682	.542013	.548702	-.000473
4	.998404	-.000226	.196671	.501220	.567548	.000479
5	.997440	-.000363	.205956	.469627	.583620	-.000042
6	.996259	-.000530	.214201	.441573	.596761	.000245
7	.994867	-.000726	.221169	.417864	.608279	.000094
8	.993267	-.000951	.227405	.396646	.618255	.000167
9	.991463	-.001205	.233107	.377245	.627432	.000149
10	.989456	-.001486	.238500	.358895	.636000	.000189
11	.987255	-.001794	.243378	.342297	.643829	.000132
12	.984857	-.002128	.247929	.326812	.651014	.000156
13	.982267	-.002488	.252471	.311358	.658128	.000209
14	.979488	-.002873	.256673	.297060	.664834	.000136
15	.976521	-.003282	.260505	.284022	.670849	.000141
16	.973371	-.003716	.264340	.270973	.676801	.000193
17	.970039	-.004172	.268090	.258214	.682709	.000157
18	.966528	-.004651	.271631	.246165	.688243	.000152
19	.962840	-.005152	.275056	.234511	.693565	.000166
20	.958979	-.005674	.278398	.223140	.698767	.000165
21	.954946	-.006216	.281625	.212160	.703786	.000161
22	.950743	-.006779	.284713	.201653	.708587	.000153
23	.946375	-.007360	.287720	.191422	.713243	.000157
24	.941842	-.007960	.290743	.181136	.717907	.000171
25	.937148	-.008579	.293734	.170959	.722542	.000163
26	.932296	-.009215	.296625	.161122	.727011	.000161
27	.927286	-.009867	.299384	.151734	.731280	.000153
28	.922123	-.010535	.302068	.142602	.735413	.000160
29	.916809	-.011218	.304747	.133487	.739534	.000168
30	.911346	-.011916	.307399	.124463	.743625	.000164
31	.905738	-.012628	.310028	.115518	.747665	.000171
32	.899985	-.013354	.312650	.106596	.751691	.000180
33	.894092	-.014092	.315172	.098015	.755586	.000166
34	.888061	-.014842	.317565	.089873	.759273	.000159
35	.881894	-.015603	.320005	.081571	.762988	.000193
36	.875594	-.016376	.322493	.073105	.766815	.000190
37	.869164	-.017158	.324898	.064922	.770524	.000176
38	.862607	-.017950	.327241	.056950	.774110	.000189
39	.855924	-.018751	.329576	.049005	.777688	.000197
40	.849119	-.019560	.331907	.041073	.781262	.000202
41	.842195	-.020376	.334211	.033234	.784793	.000209
42	.835154	-.021200	.336469	.025551	.788261	.000208
43	.827999	-.022029	.338705	.017943	.791682	.000219
44	.820733	-.022865	.340946	.010318	.795116	.000226
45	.813358	-.023706	.343208	.002621	.798578	.000237
46	.805878	-.024552	.345466	-.005062	.802041	.000242
47	.798294	-.025401	.347684	-.012609	.805444	.000245
48	.790610	-.026254	.349875	-.020064	.808800	.000254
49	.782828	-.027109	.352074	-.027546	.812166	.000267
50	.774952	-.027967	.354306	-.035140	.815579	.000284
51	.766984	-.028826	.356515	-.042656	.818974	.000284
52	.758927	-.029686	.358652	-.049928	.822261	.000282
53	.750783	-.030545	.360812	-.057277	.825556	.000310
54	.742556	-.031406	.363042	-.064865	.828975	.000321
55	.734249	-.032265	.365264	-.072425	.832397	.000319
56	.725863	-.033123	.367484	-.079979	.835798	.000336
57	.717403	-.033979	.369738	-.087648	.839253	.000353
58	.708870	-.034832	.371953	-.095185	.842672	.000347
59	.700268	-.035682	.374129	-.102589	.846020	.000354
60	.691599	-.036527	.376411	-.110353	.849503	.000393
61	.682867	-.037369	.378755	-.118329	.853120	.000394
62	.674074	-.038205	.381011	-.126005	.856615	.000382
63	.665224	-.039035	.383223	-.133532	.860016	.000400
64	.656318	-.039859	.385506	-.141300	.863532	.000415
65	.647359	-.040676	.387906	-.149466	.867227	.000435
66	.638352	-.041486	.390378	-.157741	.870992	.000436
67	.629298	-.042287	.392676	-.165696	.874628	.000423
68	.620201	-.043078	.394[illegible]	-.173697	.878210	.000444
69	.611063	-.043860	.397[illegible]	-.181783	.881932	.000458
70	.601888	-.044632	.399[illegible]	-.190160	.885757	.000459

Table 6.5 (continued).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
71	.592677	-.045393	.402356	-.198632	.889622	.000467
72	.583435	-.046142	.404866	-.207173	.893523	.000474
73	.574163	-.046878	.407359	-.215655	.897414	.000468
74	.564866	-.047601	.409845	-.224114	.901291	.000470
75	.555545	-.048311	.412427	-.232899	.905299	.000497
76	.546204	-.049005	.415072	-.241899	.909439	.000493
77	.536846	-.049685	.417641	-.250640	.913482	.000471
78	.527474	-.050347	.420201	-.259351	.917480	.000488
79	.518090	-.050993	.422880	-.268466	.921672	.000503
80	.508698	-.051622	.425628	-.277816	.926000	.000495
81	.499300	-.052233	.428392	-.287221	.930350	.000497
82	.489900	-.052824	.431180	-.296707	.934741	.000503
83	.480500	-.053395	.433976	-.306221	.939162	.000497
84	.471105	-.053946	.436774	-.315741	.943590	.000496
85	.461715	-.054475	.439626	-.325445	.948084	.000513
86	.452335	-.054982	.442507	-.335248	.952672	.000509
87	.442968	-.055466	.445314	-.344799	.957156	.000486
88	.433616	-.055926	.448107	-.354302	.961608	.000483
89	.424283	-.056362	.451117	-.364544	.966404	.000495
90	.414971	-.056772	.454527	-.376147	.971833	.000526
91	.405685	-.057157	.458256	-.388835	.977776	.000570
92	.396425	-.057514	.461847	-.401053	.983529	.000537
93	.387197	-.057844	.464523	-.410158	.987860	.000577
94	.378003	-.058147	.465454	-.413326	.989443	.000485
95	.368846	-.058420	.464345	-.409553	.987811	.000302
96	.359728	-.058664	.462312	-.402635	.984664	.000151
97	.350654	-.058877	.462330	-.402697	.984613	.000244
98	.341627	-.059059	.468363	-.423224	.993986	.000671
99	.332648	-.059209	.482327	-.470737	1.016296	.001171
100	.323722	-.059327	.500619	-.532977	1.046573	.001096
101	.314852	-.059412	.515879	-.584900	1.072679	.000506
102	.306041	-.059464	.523641	-.611310	1.086249	.000038
103	.297291	-.059481	.525254	-.616798	1.089040	-.000007
104	.288606	-.059464	.524251	-.613386	1.087199	.000150
105	.279990	-.059412	.522803	-.608459	1.084632	.000269
106	.271445	-.059324	.521576	-.604284	1.082506	.000313
107	.262974	-.059200	.520547	-.600783	1.080756	.000312
108	.254581	-.059040	.519498	-.597213	1.078983	.000300
109	.246268	-.058843	.518259	-.592998	1.076888	.000290
110	.238040	-.058608	.516763	-.587907	1.074353	.000289
111	.229898	-.058336	.515000	-.581909	1.071373	.000286
112	.221847	-.058025	.512987	-.575059	1.067979	.000280
113	.213889	-.057676	.510799	-.567615	1.064282	.000294
114	.206028	-.057289	.508497	-.559782	1.060405	.000304
115	.198265	-.056864	.506062	-.551497	1.056320	.000307
116	.190606	-.056400	.503425	-.542524	1.051909	.000308
117	.183052	-.055897	.500519	-.532636	1.047071	.000298
118	.175608	-.055355	.497359	-.521884	1.041817	.000298
119	.168275	-.054774	.494015	-.510506	1.036269	.000305
120	.161058	-.054154	.490568	-.498778	1.030558	.000324
121	.153958	-.053495	.487015	-.486688	1.024704	.000327
122	.146980	-.052798	.483288	-.474007	1.018585	.000328
123	.140126	-.052062	.479335	-.460557	1.012116	.000331
124	.133399	-.051288	.475135	-.446266	1.005268	.000332
125	.126803	-.050475	.470694	-.431156	.998055	.000331
126	.120339	-.049625	.466088	-.415483	.990581	.000353
127	.114012	-.048737	.461348	-.399355	.982917	.000376
128	.107824	-.047811	.456308	-.382207	.974845	.000346
129	.101778	-.046849	.450949	-.363972	.966255	.000359
130	.095878	-.045850	.445433	-.345204	.957417	.000405
131	.090125	-.044815	.439666	-.325581	.948265	.000392
132	.084522	-.043744	.433498	-.304594	.938505	.000387
133	.079073	-.042637	.426986	-.282437	.928207	.000418
134	.073781	-.041495	.420162	-.259218	.917470	.000432
135	.068647	-.040320	.412967	-.234737	.906193	.000443
136	.063676	-.039110	.405314	-.208697	.894251	.000442
137	.058869	-.037867	.397228	-.181184	.881652	.000465
138	.054229	-.036591	.388764	-.152385	.868479	.000516
139	.049759	-.035283	.379663	-.121419	.854434	.000486
140	.045461	-.033942	.369772	-.087764	.839179	.000483
141	.041339	-.032570	.359356	-.052323	.823060	.000570
142	.037394	-.031167	.348254	-.014548	.806002	.000562
143	.033630	-.029734	.336121	.026735	.787387	.000541
144	.030049	-.028270	.323025	.071295	.767208	.000598
145	.026653	-.026776	.308890	.119390	.745450	.000606
146	.023445	-.025253	.293457	.171901	.721644	.000593
147	.020428	-.023699	.276618	.229197	.695501	.000606
148	.017604	-.022117	.258269	.291630	.666797	.000604
149	.014976	-.020505	.238238	.359786	.635077	.000604
150	.012548	-.018863	.216270	.434533	.599726	.000564
151	.010322	-.017191	.192264	.516215	.560107	.000530
152	.008302	-.015490	.166374	.604307	.515784	.000532
153	.006492	-.013758	.138776	.698210	.466107	.000533
154	.004896	-.011997	.109835	.796683	.410232	.000484
155	.003518	-.010208	.080553	.896317	.347779	.000325
156	.002365	-.008391	.052622	.991353	.278390	.000223
157	.001440	-.006551	.028329	1.074011	.202415	.000175
158	.000746	-.004692	.010425	1.134930	.121172	.000217
159	.000286	-.002820	.001545	1.165145	.042215	.000299
160	.000057	-.000941	.003446	1.158677	.067258	.000287
161	.000057	.000941	.016607	1.113896	.154537	.000069
162	.000286	.002820	.040515	1.032548	.244415	-.000211
163	.000746	.004692	.073246	.921179	.332349	-.000410
164	.001440	.006551	.111808	.789970	.415830	-.000427
165	.002365	.008391	.152893	.650177	.493006	-.000204
166	.003518	.010208	.193649	.511502	.563285	-.000104
167	.004896	.011997	.232099	.380675	.626069	-.000056
168	.006492	.013758	.267510	.260187	.681891	.000080
169	.008302	.015490	.299502	.151333	.731364	.000243
170	.010322	.017191	.328097	.054037	.775280	.000329
171	.012548	.018863	.353571	-.032639	.814318	.000416
172	.014976	.020505	.376077	-.109217	.848882	.000503
173	.017604	.022117	.395965	-.176887	.879632	.000528
174	.020428	.023699	.413746	-.237387	.907323	.000539
175	.023445	.025253	.429758	-.291869	.932480	.000523
176	.026653	.026773	.444164	-.340886	.955276	.000543
177	.030049	.028270	.457111	-.384939	.975965	.000539
178	.033630	.029734	.468950	-.425222	.995121	.000456
179	.037394	.031167	.479797	-.462129	1.012745	.000479
180	.041339	.032570	.489545	-.495297	1.028711	.000514
181	.045461	.033942	.498599	-.526104	1.043787	.000406
182	.049759	.035283	.507231	-.555474	1.058214	.000385
183	.054229	.036591	.515147	-.582409	1.071499	.000436
184	.058869	.037867	.522406	-.607108	1.083856	.000391
185	.063676	.039110	.529282	-.630504	1.095642	.000363
186	.068647	.040320	.535782	-.652620	1.106848	.000363
187	.073781	.041495	.541888	-.673396	1.117460	.000358
188	.079073	.042637	.547684	-.693117	1.127612	.000347
189	.084522	.043744	.553260	-.712090	1.137471	.000311
190	.090125	.044815	.558589	-.730222	1.146931	.000315
191	.095878	.045850	.563570	-.747170	1.155815	.000344
192	.101778	.046849	.568325	-.763349	1.164409	.000301
193	.107824	.047811	.572984	-.779202	1.172873	.000276
194	.114012	.048737	.577405	-.794244	1.180911	.000312
195	.120339	.049625	.581566	-.808402	1.188558	.000304
196	.126803	.050475	.585613	-.822173	1.196052	.000283
197	.133399	.051288	.589556	-.835589	1.203383	.000283
198	.140126	.052062	.593350	-.848498	1.210481	.000281
199	.146980	.052798	.596988	-.860877	1.217330	.000278
200	.153958	.053495	.600465	-.872707	1.223909	.000281
201	.161058	.054154	.603799	-.884041	1.230249	.000283
202	.168275	.054774	.607038	-.895072	1.236465	.000269
203	.175608	.055355	.610221	-.905902	1.242596	.000264
204	.183052	.055897	.613314	-.916426	1.248583	.000263
205	.190606	.056400	.616275	-.926501	1.254340	.000269
206	.198265	.056864	.619084	-.936059	1.259831	.000273
207	.206028	.057289	.621770	-.945198	1.265113	.000271
208	.213889	.057676	.624383	-.954089	1.270279	.000265
209	.221847	.058025	.626953	-.962834	1.275386	.000257
210	.229898	.058336	.629452	-.971337	1.280364	.000265
211	.238040	.058608	.631844	-.979476	1.285154	.000269
212	.246268	.058843	.634141	-.987291	1.289779	.000267
213	.254581	.059040	.636362	-.994848	1.294271	.000265
214	.262974	.059200	.638512	-1.002164	1.298638	.000263
215	.271445	.059324	.640584	-1.009214	1.302862	.000264
216	.279990	.059412	.642562	-1.015944	1.306911	.000265
217	.288606	.059464	.644446	-1.022354	1.310779	.000270
218	.297291	.059481	.646268	-1.028554	1.314540	.000268
219	.306041	.059464	.648057	-1.034641	1.318254	.000255
220	.314852	.059412	.649780	-1.040504	1.321824	.000270
221	.323722	.059327	.651408	-1.046043	1.325216	.000275
222	.332648	.059209	.652981	-1.051395	1.328516	.000264
223	.341627	.059059	.654502	-1.056570	1.331707	.000267
224	.350654	.058877	.655947	-1.061487	1.334741	.000281
225	.359728	.058664	.657348	-1.066254	1.337710	.000269
226	.368846	.058420	.658719	-1.070919	1.340623	.000258
227	.378003	.058147	.659991	-1.075247	1.343308	.000283
228	.387197	.057844	.661162	-1.079231	1.345803	.000284
229	.396425	.057514	.662307	-1.083127	1.348258	.000272
230	.405685	.057157	.663438	-1.086976	1.350678	.000275
231	.414971	.056772	.664523	-1.090667	1.353006	.000278
232	.424283	.056362	.665539	-1.094124	1.355186	.000287
233	.433616	.055926	.666500	-1.097394	1.357259	.000287
234	.442968	.055466	.667434	-1.100572	1.359287	.000275
235	.452335	.054982	.668313	-1.103563	1.361181	.000289
236	.461715	.054475	.669110	-1.106275	1.362903	.000299
237	.471105	.053946	.669882	-1.108902	1.364590	.000287
238	.480500	.053395	.670652	-1.111522	1.366270	.000283
239	.489900	.052824	.671383	-1.114009	1.367853	.000300
240	.499300	.052233	.672070	-1.116346	1.369360	.000292
241	.508698	.051622	.672719	-1.118555	1.370779	.000294
242	.518090	.050993	.673285	-1.120480	1.372018	.000297
243	.527474	.050347	.673799	-1.122229	1.373121	.000332
244	.536846	.049685	.674350	-1.124104	1.374393	.000246
245	.546204	.049005	.674917	-1.126033	1.375566	.000350
246	.555545	.048311	.675363	-1.127551	1.376635	.000230
247	.564866	.047601	.675804	-1.129051	1.377439	.000465
248	.574163	.046878	.676186	-1.130385	1.378606	.000041
249	.583435	.046142	.676667	-1.131988	1.379128	.000769
250	.592677	.045393	.676991	-1.133090	1.380708	-.000439
251	.601888	.044632	.677606	-1.135183	1.380813	.001319
252	.611063	.043860	.677323	-1.134220	1.381716	-.000822
253	.620201	.043078	.675286	-1.127289	1.373565	.004272
254	.629298	.042287	.650653	-1.043474	1.310627	.017927
255	.638352	.041486	.552235	-.708602	1.090365	.055284
256	.647359	.040676	.421976	-.265390	.865887	.057405
257	.656318	.039859	.337689	.021400	.750665	.037536
258	.665224	.039035	.337836	.020900	.751790	.036726
259	.674074	.038205	.339457	.015384	.754115	.036966
260	.682867	.037369	.340692	.011182	.755851	.037182
261	.691599	.036527	.340910	.010440	.756222	.037161
262	.700268	.035682	.340878	.010549	.756249	.037090
263	.708870	.034832	.340841	.010675	.756197	.037083
264	.717403	.033979	.340614	.011447	.755823	.037094
265	.725863	.033123	.340187	.012900	.755157	.037079
266	.734249	.032265	.339645	.014745	.754309	.037063
267	.742556	.031406	.338974	.017028	.753233	.037067
268	.750783	.030545	.338181	.019726	.751975	.037059
269	.758927	.029686	.337340	.022587	.750651	.037041
270	.766984	.028826	.336419	.025721	.749172	.037048
271	.774952	.027967	.335347	.029369	.747457	.037049
272	.782828	.027109	.334181	.033336	.745602	.037041
273	.790610	.026254	.332967	.037467	.743662	.037040
274	.798294	.025401	.331686	.041825	.741617	.037036
275	.805878	.024552	.330319	.046477	.739424	.037042
276	.813358	.023706	.328859	.051444	.737086	.037043
277	.820733	.022865	.327342	.056606	.734662	.037039
278	.827999	.022029	.325791	.061883	.732175	.037041
279	.835154	.021200	.324194	.067317	.729618	.037039
280	.842195	.020376	.322533	.072969	.726949	.037044
281	.849119	.019560	.320794	.078886	.724157	.037046
282	.855924	.018751	.318996	.085004	.721270	.037047
283	.862607	.017950	.317159	.091254	.718317	.037050
284	.869164	.017158	.315281	.097644	.715302	.037047
285	.875594	.016376	.313319	.104320	.712128	.037064
286	.881894	.015603	.311258	.111333	.708806	.037068

Table 6.5 (continued).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF						
287	888061	014842	309213	118291	705537	.037046	304	970039	004172	264499	.270432	632482	.037112
288	894092	014092	307180	125208	702244	.037059	305	973371	003716	260992	.282365	626617	.037143
289	899950	013354	305010	132592	698723	.037076	306	976521	003282	257388	294628	620670	.037098
290	905738	012628	302737	140326	695054	.037073	307	979488	002873	253764	306958	614605	.037102
291	911346	011916	300439	148145	691341	.037071	308	982267	002488	249797	320456	607863	.037166
292	916809	011218	298099	156107	687540	.037081	309	984857	002128	245514	335029	600706	.037117
293	922123	010535	295714	164222	683678	.037077	310	987255	001794	241196	349722	593410	037104
294	927286	009867	293307	172412	679770	037078	311	989458	001486	236555	365513	585437	.037156
295	932296	009215	290818	180881	675711	.037089	312	991463	001205	231437	382927	576707	037128
296	937148	.008579	288199	189792	.671443	.037093	313	993267	000951	226008	401399	567327	.037139
297	941842	007960	285482	199037	.667000	.037103	314	994867	000726	220068	421607	557057	.037089
298	946375	007360	282720	208434	.662499	.037094	315	996259	000530	213425	444214	545258	.037196
299	950743	006779	279952	217853	.657970	037093	316	997440	000363	205659	470638	531722	.037023
300	954946	006216	277096	227570	653275	.037102	317	998404	000226	196846	500625	515338	.037361
301	958979	005674	274106	237744	.648356	.037107	318	999147	000121	185730	538447	495956	.036694
302	962840	005152	271003	248302	.643234	.037115	319	999659	000048	172812	582401	469664	.037887
303	966528	.004651	267811	259163	.637978	.037103	320	999928	000010	148697	664454	422318	.037591

6.6. Reference test case 02 (NACA 0012, $M_\infty = 0.85$, $\alpha = 1°$)

The sever solutions of group 2 are listed in table 6.6 below. The full sets of data for these solutions are given in Appendix A1 in microfiche form.

Table 6.6 – Solutions of group 2 for test case 02 (NACA 0012, $M_\infty = 0.85$, $\alpha = 1°$).

Solution	MESH			outer boundary (chords)	C_L	Γ	C_D	C_M
	type	points or cells						
		total	on airfoil					
1	C	193 x 29	147	10/14/10	0.3405	0.1699	0.0464*	-0.0951*
2	C	188 x 24	146	4/6/7	0.3436	0.1733	0.0541	-0.1093
3	O	158 x 23	158	16	0.3637	0.187	0.0556	-0.1209
5	C	249 x 67	181	48/96/96	0.3889*	0.2005*	0.0590*	-0.1378*
6	O	192 x 39	192	50	0.3472		0.0557	-0.1167
8	O	128 x 28	128	5	0.330*	0.166*	0.0528	-0.104
9	O	320 x 64	320	25	0.3584		0.0580	-0.1228
				scatter :	0.0589	0.0345	0.0126	0.0427
					= 16.4 %	= 18.9 %	= 23.9 %	= 36.7 %

A physical picture of the flow field is given by the map of iso-Mach lines shown on Fig. 6.19 and taken from solution N° 9.

The scatter of the solutions of group 2 can be evaluated from Fig. 6.16 which gives cross-plots of p, M and p_i. Enlarged shock profiles are shown on Fig. 6.17 together with a characteristic shock jump. The scatter on shock positions is seen to be appreciably larger here than for test case 01.

As for test case 01, we can divide the solutions of group 2 into two sub-groups according to the distance of the outer boundary and to the mesh fineness at the airfoil :

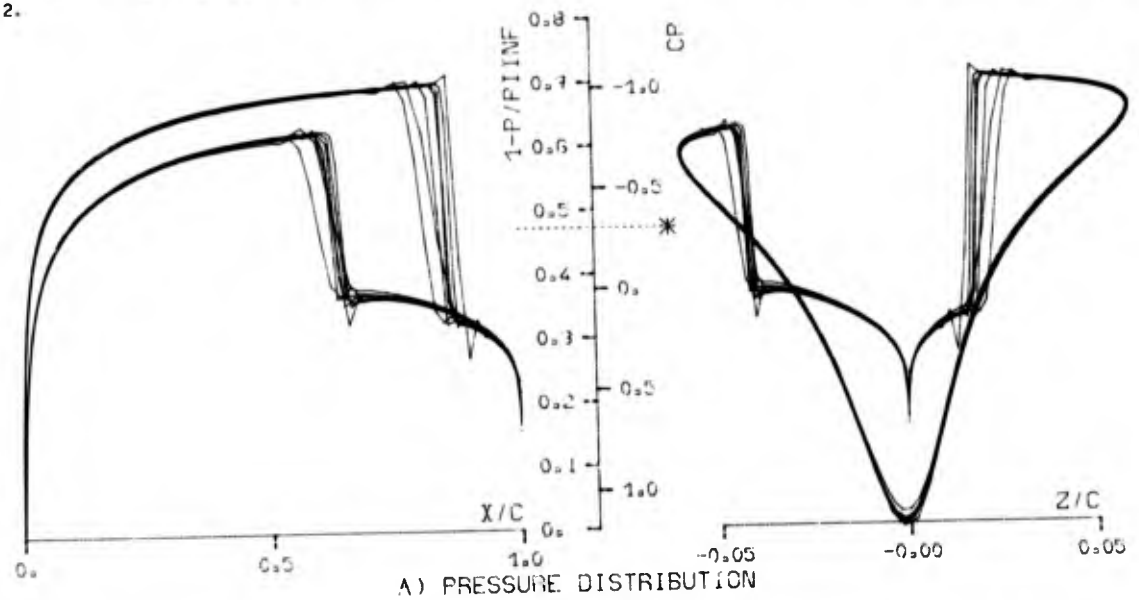
- sub-group 2.a, made of the solutions N° 1, 2 and 8 for which there are 147 or less points on the airfoil and the outer boundary distance is at most 14 chords in any direction ;

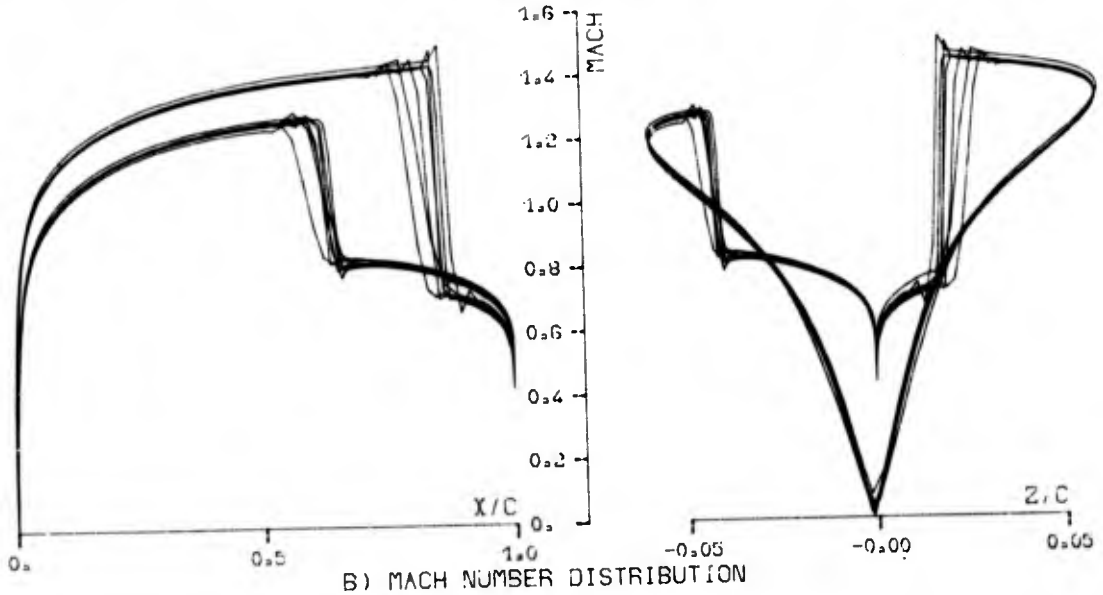
- sub-group 2-b, made of the solutions N° 3, 5, 6 and 9 for which there are 158 or more points on the airfoil and the outer boundary distance is at least 16 chords in any direction.

It is striking to see that the sets of values of C_L, C_D, C_M and of the upper shock positions, for sub-group 2.a on the one hand and for sub-group 2.b on the other hand do not overlap : sub-group 2.a corresponds to lower values of C_L, C_D, $|C_M|$ and to more upstream upper shocks than sub-group 2.b. This correlation points out to a greater sensitivity of the solution to the outer boundary distance for test case 02 than for test case 01, which is related to the fact that the supersonic regions are more extended laterally (the lateral extent of the upper supersonic region is of about 1.75 chords for sub-group 2.b, while it varies from 1.5 to 1.7 chords for sub-group 2.a).

However, the comparison of solutions N° 1 and 3 indicates that the distinction between these two sub-groups is not so clear-cut. Indeed, if these two solutions bridge the gap between sub-group 2.a and sub-group 2.b as far as mesh size and distance of the outer boundary are concerned, they don't as far as the values of C_L, C_D, C_M and the upper shock positions are concerned. A closer look at these quantities shows

that it is in fact solution N° 1 which appears as a singular point inside sub-group 2.a ; this solution gives both the upper and the lower shocks located much more upstream than all the other solutions of group 2.





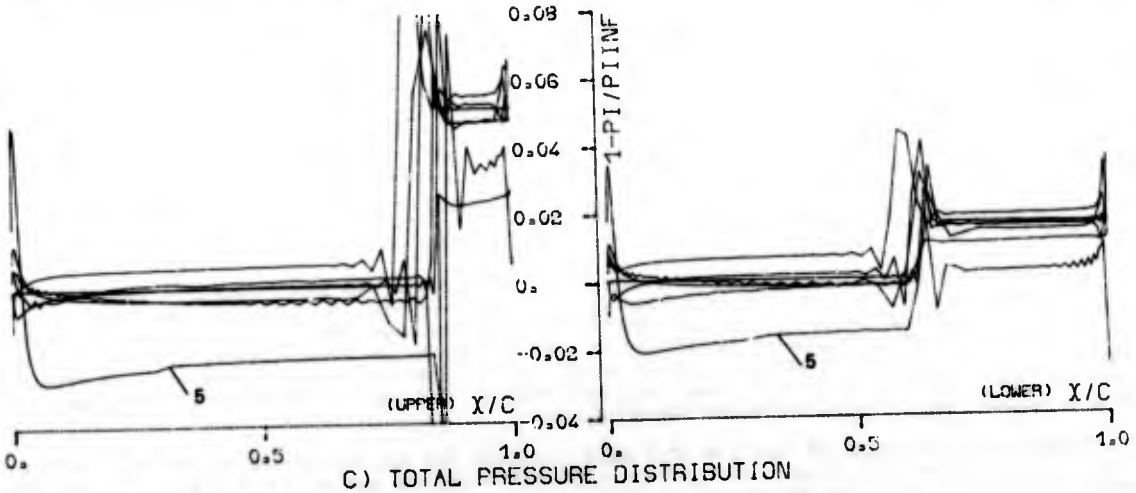


Fig. 6.16 – Solutions of group 2 for test case 02 (NACA 0012, Mach = 0.85, α = 1).

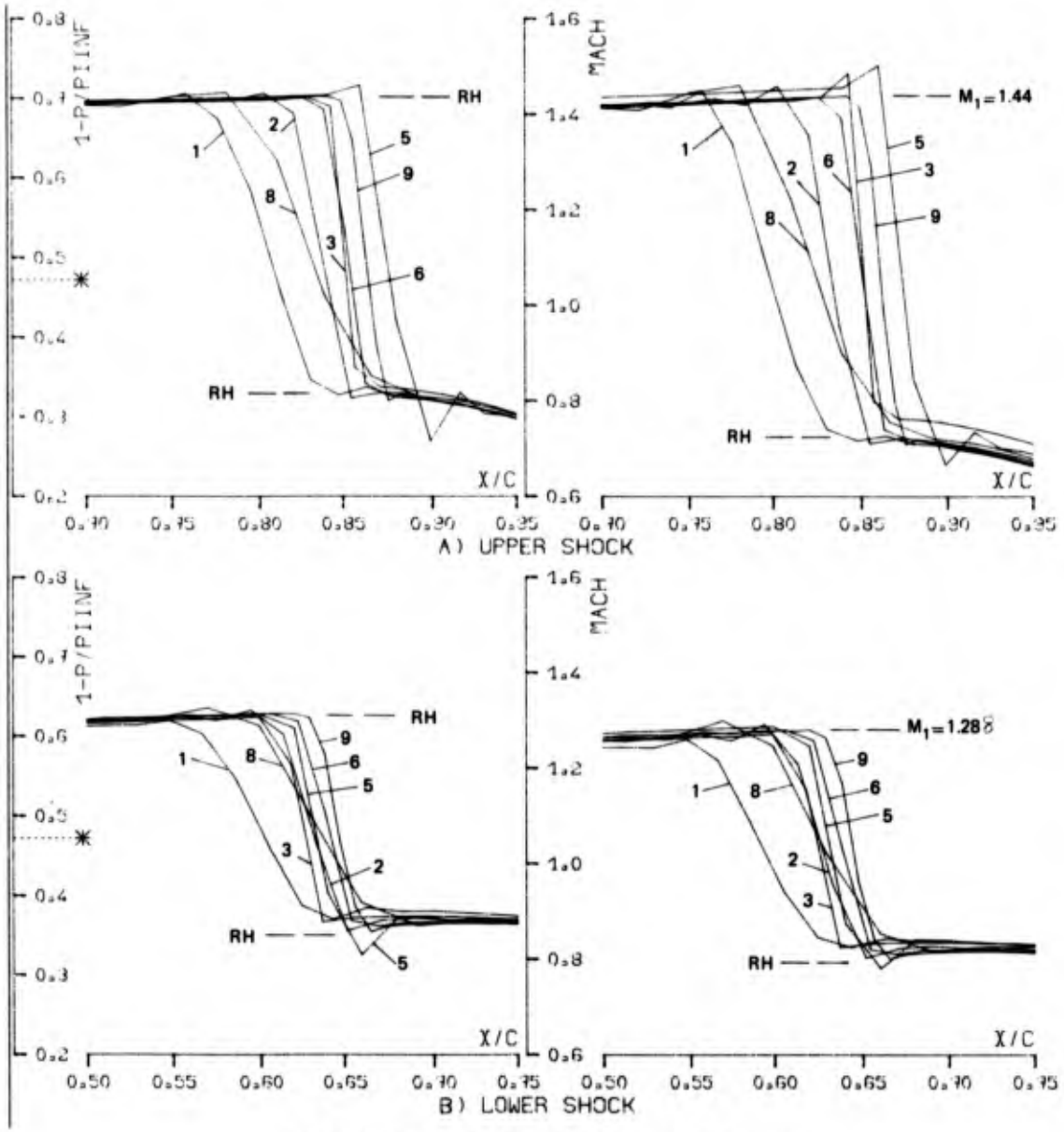


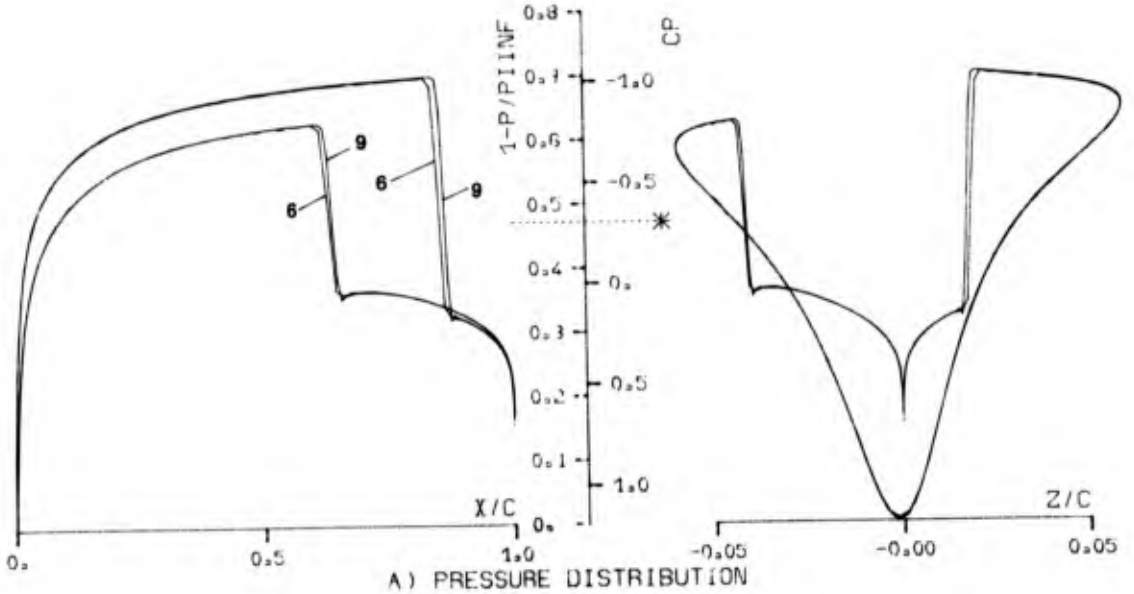
Fig. 6.17 – Shock profiles for solutions of group 2. Test case 02.

It can be noted also that the global scatter of the aerodynamic coefficients of sub-group 2.b remains important and is in fact not much smaller than the global scatter of group 2 without solution N° 1.

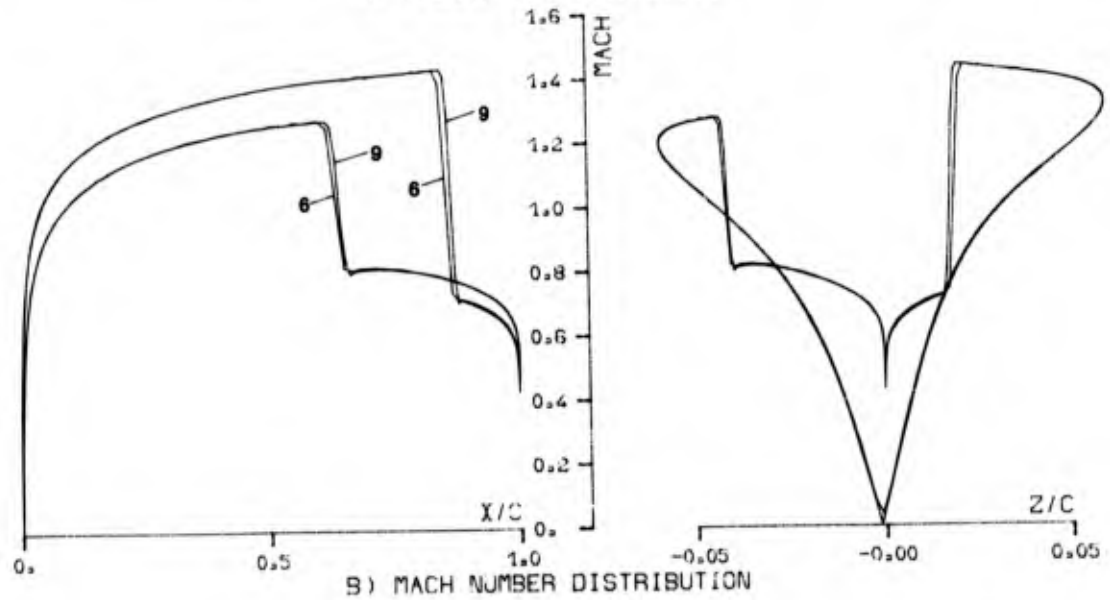
These observations tend to indicate that, even if the outer boundary distance plays an important role, its influence is mixed up with that of other factors such as artificial viscosity, truncation error, convergence... This test case is an illustration of the general comment made in § 6.3, namely that we do not have a real control over all the numerical parameters on which the numerical solution depends.

Considering then sub-group 2.b, solution N°5 appears as standing somewhat apart from the three others ; in particular the upper shock is located more downstream. The relative error on the total pressure at the wall upstream of shocks is appreciably larger for solution N° 5 (Fig. 6.16 c), and it is the smallest for solution N° 9 (Fig. 6.18 c). The shock jumps are good or very good, except the Mach number jump on the upper surface for solution N° 3, and the pressure jump on the upper surface for solution N° 5. Solutions N° 3 and 5 have an important overshoot of the Mach number just upstream of the upper shock, whereas the shock profiles for solutions N° 6 and 9 show no oscillation nor overshoot.

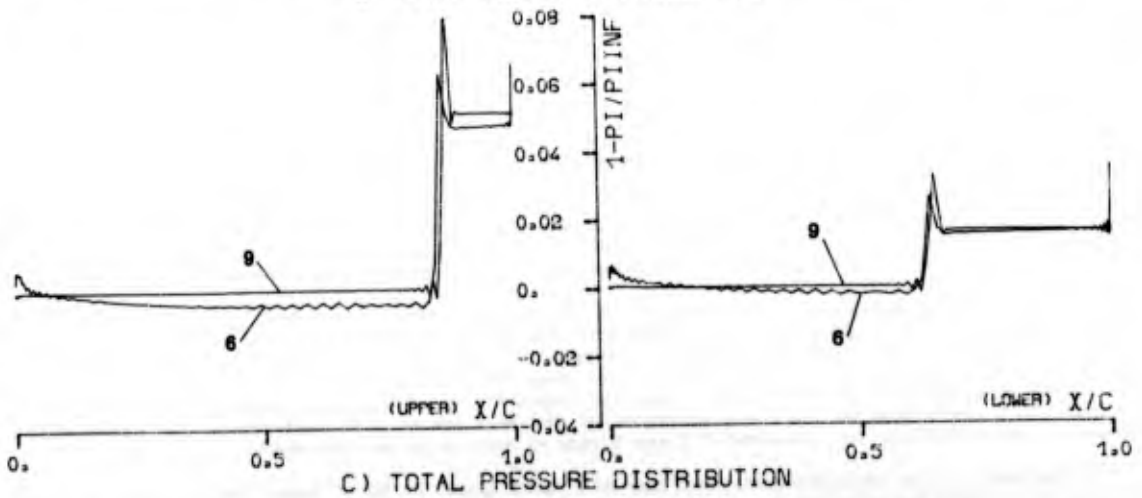
On the basis of the criteria used, solutions N° 6 and 9 appear to be of higher quality than solutions N° 3 and 5, and they are selected for the group 3. Figure 6.18 gives the cross-plots of p, M and p_i for the solutions N° 6 and 9 ; the tabulated wall values of solution N° 9 are presented in table 6.7. Figure 6.19 shows the map of iso-Mach lines of solution N° 9.



A) PRESSURE DISTRIBUTION



B) MACH NUMBER DISTRIBUTION



C) TOTAL PRESSURE DISTRIBUTION

Fig. 6.18 – Solutions of group 3 for test case 02 (NACA 0012, Mach = 0.85, α = 1).

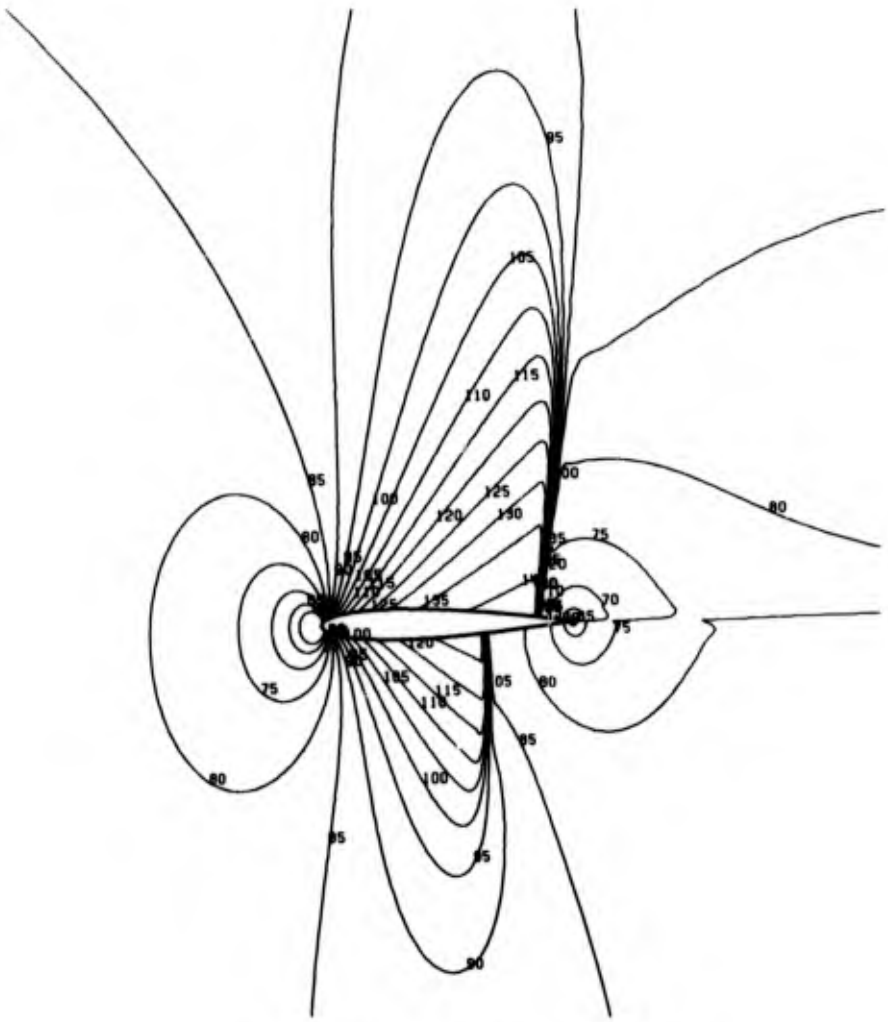


Fig. 6.19 – Iso-Mach lines of solution n° 9 for test case 02 ($\Delta M = 0.05$, curve parameter = 100 M).

Table 6.7 – Wall values of solution n° 9 for test case 02 (NACA 0012 $M_\infty = 0.85$, $\alpha = 1°$).

N	x/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.999928	-.000010	.155450	.700949	.472855	.016711
2	.999659	-.000048	.186701	.601847	.527543	.016929
3	.999147	-.000121	.200772	.557226	.554142	.015380
4	.998404	-.000226	.212833	.518978	.573326	.016335
5	.997440	-.000363	.222192	.489299	.589685	.015830
6	.996259	-.000530	.230499	.462956	.603070	.016129
7	.994867	-.000726	.237522	.440683	.614797	.015993
8	.993267	-.000951	.243807	.420754	.624959	.016079
9	.991463	-.001205	.249553	.402533	.634308	.016071
10	.989458	-.001486	.254986	.385304	.643036	.016121
11	.987255	-.001794	.259896	.369733	.651003	.016075
12	.984857	-.002128	.264477	.355206	.658313	.016113
13	.982267	-.002488	.269045	.340720	.665546	.016179
14	.979488	-.002873	.273267	.327332	.672357	.016118
15	.976521	-.003282	.277114	.315132	.678465	.016132
16	.973371	-.003716	.280960	.302936	.684499	.016198
17	.970039	-.004172	.284716	.291025	.690483	.016174
18	.966528	-.004651	.288259	.279790	.696084	.016180
19	.962840	-.005152	.291678	.268947	.701459	.016204
20	.958979	-.005674	.295010	.258381	.706704	.016216
21	.954946	-.006216	.298220	.248202	.711752	.016225
22	.950743	-.006779	.301283	.238488	.716572	.016226
23	.946375	-.007360	.304258	.229054	.721233	.016241
24	.941842	-.007960	.307240	.219598	.725888	.016267
25	.937148	-.008579	.310183	.210265	.730502	.016272
26	.932296	-.009215	.313016	.201281	.734932	.016283
27	.927286	-.009867	.315703	.192760	.739142	.016284
28	.922123	-.010535	.318305	.184509	.743197	.016302
29	.916809	-.011218	.320887	.176321	.747220	.016319
30	.911346	-.011916	.323430	.168256	.751193	.016324
31	.905738	-.012628	.325934	.160316	.755089	.016342
32	.899985	-.013354	.328413	.152454	.758944	.016361
33	.894092	-.014092	.330772	.144874	.762635	.016356
34	.888061	-.014842	.332981	.137969	.766083	.016359
35	.881894	-.015603	.335215	.130884	.769530	.016398
36	.875594	-.016376	.337471	.123730	.773045	.016406
37	.869164	-.017158	.339617	.116925	.776401	.016400
38	.862607	-.017950	.341669	.110417	.779583	.016421
39	.855924	-.018751	.343680	.104040	.782706	.016436
40	.849119	-.019560	.345649	.097796	.785768	.016447
41	.842195	-.020376	.347550	.091768	.788727	.016454
42	.835154	-.021200	.349362	.086022	.791544	.016465
43	.827999	-.022029	.351101	.080507	.794246	.016477
44	.820733	-.022865	.352791	.075148	.796871	.016489
45	.813358	-.023706	.354441	.069915	.799432	.016503
46	.805878	-.024552	.356021	.064905	.801891	.016511
47	.798294	-.025401	.357489	.060250	.804179	.016514
48	.790610	-.026254	.358848	.055940	.806291	.016524
49	.782828	-.027109	.360125	.051890	.808273	.016536
50	.774952	-.027967	.361333	.048060	.810144	.016551
51	.766984	-.028826	.362410	.044644	.811826	.016551
52	.758927	-.029686	.363294	.041841	.813211	.016547
53	.750783	-.030545	.364067	.039390	.814396	.016569
54	.742556	-.031406	.364755	.037208	.815464	.016576
55	.734249	-.032265	.365263	.035597	.816267	.016566
56	.725863	-.033123	.365566	.034636	.816733	.016574
57	.717403	-.033979	.365694	.034230	.816926	.016581
58	.708870	-.034832	.365600	.034528	.816784	.016576
59	.700268	-.035682	.365229	.035705	.816190	.016590
60	.691599	-.036527	.364445	.038191	.814979	.016576
61	.682867	-.[illegible]7369	.362994	.042792	.812852	.016438
62	.674074	-.[illegible]205	.361386	.047891	.810424	.016356
63	.665224	-.[illegible]35	.354434	.069937	.800787	.015168
64	.656318	-.[illegible]359	.386167	-.030693	.842056	.023593
65	.647359	-.040676	.468643	-.292239	.966157	.032682
66	.638352	-.041486	.577575	-.637680	1.168045	.017146
67	.629298	-.042287	.623442	-.783132	1.264026	.006140
68	.620201	-.043078	.628422	-.798925	1.279720	-.001643
69	.611063	-.043860	.628953	-.800609	1.278208	.001827
70	.601888	-.044632	.628131	-.798002	1.278569	-.000872
71	.592677	-.045393	.627749	-.796791	1.276464	.000940
72	.583435	-.046142	.627075	-.794653	1.275915	-.000129
73	.574163	-.046878	.626591	-.793118	1.274482	.000505
74	.564866	-.047601	.625928	-.791016	1.273454	.000115
75	.555545	-.048311	.625367	-.789237	1.272142	.000382
76	.546204	-.049005	.624712	-.787160	1.270971	.000211
77	.536846	-.049685	.623969	-.784804	1.269444	.000286
78	.527474	-.050347	.623198	-.782359	1.267935	.000265

Table 6.7 (continued).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
79	.518090	-.050993	.622488	-.780107	1.266503	.000305
80	.508698	-.051622	.621709	-.777637	1.265000	.000261
81	.499300	-.052233	.620840	-.774881	1.263271	.000285
82	.489900	-.052824	.619916	-.771951	1.261456	.000284
83	.480500	-.053395	.618941	-.768859	1.259545	.000281
84	.471105	-.053946	.617915	-.765605	1.257534	.000283
85	.461715	-.054475	.616884	-.762336	1.255505	.000301
86	.452335	-.054982	.615825	-.758978	1.253444	.000294
87	.442968	-.055466	.614670	-.755315	1.251202	.000284
88	.433616	-.055926	.613443	-.751424	1.248807	.000298
89	.424283	-.056361	.612181	-.747422	1.246355	.000305
90	.414971	-.056772	.610856	-.743220	1.243796	.000299
91	.405685	-.057157	.609449	-.738758	1.241082	.000297
92	.396425	-.057514	.607982	-.734106	1.238256	.000299
93	.387197	-.057844	.606493	-.729384	1.235386	.000314
94	.378003	-.058147	.604976	-.724574	1.232475	.000321
95	.368846	-.058420	.603342	-.719392	1.229369	.000301
96	.359728	-.058664	.601584	-.713617	1.226016	.000307
97	.350654	-.058877	.599783	-.708106	1.222580	.000327
98	.341627	-.059059	.597931	-.702233	1.219079	.000320
99	.332648	-.059209	.595988	-.696071	1.215413	.000319
100	.323722	-.059327	.593878	-.689697	1.211622	.000331
101	.314852	-.059412	.591900	-.683107	1.207726	.000331
102	.306041	-.059464	.589710	-.676163	1.203641	.000321
103	.297291	-.059481	.587434	-.668945	1.199393	.000333
104	.288606	-.059464	.585115	-.661591	1.195081	.000345
105	.279990	-.059412	.582720	-.653996	1.190655	.000343
106	.271445	-.059324	.580213	-.646046	1.186038	.000343
107	.262974	-.059200	.577589	-.637725	1.181223	.000344
108	.254581	-.059040	.574863	-.629080	1.176234	.000354
109	.246268	-.058843	.572048	-.620153	1.171107	.000359
110	.238040	-.058608	.569139	-.610928	1.165832	.000363
111	.229898	-.058336	.566115	-.601339	1.160374	.000364
112	.221847	-.058025	.562959	-.591331	1.154706	.000361
113	.213889	-.057676	.559711	-.581031	1.148887	.000372
114	.206028	-.057289	.556408	-.570556	1.142996	.000383
115	.198265	-.056864	.553018	-.559806	1.136984	.000386
116	.190606	-.056400	.549483	-.548596	1.130742	.000390
117	.183052	-.055897	.545755	-.536774	1.124197	.000386
118	.175608	-.055355	.541856	-.524409	1.117376	.000393
119	.168275	-.054774	.537835	-.511658	1.110376	.000400
120	.161058	-.054154	.533742	-.498679	1.103277	.000419
121	.153958	-.053495	.529547	-.485375	1.096050	.000421
122	.146980	-.052798	.525179	-.471524	1.088564	.000422
123	.140126	-.052062	.520607	-.457025	1.080763	.000428
124	.133399	-.051288	.515832	-.441883	1.072659	.000434
125	.126803	-.050475	.510867	-.426138	1.064281	.000434
126	.120339	-.049625	.505780	-.410006	1.055719	.000462
127	.114012	-.048737	.500575	-.393500	1.047011	.000482
128	.107824	-.047811	.495083	-.376084	1.037914	.000452
129	.101778	-.046849	.489298	-.357739	1.028341	.000470
130	.095878	-.045850	.483379	-.338969	1.018574	.000517
131	.090125	-.044815	.477214	-.319419	1.008509	.000502
132	.084522	-.043744	.470651	-.298606	.997841	.000499
133	.079073	-.042637	.463759	-.276751	.986667	.000532
134	.073781	-.041495	.456574	-.253966	.975097	.000546
135	.068647	-.040320	.449031	-.230046	.963017	.000538
136	.063676	-.039110	.441048	-.204730	.950308	.000561
137	.058869	-.037867	.432655	-.178115	.936994	.000587
138	.054229	-.036591	.423889	-.150316	.923135	.000639
139	.049759	-.035283	.414469	-.120444	.908395	.000603
140	.045461	-.033942	.404257	-.088060	.892450	.000608
141	.041339	-.032570	.393534	-.054055	.875698	.000700
142	.037394	-.031167	.382118	-.017853	.858032	.000689
143	.033630	-.029734	.369640	.021717	.838797	.000667
144	.030049	-.028270	.356179	.064404	.818017	.000729
145	.026653	-.026776	.341648	.110484	.795675	.000739
146	.023445	-.025253	.325764	.160855	.771289	.000722
147	.020428	-.023699	.308408	.215894	.744566	.000739
148	.017604	-.022117	.289453	.276003	.715293	.000732
149	.014976	-.020505	.268700	.341814	.683012	.000726
150	.012548	-.018863	.245835	.414323	.647075	.000677
151	.010322	-.017191	.220703	.494021	.606844	.000632
152	.008302	-.015490	.193400	.580603	.561895	.000616
153	.006492	-.013758	.164027	.673750	.511579	.000593
154	.004896	-.011997	.132891	.772488	.455056	.000559
155	.003518	-.010208	.100821	.874187	.391832	.000417
156	.002365	-.008391	.069439	.973705	.321663	.000280
157	.001440	-.006551	.041053	1.063722	.244779	.000227
158	.000746	-.004692	.018476	1.135317	.162246	.000270
159	.000286	-.002820	.004575	1.179399	.077357	.000399
160	.000057	-.000941	.001392	1.189493	.036420	.000464
161	.000057	.000941	.009662	1.163268	.115899	.000319
162	.000286	.002820	.029076	1.101703	.205505	.000069
163	.000746	.004692	.057966	1.010088	.293641	-.000129
164	.001440	.006551	.093505	.897387	.377433	-.000155
165	.002365	.008391	.132403	.774035	.455056	-.000004
166	.003518	.010208	.171807	.649079	.525780	.000158
167	.004896	.011997	.209562	.529351	.589214	.000213
168	.006492	.013758	.244669	.418021	.645675	.000301
169	.008302	.015490	.276724	.316369	.695860	.000434
170	.010322	.017191	.305637	.224681	.740543	.000607
171	.012548	.018863	.331594	.142367	.780385	.000588
172	.014976	.020505	.354696	.069107	.815797	.000668
173	.017604	.022117	.375257	.003904	.847436	.000690
174	.020428	.023699	.393748	-.054734	.876026	.000704
175	.023445	.025253	.410479	-.107791	.902078	.000690
176	.026653	.026776	.425605	-.155758	.925767	.000712
177	.030049	.028270	.439274	-.199105	.947360	.000711
178	.033630	.029734	.451827	-.238912	.967417	.000634
179	.037394	.031167	.463374	-.275530	.985936	.000659
180	.041339	.032570	.473812	-.308630	1.002810	.000690
181	.045461	.033942	.483543	-.339489	1.018786	.000584
182	.049759	.035283	.492826	-.368927	1.034081	.000569
183	.054229	.036591	.501360	-.395990	1.048204	.000621
184	.058869	.037867	.509217	-.420906	1.061387	.000579
185	.063676	.039110	.516679	-.444569	1.073997	.000551
186	.068647	.040320	.523755	-.467008	1.086025	.000553
187	.073781	.041495	.530426	-.488163	1.097459	.000547
188	.079073	.042637	.536777	-.508303	1.108430	.000539
189	.084522	.043744	.542892	-.527695	1.119095	.000504
190	.090125	.044815	.548741	-.546243	1.129342	.000508
191	.095878	.045850	.554226	-.563637	1.139000	.000541
192	.101778	.046849	.559469	-.580263	1.148356	.000498
193	.107824	.047811	.564603	-.596544	1.157568	.000474
194	.114012	.048737	.569483	-.612019	1.166337	.000514
195	.120339	.049625	.574089	-.626626	1.174707	.000504
196	.126803	.050475	.578572	-.640842	1.182916	.000484
197	.133399	.051288	.582942	-.654700	1.190955	.000486
198	.140126	.052062	.587153	-.668054	1.198751	.000490
199	.146980	.052798	.591197	-.680878	1.206291	.000487
200	.153958	.053495	.595071	-.693163	1.213556	.000490
201	.161058	.054154	.598791	-.704960	1.220573	.000495
202	.168275	.054774	.602414	-.716449	1.227462	.000483
203	.175608	.055355	.605973	-.727735	1.234263	.000481
204	.183052	.055897	.609434	-.738711	1.240914	.000482
205	.190606	.056400	.612756	-.749245	1.247331	.000489
206	.198265	.056864	.615919	-.759276	1.253478	.000493
207	.206028	.057289	.618954	-.768900	1.259411	.000494
208	.213889	.057676	.621910	-.778274	1.265224	.000492
209	.221847	.058025	.624818	-.787496	1.270978	.000484
210	.229898	.058336	.627651	-.796480	1.276600	.000494
211	.238040	.058608	.630372	-.805109	1.282030	.000501
212	.246268	.058843	.632994	-.813423	1.287294	.000502
213	.254581	.059040	.635535	-.821481	1.292422	.000502
214	.262974	.059200	.638003	-.829308	1.297426	.000503
215	.271445	.059324	.640388	-.836871	1.302282	.000508
216	.279990	.059412	.642675	-.844124	1.306964	.000508
217	.288606	.059464	.644867	-.851075	1.311465	.000518
218	.297291	.059481	.646993	-.857817	1.315858	.000516
219	.306041	.059464	.649084	-.864448	1.320202	.000508
220	.314852	.059412	.651106	-.870860	1.324405	.000522
221	.323722	.059327	.653033	-.876970	1.328428	.000535
222	.332648	.059209	.654901	-.882894	1.332360	.000524
223	.341627	.059059	.656716	-.888650	1.336185	.000528
224	.350654	.058877	.658454	-.894161	1.339851	.000547
225	.359728	.058664	.660146	-.899527	1.343455	.000536
226	.368846	.058420	.661808	-.904797	1.347003	.000532
227	.378003	.058147	.663369	-.909710	1.350327	.000557
228	.387197	.057844	.664829	-.914278	1.353461	.000559
229	.396425	.057514	.666263	-.918925	1.356556	.000553
230	.405685	.057157	.667681	-.923422	1.359621	.000553
231	.414971	.056772	.669054	-.927776	1.362593	.000561
232	.424283	.056362	.670359	-.931914	1.365420	.000578
233	.433616	.055926	.671607	-.935872	1.368143	.000578
234	.442968	.055466	.672830	-.939750	1.370825	.000569
235	.452335	.054982	.673997	-.943451	1.373376	.000583
236	.461715	.054475	.675084	-.946898	1.375756	.000599
237	.471105	.053946	.676146	-.950266	1.378106	.000588
238	.480500	.053395	.677207	-.953630	1.380450	.000591
239	.489900	.052824	.678228	-.956868	1.382704	.000604
240	.499300	.052233	.679209	-.959979	1.384881	.000607
241	.508698	.051622	.680151	-.962966	1.386983	.000602
242	.518090	.050993	.681015	-.965706	1.388893	.000627
243	.527474	.050347	.681824	-.968272	1.390697	.000635
244	.536846	.049685	.682676	-.970973	1.392630	.000602
245	.546204	.049005	.683535	-.973697	1.394544	.000623
246	.555545	.048311	.684296	-.976111	1.396234	.000654
247	.564866	.047601	.685016	-.978394	1.397865	.000643
248	.574163	.046878	.685755	-.980737	1.399538	.000637
249	.583435	.046142	.686482	-.983043	1.401174	.000649
250	.592677	.045393	.687178	-.985250	1.402745	.000659
251	.601888	.044632	.687843	-.987359	1.404256	.000657
252	.611063	.043860	.688456	-.989303	1.405638	.000673
253	.620201	.043078	.689034	-.991136	1.406945	.000687
254	.629298	.042287	.689662	-.993127	1.408398	.000657
255	.638352	.041486	.690325	-.995230	1.409907	.000665
256	.647359	.040676	.690911	-.997068	1.411228	.000693
257	.656318	.039859	.691416	-.998689	1.412377	.000705
258	.665224	.039035	.691915	-1.000272	1.413519	.000709
259	.674074	.038205	.692482	-1.002070	1.414843	.000678
260	.682867	.037369	.693082	-1.003973	1.416216	.000689
261	.691599	.036527	.693590	-1.005584	1.417353	.000736
262	.700268	.035682	.694054	-1.007055	1.418430	.000727
263	.708870	.034832	.694572	-1.008698	1.419640	.000708
264	.717403	.033979	.695094	-1.010353	1.420835	.000725
265	.725863	.033123	.695590	-1.011926	1.421969	.000746
266	.734249	.032265	.696091	-1.013515	1.423149	.000720
267	.742556	.031406	.696573	-1.015043	1.424247	.000750
268	.750783	.030545	.696999	-1.016394	1.425238	.000749
269	.758927	.029686	.697456	-1.017843	1.426287	.000770
270	.766984	.028826	.697960	-1.019442	1.427509	.000703
271	.774952	.027967	.698468	-1.021053	1.428607	.000827
272	.782828	.027109	.698914	-1.022467	1.429758	.000672
273	.790610	.026254	.699397	-1.023999	1.430700	.000939
274	.798294	.025401	.699829	-1.025368	1.432010	.000515
275	.805878	.024552	.700393	-1.027157	1.432869	.001174
276	.813358	.023706	.700744	-1.028270	1.434417	.000145
277	.820733	.022865	.701328	-1.030122	1.434602	.001833
278	.827999	.022029	.701560	-1.030858	1.436996	-.000796
279	.835154	.021200	.702561	-1.034032	1.436804	.002834
280	.842195	.020376	.701947	-1.032085	1.438582	-.001758
281	.849119	.019560	.696970	-1.016302	1.417163	.012025
282	.855924	.018751	.646388	-.855898	1.285489	.039328
283	.862607	.017950	.511066	-.426769	.992154	.082894
284	.869164	.017158	.388143	-.036959	.797973	.069195
285	.875594	.016376	.319951	.179289	.708655	.049351
286	.881894	.015603	.328124	.153371	.717957	.052824
287	.888061	.014842	.325030	.163183	.713505	.052304
288	.894092	.014092	.322610	.170857	.709796	.052093
289	.899985	.013354	.320786	.176641	.706706	.052183
290	.905738	.012628	.318802	.182933	.703386	.052244
291	.911346	.011916	.316612	.189877	.699794	.052246
292	.916809	.011218	.314359	.197022	.696086	.052255
293	.922123	.010535	.312069	.204284	.692321	.052258
294	.927286	.009867	.309739	.211673	.688488	.052259
295	.932296	.009215	.307311	.219372	.684482	.052266
296	.937148	.008579	.304741	.227522	.680243	.052267

Table 6.7 (continued).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF	N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
297	.941842	.007960	.302063	.236015	.675818	.052270	309	.984857	.002128	.262135	.362633	.609009	.052140
298	.946375	.007360	.299333	.244672	.671324	.052252	310	.987255	.001794	.257791	.376409	.601616	.052109
299	.950743	.006779	.296591	.253367	.666790	.052244	311	.989458	.001486	.253118	.391224	.593535	.052142
300	.954946	.006216	.293755	.262361	.662083	.052244	312	.991463	.001205	.247964	.407572	.584675	.052099
301	.958979	.005674	.290778	.271801	.657139	.052238	313	.993267	.000951	.242490	.424931	.575144	.052097
302	.962840	.005152	.287683	.281616	.651988	.052232	314	.994867	.000726	.236499	.443929	.564712	.052038
303	.966528	.004651	.284495	.291726	.646687	.052212	315	.996259	.000530	.229793	.465195	.552717	.052120
304	.970039	.004172	.281183	.302229	.641148	.052205	316	.997440	.000363	.221952	.490060	.538952	.051929
305	.973371	.003716	.277671	.313366	.635223	.052225	317	.998404	.000226	.213050	.518290	.522293	.052250
306	.976521	.003282	.274059	.324820	.629212	.052166	318	.999147	.000121	.201831	.553867	.502583	.051566
307	.979488	.002873	.270423	.336351	.623085	.052151	319	.999659	.000048	.188766	.595299	.475845	.052741
308	.982267	.002488	.266440	.348981	.616260	.052203	320	.999928	.000010	.164385	.672615	.427723	.052389

6.7. Reference test case 03 (NACA 0012, $M_\infty = 0.95$, $\alpha = 0°$)

The six solutions of group 2 are listed in table 6.8 below. Since this is a symmetric flow case, only the drag coefficient appears. This table also gives the abscissa of the sonic point on the downstream x-axis. The full sets of data for these solutions are given in Appendix A1 in microfiche form.

Table 6.8 – Solutions of group 2 for test case 03 (NACA 0012, $M_\infty = 0.95$, $\alpha = 0°$)

Solution	MESH			outer boundary (chords)	C_D	sonic point on downstream x-axis (x/c)
	type	points or cells				
		total	on airfoil			
1	C	439 x 37	201	7/15/12	0.1080	2.1
3	O	160 x 24	160	16	0.1085	3.1
6	O	192 x 39	192	50	0.1086*	> 2.5
8	O	128 x 32	128	10	0.108	2.5
9	O	320 x 64	320	25	0.1084	1.4
10	C	129 x 25	80	9	0.1078*	1.9
				scatter :	0.0008 = 0.7 %	

A physical picture of the flow field, with the oblique shock attached at the trailing-edge, is given by the map of iso-Mach lines shown on Fig. 6.24 and taken from solution N° 9.

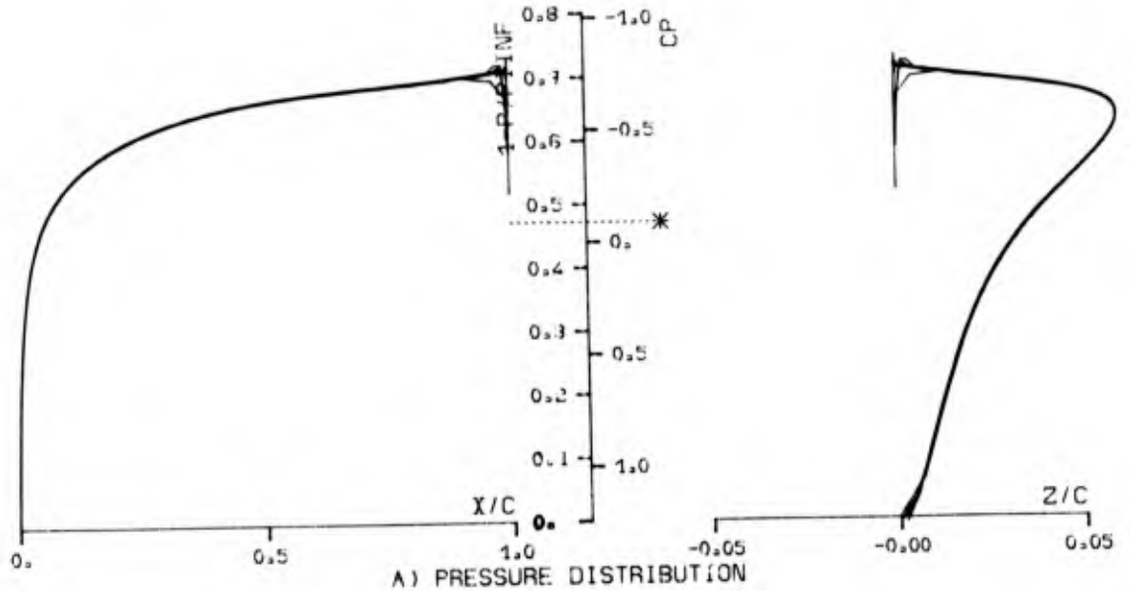
Cross-plots of the wall distributions of p, M and p_i for the solutions of group 2 are presented on Fig. 6.20. From these cross-plots and from the values of C_D (table 6.8), we can see that there is a very good agreement of all the solutions -at least as far as the wall values are concerned- except in a neighborhood of the trailing-edge.

The discrepancy near the trailing-edge comes essentially from solution N° 10 which uses a much coarser mesh than the other solutions.

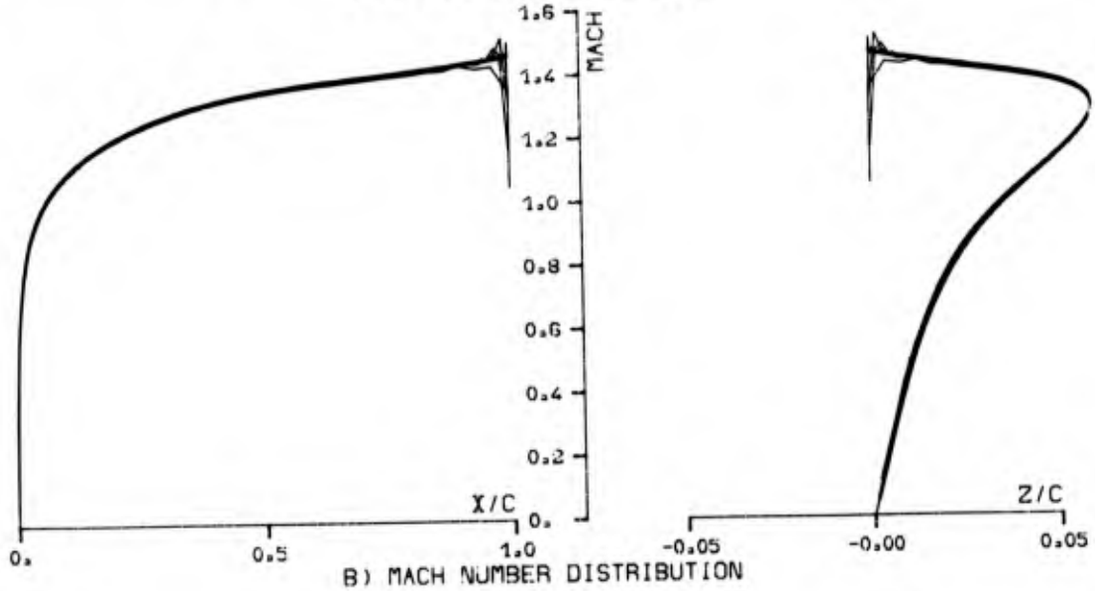
The error on total pressure at the wall is largest for solution N° 3, then come solutions N° 1, 6, 8, 10 with errors of same order, and finally solution N° 9 with the smallest error.

Figure 6.21 shows enlarged plots of p and M near the trailing-edge. We see that solutions N° 1, 6 and 8 have some oscillations announcing the oblique shock at the trailing-edge. On the contrary, solutions N° 3 and 9 show no oscillation at all.

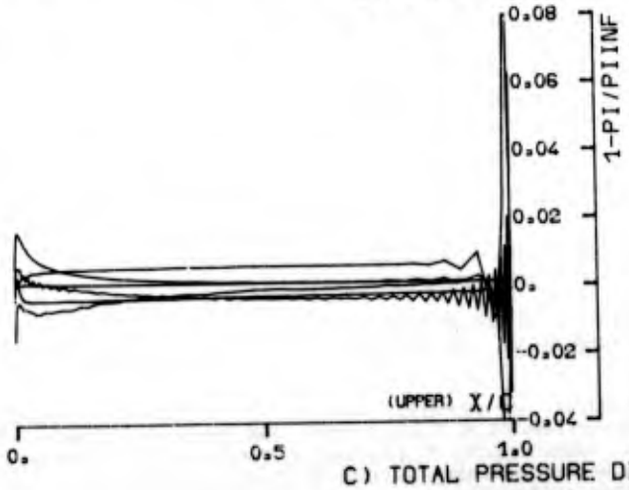
Thus, so far as the flow properties on the airfoil are concerned, solutions N° 1, 3, 6, 8 and 9 show a remarkable agreement, with a superiority conceded to results N° 3 and 9 since they have no oscillation at the trailing-edge. Figure 6.23 compares the wall distributions of p, M and p_i for these two solutions ; there is almost no visible difference for p and M. The fact that solution N° 3 has a larger error on p_i than solution N° 9 does not reflect into visible differences on p and M. The tabulated values on the airfoil and on the downstream x-axis for solution N° 9 are presented in table 6.9.



A) PRESSURE DISTRIBUTION



B) MACH NUMBER DISTRIBUTION



C) TOTAL PRESSURE DISTRIBUTION

Fig. 6.20 – Solutions of group 2 for test case 03 (NACA 0012, Mach = 0.95, α = 0).

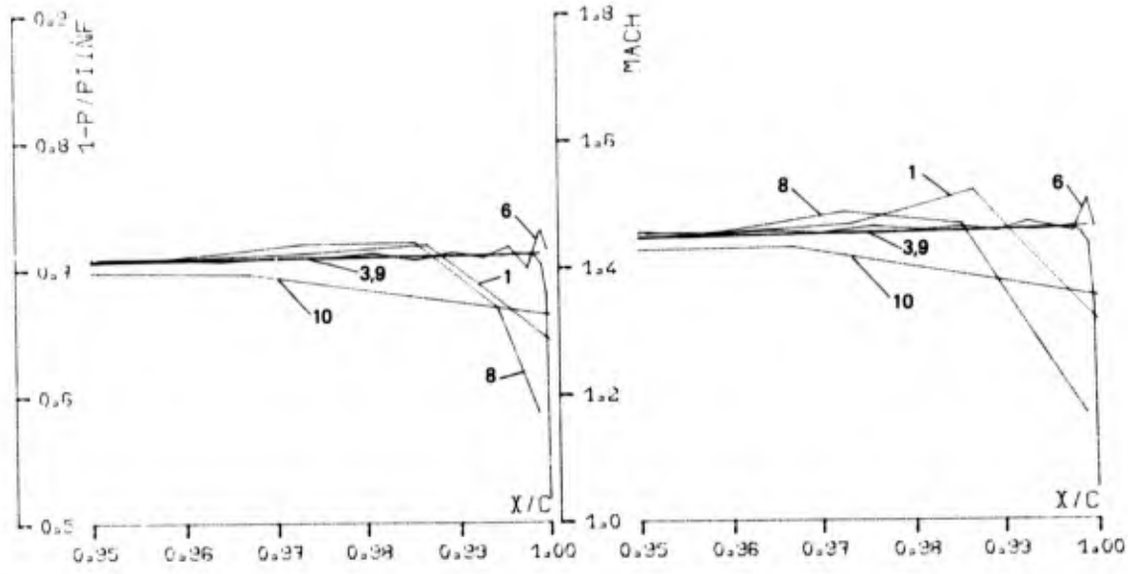
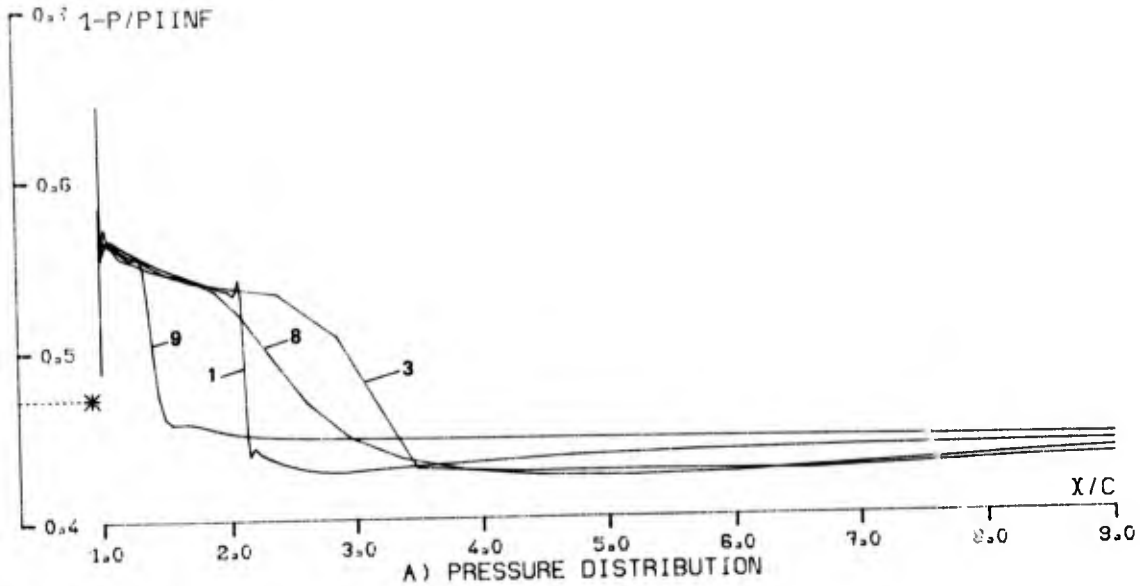
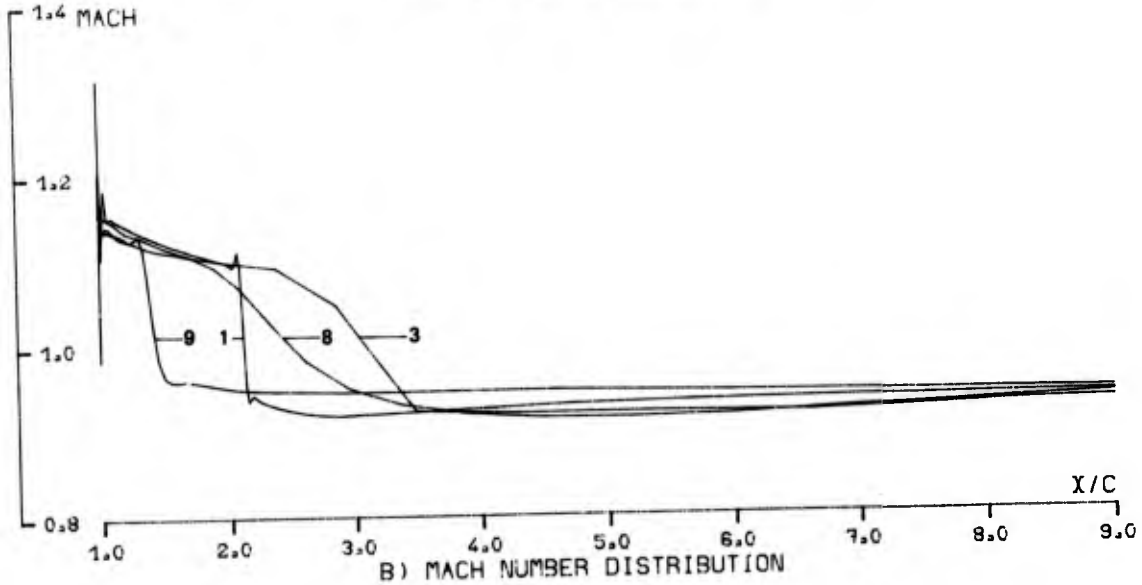


Fig. 6.21 – Trailing edge behaviour for solutions of group 2. Test case 03.

The flow pattern downstream of the trailing-edge is of special interest for this test case since the flow has to change from supersonic velocity at the trailing-edge to subsonic velocity somewhere downstream. Figure 6.22 shows the pressure and Mach number distributions on the downstream x-axis (or very close to this axis) for the solutions N° 1, 3, 8, and 9 for which these data are available in tabulated form. The solutions N° 1, 9 and also 10 exhibit a normal shock standing at various distances downstream of the trailing-edge and corresponding to a lambda shock pattern. The solutions N° 3 and 8 on the contrary show a more or less continuous compression to subsonic velocity. This behaviour seems to result from the coarsness of the mesh. Indeed the mesh size Δx at the sonic point is approximately equal to 0.62 c for N° 3 and to 0.29 c for N° 8, which is too large for proper shock capturing, whereas it is only 0.02 c for N° 1 and 0.04 c for N° 9 ; for N° 10 it is also rather large, 0.18 c, and gives a thick shock. In the interval $1 \leq x/c \leq 4$, we have 114 meshes for N° 1, 59 for N° 9, and only 27 for N° 8 and 16 for N° 3. For solution N° 6, the given data stop at x/c = 2.5 with supersonic velocity.

We see that there are large variations between the solutions concerning the flow field downstream of the trailing-edge ; these variations contrast strongly with the good agreement observed on the airfoil, but they are not incompatible with it since the flow remains supersonic on the airfoil up to the trailing-edge. Clearly more numerical experiments are necessary, concerning the influence of the mesh, including the position of the downstream boundary, and possibly also the influence of the numerical treatment applied at this boundary.





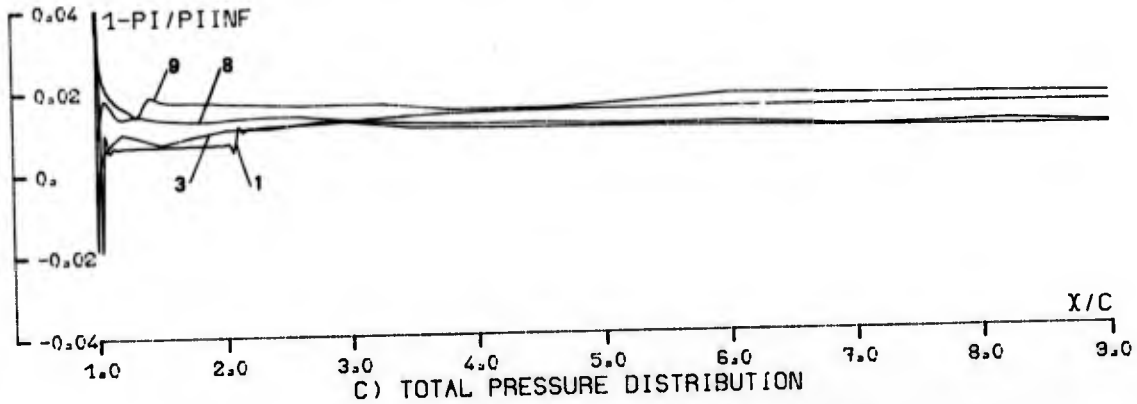


Fig. 6.22 – Solutions 1/3/8/9 on downstream x-axis. Test case 03.

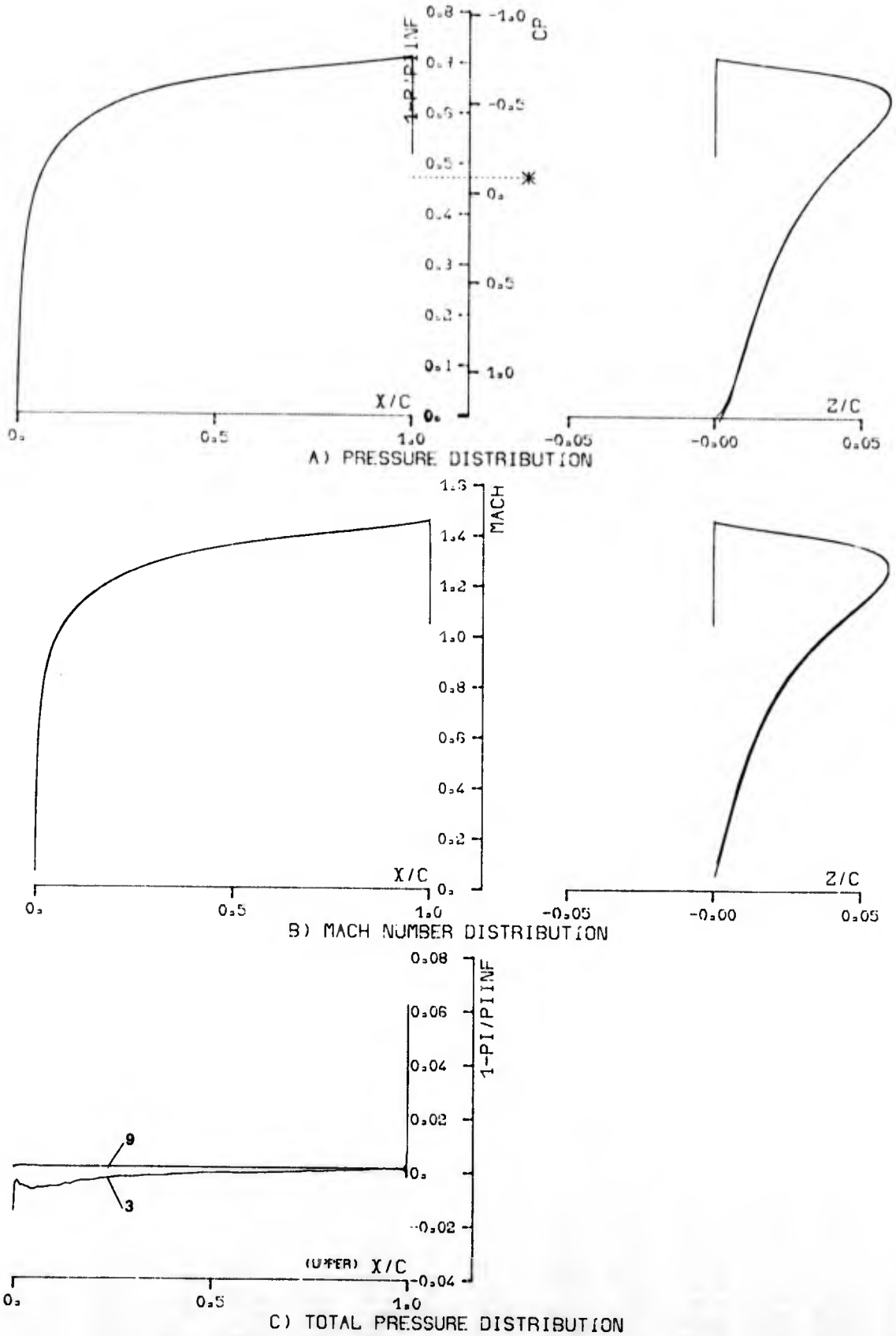


Fig. 6.23 – Solutions of group 3 for test case 03 (NACA 0012, Mach = 0.95, $\alpha = 0$).

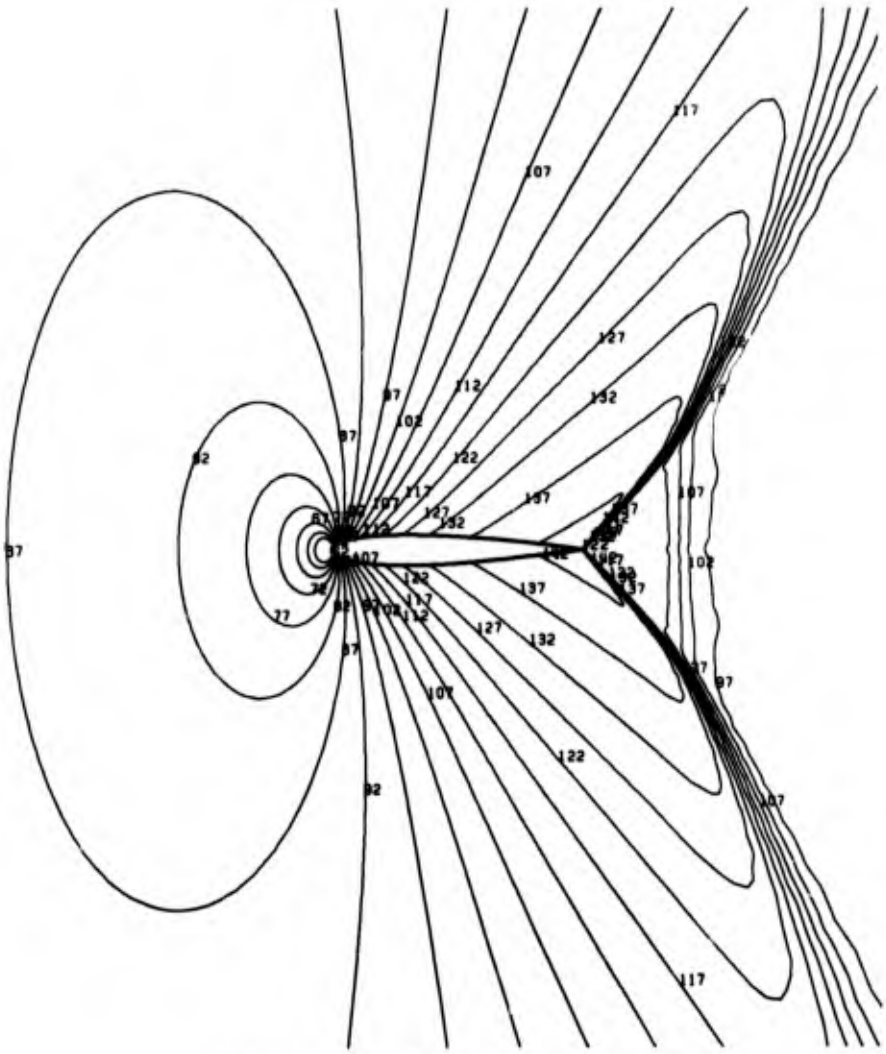


Fig. 6.24 – Iso-Mach lines of solution n° 9 for test case 03 ($\Delta M = 0.05$, curve parameter = 100 M).

Table 6.9 – Solution n° 9 for test case 03 (NACA 0012, $M_\infty = 0.95$, $\alpha = 0°$). A - wall values.

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.000057	.000941	.003680	1.236027	.055880	.001501
2	.000286	.002820	.015141	1.203600	.141204	.001327
3	.000746	.004692	.036864	1.142138	.228665	.001149
4	.001440	.006551	.066386	1.058610	.312215	.001113
5	.002365	.008391	.100553	.961940	.389828	.001183
6	.003518	.010208	.136546	.860104	.460546	.001405
7	.004896	.011997	.172051	.759648	.524314	.001473
8	.006492	.013758	.205662	.664551	.581121	.001495
9	.008302	.015490	.236889	.576199	.631736	.001577
10	.010322	.017191	.265473	.495325	.676927	.001624
11	.012548	.018863	.291456	.421810	.717345	.001688
12	.014976	.020505	.314844	.355637	.753403	.001755
13	.017604	.022117	.335876	.296130	.785754	.001770
14	.020428	.023699	.354949	.242166	.815079	.001782
15	.023445	.025253	.372322	.193012	.841862	.001770
16	.026653	.026776	.388135	.148272	.866296	.001790
17	.030049	.028270	.402526	.107555	.888657	.001787
18	.033630	.029734	.415812	.069964	.909476	.001718
19	.037394	.031167	.428093	.035217	.928754	.001743
20	.041339	.032570	.439275	.003579	.946422	.001766
21	.045461	.033942	.449750	-.026058	.963193	.001663
22	.049759	.035283	.459738	-.054318	.979216	.001653
23	.054229	.036591	.468942	-.080359	.994037	.001700
24	.058869	.037867	.477466	-.104476	1.007937	.001654
25	.063676	.039110	.485602	-.127496	1.021285	.001624
26	.068647	.040320	.493349	-.149415	1.034060	.001624
27	.073781	.041495	.500677	-.170148	1.046238	.001615
28	.079073	.042637	.507669	-.189931	1.057940	.001604
29	.084522	.043744	.514395	-.208961	1.069297	.001569
30	.090125	.044815	.520819	-.227137	1.080190	.001572
31	.095878	.045850	.526850	-.244201	1.090467	.001600
32	.101778	.046849	.532627	-.260546	1.100436	.001555
33	.107824	.047811	.538276	-.276529	1.110234	.001531
34	.114012	.048737	.543648	-.291728	1.119569	.001564
35	.120339	.049625	.548732	-.306112	1.128498	.001551
36	.126803	.050475	.553688	-.320135	1.137266	.001528
37	.133399	.051288	.558523	-.333814	1.145858	.001528
38	.140126	.052062	.563185	-.347005	1.154197	.001526
39	.146980	.052798	.567666	-.359683	1.162266	.001521
40	.153958	.053495	.571964	-.371844	1.170048	.001524
41	.161058	.054154	.576096	-.383534	1.177578	.001523
42	.168275	.054774	.580127	-.394940	1.184978	.001510
43	.175608	.055355	.584087	-.406144	1.192286	.001505
44	.183052	.055897	.587939	-.417042	1.199436	.001501
45	.190606	.056400	.591639	-.427511	1.206339	.001505
46	.198265	.056864	.595167	-.437493	1.212960	.001508
47	.206028	.057289	.598558	-.447087	1.219362	.001507
48	.213889	.057676	.601863	-.456438	1.225641	.001501
49	.221847	.058025	.605114	-.465636	1.231855	.001490
50	.229898	.058336	.608282	-.474600	1.237928	.001499
51	.238040	.058608	.611328	-.483218	1.243806	.001498
52	.246268	.058843	.614268	-.491536	1.249510	.001497
53	.254581	.059040	.617120	-.499605	1.255073	.001493
54	.262974	.059200	.619891	-.507446	1.260506	.001489
55	.271445	.059324	.622571	-.515028	1.265783	.001491
56	.279990	.059412	.625146	-.522314	1.270879	.001490
57	.288606	.059464	.627619	-.529311	1.275790	.001499
58	.297291	.059481	.630020	-.536104	1.280592	.001490
59	.306041	.059464	.632382	-.542787	1.285338	.001482
60	.314852	.059412	.634669	-.549258	1.289940	.001492
61	.323722	.059327	.636853	-.555437	1.294358	.001497
62	.332648	.059209	.638975	-.561441	1.298681	.001485
63	.341627	.059059	.641039	-.567261	1.302892	.001489
64	.350654	.058877	.643019	-.572883	1.306942	.001501
65	.359728	.058664	.644952	-.578352	1.310930	.001487
66	.368846	.058420	.646849	-.583719	1.314855	.001480
67	.378003	.058147	.648639	-.588784	1.318550	.001503
68	.387197	.057844	.650322	-.593545	1.322056	.001500
69	.396425	.057514	.651977	-.598228	1.325521	.001489
70	.405685	.057157	.653613	-.602857	1.328953	.001485
71	.414971	.056772	.655200	-.607347	1.332287	.001490
72	.424283	.056362	.656714	-.611631	1.335474	.001501
73	.433616	.055926	.658169	-.615747	1.338557	.001498
74	.442968	.055466	.659595	-.619782	1.341595	.001485
75	.452335	.054982	.660962	-.623650	1.344498	.001497
76	.461715	.054475	.662244	-.627277	1.347228	.001510

Table 6.9 – A - wall values (continued).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
77	.4711 6	.053946	.663499	-.630828	1.349929	.001493
78	.4805[illegible]	.053395	.664752	-.634373	1.352621	.001493
79	.489900	.052824	.665962	-.637796	1.355221	.001503
80	.499300	.052233	.667128	-.641095	1.357740	.001503
81	.508698	.051622	.668252	-.644275	1.360181	.001494
82	.518090	.050993	.669294	-.647224	1.362430	.001512
83	.527474	.050347	.670279	-.650011	1.364571	.001516
84	.536846	.049685	.671309	-.652925	1.366843	.001481
85	.546204	.049005	.672341	-.655845	1.369088	.001497
86	.555545	.048311	.673271	-.658476	1.371106	.001525
87	.564866	.047601	.674158	-.660986	1.373066	.001509
88	.574163	.046878	.675065	-.663552	1.375069	.001499
89	.583435	.046142	.675957	-.666076	1.377030	.001508
90	.592677	.045393	.676815	-.668503	1.378925	.001510
91	.601888	.044632	.677640	-.670837	1.380755	.001505
92	.611063	.043860	.678410	-.673016	1.382454	.001518
93	.620201	.043078	.679145	-.675096	1.384081	.001528
94	.629298	.042287	.679930	-.677317	1.385851	.001497
95	.638352	.041486	.680748	-.679631	1.387674	.001500
96	.647359	.040676	.681484	-.681713	1.389301	.001525
97	.656318	.039859	.682136	-.683558	1.390759	.001528
98	.665224	.039035	.682783	-.685389	1.392210	.001528
99	.674074	.038205	.683499	-.687414	1.393844	.001492
100	.682867	.037369	.684245	-.689525	1.395518	.001499
101	.691599	.036527	.684895	-.691364	1.396951	.001544
102	.700268	.035682	.685499	-.693073	1.398327	.001526
103	.708870	.034832	.686158	-.694938	1.399837	.001499
104	.717403	.033979	.686821	-.696814	1.401323	.001521
105	.725863	.033123	.687453	-.698602	1.402753	.001526
106	.734249	.032265	.688091	-.700407	1.404215	.001508
107	.742556	.031406	.688705	-.702144	1.405605	.001519
108	.750783	.030545	.689265	-.703728	1.406868	.001537
109	.758927	.029686	.689849	-.705381	1.408219	.001512
110	.766984	.028826	.690491	-.707197	1.409692	.001504
111	.774952	.027967	.691116	-.708966	1.411111	.001521
112	.782828	.027109	.691704	-.710629	1.412457	.001524
113	.790610	.026254	.692285	-.712273	1.413793	.001522
114	.798294	.025401	.692884	-.713968	1.415176	.001514
115	.805878	.024552	.693495	-.715697	1.416568	.001508
116	.813358	.023706	.694083	-.717360	1.417937	.001519
117	.820733	.022865	.694638	-.718931	1.419219	.001519
118	.827999	.022029	.695186	-.720481	1.420489	.001516
119	.835154	.021200	.695754	-.722088	1.421811	.001508
120	.842195	.020376	.696346	-.723763	1.423185	.001508
121	.849119	.019560	.696930	-.725415	1.424543	.001507
122	.855924	.018751	.697489	-.726997	1.425839	.001514
123	.862607	.017950	.698039	-.728553	1.427115	.001523
124	.869164	.017158	.698629	-.730222	1.428517	.001488
125	.875594	.016376	.699228	-.731917	1.429918	.001487
126	.881894	.015603	.699728	-.733332	1.431055	.001535
127	.888061	.014842	.700209	-.734693	1.432203	.001506
128	.894092	.014092	.700791	-.736340	1.433592	.001474
129	.899985	.013354	.701386	-.738023	1.434978	.001493
130	.905738	.012628	.701932	-.739568	1.436256	.001504
131	.911346	.011916	.702443	-.741014	1.437471	.001490
132	.916809	.011218	.702915	-.742349	1.438581	.001497
133	.922123	.010535	.703368	-.743631	1.439651	.001498
134	.927286	.009867	.703873	-.745060	1.440862	.001477
135	.932296	.009215	.704437	-.746655	1.442204	.001470
136	.937148	.008579	.704988	-.748214	1.443518	.001462
137	.941842	.007960	.705449	-.749519	1.444591	.001495
138	.946375	.007360	.705821	-.750571	1.445478	.001493
139	.950743	.006779	.706223	-.751709	1.446454	.001467
140	.954946	.006216	.706683	-.753010	1.447562	.001452
141	.958979	.005674	.707148	-.754326	1.448672	.001453
142	.962840	.005152	.707564	-.755503	1.449648	.001480
143	.966528	.004651	.707977	-.756671	1.450650	.001461
144	.970039	.004172	.708420	-.757925	1.451761	.001391
145	.973371	.003716	.708718	-.758768	1.452384	.001523
146	.976521	.003282	.708922	-.759345	1.452907	.001476
147	.979488	.002873	.709365	-.760598	1.454042	.001375
148	.982267	.002488	.709772	-.761750	1.455005	.001399
149	.984857	.002128	.709956	-.762270	1.455300	.001610
150	.987255	.001794	.710178	-.762899	1.456101	.001230
151	.989458	.001486	.710538	-.763917	1.456636	.001706
152	.991463	.001205	.710626	-.764166	1.457368	.000963
153	.993267	.000951	.710875	-.764871	1.457056	.002269
154	.994867	.000726	.710755	-.764531	1.458127	.000323
155	.996259	.000530	.711951	-.767915	1.459213	.002906
156	.997440	.000363	.711594	-.766905	1.461506	-.001616
157	.998404	.000226	.710266	-.763148	1.452341	.006890
158	.999147	.000121	.703158	-.743037	1.435113	.007227
159	.999659	.000048	.679709	-.676691	1.340085	.062442
160	.999928	.000010	.518416	-.220338	1.049450	.033356

Table 6.9 – Solution n° 9 for test case 03 (NACA 0012, $M_\infty = 0.95$, $\alpha = 0°$). B - values near the downstream x-axis.

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.999979	- .000062	.516718	-.215534	1.046500	.033384
2	1.000162	-.000164	.487560	-.133036	.985561	.046113
3	1.000510	-.000262	.507105	-.188335	1.010255	.055716
4	1.001024	-.000358	.536397	-.271212	1.062775	.054337
5	1.001706	-.000453	.558910	-.334909	1.104512	.052922
6	1.002563	-.000549	.576206	-.383846	1.137323	.051836
7	1.003600	-.000644	.582305	-.401102	1.149746	.050632
8	1.004825	-.000740	.578346	-.389901	1.144696	.047767
9	1.006244	-.000837	.571569	-.370726	1.134172	.045272
10	1.007867	-.000935	.566781	-.357179	1.129421	.040370
11	1.009704	-.001034	.564521	-.350785	1.127951	.037148
12	1.011765	-.001135	.564592	-.350986	1.130010	.034805
13	1.014061	-.001237	.565016	-.352185	1.132453	.032770
14	1.016606	-.001341	.565268	-.352898	1.134295	.031080
15	1.019411	-.001447	.565351	-.353133	1.135499	.029790
16	1.022494	-.001556	.565274	-.352915	1.136252	.028694
17	1.025868	-.001666	.565087	-.352386	1.136704	.027721
18	1.029553	-.001779	.564774	-.351501	1.136932	.026740
19	1.033567	-.001895	.564417	-.350491	1.137068	.025774
20	1.037931	-.002014	.564094	-.349577	1.137198	.024892
21	1.042668	-.002137	.563832	-.348835	1.137363	.024102
22	1.047804	-.002262	.563597	-.348171	1.137508	.023397
23	1.053365	-.002392	.563348	-.347466	1.137574	.022758
24	1.059381	-.002526	.563060	-.346651	1.137532	.022166
25	1.065887	-.002664	.562734	-.345729	1.137406	.021592
26	1.072919	-.002807	.562379	-.344724	1.137213	.021037
27	1.080518	-.002956	.561991	-.343627	1.136944	.020502
28	1.088727	-.003110	.561565	-.342421	1.136582	.019998
29	1.097599	-.003270	.561091	-.341080	1.136116	.019517
30	1.107188	-.003438	.560576	-.339623	1.135557	.019059
31	1.117557	-.003612	.560035	-.338092	1.134939	.018618
32	1.128775	-.003795	.559484	-.336533	1.134290	.018195
33	1.140923	-.003987	.558930	-.334966	1.133627	.017783
34	1.154087	-.004188	.558364	-.333365	1.132935	.017381
35	1.168370	-.004401	.557724	-.331554	1.132099	.016994
36	1.183885	-.004625	.556890	-.329194	1.130880	.016654
37	1.200764	-.004862	.555774	-.326037	1.129111	.016372
38	1.219158	-.005115	.554547	-.322565	1.127124	.016120
39	1.239238	-.005383	.553766	-.320355	1.126011	.015774
40	1.261206	-.005670	.554068	-.321266	1.127030	.015222
41	1.285298	-.005978	.555326	-.324769	1.129869	.014440
42	1.311787	-.006309	.555153	-.324280	1.129910	.014005
43	1.340998	-.006667	.547420	-.302400	1.115477	.014876
44	1.373318	-.007055	.527040	-.244738	1.078063	.017100
45	1.409211	-.007478	.498582	-.164221	1.028223	.018778
46	1.449237	-.007941	.473845	-.094231	.987276	.018639
47	1.494081	-.008452	.460656	-.056915	.966396	.017874
48	1.544587	-.009018	.456866	-.046192	.960616	.017455
49	1.601811	-.009650	.456918	-.046339	.960788	.017357
50	1.667089	-.010361	.457168	-.047046	.961199	.017351
51	1.742135	-.011168	.456345	-.044718	.959895	.017317
52	1.829189	-.012093	.454590	-.039752	.957139	.017220
53	1.931236	-.013165	.452554	-.033992	.953985	.017065
54	2.052337	-.014424	.450772	-.028950	.951263	.016890
55	2.198175	-.015926	.449457	-.025229	.949281	.016735
56	2.376947	-.017751	.448560	-.022691	.948030	.016519
57	2.600935	-.020020	.447962	-.020899	.947303	.016257
58	2.889438	-.022922	.447586	-.019936	.946603	.016361
59	3.274622	-.026773	.447297	-.019118	.946176	.016319
60	3.814541	-.032144	.446991	-.018252	.946933	.014937
61	4.626147	-.040182	.446866	-.017898	.946804	.014857
62	5.987495	-.053617	.446314	-.016337	.943319	.017724
63	8.779475	-.081097	.444335	-.010737	.941058	.016707
6418	.586113	-.177447	.443988	-.009756	.943781	.013086

6.8. Reference test case 04 (NACA 0012, M∞ = 1.2, α = 0°)

The four solutions of group 2 are listed in table 6.10 below, with the value of the drag coefficient and the abscissa of the sonic point on the upstream x-axis ; the latter is used to characterize the position of the detached shock wave in front of the airfoil. The full sets of data for these solutions are given in Appendix A1 in microfiche form.

A physical picture of the flow field, showing the detached shock and the oblique shocks attached at the trailing-edge, is given (Fig. 6.29) by the map of iso-Mach lines taken from solution N° 9.

Table 6.10 – Solutions of group 2 for test case 04 (NACA 0012, $M_\infty = 1.2$, $\alpha = 0°$)

Solution	MESH			outer boundary (chords)	C_D	sonic point on upstream x-axis (x/c)
	type	points or cells				
		total	on airfoil			
1	C	201 x 55	169	3/15/2	0.0946*	- 0.54
3	O	160 x 24	160	16	0.0951	- 0.45
6	O	192 x 39	192	50	0.0957	- 0.41
9	O	320 x 64	320	25	0.0960*	- 0.42
				scatter :	0.0014 = 1.5 %	

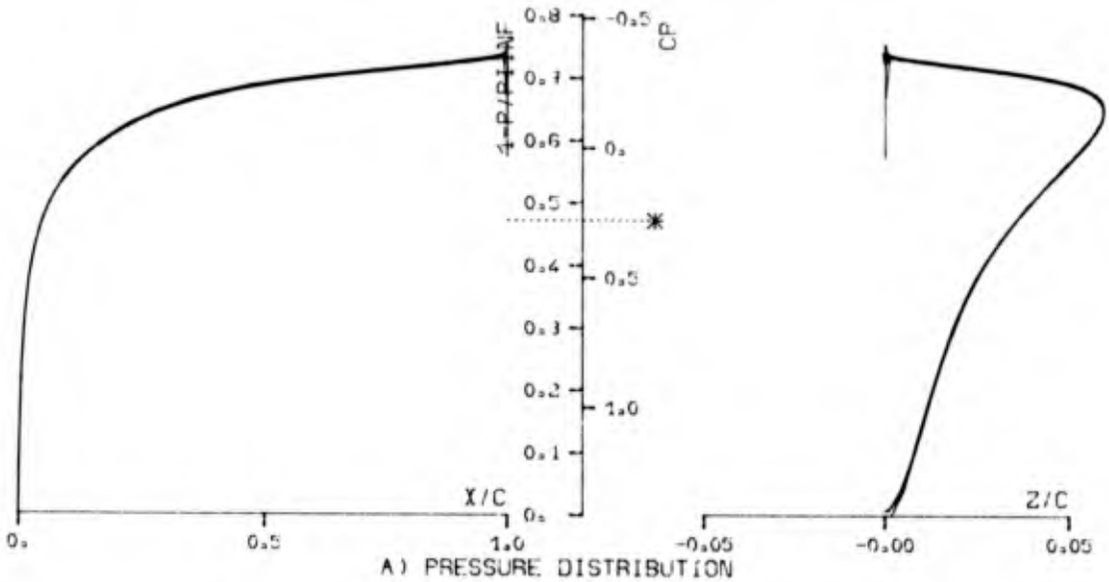
Figure 6.25 shows the cross-plots of p, M and p_i for the solutions of group 2. The agreement between these solutions is seen to be very good, as good as for test case 03 ; however, table 6.8 shows that the scatter on the drag coefficient is higher. The error on the total pressure at the wall, disregarding the vicinity of the trailing-edge, is highest for solution N° 3 (although small, not exceeding 1.7×10^{-2}), and smallest for solution N° 9 ; note that, due to the detached shock, the exact value of p_i at the wall is $p_{i_\infty} = 0.9928\ p_{i_\infty}$.

Enlarged plots of p and M near the trailing-edge are given on Fig. 6.26. Solutions N° 1 and 6 show some pre-shock oscillations, whereas solutions N° 3 and 9 show none. For this reason, we retain solutions N° 3 and 9 for group 3, with a preference for solution N° 9 which has a better accuracy on p_i at the wall.

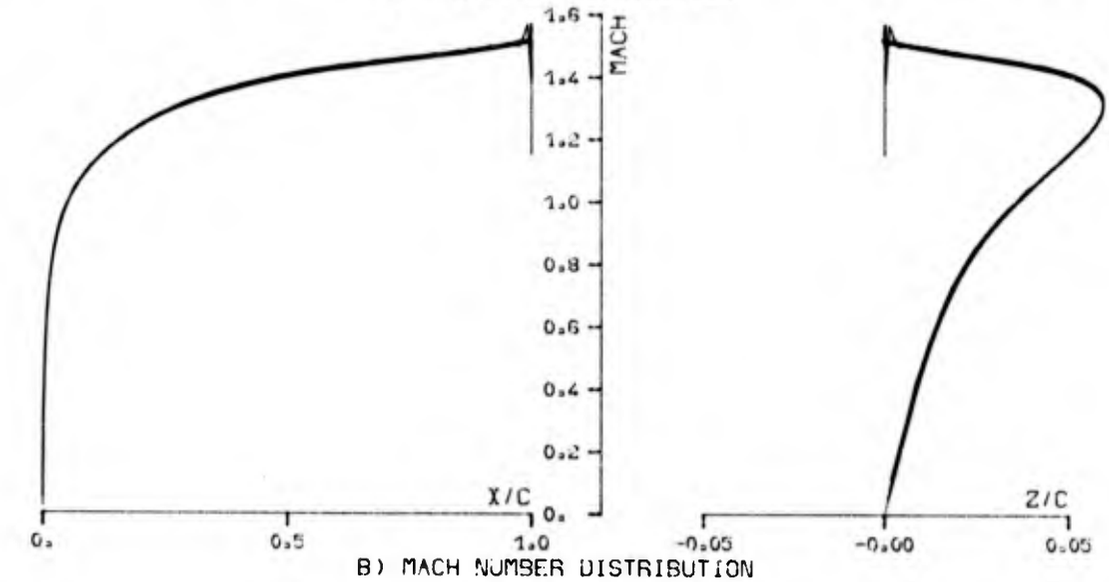
The tabulated values on the airfoil and on the upstream x-axis for solution N° 9 are presented in Table 6.11.

For this test case, and also for test case 05, the solution behaviour upstream of the leading-edge is of particular interest because of the presence of a detached shock. Figure 6.27 gives the plots of p and M versus x/c on (or very close to) the upstream x-axis, for solutions N° 1, 3 and 9 for which tabulated data are available. The position of the sonic point on this axis is also given in table 6.10. The shock profiles and the positions of the sonic point are appreciably different, but we see on Fig. 6.27 that, curiously enough, the pressure or the Mach number distributions for solutions N° 1, 3 and 9 merge into a single curve from the downstream side of the shock to the stagnation point.

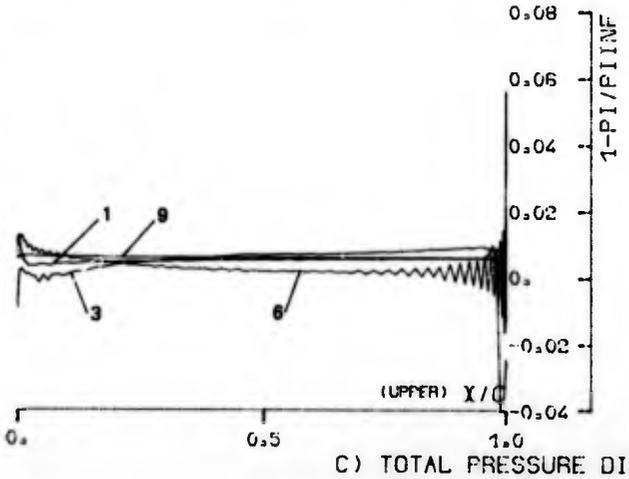
The available solutions do not permit to conclude precisely as to the position of the detached shock. Mesh fitting or shock fitting techniques seem to be required for a very precise determination of this shock, but we see that the uncertainty on the shock does not prevent from having a good agreement on the flow properties on the airfoil.



A) PRESSURE DISTRIBUTION



B) MACH NUMBER DISTRIBUTION



C) TOTAL PRESSURE DISTRIBUTION

Fig. 6.25 – Solutions of group 2 for test case 04 (NACA 0012, Mach = 1.20, α = 0).

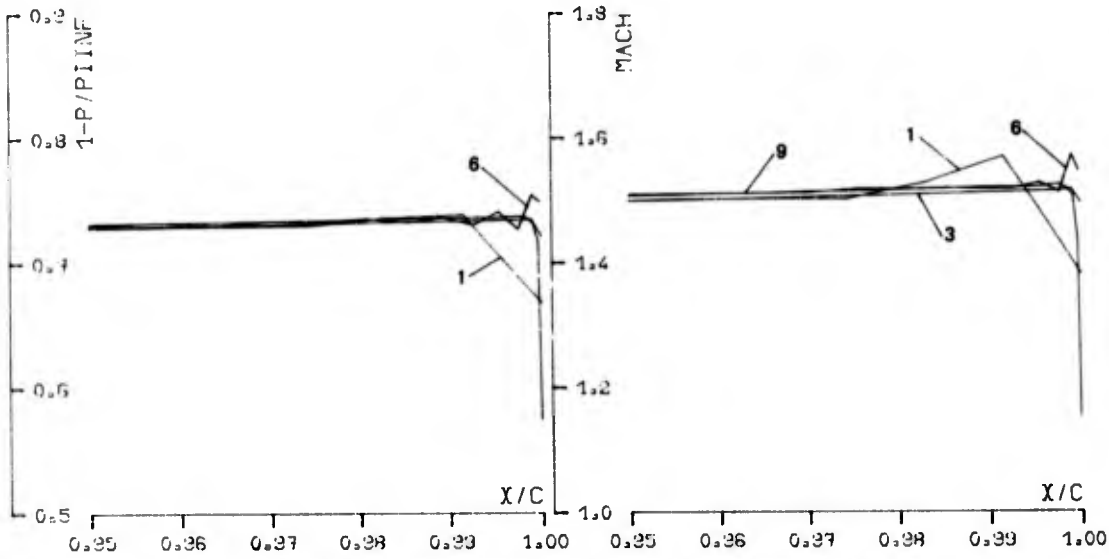


Fig. 6.26 – Trailing edge behaviour for solutions of group 2. Test case 04.

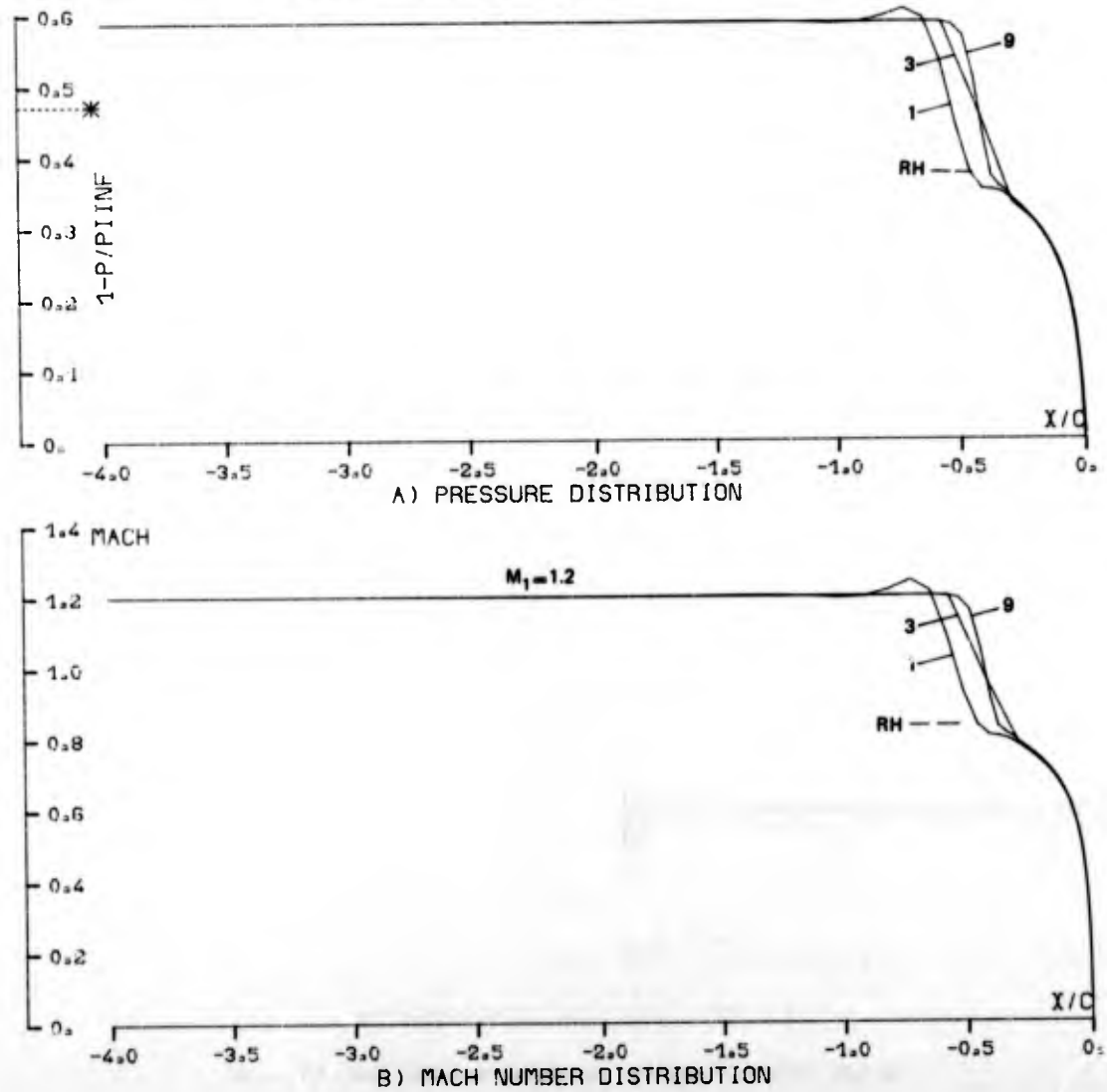
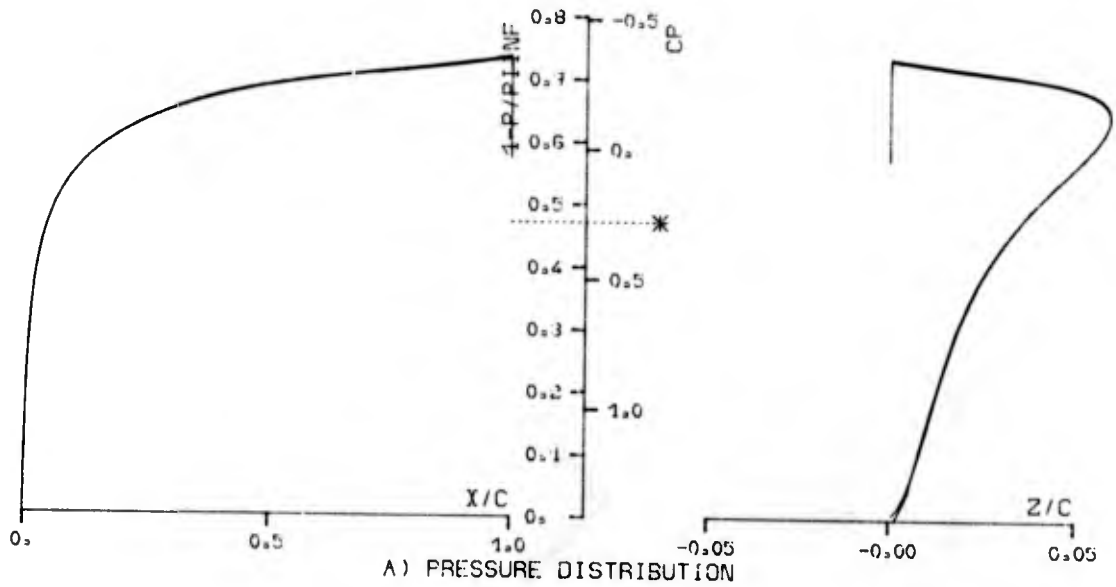
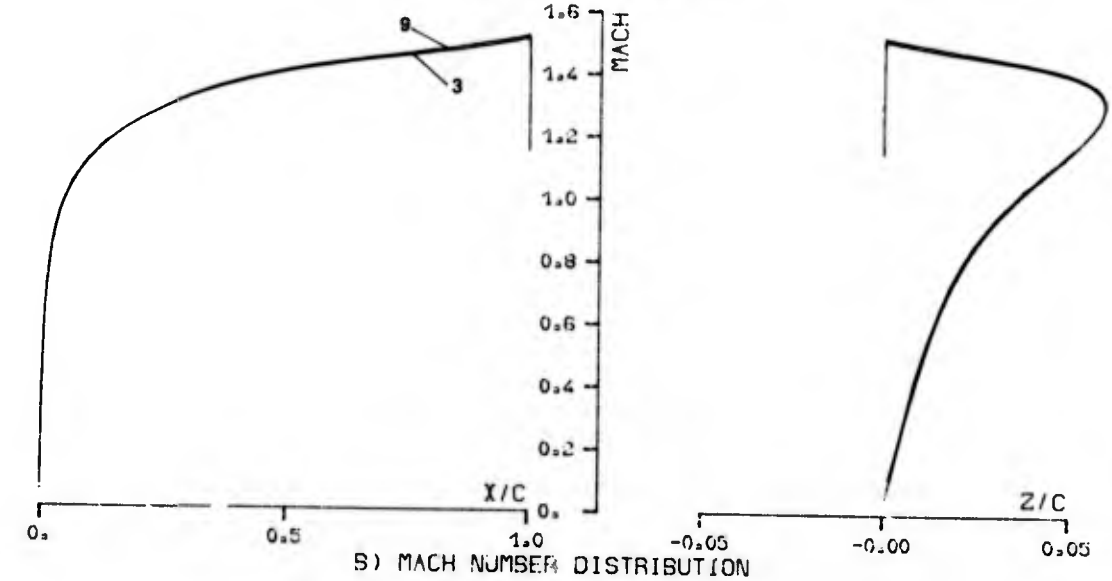


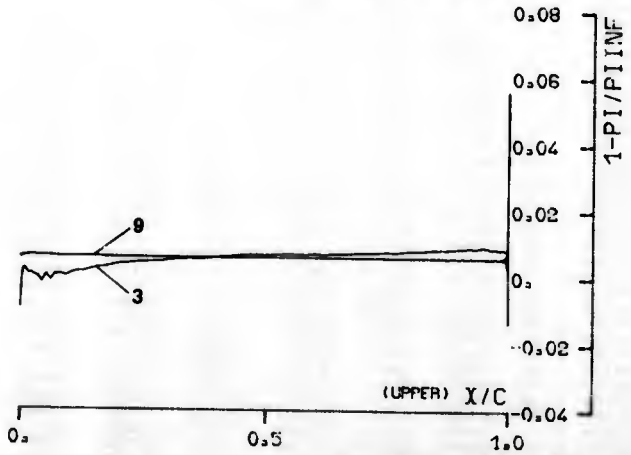
Fig. 6.27 – Solutions 1/3/9 on upstream x-axis. Test case 04.



A) PRESSURE DISTRIBUTION



B) MACH NUMBER DISTRIBUTION



C) TOTAL PRESSURE DISTRIBUTION

Fig. 6.28 – Solutions of group 3 for test case 04 (NACA 0012, Mach = 1.20, α = 0).

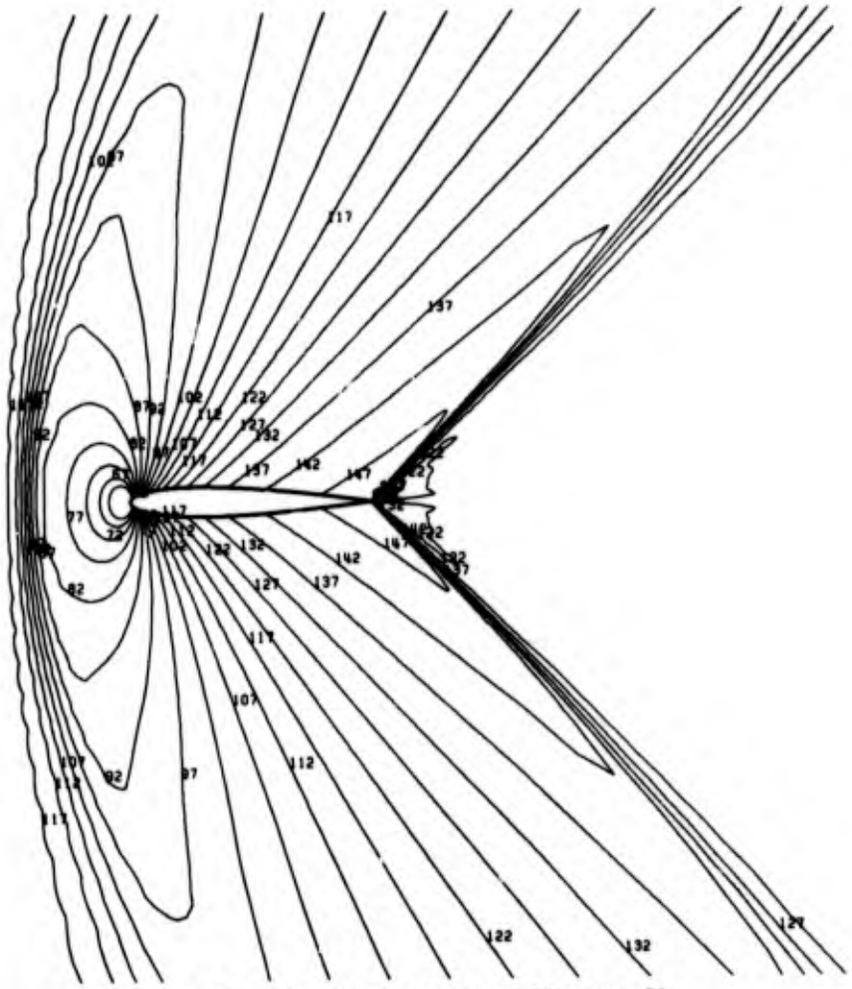


Fig. 6.29 – Iso-Mach lines of solution n° 9 for test case 04 (ΔM = 0.05, curve parameter = 100 M).

Table 6.11 – Solution n° 9 for test case 04 (NACA 0012, M_∞ = 1.2, α = 0°). A - wall values.

N	x/C	z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.000057	.000941	.008199	1.393932	.055963	.006023
2	.000286	.002820	.019794	1.366037	.142216	.005846
3	.000746	.004692	.041770	1.319169	.230484	.005662
4	.001440	.006551	.071645	1.241298	.314823	.005624
5	.002365	.008391	.106229	1.158099	.393221	.005693
6	.003518	.010208	.142677	1.070415	.464726	.005918
7	.004896	.011997	.178650	.983874	.529284	.005985
8	.006492	.013758	.212723	.901904	.586866	.006010
9	.008302	.015490	.244399	.825701	.638251	.006090
10	.010322	.017191	.273421	.755882	.684207	.006138
11	.012548	.018863	.299825	.692361	.725381	.006201
12	.014976	.020505	.323618	.635122	.762185	.006269
13	.017604	.022117	.345037	.583594	.795266	.006285
14	.020428	.023699	.364481	.536817	.825310	.006296
15	.023445	.025253	.382214	.494156	.852807	.006284
16	.026653	.026776	.398376	.455275	.877946	.006304
17	.030049	.028270	.413101	.419851	.901000	.006299
18	.033630	.029734	.426712	.387107	.922506	.006226
19	.037394	.031167	.439308	.356804	.942462	.006250
20	.041339	.032570	.450794	.329172	.960791	.006273
21	.045461	.033942	.461559	.303275	.978208	.006171
22	.049759	.035283	.471837	.278549	.994889	.006158
23	.054229	.036591	.481325	.255723	1.010363	.006201
24	.058869	.037867	.490120	.234565	1.024895	.006153
25	.063676	.039110	.498513	.214374	1.038854	.006125
26	.068647	.040320	.506505	.195147	1.052231	.006123
27	.073781	.041495	.514073	.176941	1.065003	.006114
28	.079073	.042637	.521298	.159559	1.077296	.006100
29	.084522	.043744	.528256	.142820	1.089249	.006061
30	.090125	.044815	.534914	.126803	1.100745	.006060
31	.095878	.045850	.541179	.111731	1.111625	.006066
32	.101778	.046849	.547181	.097292	1.122186	.006037
33	.107824	.047811	.553051	.083170	1.132573	.006014
34	.114012	.048737	.558642	.069720	1.142501	.006042
35	.120339	.049625	.563941	.056972	1.152011	.006029
36	.126803	.050475	.569102	.044556	1.161348	.006007
37	.133399	.051288	.574134	.032451	1.170505	.006002
38	.140126	.052062	.578990	.020768	1.179403	.006000
39	.146980	.052798	.583662	.009529	1.188031	.005991
40	.153958	.053495	.588148	-.001263	1.196369	.005988
41	.161058	.054154	.592466	-.011651	1.204450	.005985
42	.168275	.054774	.596675	-.021777	1.212390	.005971
43	.175608	.055355	.600806	-.031715	1.220232	.005961
44	.183052	.055897	.604826	-.041386	1.227912	.005956
45	.190606	.056400	.608694	-.050691	1.235346	.005958
46	.198265	.056864	.612390	-.059583	1.242497	.005958
47	.206028	.057289	.615947	-.068140	1.249426	.005954
48	.213889	.057676	.619413	-.076478	1.256226	.005943
49	.221847	.058025	.622822	-.084679	1.262957	.005930
50	.229898	.058336	.626145	-.092673	1.269546	.005935
51	.238040	.058608	.629345	-.100372	1.275934	.005934
52	.246268	.058843	.632437	-.107810	1.282146	.005929
53	.254581	.059040	.635439	-.115032	1.288214	.005924
54	.262974	.059200	.638359	-.122057	1.294149	.005920
55	.271445	.059324	.641186	-.128858	1.299928	.005916
56	.279990	.059412	.643909	-.135408	1.305524	.005914
57	.288606	.059464	.646528	-.141709	1.310930	.005919
58	.297291	.059481	.649072	-.147829	1.316222	.005907
59	.306041	.059464	.651575	-.153851	1.321457	.005894
60	.314852	.059412	.654001	-.159687	1.326542	.005903
61	.323722	.059327	.656325	-.165278	1.331440	.005906
62	.332648	.059209	.658584	-.170712	1.336240	.005892
63	.341627	.059059	.660783	-.176003	1.340924	.005891
64	.350654	.058877	.662899	-.181093	1.345444	.005903
65	.359728	.058664	.664963	-.186058	1.349895	.005884
66	.368846	.058420	.666990	-.190935	1.354280	.005875
67	.378003	.058147	.668912	-.195559	1.358435	.005895
68	.387197	.057844	.670728	-.199927	1.362394	.005892
69	.396425	.057514	.672512	-.204219	1.366306	.005880
70	.405685	.057157	.674274	-.208458	1.370180	.005875
71	.414971	.056772	.675986	-.212577	1.373956	.005876
72	.424283	.056362	.677626	-.216522	1.377582	.005884
73	.433616	.055926	.679204	-.220318	1.381093	.005880
74	.442968	.055466	.680751	-.224040	1.384557	.005863
75	.452335	.054982	.682240	-.227622	1.387884	.005874
76	.461715	.054475	.683645	-.231002	1.391035	.005883
77	.471105	.053946	.685019	-.234308	1.394147	.005864
78	.480500	.053395	.686388	-.237601	1.397246	.005862
79	.489900	.052824	.687713	-.240789	1.400249	.005869
80	.499300	.052233	.688994	-.243870	1.403168	.005867

Table 6.11 — A - wall values (continued).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
81	.508698	.051622	.690232	-.246849	1.406006	.005854
82	.518090	.050993	.691391	-.249637	1.408648	.005874
83	.527474	.050347	.692491	-.252283	1.411174	.005877
84	.536846	.049685	.693627	-.255016	1.413819	.005840
85	.546204	.049005	.694765	-.257754	1.416444	.005848
86	.555545	.048311	.695807	-.260260	1.418839	.005877
87	.564866	.047601	.696803	-.262657	1.421165	.005861
88	.574163	.046878	.697812	-.265084	1.423524	.005851
89	.583435	.046142	.698805	-.267473	1.425840	.005856
90	.592677	.045393	.699765	-.269782	1.428089	.005856
91	.601888	.044632	.700692	-.272012	1.430269	.005852
92	.611063	.043860	.701564	-.274110	1.432314	.005862
93	.620201	.043078	.702398	-.276117	1.434275	.005872
94	.629298	.042287	.703274	-.278224	1.436371	.005837
95	.638352	.041486	.704181	-.280406	1.438520	.005838
96	.647359	.040676	.705012	-.282405	1.440479	.005860
97	.656318	.039859	.705762	-.284209	1.442262	.005864
98	.665224	.039035	.706499	-.285982	1.444018	.005867
99	.674074	.038205	.707295	-.287897	1.445949	.005828
100	.682867	.037369	.708122	-.289887	1.447928	.005831
101	.691599	.036527	.708860	-.291662	1.449671	.005873
102	.700268	.035682	.709550	-.293322	1.451341	.005859
103	.708870	.034832	.710284	-.295088	1.453129	.005832
104	.717403	.033979	.711020	-.296859	1.454897	.005846
105	.725863	.033123	.711728	-.298562	1.456605	.005855
106	.734249	.032265	.712439	-.300272	1.458344	.005834
107	.742556	.031406	.713126	-.301925	1.460004	.005847
108	.750783	.030545	.713758	-.303446	1.461530	.005865
109	.758927	.029686	.714408	-.305009	1.463135	.005837
110	.766984	.028826	.715109	-.306696	1.464854	.005829
111	.774952	.027967	.715795	-.308346	1.466524	.005843
112	.782828	.027109	.716447	-.309915	1.468120	.005848
113	.790610	.026254	.717087	-.311454	1.469692	.005849
114	.798294	.025401	.717737	-.313018	1.471303	.005834
115	.805878	.024552	.718399	-.314610	1.472938	.005831
116	.813358	.023706	.719039	-.316150	1.474510	.005841
117	.820733	.022865	.719677	-.317613	1.476019	.005840
118	.827999	.022029	.720244	-.319049	1.477501	.005839
119	.835154	.021200	.720855	-.320519	1.479026	.005829
120	.842195	.020376	.721487	-.322039	1.480599	.005829
121	.849119	.019560	.722112	-.323543	1.482159	.005827
122	.855924	.018751	.722713	-.324989	1.483654	.005837
123	.862607	.017950	.723299	-.326399	1.485114	.005846
124	.869164	.017158	.723918	-.327888	1.486690	.005812
125	.875594	.016376	.724547	-.329401	1.488273	.005807
126	.881894	.015603	.725086	-.330698	1.489593	.005860
127	.888061	.014842	.725601	-.331936	1.490909	.005834
128	.894092	.014092	.726201	-.333380	1.492449	.005797
129	.899985	.013354	.726815	-.334857	1.493990	.005814
130	.905738	.012628	.727387	-.336233	1.495429	.005829
131	.911346	.011916	.727925	-.337527	1.496801	.005819
132	.916809	.011218	.728421	-.338721	1.498058	.005825
133	.922123	.010535	.728895	-.339861	1.499263	.005827
134	.927286	.009867	.729413	-.341107	1.500599	.005805
135	.932296	.009215	.729985	-.342483	1.502064	.005798
136	.937148	.008579	.730549	-.343840	1.503510	.005794
137	.941842	.007960	.731031	-.345000	1.504722	.005827
138	.946375	.007360	.731425	-.345947	1.505732	.005828
139	.950743	.006779	.731836	-.346936	1.506805	.005803
140	.954946	.006216	.732298	-.348048	1.508004	.005788
141	.958979	.005674	.732770	-.349183	1.509219	.005789
142	.962840	.005152	.733199	-.350215	1.510305	.005819
143	.966528	.004651	.733620	-.351228	1.511400	.005808
144	.970039	.004172	.734065	-.352298	1.512605	.005730
145	.973371	.003716	.734380	-.353056	1.513327	.005865
146	.976521	.003282	.734599	-.353583	1.513923	.005824
147	.979488	.002873	.735031	-.354622	1.515112	.005726
148	.982267	.002488	.735435	-.355594	1.516151	.005741
149	.984857	.002128	.735646	-.356102	1.516552	.005954
150	.987255	.001794	.735880	-.356665	1.517410	.005594
151	.989458	.001486	.736229	-.357504	1.518021	.006025
152	.991463	.001205	.736341	-.357774	1.518752	.005390
153	.993267	.000951	.736629	-.358467	1.518799	.006408
154	.994867	.000726	.736502	-.358161	1.519408	.005048
155	.996259	.000530	.737382	-.360278	1.520443	.006876
156	.997440	.000363	.737537	-.360651	1.523432	.003133
157	.998404	.000226	.736860	-.359022	1.516755	.010227
158	.999147	.000121	.732111	-.347598	1.505971	.008024
159	.999659	.000048	.717141	-.311584	1.433684	.055914
160	.999928	.000010	.574604	.031320	1.151928	.030437

Table 6.11 — Solution n° 9 for test case 04 (NACA 0012, $M_\infty = 1.2$, $\alpha = 0°$). B - values near the upstream x-axis.

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	-.000605	.000977	.008070	1.394242	.054231	.006026
2	-.001991	.001049	.012585	1.383380	.093981	.006467
3	-.003503	.001123	.018868	1.368265	.137970	.005732
4	-.005150	.001198	.027993	1.346313	.178299	.006190
5	-.006937	.001274	.037634	1.323119	.215733	.005915
6	-.008871	.001352	.048279	1.297510	.249905	.006019
7	-.010960	.001431	.059164	1.271324	.281451	.005953
8	-.013213	.001512	.070281	1.244580	.310597	.005969
9	-.015638	.001594	.081400	1.217830	.337689	.005960
10	-.018245	.001678	.092449	1.191250	.362960	.005964
11	-.021044	.001764	.103347	1.165032	.386635	.005962
12	-.024047	.001852	.114055	1.139272	.408891	.005962
13	-.027265	.001943	.124542	1.114043	.429886	.005962
14	-.030712	.002035	.134792	1.089384	.449752	.005963
15	-.034401	.002130	.144795	1.065320	.468605	.005962
16	-.038347	.002227	.154550	1.041852	.486546	.005963
17	-.042567	.002328	.164057	1.018981	.503662	.005962
18	-.047079	.002431	.173322	.996692	.520030	.005962
19	-.051901	.002537	.182352	.974968	.535720	.005962
20	-.057057	.002647	.191155	.953791	.550791	.005964
21	-.062567	.002760	.199739	.933140	.565299	.005963
22	-.068458	.002877	.208117	.912985	.579293	.005965
23	-.074757	.002999	.216298	.893304	.592819	.005965
24	-.081495	.003124	.224293	.874070	.605917	.005965
25	-.088705	.003255	.232115	.855252	.618626	.005966
26	-.096423	.003390	.239775	.836825	.630981	.005967
27	-.104691	.003531	.247285	.818758	.643016	.005968
28	-.113554	.003678	.254657	.801023	.654761	.005969
29	-.123061	.003832	.261904	.783588	.666249	.005969
30	-.133269	.003992	.269039	.766424	.677507	.005970
31	-.144240	.004161	.276077	.749492	.688567	.005972
32	-.156044	.004337	.283032	.732760	.699459	.005973
33	-.168760	.004523	.289918	.716195	.710208	.005974
34	-.182477	.004718	.296742	.699778	.720840	.005971
35	-.197295	.004925	.303545	.683412	.731409	.005972
36	-.213329	.005144	.310398	.666925	.742015	.005993
37	-.230710	.005376	.317292	.650340	.752660	.006022
38	-.249588	.005623	.323936	.634357	.762995	.005966
39	-.270137	.005887	.330478	.618619	.773228	.005848
40	-.292558	.006169	.338407	.599544	.785240	.006075
41	-.317084	.006473	.348613	.574991	.800186	.006881
42	-.343992	.006799	.356552	.555892	.812144	.007198
43	-.373604	.007153	.368461	.524836	.831197	.008147
44	-.406310	.007537	.427219	.385887	.914977	.015297
45	-.442570	.007957	.509149	.188786	1.048935	.015366
46	-.482947	.008417	.566941	.049755	1.156981	.006587
47	-.528124	.008924	.583245	.010502	1.190951	.001217
48	-.578947	.009487	.586377	.002997	1.197394	.000380
49	-.636471	.010116	.587569	.000130	1.200059	-.000208
50	-.702031	.010825	.587418	.000493	1.199773	-.000201
51	-.777342	.011629	.587007	.001482	1.198887	-.000041
52	-.864644	.012551	.586822	.001927	1.198504	.000010
53	-.966921	.013621	.586868	.001816	1.198582	.000020
54	-1.088235	.014878	.586981	.001544	1.198809	-.000002
55	-1.234268	.016377	.587065	.001342	1.198975	-.000015
56	-1.413218	.018201	.587102	.001253	1.199046	-.000018
57	-1.637367	.020468	.587113	.001227	1.199065	-.000017
58	-1.926010	.023369	.587117	.001217	1.199071	-.000015
59	-2.311317	.027219	.587124	.001200	1.199083	-.000013
60	-2.851340	.032588	.587137	.001169	1.199107	-.000013
61	-3.663035	.040625	.587157	.001121	1.199144	-.000013
62	-5.024451	.054060	.587184	.001056	1.199196	-.000015
63	-7.816479	.081540	.587222	.000965	1.199265	-.000013
64	-17.623149	.176989	.587271	.000847	1.199351	-.000007

6.9. Reference test case 05 (NACA 0012, $M_\infty = 1.2$, $\alpha = 7°$)

The seven solutions of group 2 are listed in table 6.12 below. The full sets of data for these solutions are given in Appendix A1 in microfiche form.

A physical picture of the flow field is given on Fig. 6.36 by the map of iso-Mach lines taken from solution N° 1. Compared to the flow field of test case 04, the lower shock has vanished but a very weak recompression wave remains.

The drag coefficient is 60 % higher than for test case 04, but the absolute scatter of the values of C_D in group 2 is about the same. The scatter of the values of C_L or C_M is much smaller than for the test cases 01 and 02.

Figure 6.30 shows the cross-plots of p, M and p_i for the solutions of group 2. The scatter is seen to be much more important than for test case 04, especially on the Mach number distribution, and the error on the total pressure at the wall is also more important. The exact value $p''_{i\infty}$ of p_i at the wall is unknown ; it should be slightly higher than for test case 04 (i.e. $0.9928\ p_{i\infty} < p''_{i\infty} < p_{i\infty}$) because the stagnation streamline does not cross the detached shock exactly at right angle. In any case, the uncertainty on $p''_{i\infty}$ is small compared to the errors on p_i for some of the solutions (Fig. 6.30 c). Solutions N° 3 and 5 have the largest errors ; solution N° 6 also shows a large error for p_i on the upper surface, and for solution N° 8 the error is important only at the leading-edge on the upper side. The comparison with test case 04 shows that for solutions N° 3 and 6 the error on p_i is very much enhanced by the lifting effect.

Table 6.12 – Solutions of group 2 for test case 05 (NACA 0012, $M_\infty = 1.2$, $\alpha = 7°$).

Solution	MESH			outer boundary (chords)	C_L	Γ	C_D	C_M
	type	points or cells total	points or cells on airfoil					
1	C	201 x 55	169	3/15/2	0.5280*	0.3046	0.1536	-0.1121*
3	O	160 x 24	160	16	0.5214	0.2863	0.1542	-0.1109
5	C	249 x 41	181	2/12/18	0.5196	0.2995	0.1543*	-0.1102
6	O	192 x 39	192	50	0.5177		0.1538	-0.1103
8	O	128 x 32	128	10	0.528*	0.303	0.154	-0.112
9	O	320 x 64	320	25	0.5138*		0.1538	-0.1087
10	C	129 x 25	80	9	0.5189		0.1531*	-0.1071*
				scatter :	0.0142 = 2.7 %		0.0012 = 0.8 %	0.005 = 4.6 %

Figure 6.31 gives enlarged plots of p and M just upstream of the trailing-edge. The flow being supersonic, the influence of the trailing-edge should not be felt upstream, but Fig. 6.31 shows that the numerical solutions are more or less perturbed upstream, solutions N° 8 and 10 being those for which the perturbations are felt the most upstream.

A more detailed comparison of the pressure and Mach number distributions reveals that, inside group 2, we can distinguish a sub-group 2a made of solutions N° 1, 8 and 10, and a sub-group 2.b made of solutions N° 6 and 9, such that there is a rather good general agreement (and partly very good agreement) between the solutions of each sub-group, on both upper and lower surfaces. This is shown on Figs. 6.33 and 6.34 which give the cross-plots of p, M and p_i for these two sub-groups. The solutions N° 3 and 5 do not fit well neither with sub-group 2.a nor with sub-group 2.b, and they do not agree well together, especially on the Mach number. In view of this and of the fact that they have a large error on p_i, we cannot consider the solutions N° 3 and 5 for group 3.

Inside sub-group 2.a, solution N° 1 appears to be the best one because of its finer mesh, its better accuracy on p_i and its better behaviour at the trailing-edge. Inside sub-group 2.b, solution N° 6 has a rather large error on p_i on the upper surfsace and shows small ripples in p, M and p_i over parts of the airfoil ; whereas solution N° 9 is very accurate on p_i and well-behaved near the trailing-edge except right at the trailing-edge where an important overshoot occurs.

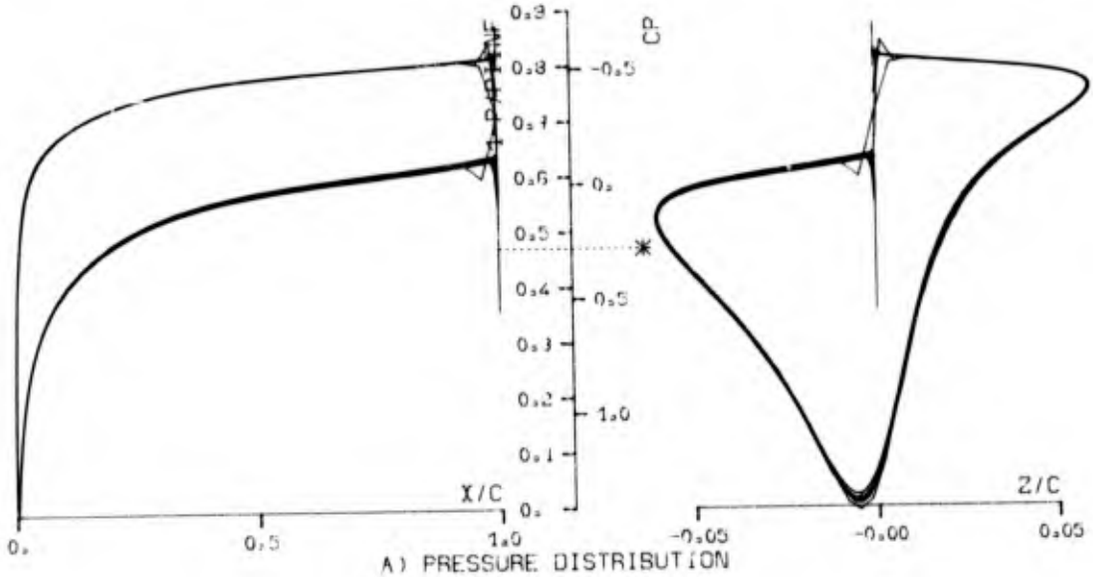
Therefore we keep solutions N° 1 and 9 to form group 3, conceding a superiority to N° 9 for its finer mesh, its better accuracy on p_i and its better behaviour near the trailing-edge; Figure 6.35 shows the cross-plots of p, M and p_i for these two solutions ; one sees that the difference between them is essentially confined to the lower surface.

Tabulated wall values and upstream x-axis values for solutions N° 1 and N° 9 are given in tables 6.13 and 6.14 respectively.

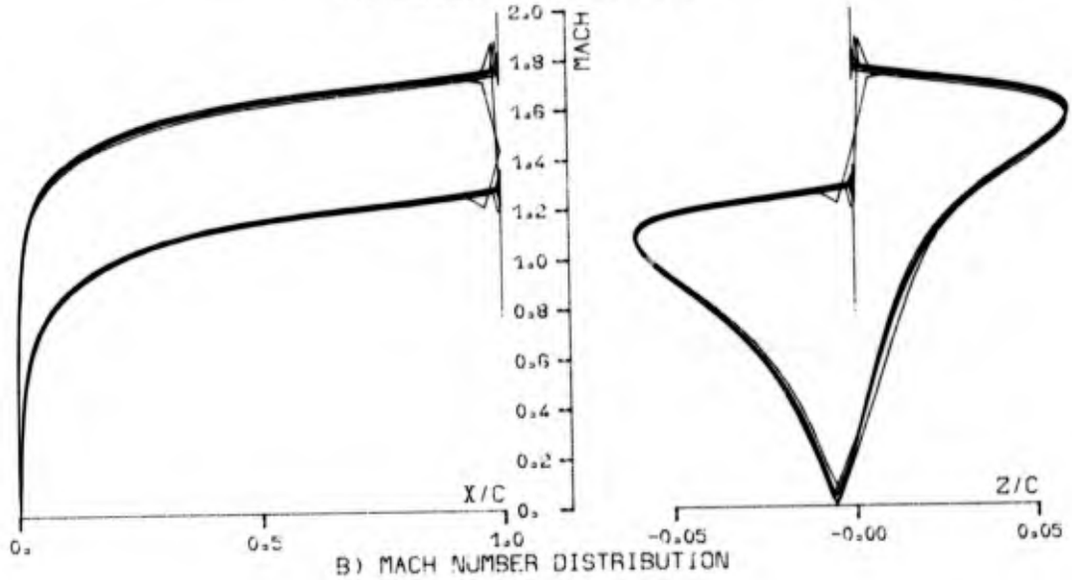
Figure 6.32 gives the pressure and Mach number distributions on (or very close to) the upstream x-axis for solutions N° 1, 3, 8 and 9 for which tabulated data are available. The distances of the sonic point on this axis for all the solutions of group 2 are listed below :

Solution N°	1	3	5	6	8	9	10
Sonic point on upstream x-axis (x/c)	- 0.68	- 0.52	- 0.55	- 0.51	- 0.72	- 0.51	- 0.70

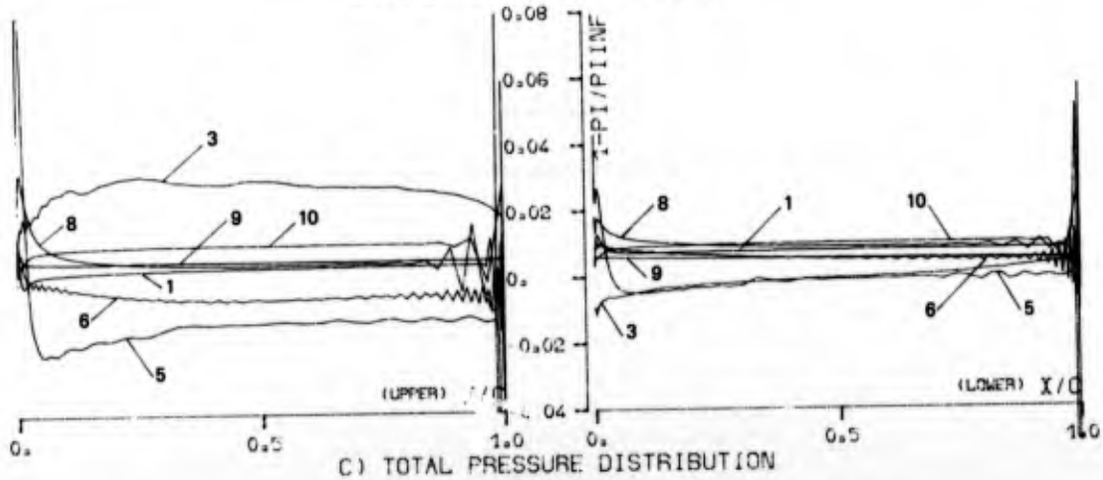
There are important variations in shock profiles and sonic point positions, as for test case 04. The merging of the pressure or Mach number distributions into a single curve downstream of the shock, already observed for test case 04, occurs at a larger distance from the shock.



A) PRESSURE DISTRIBUTION



B) MACH NUMBER DISTRIBUTION



C) TOTAL PRESSURE DISTRIBUTION

Fig. 6.30 – Solutions of group 2 for test case 05 (NACA 0012, Mach = 1.20, α = 7).

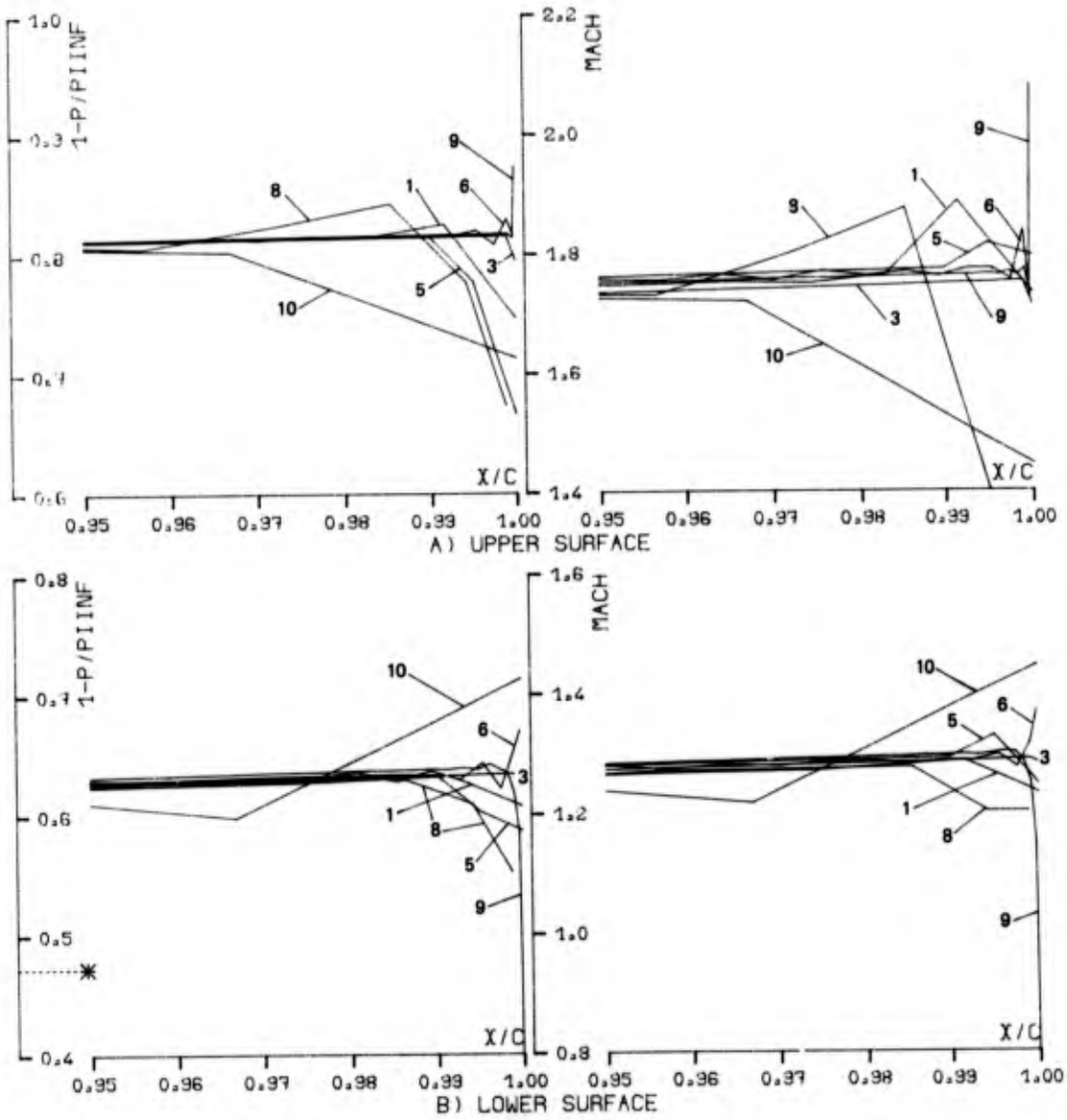


Fig. 6.31 – Trailing edge behaviour for solutions of group 2. Test case 05.

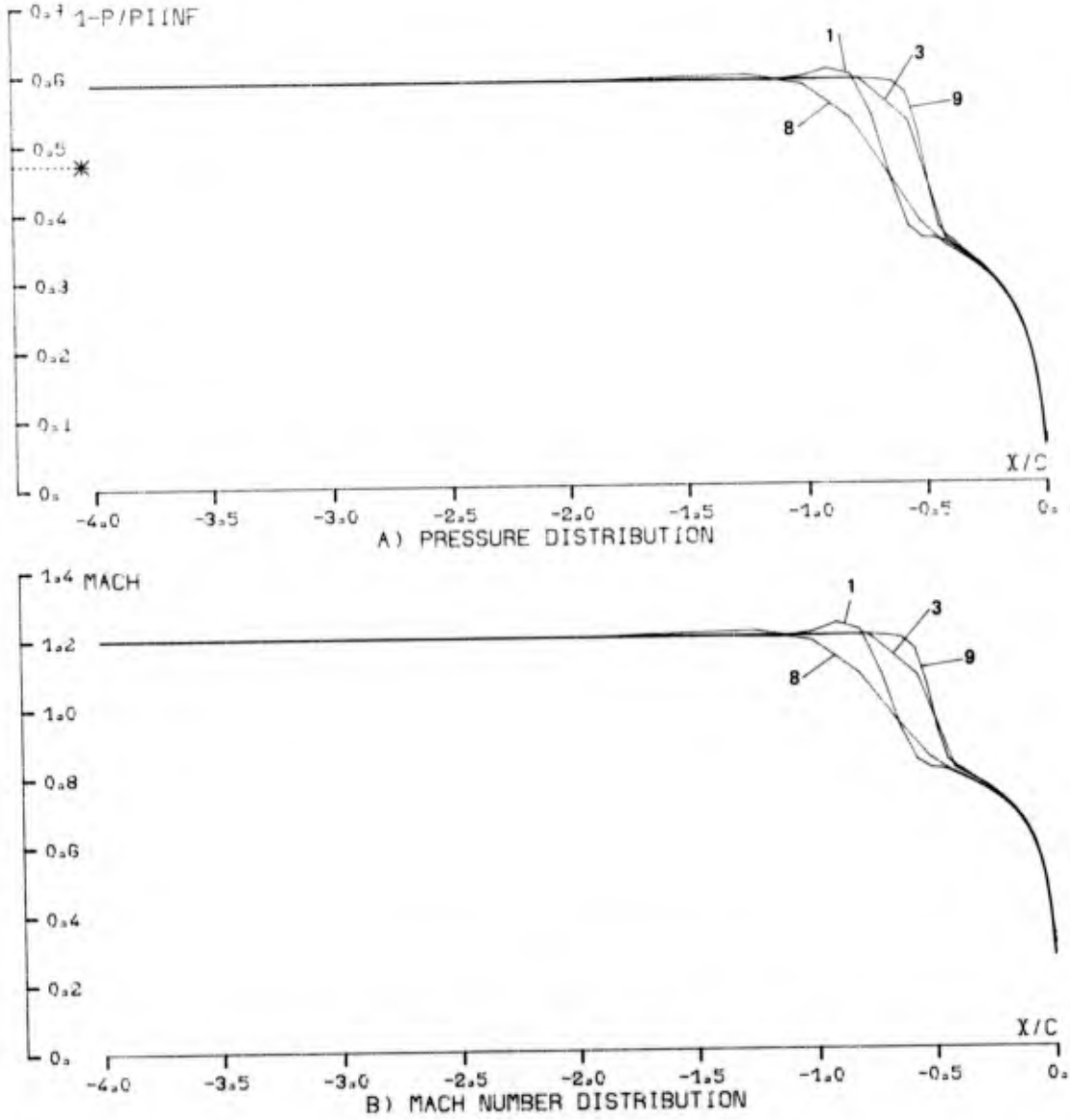
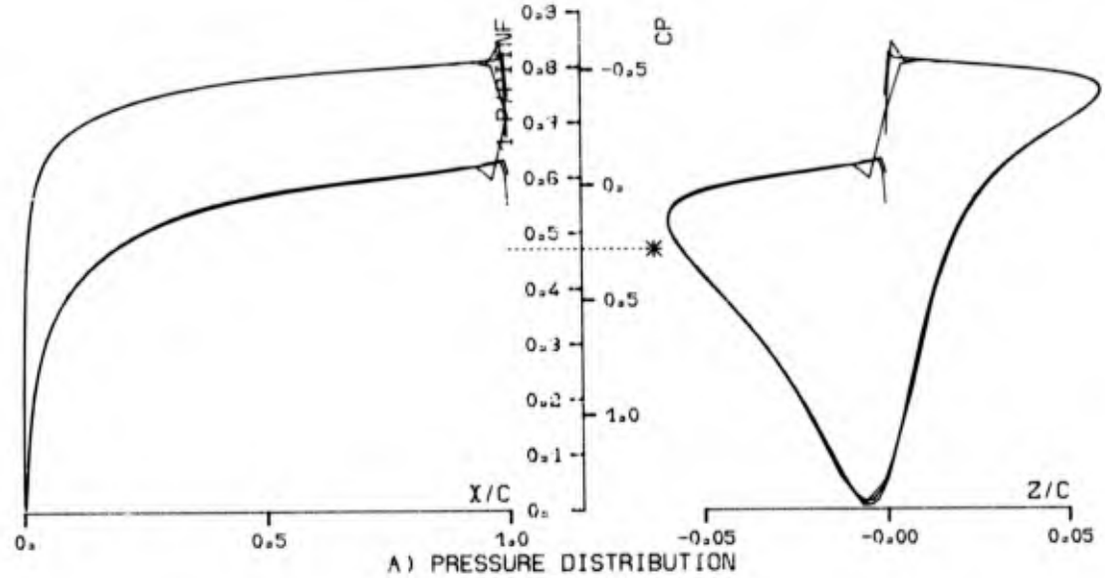
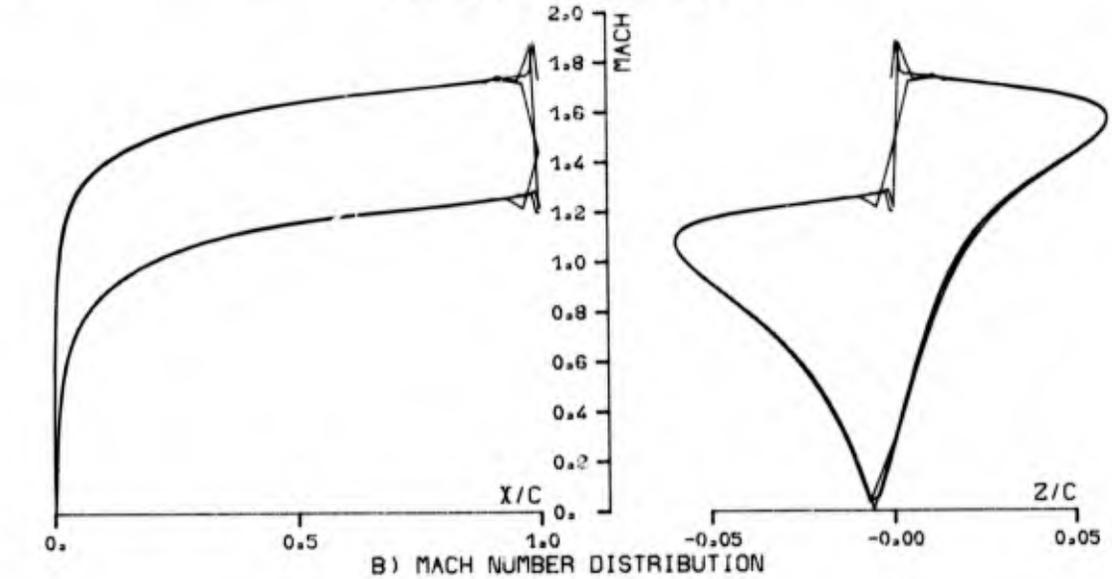


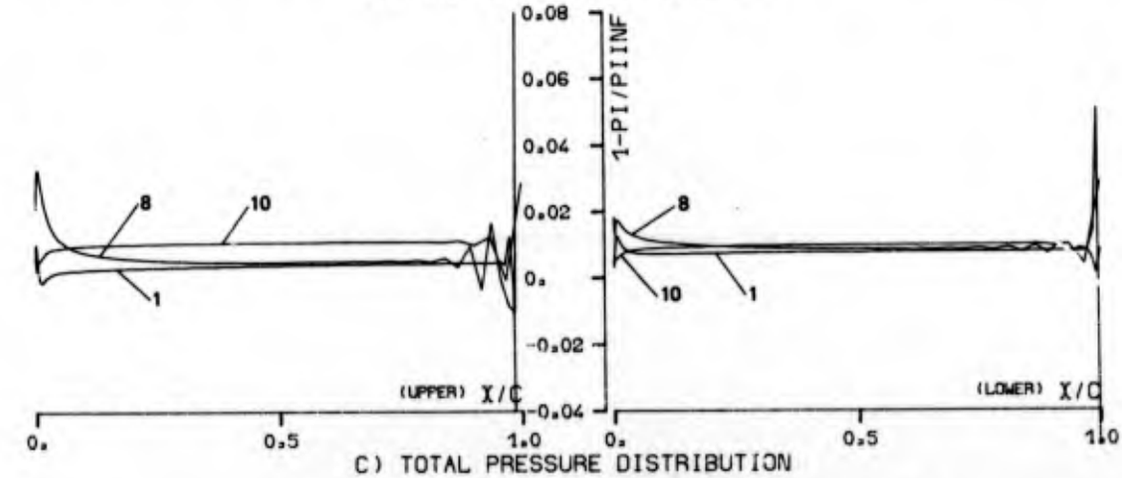
Fig. 6.32 – Solutions 1/3/8/9 on upstream x-axis. Test case 05.



A) PRESSURE DISTRIBUTION

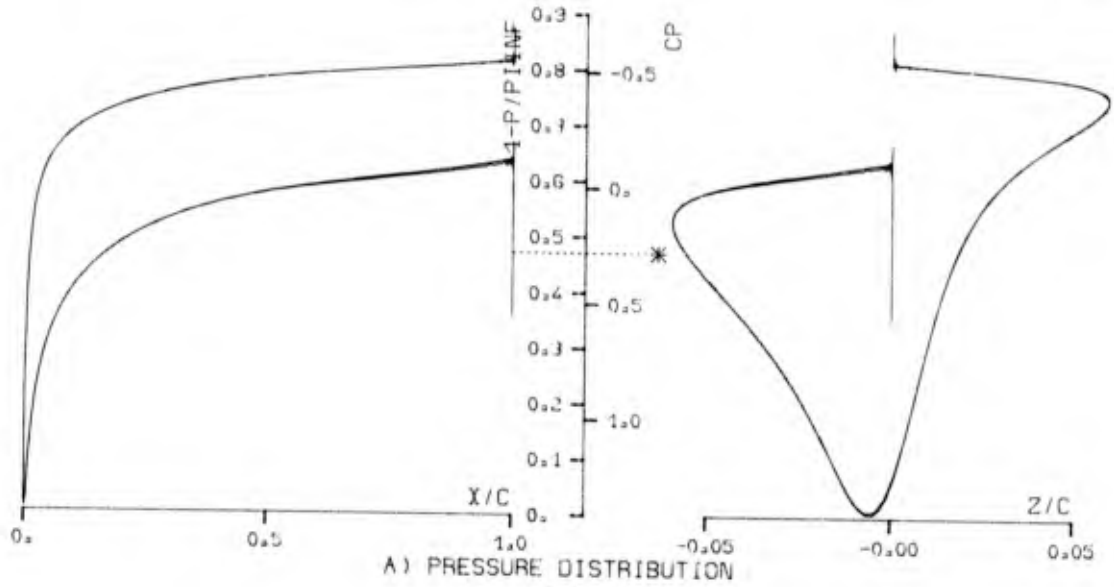


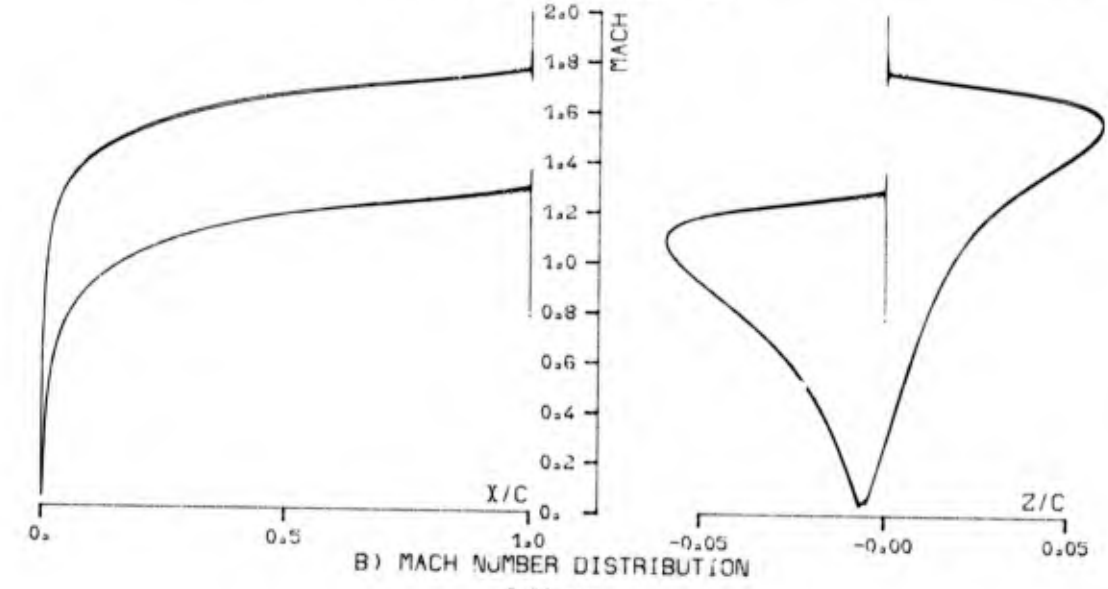
B) MACH NUMBER DISTRIBUTION



C) TOTAL PRESSURE DISTRIBUTION

Fig. 6.33 – Solutions of group 2A for test case 05 (NACA 0012, Mach = 1.20, α = 7).





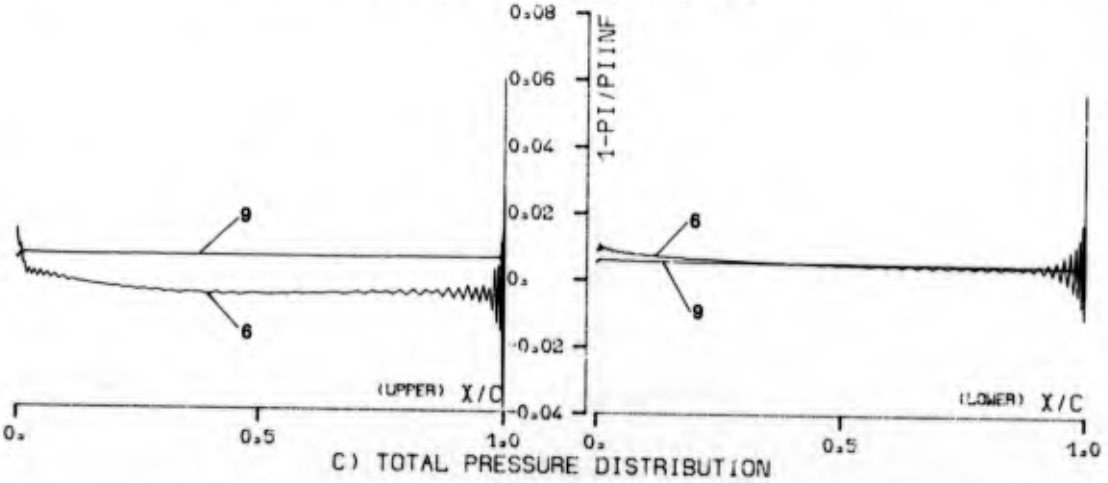


Fig. 6.34 – Solutions of group 2B for test case 05 (NACA 0012, Mach = 1.20, α = 7).

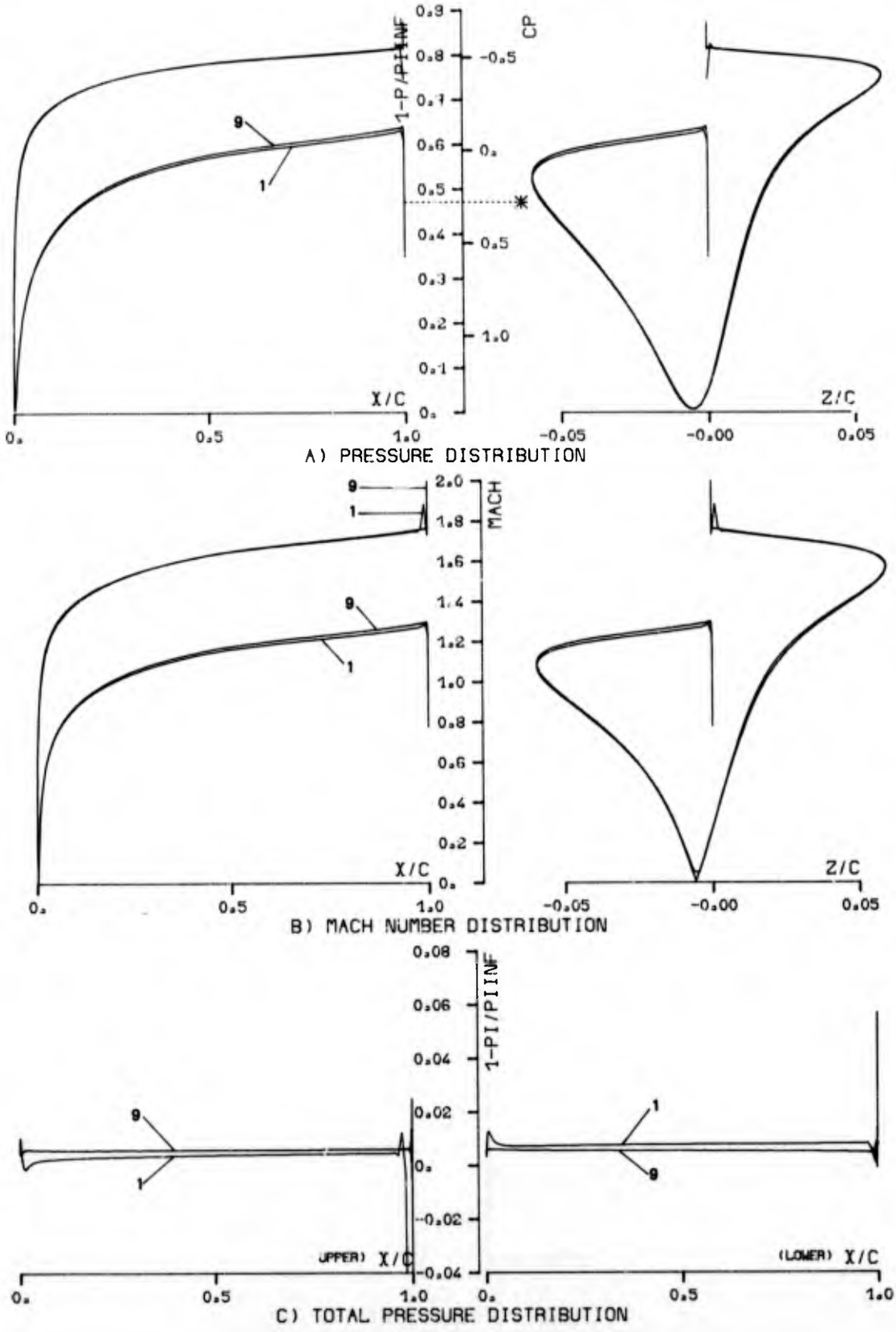


Fig. 6.35 -- Solutions of group 3 for test case 05 (NACA 0012, Mach = 1.20, α = 7).

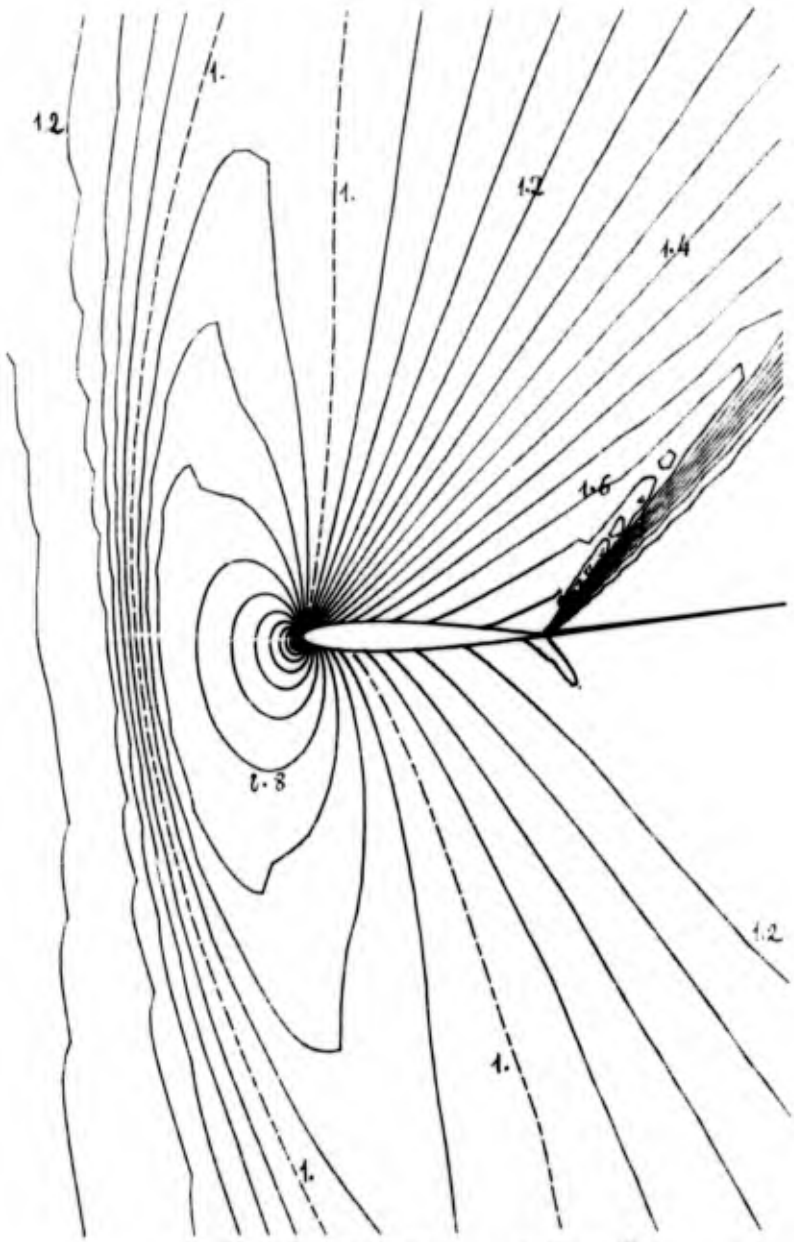


Fig. 6.36 – Iso-Mach lines of solution n° 1 for test case 05 ($\Delta M = 0.05$, curve parameter = M).

Table 6.13 – Solution n° 1 for test case 05 (NACA 0012, $M_\infty = 1.2$, $\alpha = 7°$). A - wall values.

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	1.000000	0.000000	.607544	-.047924	1.231226	.008459
2	.991610	-.001180	.632479	-.107911	1.285637	.001341
3	.983080	-.002370	.630159	-.102330	1.277615	.005867
4	.974300	-.003590	.627023	-.094755	1.269671	.008102
5	.965140	-.004840	.626037	-.092413	1.267741	.008056
6	.955500	-.006140	.624723	-.089252	1.265210	.007947
7	.945320	-.007500	.623242	-.085689	1.262368	.007951
8	.934530	-.008920	.621760	-.082124	1.259335	.007956
9	.923110	-.010410	.620203	-.078378	1.256267	.007952
10	.911050	-.011950	.618631	-.074597	1.253178	.007948
11	.898370	-.013560	.617044	-.070779	1.250069	.007943
12	.885090	-.015210	.615447	-.066937	1.246945	.007945
13	.871260	-.016900	.613761	-.062881	1.243664	.007936
14	.856930	-.018630	.612080	-.058837	1.240401	.007929
15	.842170	-.020380	.610424	-.054853	1.237196	.007923
16	.827020	-.022140	.608692	-.050686	1.233853	.007917
17	.811560	-.023910	.607010	-.046640	1.230608	.007921
18	.795830	-.025680	.605357	-.042663	1.227453	.007893
19	.779900	-.027430	.603691	-.038655	1.224254	.007902
20	.763790	-.029170	.602012	-.034616	1.221055	.007890
21	.747560	-.030880	.600324	-.030555	1.217848	.007878
22	.731240	-.032580	.598687	-.026617	1.214733	.007883
23	.714840	-.034240	.597023	-.022614	1.211591	.007869
24	.698400	-.035870	.595308	-.018488	1.208355	.007862
25	.681930	-.037460	.593578	-.014326	1.205107	.007846
26	.665440	-.039020	.591851	-.010171	1.201860	.007848
27	.648950	-.040530	.590103	-.005966	1.198596	.007832
28	.632450	-.042010	.588289	-.001602	1.195207	.007830
29	.615960	-.043440	.586440	.002846	1.191769	.007820
30	.599490	-.044830	.584519	.007467	1.188207	.007811
31	.583030	-.046180	.582526	.012262	1.184524	.007799
32	.566590	-.047470	.580454	.017247	1.180706	.007788
33	.550170	-.048710	.578301	.022426	1.176743	.007787
34	.533780	-.049910	.576028	.027894	1.172579	.007778
35	.517420	-.051040	.573677	.033550	1.168296	.007757
36	.501090	-.052120	.571202	.039504	1.163795	.007745
37	.484790	-.053140	.568575	.045824	1.159030	.007739
38	.468530	-.054100	.565792	.052519	1.154011	.007721
39	.452310	-.054990	.562889	.059503	1.148792	.007707
40	.436140	-.055810	.559805	.066922	1.143261	.007705
41	.420010	-.056560	.556491	.074895	1.137361	.007679
42	.403930	-.057230	.553012	.083264	1.131178	.007675
43	.387900	-.057820	.549357	.092057	1.124721	.007659
44	.371930	-.058330	.545462	.101427	1.117881	.007634
45	.356030	-.058760	.541290	.111464	1.110579	.007622
46	.340200	-.059090	.536846	.122155	1.102847	.007603
47	.324460	-.059320	.532123	.133517	1.094373	.007586
48	.308810	-.059460	.527114	.145568	1.086052	.007569
49	.293280	-.059480	.521782	.158395	1.076934	.007545
50	.277860	-.059400	.516084	.172103	1.067242	.007529

Table 6.13 — A - wall values (continued).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
51	.262570	-.059200	510014	.186705	1.056986	.007506
52	.247440	-.058880	503542	.202275	1.046120	.007484
53	.232470	-.058430	496680	.218783	1.034668	.007469
54	.217680	-.057850	489309	.236516	1.022460	.007440
55	.203100	-.057140	481429	.255473	1.009496	.007412
56	.188760	-.056290	473067	.275590	.995818	.007401
57	.174670	-.055290	464085	.297198	.981255	.007359
58	.160880	-.054140	454484	.320295	.965761	.007354
59	.147420	-.052750	444193	.345052	.949291	.007323
60	.134330	-.051400	433181	.371544	.931773	.007303
61	.121640	-.049810	421440	.399790	.913198	.007301
62	.109420	-.048060	408745	.430330	.893267	.007263
63	.097700	-.046170	.395064	.463243	.871878	.007254
64	.086540	-.044140	.380434	.498439	.849088	.007270
65	.075990	-.041990	.364661	.536384	.824619	.007276
66	.066090	-.039720	.347611	.577401	.798205	.007307
67	.056900	-.037340	.329175	.621753	.769640	.007357
68	.048450	-.034890	.09356	.669432	.738802	.007474
69	.040770	-.032390	.287998	.720814	.705356	.007634
70	.033880	-.029850	.264894	.776395	.668762	.007859
71	.027780	-.027300	.240203	.835795	.628856	.008250
72	.022450	-.024770	.213840	.899217	.585101	.008764
73	.017860	-.022280	.186087	.965963	.537157	.009493
74	.013970	-.019870	.157238	1.035385	.484578	.010388
75	.010730	-.017540	.127855	1.106073	.427063	.011340
76	.008070	-.015310	.098902	1.175726	.364696	.012181
77	.005920	-.013190	.071528	1.241580	.297810	.012596
78	.004220	-.011190	.047173	1.300171	.227235	.012286
79	.002890	-.009310	.027416	1.347701	.154198	.011132
80	.001880	-.007550	.013628	1.380871	.080102	.009191
81	.001140	-.005900	.006823	1.397242	.006278	.006796
82	.000610	-.004340	.008862	1.392337	.066403	.005799
83	.000260	-.002850	.016931	1.372925	.140203	.003338
84	.000060	-.001410	.035352	1.328609	.210885	.004986
85	0.000000	0.000000	.056752	1.277127	.276627	.005252
86	.000060	.001410	.089808	1.197603	.350098	.009293
87	.000260	.002850	.124982	1.112984	.423626	.010041
88	.000610	.004340	.165520	1.015461	.499622	.010379
89	.001140	.005900	.210216	.907935	.577374	.010042
90	.001880	.007550	.257897	.793228	.656403	.008916
91	.002890	.009310	.306631	.675988	.735084	.007000
92	.004220	.011190	.354547	.560715	.811736	.004513
93	.005920	.013190	.400062	.451219	.884521	.002107
94	.008070	.015310	.441671	.351119	.951604	.000215
95	.010730	.017540	.478748	.261923	1.012140	-.000824
96	.013970	.019870	.511366	.183453	1.066243	-.000931
97	.017860	.022280	.539525	.115710	1.113976	-.000430
98	.022450	.024770	.563777	.057367	1.156227	.000292
99	.027780	.027300	.584822	.006738	1.194055	.000974
100	.033880	.029850	.602994	-.036978	1.227808	.001485
101	.040770	.032390	.618946	-.075354	1.258386	.001844
102	.048450	.034890	.633013	-.109196	1.286142	.002111
103	.056900	.037340	.645404	-.139005	1.311272	.002292
104	.066090	.039720	.656455	-.165591	1.334250	.002432
105	.075990	.041990	.666489	-.189730	1.355605	.002547
106	.086540	.044140	.675582	-.211605	1.375370	.002668
107	.097700	.046170	.683840	-.231471	1.393710	.002755
108	.109420	.048060	.691494	-.249885	1.411049	.002830
109	.121640	.049810	.698585	-.266944	1.427387	.002943
110	.134330	.051400	.705098	-.282612	1.442702	.002995
111	.147420	.052850	.711177	-.297236	1.457207	.003095
112	.160880	.054140	.716855	-.310896	1.471004	.003156
113	.174670	.055290	.722161	-.323661	1.484104	.003211
114	.188760	.056290	.727143	-.335646	1.496579	.003282
115	.203100	.057140	.731772	-.346782	1.508350	.003334
116	.217680	.057850	.736153	-.357322	1.519635	.003401
117	.232470	.058430	.740273	-.367233	1.530398	.003455
118	.247440	.058880	.744109	-.376462	1.540552	.003501
119	.262570	.059200	.747737	-.385189	1.550263	.003562
120	.277860	.059400	.751149	-.393398	1.559517	.003601
121	.293280	.059480	.754331	-.401053	1.568219	.003676
122	.308810	.059460	.757381	-.408390	1.576685	.003698
123	.324460	.059320	.760233	-.415251	1.584660	.003754
124	.340200	.059090	.762889	-.421641	1.592164	.003803
125	.356030	.058760	.765412	-.427711	1.599354	.003858
126	.371930	.058330	.767774	-.433393	1.606174	.003868
127	.387900	.057820	.770009	-.438770	1.612655	.003919
128	.403930	.057230	.772137	-.443889	1.618872	.003975
129	.420010	.056560	.774123	-.448667	1.624732	.004010
130	.436140	.055810	.776007	-.453199	1.630341	.004032
131	.452310	.054990	.777779	-.457462	1.635633	.004084
132	.468530	.054100	.779445	-.461470	1.640652	.004118
133	.484790	.053140	.781052	-.465336	1.645540	.004129
134	.501090	.052120	.782563	-.468971	1.650157	.004152
135	.517420	.051040	.783988	-.472399	1.654518	.004202
136	.533780	.049910	.785345	-.475664	1.658716	.004217
137	.550170	.048710	.786652	-.478808	1.662770	.004250
138	.566590	.047470	.787890	-.481786	1.666643	.004262
139	.583030	.046180	.789078	-.484644	1.670355	.004309
140	.599490	.044830	.790221	-.487394	1.673976	.004306
141	.615960	.043440	.791298	-.489985	1.677371	.004353
142	.632450	.042010	.792375	-.492576	1.680805	.004365
143	.648950	.040530	.793402	-.495047	1.684065	.004420
144	.665440	.039020	.794404	-.497457	1.687299	.004415
145	.681930	.037460	.795398	-.499848	1.690512	.004424
146	.698400	.035870	.796346	-.502129	1.693554	.004486
147	.714840	.034240	.797293	-.504407	1.696644	.004490
148	.731240	.032580	.798231	-.506664	1.699706	.004511
149	.747560	.030890	.799167	-.508916	1.702769	.004540
150	.763790	.029170	.800090	-.511136	1.705831	.004525
151	.779900	.027430	.800992	-.513306	1.708778	.004597
152	.795830	.025680	.801926	-.515553	1.711886	.004607
153	.811560	.023910	.802856	-.517790	1.715012	.004588
154	.827020	.022140	.803771	-.519992	1.718082	.004598
155	.842170	.020380	.804677	-.522171	1.721121	.004629
156	.856930	.018630	.805596	-.524382	1.724231	.004638
157	.871260	.016900	.806500	-.526557	1.727291	.004665
158	.885090	.015210	.807387	-.528691	1.730312	.004683
159	.898370	.013560	.808275	-.530827	1.733356	.004691
160	.911050	.011950	.809128	-.532879	1.736294	.004696
161	.923110	.010410	.810000	-.534977	1.739301	.004714
162	.934530	.008920	.810819	-.536947	1.742148	.004713
163	.945320	.007500	.811574	-.538763	1.744832	.004638
164	.955500	.006140	.812256	-.540404	1.747005	.004963
165	.965140	.004840	.813210	-.542699	1.750903	.004139
166	.974300	.003590	.813835	-.544203	1.747639	.012381
167	.983080	.002380	.815385	-.547932	1.762943	-.002453
168	.991610	.001180	.825719	-.572792	1.884677	-.140495
169	1.000000	0.000000	.746830	-.383007	1.731086	-.309777

Table 6.13 — Solution n° 1 for test case 05 (NACA 0012, $M_\infty = 1.2$, $\alpha = 7°$). B - values on the upstream x-axis.

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	.056752	1.277127	.276627	.005252
2	-.003210	0.000000	.057842	1.274504	.282173	.011726
3	-.006300	0.000000	.062607	1.263041	.281096	.009727
4	-.009500	0.000000	.073909	1.235852	.308111	.010893
5	-.012820	0.000000	.085187	1.208720	.336742	.010490
6	-.016240	0.000000	.096786	1.180816	.363752	.010326
7	-.019780	0.000000	.108041	1.153740	.388569	.010157
8	-.023430	0.000000	.118834	1.127775	.411186	.010064
9	-.027200	0.000000	.129075	1.103138	.431826	.009993
10	-.031090	0.000000	.138786	1.079776	.450760	.009947
11	-.035110	0.000000	.147992	1.057629	.468219	.009919
12	-.039270	0.000000	.156736	1.036993	.484425	.009897
13	-.043590	0.000000	.165078	1.016525	.499573	.009887
14	-.048090	0.000000	.173059	.997325	.513826	.009875
15	-.052780	0.000000	.180740	.978846	.527337	.009866
16	-.057710	0.000000	.188173	.960965	.540238	.009859
17	-.062910	0.000000	.195417	.943538	.552653	.009860
18	-.068430	0.000000	.202503	.926491	.564678	.009854
19	-.074330	0.000000	.209495	.909670	.576422	.009853
20	-.080680	0.000000	.216433	.892979	.587964	.009858
21	-.087550	0.000000	.223348	.876343	.599383	.009856
22	-.095050	0.000000	.230294	.859633	.610762	.009858
23	-.103280	0.000000	.237295	.842791	.622148	.009863
24	-.112380	0.000000	.244377	.825753	.633591	.009868
25	-.122480	0.000000	.251563	.808466	.645135	.009872
26	-.133770	0.000000	.258874	.790878	.656805	.009884
27	-.146410	0.000000	.266312	.772984	.668625	.009889
28	-.160640	0.000000	.273891	.754751	.680607	.009900
29	-.176680	0.000000	.281607	.736189	.692752	.009914
30	-.194820	0.000000	.289453	.717313	.705054	.009930
31	-.215330	0.000000	.297419	.698149	.717501	.009949
32	-.238560	0.000000	.305511	.678682	.730108	.009970
33	-.264870	0.000000	.313726	.658919	.742869	.009999
34	-.294660	0.000000	.321951	.639132	.755650	.010003
35	-.328370	0.000000	.330225	.619227	.768509	.009989
36	-.366480	0.000000	.339354	.597265	.782436	.010214
37	-.409530	0.000000	.349198	.573584	.797296	.010613
38	-.458100	0.000000	.355227	.559079	.807559	.009715
39	-.512790	0.000000	.355913	.557429	.811215	.007139
40	-.574400	0.000000	.373619	.514833	.836056	.009770
41	-.643360	0.000000	.439784	.355659	.928079	.022881
42	-.720760	0.000000	.532871	.131718	1.083998	.022124
43	-.807350	0.000000	.593258	-.013556	1.213545	-.003971
44	-.904060	0.000000	.601845	-.034214	1.234439	-.010226
45	-1.011870	0.000000	.590747	-.007516	1.207216	-.001825
46	-1.131840	0.000000	.585668	.004703	1.194964	.001830
47	-1.265110	0.000000	.586489	.002728	1.197162	.000953
48	-1.412890	0.000000	.587760	-.000330	1.200366	-.000145
49	-1.576470	0.000000	.587904	-.000676	1.200726	-.000265
50	-1.757230	0.000000	.587639	-.000039	1.200057	-.000035
51	-1.956640	0.000000	.587551	.000173	1.199806	.000079
52	-2.176260	0.000000	.587592	.000074	1.199910	.000042
53	-2.417740	0.000000	.587633	-.000024	1.200018	.000001
54	-2.682850	0.000000	.587628	-.000012	1.200015	-.000007
55	-2.973450	0.000000	.587628	-.000012	1.200015	-.000007

Table 6.14 – Solution n° 9 for test case 05 (NACA 0012, $M_\infty = 1.2$, $\alpha = 7°$). A - wall values.

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.999928	-.000010	.350145	571305	.780297	.028409
2	.999659	-.000048	.584395	.007766	1.148386	.057015
3	.999147	-.000121	.617343	-.071498	1.248738	.010475
4	.998404	-.000226	.635068	-.114139	1.281499	.013907
5	.997440	-.000363	.637913	-.120984	1.298296	-.000928
6	.996259	-.000530	.642525	-.132079	1.300531	.008813
7	.994867	-.000726	.637922	-.121005	1.297182	.000611
8	.993267	-.000951	.639199	-.124077	1.294510	.007743
9	.991463	-.001205	.638081	-.121388	1.296046	.002590
10	.989458	-.001486	.638379	-.122105	1.294154	.005968
11	.987255	-.001794	.637607	-.120248	1.294155	.003844
12	.984857	-.002128	.637395	-.119738	1.292698	.005230
13	.982267	-.002488	.637050	-.118908	1.292548	.004486
14	.979488	-.002873	.636540	-.117681	1.291290	.004787
15	.976521	-.003282	.635876	-.116083	1.290017	.004687
16	.973371	-.003716	.635554	-.115309	1.289216	.004888
17	.970039	-.004172	.635127	-.114281	1.288483	.004708
18	.966528	-.004651	.634519	-.112819	1.287183	.004805
19	.962840	-.005152	.633924	-.111367	1.285965	.004826
20	.958979	-.005674	.633347	-.109999	1.284798	.004830
21	.954946	-.006216	.632709	-.108464	1.283514	.004827
22	.950743	-.006779	.632055	-.106891	1.282181	.004849
23	.946375	-.007360	.631464	-.105469	1.280967	.004884
24	.941842	-.007960	.630926	-.104175	1.279869	.004907
25	.937148	-.008579	.630293	-.102652	1.278616	.004884
26	.932296	-.009215	.629541	-.100843	1.277098	.004899
27	.927286	-.009867	.628755	-.098952	1.275514	.004915
28	.922123	-.010535	.628035	-.097220	1.274053	.004945
29	.916809	-.011218	.627383	-.095652	1.272742	.004958
30	.911346	-.011916	.626712	-.094037	1.271405	.004958
31	.905738	-.012628	.626000	-.092324	1.269970	.004982
32	.899985	-.013354	.625246	-.090510	1.268467	.004988
33	.894092	-.014092	.624416	-.088514	1.266830	.004974
34	.888061	-.014842	.623588	-.086522	1.265163	.005009
35	.881894	-.015603	.622892	-.084847	1.263750	.005057
36	.875594	-.016376	.622191	-.083161	1.262390	.005023
37	.869164	-.017158	.621362	-.081167	1.260754	.005023
38	.862607	-.017950	.620523	-.079148	1.259070	.005064
39	.855924	-.018751	.619735	-.077253	1.257514	.005072
40	.849119	-.019560	.618948	-.075359	1.255963	.005078
41	.842195	-.020376	.618129	-.073389	1.254353	.005082
42	.835154	-.021200	.617292	-.071375	1.252707	.005091
43	.827999	-.022028	.616479	-.069420	1.251101	.005111
44	.820733	-.022865	.615693	-.067529	1.249557	.005123
45	.813358	-.023706	.614904	-.065631	1.248013	.005130
46	.805878	-.024552	.614077	-.063641	1.246401	.005131
47	.798294	-.025401	.613211	-.061558	1.244711	.005139
48	.790610	-.026254	.612353	-.059494	1.243030	.005159
49	.782828	-.027109	.611520	-.057490	1.241405	.005171
50	.774952	-.027967	.610688	-.055488	1.239789	.005178
51	.766984	-.028826	.609810	-.053376	1.238098	.005170
52	.758927	-.029686	.608900	-.051187	1.236333	.005181
53	.750783	-.030545	.608057	-.049159	1.234680	.005218
54	.742556	-.031406	.607253	-.047224	1.233136	.005213
55	.734249	-.032265	.606385	-.045136	1.231475	.005204
56	.725863	-.033123	.605485	-.042971	1.229727	.005231
57	.717403	-.033979	.604591	-.040820	1.228009	.005238
58	.708870	-.034832	.603655	-.038569	1.226229	.005223
59	.700268	-.035682	.602713	-.036302	1.224409	.005251
60	.691599	-.036527	.601847	-.034219	1.222733	.005262
61	.682867	-.037369	.600944	-.032047	1.221035	.005254
62	.674074	-.038205	.599915	-.029571	1.219083	.005248
63	.665224	-.039035	.598898	-.027125	1.217124	.005285
64	.656318	-.039859	.597967	-.024885	1.215350	.005298
65	.647359	-.040676	.597054	-.022688	1.213616	.005306
66	.638352	-.041486	.596044	-.020259	1.211720	.005290
67	.629298	-.042287	.594916	-.017545	1.209595	.005287
68	.620201	-.043078	.593814	-.014894	1.207489	.005328
69	.611063	-.043860	.592782	-.012411	1.205544	.005335
70	.601888	-.044632	.591719	-.009854	1.203557	.005325
71	.592677	-.045393	.590590	-.007138	1.201433	.005337
72	.583435	-.046142	.589413	-.004306	1.199228	.005343
73	.574163	-.046878	.588189	-.001362	1.196943	.005344
74	.564866	-.047601	.586940	.001643	1.194608	.005355
75	.555545	-.048311	.585722	.004573	1.192321	.005395
76	.546204	-.049005	.584464	.007600	1.190000	.005366
77	.536846	-.049685	.583076	.010939	1.187440	.005355
78	.527474	-.050347	.581673	.014314	1.184818	.005393
79	.518090	-.050993	.580329	.017547	1.182327	.005409
80	.508698	-.051622	.578929	.020615	1.179763	.005394
81	.499300	-.052233	.577425	.024533	1.176996	.005401
82	.489900	-.052824	.575861	.028296	1.174120	.005415
83	.480500	-.053395	.574240	.032196	1.171159	.005413
84	.471105	-.053946	.572564	.036228	1.168099	.005418
85	.461715	-.054475	.570885	.040267	1.165029	.005439
86	.452335	-.054982	.569182	.044364	1.161938	.005440
87	.442968	-.055466	.567377	.048706	1.158675	.005436
88	.433616	-.055926	.565486	.053255	1.155250	.005450
89	.424283	-.056362	.563555	.057901	1.151764	.005462
90	.414971	-.056772	.561557	.062707	1.148177	.005462
91	.405685	-.057157	.559472	.067723	1.144443	.005463
92	.396425	-.057514	.557317	.072908	1.140589	.005471
93	.387197	-.057844	.555137	.078152	1.136696	.005487
94	.378003	-.058147	.552932	.083457	1.132771	.005501
95	.368846	-.058420	.550602	.089062	1.128660	.005485
96	.359728	-.058664	.548127	.095016	1.124288	.005492
97	.350654	-.058877	.545594	.101110	1.119814	.005517
98	.341627	-.059059	.543005	.107338	1.115276	.005516
99	.332648	-.059209	.540321	.113795	1.110586	.005517
100	.323722	-.059327	.537561	.120435	1.105765	.005535
101	.314852	-.059412	.534724	.127260	1.100838	.005539
102	.306041	-.059464	.531761	.134388	1.095718	.005534
103	.297291	-.059481	.528696	.141762	1.090425	.005547
104	.288606	-.059464	.525579	.149260	1.085058	.005564
105	.279990	-.059412	.522381	.156954	1.079584	.005566
106	.271445	-.059324	.519058	.164948	1.073914	.005571
107	.262974	-.059200	.515593	.173284	1.068024	.005575
108	.254581	-.059040	.511996	.181937	1.061928	.005586
109	.246268	-.058843	.508286	.190862	1.055666	.005594
110	.238040	-.058607	.504464	.200057	1.049239	.005604
111	.229898	-.058376	.500506	.209579	1.042615	.005606
112	.221847	-.058025	.496393	.219474	1.035760	.005607
113	.213889	-.057676	.492172	.229628	1.028742	.005621
114	.206028	-.057289	.487901	.239903	1.021667	.005637
115	.198265	-.056864	.483569	.250325	1.014523	.005647
116	.190606	-.056400	.479105	.261064	1.007189	.005658
117	.183052	-.055897	.474423	.272327	.999538	.005656
118	.175608	-.055355	.469506	.284156	.991527	.005662
119	.168275	-.054774	.464395	.296452	.983235	.005666
120	.161058	-.054154	.459167	.309029	.974768	.005690
121	.153958	-.053495	.453834	.321859	.966175	.005702
122	.146980	-.052798	.448347	.335059	.957374	.005706
123	.140126	-.052062	.442662	.348735	.948281	.005719
124	.133399	-.051288	.436746	.362968	.938860	.005724
125	.126803	-.050475	.430585	.377789	.929087	.005726
126	.120339	-.049625	.424245	.393042	.919013	.005752
127	.114012	-.048737	.417770	.408619	.908817	.005779
128	.107824	-.047811	.411008	.424891	.898213	.005760
129	.101778	-.046849	.403913	.441955	.887097	.005771
130	.095878	-.045850	.396646	.459437	.875706	.005819
131	.090125	-.044815	.389128	.477523	.864001	.005817
132	.084522	-.043744	.381221	.496545	.851718	.005815
133	.079073	-.042637	.372966	.516404	.838889	.005846
134	.073781	-.041495	.364392	.537031	.825601	.005863
135	.068647	-.040320	.355451	.558541	.811764	.005879
136	.063676	-.039110	.346056	.581142	.797249	.005883
137	.058869	-.037867	.336211	.604827	.782025	.005904
138	.054229	-.036591	.325990	.629416	.766184	.005953
139	.049759	-.035283	.315182	.655417	.749481	.005940
140	.045461	-.033942	.303634	.683198	.731589	.005934
141	.041339	-.032570	.291569	.712223	.712744	.006009
142	.037394	-.031167	.278871	.742771	.692800	.006013
143	.033630	-.029734	.265263	.775508	.671524	.005996
144	.030049	-.028270	.250814	.810268	.648551	.006048
145	.026653	-.026776	.235476	.847167	.623938	.006063
146	.023445	-.025253	.219081	.886609	.597267	.006061
147	.020428	-.023699	.201590	.928687	.568238	.006087
148	.017604	-.022117	.182974	.973472	.536594	.006102
149	.014976	-.020505	.163204	1.021033	.501909	.006116
150	.012548	-.018863	.142246	1.071452	.463601	.006115
151	.010322	-.017191	.120254	1.124359	.421077	.006139
152	.008302	-.015490	.097546	1.178988	.373788	.006158
153	.006492	-.013758	.074651	1.234067	.321208	.006079
154	.004896	-.011997	.052531	1.287281	.262591	.006005
155	.003518	-.010208	.032598	1.335234	.197519	.005920
156	.002365	-.008391	.016851	1.373117	.126137	.005858
157	.001440	-.006551	.007694	1.395146	.051980	.005816
158	.000746	-.004692	.007580	1.395421	.051107	.005764
159	.000286	-.002820	.018325	1.369571	.135790	.005596
160	.000057	-.000941	.040674	1.315806	.227839	.005360
161	.000057	.000941	.073970	1.235705	.322203	.004910
162	.000286	.002820	.116848	1.132552	.417128	.004522
163	.000746	.004692	.166260	1.013681	.510004	.004329
164	.001440	.006551	.218518	.887963	.598305	.004538
165	.002365	.008391	.269808	.764574	.680273	.004623
166	.003518	.010208	.317658	.649460	.754556	.004768
167	.004896	.011997	.361068	.545028	.821218	.005101
168	.006492	.013758	.399551	.452448	.880581	.005455
169	.008302	.015490	.433173	.371563	.933146	.005772
170	.010322	.017191	.462432	.301174	.979831	.005928
171	.012548	.018863	.487949	.239788	1.021383	.006064
172	.014976	.020505	.510061	.186592	1.058152	.006200
173	.017604	.022117	.529189	.140576	1.090716	.006230
174	.020428	.023699	.545970	.100205	1.119900	.006232
175	.023443	.025253	.560899	.064290	1.146419	.006193
176	.026653	.026776	.574210	.032268	1.170485	.006205
177	.030049	.028270	.586044	.003799	1.192288	.006200
178	.033630	.029734	.596783	-.022036	1.212505	.006087
179	.037394	.031167	.606604	-.045663	1.231227	.006083
180	.041339	.032570	.615362	-.066732	1.248139	.006146
181	.045461	.033942	.623380	-.086021	1.263984	.006033
182	.049759	.035283	.630983	-.104312	1.278175	.005992
183	.054229	.036591	.637974	-.121130	1.293269	.006049
184	.058869	.037867	.644374	-.136527	1.306407	.006016
185	.063676	.039110	.650413	-.151055	1.318961	.005985
186	.068647	.040320	.656119	-.164782	1.330951	.005981
187	.073781	.041495	.661479	-.177677	1.342343	.005985
188	.079073	.042637	.666143	-.189859	1.353230	.005989
189	.084522	.043744	.671098	-.201539	1.363813	.005954
190	.090125	.044815	.676756	-.212745	1.374059	.005947
191	.095878	.045850	.680424	-.223253	1.383731	.005995
192	.101778	.046849	.684578	-.233247	1.393082	.005961
193	.107824	.047811	.688647	-.243036	1.402334	.005927
194	.114012	.048737	.692536	-.252391	1.411214	.005967
195	.120339	.049625	.696210	-.261230	1.419708	.005971
196	.126803	.050475	.699774	-.269804	1.428041	.005954
197	.133399	.051288	.703249	-.278164	1.436230	.005953
198	.140126	.052062	.706607	-.286242	1.444210	.005961
199	.146980	.052798	.709841	-.294022	1.451971	.005960
200	.153958	.053495	.712947	-.301494	1.459487	.005964
201	.161058	.054154	.715932	-.308676	1.466771	.005970
202	.168275	.054774	.718838	-.315667	1.473932	.005961
203	.175608	.055355	.721693	-.322535	1.481020	.005962
204	.183052	.055897	.724476	-.329230	1.487988	.005960
205	.190606	.056400	.727160	-.335687	1.494754	.005972
206	.198265	.056864	.729724	-.341855	1.501274	.005976
207	.206028	.057289	.732188	-.347783	1.507588	.005980
208	.213889	.057676	.734586	-.353552	1.513786	.005974
209	.221847	.058025	.736948	-.359234	1.519941	.005961
210	.229898	.058336	.739259	-.364794	1.525992	.005972
211	.238040	.058608	.741487	-.370154	1.531871	.005979
212	.246268	.058843	.743637	-.375326	1.537586	.005983
213	.254581	.059040	.745721	-.380340	1.543168	.005982
214	.262974	.059200	.747749	-.385218	1.548639	.005978
215	.271445	.059324	.749719	-.389958	1.553985	.005980
216	.279990	.059412	.751619	-.394528	1.559176	.005981

Table 6.14 — A - wall values (continued).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
217	.288606	.059464	.753446	-.398924	1.564193	.005991
218	.297291	.059481	.755216	-.403182	1.569092	.005988
219	.306041	.059464	.756958	-.407373	1.573952	.005973
220	.314852	.059412	.758655	-.411455	1.578695	.005987
221	.323722	.059327	.760281	-.415367	1.583267	.006001
222	.332648	.059209	.761858	-.419161	1.587743	.005990
223	.341627	.059059	.763394	-.422856	1.592120	.005989
224	.350654	.058877	.764871	-.426409	1.596342	.006004
225	.359728	.058664	.766312	-.429876	1.600498	.005996
226	.368846	.058420	.767730	-.433287	1.604612	.005985
227	.378003	.058147	.769081	-.436537	1.608528	.006009
228	.387197	.057844	.770355	-.439602	1.612250	.006016
229	.396425	.057514	.771598	-.442592	1.615911	.006004
230	.405685	.057157	.772824	-.445542	1.619535	.005999
231	.414971	.056772	.774024	-.448429	1.623096	.005997
232	.424283	.056362	.775180	-.451210	1.626530	.006014
233	.433616	.055926	.776288	-.453875	1.629841	.006022
234	.442968	.055466	.777368	-.456473	1.633098	.006007
235	.452335	.054982	.778411	-.458983	1.636239	.006018
236	.461715	.054475	.779396	-.461352	1.639215	.006032
237	.471105	.053946	.780358	-.463666	1.642148	.006023
238	.480500	.053395	.781313	-.465964	1.645070	.006015
239	.489900	.052824	.782242	-.468199	1.647909	.006029
240	.499300	.052233	.783142	-.470364	1.650675	.006034
241	.508698	.051622	.784014	-.472462	1.653374	.006025
242	.518090	.050993	.784830	-.474425	1.655890	.006044
243	.527474	.050347	.785597	-.476270	1.658263	.006061
244	.536846	.049685	.786381	-.478156	1.660735	.006021
245	.546204	.049005	.787175	-.480066	1.663218	.006024
246	.555545	.048311	.787916	-.481849	1.665519	.006061
247	.564866	.047601	.788623	-.483550	1.667747	.006058
248	.574163	.046878	.789325	-.485239	1.669971	.006048
249	.583435	.046142	.790013	-.486894	1.672143	.006058
250	.592677	.045393	.790683	-.488506	1.674269	.006061
251	.601888	.044632	.791337	-.490079	1.676355	.006057
252	.611063	.043860	.791956	-.491568	1.678324	.006069
253	.620201	.043078	.792540	-.492973	1.680180	.006090
254	.629298	.042287	.793143	-.494424	1.682134	.006063
255	.638352	.041486	.793770	-.495932	1.684155	.006059
256	.647359	.040676	.794361	-.497354	1.686049	.006079
257	.656318	.039859	.794904	-.498660	1.687797	.006092
258	.665224	.039035	.795421	-.499904	1.689462	.006109
259	.674074	.038205	.795960	-.501200	1.691236	.006076
260	.682867	.037369	.796530	-.502572	1.693089	.006067
261	.691598	.036527	.797059	-.503844	1.694798	.006110
262	.700268	.035682	.797558	-.505045	1.696431	.006111
263	.708870	.034832	.798073	-.506284	1.698133	.006092
264	.717403	.033979	.798580	-.507503	1.699793	.006103
265	.725863	.033123	.799074	-.508692	1.701410	.006119
266	.734249	.032265	.799576	-.509900	1.703077	.006106
267	.742556	.031406	.800065	-.511076	1.704691	.006113
268	.750783	.030545	.800516	-.512161	1.706169	.006140
269	.758927	.029686	.800971	-.513256	1.707692	.006124
270	.766984	.028826	.801455	-.514420	1.709311	.006114
271	.774952	.027967	.801936	-.515577	1.710907	.006128
272	.782828	.027109	.802405	-.516705	1.712471	.006136
273	.790610	.026254	.802865	-.517812	1.714008	.006143
274	.798294	.025401	.803323	-.518914	1.715550	.006138
275	.805878	.024552	.803785	-.520025	1.717105	.006139
276	.813358	.023706	.804236	-.521110	1.718621	.006147
277	.820733	.022865	.804672	-.522159	1.720092	.006152
278	.827999	.022029	.805099	-.523186	1.721535	.006157
279	.835154	.021200	.805529	-.524221	1.723000	.006148
280	.842195	.020376	.805972	-.525287	1.724504	.006152
281	.849119	.019560	.806416	-.526355	1.726014	.006157
282	.855924	.018761	.806850	-.527399	1.727492	.006163
283	.862607	.017950	.807272	-.528414	1.728921	.006186
284	.869164	.017158	.807706	-.529458	1.730427	.006159
285	.875594	.016376	.808149	-.530524	1.731957	.006147
286	.881894	.015603	.808542	-.531469	1.733273	.006202
287	.888061	.014842	.808917	-.532371	1.734573	.006192
288	.894092	.014092	.809336	-.533379	1.736042	.006160
289	.899985	.013354	.809761	-.534402	1.737505	.006173
290	.905738	.012628	.810172	-.535391	1.738920	.006189
291	.911346	.011916	.810569	-.536346	1.740305	.006182
292	.916809	.011218	.810935	-.537226	1.741570	.006196
293	.922123	.010535	.811274	-.538042	1.742744	.006209
294	.927286	.009867	.811632	-.538903	1.744008	.006189
295	.932296	.009215	.812024	-.539846	1.745381	.006187
296	.937148	.008579	.812423	-.540806	1.746790	.006173
297	.941842	.007960	.812787	-.541682	1.748044	.006210
298	.946375	.007360	.813092	-.542415	1.749106	.006227
299	.950743	.006779	.813388	-.543127	1.750158	.006214
300	.954946	.006216	.813697	-.543871	1.751253	.006207
301	.958979	.005674	.814018	-.544643	1.752396	.006195
302	.962840	.005152	.814329	-.545391	1.753474	.006230
303	.966528	.004651	.814637	-.546132	1.754564	.006233
304	.970039	.004172	.814961	-.546912	1.755764	.006158
305	.973371	.003716	.815201	-.547489	1.756548	.006263
306	.976521	.003282	.815371	-.547898	1.757127	.006303
307	.979488	.002873	.815652	-.548574	1.758228	.006152
308	.982267	.002488	.815919	-.549216	1.759140	.006214
309	.984857	.002128	.816071	-.549582	1.759609	.006326
310	.987255	.001794	.816283	-.550092	1.760478	.006158
311	.989458	.001486	.816489	-.550588	1.761088	.006351
312	.991463	.001205	.816611	-.550881	1.761749	.006012
313	.993267	.000951	.816736	-.551182	1.761651	.006838
314	.994867	.000726	.816914	-.551610	1.763481	.005035
315	.996259	.000530	.817074	-.551995	1.761640	.008686
316	.997440	.000363	.817052	-.551942	1.766059	.001875
317	.998404	.000226	.817691	-.553479	1.760504	.013736
318	.999147	.000121	.817220	-.552346	1.771003	-.004746
319	.999659	.000048	.814129	-.544910	1.740100	.025162
320	.999928	.000010	.874160	-.689328	2.078408	-.112611

Table 6.14 — Solution n° 9 for test case 05 (NACA 0012, $M_\infty = 1.2$, $\alpha = 7°$). B - values near the upstream x-axis

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	-.000605	.000977	.068664	1.248470	.308991	.004920
2	-.001991	.001048	.064185	1.259221	.296401	.005370
3	-.003503	.001123	.062831	1.262502	.293665	.005026
4	-.005150	.001198	.065228	1.256736	.298540	.005598
5	-.006937	.001274	.069154	1.247291	.306991	.005444
6	-.008871	.001352	.074783	1.233749	.322666	.005580
7	-.010960	.001431	.081355	1.217839	.338420	.005575
8	-.013213	.001512	.088678	1.200322	.355236	.005605
9	-.015638	.001594	.096481	1.181550	.372540	.005616
10	-.018245	.001678	.104604	1.162008	.389935	.005625
11	-.021044	.001764	.112920	1.142002	.407178	.005631
12	-.024047	.001852	.121336	1.121756	.424118	.005638
13	-.027265	.001943	.129783	1.101435	.440668	.005638
14	-.030712	.002035	.138212	1.081157	.456780	.005642
15	-.034401	.002130	.146584	1.061016	.472434	.005643
16	-.038347	.002227	.154874	1.041073	.487625	.005645
17	-.042567	.002328	.163063	1.021372	.502362	.005647
18	-.047079	.002431	.171138	1.001946	.516659	.005647
19	-.051901	.002537	.179093	.982808	.530534	.005649
20	-.057057	.002647	.186922	.963974	.544009	.005649
21	-.062567	.002760	.194624	.945445	.557105	.005650
22	-.068458	.002877	.202200	.927220	.569845	.005651
23	-.074757	.002999	.209652	.909292	.582253	.005652
24	-.081495	.003124	.216984	.891653	.594351	.005653
25	-.088705	.003255	.224200	.874294	.606161	.005654
26	-.096423	.003390	.231302	.857194	.617707	.005656
27	-.104691	.003531	.238312	.840344	.629010	.005657
28	-.113554	.003678	.245221	.823723	.640091	.005659
29	-.123061	.003832	.252042	.807314	.650972	.005660
30	-.133269	.003992	.258784	.791094	.661674	.005661
31	-.144240	.004161	.265457	.775041	.672220	.005662
32	-.156044	.004337	.272070	.759132	.682629	.005663
33	-.168760	.004523	.278636	.743336	.692928	.005665
34	-.182477	.004718	.285168	.727622	.703141	.005667
35	-.197295	.004925	.291678	.711961	.713291	.005669
36	-.213329	.005144	.298167	.696350	.723390	.005668
37	-.230710	.005376	.304682	.680677	.733504	.005668
38	-.249588	.005623	.311300	.664756	.743734	.005693
39	-.270137	.005887	.317984	.648676	.754050	.005721
40	-.292558	.006169	.324423	.633185	.764082	.005648
41	-.317084	.006473	.330863	.617692	.774157	.005526
42	-.343892	.006798	.338851	.598476	.786199	.005809
43	-.373604	.007153	.348074	.573882	.801109	.006674
44	-.406310	.007537	.357211	.554307	.813319	.007043
45	-.442570	.007957	.372213	.518216	.835103	.01518
46	-.492947	.008417	.430875	.377092	.920202	.946
47	-.528124	.008924	.511549	.183013	1.052601	.05342
48	-.578947	.009487	.566563	.050664	1.155954	.007023
49	-.636471	.010116	.582657	.011947	1.189749	.001368
50	-.702031	.010825	.586080	.003712	1.196693	.000575
51	-.777342	.011629	.587393	.000553	1.199777	-.000267
52	-.864644	.012551	.587315	.000741	1.199575	-.000192
53	-.966921	.013621	.586841	.001881	1.198604	-.000074
54	-1.088235	.014878	.586572	.002528	1.198032	.000020
55	-1.234268	.016377	.586559	.002560	1.197996	.000036
56	-1.413218	.018201	.586666	.002302	1.198206	.000021
57	-1.637367	.020468	.586779	.002030	1.198429	.000004
58	-1.926010	.023369	.586858	.001840	1.198583	-.000006
59	-2.311317	.027219	.586909	.001718	1.198679	-.000007
60	-2.851340	.032588	.586948	.001624	1.198751	-.000007
61	-3.663035	.040625	.586989	.001525	1.198827	-.000007
62	-5.024451	.054060	.587039	.001405	1.198920	-.000007
63	-7.816479	.081540	.587102	.001253	1.199037	-.000007
64	-17.623149	.177889	.587182	.001061	1.199179	.000002

6.10 Reference test case 06 (RAE 2822, $M_\infty = 0.75$, $\alpha = 3°$)

The five solutions of group 2 are listed in table 6.15 below. The full sets of data for these solutions are given in Appendix A1 in microfiche form.

A physical picture of the flow field is given on Fig. 6.40 by the map of iso-Mach lines taken from solution N° 9.

Before discussing the solutions of group 2, we present the most significant part of stage 2 of the evaluation (see § 6.3 for definition of stage 2) showing the effects of the outer boundary position and of the mesh refinement on the aerodynamic coefficients.

Table 6.15 – Solutions of group 2 for test case 06 (RAE 2822, $M_\infty = 0.75$, $\alpha = 3°$).

Solution	MESH			outer boundary (chords)	C_L	Γ	C_D	C_M
	type	points or cells						
		total	on airfoil					
1	C	251 x 35	195	4/6/7	1.0975	0.5340	0.0471	- 0.1946
2	C	298 x 34	230	5/6/7	1.1292*	0.5440	0.0504*	- 0.2035*
3	O	158 x 24	158	16	1.0971*	0.5149	0.0461	- 0.1894*
6	O	192 x 36	192	80	1.1008		0.0450	- 0.1902
9	O	320 x 64	320	50	1.1044		0.0448*	- 0.1897
				scatter :	0.0321 = 2.9 %		0.0056 = 11.8 %	0.0141 = 7.2 %

First we compare several solutions N° 3 for which the outer boundary distance varies, but with the total number of mesh points being kept constant so that the mesh fineness also varies. Note that a vortex term is used for the far field treatment except in solution N° 3.7.

Solution	Outer boundary distance (chords)	C_L	C_D	C_M
3.2	8	1.0903	0.0453	-
3.1	16	1.0971	0.0461	- 0.1894
3.7*	16	1.0951	0.0455	- 0.1885
3.3	32	1.1031	0.0465	- 0.1909

(* no vortex term for the far field treatment)

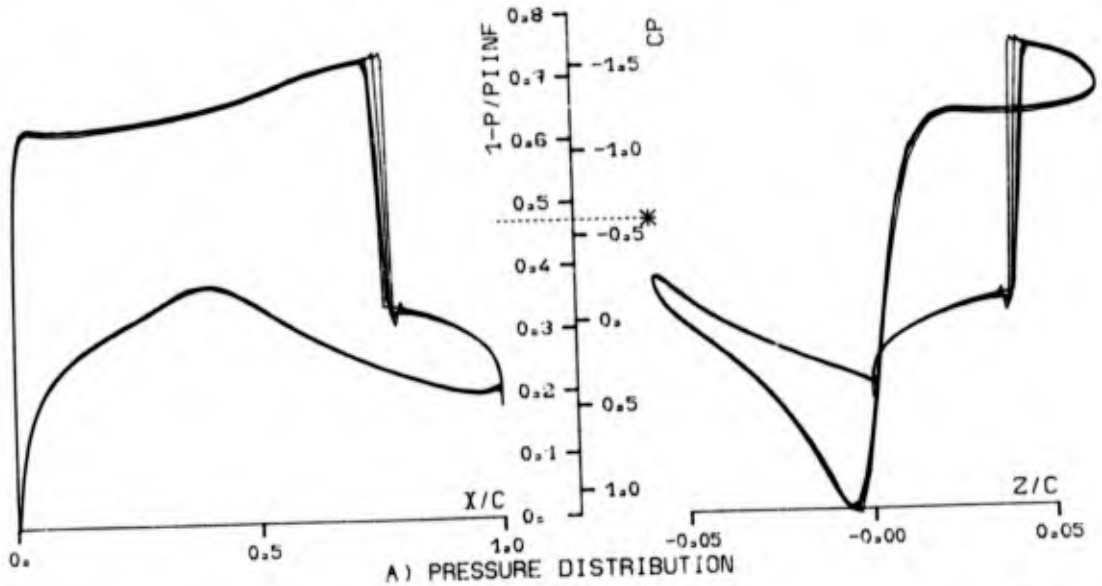
We see that C_L, C_D and $|C_M|$ increase with the distance of the outer boundary ; the relative variations, when this distance increases from 8 to 32 chords, are of 1.2 % for C_L and of 2.6 % for C_D. This indicates that the far field conditions have to be applied very far away even if a vortex term is included. However, the effect of the outer boundary position is certainly intermingled with other numerical factors (details of the far field treatment, artificial viscosity, mesh fineness...) since solution N° 2, for which the outer boundary is very close, gives values of C_L, C_D and $|C_M|$ appreciably higher than the values given by solution N° 3.3. The comparison of solutions N° 3.1 and 3.7 shows that the influence of the vortex term is more noticeable on C_D than on C_L and C_M. The solution referred to as N° 3 in group 2 is the solution N° 3.1, complete data being not available for solution N° 3.3.

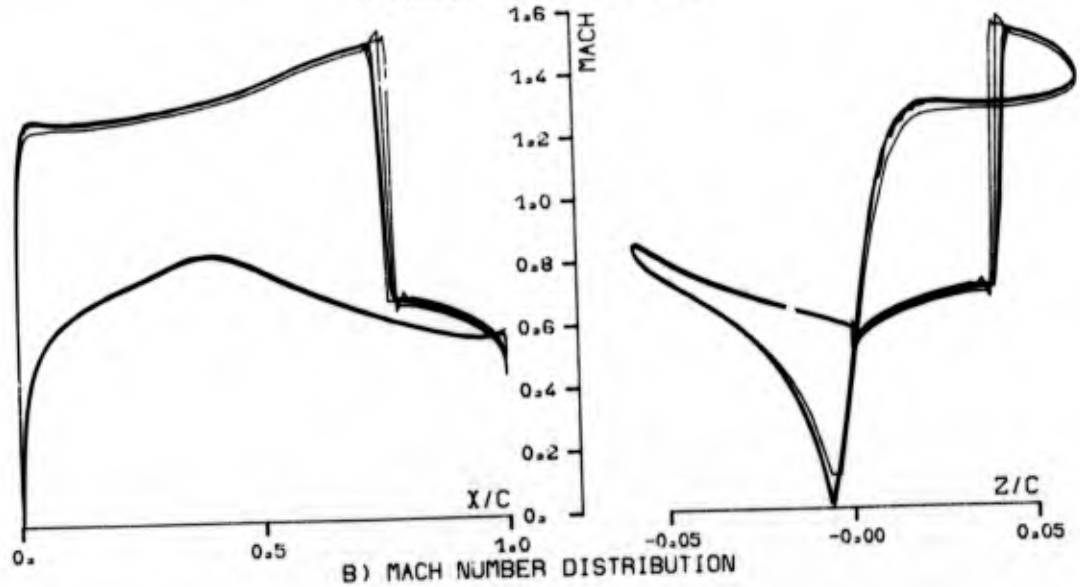
The effect of mesh fineness can be seen from the three solutions N° 9.1, 9.2 and 9.3 for which the outer boundary is the same (50 chords) ; from one solution to the next one, the mesh size is divided by 2 in each direction :

Solution	Mesh	C_L	C_D	C_M
9.1	80 x 16	1.0276	0.0455	- 0.1801
9.2	160 x 32	1.0950	0.0450	- 0.1888
9.3	320 x 64	1.1044	0.0448	- 0.1897

The coefficients C_L and $|C_M|$ increase as the mesh is refined, whereas C_D decreases. The mesh 80 x 16 is clearly insufficient; the variations which occur when the mesh is changed from (160 x 32) to (320 x 64) are small but not negligible : 0.9 % for C_L, 0.4 % for C_D and 0.5 % for C_M. The solution referred to as N° 9 in group 2 is the solution N° 9.3.

We go back now to the solutions of group 2. Cross-plots of p, M and p_i are given on Fig. 6.37. The error on the total pressure on the upper surface (Fig. 6.37 c) is appreciably larger for solution N° 3 than for all the other solutions of group 2 and it is by far the smallest for solution N° 9. In relation with its higher error on p_i, solution N° 3 is seen to differ from the others on the Mach number distribution on the upper surface upstream of the shock (Fig. 6.37 b) ; in particular, the stagnation point is not well represented.





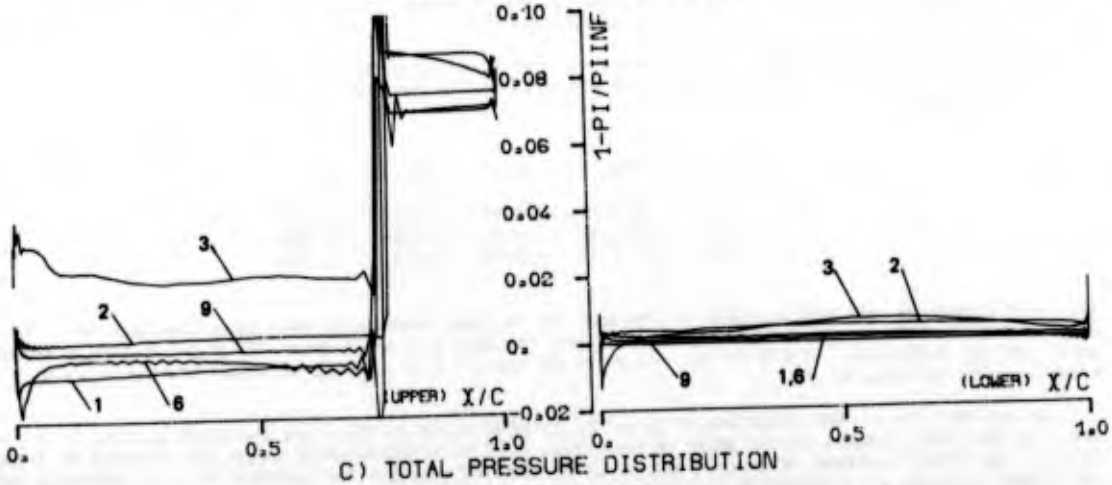


Fig. 6.37 – Solutions of group 2 for test case 06 (RAE 2822, Mach = 0.75, α = 3).

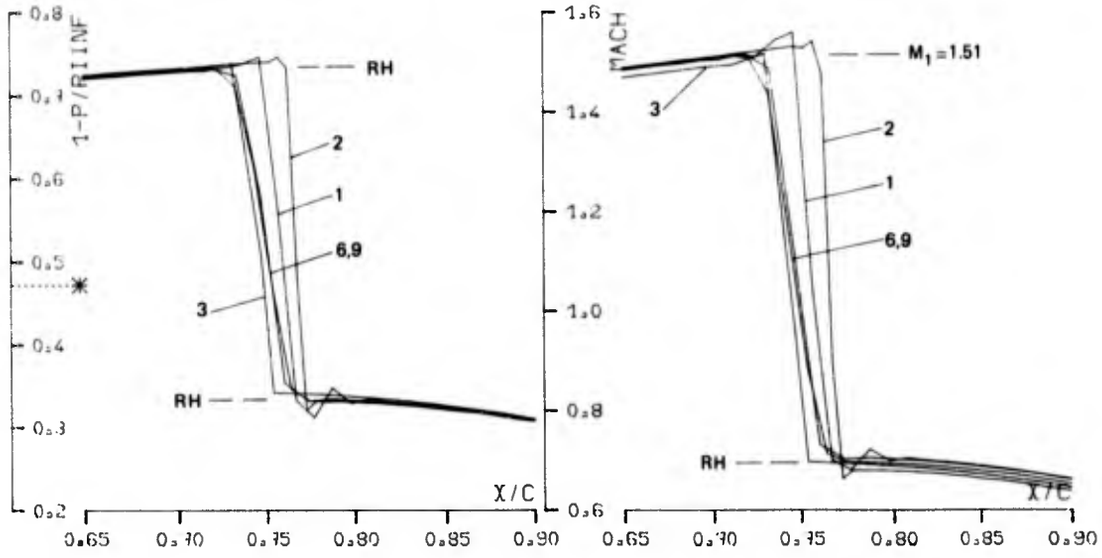


Fig. 6.38 – Shock profiles for solutions of group 2. Test case 06.

Solution N° 2 exhibits small wiggles or steps in the leading-edge region (upper surface), visible only on the plots of p and M versus z/c ; this could denote an insufficiently converged solution. Solution N° 6 exhibits a different kind of wiggles (saw tooth shape) on parts of the upper surface ; they are almost not visible on p and M, but quite apparent on p_i.

Figure 6.38 gives enlarged plots of p and M in the shock region. The shock jumps are good or very good (the figure shows only a sample of an exact shock jump).

Concerning shock sharpness, the solutions rank in the order 2, 1, 3, 9 and 6 (decreasing sharpness). Solution N° 1 shows an overshoot (or half-oscillation) on the Mach number upstream of the shock ; solutions N° 2 and 3 also show a similar overshoot, but much smaller. A similar but much less marked behaviour can be noted for the pressure. Solution N° 1 also gives some oscillation downstream of the shock. Solutions N° 6 and 9 have no oscillation at the shock.

Solutions N° 1 and 2 find the shock at a position about 1 % of the chord more downstream than the other solutions of group 2. The lateral extent of the supersonic region is also slightly larger for these two solutions :

Solution	1	2	3	6	9
$(z/c)_{max}$ on sonic line	1.04	1.1	1.02	1.02	1.01

These observations correlate well with the closeness of the outer boundary for solutions N° 1 and 2.

In summary, for solutions N° 1 and 2, the outer boundary is not placed far enough, and solution N° 3 has an important error on p_i. Solutions N° 6 and 9 stand out as the best ones in group 2, with a preference for N° 9 due to its much finer mesh and to its accuracy on p_i. Figure 6.39 gives the cross-plots of p, M and p_i for these two solutions which constitute group 3.

Figure 6.40 shows the map of iso-Mach lines given by solution N° 9, and tabulated wall values of N° 9 are given in table 6.16.

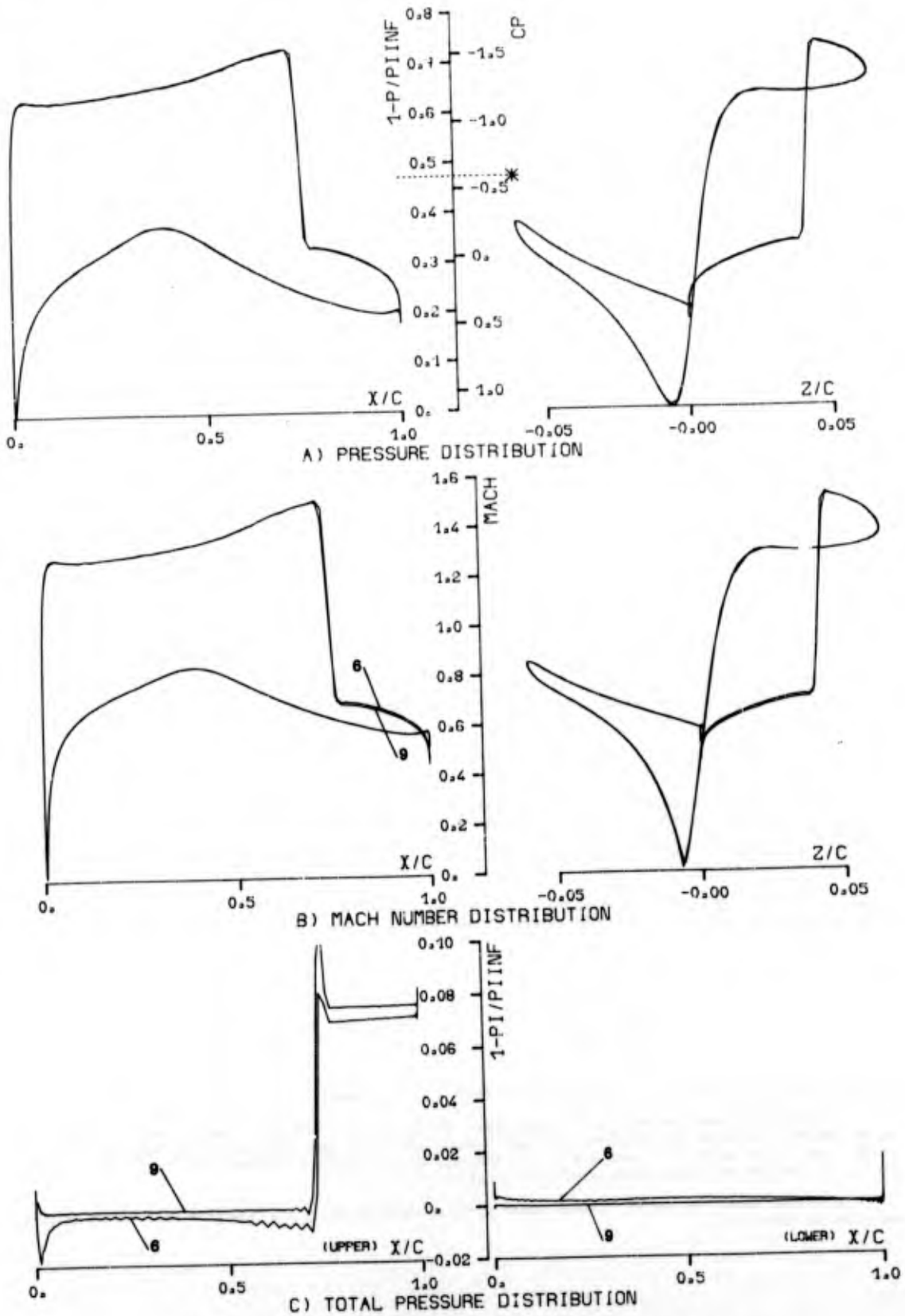


Fig. 6.39 – Solutions of group 3 for test case 06 (RAE 2822, Mach = 0.75, α = 3).

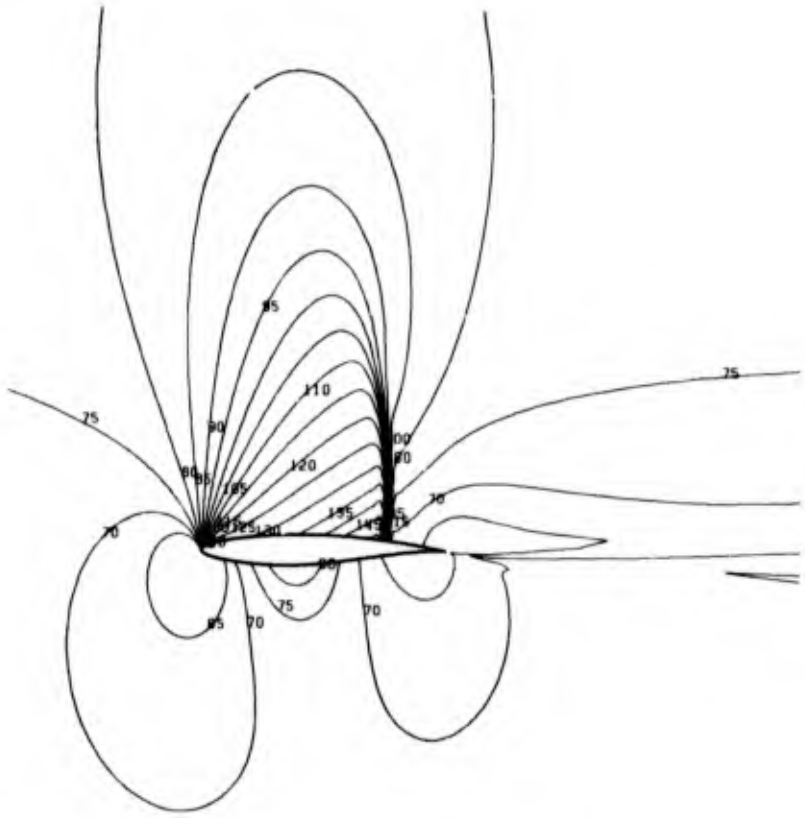


Fig. 6.40 – Iso-Mach lines of solution n° 9 for test case 06 ($\Delta M = 0.05$, curve parameter = 100 M).

Table 6.16 – Wall values of solution n° 9 for test case 06 (RAE 2822, $M_\infty = 0.75$, $\alpha = 3°$).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.999868	.000009	.179194	.487719	.535966	.001949
2	.999356	.000042	.194177	.432457	.563961	.000049
3	.998357	.000099	.201066	.407048	.575600	-.000083
4	.996881	.000178	.204315	.395064	.581055	-.000148
5	.994937	.000281	.204932	.392789	.582145	-.000204
6	.992531	.000400	.205315	.391376	.582401	.000083
7	.989667	.000530	.204836	.393143	.581971	-.000192
8	.986350	.000667	.204046	.396057	.580579	-.000124
9	.982585	.000802	.203589	.397742	.579807	.000042
10	.978379	.000930	.202675	.401113	.578355	-.000154
11	.973736	.001046	.201300	.406185	.576160	-.000214
12	.968662	.001139	.200488	.409180	.574534	-.000002
13	.963166	.001197	.199858	.411503	.573628	-.000106
14	.957253	.001216	.199084	.414358	.572488	-.000215
15	.950931	.001183	.198956	.414830	.572058	-.000051
16	.944210	.001089	.199477	.412909	.572909	-.000041
17	.937097	.000931	.200126	.410515	.574065	-.000100
18	.929603	.000708	.200676	.408486	.575007	-.000123
19	.921737	.000415	.201197	.406565	.575920	-.000161
20	.913511	.000044	.202288	.402541	.577564	-.000039
21	.904934	-.000413	.203737	.397196	.579998	-.000069
22	.896018	-.000953	.205123	.392084	.582410	-.000166
23	.886776	-.001580	.206860	.385678	.585135	-.000063
24	.877219	-.002295	.208989	.377825	.588585	-.000027
25	.867359	-.003097	.210930	.370666	.591938	-.000161
26	.857211	-.003983	.212933	.363278	.595158	-.000118
27	.846786	-.004959	.215448	.353999	.599148	-.000030
28	.836097	-.006024	.218214	.343800	.603704	-.000077
29	.825160	-.007170	.220998	.333532	.608228	-.000085
30	.813986	-.008393	.223660	.323714	.612575	-.000119
31	.802590	-.009691	.226379	.313685	.616951	-.000112
32	.790986	-.011067	.229432	.302425	.621802	-.000065
33	.779188	-.012519	.232769	.290117	.627168	-.000077
34	.767209	-.014041	.236279	.277171	.632772	-.000070
35	.755063	-.015627	.239780	.264258	.638406	-.000114
36	.742765	-.017272	.243427	.250807	.644196	-.000109
37	.730328	-.018975	.247588	.235459	.650682	-.000018
38	.717767	-.020730	.251962	.219327	.657648	-.000064
39	.705094	-.022524	.256213	.203648	.664419	-.000128
40	.692323	-.024351	.260595	.187485	.671247	-.000080
41	.679468	-.026208	.265306	.170110	.678608	-.000063
42	.666542	-.028089	.270331	.151576	.686454	-.000058
43	.653557	-.029983	.275535	.132382	.694559	-.000054
44	.640527	-.031879	.280703	.113321	.702631	-.000087
45	.627464	-.033769	.285831	.094407	.710583	-.000085
46	.614381	-.035646	.291029	.075235	.718641	-.000094
47	.601289	-.037508	.296534	.054931	.727112	-.000061
48	.588200	-.039347	.302454	.033096	.736192	-.000011
49	.575127	-.041153	.308393	.011191	.745416	-.000081
50	.562079	-.042915	.314196	-.010213	.754381	-.000115
51	.549068	-.044627	.320252	-.032549	.763608	-.000037
52	.536105	-.046282	.326642	-.056118	.773406	-.000020
53	.523200	-.047872	.332983	-.079505	.783206	-.000083
54	.510364	-.049384	.339197	-.102425	.792743	-.000082
55	.497605	-.050812	.345492	-.125643	.802346	-.000022
56	.484934	-.052149	.351773	-.148809	.811990	-.000021
57	.472359	-.053384	.357685	-.170614	.821103	-.000051
58	.459890	-.054509	.363053	-.190413	.829350	-.000044
59	.447535	-.055517	.367800	-.207922	.836648	-.000037
60	.435303	-.056405	.371801	-.222679	.842814	-.000041
61	.423201	-.057170	.374867	-.233987	.847562	-.000064
62	.411237	-.057810	.376935	-.241615	.850753	-.000066
63	.399419	-.058327	.378001	-.245546	.852411	-.000080
64	.387753	-.058723	.378151	-.246100	.852640	-.000078
65	.376245	-.059003	.377483	-.243636	.851600	-.000068
66	.364901	-.059170	.375974	-.238070	.849277	-.000073
67	.353727	-.059228	.373498	-.228938	.845494	-.000108
68	.342728	-.059184	.370116	-.216464	.840291	-.000116
69	.331909	-.059045	.366019	-.201353	.833990	-.000123
70	.321273	-.058821	.361435	-.184446	.826942	-.000126
71	.310824	-.058522	.356651	-.166801	.819570	-.000107
72	.300566	-.058159	.351871	-.149170	.812219	-.000100
73	.290501	-.057740	.347227	-.132042	.805076	-.000088
74	.280631	-.057271	.342800	-.115714	.798248	-.000057
75	.270958	-.056758	.338423	-.099570	.791546	-.000073
76	.261485	-.056204	.333886	-.082836	.784631	-.000121
77	.252213	-.055615	.329372	-.066187	.777695	-.000114
78	.243142	-.054999	.325378	-.051456	.771486	-.000041
79	.234273	-.054360	.321975	-.038904	.766211	.000005
80	.225607	-.053696	.318570	-.026345	.761034	-.000047
81	.217145	-.053007	.314668	-.011954	.755112	-.000120
82	.208885	-.052294	.310613	.003003	.748844	-.000091
83	.200828	-.051564	.307027	.016229	.743239	-.000012
84	.192974	-.050822	.303911	.027722	.738415	.000010
85	.185320	-.050063	.300708	.039536	.733518	-.000028
86	.177868	-.049287	.296989	.053252	.727843	-.000087
87	.170615	-.048494	.293017	.067902	.721679	-.000061
88	.163560	-.047690	.289182	.082047	.715711	-.000029
89	.156700	-.046878	.285598	.095266	.710143	-.000013
90	.150036	-.046060	.282128	.108065	.704769	-.000021
91	.143563	-.045234	.278666	.120834	.699386	-.000015
92	.137281	-.044401	.275152	.133794	.693916	-.000012
93	.131188	-.043561	.271516	.147205	.688250	-.000012
94	.125280	-.042715	.267706	.161258	.682313	-.000021
95	.119556	-.041864	.263781	.175734	.676164	-.000014
96	.114013	-.041008	.259811	.190377	.669929	-.000005
97	.108647	-.040151	.255830	.205060	.663665	.000001
98	.103457	-.039292	.251822	.219843	.657344	.000006
99	.098440	-.038433	.247768	.234792	.650932	.000013
100	.093591	-.037574	.243610	.249947	.644417	.000015

Table 6.16 (continued).

101	.088909	-.036716	.239500	.265291	.637796	.000021	211	.125439	.042458	.633417	-1.187604	1.288112	.000548
102	.084391	-.035860	.235296	.280796	.631081	.000029	212	.129966	.043134	.633225	-1.186896	1.287727	.000546
103	.080032	-.035005	.231046	.296472	.624270	.000034	213	.134610	.043810	.633036	-1.186199	1.287361	.000499
104	.075830	-.034153	.226736	.312369	.617338	.000039	214	.139373	.044486	.633073	-1.186336	1.287477	.000470
105	.071782	-.033304	.222365	.328490	.610274	.000047	215	.144255	.045160	.633389	-1.187501	1.288124	.000455
106	.067885	-.032457	.217924	.344870	.603066	.000054	216	.149260	.045832	.633900	-1.189386	1.289134	.000482
107	.064135	-.031614	.213380	.361630	.595660	.000059	217	.154388	.046501	.634442	-1.191385	1.290204	.000514
108	.060529	-.030773	.208671	.378898	.587944	.000065	218	.159642	.047165	.634960	-1.193295	1.291241	.000527
109	.057065	-.029934	.203727	.397233	.579815	.000071	219	.165023	.047825	.635452	-1.195110	1.292240	.000521
110	.053738	-.029099	.198604	.416129	.571311	.000076	220	.170532	.048479	.635925	-1.196855	1.293204	.000512
111	.050546	-.028268	.193365	.435452	.562567	.000076	221	.176171	.049129	.636370	-1.198496	1.294111	.000504
112	.047484	-.027442	.188095	.454869	.553689	.000094	222	.181941	.049773	.636783	-1.200019	1.294950	.000501
113	.044551	-.026622	.182772	.474522	.544671	.000098	223	.187844	.050412	.637186	-1.201506	1.295773	.000494
114	.041742	-.025806	.177322	.494624	.535353	.000108	224	.193880	.051044	.637611	-1.203073	1.296638	.000491
115	.039055	-.024995	.171631	.515614	.525548	.000107	225	.200051	.051669	.638069	-1.204762	1.297569	.000491
116	.036487	-.024187	.165583	.537921	.515039	.000094	226	.206357	.052287	.638572	-1.206618	1.298592	.000491
117	.034033	-.023385	.159295	.561113	.503935	.000116	227	.212800	.052896	.639137	-1.208702	1.299741	.000493
118	.031692	-.022588	.152864	.584833	.492459	.000121	228	.219381	.053496	.639770	-1.211036	1.301038	.000484
119	.029459	-.021799	.146391	.608707	.480724	.000142	229	.226100	.054086	.640447	-1.213533	1.302418	.000487
120	.027331	-.021017	.139895	.632667	.468778	.000158	230	.232958	.054664	.641105	-1.215960	1.303761	.000490
121	.025304	-.020242	.133304	.656976	.456481	.000162	231	.239955	.055231	.641720	-1.218228	1.305006	.000509
122	.023377	-.019474	.126559	.681854	.443657	.000175	232	.247093	.055787	.642374	-1.220641	1.306350	.000504
123	.021545	-.018712	.119565	.707650	.430125	.000172	233	.254370	.056328	.643240	-1.223835	1.308136	.000492
124	.019806	-.017955	.112306	.734424	.415782	.000178	234	.261789	.056854	.644369	-1.227999	1.310492	.000446
125	.018158	-.017204	.104846	.761939	.400601	.000188	235	.269347	.057363	.645566	-1.232414	1.312949	.000460
126	.016596	-.016457	.097222	.790059	.384680	.000197	236	.277047	.057854	.646483	-1.235796	1.314815	.000499
127	.015117	-.015716	.089433	.818787	.367900	.000202	237	.284886	.058329	.647051	-1.237891	1.315958	.000544
128	.013719	-.014979	.081484	.848105	.350146	.000210	238	.292865	.058789	.647563	-1.239779	1.317044	.000509
129	.012397	-.014246	.073413	.877874	.331365	.000217	239	.300983	.059232	.648419	-1.242937	1.318869	.000449
130	.011150	-.013516	.065247	.907993	.311449	.000223	240	.309239	.059655	.649647	-1.247466	1.321437	.000421
131	.009973	-.012788	.057028	.938307	.290281	.000226	241	.317633	.060055	.650954	-1.252287	1.324134	.000459
132	.008864	-.012061	.048811	.968614	.267712	.000230	242	.326164	.060432	.652083	-1.256451	1.326447	.000523
133	.007820	-.011333	.040615	.998844	.243455	.000218	243	.334830	.060787	.653092	-1.260172	1.328563	.000519
134	.006839	-.010601	.032535	1.028645	.217186	.000212	244	.343630	.061118	.654269	-1.264513	1.331062	.000481
135	.005918	-.009864	.024721	1.057466	.188684	.000199	245	.352562	.061423	.655732	-1.269909	1.334176	.000434
136	.005054	-.009118	.017446	1.084299	.157836	.000205	246	.361626	.061698	.657315	-1.275748	1.337808	.000451
137	.004248	-.008362	.010892	1.108472	.124173	.000175	247	.370819	.061945	.658757	-1.281067	1.340529	.000499
138	.003500	-.007591	.005502	1.128352	.087434	.000170	248	.380138	.062162	.660029	-1.285758	1.343231	.000502
139	.002811	-.006802	.001891	1.141671	.049428	.000183	249	.389582	.062350	.661289	-1.290405	1.345934	.000478
140	.002183	-.005993	.000849	1.145514	.030288	.000207	250	.399148	.062509	.662652	-1.295433	1.348856	.000466
141	.001619	-.005161	.003413	1.136057	.067553	.000226	251	.408833	.062635	.664174	-1.301046	1.352115	.000473
142	.001128	-.004305	.010933	1.108321	.124024	.000242	252	.418634	.062728	.665909	-1.307445	1.355865	.000452
143	.000717	-.003425	.024796	1.057189	.188924	.000213	253	.428549	.062783	.667819	-1.314490	1.360000	.000442
144	.000395	-.002523	.046110	.978576	.260328	.000086	254	.438574	.062799	.669727	-1.321527	1.364119	.000474
145	.000168	-.001604	.075427	.870446	.336965	-.000169	255	.448705	.062776	.671540	-1.328214	1.368043	.000513
146	.000041	-.000674	.112693	.732996	.418096	-.000709	256	.458938	.062713	.673412	-1.335119	1.372159	.000489
147	.000017	.000259	.156474	.571518	.500728	-.001087	257	.469271	.062608	.675575	-1.343097	1.376945	.000450
148	.000099	.001189	.203444	.398277	.580951	-.001164	258	.479697	.062457	.678048	-1.352218	1.382412	.000453
149	.000279	.002105	.251622	.220581	.658209	-.000995	259	.490214	.062256	.680739	-1.362143	1.388393	.000464
150	.000554	.003003	.298948	.046027	.731430	-.000608	260	.500816	.062002	.683579	-1.372618	1.394753	.000468
151	.000914	.003875	.342797	-.115703	.797801	.000382	261	.511497	.061693	.686489	-1.383351	1.401313	.000476
152	.001353	.004719	.381400	-.258083	.856079	.001570	262	.522253	.061327	.689420	-1.394162	1.407969	.000484
153	.001859	.005533	.414550	-.380351	.906401	.002912	263	.533079	.060905	.692360	-1.405005	1.414707	.000474
154	.002424	.006317	.442952	-.485107	.950352	.003916	264	.543968	.060424	.695311	-1.415890	1.421504	.000489
155	.003041	.007074	.468704	-.580089	.991428	.004273	265	.554914	.059885	.698350	-1.427098	1.428570	.000488
156	.003704	.007805	.492345	-.667285	1.029951	.004530	266	.565911	.059284	.701621	-1.439163	1.436284	.000423
157	.004412	.008512	.512655	-.742194	1.063797	.004673	267	.576953	.058619	.705063	-1.451858	1.444433	.000412
158	.005163	.009199	.529407	-.803981	1.092291	.004758	268	.588033	.057888	.708384	-1.464107	1.452328	.000458
159	.005953	.009868	.543504	-.855976	1.117035	.004414	269	.599143	.057095	.711406	-1.475253	1.459621	.000435
160	.006782	.010521	.556055	-.902268	1.139564	.003930	270	.610277	.056244	.714060	-1.485042	1.466030	.000483
161	.007651	.011161	.567008	-.942666	1.159568	.003450	271	.621429	.055339	.716362	-1.493533	1.471669	.000465
162	.008560	.011790	.576028	-.975935	1.176277	.003038	272	.632590	.054385	.718603	-1.501798	1.477178	.000472
163	.009507	.012411	.583177	-1.002303	1.189695	.002682	273	.643752	.053382	.720975	-1.510547	1.483189	.000276
164	.010495	.013024	.589066	-1.024023	1.200947	.002267	274	.654909	.052328	.723377	-1.519406	1.489013	.000517
165	.011524	.013633	.594347	-1.043501	1.211130	.001884	275	.666052	.051227	.725497	-1.527226	1.494576	.000171
166	.012595	.014236	.599346	-1.061939	1.220796	.001585	276	.677174	.050083	.727411	-1.534285	1.498939	.000854
167	.013710	.014835	.604324	-1.080300	1.230464	.001331	277	.688265	.048900	.729012	-1.540190	1.503736	-.000205
168	.014869	.015431	.609305	-1.098671	1.240189	.001114	278	.699318	.047681	.731017	-1.547585	1.507878	.001213
169	.016075	.016023	.613965	-1.115859	1.249278	.001021	279	.710325	.046427	.732643	-1.553582	1.513828	-.001364
170	.017327	.016613	.618000	-1.130741	1.257189	.000966	280	.721276	.045138	.731960	-1.551063	1.507600	.005116
171	.018628	.017201	.621348	-1.143090	1.263815	.000896	281	.732161	.043814	.710353	-1.471369	1.436940	.028768
172	.019977	.017788	.623993	-1.152846	1.269109	.000799	282	.742973	.042458	.613141	-1.112820	1.172934	.094220
173	.021376	.018374	.626028	-1.160351	1.273226	.000689	283	.753701	.041075	.465939	-.569891	.886832	.109479
174	.022825	.018961	.627649	-1.166330	1.276546	.000561	284	.764337	.039670	.346470	-.129250	.713622	.082310
175	.024326	.019549	.629043	-1.171472	1.279416	.000441	285	.774872	.038245	.331597	-.074393	.695771	.076342
176	.025880	.020138	.630318	-1.176174	1.282030	.000355	286	.785295	.036801	.331706	-.074795	.695820	.076452
177	.027488	.020729	.631561	-1.180759	1.284559	.000305	287	.795596	.035340	.331176	-.072840	.694838	.076525
178	.029152	.021320	.632780	-1.185255	1.287029	.000278	288	.805767	.033867	.330148	-.069049	.693110	.076521
179	.030873	.021914	.633881	-1.189316	1.289228	.000303	289	.815796	.032386	.328890	-.064409	.690962	.076542
180	.032653	.022509	.634772	-1.192602	1.291000	.000339	290	.825673	.030899	.327364	-.058781	.688372	.076553
181	.034491	.023106	.635436	-1.195051	1.292325	.000362	291	.835389	.029407	.325485	-.051850	.685158	.076585
182	.036391	.023705	.635877	-1.196678	1.293220	.000358	292	.844934	.027914	.323186	-.043371	.681157	.076675
183	.038354	.024307	.636133	-1.197622	1.293750	.000342	293	.854296	.026429	.320735	-.034331	.677047	.076640
184	.040380	.024912	.636231	-1.197983	1.293963	.000323	294	.863467	.024958	.318618	-.026522	.673579	.076541
185	.042471	.025520	.636194	-1.197847	1.293900	.000306	295	.872434	.023495	.316495	-.018692	.669827	.076657
186	.044630	.026131	.636036	-1.197264	1.293588	.000296	296	.881187	.022042	.313681	-.008313	.664891	.076774
187	.046856	.026745	.635772	-1.196290	1.293050	.000300	297	.889716	.020607	.310603	.003040	.659757	.076683
188	.049153	.027364	.635439	-1.195062	1.292370	.000309	298	.898011	.019194	.307858	.013164	.655114	.076646
189	.051521	.027986	.635093	-1.193786	1.291665	.000316	299	.906059	.017805	.305049	.023524	.650161	.076756
190	.053962	.028612	.634779	-1.192628	1.291018	.000333	300	.913851	.016441	.301860	.035287	.644643	.076790
191	.056478	.029242	.634539	-1.191743	1.290523	.000347	301	.921377	.015109	.298678	.047023	.639266	.076713
192	.059072	.029876	.634378	-1.191149	1.290184	.000366	302	.928624	.013810	.295588	.058420	.633879	.076754
193	.061744	.030512	.634229	-1.190599	1.289865	.000391	303	.935583	.012546	.292155	.071082	.627769	.076881
194	.064496	.031153	.634030	-1.189865	1.289442	.000420	304	.942243	.011323	.288522	.084481	.621548	.076813
195	.067331	.031796	.633750	-1.188833	1.288869	.000432	305	.948594	.010145	.285208	.096705	.615888	.076727
196	.070250	.032444	.633395	-1.187523	1.288144	.000445	306	.954625	.009012	.281761	.109418	.609596	.076921
197	.073255	.033095	.633033	-1.186188	1.287416	.000443	307	.960325	.007928	.277689	.124511	.602323	.076983
198	.076347	.033749	.632761	-1.185195	1.286873	.000437	308	.965686	.006901	.273754	.138951	.595723	.076760
199	.079530	.034407	.632637	-1.184727	1.286619	.000444	309	.970697	.005932	.270265	.151819	.589407	.076856
200	.082804	.035068	.632688	-1.184916	1.286725	.000439	310	.975346	.005019	.266059	.167406	.581585	.077064
201	.086173	.035730	.632827	-1.185428	1.286987	.000463	311	.979625	.004170	.261201	.185250	.573095	.076938
202	.089637	.036395	.632884	-1.185638	1.287081	.000491	312	.983525	.003390	.256666	.201977	.565019	.076867
203	.093199	.037061	.632766	-1.185203	1.286837	.000500	313	.987035	.002682	.251988	.219231	.556233	.077065
204	.096860	.037731	.632446	-1.184023	1.286180	.000518	314	.990147	.002050	.246753	.238539	.546695	.077035
205	.100622	.038403	.632060	-1.182599	1.285419	.000498	315	.992850	.001498	.241608	.257516	.537572	.076788
206	.104488	.039079	.631854	-1.181839	1.285026	.000469	316	.995135	.001025	.236031	.278085	.526735	.077078
207	.108459	.039755	.631965	-1.182249	1.285254	.000463	317	.996991	.000636	.228710	.305088	.512398	.077407
208	.112538	.040432	.632408	-1.183883	1.286157	.000446	318	.998408	.000339	.220387	.335786	.498124	.078367
209	.116726	.041108	.632969	-1.185952	1.287253	.000490	319	.999374	.000135	.212420	.365171	.480821	.077426
210	.121026	.041784	.633347	-1.187346	1.287990	.000522	320	.999871	.000028	.197994	.418378	.450826	.077976

6.11. Reference test case 08 (Chiocchia-Nocilla profile, $M_\infty = 0.769$, $\alpha = 0°$)

This test case corresponds to an exact hodograph solution, for a Tomotika-Tamada gas, with an isentropic shock occuring at a convex corner point of the airfoil. The flow is symmetric. A physical picture of the flow field is given on Fig. 6.44 by the map of iso-Mach lines taken from solution N° 11.

Table 6.17 lists the four numerical solutions available for this test case, one of them (N° 9.2) being obtained for an upstream Mach number slightly different from the design value ($M_\infty = 0.785$ instead of $M_\infty = 0.769$). The full sets of data given by the contributors are presented in microfiche form in Appendix A1.

Table 6.17 – Numerical solutions for test case 08 (Chiocchia-Nocilla profile, $M_\infty = 0.769$, $\alpha = 0°$).

Solution	MESH			outer boundary (chords)	$10^3 \times C_D$	sonic point in shock x_s/c	
	type	points or cells					
		total	on airfoil				
7	C	150 x 25	120	3.6/4.6/3.2	2.98	0.631	
9.1	O	320 x 64	320	50	0.43	0.637	
9.2	O	320 x 64	320	50	1.31	0.629	solution calculated for $M_\infty = 0.785$
11	H	11 x 30	17	0.4/1.3/2.3	1.54	0.624	solution calculated in half-plane (symmetry)
"exact"					0.914	0.622	

Solution N° 11 is calculated in a half-plane only, using the symmetry condition ; the method involves an incompressible flow solution which allows to use a coarse mesh and to place the outer boundary very close. The other solutions are calculated in the full plane. The values of C_L and $|C_M|$ given by the solutions N° 9.1 and 9.2 are less than 10^{-13}, whereas solution N° 7 gives $C_L = 0.5 \times 10^{-3}$ and $C_M = -0.4 \times 10^{-3}$ denoting a very slight asymmetry of the flow.

The drag coefficient is obtained by integration of wall pressure ; for the "exact" solution, since the shock is isentropic, the value of the drag is correct only within the framework of transonic small perturbation theory. In any case, the drag coefficient is of the order of 10^{-3} and the differences observed among the solutions are not really significant, except perhaps for solution N° 7 which gives a relatively much higher drag than the other solutions.

The position of the shock, defined as that of the sonic point, is very well determined by solution N° 11 despite the coarse mesh used (the sonic point is determined by a linear interpolation on the tabulated values of M). The other solutions find the shock more or less downstream of the "exact" position (from 0.007 c for solution N° 9.2 to 0.015 c for solution N° 9.1).

The numerical solutions are compared with the "exact" solution on Figs. 6.41 to 6.43 which give cross-plots of C_p and M. The total pressure distribution is shown for the numerical solutions only since the "exact" solution corresponds to an isentropic flow of a gas which does not follow strictly the perfect gas law.

Solution N° 7 (Fig. 6.41) has an important error on p_i just at the stagnation point. This error first diminishes rapidly as x increases, and then stays around 0.01 up to the shock ; curiously no jump on p_i is visible. Up to the shock, solution N° 7 is very underexpanded (for C_p and for M) compared to the "exact" solution ; a compression zone is seen to precede the shock.

Solution N° 9.1 (Fig. 6.42) shows a similar behaviour for the pressure and Mach number distributions, but with practically no error on p_i upstream of the shock and with a sharper compression zone preceding the shock. Solution N° 9.2, also shown on Fig. 6.42, obtained with a modified value of M ($M_\infty = 0.785$ instead of 0.769), has now a regular behaviour (no compression "bump") but it is over-expanded, compared to the "exact" solution, upstream of the shock.

Contrary to the solutions N° 7 and 9.1, solution N° 11 compares very well with the "exact" solution, especially on the Mach number as can be seen on Fig. 6.43. The only appreciable difference on M comes from the shock thickness (of one mesh, corresponding to about 4 % of the chord). In particular, the accuracy on p_i upstream of the shock appears remarkable in view of the coarse mesh used. It should be noted nevertheless that the coarsness of the mesh completely erases the sharp corner at which the shock is attached in the "exact" solution ; it would have been interesting to see how the numerical solution changes as the mesh is refined.

Tabulated wall values for solution N° 11 are given in table 6.18, and the map of iso-Mach lines for this solution is shown on Fig. 6.44.

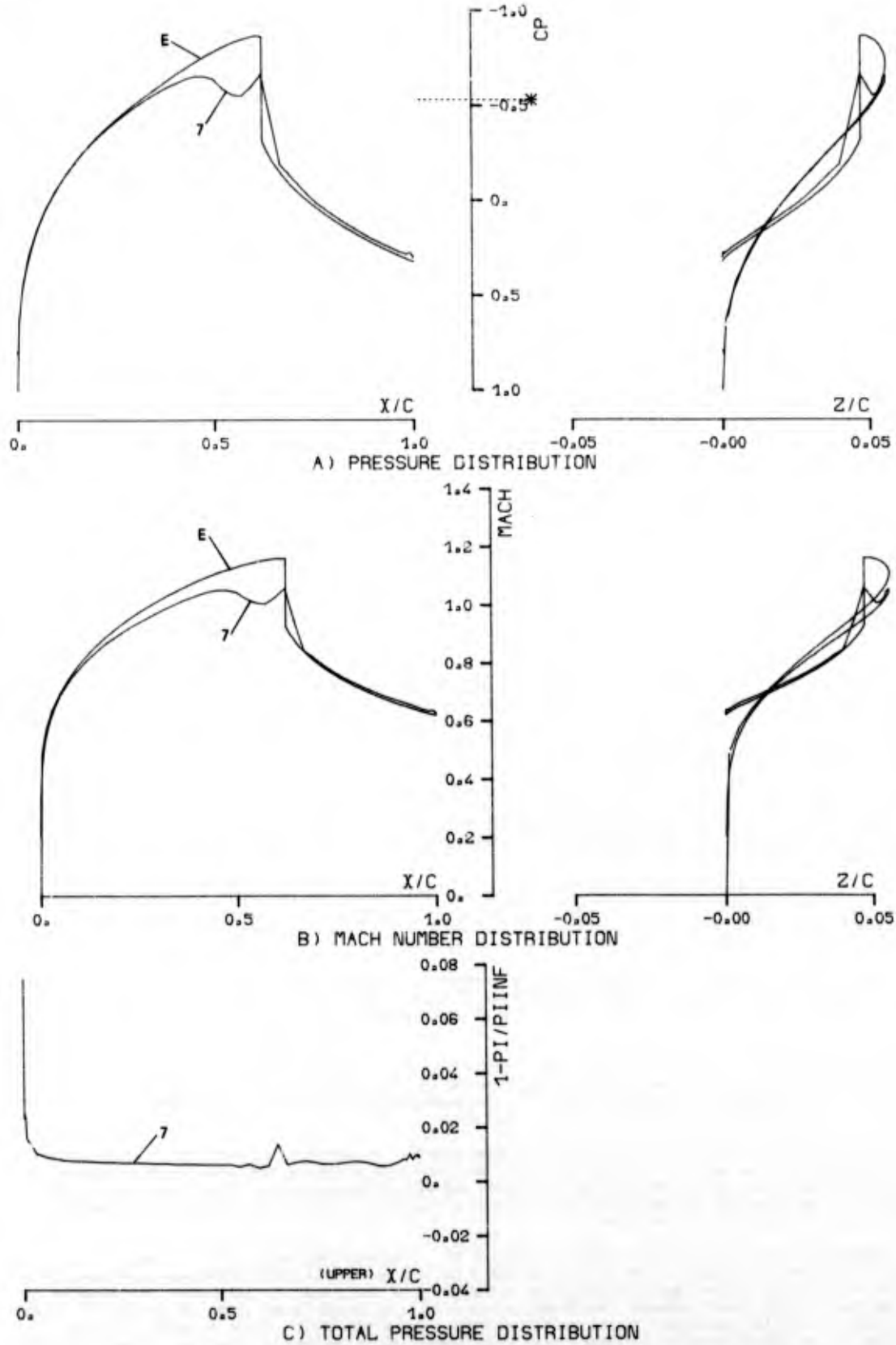
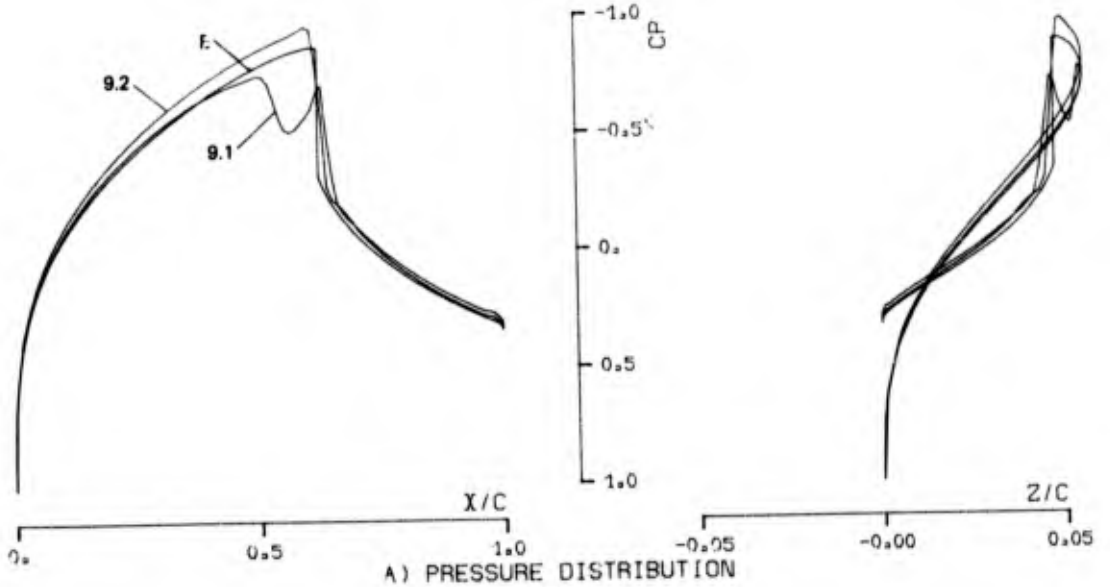
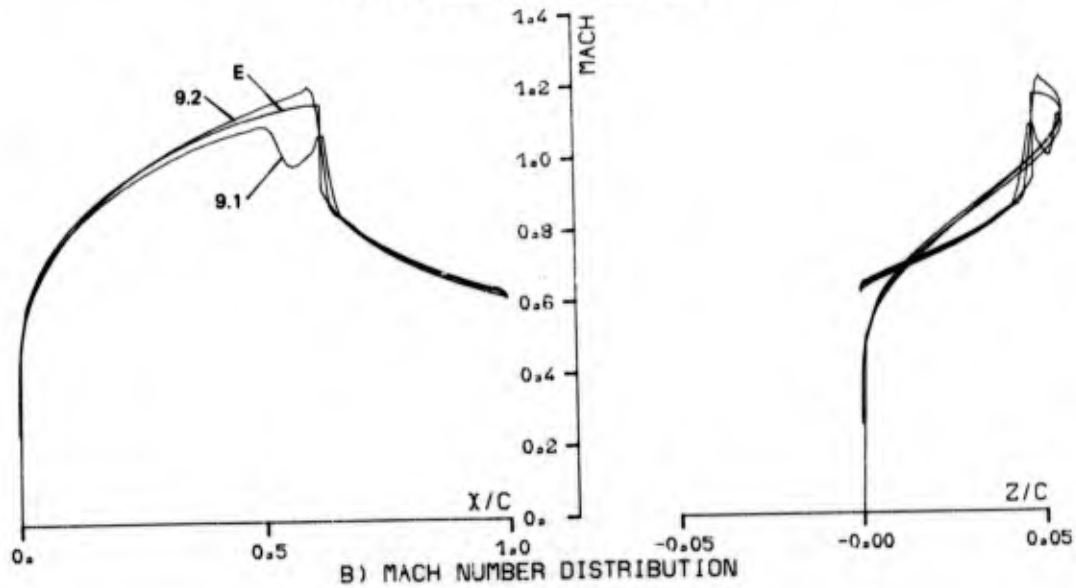


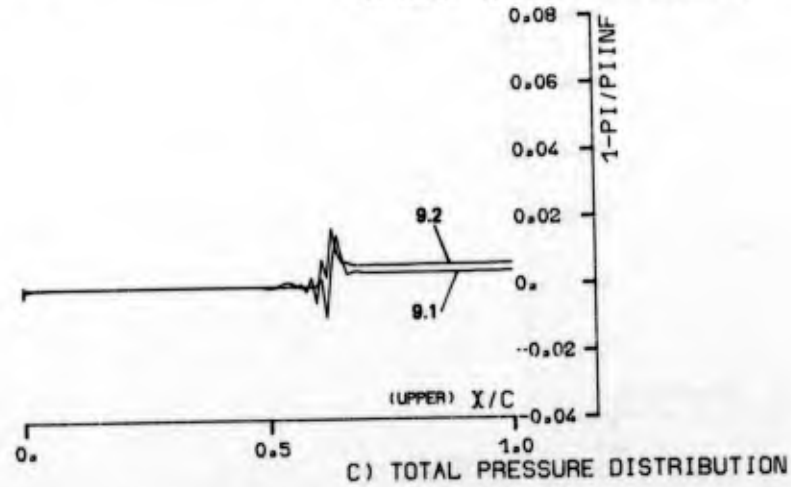
Fig. 6.41 – Solutions 7 and exact for test case 08 (Chiocchia-Nocilla, Mach = 0.769, α = 0).



A) PRESSURE DISTRIBUTION



B) MACH NUMBER DISTRIBUTION



C) TOTAL PRESSURE DISTRIBUTION

Fig. 6.42 – Solutions 9.1/9.2 and exact for test case 08 (Chiocchia-Nocilla, Mach = 0.769/0.785/0.769, α = 0).

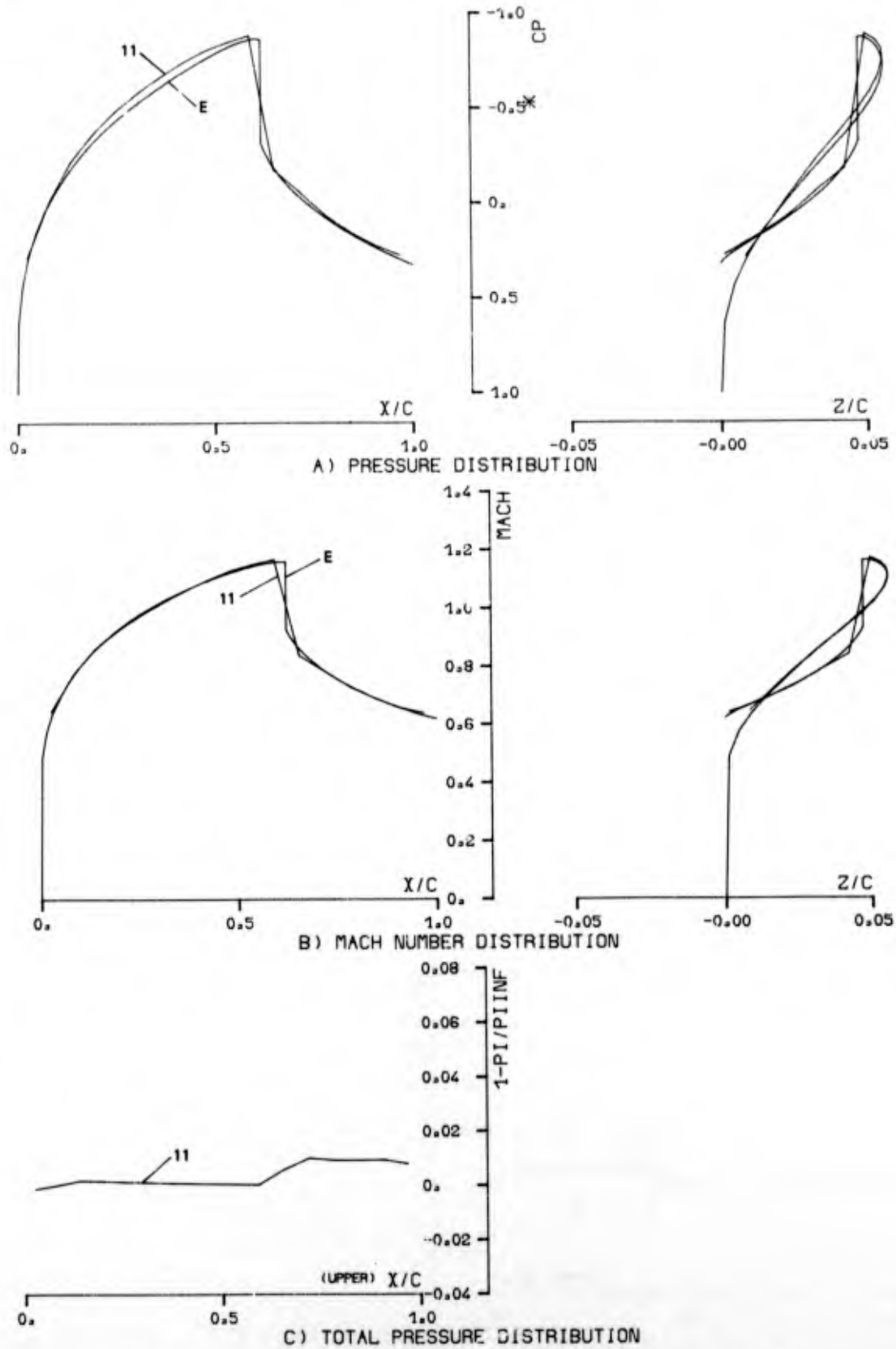


Fig. 6.43 – Solutions 11 and exact for test case 08 (Chiocchia-Nocilla, Mach = 0.769, α = 0).

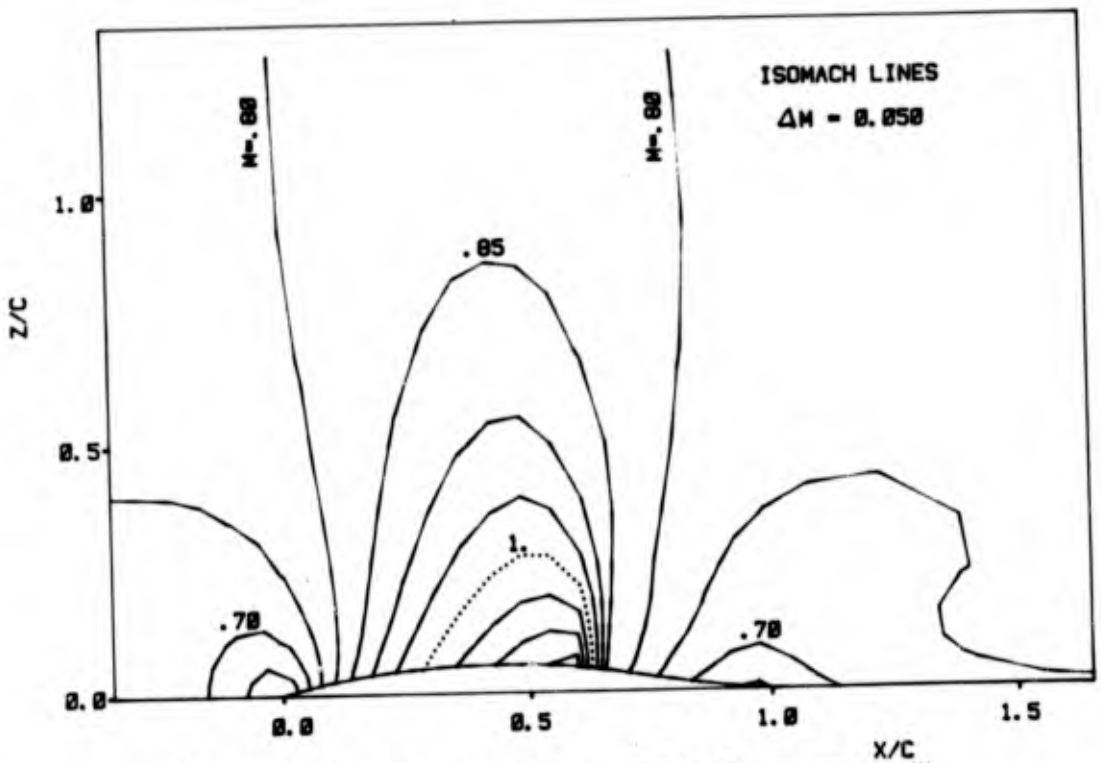


Fig. 6.44 – Iso-Mach lines of solution n° 11 for test case 08 (ΔM = 7.05, curve parameter = M).

Table 6.18 – Wall values of solution n° 11 for test case 08 (Chiocchia-Nocilla profile, $M_\infty = 0.769041$, $\alpha = 0°$).

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.028270	.008410	.244560	.283033	.647092	-.001027
2	.084820	.021880	.326146	-.008428	.772220	.000390
3	.141360	.032450	.384349	-.216355	.860231	.002000
4	.197900	.040720	.425036	-.361707	.923852	.001838
5	.254440	.047030	.458360	-.480755	.977092	.001547
6	.310990	.051520	.486795	-.582338	1.023472	.001357
7	.367540	.054300	.510709	-.667769	1.063437	.001135
8	.424080	.055520	.531344	-.741487	1.098710	.000554
9	.480620	.055180	.548751	-.803672	1.129132	.000795
10	.537170	.053310	.560945	-.847235	1.150902	.000613
11	.593700	.049850	.571305	-.884245	1.169634	.000519
12	.653480	.042930	.372987	-.175765	.838902	.005866
13	.716490	.032820	.340199	-.058632	.783750	.010210
14	.779480	.023280	.305197	.066411	.730177	.009459
15	.842470	.014490	.280476	.154725	.691377	.009560
16	.905460	.006970	.260786	.225067	.660051	.009715
17	.968480	.001510	.246918	.274610	.639862	.008082

6.12. Reference test cases 09 (Hobson1 cascade, $M_{\infty e}$ = 0.476, α=43.544°) and 10 (Hobson2 cascade, $M_{\infty e}$ =0.575, α = 46.123°).

These two cases correspond to exact hodograph solutions for supercritical shockless flows through plane cascades. Only two solutions for the Hobson1 cascade, and one solution for the Hobson2 cascade are available ; these solutions are listed in table 6.19 with characteristic parameters of the mesh and with the values of the aerodynamic coefficients C_x, C_z and of the circulation Γ (when available). The coefficients C_x and C_z correspond to the components of the aerodynamic force respectively normal and parallel to the front plane of the cascade. Since the exact flow field is symmetrical with respect to the mid-chord vertical axis, the exact value of C_x is zero.

Table 6.19 – Numerical solutions for test case 09 (Hobson 1 cascade, $M_\infty = 0.476$, $\alpha = 43.544°$) and for test case 10 (Hobson 2 cascade, $M_\infty = 0.575$, $\alpha = 46.123°$).

	Solution	MESH			outer boundary		C_z	Γ	C_x
		type	points		upstream	downstream			
			total	on blade	x/c	x/c			
HOBSON 1	12	H	98 x 21	55 + 31	- 1.	2.	2.0421		0.0082
	13	H	25 x 10	11 + 11	- 0.6	1.6	1.96	1.31	0.18
	exact						2.0216	1.3945	0
HOBSON 2	12	H	98 x 11	45 + 35	- 1.	2.	1.0622		0.0037
	exact						1.051	0.7582	0

For both solutions N° 12 and N° 13, the computation domain is of channel type, bounded by the upper and lower surfaces of two successive blades extended by two artificial permeable boundaries verifying the periodicity condition. Table 6.19 gives the axial distance, measured from the leading-edge, of the upstream and downstream boundaries. The number of points on the blade is given as the sum of two terms, the first one corresponding to the upper surface (suction side), and the second one to the lower surface (pressure side).

The full sets of data for these solutions are given in microfiche form in Appendix A1.

The plots of p, M and p_i are shown separately for each solution, and compared to the exact solution, on Figs. 6.45 to 6.47.

Solution N° 12 for test case 09 (Fig. 6.45) is in good agreement with the exact solution except on the rear half-part of the upper surface where the solution shows a tendency to form shocks. This is related to the rapid decrease of the total pressure which occurs in this region, corresponding to a rather large error. It is possible also that the convergence to a steady state is not quite sufficient. Nevertheless the value of C_Z is good (1 % of relative error) and the value of C_X is less than 0.01.

Solution N° 13 for test case 09 (Fig. 6.46) suffers clearly from the coarsness of the mesh, especially for the values on the upper surface. There is an appreciable error on p_i on the upper surface, and the minimum pressure at mid-chord is too high. This reflects into the value of C_X, 0.18, which is far from zero, but the accuracy on C_Z is much better (3 % of relative error).

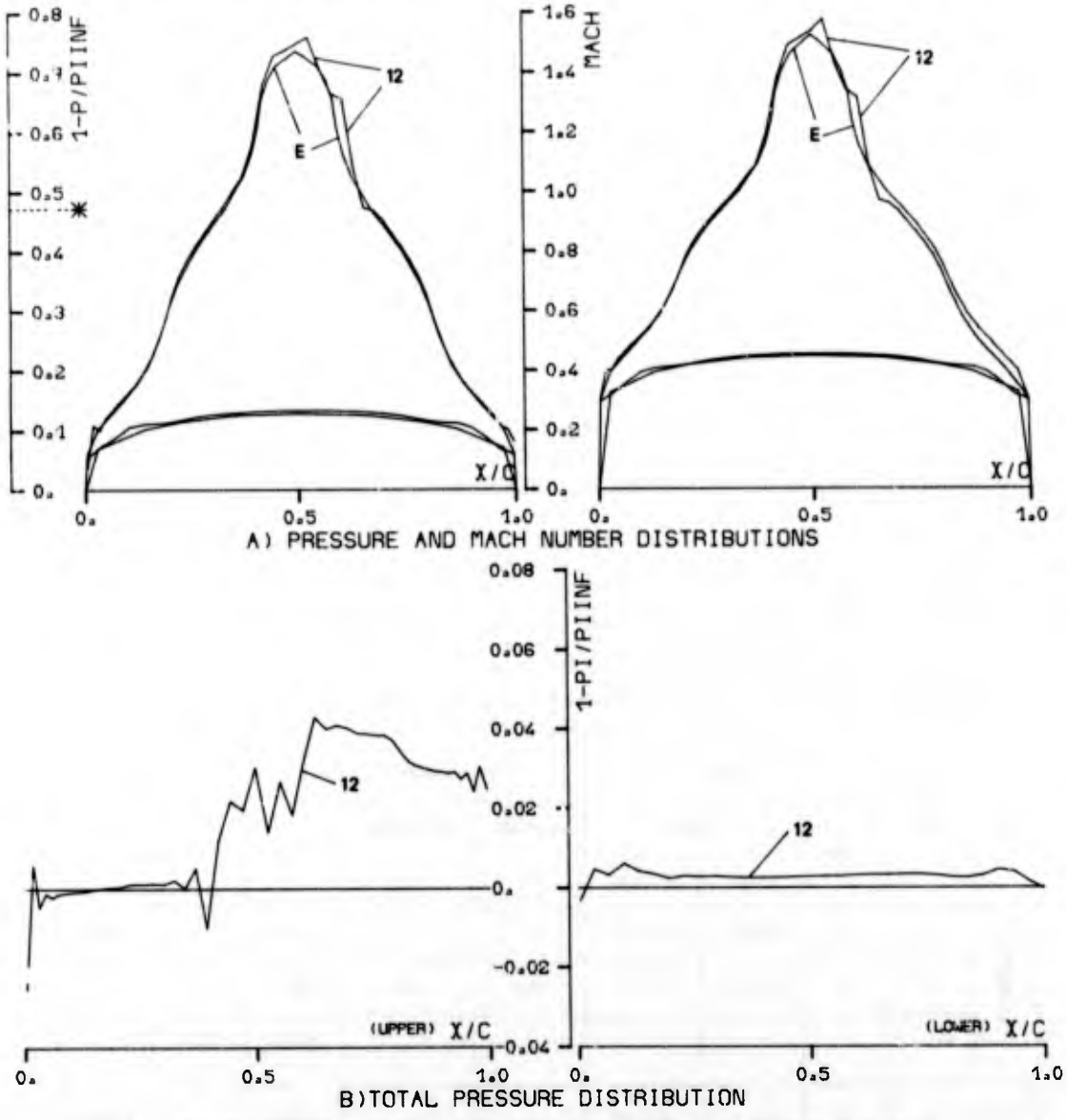


Fig. 6.45 – Solutions 12 and exact for test case 09 (Hobson-1 cascade, Mach = 0.476, α = 43.544).

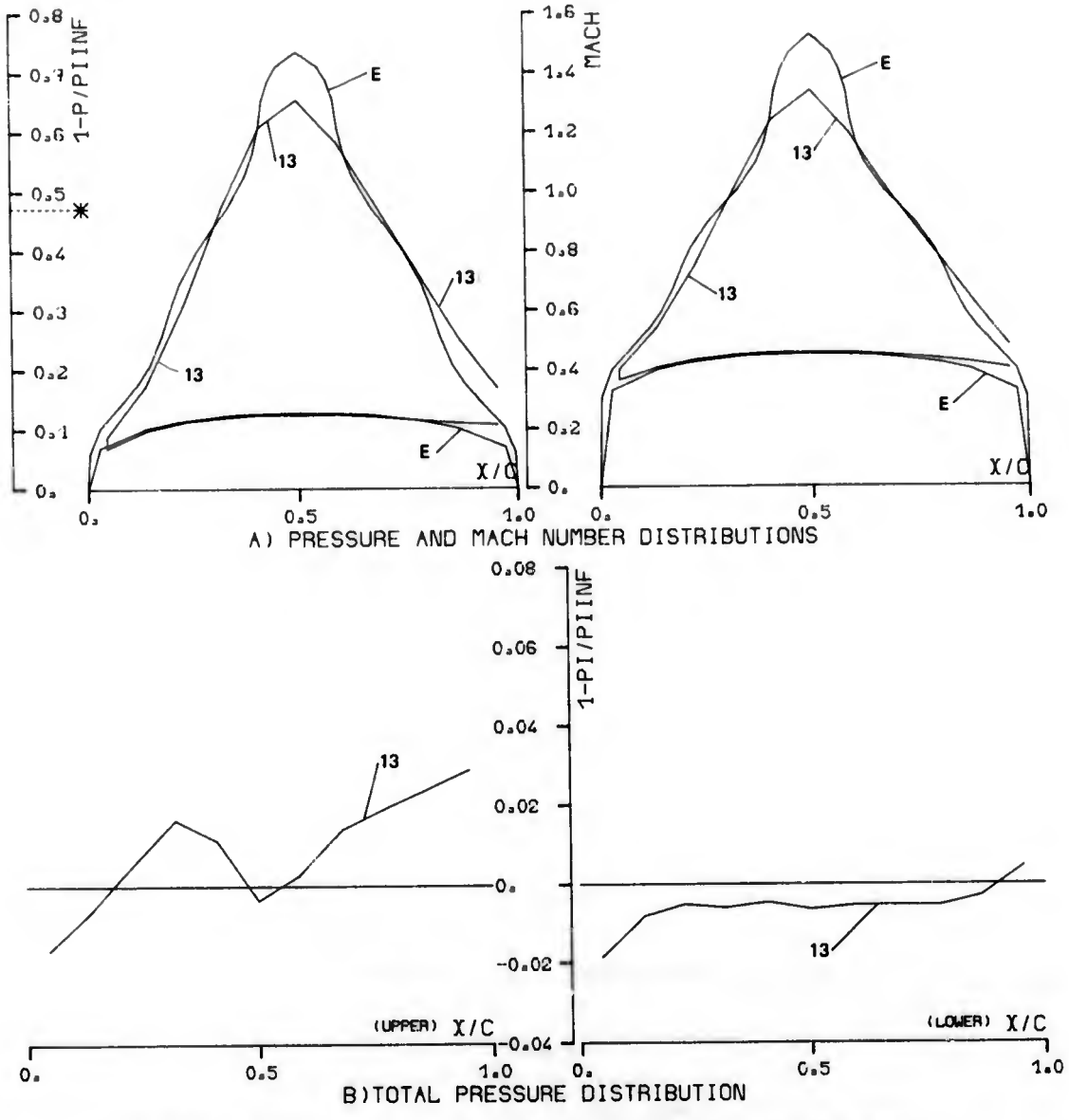


Fig. 6.46 – Solutions 13 and exact for test case 09 (Hobson-1 cascade, Mach = 0.476, α = 43.544).

Surprisingly, whereas test case 10 seems less difficult than test case 09, solution N° 12 for the former (Fig. 6.47) is much more in error than solution N° 12 for the latter as far as pressure and Mach number distributions are concerned, but on the contrary is more accurate as far as the total pressure is concerned. This is probably due to the fact that the mesh is coarser in the transverse direction for test case 10. The errors on the pressure on the lower and upper surfaces compensate each other to a large extent (the pressure is too low on both surfaces) so that C_x remains very small and the relative error on C_z is only 1 %.

Finer meshes seem required to solve these supercritical shockless cascade flows with a really satisfactory accuracy.

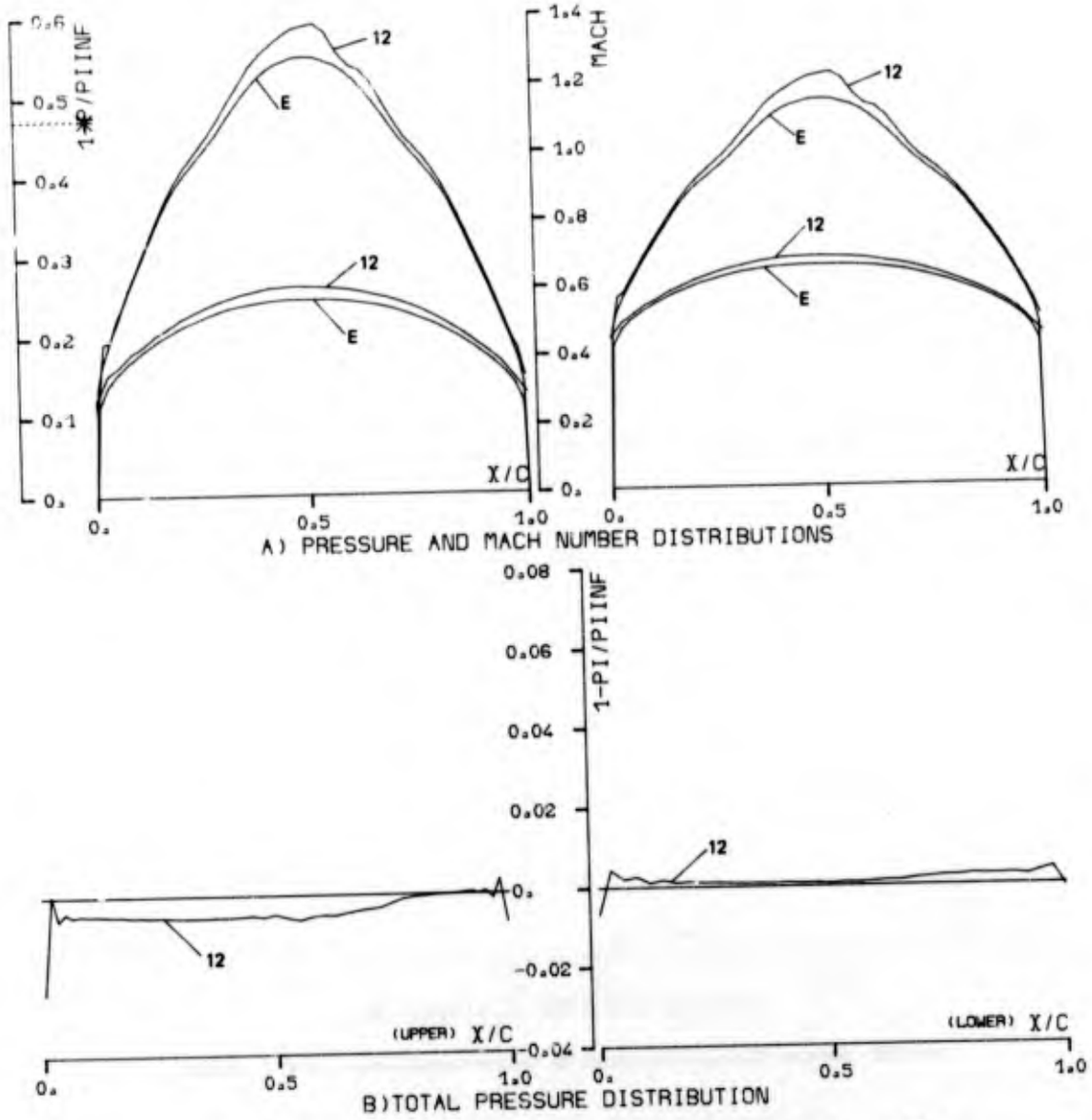


Fig. 6.47 – Solutions 12 and exact for test case 10 (Hobson-2 cascade, Mach = 0.575, α = 46.123).

6.13 Conclusion about the evaluation of the numerical solutions to the two-dimensional test cases

A large number of numerical solutions for ten test cases corresponding to plane flows past airfoils or through cascades have been made available to the Working Group and have been evaluated with the objective of determining reference solutions. This objective can be considered as essentially achieved (some reservation being in order for the cascade flow cases) if reference solutions are understood not to be

definitive solutions but rather to be representative of the highest presently attainable quality and accuracy. Indeed much effort is being devoted to the numerical solution of the Euler equations, and important progress on the accuracy can be expected in the next few years. The reference solutions presented here should prove very useful as benchmarks either to test approximate methods or to measure future progress.

Trying to summarize the main points of this evaluation, we find that the test cases separate into three groups as follows.

a) Test cases 07, 08, 09 and 10

They correspond to exact or almost exact Euler solutions determined from hodograph theory. The exact solutions constitute the true benchmarks, and the evaluation of numerical solutions should be of particular interest for determining the state of the art since only for these test cases can we assess the accuracy of numerical solutions by direct comparison with the exact solution.

However it must be kept in mind that these exact solutions all present special features : shockless supercritical flow, or special gas law and isentropic shock attached at a corner point (test case 08) ; the difficulties in obtaining highly accurate numerical solutions may be enhanced because of these features.

Shockless accurate numerical solutions exist for the test case 07 (NLR 7301 airfoil). However, solutions of different types which differ markedly from the exact solution have also been obtained ; although their validity is in doubt, we cannot reject them completely and the question of well-posedness (uniqueness and stability of solution) of this test case could be raised.

Test case 08 must be considered with caution due to its peculiarities and also in view of the fact that an accurate numerical solution in a fine mesh has not been presented yet.

No accurate numerical solutions have been given for the test cases 09 and 10 which relate to cascades, and the number of available solutions is too small to conclude about the differences with respect to the exact solution. It seems likely that the meshes used are not fine enough.

b) Test cases 01, 02 and 06

These cases correspond to supercritical lifting flows at Mach numbers not close to unity.

Here a significant number of solutions are found to be in good agreement with each other, giving confidence in the validity of these solutions. However, the agreement is not complete enough (especially on shock wave positions) to allow us to qualify these solutions as definitive solutions. At the same time, the convergence with respect to the parameters of the discretized problem (such as mesh size, mesh topology, mesh variations, outer boundary position, artificial viscosity...) cannot be considered as fully established for any of these solutions. In fact, because of the large number of these parameters, many more numerical experiments would be necessary to assess this convergence. But, contrary to the test cases a) above, the remaining discrepancies do not hint at a well-posedness problem. It can be noted that the largest variations occur for test case 02.

c) Test cases 03, 04 and 05

These cases correspond to high transonic or low supersonic flows.

For these cases, we also find a significant number of solutions which are in good agreement together, and moreover this agreement is appreciably better than for test cases b) above, at least as far as the flow properties at the wall are concerned. This is particularly striking for the test cases 03 and 04 which are non-lifting cases.

The lifting effect is of course a main source of numerical difficulties, hence of discrepancies between solutions, so that it is not surprising to find a much better agreement for test cases 03 and 04. However, it should be noticed that for these three test cases, the shock waves on the airfoil are shifted back exactly at the trailing-edge, so that the discrepancies in shock positions vanish ; some discrepancies due to shock thickness still exist but they are small if the meshes are fine enough.

Although the solutions agree well at the wall, appreciable differences remain either downstream of the trailing edge (test case 03) or upstream of the airfoil at the detached shock (test cases 04 and 05).

Progress made in the last few years can be seen by comparison with the Euler solutions presented at a GAMM Workshop in 1979 [1] for the test cases 01, 02, 03 and 06. The emphasis at this workshop was on potential solutions more than on Euler solutions and the latter were only a few. Nevertheless the comparison shows that the scatter of the present solutions of group 2 is much smaller than the scatter of the Euler solutions of [1], with one noticeable exception concerning the drag coefficient for test case 02. We have already noted that this test case seems the most difficult of test cases 01 to 07.

Following the present evaluation of numerical Euler solutions, we think that three points should be emphasized for future studies ; they relate to the trailing-edge behaviour, to shock waves and to the outer boundary.

In all the numerical Euler solutions obtained up to now, the exact trailing-edge values (corresponding to a stagnation point on the side with the lower total pressure, or on both sides if they have same total pressure) are far from being satisfied, essentially because the flow properties vary very fast over a distance much smaller than the local mesh size (even if the mesh is much refined at the trailing-edge as it is often the case). This error is localized over a very small distance, of the order of one mesh, and as such it should not appreciably affect the global quantities. However, a relation between the shock position and the pressure reached at the trailing-edge in a numerical solution has been recently proposed by Hirschel

and Lucchi [2]. Such a relation, if it is confirmed, could mean that the shock location is sensitive to trailing-edge error, and it would then be necessary, in order to achieve definiteness in inviscid solutions, to make the error at the trailing-edge much smaller by using extremely refined meshes near this point.

The second point, which has not yet received much attention in numerical solutions, is the accurate representation of the Zierep singularity [3], [4], which occurs on a curved wall just at the downstream side of a shock (infinite gradients in the wall direction). The influence of mesh refinement on the representation of this singularity has not been sufficiently studied, and the combination of a shock fitting technique and of mesh refinement on the downstream side of the shock may prove necessary to achieve a high accuracy. As an example of the difficulty of this problem, we recall the weak shock occuring on the lower surface in test case 01.

The present evaluation has shown the importance of the outer boundary position in relation with the boundary conditions and the numerical treatment applied at this boundary. It seems that the minimum distance at which this boundary should be located in order to achieve a given accuracy can vary to a very large extent depending on the boundary treatment. This is an important question which requires detailed studies of all the factors involved. Whereas the trailing-edge problem and the Zierep singularity problem change in nature when viscous effects are taken into account, the problem of the far field treatment (outside the viscous wake) remains exactly the same at high Reynolds numbers.

As a final conclusion, it is recommended that further investigations of the effects of all the various parameters of the discretized problem be carried out. Because of the large number of these parameters and of the intricate way in which they can interact, it seems preferable to carry out in-depth investigations for one test case only rather than to consider several test cases simultaneously. We suggest that test case 02 be given the priority for such investigations.

References

[1] RIZZI, A. and VIVIAND, H. (Eds.), Numerical Methods for the Computation of Inviscid Transonic Flows with Shock Waves, Notes on Numerical Fluid Mechanics, Vol. 3, Friedr. Vieweg & Sohn (1981).

[2] HIRSCHEL, E.H. and LUCCHI, C.W., On the Kutta Condition for Transonic Airfoils, MBB-UFE 122-AERO-MT 651 Report, 1983.

[3] ZIEREP, J., Der Senkrechte Verdichtungsstoss am Gekrümmten Profil, ZAMP, Vol. 9b, 1958, pp. 764-776.

[4] OSWATITSCH, K. and ZIEREP, J., Das Problem des Senkrechten Stosses an einer Gekrümmten Wand, ZAMM, Vol. 40, 1960, p. 143.

Acknowledgments

The Working Group wishes to thank Mrs. A.M. Vuillot for her important and efficient help in the processing and plotting of the numerical solutions for the two-dimensional test cases.

7. NUMERICAL SOLUTIONS FOR THREE-DIMENSIONAL CASES - SWEPT WINGS (P.SACHER)

Nomenclature: All Symbols are used in accordance with chapter 6

7.1 Introduction

Nearly all problems in Aircraft Industry are related to 3D compressible flow. So numerical methods solving the Euler Equations should be extended consequently to three dimensions. But in contrast to 2D-Test Cases in Chapter 6, where up to 13 different authors have contributed to 10 Test Cases, only 4 solutions were obtained even for the simplest geometry.

This can be attributed to the extraordinarily high computing cost, the need of access to a large memory and high speed computer, and, at least for complex wing shapes or wing-body-configurations, due to problems in generating mesh-grids.

The simplest swept wing geometry of practical interest was Test Case 11 and 12, ONERA M6, with constant section, moderate Aspect Ratio = 3.8 and only 30° leading edge sweep. But even this simple planform produces in TC11 with 3.06° angle of attack the rolling up of a Tip-Vortex which may contribute to induced drag. The numerical analysis of the nonlinear wake leaving the trailing edge of a lifting wing including the rolling up at the wing tips is one of the most promising aspects of the potential of solving the Euler equations at considerably higher cost in place of Full Potential equation. Of course all arguments concerning the prediction of shock-position and strength according to Chapter 6 (2D-Test Cases) are still valid.

Consequently the complexity of a realistic transport type planform with twist, camber, variation of section profiles and breakpoints in leading and/or trailing edge sweep can be represented by Test Case 16, NASA AMES SWEPT WING. More or less all additional problems in computation of the flow field are due to mesh-grid generation and the increase of the number of grid points which are necessary to simulate the flow sufficiently accurate. Only one contribution was obtained for this Test Case.

The next order of complexity was reached by prescribing 3D swept wings at supersonic speed, high angle of attack and in presence of a body as reported in Chapter 8.

7.2 ASSESSMENT OF SOLUTIONS

Data used for assessment of solutions are organized according to the following scheme:

- Test Case No. 11 (Chap. 7.3)
  "Onera M6"
  $M = .84$, $\alpha = 3.06°$
- Test Case No. 12 (Chap. 7.4)
  "Onera M6"
  $M = .92$, $\alpha = 0°$
- Test Case No. 16*
  "NASA AMES Swept Wing"
  $M = .833$, $\alpha = 1.75°$

For detailed discussion, each Test Case will be subdivided in 7 sections:

- Compilation of data received

  Tables 7-1/7-7 Contributions obtained

  Tables 7-2/7-8 Contour-maps and total coefficients (completeness check)

  Tables 7-3/7-9 Section characteristics (completeness check)

- Description of methods

  ONERA/MATRA (1)
  DORNIER/JAMESON (2)
  FFA (3)
  MBB (4)

- Planform contour maps

  ONERA/MATRA (1)
  DORNIER/JAMESON (2)
  FFA (3)
  MBB (4)

* Data for Test Case No. 16, the NASA Ames Swept Wing, was not available for discussion or presentation at the time of printing.

- Sectional field plots

  ONERA/MATRA (1)
  DORNIER/JAMESON (2)
  FFA (3)
  MBB (4)

- Comparison of section characteristics

  Mach = f(x/c)
  $1 - p/p_\infty = f(x/c)$
  $1 - p_i/p_{i_\infty} = f(x/c)$
  $1 - T_i/T_{i_\infty} = f(x/c)$
  $C_p = f(x/c)$

- Convergence history

- Tabulated data for spanwise sections and local coefficients for lift, drag and pitching moment

  ONERA/MATRA (1)
  DORNIER/JAMESON (2)
  FFA (3)
  MBB (4)

- Additional GARTEUR sections

  $C_p = f(x/c)$
  tabulated data

7.3 ONERA M6 - Test Case 11

7.3.1 COMPILATION OF DATA RECEIVED

Solutions were obtained from 4 contributors:

- M. Neron (ONERA)/C. Koeck (MATRA)
- W. Schmidt (DORNIER)/A. Jameson (Princeton)
- A. Rizzi (FFA)
- A. Eberle (MBB)

Table 7-1 gives a collection of characteristic data used for the mesh-grid generation in each contribution. Integrated overall coefficients for lift, drag and pitching moment are compared if available. In most cases sectional cuts for presentation of data are slightly different from specified values (Table 7-2).

Table 7-1 AGARD TC 11, SURVEY ON DATA OBTAINED

AGARD WG07 TC11 M = .84 / α = 3.06°

CONTRIBUTION		MESH							OUTER BOUNDARY			C_L	C_D	C_M (APEX)	REMARKS
NO.	COMP.	TYPE		NO. OF POINTS					x_{MIN}/x_{MAX} (CHORD)	z_{MAX}/z_{MIN} (CHORD)	y_{MAX} (SPAN)				
		A	Y	TOTAL X	TOTAL Y	TOTAL Z	ON WING UPPER SURF. CHORD	ON WING UPPER SURF. SECT.							
1a	ONERA/ MATRA	C	O	57	50	19	42	25	-4/6	8/-8	5				M6P20
2a	DORNIER/ JAMESON	C	H	81	17	17	31	13	-8/10	9/-9	2	0.258	0.0046	-0.1509	„MEDIUM MESHGRID" y/b = .135 .503 .770
2b	DORNIER / JAMESON	C	H	161	33	33	61	25	-8/10	9/-9	2	0.279	0.0141	-0.1666	"FINE GRID"
3a	FFA	O	O	96	20	20	24	20	-5/5	5/-5	3.5	0.285	0.0113		y/b = .06 .468 .816
3b	FFA	O	O	192	40	40	48	40	-5/5	5/-5	3.5	0.283	0.0111		"FINE GRID"
4	MBB	C	H	90	21	10	36	13	-3/4	6/-6	2	0.290	0.0251	-0.1099	y/b = .122 .531 .776

Table 7-2 AGARD TC 11, FIGURES REQUESTED AND OBTAINED

AGARD WG07 TC11 / M = 0.84, α = 3.06°

CONTRIBUTION			SURFACE – PLOTS					FIELD – PLOTS					LOCAL COEFF.			TABULATED DATA					
NO	COMPANY	Y/S	M	1 P/PINF	1- Pi/PINF	1- Ti/TINF	C_p	M	1- P/PINF	1- Pi/PINF	1- Ti/TINF		C_l	C_m	C_d	X/C	M	1- P/ PINF	1- Pi/ PINF	1- Ti/ TINF	C_p
1	ONERA/MATRA	0.1	x	x	x		x	x	x	x						x	x	x	x		x
		0.2					o														
		0.44					o														
		0.5	x	x	x		x	x	x	x						x	x	x	x		x
		0.8	x	x	x		●	x	x	x						x	x	x	x		x
		0.96					o														
2a	DORNIER/JAMESON	0.1	x	x			x	x	x	x						x	x	x	x		
		0.2																			
		0.44																			
		0.5	x	x			x	x	x	x						x	x	x	x		
		0.8	x	x			x	x	x	x						x	x	x	x		
		0.95																			
2b	DORNIER/JAMESON	0.1	x	x	x			x	x	x			x	x	x						
		0.2											x	x	x						
		0.44											x	x	x						
		0.5	x	x	x			x	x	x			x	x	x						
		0.8	x	x	x			x	x	x			x	x	x						
		0.96											x	x	x						
3a	FFA	077	x	x	x		x	x	x	x						x	x	x	x		x
		132																			
		191																			
		468	x	x	x		x	x	x	x						x	x	x	x		x
		543																			
		818	x	x	x		x	x	x	x						x	x	x	x		x
		950																			
4	MBB	041											x	x	x						
		122	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x
		204											x	x	x						
		367											x	x	x						
		531	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x
		694											x	x	x						
		776	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x
		857											x	x	x						
		937											x	x	x						

x = INCLUDED IN REPORT
o = ADDITIONAL PLOT GARTEUR SCALE
Y/C = SECTIONS AVAILABLE

The total number of meshpoints used was completely different:

			TC 11	TC 12
(1)	ONERA		54 150	36 414
(2)	DORNIER/JAMESON	a	23 409	23 409
		b	175 329	175 329
(3)	FFA	a	38 400	38 400
		b	307 200	-
(4)	MBB		18 900	18 900

Results for the "fine grid" solution from A. Rizzi (3b) will be presented in a separate Appendix A after Chapter 8.

Whereas integrated values for lift are within 10 % scatter, the drag shows strong dependency on the mesh-grid refinement. The results for coarse grids (2a), (4) are unreliable, the differences can be explained by looking at the values obtained for pressure near the leading and trailing edges at all wing sections.

The completeness of each contribution can be checked by comparing the Table 7-3 with the standard format Table 7-4 which was originally requested by the Working Group. There is only one method which uses the energy equation (4), the others keep total temperature constant by definition.

7.3.2 DESCRIPTION OF METHODS

7.3.2.1 PRINCIPLES OF THE NUMERICAL METHOD
M. Neron (ONERA) and C. Koeck (MATRA)

The Euler equations are numerically solved by a pseudo unsteady type method assuming that the stagnation enthalpy is constant ($T_i = T_{i_\infty}$). The continuity and momentum equation are integrated step by step in time, using an explicit predictor-corrector scheme with a local time step technique.

The spatial derivates are discretized directly in the physical space (x, y, z) by means of finite difference formulae. The treatment of the boundary conditions is

Table 7-3 AGARD TC 11, COMPLETENESS OF CONTRIBUTIONS RECEIVED

AGARD WG07 TC11 / M = 0.84, α = 3.06

CONTRIBUTION		CONTOUR MAPS								TOTAL COEFF.		
		UPPER SURFACE				LOWER SURFACE						
No.	COMPANY	M	1-P/PINF	1-Pi/PINF	1-Ti/TINF	M	1-P/PINF	1-Pi/PINF	1-Ti/TINF	C_L	C_M	C_D
1	ONERA/MATRA	x	x	x		x	x	x				
2a	DORNIER/JAMESON	x	x	x		x	x	x		x	x	x
2b	DORNIER/JAMESON	x	x	x		x	x	x		x	x	x
3a	FFA	x	x	x			x	x		x	x	
4	MBB	x	x	x	x	x	x	x	x	x	x	x

Table 7-4 SCALES REQUESTED FOR PRESENTATION OF DATA

AGARD WG 07 - ONERA M 6

Scale for presentation of data

- Contour maps

  root = 13.5 cm
  span = 20.0 cm

  ISO-Mach $\Delta = 0.05$
  $1 - p/p_{1_\infty}$ $\Delta = 0.025$
  $1 - p_1/p_{1_\infty}$ $\Delta = 0.005$
  $1 - T_1/T_{1_\infty}$ $\Delta = 0.001$

- Spanwise sections

  y/s = 0.1 / (0.2)* / (0.44)* / 0.5 / 0.8 / (0.95)*

  x/c 1.0 ≙ 5 cm

  ISO-Mach $\Delta = 0.05$
  $1 - p/p_{1_\infty}$ $\Delta = 0.025$
  $1 - p_1/p_{1_\infty}$ $\Delta = 0.005$
  $1 - T_1/T_{1_\infty}$ $\Delta = 0.001$
  } Field

  x/c 1.0 ≙ 10 cm
  (TC 12: x/c 1.0 ≙ 20 cm)*
  (TC 11: x/c 1.0 ≙ 15 cm)*

  Mach 0.1 ≙ 1.0 cm
  $1 - p/p_{1_\infty}$ 0.05 ≙ 1.0 cm
  $1 - p_1/p_{1_\infty}$ 0.01 ≙ 1.0 cm
  $1 - T_1/T_{1_\infty}$ 0.01 ≙ 1.0 cm
  $-c_p$ 0.2 ≙ 1.0 cm
  } Surface

*optional for comparison of c_p with AGARD AR 138 (exp. data)

achieved by a technique based on compatibility relations. The main features of the numerical method are described in Ref. 7-1, Ref. 7-2, Ref. 7-3.

The mesh, which is of C-O type, is symmetrical with respect to the (z = 0) plane, as the M6 wing itself.

The basic numerical scheme is the MacCormack scheme, being non-centered and therefore non-isotropic, the computational domain has been divided into two parts, respectively for the upper and lower half-spaces, in order to compute the flow in both sub-domains by symmetrical discretizations.

Artificial viscosity terms are added to the equation in order to insure the stability of the scheme, and in order to correctly capture shocks. Two extra-terms are added after the computation of the corrector step, noted f^{n+1} and the final value of the variable f, noted f^{n+1}, is given by:

$$f^{n+1} = \overline{f^{n+1}} + D_1(f^n) + D_2(f^n)$$

The first term is a smoothing term added to each variable. It is of the form:

$$D_1(f^n) = -(Q_{1i}\,\delta_i^{(4)} f^n + Q_{1j}\,\delta_j^{(4)} f^n + Q_{1k}\,\delta_k^{(4)} f^n)$$

$$\text{with } \delta_i^{(4)} f = f_{i+2} - 4f_{i+1} + 6f_i - 4f_{i-1} + f_{i-2}$$

Q_{1i}, Q_{1j} and Q_{1k} are three constants.

Two different types of term D_2 have been used:

Type A:

$$D_2(f^n) = c_i\,\delta_i^{(2)} f^n + c_j\,\delta_j^{(2)} f^n + c_k\,\delta^{(2)} f^n$$

$$\text{with} \quad c_i = Q_{2i}\left|g_{i+1} - 2g_i + g_{i-1}\right|/g_i$$

$$\delta_i^{(2)} f = f_{i+1} - 2f_i + f_{i-1}$$

Q_{2i}, Q_{2j} and Q_{2k} are three constants; D_2 is added to each variable.

Type B:

Now, the term D_2 is added only to the momentum equation. The form of D_2, for instance for the x-component, is:

$$(D_2)_x = \Delta t_{ijk}\left(\frac{Q_{2i}}{4_{hi}}\left[(g_{i+i} + g_i)\left|u_{i+1} - u_i\right|(u_{i+1} - u_i)\right.\right.$$

$$\left. - (g_i + g_{i-1})\left|u_i - u_{i-1}\right|(u_i - u_{i-1})\right]$$

$$\left. + \text{following terms for } j \text{ and } k\right)$$

Q_{2i}, Q_{2j}, Q_{2k} are constants.

$h_i = 1/NPI$, with NPI equal to the number of mesh surfaces of index i.

Slip conditions are applied on both the wing surface and the root sidewall boundary. On the inflow boundary, the total pressure and the direction of the velocity vector are given. A non-reflective condition is used for the outflow boundary. Periodicity conditions are used for the inner boundaries, that is, here, at the cut between the upper and lower sub-domains (z = 0 plane).

Initial conditions are the uniform flow:

$$\vec{V} = \vec{V}_\infty$$

$$g = g_\infty$$

Type A of artificial viscosity is used for TC 11; the constants are:

$$(Q_{1i}, Q_{1j}, Q_{1k}) = (0.001, 0.003, 0.002)$$

$$(Q_{2i}, Q_{2j}, Q_{2k}) = (0.10, 0.20, 0.15)$$

Fig. 7-1 to 7-5 illustrate the mesh-grid used for representation of wing and flow field. Three additional Fig. 7-6, 7-7 and 7-8 show the solution for cross-flow velocity near the wing tips.

7.3.2.2 PRINCIPLES OF THE NUMERICAL APPROACH
W. Schmidt (Dornier)/A. Jameson (Princeton)

The numerical method to solve the time-dependent Euler equations is described in detail in Ref. 7-4 and 7-C

The version used is the unsplit four-stage two-level scheme with the enthalpy-forcing term and the local time stepping. A blend of second and fourth differences is used to construct dissipative terms of a filter-type.

The farfield boundary conditions are nonreflecting and allow either for sub- or supersonic freestream Mach numbers.

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
ONERA/MATRA (1a)

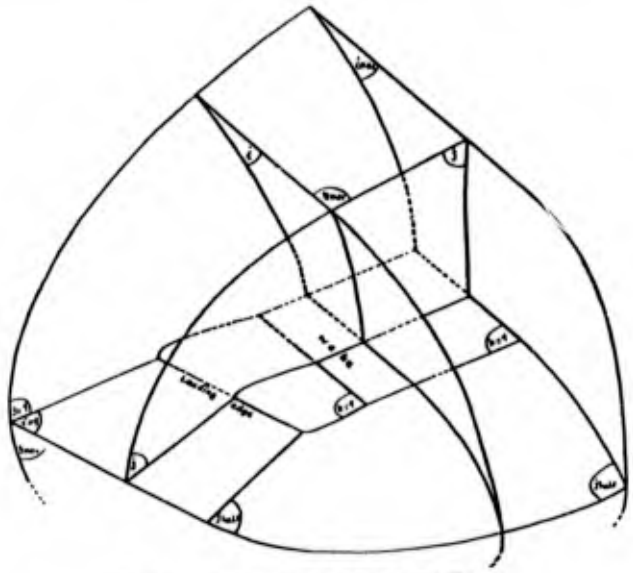
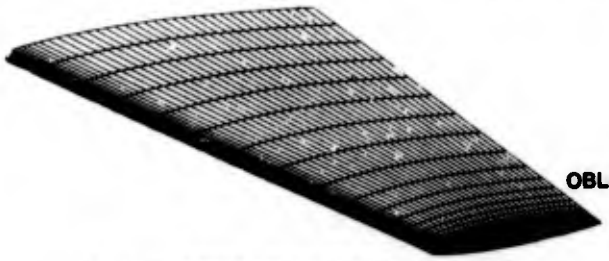


Fig. 7-1 MESH-GRID BOUNDARIES



OBLIQUE VIEW OF THE MESH ON THE WING

Fig. 7-2 REPRESENTATION OF WINC TIPS

PLANAR VIEW OF THE MESH SURFACE

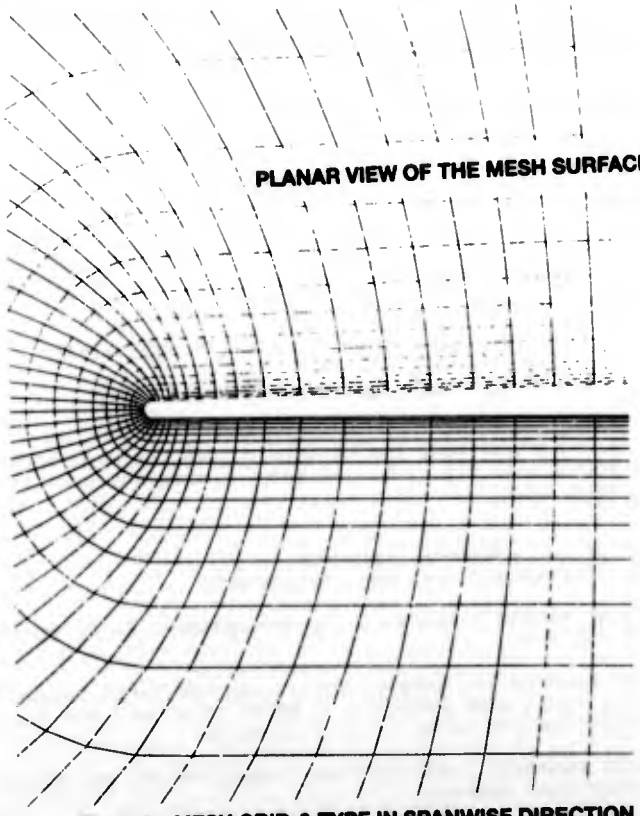


Fig. 7-3 MESH GRID-0-TYPE IN SPANWISE DIRECTION

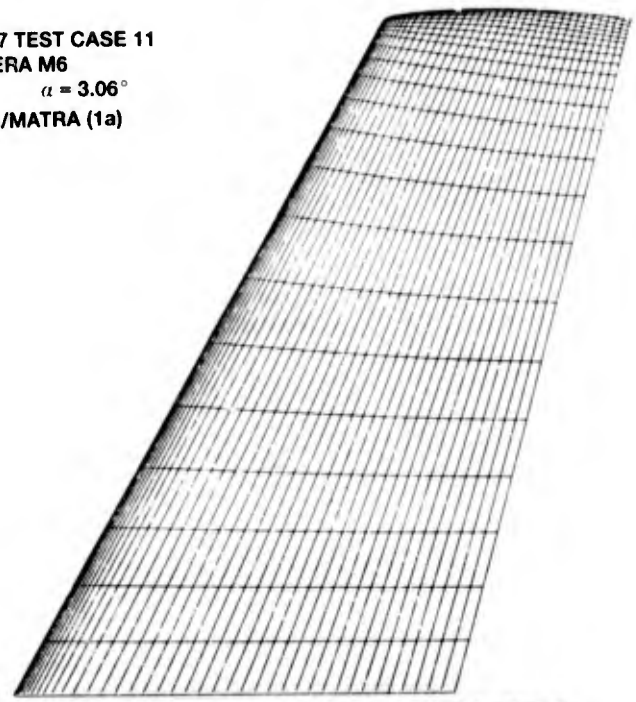


Fig. 7-4 MESH GRID ON WING UPPER SURFACE

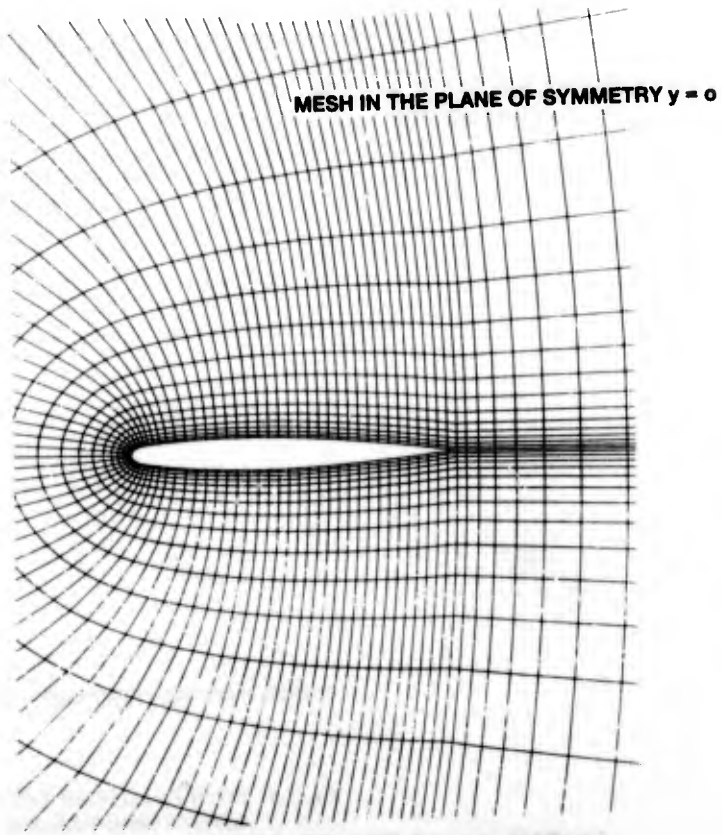


Fig. 7-5 C-C TYPE MESH GRID AT WING SECTIONS

CROSS-FLOW VELOCITY MESH SURFACE i = 38

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
ONERA/MATRA

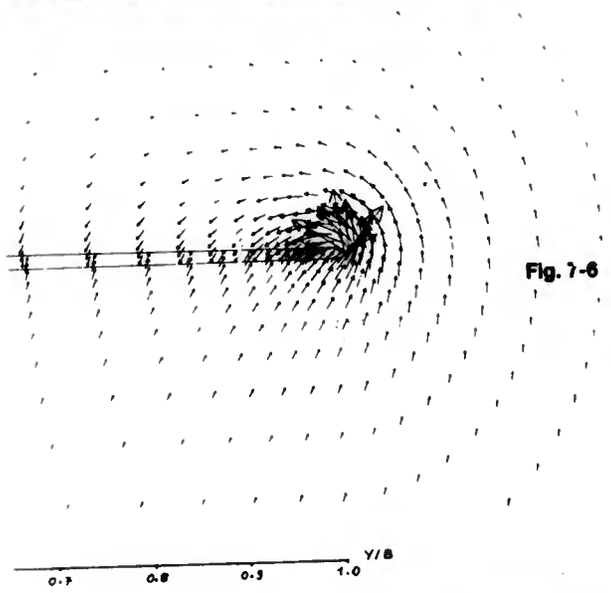


Fig. 7-6 FLOW FIELD NEAR THE WING TIP, SPANWISE SECTION ON WING PLANFORM

CROSS-FLOW VELOCITY MESH SURFACE i = 42

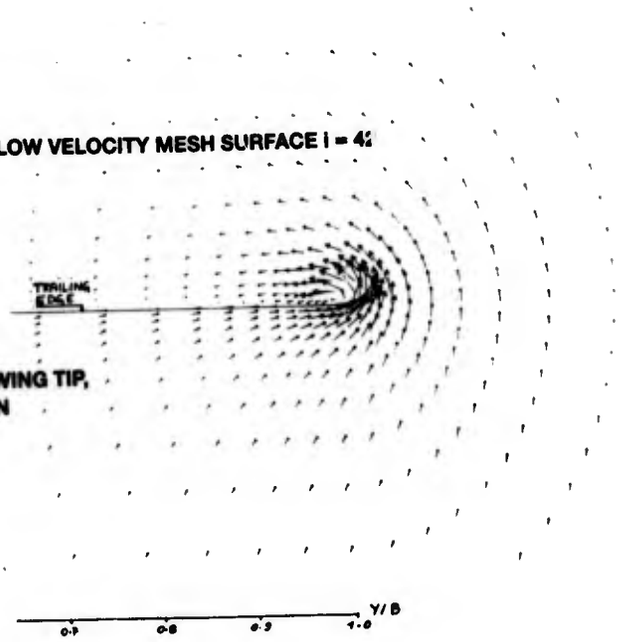


Fig. 7-7 FLOW FIELD NEAR THE WING TIP, TRAILING EDGE SECTION

CROSS-FLOW VELOCITY MESH SURFACE i = 46

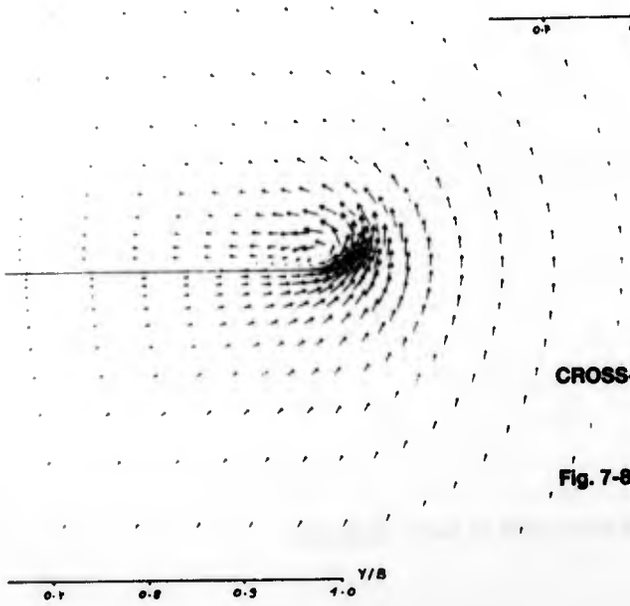


Fig. 7-8 FLOW FIELD NEAR THE WING TIP, BEHIND WING TRAILING EDGE

All solid surfaces have no-flux boundary conditions, the wall pressure being extrapolated from the field. No special treatment is given to any wakes or vortices emanating from leading or trailing edges.

A C-H Type mesh-grid was used to solve the equations. To study the effect of mesh-grid refinement two grids were investigated. A "medium grid" 81x17x17 and a "fine grid" 161x33x33 solution will be presented within this report. The extension of the outer boundaries is shown in Fig. 7-9, the distribution of grid points on the wing surface can be taken from Fig. 7-10. The wing surface was defined by constant wing sections using the numbers from Table 7-5.

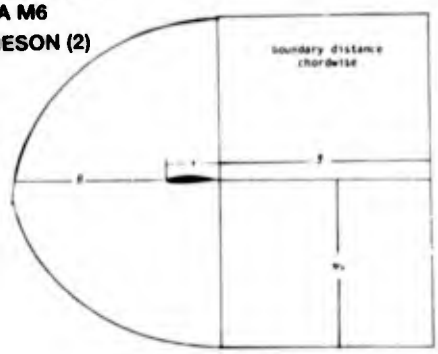
Table 7-5 DEFINITION OF WING SECTIONS USED BY DORNIER/JAMESON

AGARD WG07 TEST CASE
ONERA M6

POINT DISTRUBUTION x/c FOR ALL WING SECTIONS

UPPER SURFACE		LOWER SURFACE	
0.0	0.0	1.00000	0.0
0.00022	0.00249	0.99380	-0.00077
0.00088	0.00525	0.98589	-0.00175
0.00223	0.00824	0.97582	-0.00299
0.00429	0.01134	0.96298	-0.00458
0.00715	0.01453	0.94661	-0.00661
0.01092	0.01765	0.92576	-0.00918
0.01569	0.02059	0.89917	-0.01239
0.02154	0.02320	0.86966	-0.01580
0.02853	0.02542	0.84101	-0.01894
0.03671	0.02728	0.81318	-0.02183
0.04616	0.02895	0.78615	-0.02450
0.05701	0.03064	0.75989	-0.02699
0.06945	0.03241	0.73436	-0.02933
0.08370	0.03424	0.70953	-0.03153
0.10004	0.03611	0.68537	-0.03360
0.11876	0.03800	0.66183	-0.03554
0.13860	0.03975	0.63889	-0.03736
0.15813	0.04125	0.61651	-0.03904
0.17736	0.04255	0.59466	-0.04059
0.19633	0.04369	0.57330	-0.04201
0.21507	0.04468	0.55240	-0.04329
0.23362	0.04554	0.53191	-0.04442
0.25201	0.04629	0.51182	-0.04542
0.27027	0.04693	0.49207	-0.04627
0.28844	0.04747	0.47265	-0.04699
0.30656	0.04791	0.45351	-0.04758
0.32464	0.04825	0.43462	-0.04803
0.34274	0.04849	0.41595	-0.04836
0.36089	0.04862	0.39746	-0.04856
0.37912	0.04865	0.37912	-0.04865
0.39746	0.04856	0.36090	-0.04862
0.41595	0.04836	0.34275	-0.04849
0.43462	0.04803	0.32465	-0.04825
0.45350	0.04758	0.30656	-0.04791
0.47264	0.04699	0.28845	-0.04747
0.49207	0.04627	0.27028	-0.04693
0.51181	0.04542	0.25201	-0.04629
0.53191	0.04442	0.23362	-0.04554
0.55239	0.04329	0.21507	-0.04468
0.57329	0.04201	0.19633	-0.04369
0.59466	0.04059	0.17736	-0.04255
0.61651	0.03904	0.15813	-0.04125
0.63889	0.03736	0.13860	-0.03975
0.66183	0.03554	0.11876	-0.03800
0.68536	0.03360	0.10004	-0.03612
0.70953	0.03153	0.08371	-0.03424
0.73436	0.02933	0.06945	-0.03241
0.75989	0.02699	0.05702	-0.03064
0.78615	0.02450	0.04617	-0.02895
0.81318	0.02183	0.03671	-0.02728
0.84100	0.01894	0.02853	-0.02542
0.86966	0.01580	0.02154	-0.02321
0.89917	0.01239	0.01569	-0.02059
0.92575	0.00918	0.01093	-0.01765
0.94661	0.00661	0.00715	-0.01454
0.96297	0.00458	0.00429	-0.01135
0.97581	0.00299	0.00223	-0.00824
0.98589	0.00175	0.00088	-0.00525
0.99380	0.00077	0.00022	-0.00249
1.00000	0.0	0.0	0.0

AGARD WG07 TEST CASE
ONERA M6
DORNIER/JAMESON (2)



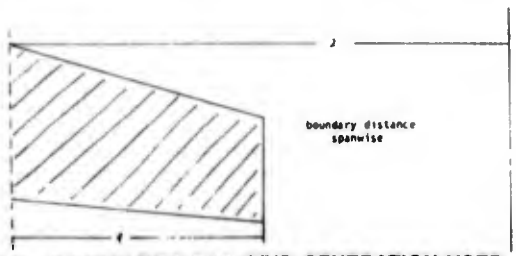


Fig. 7-9 BOUNDARIES FOR GRID GENERATION USED FOR THE DORNIER/JAMESON CONTRIBUTION

AGARD WG07 TEST CASE
ONERA M6
DORNIER/JAMESON (2b) "FINE GRID"

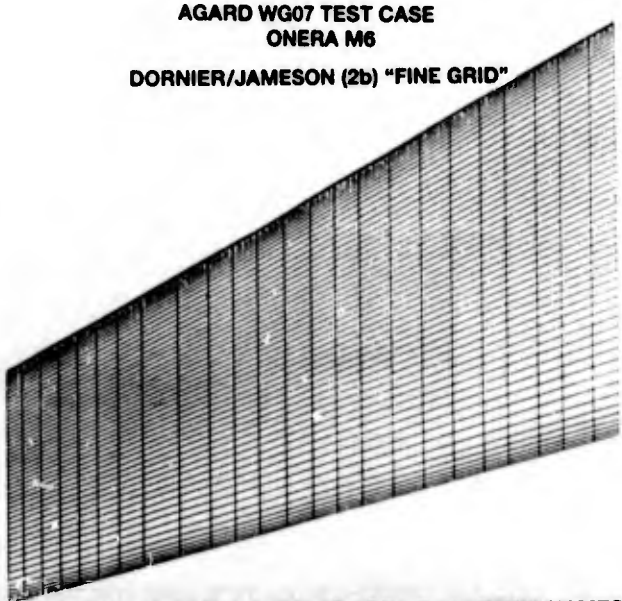
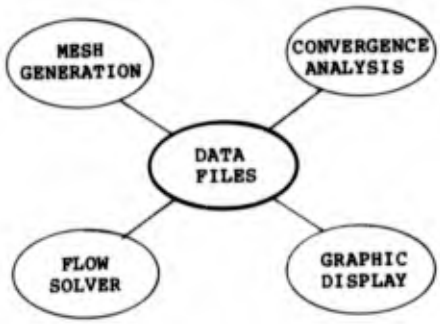


Fig. 7-10 MESH-GRID ON ONERA M6 – WING SURFACE USED BY DORNIER/JAMESON

7.3.2.3 THE AERODYNAMIC FLOW CODE FOR CYBER 205 - WING A2
Art Rizzi (FFA)

The numerical solution of the Euler equations for flow past wings of arbitrary geometry is carried out by a set of software modules called WING A2 organized around common data files.

The first module is a pre-solution processor that constructs an O-O mesh around the wing. The second, the main processor itself, solves the Euler equations for steady compressible flow upon the generated mesh. Following the solution procedure is a sophisticated post-processing graphics module to visually display the results from the computation. This set of modules WING A2 has been written in special FORTRAN to obtain a high degree of vector processing on the CYBER 205 and offers to the aircraft designer a fast and easy-to-use tool for aerodynamic flow analysis.



Lastly another type of post-processor has been devised to aid the numerical analysis in understanding the method's convergence to a steady-state solution. It analyzes the least-damped transient modes in the eigen-decomposition of the solution. The eigensystem analysis is carried out numerically by computer and the results are displayed graphically.

GRID GENERATION USING TRANSFINITE INTERPOLATION

The computer program of a computational procedure for generating 3D nonorthogonal surface-fitted mesh systems around either trapezoidal or delta wings is based on the concept of transfinite interpolation (Ref. 7-6). The theory has been extended to handle very general mapping-function specifications at the boundaries, thereby making it possible to generate single-block O-O mappings with geometry data specified only at the outer boundaries of the computational domain. Since it is a direct algebraic mapping technique, the method is very inexpensive in terms of computer costs. This fact allows the user to experiment freely with the control parameters and quickly obtain the desired mesh. One version of the computer program can generate grids around most types of medium-to-large aspect ratio trapezoidal wings of practical aerodynamic interest while another version treats highly swept delta wings. They have been written in a way that the nonspecialist should find convenient and simple to use. Since the eye is one of the best judges of overall mesh quality, this module contains a powerful graphics package to display the mesh with great flexibility in cross-section, plane perspective or zoom views. The mesh grid used for the calculation of TC 11 and 12 is shown in Fig. 7-11.

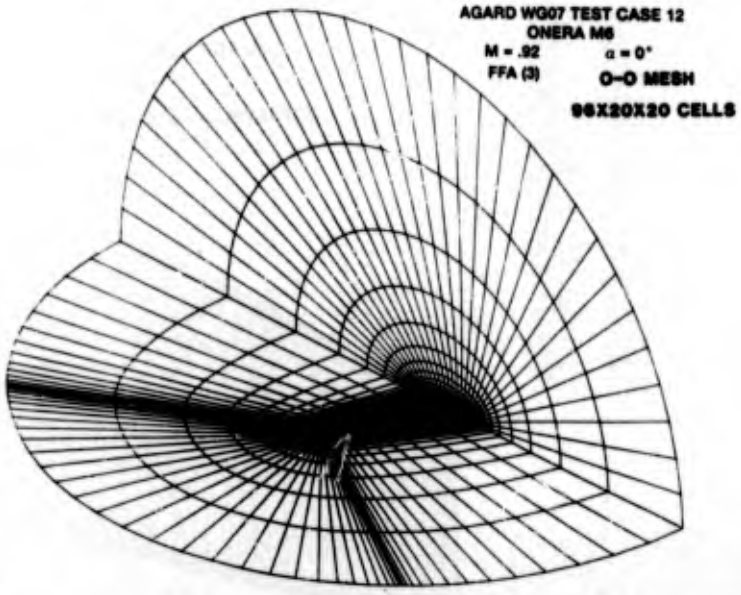


Fig. 7-11 MESH-GRID O-O TYPE USED FOR THE CONTRIBUTION OF A. RIZZI (FFA)

FINITE VOLUME PROGRAM TO SOLVE THE STEADY EULER EQUATIONS

Numerical methods to solve the Euler equations have become useful and realistic tools for the simulation of inviscid transonic flows that contain either strong shock waves or complex vortex structure.

This computer program solves the steady Euler equations for transonic flow upon an O-O mesh generated by transfinite interpolation around either moderately swept trapezoidal wings or highly swept delta wings. It is founded on an explicit time-marching finite-volume procedure to solve the flow equations and features a nonreflecting boundary condition and an internal mechanism for temporal damping together with a refined model for artificial viscosity (Ref. 7-7). The method has been coded in special vector FORTRAN specifically for the CYBER 205 so that the vector-processing unit of the machine is utilized almost exclusively (Ref. 7-8). For a typical case vectors with more than 20,000 elements are realized, and a rate of over 50 megaflops is sustained during the entire computation which indicates the high degree of vectorization that is achieved. Converged solutions are reached usually after only several minutes of CPU time.

The program consists of about 1300 FORTRAN statements. An example of the time iteration to steady state of the transient residual, number of supersonic points, and lift and drag is given for flow past the M6 wing.

COMPUTER GRAPHICS FOR 3D FLOWFIELD VISUALIZATION

Once the flowfield is computed the user needs to see the results displayed graphically in order to judge the overall correctness of the computation, to grasp the physical nature of the flow, and to detect unexpected phenomena. In most cases the usual chordwise section plots of pressure coefficient versus chord length is insufficient. In addition to the dependent flow variables (density and momentum), vorticity, velocity vectors, and loss in total head (total pressure) are useful properties to help visualize the flowfield since vortex phenomena are so prevalent in aerodynamic flows. The vorticity vector is determined by approximating the curl of the velocity field through the implementation of a finite-volume concept that corresponds to the one used to solve the flowfield.

The program is highly flexible and offers its user the possibility to investigate any or all of the flow properties: pressure, Mach number, total pressure loss, vorticity, magnitude, and velocity vectors. He can choose to display those located on the wing surface in the usual chordwise or spanwise graph, or, to gather information about the entire 3D field, he can construct 3D isograms of these properties in any of the three families of coordinate surfaces. With the specification of a viewing angle and frame, the isograms in one or multiple surfaces can be selected for the composition of a single picture seen in plane projection. Much of the program is written in special vector FORTRAN for the CYBER 205. The user composes the desired display through a straightforward set of input instructions which the nonspecialist will find easy to master (Ref. 7-9).

COMPUTER PROGRAM TO ANALYZE THE FLOW SOLVER'S CONVERGENCE TO STEADY STATE

By means of numerical differentation and approximate eigensystem analysis this program can be used to study the behaviour of the centered finite-volume scheme of the flow solver for the isoenergetic Euler equations in two space dimensions. The entire semi-discrete approximation including boundary conditions is formulated as a large system of ordinary differential equations which are linearized by numerically approximating the Frechét derivative. An approximate eigensystem procedure that only needs the Frechét derivative is used to extract the least damped eigenmodes. The overall method has been applied to the case of transonic flow past an airfoil and has revealed that the most persistent transient modes are highly structured and are associated with eigenvalues of small modulus (Ref. 7-10). Furthermore, they appear to be centered around the shock region, the stagnation region and the trailing edge/wake region of the airfoil as the plots of the most persistent eigenvectors indicate.

The insight gained from this information has been very helpful for devising boundary conditions and for improving models of artificial viscosity. In addition it can be used by the advanced numerical analyst to aid him in constructing techniques to accelerate the solution's convergence to steady state.

7.3.2.4 THE MBB 3D EULER ALGORITHM

A. Eberle (MBB)

The procedure used for the generation of the WG07 results is a characteristic finite volume code which makes use of the observation that in a finite volume code neither the fluxes nor the flow variables are defined at the cell faces since they separate a left and right state by step functions. So we need an averaging procedure prior to calculating the fluxes there. A simple device for this purpose would be for example the arithmetic mean of each individual flux as it is done in the centered diffusive schemes which have become popular recently.

In contrast to this approach MBB has developed an asymmetric weighting procedure for the flow variables at the cell faces which is based on the eigenvalue decomposition of the Euler equations: We first define a left and right state by linear combinations of the flow quantities of the two adjacent cells on each side of a volume cell face. Upon weighting these states by the elements of the characteristic split matrix the averaged flow values at the cell faces are obtained from which the conventional Euler fluxes are formed there. For updating the cell midpoint values the usual centered difference operator is then applied on the fluxes.

The scheme is second order accurate in space and first order accurate in time in the pseudo unsteady version. It solves all five equations including the energy equation. It is perfectly entropy conditioned (no wiggle at sonic surfaces, shocks extend over never more but two cells regardless of the shock strength). It only requires one grid sweep per time step, needs no farfield absorbing boundary algorithm (since this is automatically included in the interior point algorithm by the eigenvalue sign logic), is total variation diminishing, runs at a linear analysis CFL number of .5, makes use of local time stepping without consistency violation and needs only one complete solution vector which in these calculations was stored permanently in the core memory. The calculations were performed on a DIGITAL VAX computer and needed 2000 iterations each.

The details of the method are documented in Ref. 7-11.

Fig. 7-12 shows the dimensions for the outer boundaries used to generate a meshgrid of C-H Type according to Fig. 7-13. Fig. 7-14 gives the distribution of grid points on the upper and lower wing planform.

As in the contribution by ONERA/MATRA some selected results for the calculated flow field velocity vectors are plotted in Fig. 7-15, 16, 17.

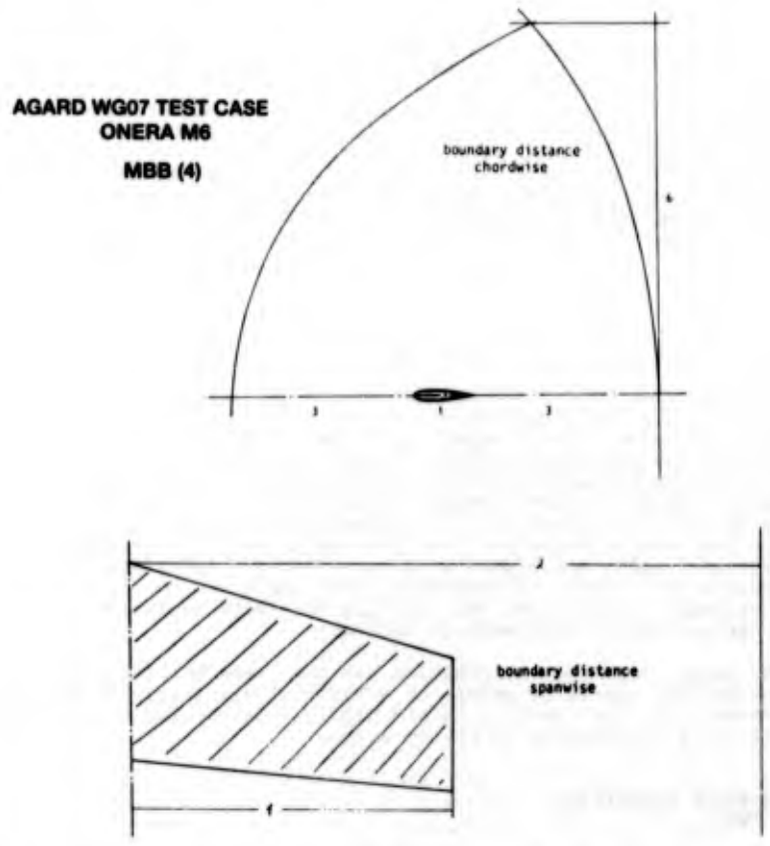


Fig. 7-12 BOUNDARIES FOR GRID GENERATION USED FOR THE MBB CONTRIBUTION

AGARD WG07 TEST CASE
ONERA M6
MBB (4)

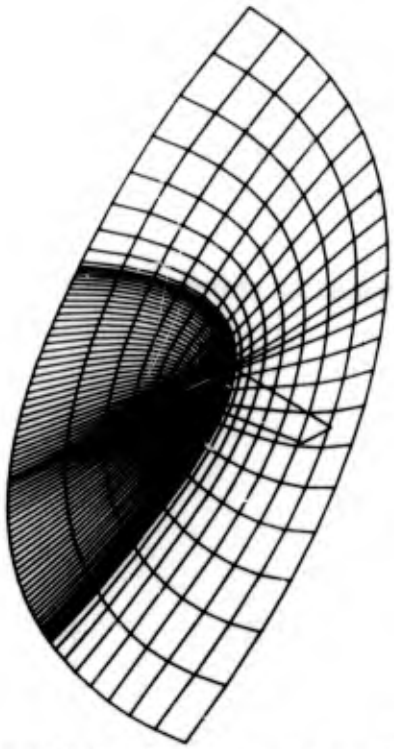


Fig. 7-13 C-C TYPE OF MESH-GRID AT WING SECTIONS USED BY MBB

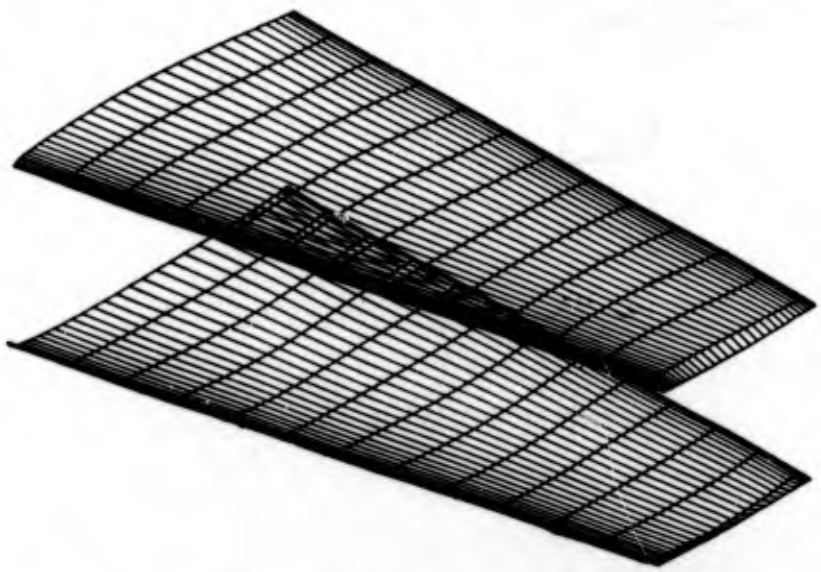


Fig. 7-14 MES-GRID ON ONERA M6 – WING SURFACE USED BY MBB

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
MBB (4)

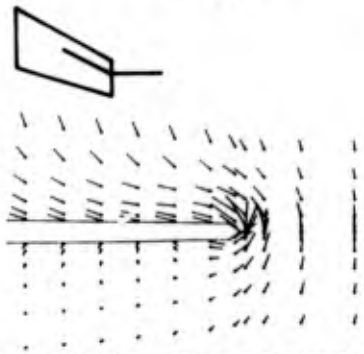


Fig. 7-15 FLOW FIELD NEAR WING TIP, SPANWISE SECTION ON WING PLANFORM NEAR WING L.E. (MBB)

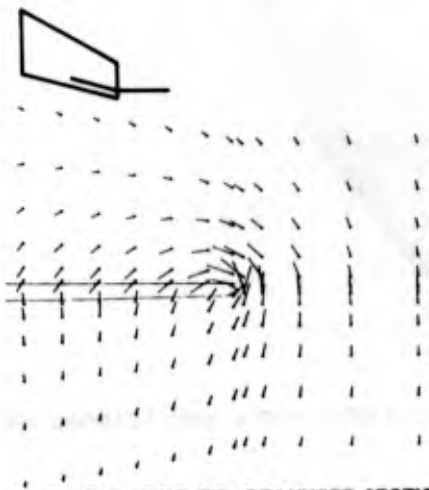


Fig. 7-16 FLOW FIELD NEAR WING TIP, SPANWISE SECTION ON WING PLANFORM NEAR WING T.E. (MBB)

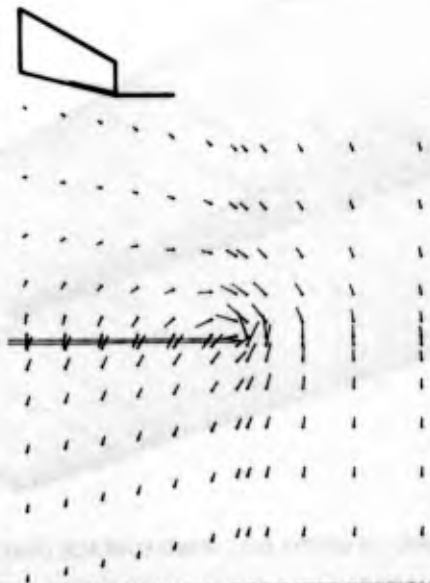


Fig. 7-17 FLOW FIELD NEAR WING TIP, SPANWISE SECTION ON WING PLANFORM AT WING T.E. (MBB)

7.3.3 PLANFORM CONTOUR MAPS

In order to obtain a quick survey on the structure of data obtained, contour maps of the wing upper and lower surface were plotted. Figs. 7-18 to 7-20 show the comparison of calculated lines for constant values ("ISO-lines") of

local Mach number
$1 - p/p_{i_\infty}$ (static pressure)
$1 - p_i/p_{i_\infty}$ (total pressure).

Due to the different representation of the real wing tip geometry the most severe differences between the 4 contributions occur in this region. For the contributions of ONERA/MATRA and FFA the numbers for the ISO-line-values are given. The numbers specified in the second contribution by DORNIER/JAMESON are correlated to calculated values according to table 7-6. No values are given for the ISO-plots of MBB.

In Figs. 7-21 and 7-22 the influence of mesh-grid density is demonstrated. From DORNIER/JAMESON two calculations were obtained. One for a 23409 point-solution ("medium" grid) and one for a 175329 point-solution ("fine" grid).

Table 7-6 CORRESPONDANCE BETWEEN NUMBERS AND CALCULATED VALUES FOR DORNIER/JAMESON (2A,2B)

ISO-MACH-LINES		ISO-P/PINF-LINES		ISO-PI/PIINF-LINES	
MEDIUM (2a)	FINE (2b)	MEDIUM (2a)	FINE (2b)	MEDIUM (2a)	FINE (2b)
1 #.65###	1 #.#5###	1 #.025##	1 -#.075##	1 #.##5##	1 #.##5##
2 #.6#####	2 #.1#####	2 #.05###	2 -#.05###	2 #.01###	2 #.01###
3 #.65###	3 #.15###	3 #.075##	3 -#.025##	3 #.015##	3 #.015##
4 #.7#####	4 #.2#####	4 #.1####	4 -#.####	4 #.02###	4 #.02###
5 #.75###	5 #.25###	5 #.125##	5 #.025##	5 #.025##	5 #.025##
6 #.8#####	6 #.3#####	6 #.15###	6 #.05###	6 #.03###	6 #.03###
7 #.85###	7 #.35###	7 #.175##	7 #.075##	7 #.035##	7 #.035##
8 #.9#####	8 #.4#####	8 #.2####	8 #.1####	8 #.04###	8 #.04###
9 #.95###	9 #.45###	9 #.225##	9 #.125##	9 #.045##	9 #.045##
1# 1.####	1# #.5####	1# #.25###	1# #.15###	1# #.05###	1# #.05###
11 1.#5###	11 #.55###	11 #.275##	11 #.175##	11 #.055##	11 #.055##
12 1.1####	12 #.6####	12 #.3####	12 #.2####	12 #.06###	12 #.06###
13 1.15###	13 #.65###	13 #.325##	13 #.225##	13 #.065##	13 #.065##
14 1.2####	14 #.7####	14 #.35###	14 #.25###	14 #.07###	14 #.07###
15 1.25###	15 #.75###	15 #.375##	15 #.275##	15 #.075##	15 #.075##
16 1.3####	16 #.8####	16 #.4####	16 #.3####	16 #.08###	16 #.08###
17 1.35###	17 #.85###	17 #.425##	17 #.325##	17 #.085##	17 #.085##
18 1.4####	18 #.9####	18 #.45###	18 #.35###	18 #.09###	18 #.09###
19 1.45###	19 #.95###	19 #.475##	19 #.375##	19 #.095##	19 #.095##
2# 1.####	2# 1.####	2# #.5####	2# #.4####	2# #.1####	2# #.1####
21 1.#5###	21 1.#5###	21 #.525##	21 #.425##	21 #.105##	21 #.105##
22 1.1####	22 1.1####	22 #.55###	22 #.45###	22 #.11###	22 #.11###
23 1.15###	23 1.15###	23 #.575##	23 #.475##	23 #.115##	23 #.115##
24 1.2####	24 1.2####	24 #.6####	24 #.5####	24 #.12###	24 #.12###
25 1.25###	25 1.25###	25 #.625##	25 #.525##	25 #.125##	25 #.125##
26 1.3####	26 1.3####	26 #.65###	26 #.55###	26 #.13###	26 #.13###
27 1.35###	27 1.35###	27 #.675##	27 #.575##	27 #.135##	27 #.135##
28 1.4####	28 1.4####	28 #.7####	28 #.6####	28 #.14###	28 #.14###
29 1.45###	29 1.45###	29 #.725##	29 #.625##	29 #.145##	29 #.145##
3# 1.5####	3# 1.5####	3# #.75###	3# #.65###	3# #.15###	3# #.15###
31 1.55###	31 1.55###	31 #.775##	31 #.675##	31 #.155##	31 #.155##
32 1.6####	32 1.6####	32 #.8####	32 #.7####	32 #.16###	32 #.16###
33 1.65###	33 1.65###	33 #.825##	33 #.725##	33 #.165##	33 #.165##
34 1.7####	34 1.7####	34 #.85###	34 #.75###	34 #.17###	34 #.17###
35 1.75###	35 1.75###	35 #.875##	35 #.775##	35 #.175##	35 #.175##
36 1.8####	36 1.8####	36 #.9####	36 #.8####	36 #.18###	36 #.18###
37 1.85###	37 1.85###	37 #.925##	37 #.825##	37 #.185##	37 #.185##
38 1.9####	38 1.9####	38 #.95###	38 #.85###	38 #.19###	38 #.19###
39 1.95###	39 1.95###	39 #.975##	39 #.875##	39 #.195##	39 #.195##

7.3.4 FIELD CONTOUR MAPS

For a first overlook on the flowfield at wing section planes, three spanwise stations were specified to show the characteristic slope of local pressure and Mach number. Figs. 7-23 to 7-25 compare the results of all four contributors at the wing sections y/b = 0.1, 0.5 and 0.8. They show generally the same overall characteristics but the lines obtained for M = 1 are significantly different located.

7.3.5 COMPARISON OF SECTION CHARACTERISTICS

From a more conventional engineering point of view the comparison of computed results at the section surface is of more practical interest. Fig. 7-26 shows the slope of local Mach number at three different spanwise sections. At least on the upper surface the deviations are remarkable. Especially the shock position is scattering within 5% of the chord length. Even the shock strength is predicted different.

The same tendency can be seen in fig. 7-27 for the static pressure and fig. 7-29 (c_p). Following the lines of 2D test cases, an attempt was made to determine the quality of computed results. In fig. 7-28 total pressure losses are plotted and compared with each other.

Obviously due to the development of a double-shock-system the peak values are reaching more than 5%. The treatment of the first shock close to the leading edge results in complete different slope. Even negative values were obtained in two cases. In order to investigate the influence of the mesh-grid-size in fig. 7-30 and fig. 7-31 results obtained by DORNIER/JAMESON using two different grids are shown. This type of work should be continued until indication for a final definitive solution has been reached. At present time solutions up to 1 million mesh points are achievable.

7.3.6 CONVERGENCE HISTORY

One of the most important questions is the stage of convergence which a particular solution has achieved before the iteration process had to stop. Several criteria proposed by different authors have been demonstrated:

Slope of
- integrated lift and drag,
- maximum residual,
- mean residual,
- number of supersonic points

as a function of the no. of iterations or cycles. Fig. 7-32 compares the convergence rate for the contribution of ONERA/MATRA. The dependence of mesh-grid size can be seen in figs. 7-33 and 7-34. With rising number of mesh-grid points the convergence process needs more and more iterations (= computer time!). So it is worthwhile to look for a compromise between the no.of field points and the quality of the computational results.

7.3.7 SECTIONAL COEFFICIENTS

For practical applications the sectional coefficients are of importance. Due to the differences already shown in fig. 7-35 the local values for lift, drag and pitching moment differ generally, see fig. 7-35. Unfortunately for the contributions (1) and (3) representing the tip shape geometry better no integrated local coefficients have been obtained.

7.3.8. APPENDICES

In addition to the figures shown before, tabulated data have been assembled as appendices. Figures 7-A-1 to 7-A-12 show the calculated results for Mach, p/pi , pi3pi at three different spanwise stations. Figures 7-A-13 to 7-A-17 show the pressure distribution of ONERA/MATRA at the so-called "GARTEUR" sections plotted in a different scale for individual comparison.

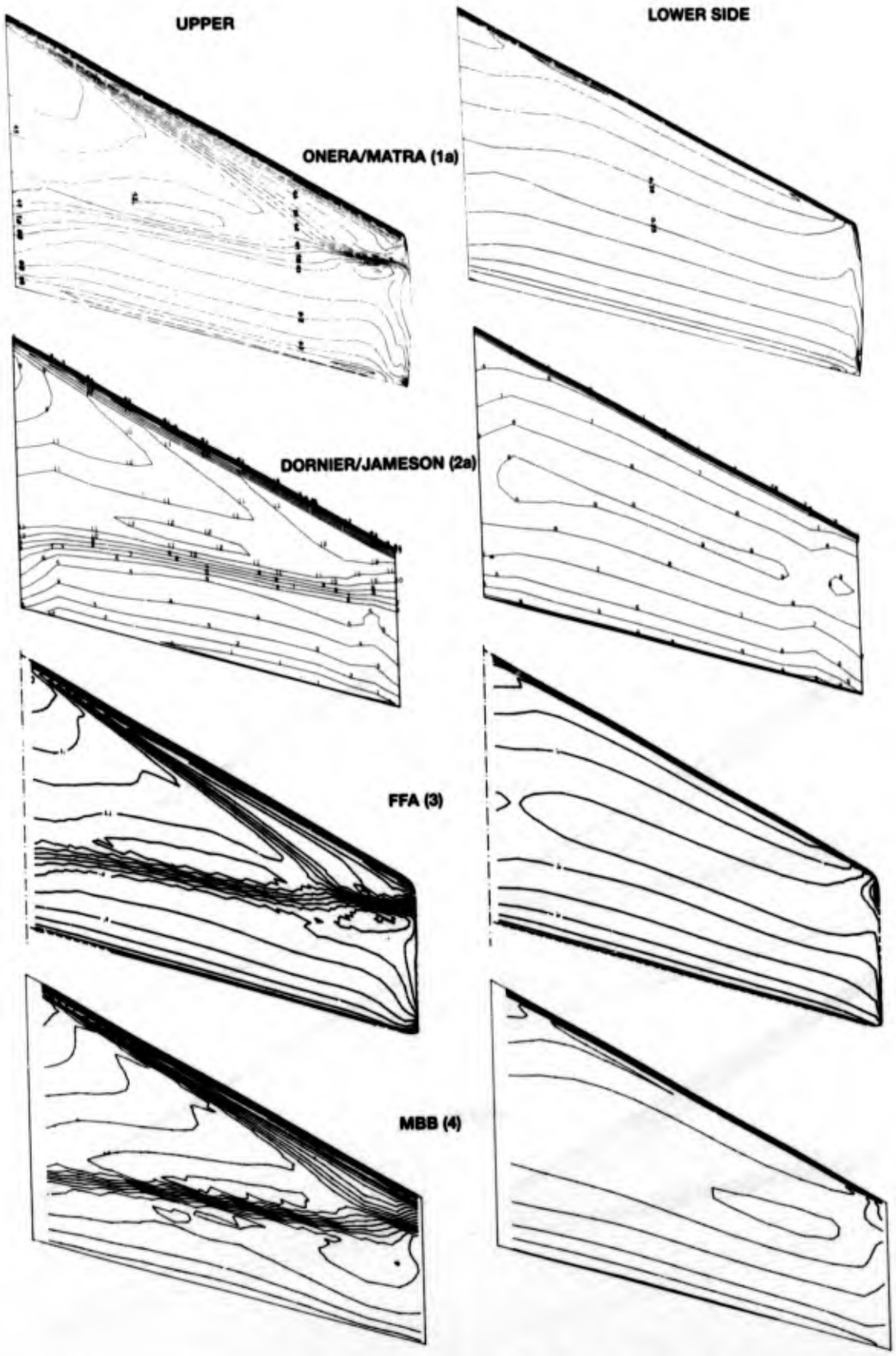


Fig. 7-18 AGARD WG07 TC11 ONERA M6 (M = .84, α = 3.06°) ISO MACH-LINES (INCR. = 0.05)

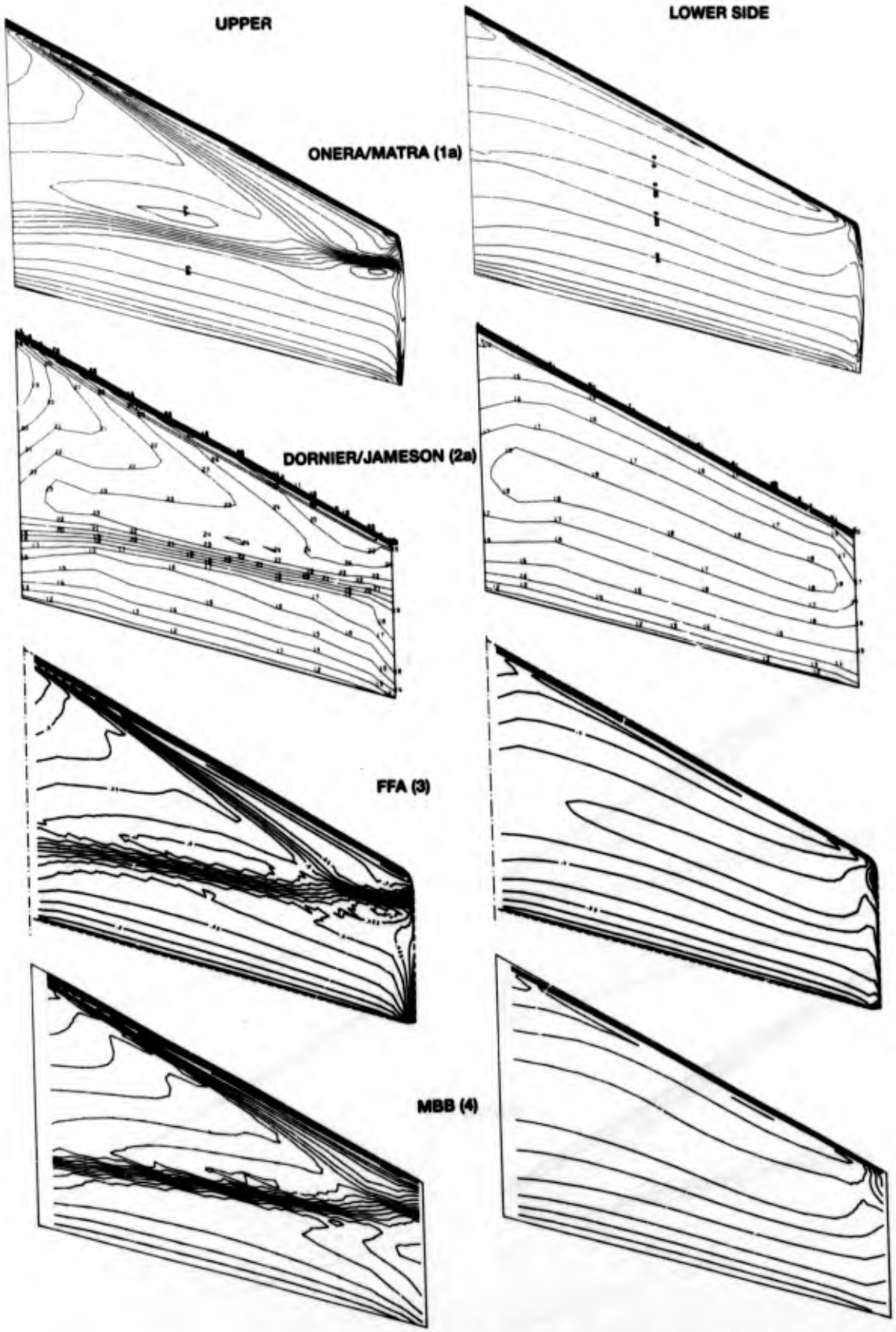


Fig. 7-19 AGARD WG07 TC11 ONERA M6 (M = .84, α = 3.04°) ISO P/PI INF-LINES (INCR. = 0.025)

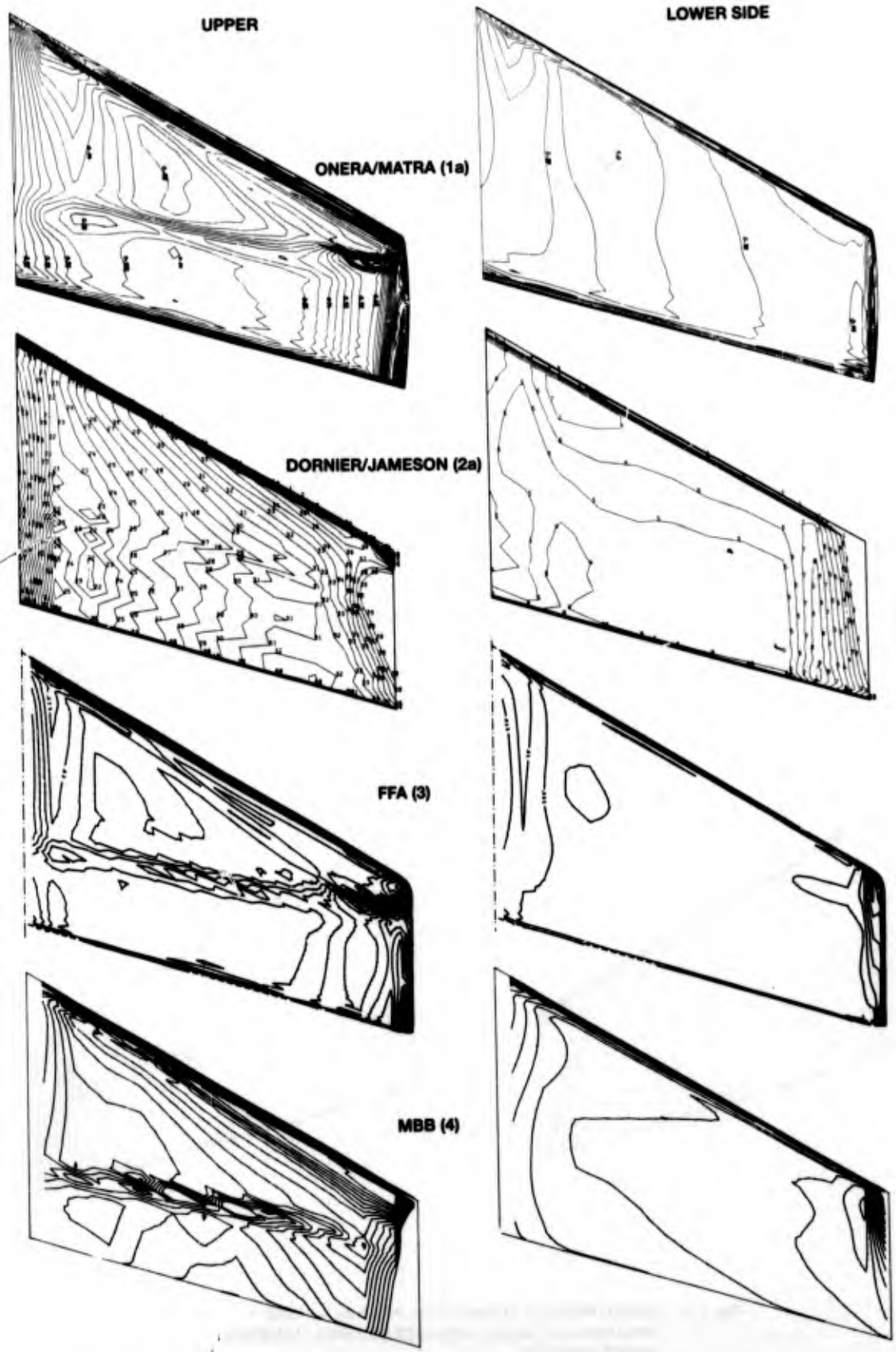


Fig. 7-20 AGARD WG07 TC11 ONERA M6 (M = .84, α = 3.06°) ISO PI/PI INF-LINES (INCR. = 0.025)

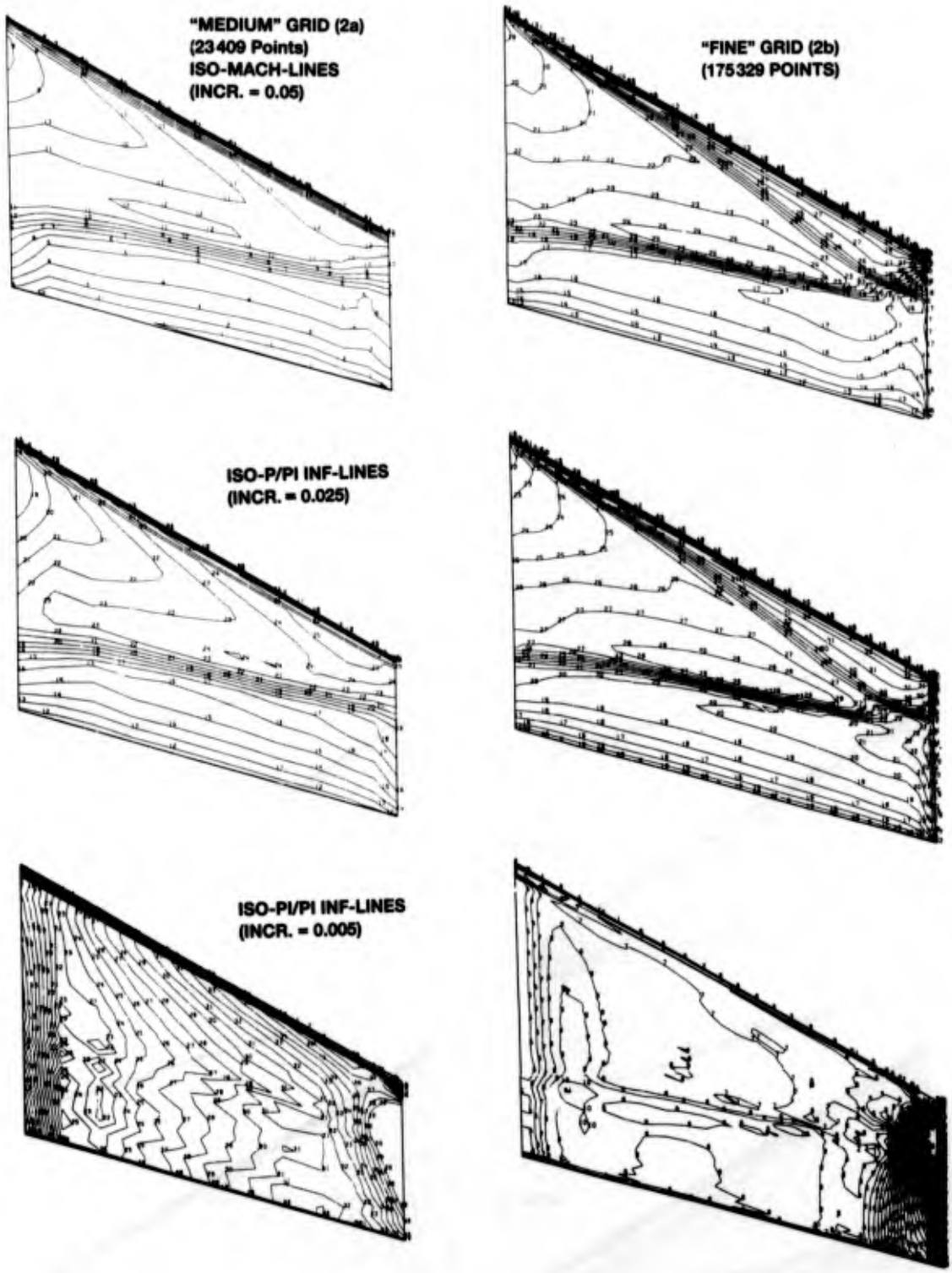


**Fig. 7-21 AGARD WG07 TC 11 ONERA M6 (M = 0.84, α = 3.06°)
INFLUENCE OF MESH-GRID-SIZE (DORNIER/JAMESON)
UPPER SURFACE**

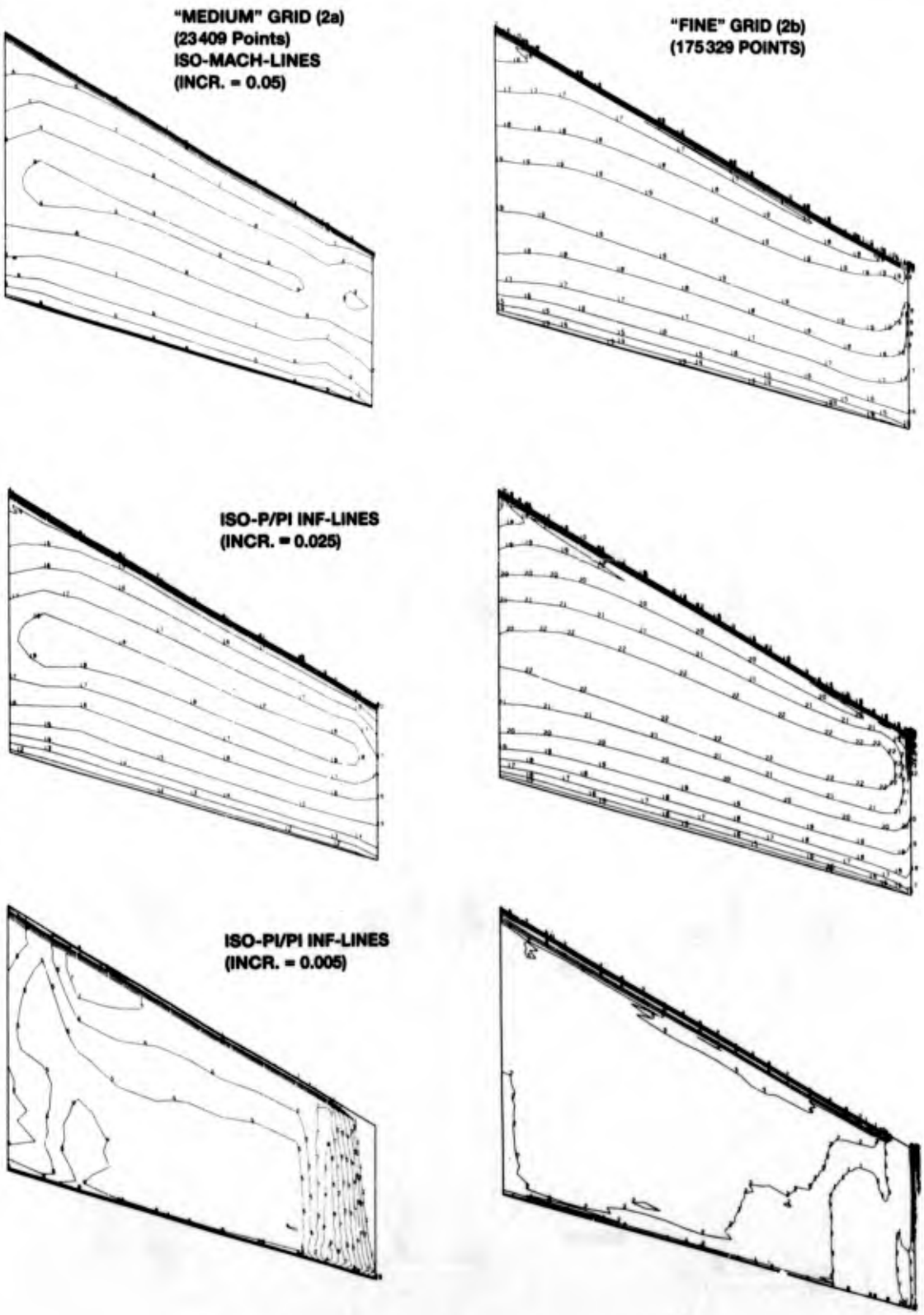


Fig. 7-22 AGARD WG07 TC 11 ONERA M6 (M = 0.84, α = 3.06°); INFLUENCE OF MESH-GRID-SIZE (DORNIER/JAMESON) LOWER SURFACE

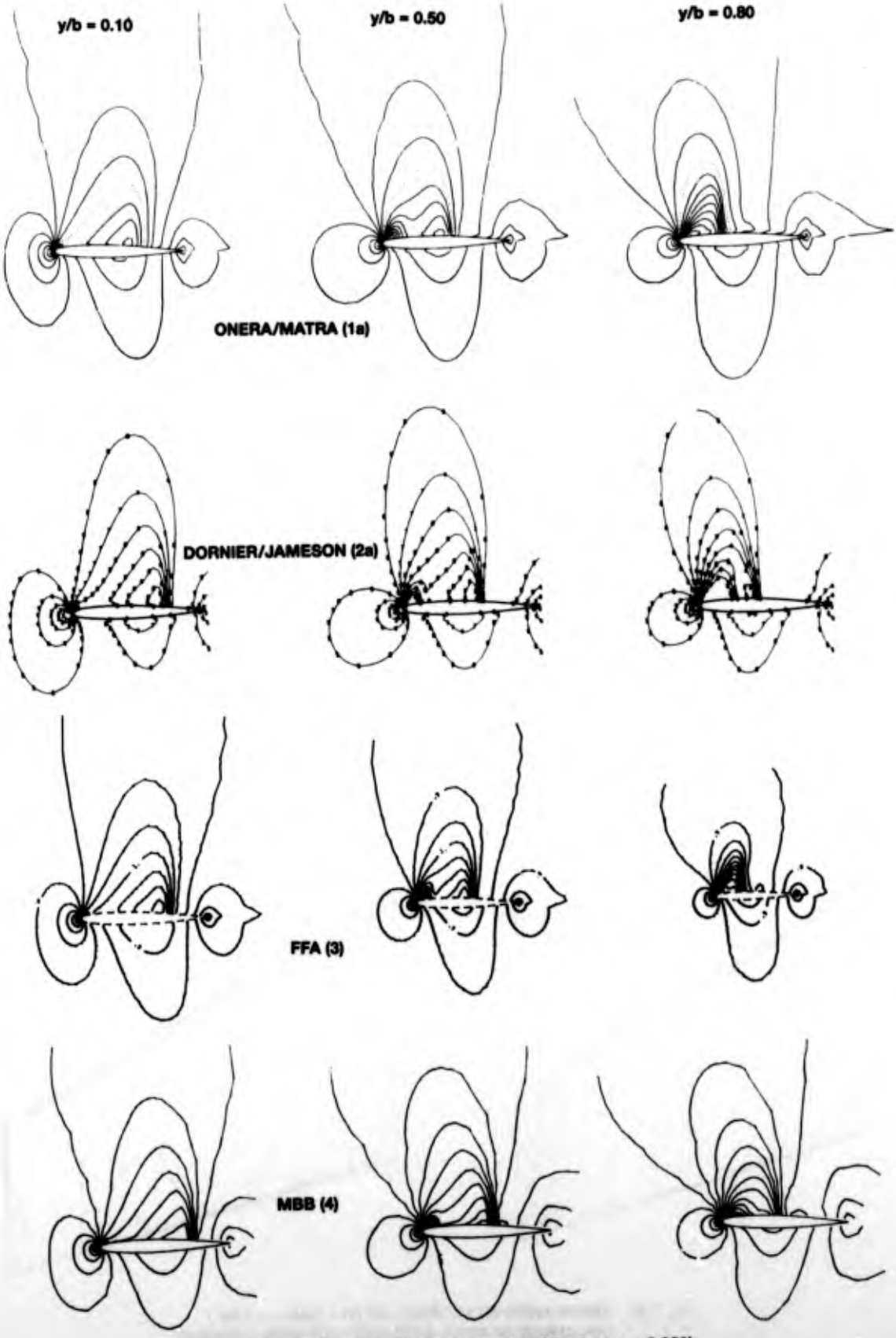


Fig. 7-23 AGARD WG07 TC 11 ONERA M6 (M = 0.84, α = 3.06°)
COMPARISON OF FIELD PLOTS AT SPANWISE SECTIONS
ISO-MACH-LINES (INCR. = 0.05)

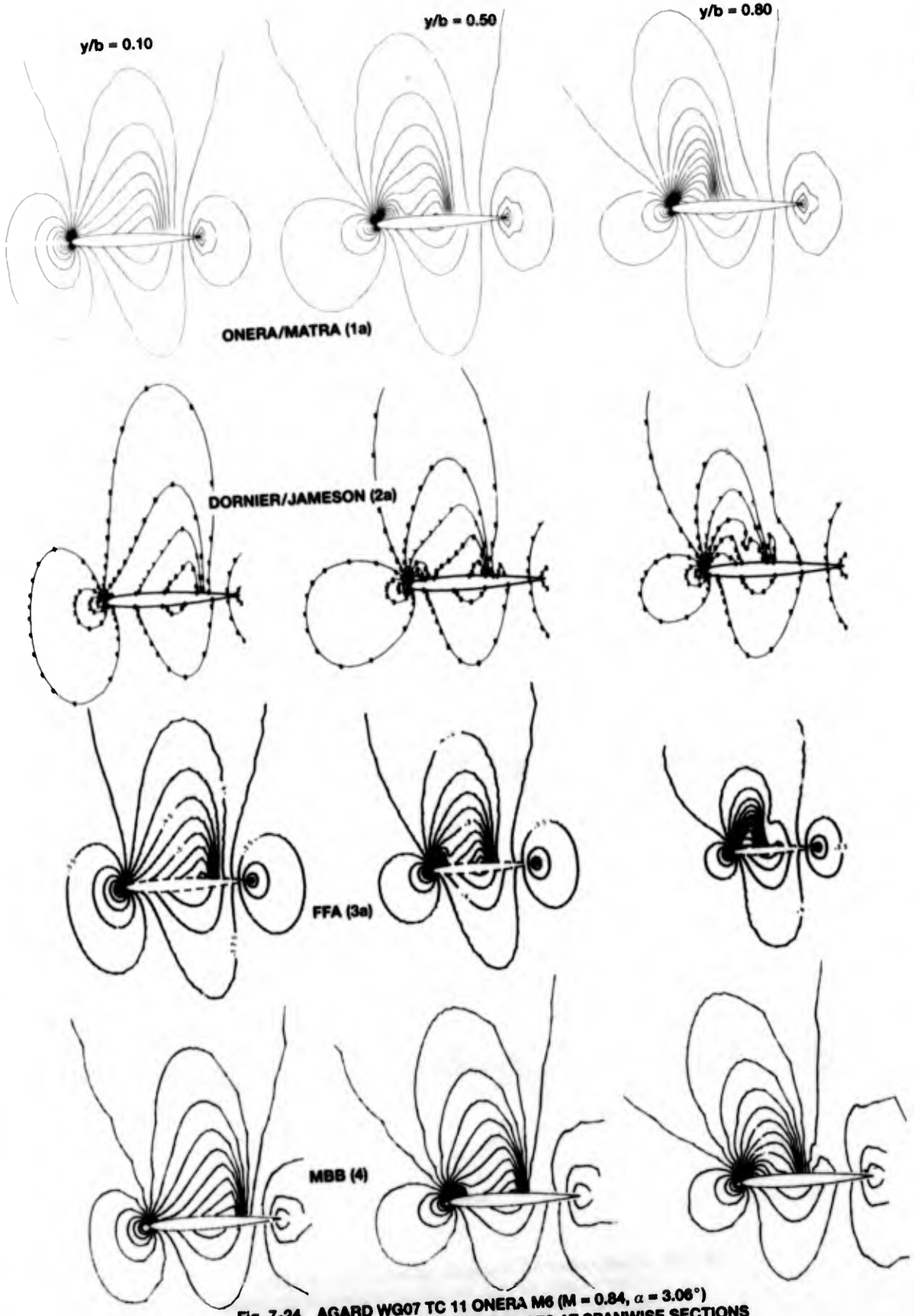


Fig. 7-24 AGARD WG07 TC 11 ONERA M6 (M = 0.84, α = 3.06°)
COMPARISON OF FIELD PLOTS AT SPANWISE SECTIONS
ISO-P/PI INF-LINES (INCR. = 0.025)

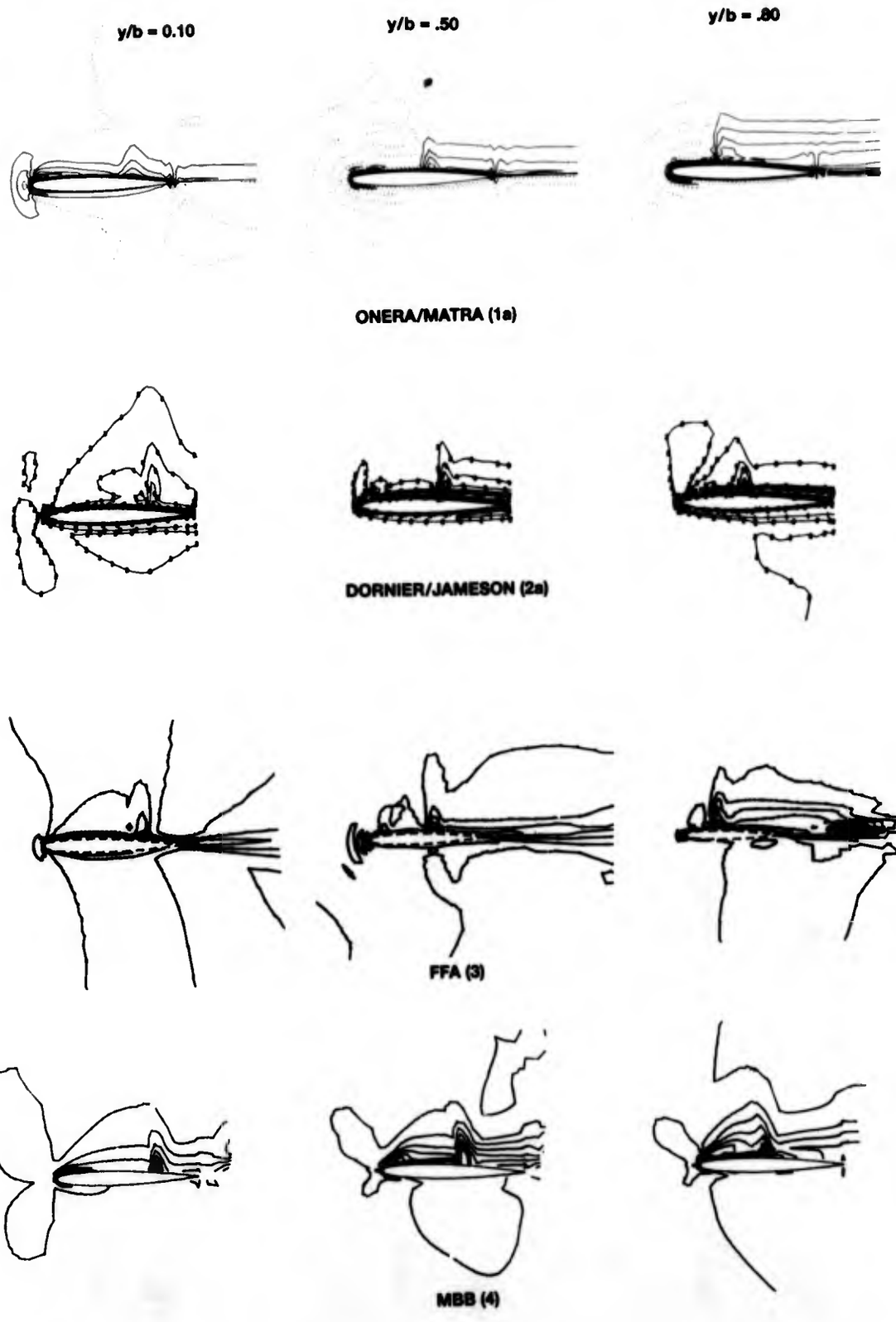
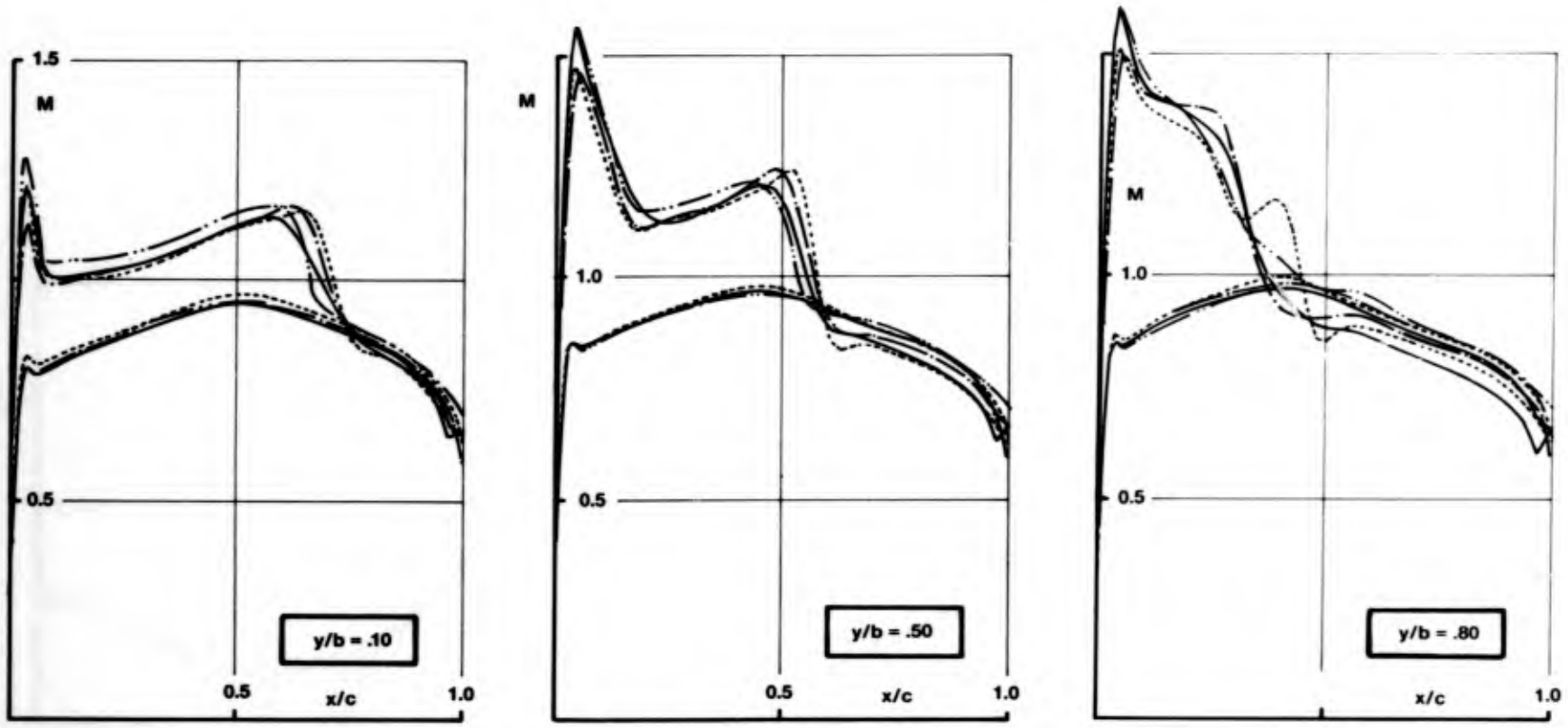


Fig. 7-25 AGARD WG07 TC 11 ONERA M6 (M = 0.84, α = 3.06°)
COMPARISON OF FIELD PLOTS AT SPANWISE SECTIONS
ISO-PI/PI INF-LINES (INCR. – 0.005)



ONERA/MATRA (1a)

DORNIER/JAMESON (2b) "FINE GRID"

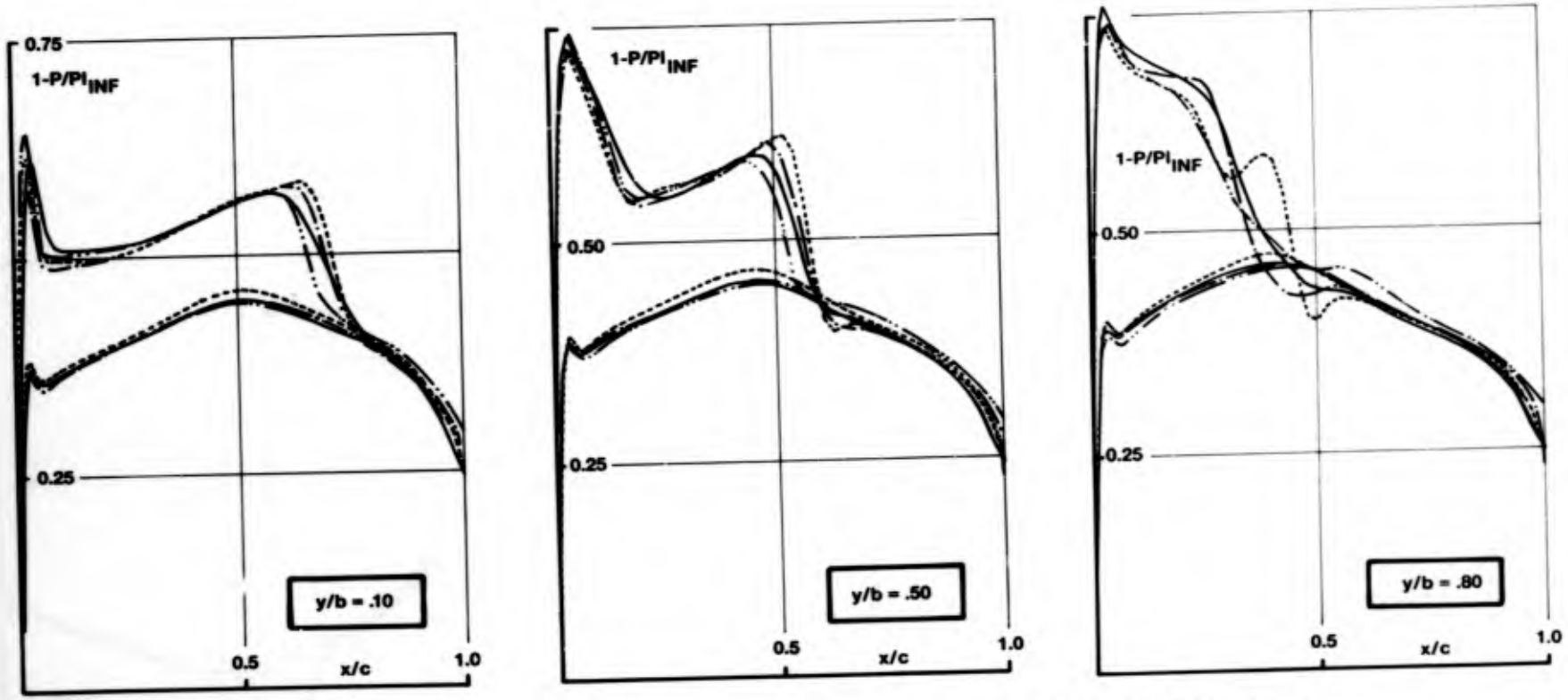
FFA (3a) "MEDIUM GRID"

MBB (4)

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°

COMPARISON OF ALL CONTRIBUTIONS

Fig. 7-26 MACHNO.-DISTRIBUTION AT SPANWISE SECTIONS



ONERA/MATRA (1a)
DORNIER/JAMESON (2b) "FINE GRID"
FFA (3a) "MEDIUM GPID"
MBB (4)

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°

COMPARISON OF ALL CONTRIBUTIONS

Fig. 7-27 P/PI INF-DISTRIBUTION AT SPANWISE SECTIONS

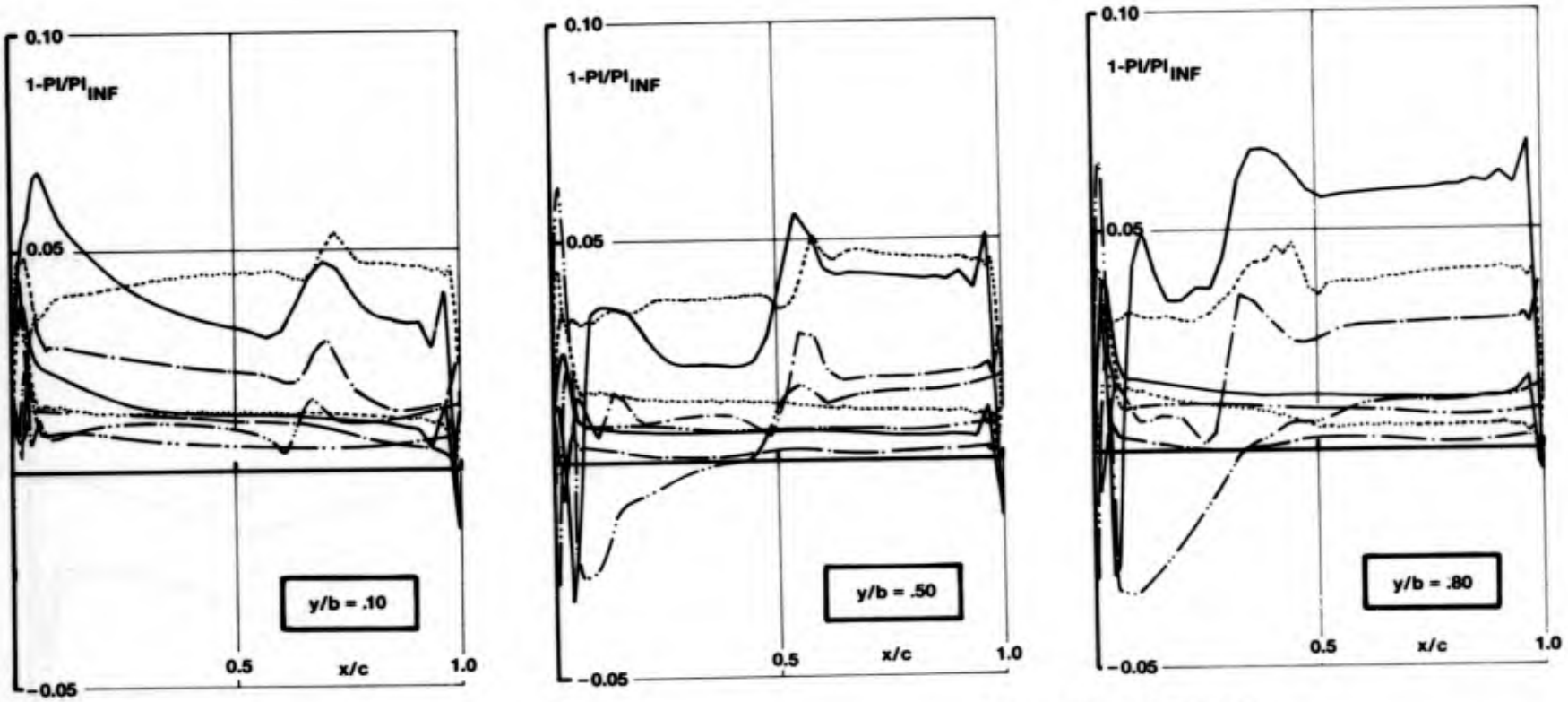


Fig. 7-28 PI/PI INF-DISTRIBUTION AT SPANWISE SECTIONS

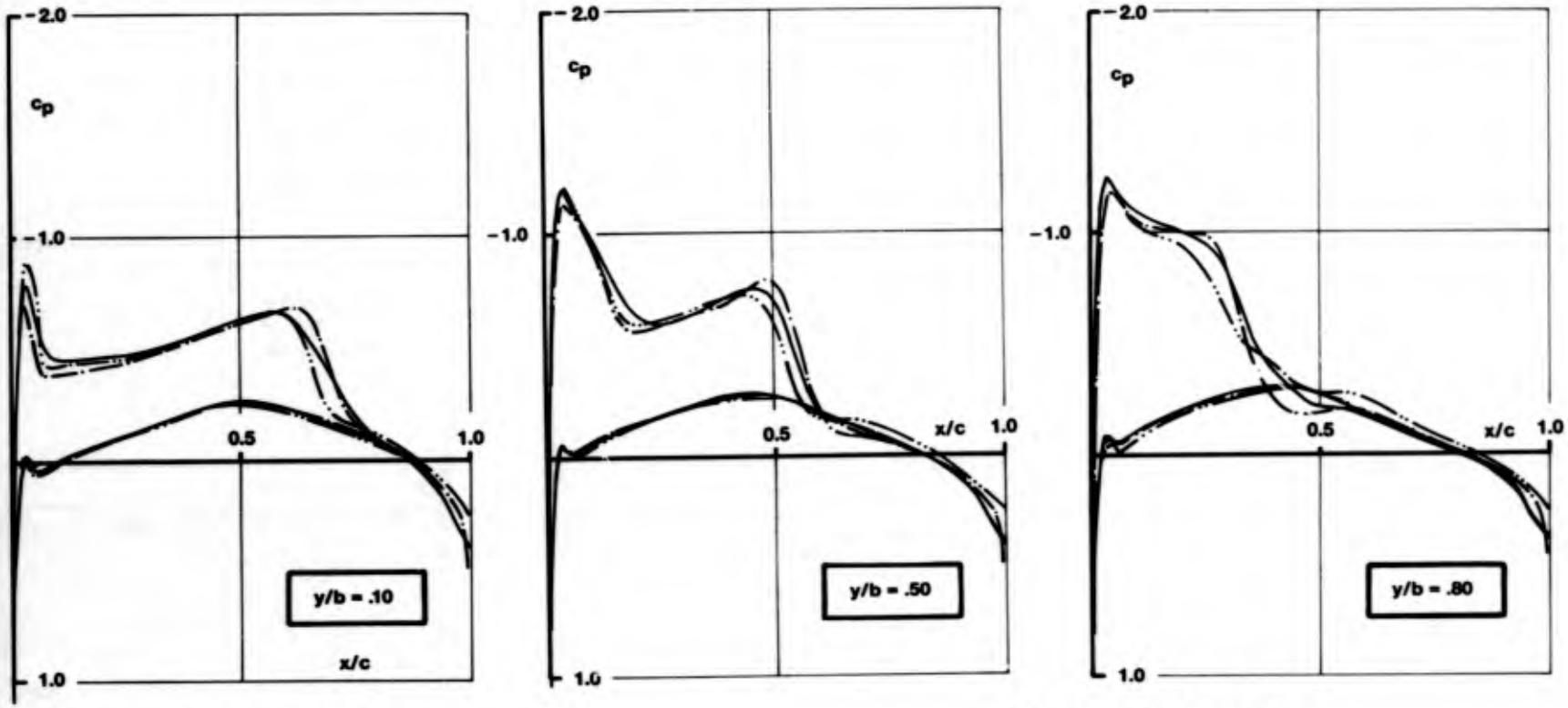


Fig. 7-29 PRESSURE-DISTRIBUTION (CP) AT SPANWISE SECTIONS

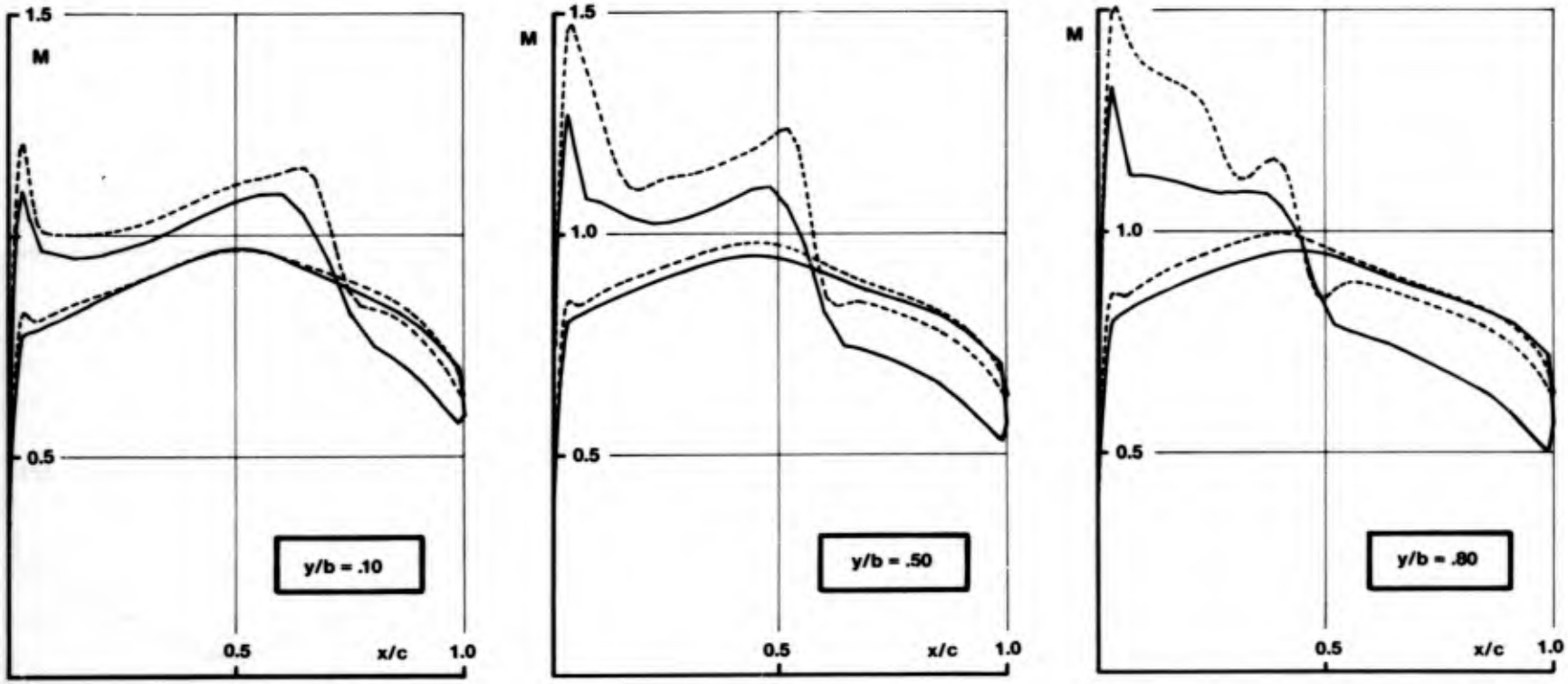
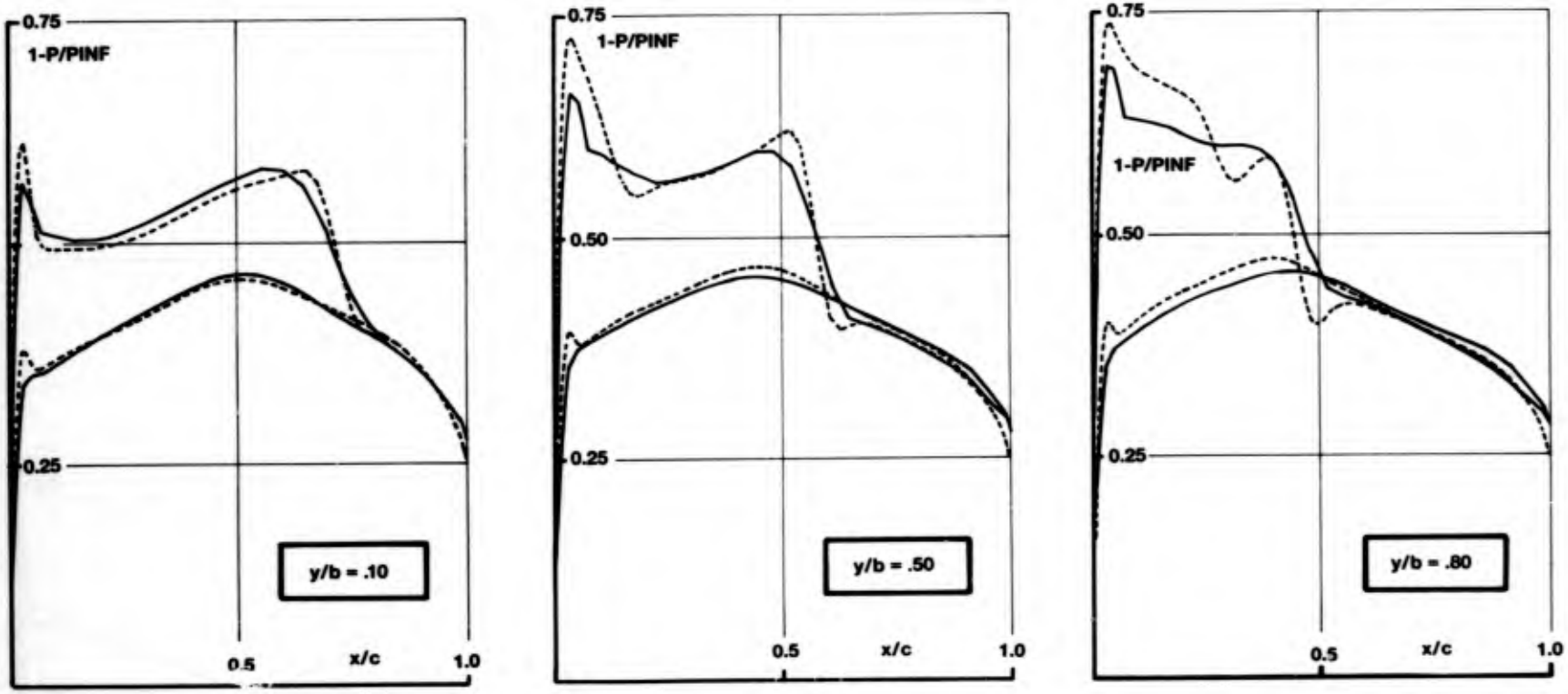


Fig. 7-30 INFLUENCE OF MESH-GRID SIZE ON MACH DISTRIBUTION AT SPANWISE SECTIONS (DORNIER/JAMESON)



——— DORNIER/JAMESON (2a) "MEDIUM GRID"

- - - - - - - - - - DORNIER/JAMESON (2b) "FINE GRID"

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°

Fig. 7-31 INFLUENCE OF MESH-GRID SIZE ON PRESSURE DISTRIBUTION AT SPANWISE SECTIONS (DORNIER/JAMESON)

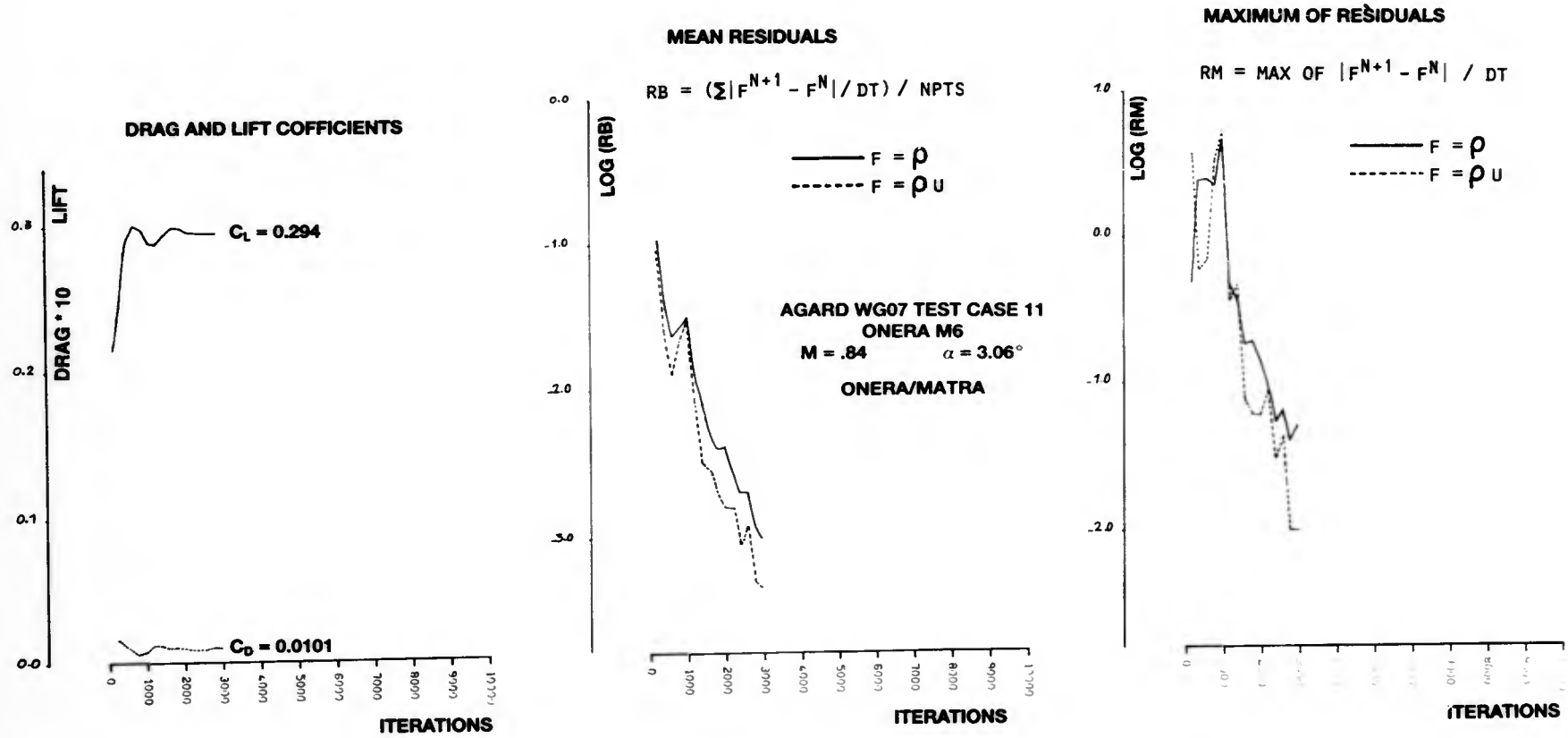


Fig. 7-32 CONVERGENCE HISTORY ONERA/MATRA (1)

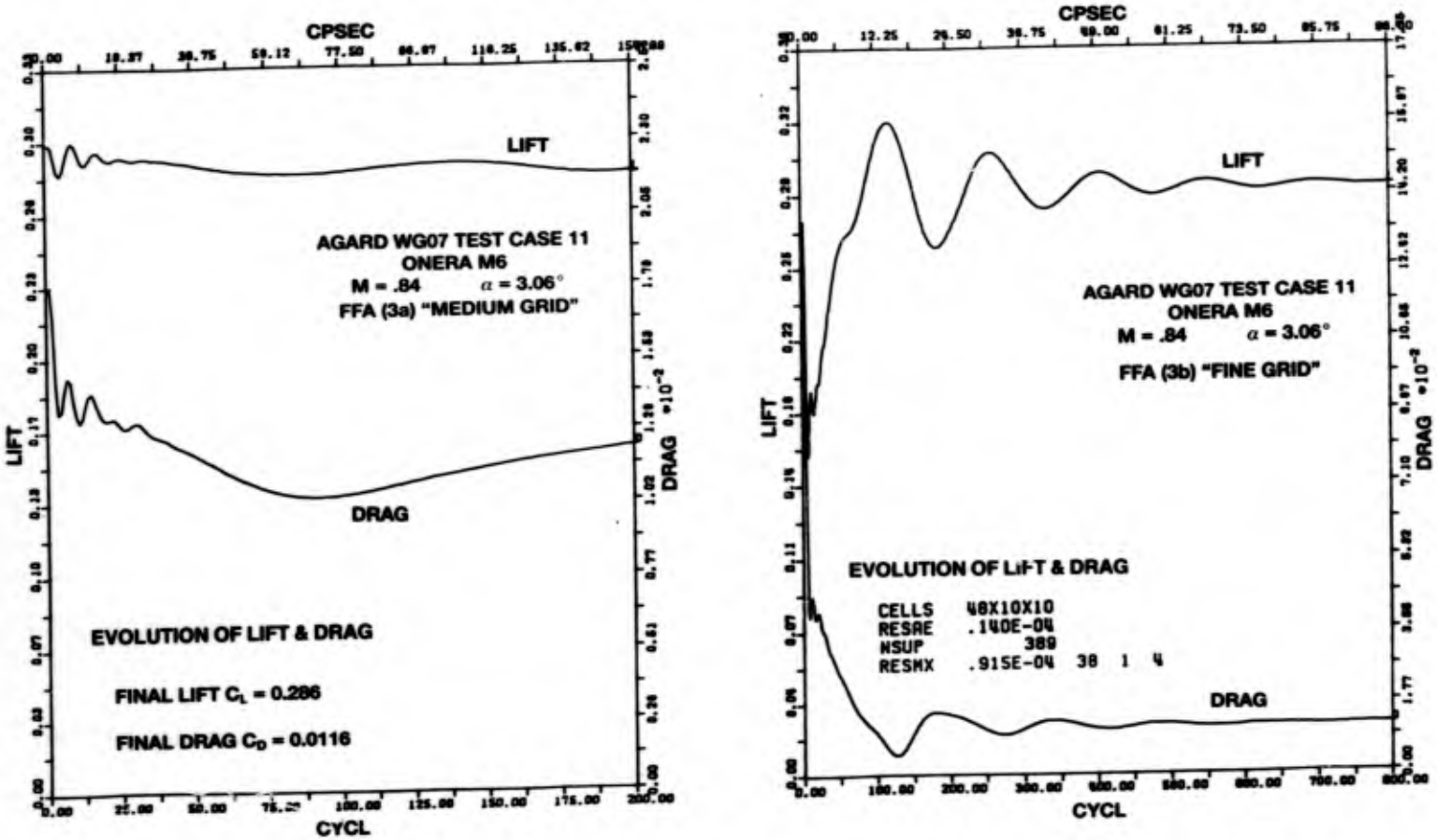


Fig. 7-33 CONVERGENCE HISTORY RIZZI/FFA (3) LIFT & DRAG (INFLUENCE OF MESH-GRID SIZE)

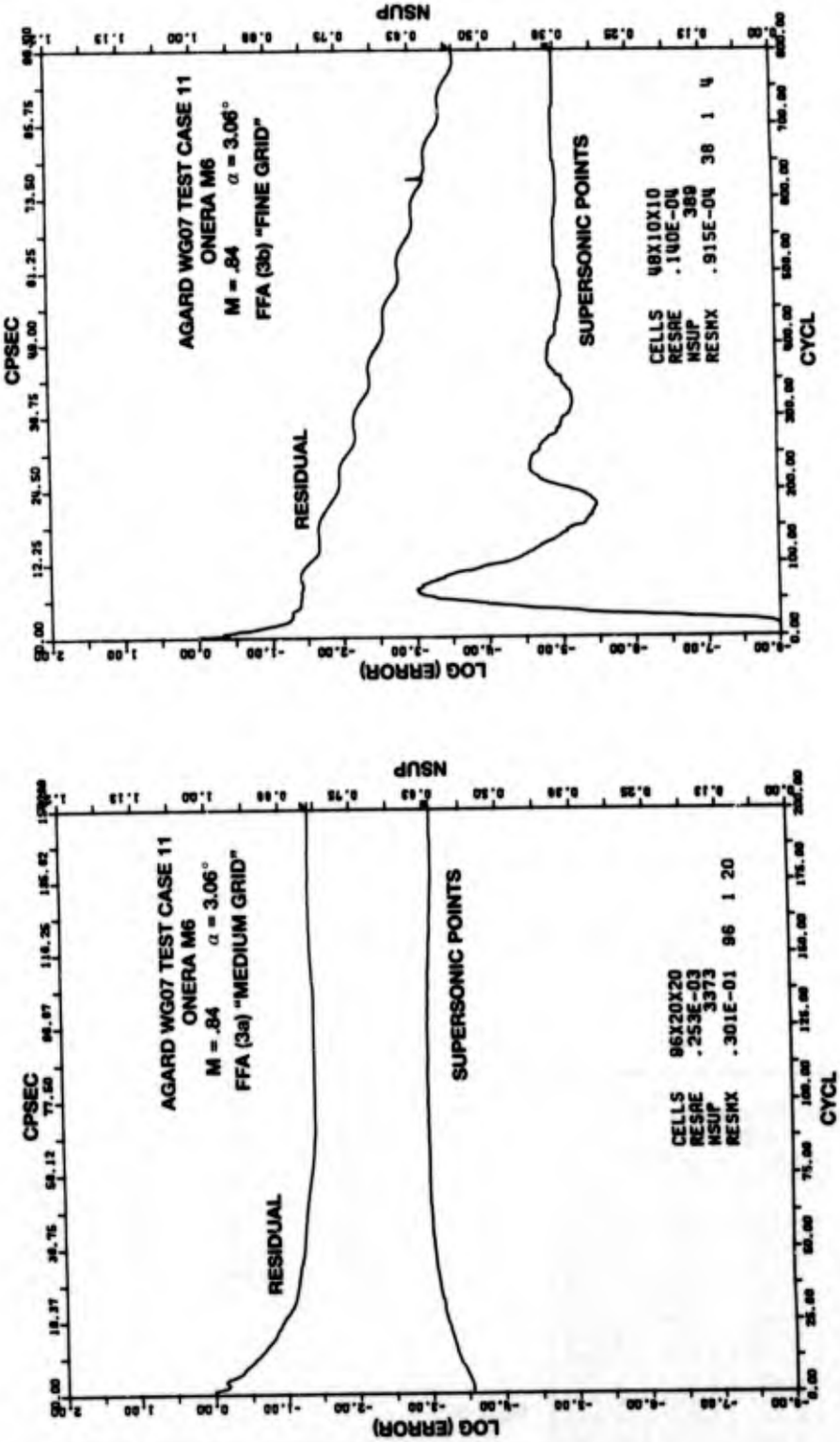
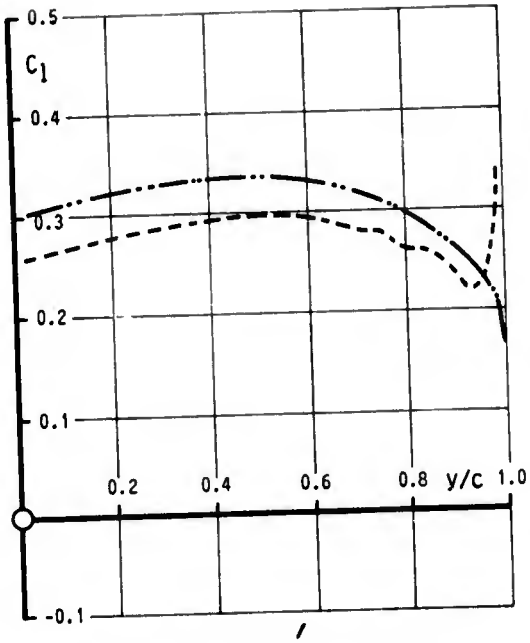
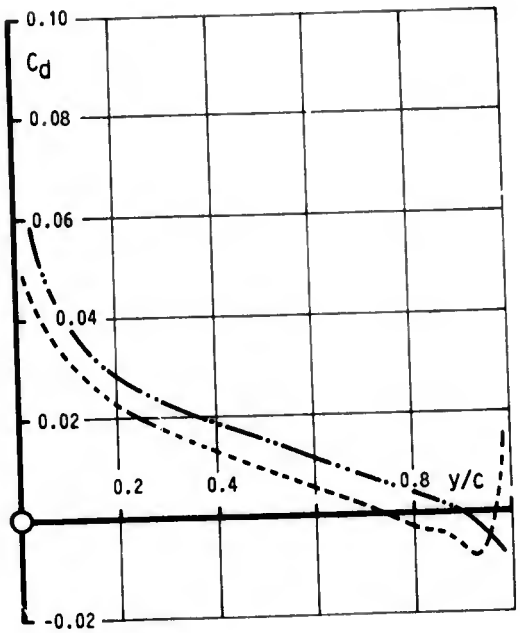
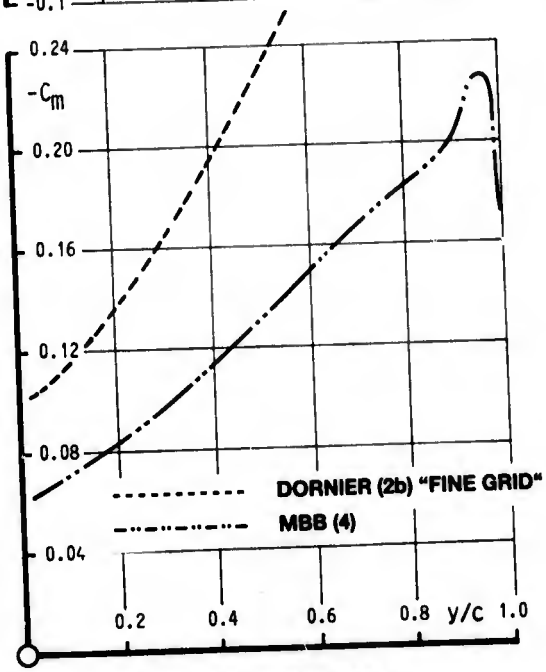


Fig. 7-34 CONVERGENCE HISTORY RIZZI/FFA (3) RESIDUAL & NO. OF SUPERSONIC POINTS (INFLUENCE OF MESH-GRID SIZE)







AGARD WG07 TEST CASE 11
ONERA M6
MBB (4) **M = .84** α **= 3.06°**

η	c_l	c_d	c_m
0.041	0.3084	0.0517	-0.0655
0.122	0.3142	0.0363	-0.0740
0.204	0.3214	0.0288	-0.0842
0.286	0.3279	0.0241	-0.0961
0.367	0.3325	0.0204	-0.1096
0.449	0.3349	0.0172	-0.1242
0.531	0.3336	0.0142	-0.1393
0.612	0.3281	0.0111	-0.1541
0.694	0.3177	0.0081	-0.1680
0.776	0.3017	0.0050	-0.1807
0.857	0.2787	0.0020	-0.1912
0.937	0.2730	-0.0022	-0.2231
0.988	0.2143	-0.0073	-0.2046

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α **= 3.06°**
DORNIER/JAMESON (2b) "FINE GRID"

y/s =	c_l	c_d	c_m
0.9875	0.3355	0.0134	-0.6052
0.9600	0.2343	-0.0036	-0.3756
0.9300	0.2206	-0.0087	-0.3266
0.9000	0.2388	-0.0065	-0.3374
0.8700	0.2543	-0.0042	-0.3434
0.8375	0.2617	-0.0031	-0.3349
0.8000	0.2635	-0.0027	-0.3151
0.7500	0.2790	-0.0002	-0.3115
0.6950	0.2831	0.0022	-0.2913
0.6500	0.2894	0.0039	-0.2795
0.6100	0.2941	0.0055	-0.2684
0.5675	0.2964	0.0071	-0.2543
0.5225	0.2971	0.0087	-0.2384
0.4800	0.2964	0.0102	-0.2232
0.4400	0.2952	0.0117	-0.2094
0.3950	0.2939	0.0135	-0.1950
0.3450	0.2913	0.0156	-0.1792
0.2950	0.2877	0.0179	-0.1642
0.2450	0.2836	0.0203	-0.1502
0.2000	0.2791	0.0230	-0.1384
0.1550	0.2754	0.0264	-0.1285
0.1100	0.2696	0.0303	-0.1189
0.0650	0.2641	0.0368	-0.1109
0.0200	0.2596	0.0474	-0.1046

Fig. 7-35

AGARD WG07 TC 11 ONERA M6 (M = 0.84 α = 3.06°)
DISTRIBUTION OF SECTIONAL COEFFICIENTS
LIFT, DRAG AND PITCHING MOMENT IN SPANWISE DIRECTION

7.4 ONERA M6 - Test Case 12

7.4.1 COMPILATION OF DATA RECEIVED

As in the previous chapter 7.3 solutions were obtained from the same four contributors:

- M.Neron (ONERA) / C.Koeck (MATRA)
- W.Schmidt (DORNIER) / A.Jameson (PRINCETON)
- A.Rizzi (FFA)
- A.Eberle (MBB)

Table 7-7 presents characteristic data used for each calculation in the same way as for the previous chapter in table 7-1. Tables 7-8 and 7-9 may be used to check the completeness of results provided by each contributor.

Table 7-7 AGARD TC 12, SURVEY ON DATA OBTAINED

AGARD WG07 TC12 M = .92 / α = 0°

CONTRIBUTION		MESH							OUTER BOUNDARY			C_L	C_D	C_M (APEX)	REMARKS
NO.	COMP.	TYPE		NO. OF POINTS					x_{MIN}/x_{MAX} CHORD	z_{MAX}/z_{MIN} (CHORD)	y_{MAX} (SPAN)				
		X	Y	TOTAL X	TOTAL Y	TOTAL Z	ON WING UPPER SURF. CHORD	ON WING UPPER SURF. SECT.							
1a	ONERA/ MATRA	C	O	51	21	17	37	21	−3.5/6	6/0	5		0.0172		USED FOR STANDARD COMPARISON M6NP4
1b	ONERA/ MATRA	C	O	51	21	17	37	21	−3.5/6	6/0	5		0.0192		INFL. OF ART. VISCOSITY M60038
2a	DORNIER/ JAMESON	C	H	81	17	17	31	13	−8/10	9/−9	2	0.0	0.01938	0.0	„MEDIUM MESHGRID"
2b	DORNIER/ JAMESON	C	H	161	33	33	61	25	−8/10	9/−9	2	−0.00003	0.01924	0.00003	„FINE GRID"
3a	FFA	O	O	96	20	20	24	20	−5/5	5/−5	3.5	0.0003	0.0226		y/b = .08 .468 .816
4	MBB	C	H	90	21	10	36	13	−3/4	6/−6	2	−.000023	0.0260	0.000016	y/b = 0.122 .531 .776

7.4.2 DESCRIPTION OF THE NUMERICAL METHOD

The numerical methods applied to test case 12 were essentially the same like in the previous test case 11 prescribed in chapter 7.3.2.

There is only one case (ONERA/MATRA) where some additional information should be given:

Using the fact that the M6 wing is symmetrical, with respect to the (z = 0) plane, the computational domain is restricted to the upper half-space. The global mesh is of C-0 type.

Slip conditions are applied to both the wing surface and the two planes of symmetry (y = 0 and z = 0).

In order to study the effect of varying the artificial viscosity terms two calculations have been carried out:

ONERA/MATRA 1a:
Type A of artificial viscosity is used; the constants are: (Q1i, Q1j, Q1k) = (0.0006, 0.0009, 0.0009); (Q2i, Q2j, Q2k) = (0.1, 0.15, 0.15).

ONERA/MATRA 1b:
The same mesh-grid as for 1a has been used and only the type of artificial viscosity has been changed. The constants used for type B of the artificial viscosity are: (Q1i, Q1j, Q1k) = (0.002, 0.002, 0.002); (Q2i, Q2j, Q2k) = (3.2, 3.2, 3.2) for ρ_u; (Q2i, Q2j, Q2k) = (0.8, 0.8, 0.8) for ρ_v and ρ_w.

Fig.7-36 shows the representation of the wing upper surface by the mesh-grid used.

Table 7-8 AGARD TC 12, FIGURES REQUESTED AND OBTAINED

AGARD WG07 TC12 / M = 0.92, α = 0°

CONTRIBUTION			SURFACE – PLOTS					FIELD – PLOTS					LOCAL COEFF.			TABULATED DATA					
NO.	COMPANY	Y/S	M	1-Pi/PINF	1-Pu/PINF	1-Tu/TINF	Cp	M	1-Pi/PINF	1-Pu/PINF	1-Tu/TINF		C_l	C_m	C_d	X/C	M	1-Pi/PINF	1-Pu/PINF	1-Tu/TINF	Cp
1a	ONERA/MATRA	0.1	X	X	X		X	X	X	X						X	X	X	X		X
		0.2					O														
		0.44					O									X	X	X	X		X
		0.9	X	X	X		X	X	X	X						X	X	X	X		X
		0.9	X	X	X		●	X	X	X											
		~ 98					O									X	X	X	X		X
1b	ONERA/MATRA		X	X	X		X	X	X	X											
		0.2					O														
		0.44					O									X	X	X	X		X
		0.9	v	X	X		X	X	X	X						X	X	X	X		X
		0.9	X	X	X		●	X	X	X											
		0.98					O														
2a	DORNIER/JAMESON	0.1	X		X		X														
		0.2																			
		0.44																			
		0.9	X		X		X														
		0.9	X		X		X														
		0.98																			
2b	DORNIER/JAMESON	0.1	X	X	X			X	X	X			X	X	X						
		0.2											X	X	X						
		0.44											X	X	X						
		0.9	X	X	X			X	X	X			X	X	X						
		0.9	X	X	X			X	X	X			X	X	X						
		0.98																			
3a	FFA	077	X	X	X		X	X	X	X						X	X	X	X		X
		132																			
		191														X	X	X	X		X
		468	X	X	X		X	X	X	X											
		543														X	X	X	X		X
		818	X	X	X		X	X	X	X											
		950											X	X	X						
4	MBB	041						X	X	X	X		X	X	X	X	X	X	X	X	X
		122	X	X	X	X	X						X	X	X						
		204											X	X	X						
		367											X	X	X	X	*	X	X	X	X
		531	X	X	X	X	X	X	X	X	X		X	X	X						
		694						X	X	X	X		X	X	X	X		X	X	X	X
		776	X	X	X	X	X						X	X	X						
		857											X	X	X						
		937																			

X = INCLUDED IN REPORT O = ADDITIONAL PLOT GARTEUR SCALE Y/C = SECTIONS AVAILABLE

Table 7-9 AGARD TC 12, COMPLETENESS OF CONTRIBUTIONS RECEIVED

AGARD WG07 TC12 / M = 92, α = 0°

CONTRIBUTION		CONTOUR MAPS								TOTAL COEFF.		
		UPPER SURFACE				LOWER SURFACE						
No.	COMPANY	M	1-P/PINF	1-Pi/PINF	1-Ti/TINF	M	1-P/PINF	1-Pi/PINF	1-TL'TINF	CL	CM	CD
1a	ONERA/MATRA	X	X	X								X
1b	ONERA/MATRA	X	X	X								
2a	DORNIER/JAMESON	X	X	X		X	X	X		X	X	X
2b	DORNIER/JAMESON	X	X	X		X	X	X		X	X	X
3a	FFA	X	X	X						X		X
4	MBB					X	X	X	X	X	X	X

7.4.3 PLANFORM CONTOUR MAPS

As in chapter 7.3.3 ISO-lines are compared in Fig.7-37 to Fig.7-39. The effect of the change of artificial viscosity seems to be important but similarity of the basic "footprints" is achieved within all contributions.

7.4.4 FIELD CONTOUR MAPS

As in chapter 7.4.3 the same ISO-lines at three stations in spanwise direction of the wing are presented, they show basically agreement (Figs.7-40 to 7-42). Even the change in artificial viscosity seems to be of minor influence for the field contours according to Figs.7-43 to 7-45.

7.4.5 SECTION CHARACTERISTICS

The comparison of calculations of Mach numbers and pressures at constant spanwise sections shows generally better agreement than for the lifting case TC 11 (Figs. 7-46 to 7-49). But also for TC 12 the shock location is predicted different. The area close to the trailing edge is characterized by different levels of recompression. Except the L.E. area and behind the shock the errors in total pressure are below 3%. These pressure losses are strongly influenced by the values of artificial viscosity used (Fig. 7-52) but this effect can also be seen for the prediction of shock strength and shock location as Figs. 7-50, 7-51 and 7-53 demonstrate.

Even more important is the influence of mesh-grid density according to Figs. 7-54 to 7-55. By the use of a finer mesh DORNIER/JAMESON have reduced the total pressure losses by about 50%.

7.4.6 CONVERGENCE HISTORY

The same convergence criteria have been applied as in TC 11. For the contributions of ONERA/MATRA (Figs. 7-56 and 7-57) and Rizzi (FFA), the level achieved for the drag coefficient seems to be stable but this says nothing about possible mutual changes in the flowfield which may still be present.

7.4.7 SECTIONAL COEFFICIENTS

Except for the tip region the prediction of local drag by DORNIER/JAMESON and MBB, Fig. 7-59 shows an agreement at least for the slope.

7.4.8. APPENDICES

Also for TC 12 tabulated data are added in the appendix which follows this chapter, Figures 7-A-18 to 7-A-27. ONERA/MATRA has, in addition, provided the so-called CARTEUR sections y/b = 0.2, 0.44, 0.8, 0.96 in a different scale on Figures 7-A-28 to 7-A-35.

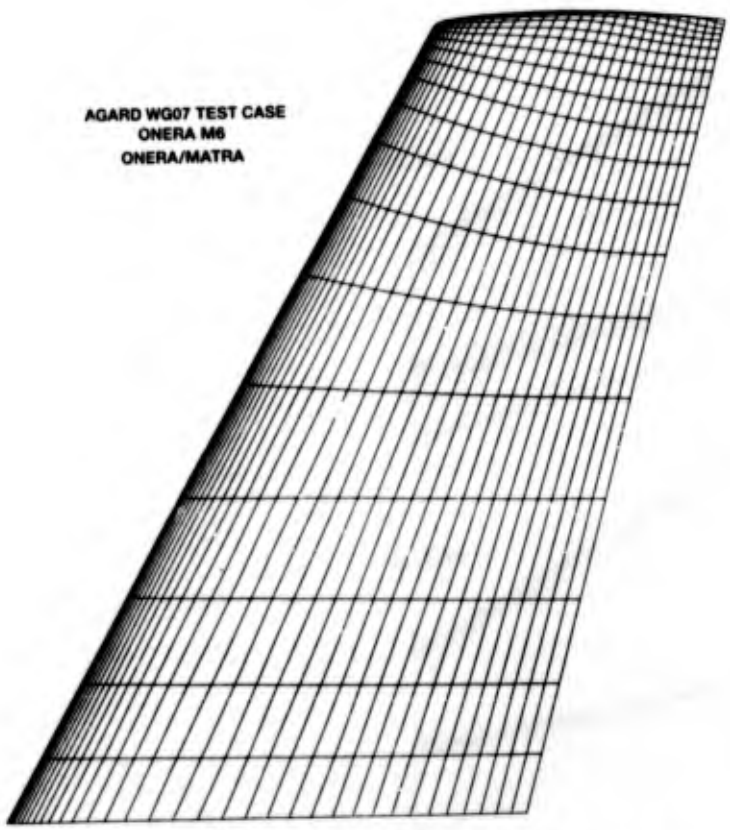


**Fig. 7-36 AGARD WG07 TC 12 ONERA M6 (M = 0.92 α = 0°)
REPRESENTATION OF WING UPPER SURFACE BY THE MESH-GRID.**

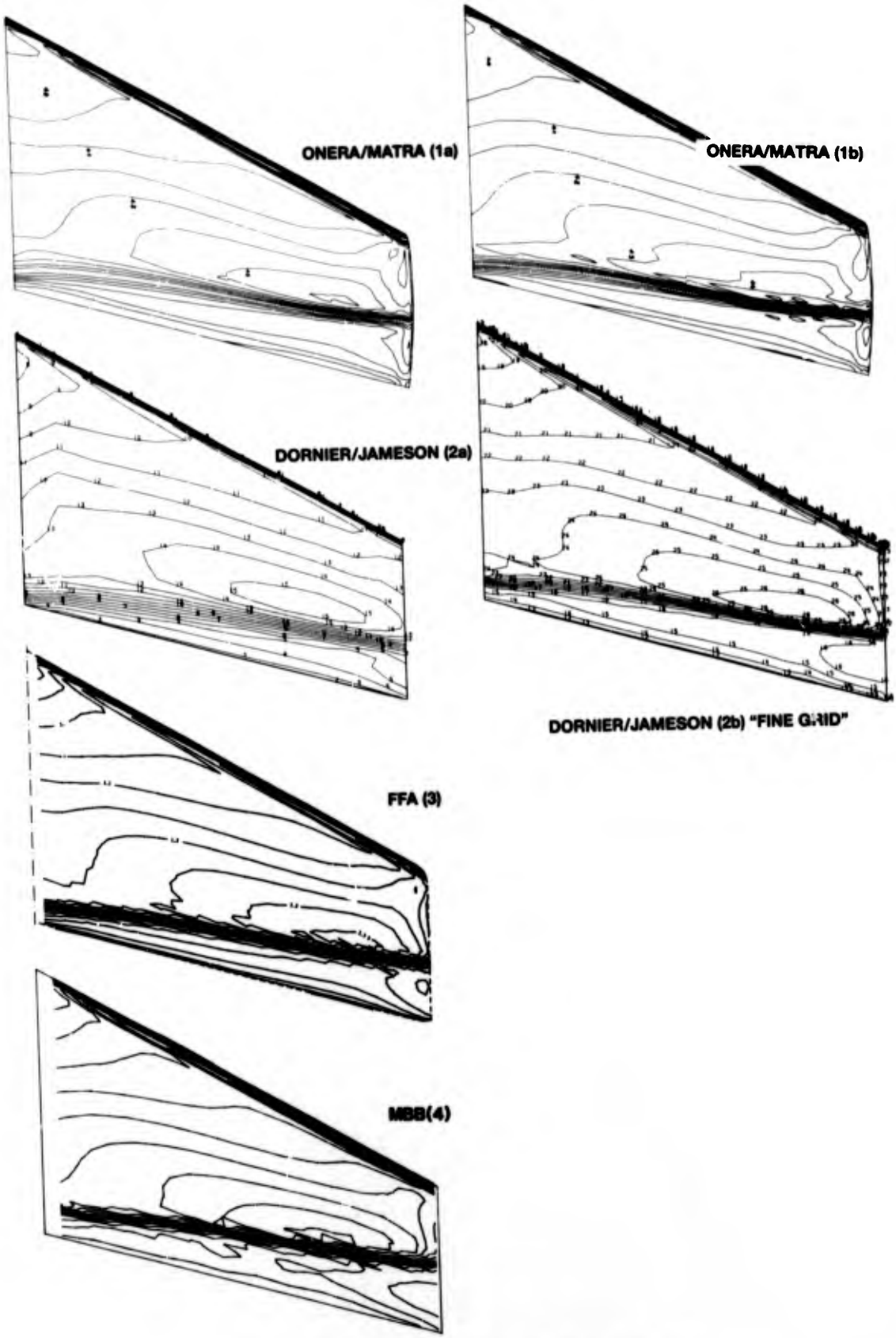


Fig. 7-37 AGARD WG07 TC 12 ONERA M6 (M = 0.92 α = 0°)
ISO-MACH-LINES (INCR. = 0.05)
UPPER SURFACE

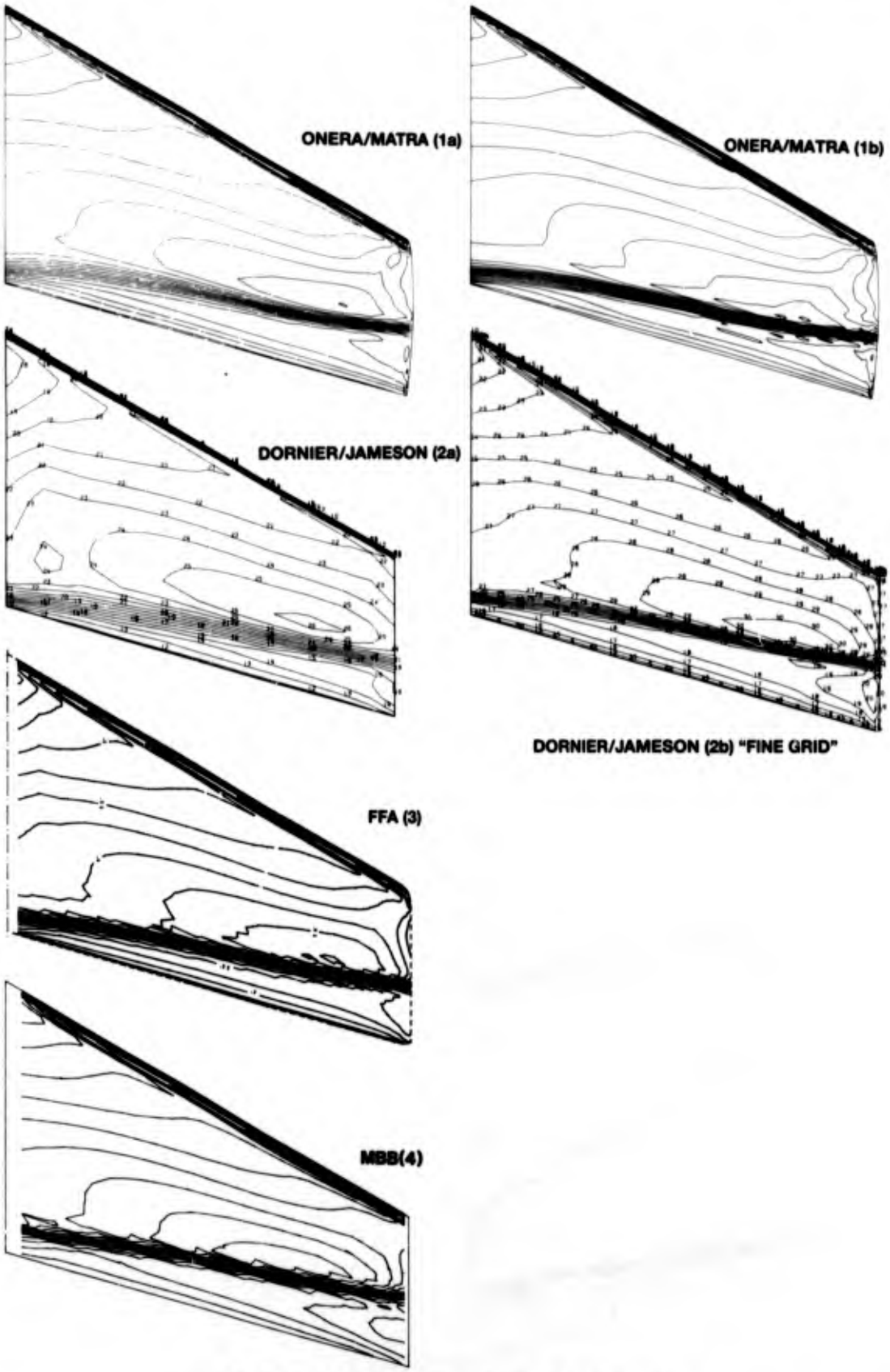


Fig. 7-38 AGARD WG07 TC 12 ONERA M6 (M = 0.92 α = 0°)
ISO-P/PI INF-LINES (INCR. = 0.025)
UPPER SURFACE

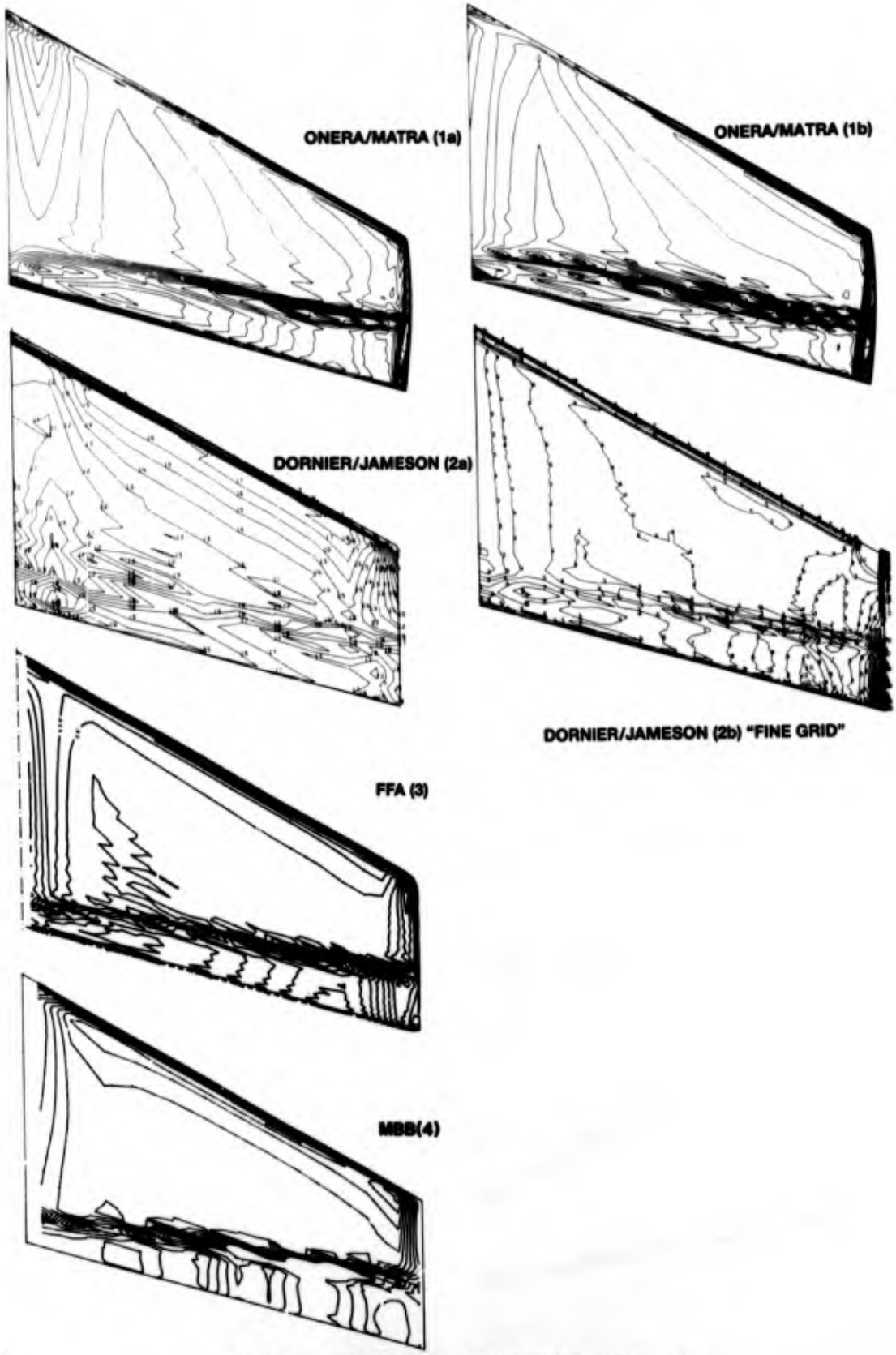


Fig. 7-39 AGARD WG07 TC 12 ONERA M6 (M = 0.92 α = 0°)
ISO-PI/PI INF-LINES (INCR. = 0.005)
UPPER SURFACE

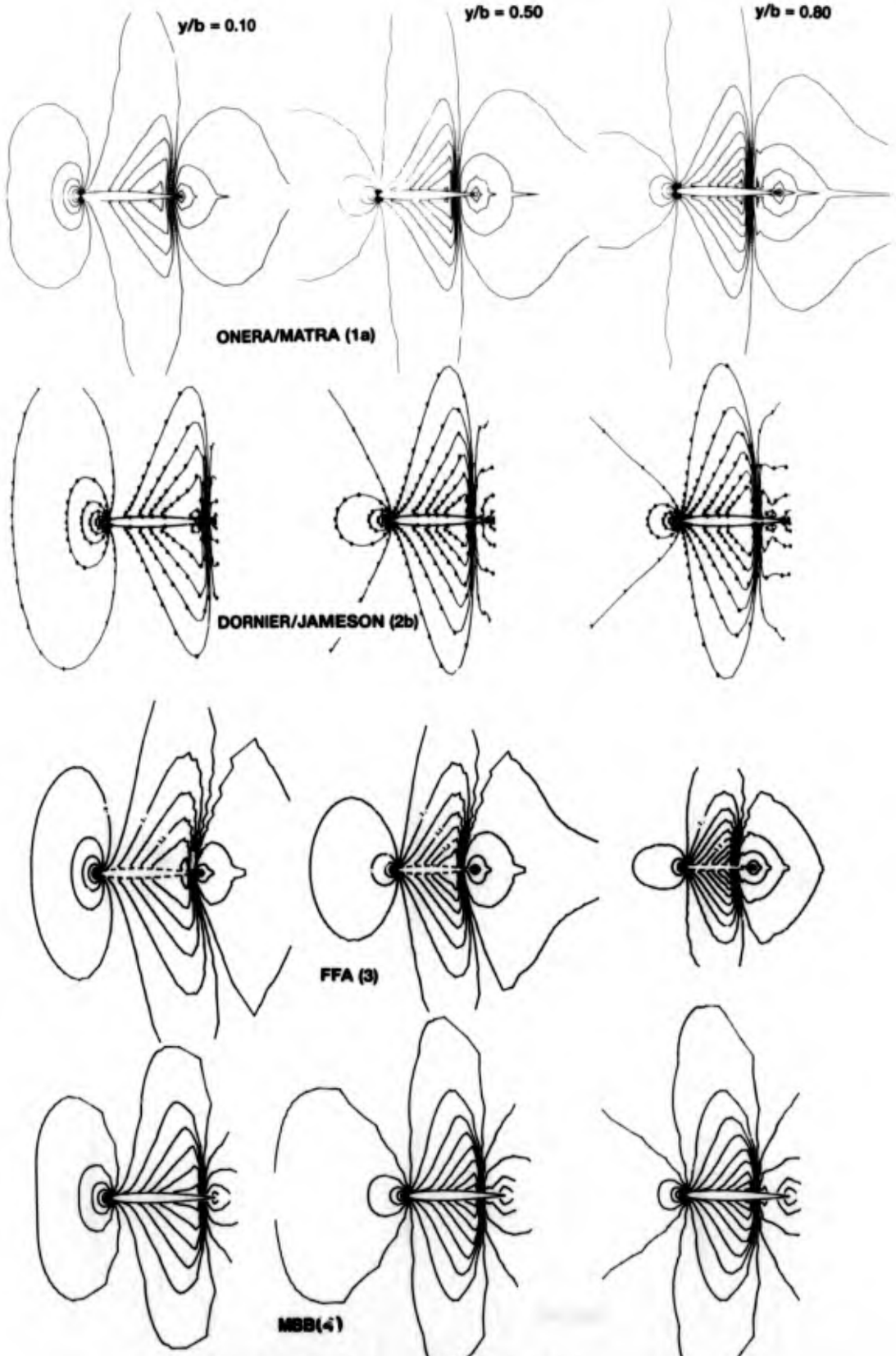


Fig. 7-40 AGARD WG07 TC 12 ONERA M6 (M = 0.92 α = 0°)
COMPARISON OF FIELD PLOTS AT SPANWISE SECTIONS y/b = 0.1, 0.5, 0.8
ISO-MACH-LINES (INCR. = 0.05)

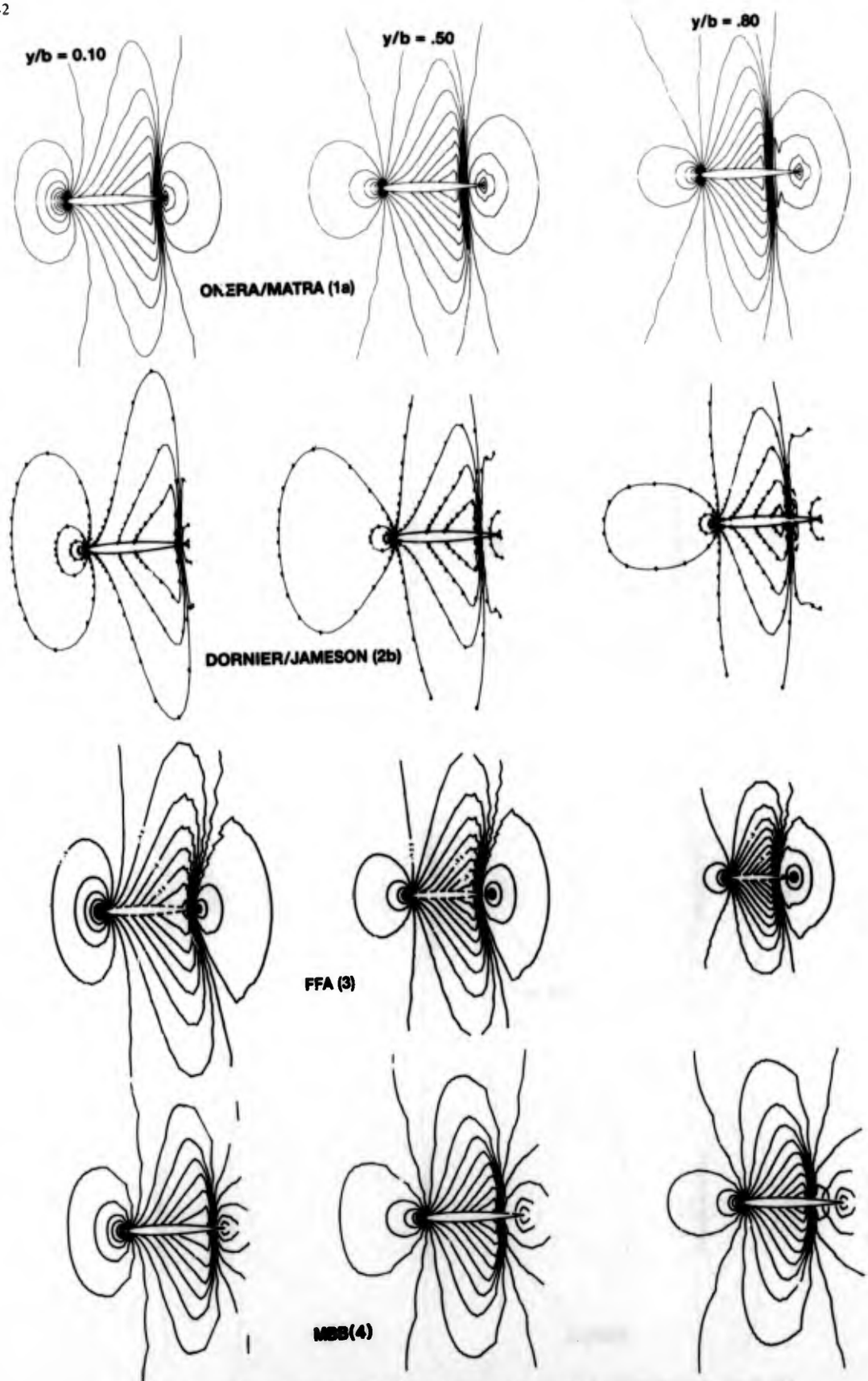


Fig. 7-41 AGARD WG07 TC 12 ONERA M6 (M = 0.92 α = 0°)
COMPARISON OF FIELD PLOTS AT SPANWISE SECTIONS y/b = 0.1, 0.5, 0.8
ISO-P/PI INF-LINES (INCR. = 0.025)

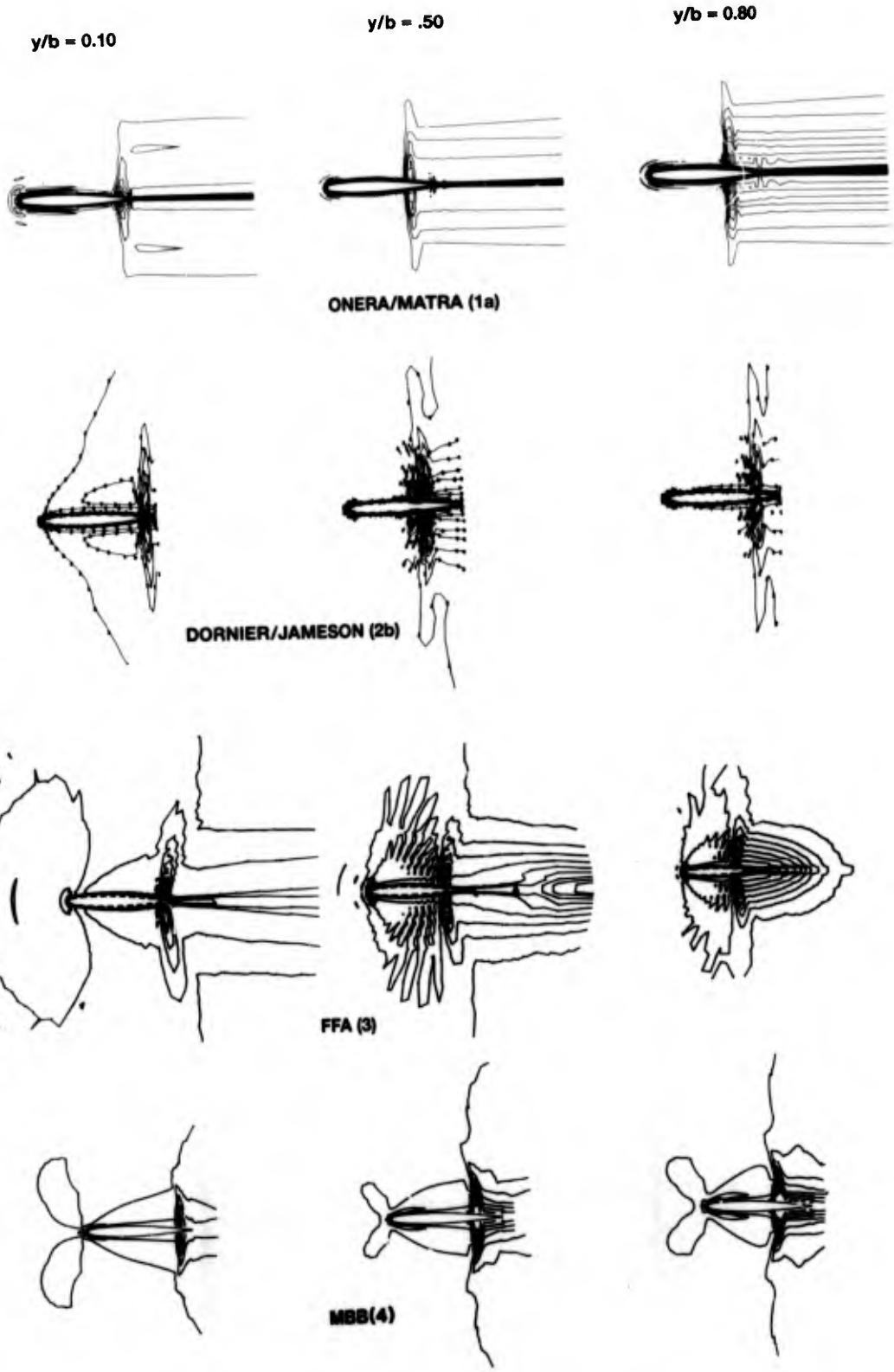


Fig. 7-42 AGARD WG07 TC 12 ONERA M6 (M = 0.92 α = 0°)
COMPARISON OF FIELD PLOTS AT SPANWISE SECTIONS y/b = 0.1, 0.5, 0.8
ISO-PI/PI INF-LINES (INCR. = 0.005)

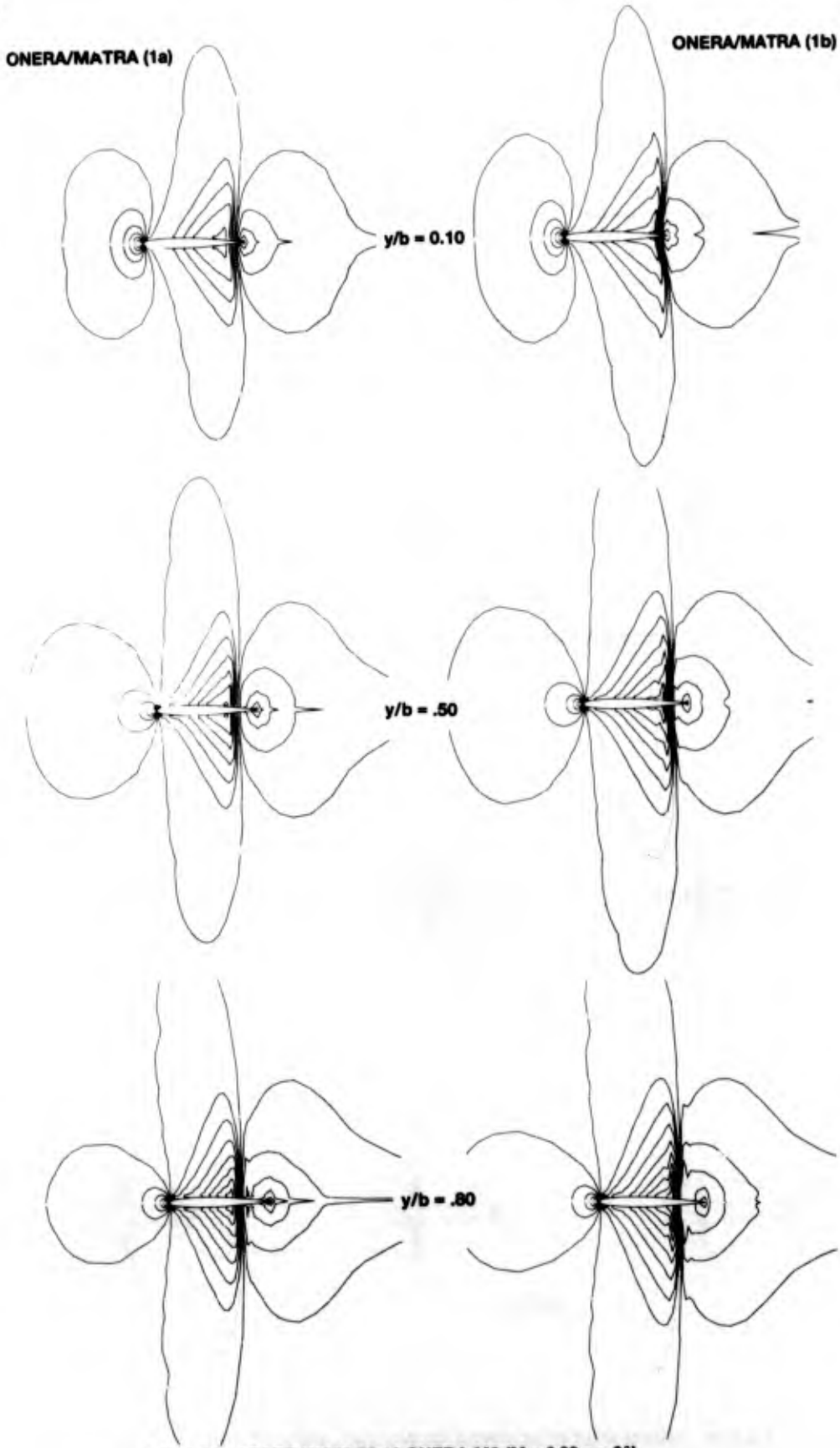


Fig. 7-43 AGARD WG07 TC 12 ONERA M6 (M = 0.92 α = 0°)
INFLUENCE OF ARTIFICIAL VISCOSITY (ONERA/MATRA)
ISO-MACH-LINES, FIELD-PLOTS AT SPANWISE SECTIONS

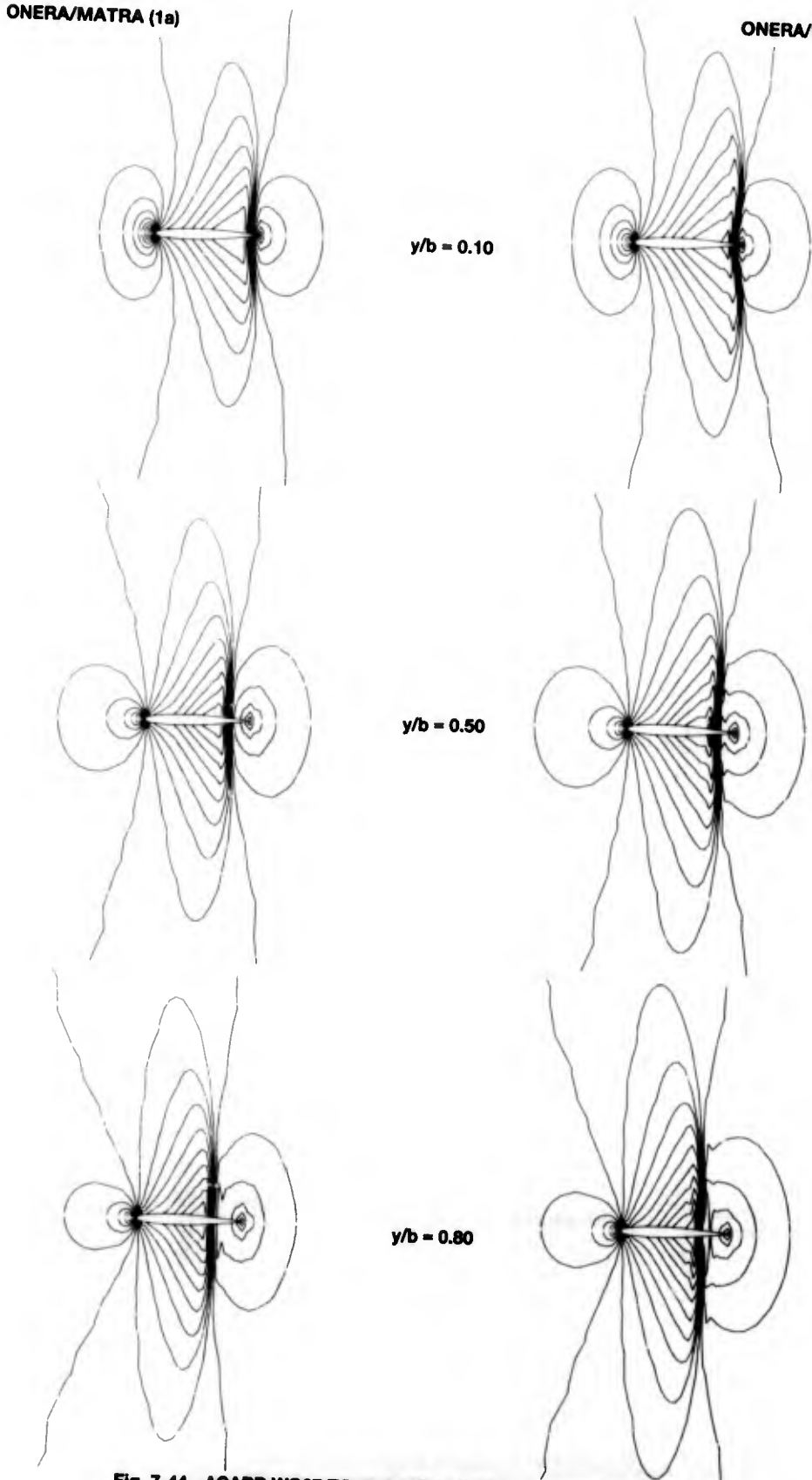


Fig. 7-44 AGARD WG07 TC 12 ONERA M6 (M = 0.92 α = 0°)
INFLUENCE OF ARTIFICIAL VISCOSITY (ONERA/MATRA)
ISO-P/PI INF-LINES, FIELD-PLOTS AT SPANWISE SECTIONS

ONERA/MATRA (1a)

ONERA/MATRA (1b)

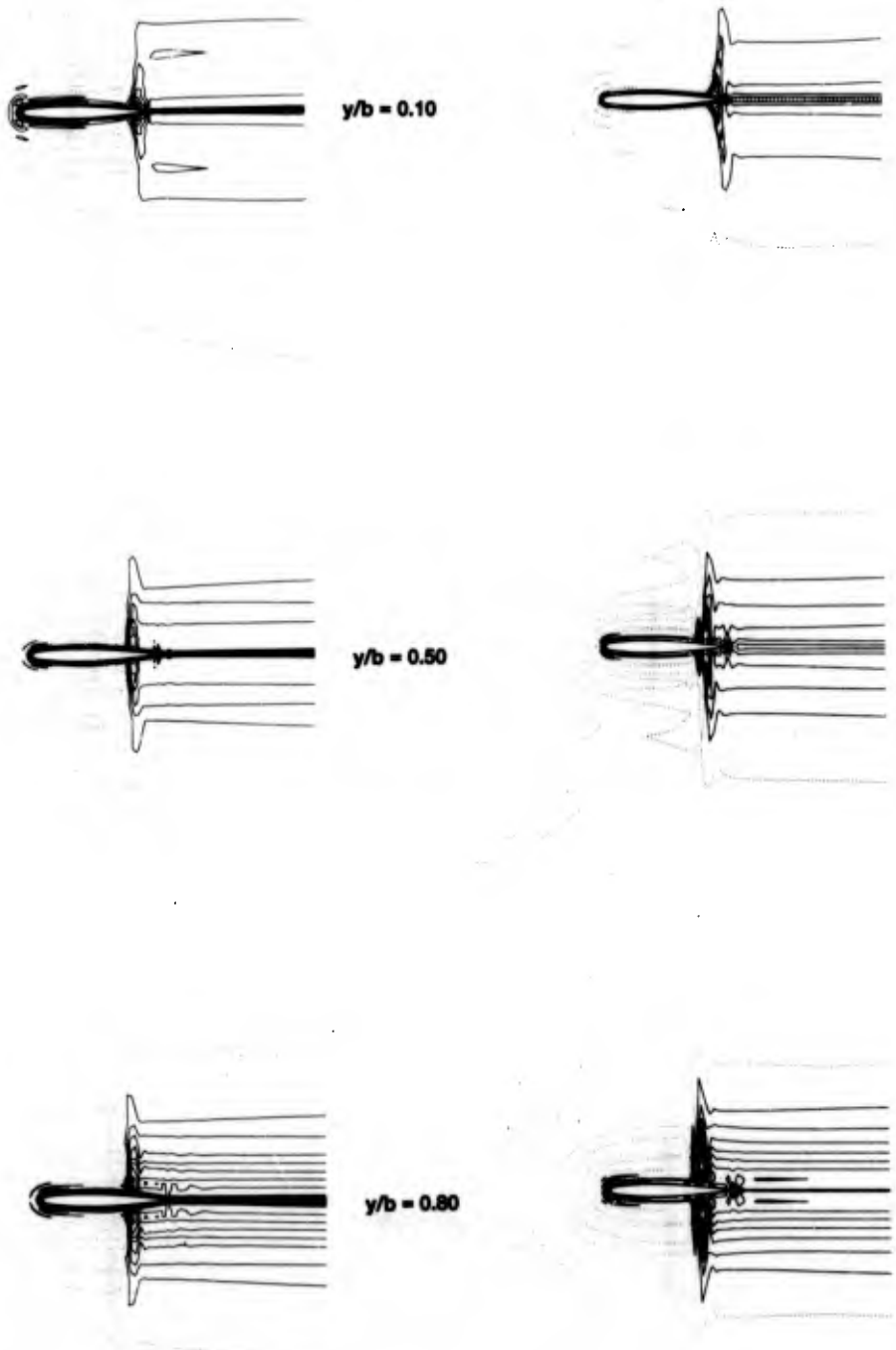


Fig. 7-45 AGARD WG07 TC 12 ONERA M6 (M = 0.92 α = 0°)
INFLUENCE OF ARTIFICIAL VISCOSITY (ONERA/MATRA)
ISO-PI/PIINF-LINES, FIELD-PLOTS AT SPANWISE SECTIONS

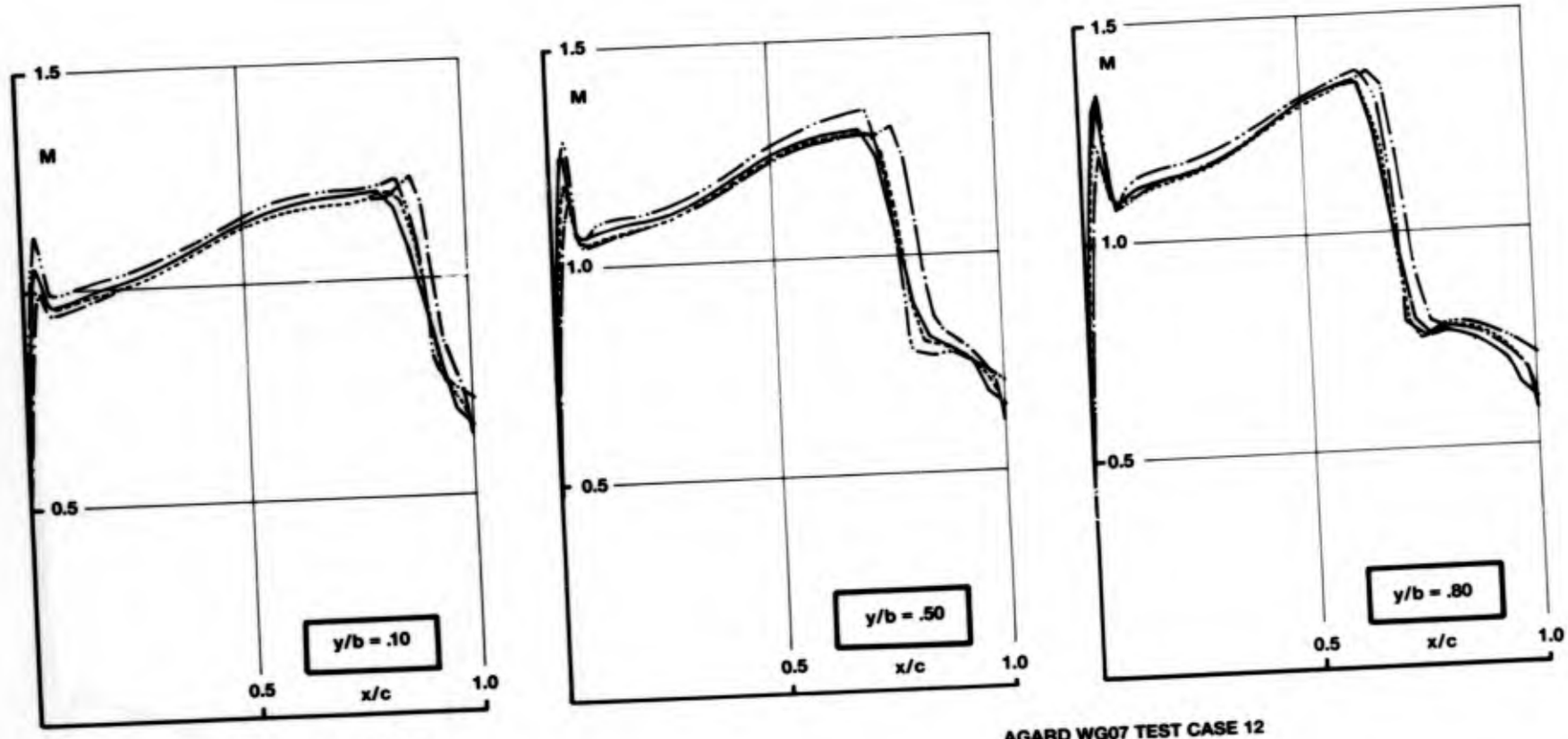
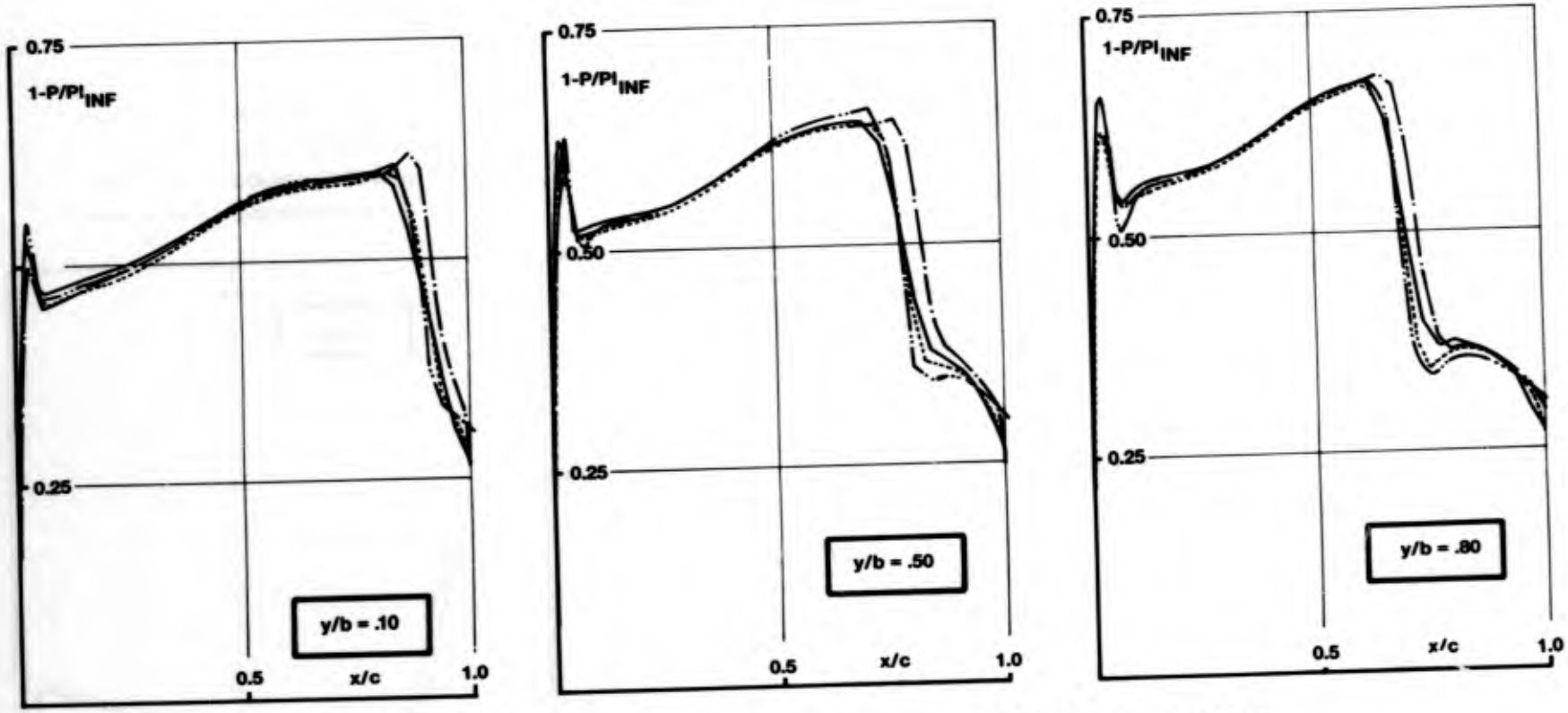


Fig. 7-46 MACHNO.-DISTRIBUTION AT SPANWISE SECTIONS (y/b = 0.1, 0.5, 0.8)



ONERA/MATRA (1a)

DORNIER/JAMESON (2b) "FINE GRID"

FFA (3a) "MEDIUM GRID"

MBB (4)

AGARD WG07 TEST CASE 12
ONERA M6
M = .92 $\alpha = 0°$

COMPARISON OF ALL CONTRIBUTIONS

Fig. 7-47 PRESSURE-DISTRIBUTION AT SPANWISE SECTIONS (y/b = 0.1, 0.5, 0.8)

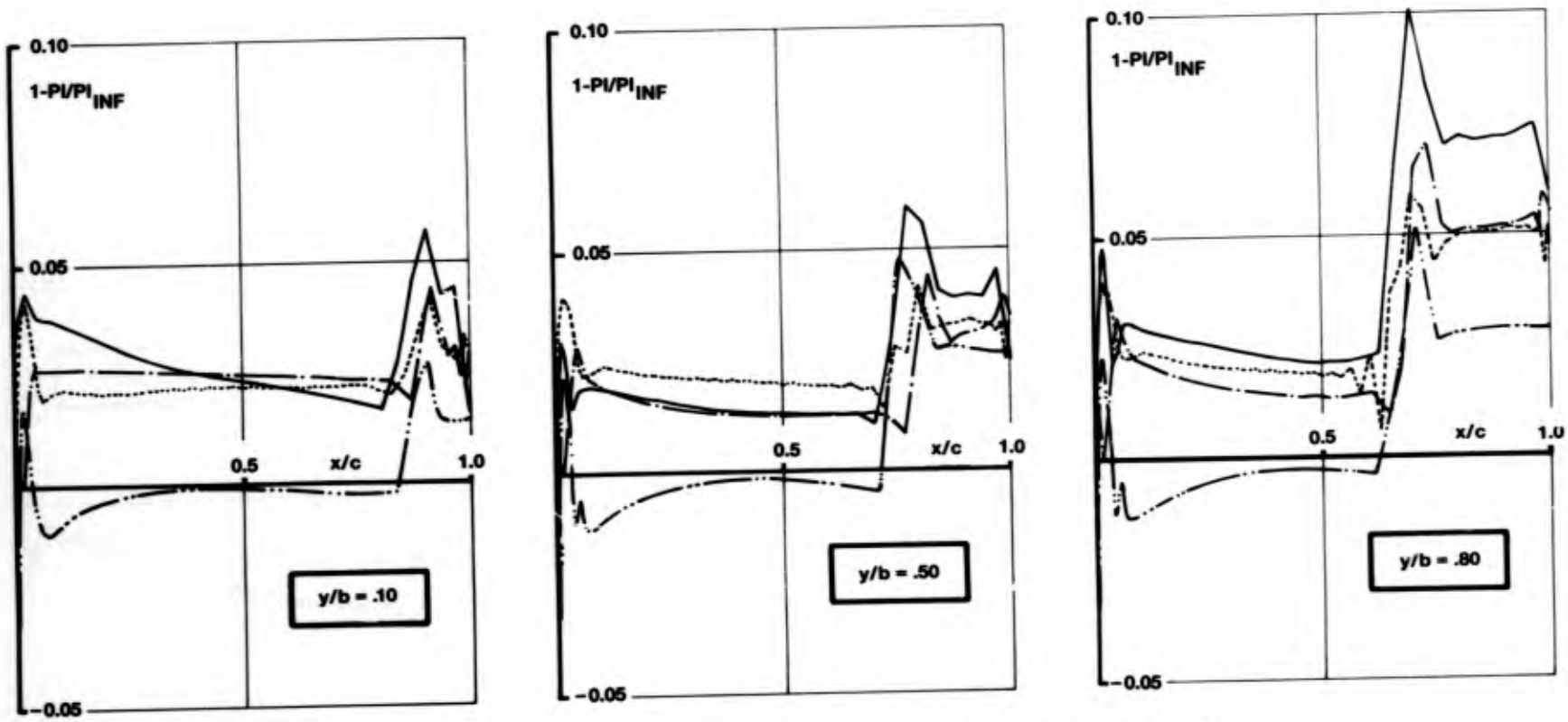


Fig. 7-48 TOTAL PRESSURE-DISTRIBUTION AT SPANWISE SECTIONS (y/b = 0.1, 0.5, 0.8)

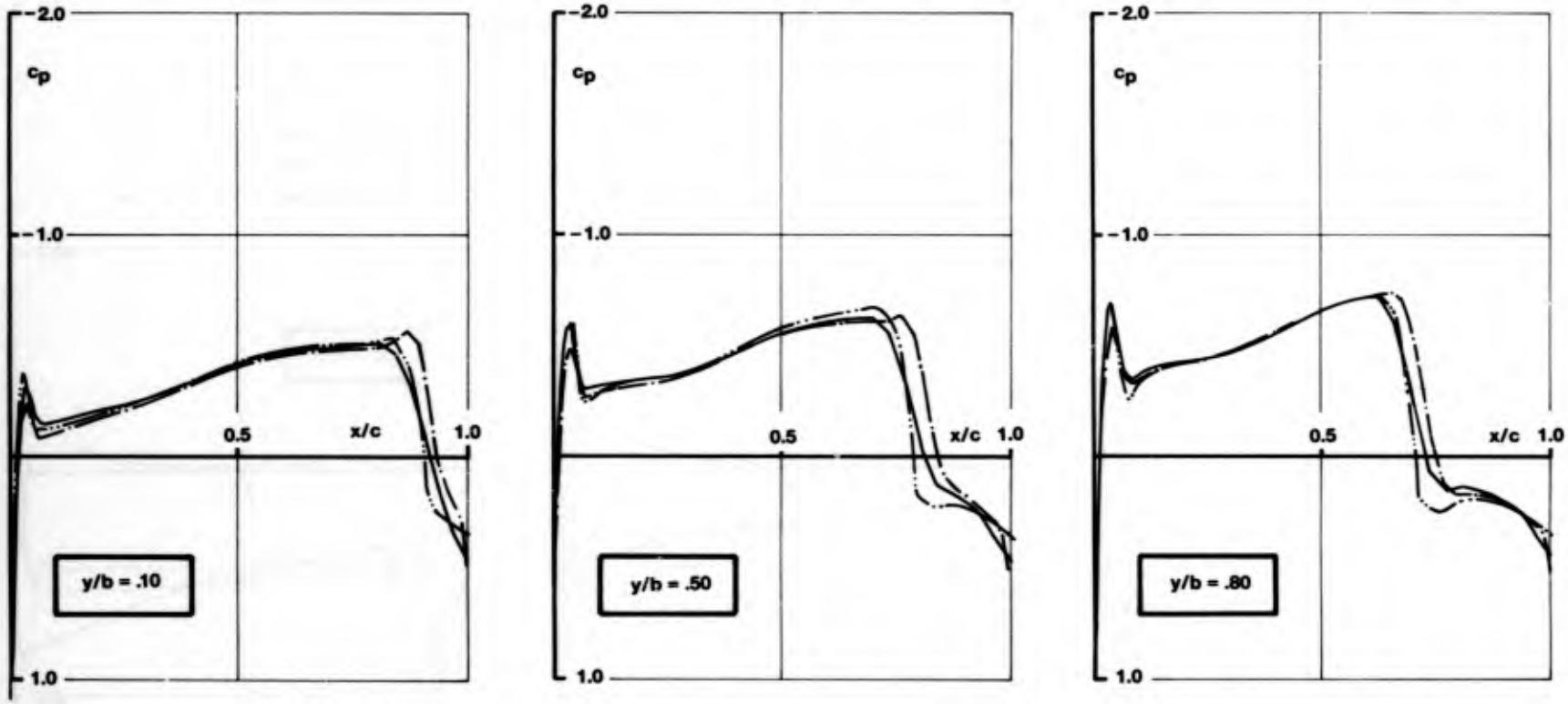


Fig. 7-49 INFLUENCE OF MESH-SIZE (DORNIER/JAMESON) PRESSURE-DISTRIBUTION (Cp) AT SPANWISE SECTIONS (y/b = 0.1, 0.5, 0.8)

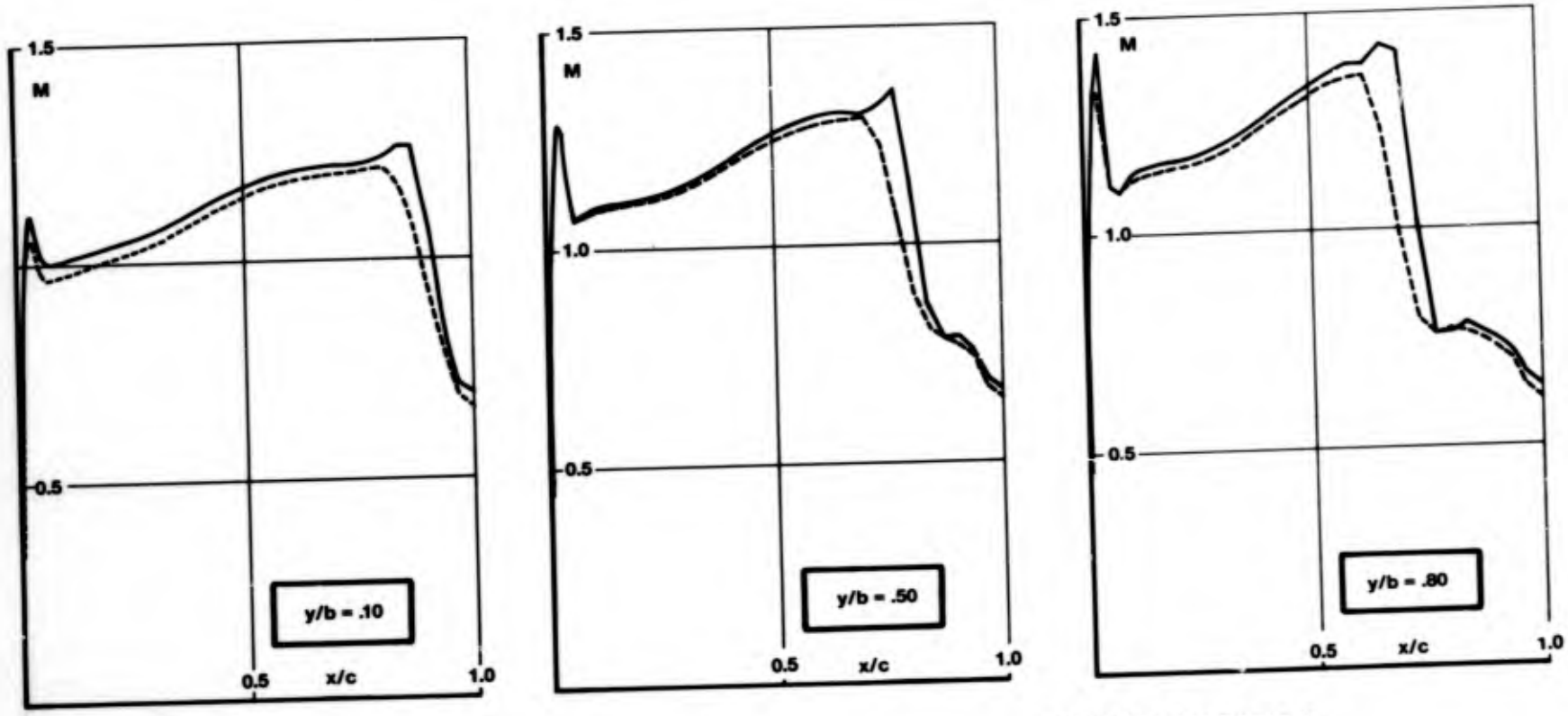


Fig. 7-5u INFLUENCE OF VARIATION OF ARTIFICIAL VISCOSITY (ONERA/MATRA) MACHNO.-DISTRIBUTION AT SPANWISE SECTIONS (y/b = 0.1, 0.5, 0.8)

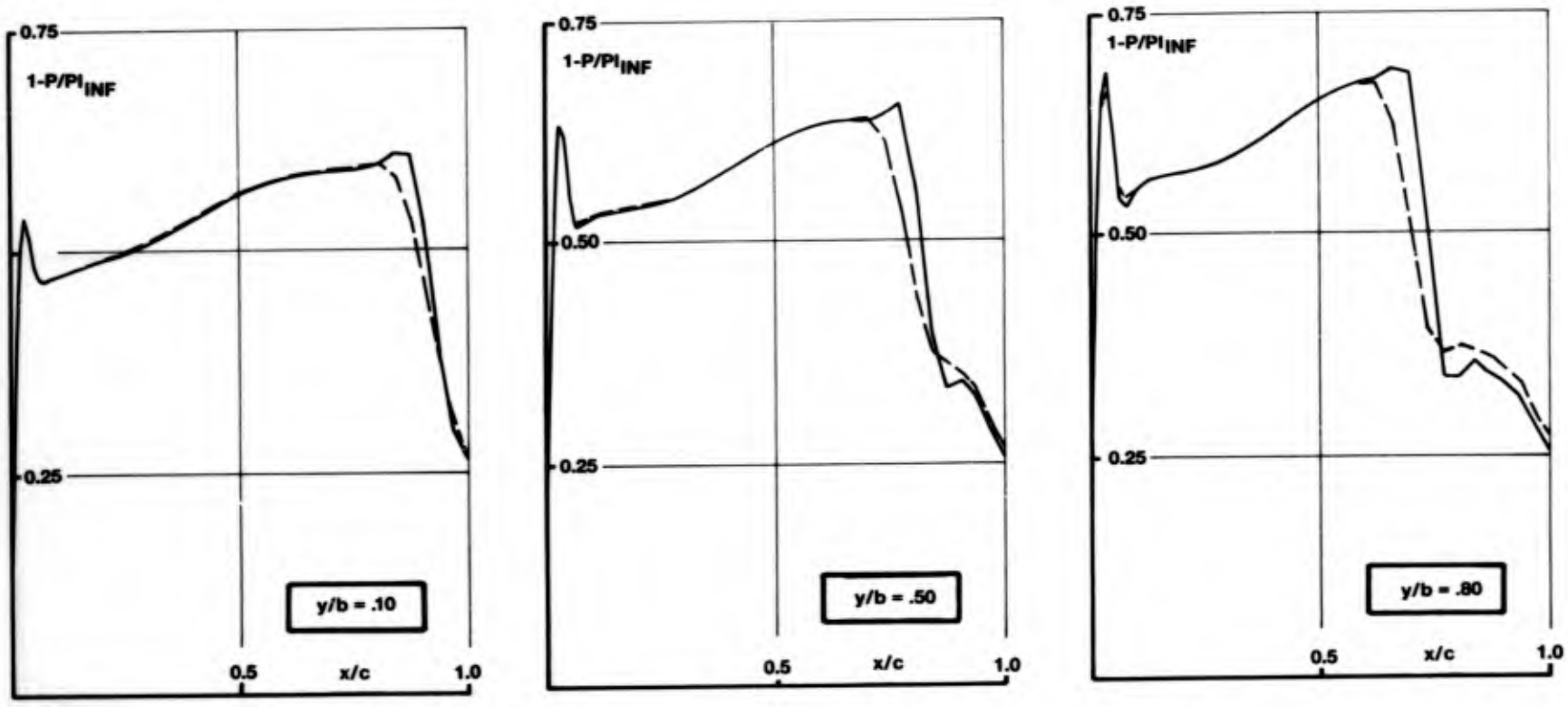


Fig. 7-51 INFLUENCE OF VARIATION OF ARTIFICIAL VISCOSITY (ONERA/MATRA) PRESSURE-DISTRIBUTION AT SPANWISE SECTIONS (y/b = 0.1, 0.5, 0.8)

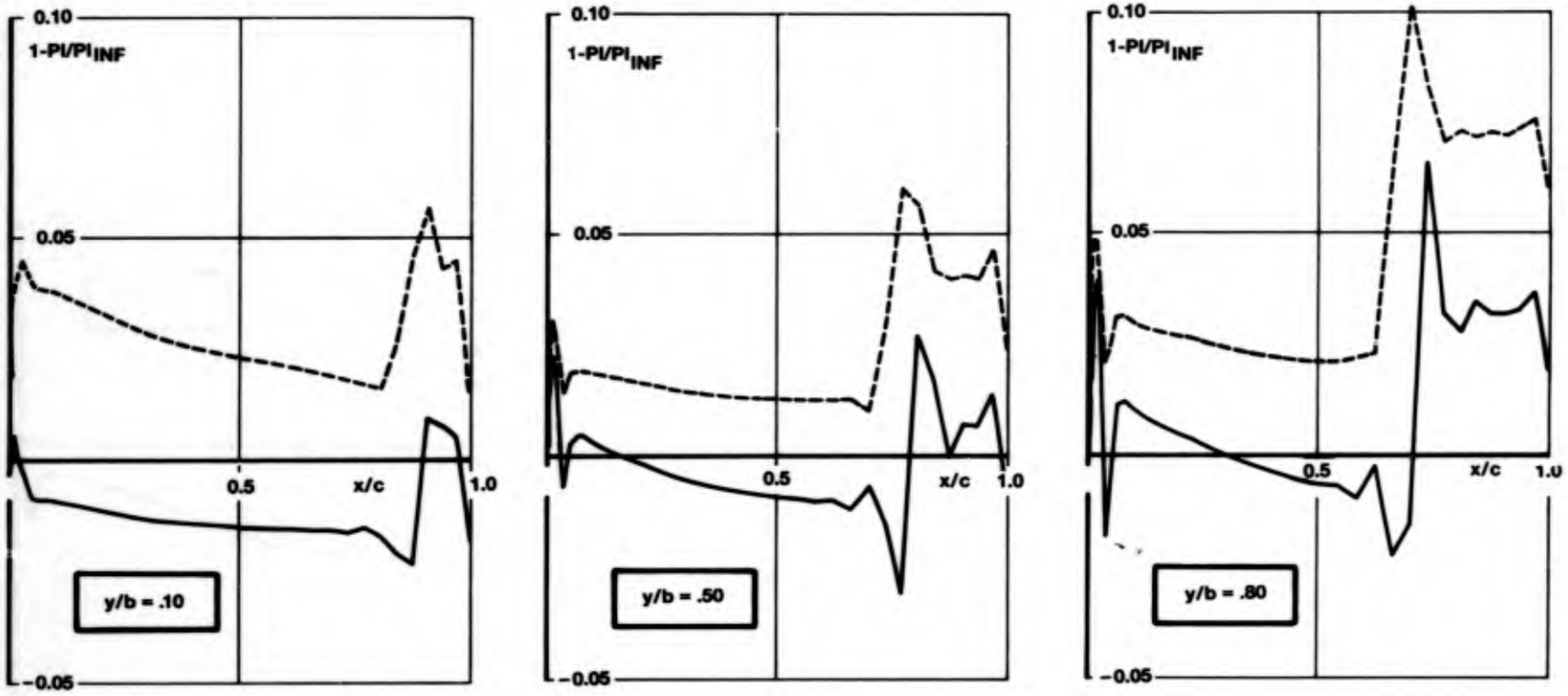
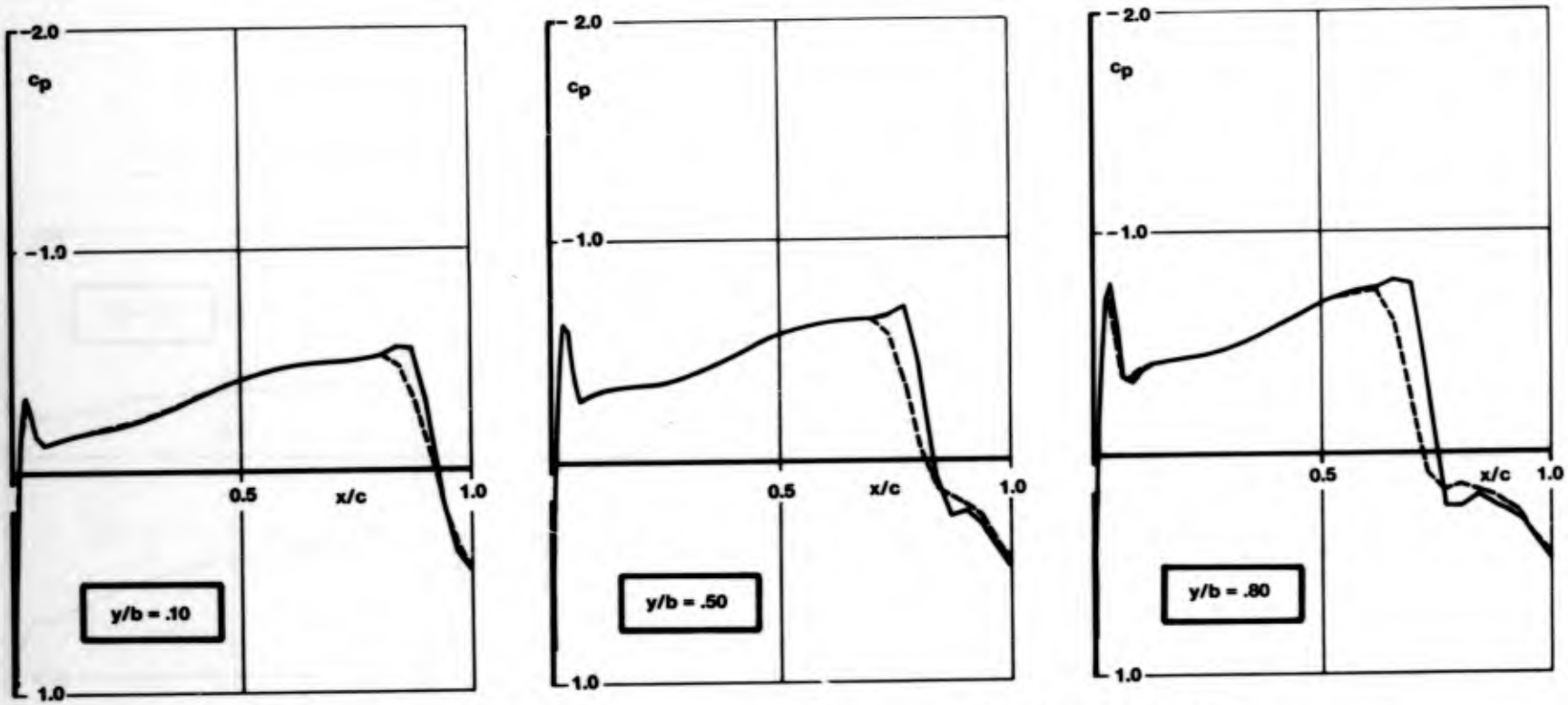


Fig. 7-52 INFLUENCE OF VARIATION OF ARTIFICIAL VISCOSITY (ONERA/MATRA) TOTAL PRESSURE-DISTRIBUTION AT SPANWISE SECTIONS (y/b = 0.1, 0.5, 0.8)



ONERA/MATRA (1b) "M6003B"

ONERA/MATRA (1a) "M6NP4"

AGARD WG07 TEST CASE 12
ONERA M6
M = .92 $\alpha = 0^\circ$

Fig. 7-53 INFLUENCE OF VARIATION OF ARTIFICIAL VISCOSITY (ONERA/MATRA) PRESSURE-DISTRIBUTION (Cp) AT SPANWISE SECTIONS (y/b = 0.1, 0.5, 0.8)

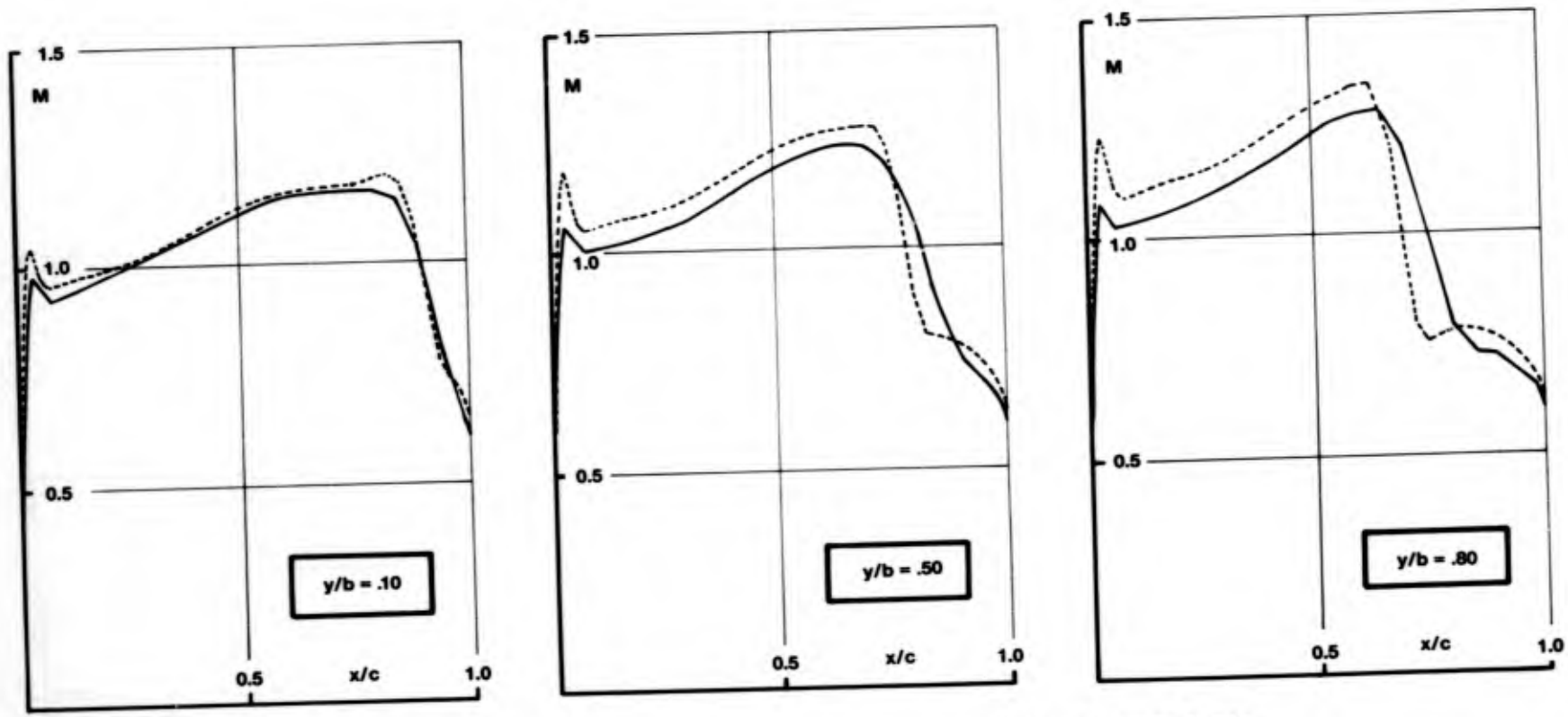


Fig. 7-54 INFLUENCE OF MESH-SIZE (DORNIER/JAMESON)
MACHNO.-DISTRIBUTION AT SPANWISE SECTIONS (y/b = 0.1, 0.5, 0.8)

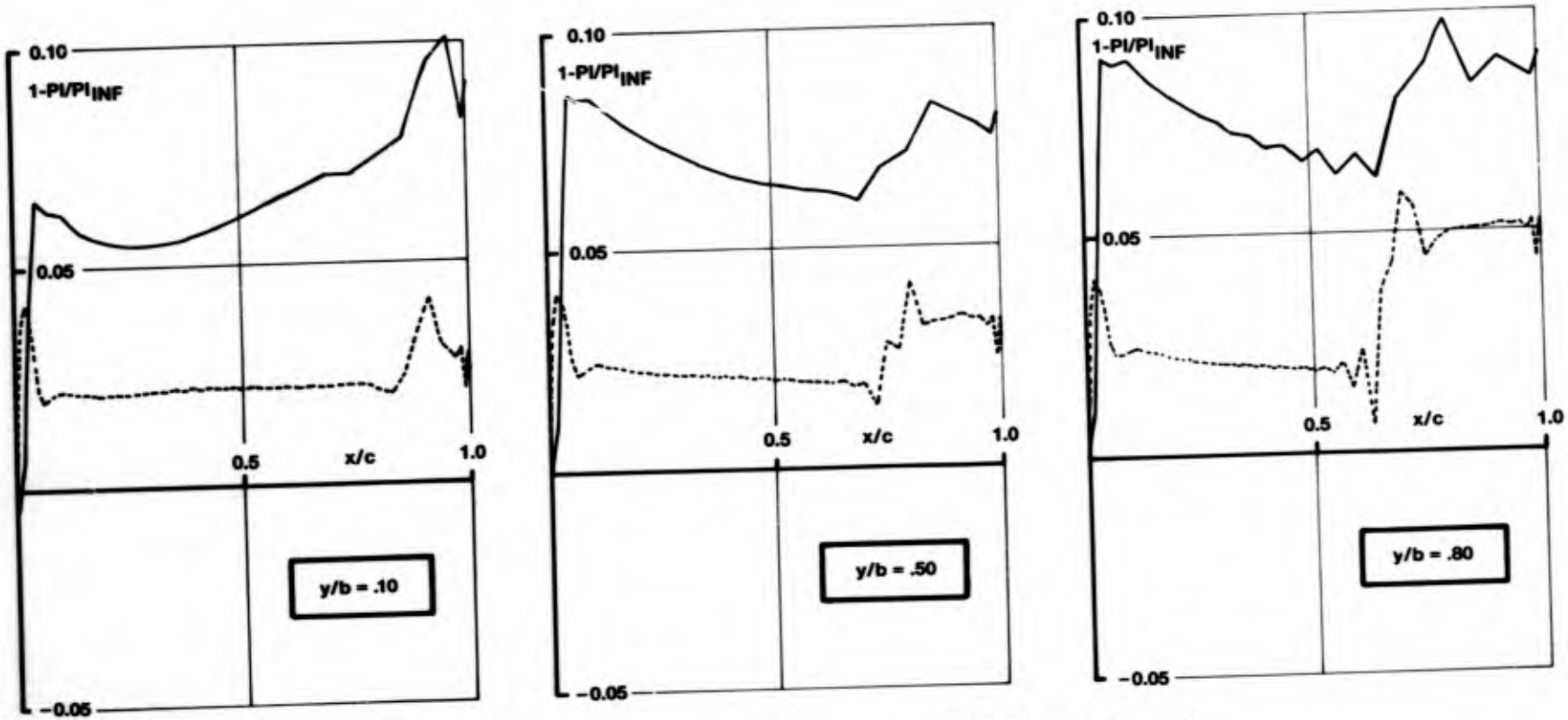


Fig. 7-55 INFLUENCE OF MESH-SIZE (DORNIER/JAMESON)
TOTAL PRESSURE-DISTRIBUTION AT SPANWISE SECTIONS (y/b = 0.1, 0.5, 0.8)

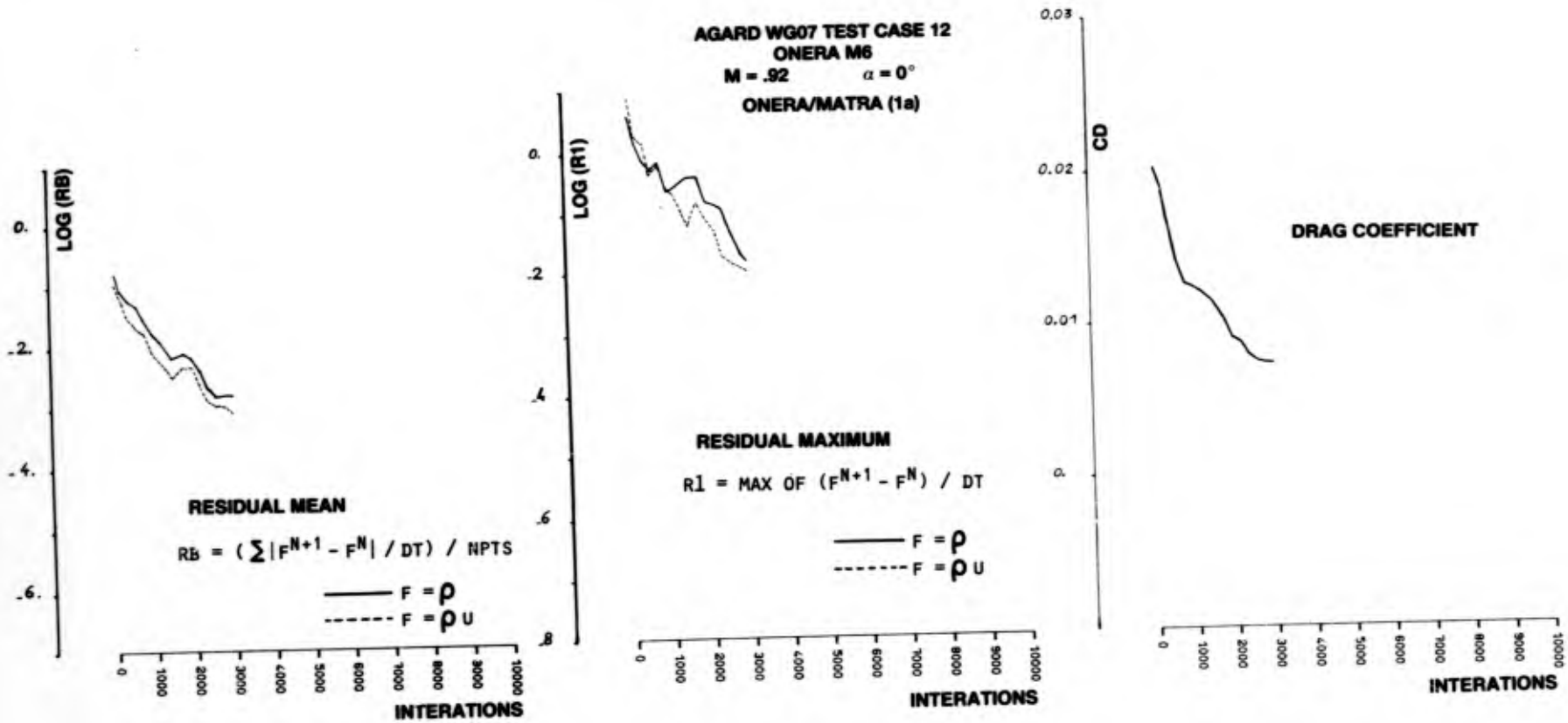


Fig. 7-56 CONVERGENCE HISTORY (ONERA/MATRA, 1a)

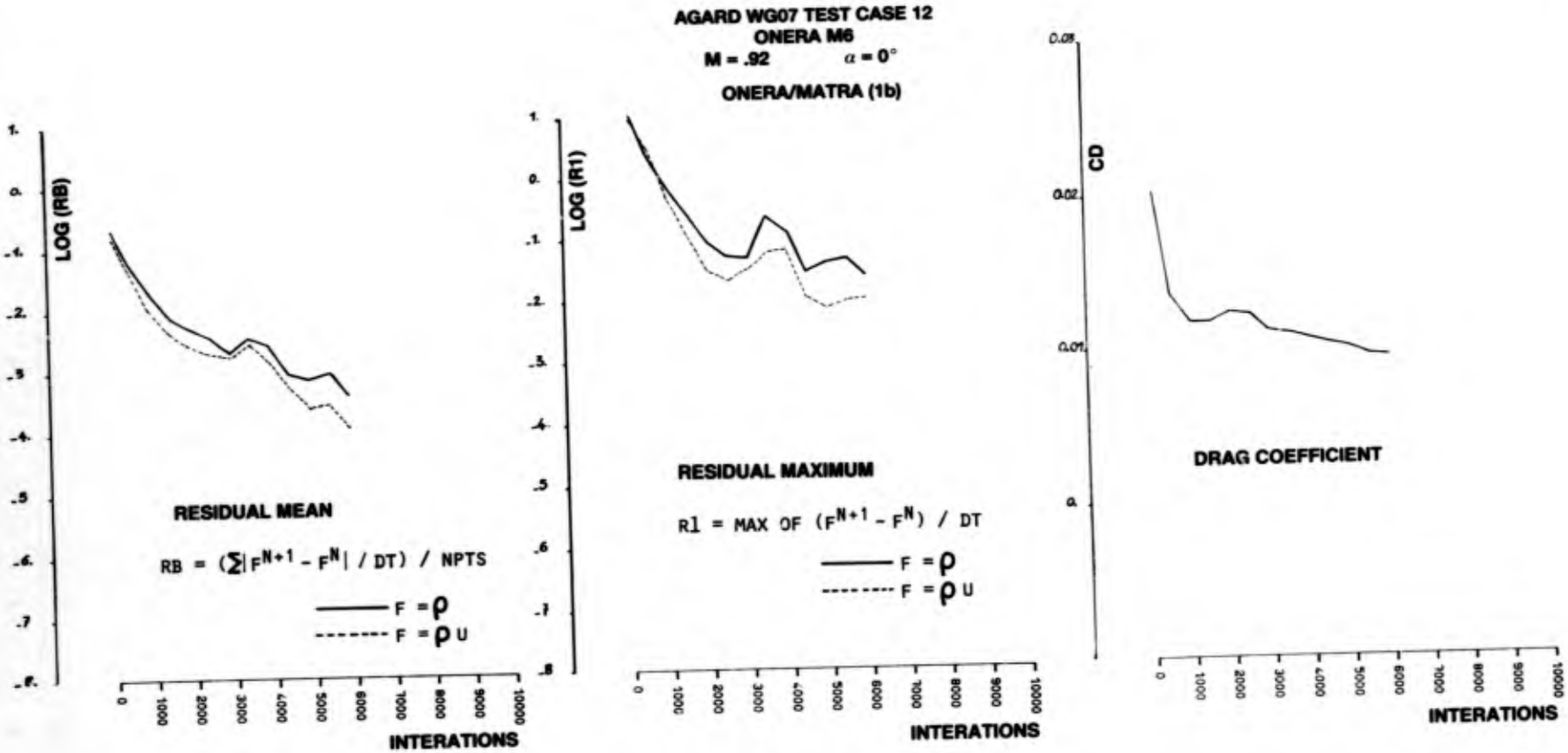
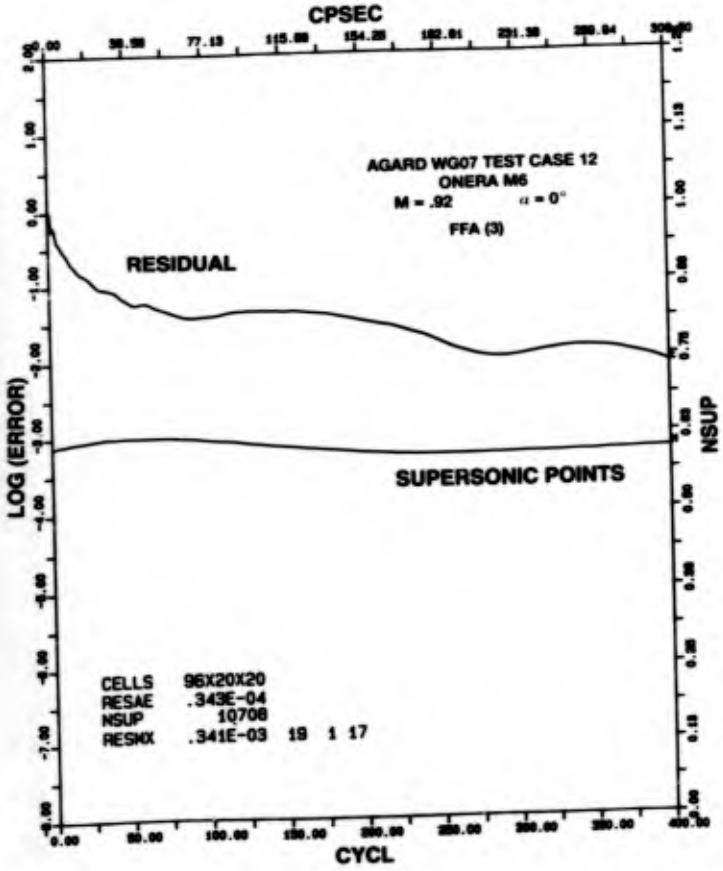


Fig. 7-57 CONVERGENCE HISTORY (ONERA/MATRA, 1b)



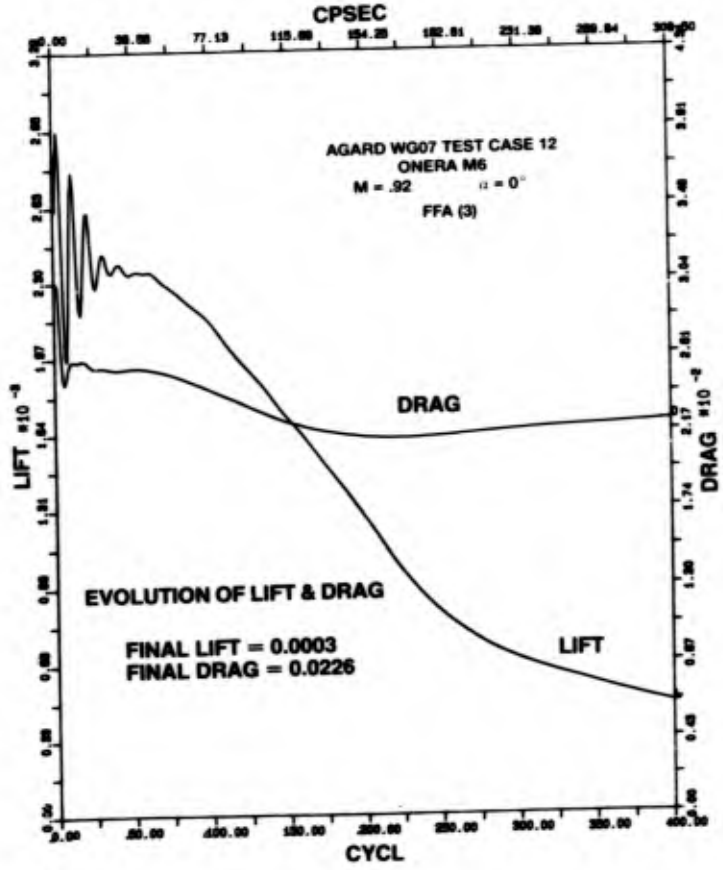
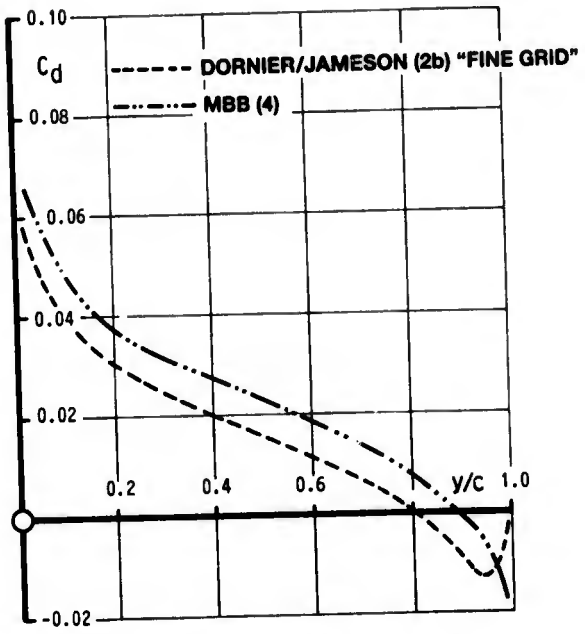


Fig. 7-58 CONVERGENCE HISTORY (RIZZI/FFA)



AGARD WG07 TEST CASE 12
ONERA M6
M = .92 α = 0°

MBB (4)

n	C_l	C_d	C_m
0.041	0.0	0.0608	0.0
0.122	0.0	0.0452	0.0
0.204	0.0	0.0374	0.0
0.286	0.0	0.0325	0.0
0.367	0.0	0.0286	0.0
0.449	0.0	0.0253	0.0
0.531	0.0	0.0219	0.0
0.612	0.0	0.0186	0.0
0.694	0.0	0.0144	0.0
0.776	0.0	0.0092	0.0
0.857	0.0	0.0027	0.0
0.937	0.0	-0.0036	0.0
0.988	0.0	-0.0172	0.0

DORNIER/JAMESON (2b) "FINE GRID"

y/s =	C_l	C_d	C_m
0.9875	0.0	-0.0053	0.0
0.9600	0.0	-0.0119	0.0
0.9300	0.0	-0.0122	0.0
0.9000	0.0	-0.0082	0.0
0.8700	0.0	-0.0045	0.0
0.8375	0.0	-0.0018	0.0
0.8000	0.0	0.0003	0.0
0.7500	0.0	0.0042	0.0
0.6950	0.0	0.0077	0.0
0.6500	0.0	0.0097	0.0
0.6100	0.0	0.0113	0.0
0.5675	0.0	0.0131	0.0
0.5225	0.0	0.0149	0.0
0.4800	0.0	0.0166	0.0
0.4400	0.0	0.0182	0.0
0.3950	0.0	0.0201	0.0
0.3450	0.0	0.0224	0.0
0.2950	0.0	0.0248	0.0
0.2450	0.0	0.0275	0.0
0.2000	0.0	0.0306	0.0
0.1550	0.0	0.0344	0.0
0.1100	0.0	0.0387	0.0
0.0650	0.0	0.0448	0.0
0.0200	0.0	0.0554	0.0

Fig. 7-59 AGARD WG07 TC 12 (M = 0.92, α = 0°)
DISTRIBUTION OF LOCAL DRAG IN SPANWISE DIRECTION

7.5 *Numerical Solution for Three-Dimensional Cases – NASA AMES SWEPT WING (W. Schmidt)*

7.5.1 General outlook on data obtained

This arrow-type wing with 36°/27° leading edge sweep and an aspect ratio of 7.2 has been only calculated by Dornier. Therefore no comparisons are available and no recommendations can be made rather than to use the data presented in the next chapters for future comparisons. To be consistent with the previous chapters 7, table 7-10 portrays some overall information about the results from Dornier.

CONTRIBUTION		MESH							OUTER BOUNDARY			C_L	C_D	C_M	REMARKS
NO.	COMP.	TYPE		NO. OF POINTS											
				TOTAL			ON WING US								
		X	Y	X	Y	Z	CHORD	SECT	x_{MIN}/x_{MAX} CHORD	z_{MAX}/z_{MIN} CHORD	Y_{MAX} (SPAN)				
1	DORNIER / JAMESON	C	H	161	33	33	61	25	+6,-5	±6	2	0.649	0.033	-0.869	

Table 7-10: Results available

Table 7-11 contains all the contour maps and total coefficients required and provided. All information except T_i is provided.

CONTRIBUTION		CONTOUR MAPS								TOTAL COEFF.		
		UPPER SURFACE				LOWER SURFACE						
No.	COMPANY	M	1-P/PINF	1-Pt/PINF	1-Tt/TINF	M	1-P/PINF	1-Pt/PINF	1-Tt/TINF	C_L	C_M	C_D
1	DORNIER / JAMESON	X	X	X		X	X	X		X	X	X

MOMENT REFERENCE POINT : X = Y = Z = 0

Table 7-11: Components required and provided
Contour maps and total coefficients

Table 7-12 contains corresponding information for section characteristics.

CONTRIBUTION		SURFACE – PLOTS						FIELD – PLOTS					LOCAL COEFF.			TABULATED DATA					
NO	COMPANY	Y/S	M	1-P/PINF	1-Pt/PINF	1-Tt/TINF	C_p	M	1-P/PINF	1-Pt/PINF	1-Tt/TINF		C_l	C_m	C_d	X/C	M	1-Pt/PINF	1-Pt/PINF	1-Tt/TINF	C_p
1	DORNIER / JAMESON	0.05	X	X	X		X						X	X	X	X	X	X	X		X
		0.25	X	X	X		X						X	X	X	X	X	X	X		X
		0.4	X	X	X		X						X	X	X	X	X	X	X		X
		0.6	X	X	X		X						X	X	X	X	X	X	X		X
		0.9	X	X	X		X						X	X	X	X	X	X	X		X

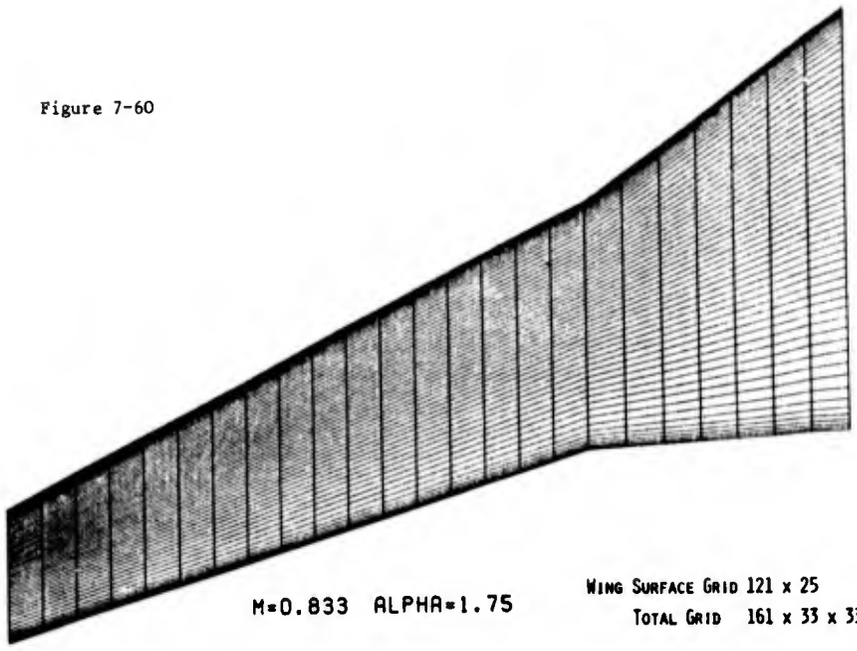
Table 7-12: Components required and provided
Section characteristics

7.5.2 Description of method and specification of mesh grid used

The Dornier/Jameson method used for all three-dimensional cases is basically an extension of the method used for the airfoil test cases. The Euler equations are solved by the finite volume multi-stage time-stepping scheme described in Ref. 7-4 and 7-12 to 7-15. The scheme used for the present calculations is the 4-2 scheme with non-standard coefficients and an evaluation of the dissipative terms twice per complete time cycle. The dissipative terms used are the blended 4th and 2nd order terms as discussed already in Ref. 7-4.

The mesh is of C-H type and has been generated using the Dornier-mesh generator for complex wing-body combinations as described in Ref. 7-12 and 7-14. The J-2-line is wrapped around the wing sections at a nearly constant distance based on local chord. The mesh spacing is smoothed using a three-dimensional Poisson solver. Details on the location of outer boundaries can be found in table 7-10. The surface mesh can be seen in figure 7-60.

Figure 7-60



7.5.3 Contour Maps

Fig. 7-61 and 7-62 portray the contour plots of constant lines of Mach number for upper and lower wing surface correspondingly. This supercritical wing has a large supersonic zone on the upper surface with local Mach numbers 1.50 and a rather strong shock from 30% half span outwards at 80% local chord. The shock is swept forward towards the wing tip. The lower surface has local Mach numbers 1.0 and almost parallel pattern over a wide range of the wing.

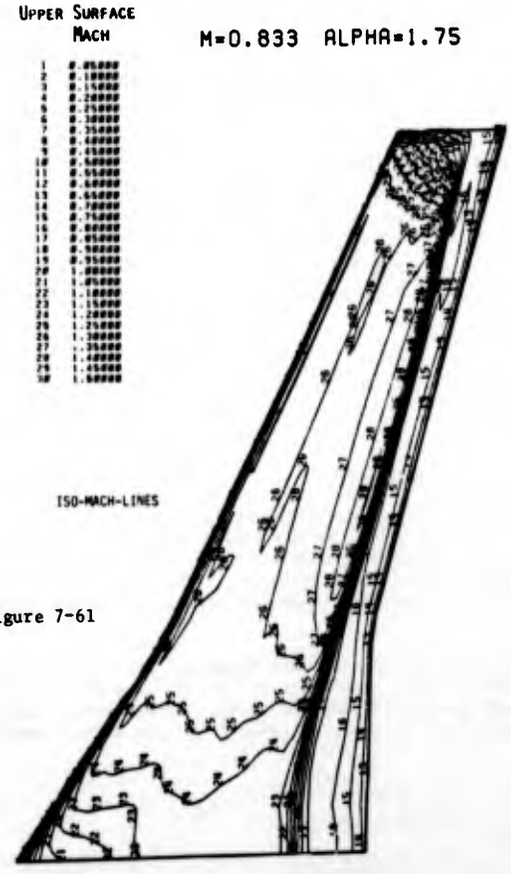


Figure 7-61

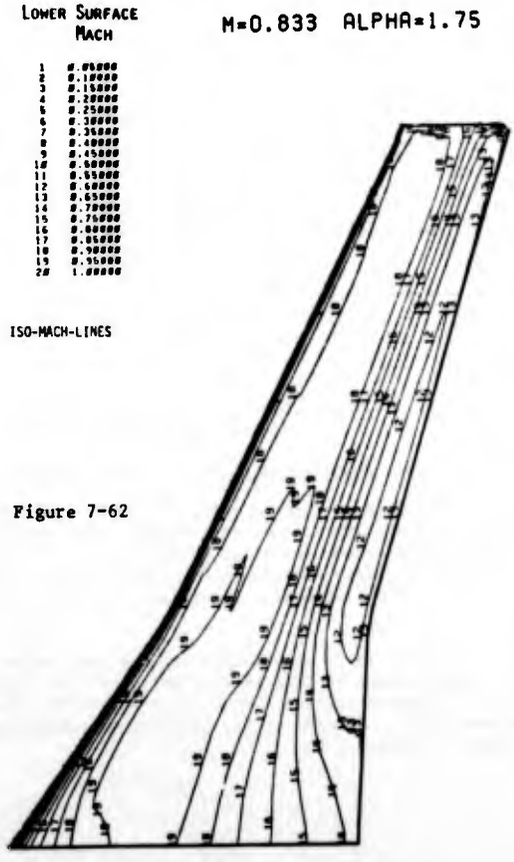


Figure 7-62

Figures 7-63 and 7-64 show the corresponding results for static pressure. The information is quite similar.

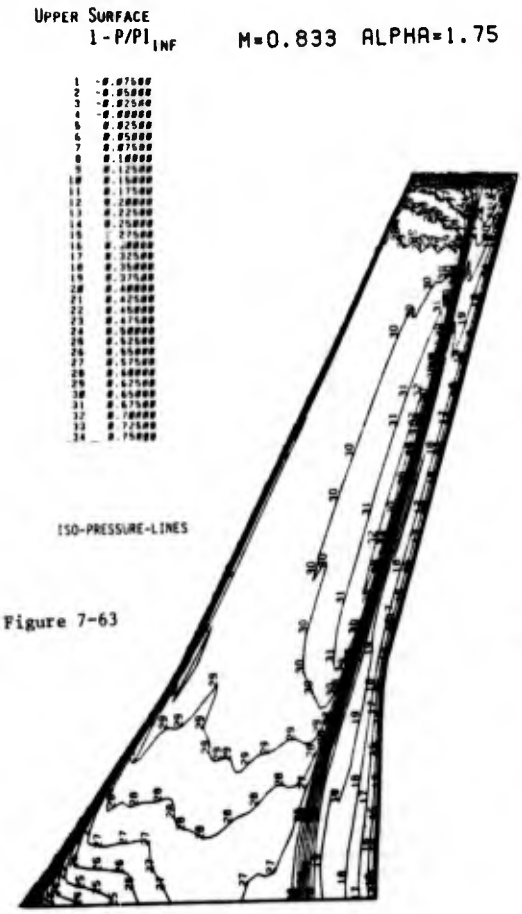


Figure 7-63

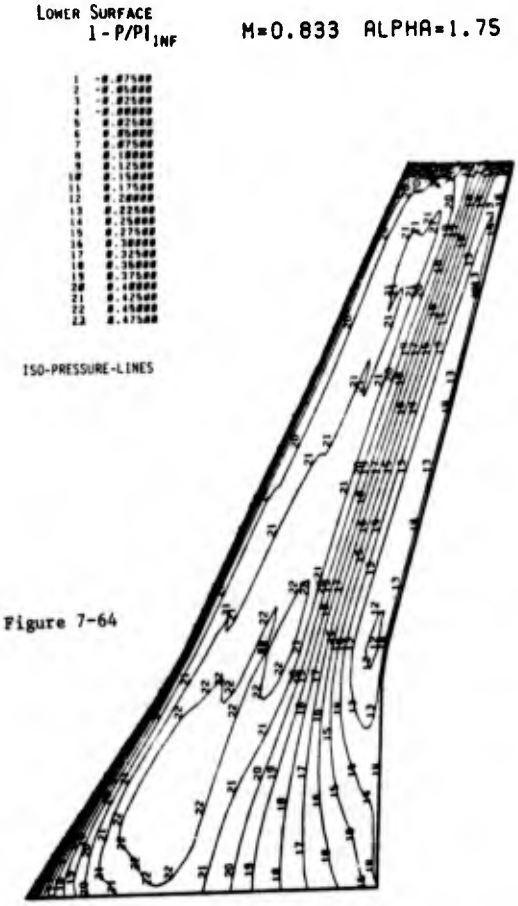


Figure 7-64

Fig. 7-65 and 7-66 present the lines of equal total pressure losses on upper and lower surface. The total pressure loss level of 5 - 6 % indicates the relatively strong shock between roughly 30 % and 80 % half span, while in the remaining part the losses are relatively small. The wing tip situation is not quite clear, but seems to indicate a tip vortex and strong crossflow.

The lower surface total pressure losses are very small except right at the leading edge where values of ∿ 2 % occur, which are caused fully by nonphysical effects.

Figure 7-65

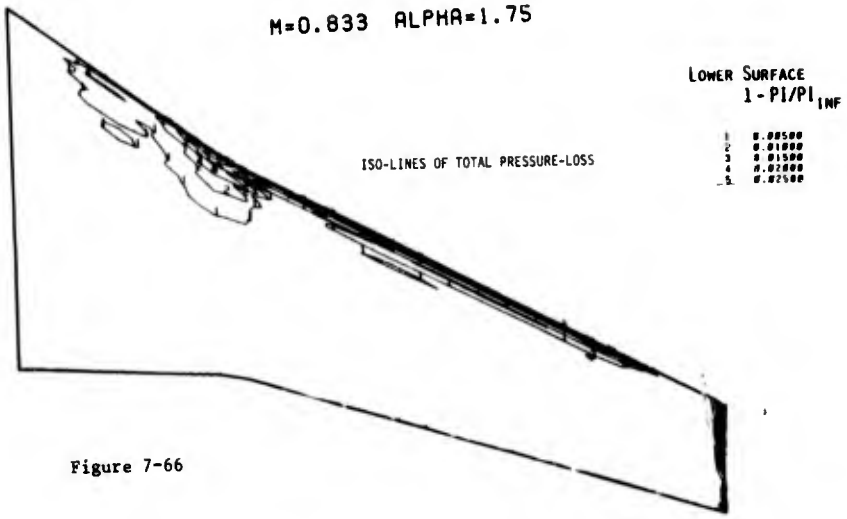


Figure 7-66

7.5.4 Section characteristics / field plots

Details on field plots are not presented here. If for future comparisons results are of individual interest, the contributors from Dornier will offer the corresponding information.

7.5.5 Comparison of section characteristics (surface plots)

The wing section Mach number distributions for span stations normalized with the wing-semispan of y/b = 0.05, 0.25, 0.40, 0.60 and 0.90 are shown on figures 7-67 to 7-71. The corresponding tabulated data are listed in section 7.5.7. All plots indicate subsonic lower surfaces, rear loaded section characteristics except in the root section, and an almost roof-top type distribution on the upper surface terminated by a shock.

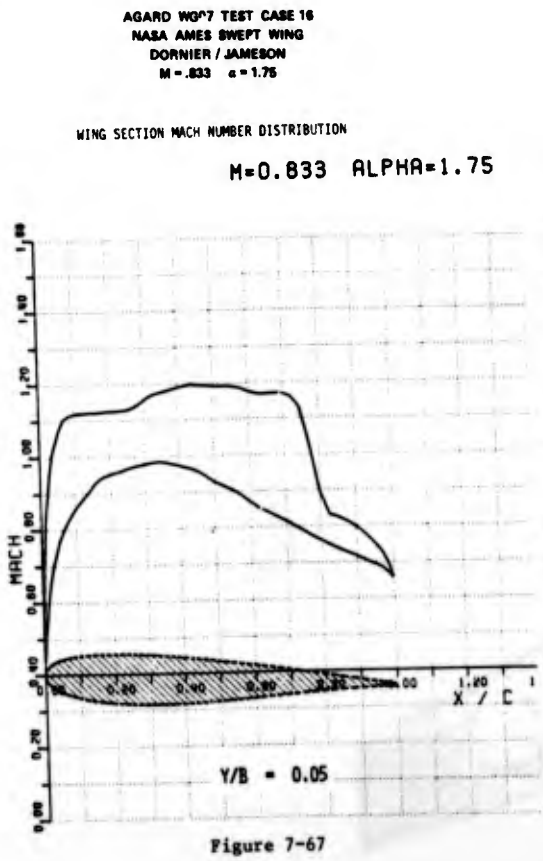


Figure 7-67

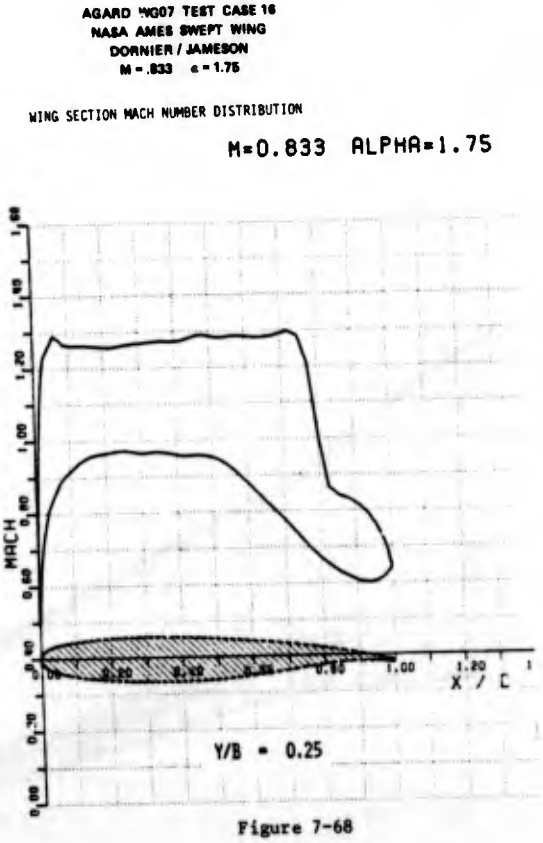


Figure 7-68

WING SECTION MACH NUMBER DISTRIBUTION

M=0.833 ALPHA=1.75

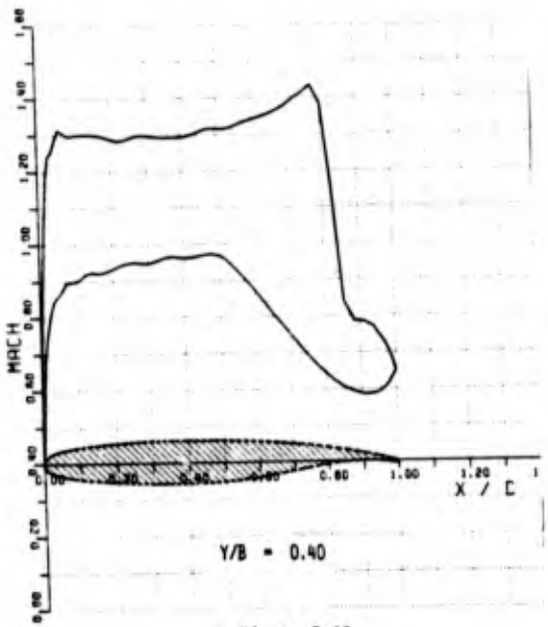


Figure 7-69

WING SECTION MACH NUMBER DISTRIBUTION

M=0.833 ALPHA=1.75

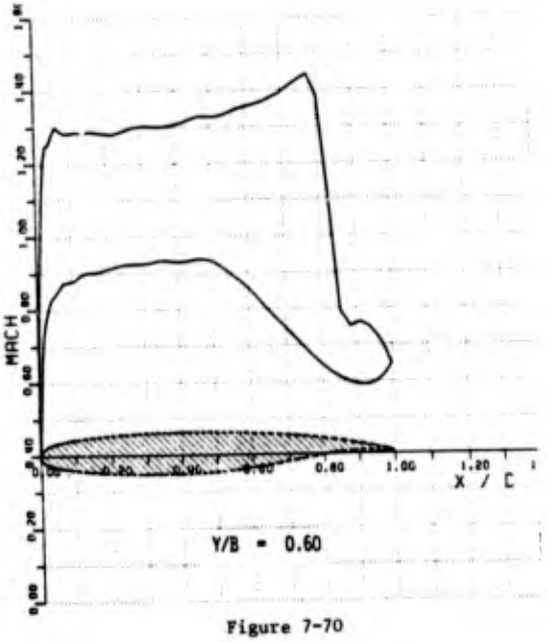


Figure 7-70

WING SECTION MACH NUMBER DISTRIBUTION

M=0.833 ALPHA=1.75

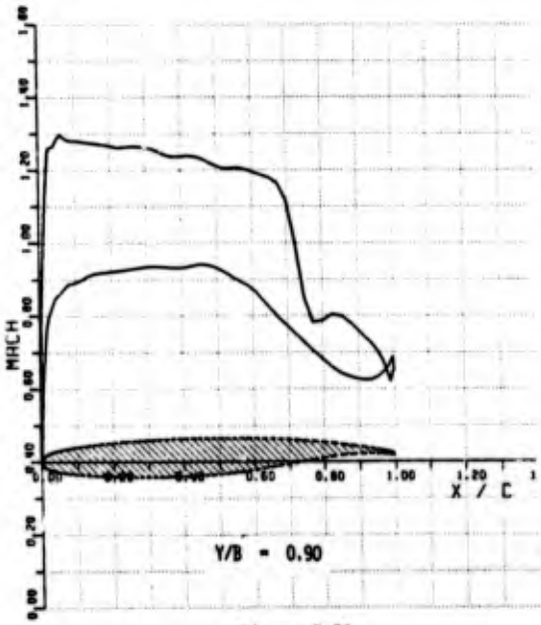


Figure 7-71

WING SECTION PRESSURE DISTRIBUTION

M=0.833 ALPHA=1.75

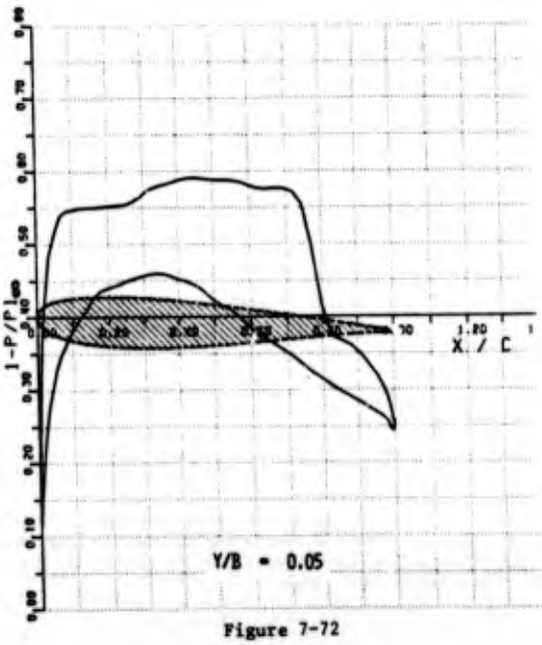


Figure 7-72

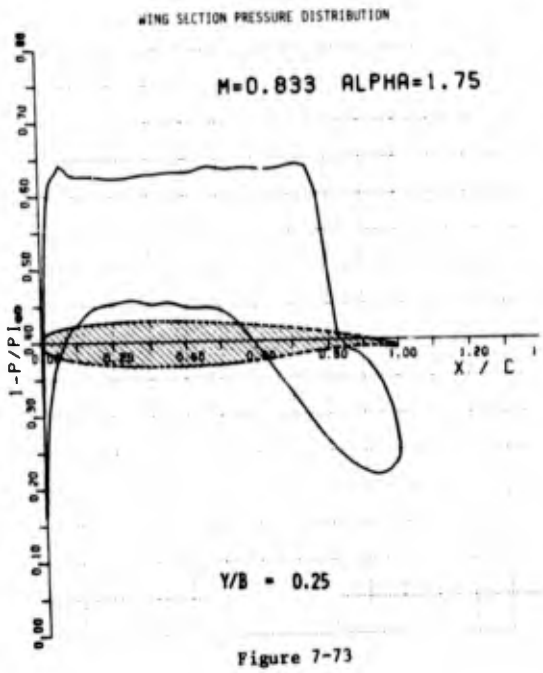


Figure 7-73

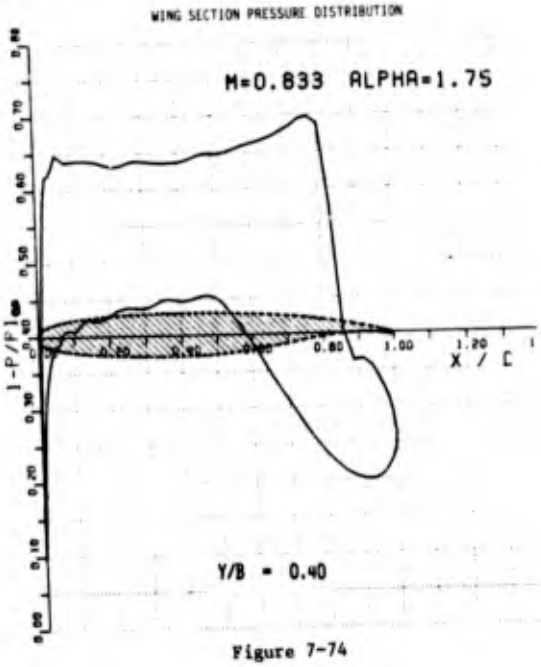


Figure 7-74

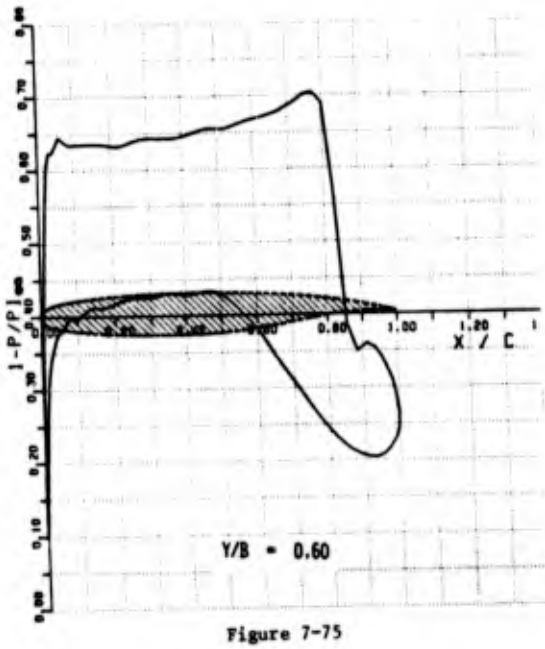


Figure 7-75

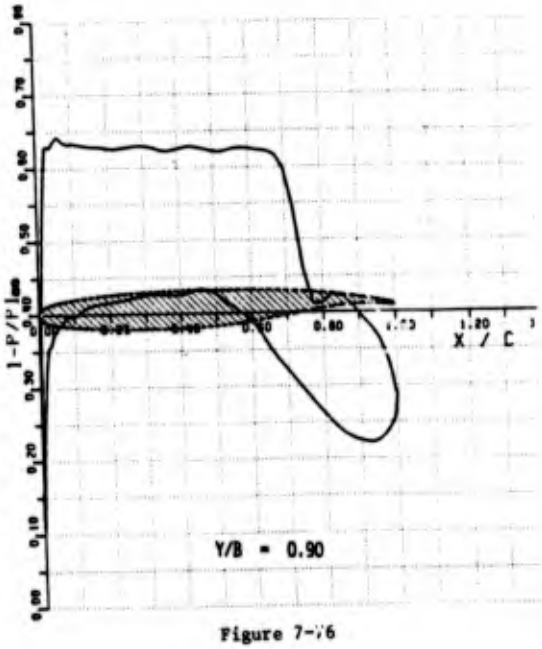


Figure 7-76

The above figures 7-72 to 7-76 portray the corresponding information for static pressure. Except for the section at y/b = 0.90 near the tip no significant difference can be seen.

Figures 7-77 to 7-81 show the total pressure losses for the same spanwise sections. Except through the shock total pressure losses occur at the leading edge that have to be attributed to numerical effects. There is room for improvements of the numerical results, especially if we compare with the accuracy for the two-dimensional test cases.

M=0.833 ALPHA=1.75

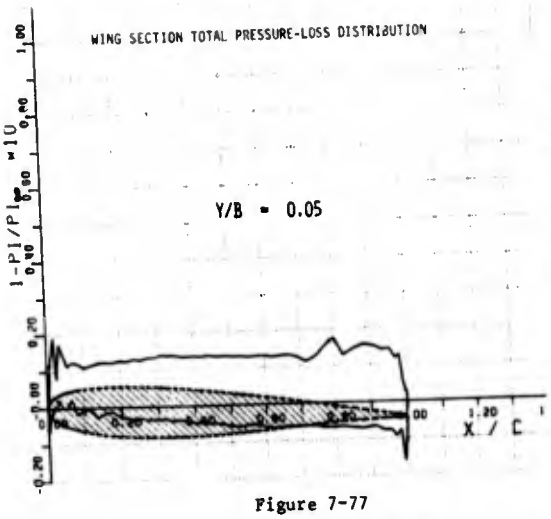


Figure 7-77

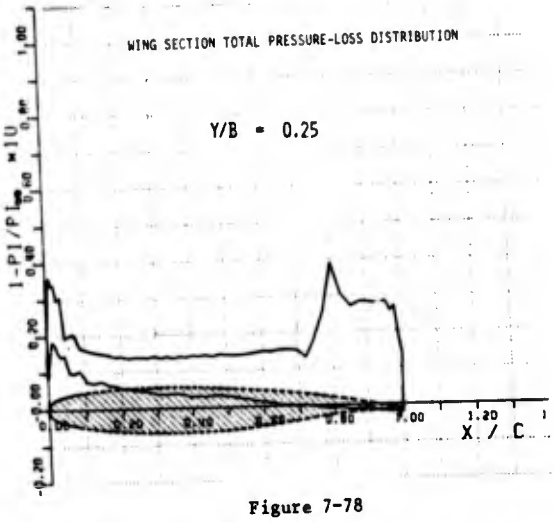


Figure 7-78

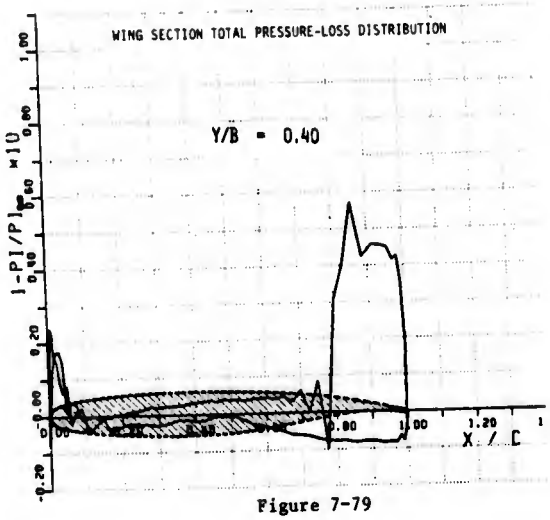


Figure 7-79

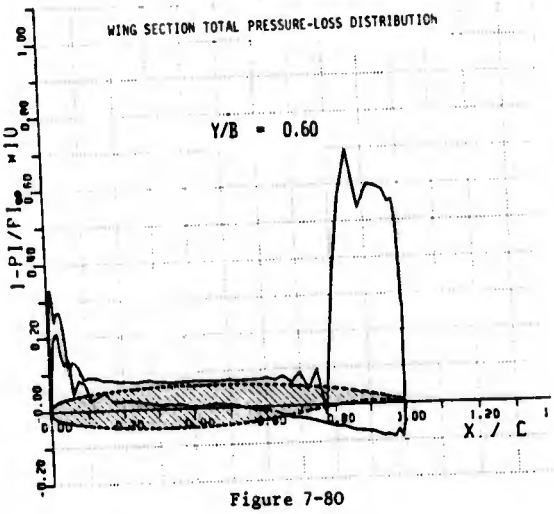


Figure 7-80

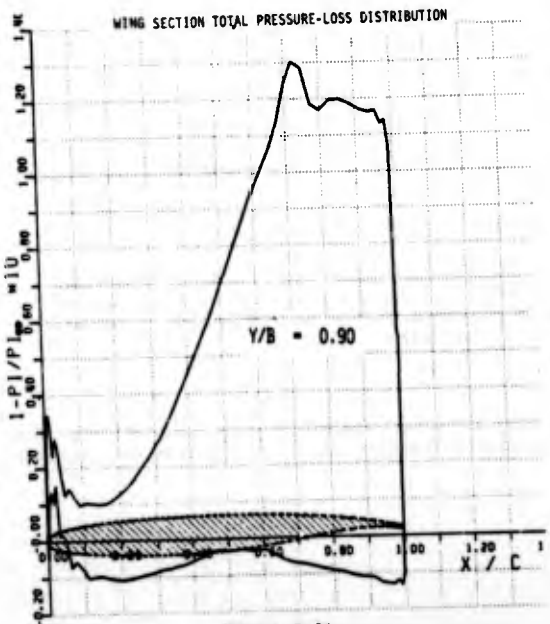


Figure 7-81

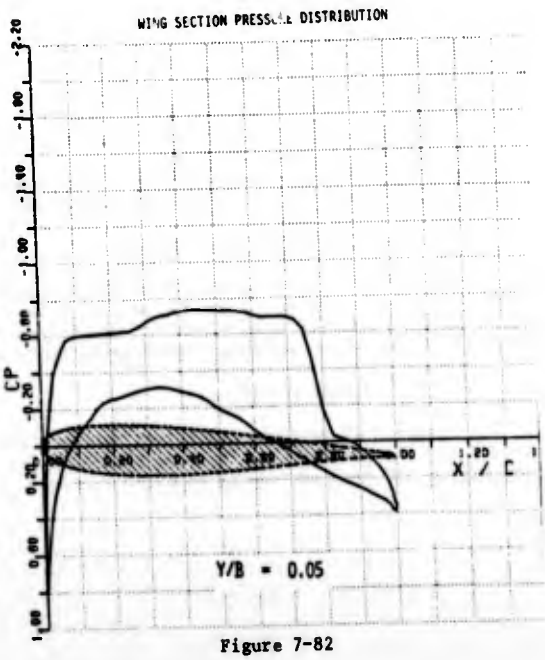


Figure 7-82

M=0.833 ALPHA=1.75

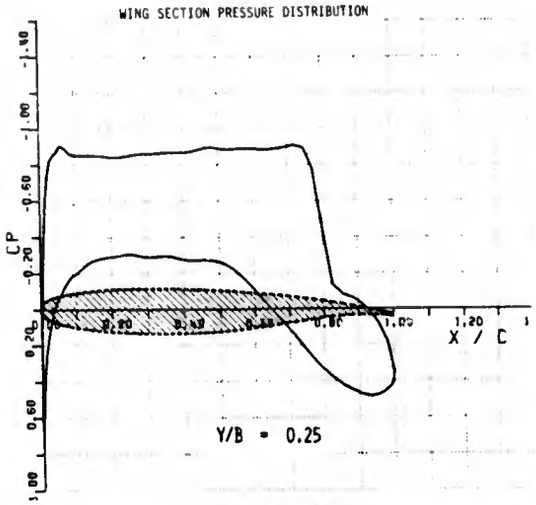


Figure 7-83

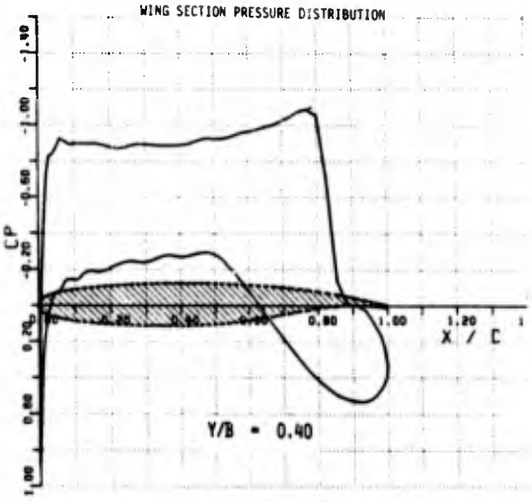


Figure 7-84

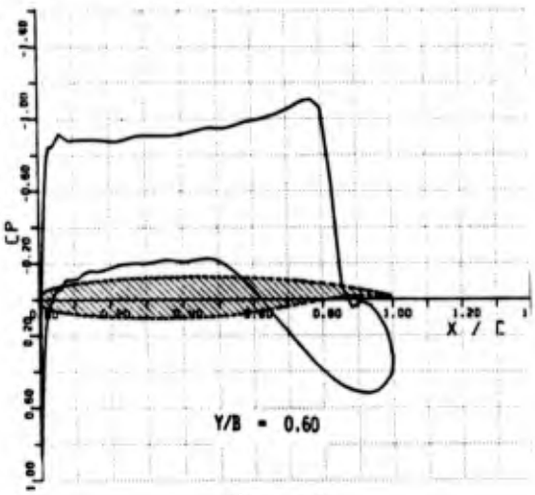


Figure 7-85

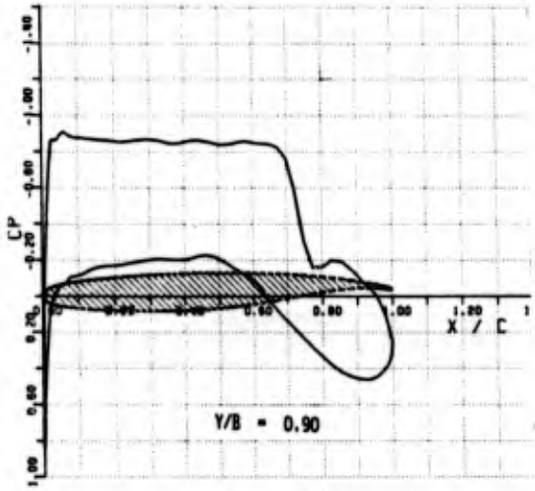


Figure 7-86

Finally, the figures 7-82 to 7-86 present the corresponding results in pressure coefficients c_p. These results are very similar to the p-plots,,only different in scale.

7.5.6 Convergence history plots

These results were obtained in 1983 using mesh refinements, but not the multigrid technique. In each mesh, 40 x 8 x 8, 80 x 16 x 16, and 160 x 32 x 32, 600 cycles were run with an reduction per cycle of approximately 0.99. The results can not be claimed to be converged down to machine accuracy, but well enough for engineering purposes. Convergence plots are not available.

7.5.7 Tabulated data

Table 7-13 presents the listed section lift, drag and moment characteristics, of which fig. 7-88 to 7-90 are the plotted results. From fig. 7-89 the increase in section drag resulting from the strong shock starting at 30% semispan can be seen.

y/b	c_l	c_d	c_m
0.9834	0.5756	0.0103	-0.2901
0.9427	0.6207	0.0012	-0.2961
0.9020	0.6601	-0.0031	-0.3108
0.8613	0.7020	-0.0007	-0.3331
0.8205	0.7394	0.0039	-0.3570
0.7798	0.7660	0.0085	-0.3757
0.7391	0.7826	0.0124	-0.3884
0.6984	0.7964	0.0159	-0.3996
0.6577	0.8020	0.0188	-0.4056
0.6170	0.8047	0.0213	-0.4100
0.5763	0.8039	0.0234	-0.4121
0.5355	0.7999	0.0250	-0.4120
0.4948	0.7933	0.0264	-0.4102
0.4541	0.7852	0.0277	-0.4072
0.4134	0.7763	0.0289	-0.4032
0.3727	0.7640	0.0293	-0.3970
0.3320	0.7383	0.0278	-0.3839
0.2894	0.7017	0.0261	-0.3597
0.2449	0.6525	0.0317	-0.3228
0.2003	0.5956	0.0360	-0.2860
0.1558	0.5430	0.0414	-0.2558
0.1113	0.4968	0.0514	-0.2315
0.0668	0.4584	0.0677	-0.2132
0.0223	0.4295	0.0896	-0.2064

c_L = 0.649 c_D = 0.033 c_M = -0.869

Figure 7-87

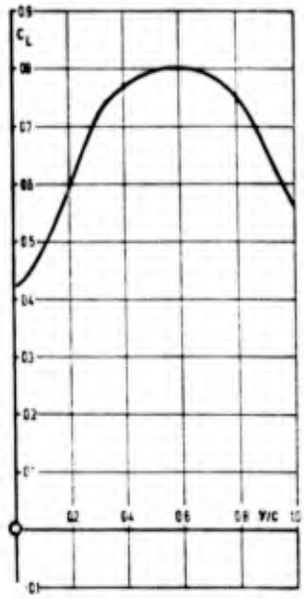


Figure 7-88

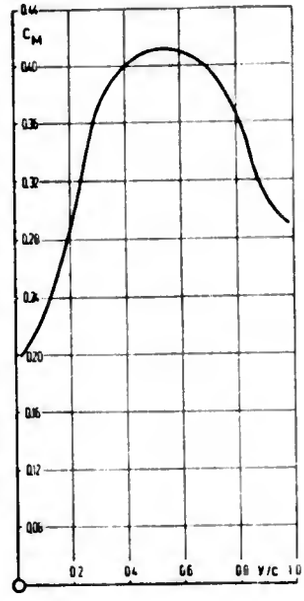


Figure 7-89

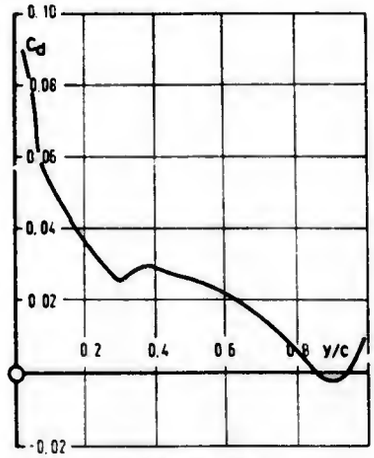


Figure 7-90

The following tables 7-13 to 7-17 contain all the listed data for the sections y/b = 0.05, 0.25, 0.40, 0.60, and 0.90. The first column contain the absolute x-value of the point with the origin in the wing apex and normalized with the root chord, the second column contain the local Mach number, the third the total pressure loss normalized with the total pressure at infinity, the next is static pressure, and the last the pressure coefficient c_p. All data read from lower surface trailing edge to upper surface trailing edge.

XC	MACH	1-PI/PINF	1-P/PINF	CP
1.00339	0.66466	-0.00036	0.26619	0.35449
1.00047	0.65567	-0.00041	0.24698	0.37774
0.99303	0.66088	-0.01300	0.24926	0.37699
0.98834	0.67515	-0.00454	0.25908	0.34208
0.97449	0.68668	-0.00636	0.26807	0.32388
0.96061	0.69224	-0.00457	0.27076	0.30722
0.94208	0.70025	-0.00468	0.27594	0.29056
0.92022	0.71150	-0.00348	0.28487	0.26424
0.89339	0.72416	-0.00391	0.29191	0.23861
0.86869	0.73611	-0.00377	0.29977	0.21389
0.83866	0.74939	-0.00338	0.30871	0.18412
0.81255	0.76347	-0.00340	0.31782	0.15456
0.78722	0.77746	-0.00348	0.32696	0.12498
0.76265	0.79245	-0.00302	0.33706	0.09212
0.73078	0.80751	-0.00301	0.34691	0.06015
0.71559	0.82095	-0.00300	0.35569	0.03168
0.69303	0.83299	-0.00304	0.36351	0.00629
0.67187	0.84456	-0.00310	0.37096	-0.01700
0.64969	0.85690	-0.00327	0.37898	-0.04309
0.62884	0.87101	-0.00292	0.38882	-0.07502
0.60849	0.88022	-0.00247	0.39969	-0.11110
0.58859	0.90242	-0.00232	0.40892	-0.14104
0.73078	0.88751	-0.00281	0.41493	-0.16054
0.71559	0.92095	-0.00300	0.42040	-0.17852
0.69303	0.93299	-0.00304	0.42773	-0.20287
0.67187	0.94456	-0.00310	0.43645	-0.23036
0.64969	0.95690	-0.00327	0.44383	-0.25431
0.62884	0.97101	-0.00292	0.44844	-0.26924
0.60849	0.98022	-0.00247	0.45186	-0.28033
0.58859	0.98242	-0.00232	0.45498	-0.29022
0.56913	0.91216	-0.00272	0.45882	-0.30034
0.55085	0.92072	-0.00268	0.46097	-0.30990
0.53133	0.93191	-0.00239	0.46148	-0.31156
0.51294	0.94528	-0.00188	0.46082	-0.30941
0.49483	0.95675	-0.00171	0.45924	-0.30420
0.47698	0.96418	-0.00175	0.45686	-0.29656
0.45935	0.96928	-0.00146	0.45399	-0.28726
0.44198	0.97412	-0.00141	0.45090	-0.27749
0.42468	0.97888	-0.00112	0.44721	-0.26525
0.40742	0.98313	-0.00057	0.44377	-0.25411
0.39033	0.98422	-0.00089	0.44103	-0.24521
0.37320	0.98273	-0.00048	0.43712	-0.23251
0.35626	0.98021	-0.00042	0.43238	-0.21691
0.33922	0.97636	-0.00038	0.42730	-0.20091
0.32213	0.97171	-0.00031	0.42129	-0.18403
0.30496	0.96674	-0.00013	0.41522	-0.16744
0.28768	0.96093	-0.00030	0.40954	-0.15144
0.27026	0.95512	0.00002	0.40377	-0.13511
0.25268	0.95007	0.00000	0.39776	-0.11813
0.23490	0.94291	0.00106	0.39254	-0.10344
0.21691	0.93776	0.00159	0.38734	-0.08877
0.19872	0.93364	0.00030	0.38254	-0.07534
0.18038	0.88811	0.00299	0.37776	-0.06203
0.16235	0.85734	0.00218	0.37344	-0.04988
0.14618	0.82949	0.00136	0.36984	-0.03978
0.13224	0.80383	0.00543	0.36682	-0.03127
0.12027	0.77428	0.00278	0.36409	-0.02359
0.11007	0.73617	0.00338	0.36175	-0.01702
0.10148	0.70861	0.00549	0.35962	-0.01104
0.09418	0.66234	0.00206	0.35749	-0.00506
0.08805	0.61967	0.00313	0.35587	-0.00051
0.08308	0.57805	0.00126	0.35362	0.00585
0.07900	0.53078	0.00100	0.35081	0.01366
0.07596	0.50212	-0.00097	0.34738	0.02329
0.07372	0.46949	-0.00313	0.34346	0.03426
0.07224	0.44670	-0.00341	0.33942	0.04557
0.07133	0.43574	-0.00344	0.33557	0.05634
0.07083	0.43479	-0.00330	0.33191	0.06657
0.07062	0.44108	-0.00241	0.32837	0.07643
0.07050	0.44108	-0.00241	0.32337	0.07643
0.07006	0.47693	-0.00164	0.34279	0.07224
0.07138	0.50000	-0.00069	0.36137	0.06214
0.07232	0.55343	0.00107	0.38939	0.05128
0.07382	0.61293	0.00471	0.42763	0.04717
0.07600	0.66845	0.00006	0.27011	0.20339
0.07929	0.76638	0.01634	0.33316	0.10478
0.08356	0.83468	0.01786	0.37775	-0.03908
0.08891	0.88727	0.02222	0.41308	-0.15713
0.09530	0.94096	0.01189	0.44689	-0.26164
0.10312	1.00618	0.02834	0.48614	-0.39166
0.11227	1.03968	0.01737	0.50462	-0.45164
0.12296	1.07586	0.01420	0.52393	-0.51419
0.13539	1.10248	0.01946	0.54031	-0.56731
0.14978	1.11352	0.01524	0.54648	-0.58733
0.16636	1.11795	0.01396	0.54848	-0.59357
0.18467	1.12115	0.01453	0.55047	-0.60028
0.20337	1.12212	0.01516	0.55138	-0.60297
0.22176	1.12207	0.01529	0.55144	-0.60344
0.23907	1.12372	0.01518	0.55221	-0.60592
0.25772	1.12636	0.01572	0.55330	-0.60971
0.27636	1.12636	0.01569	0.55384	-0.61121
0.29288	1.12718	0.01604	0.55458	-0.61336
0.31088	1.12972	0.01578	0.55603	-0.61789
0.32723	1.13783	0.01636	0.56010	-0.63181
0.34429	1.14853	0.01631	0.56683	-0.65248
0.36138	1.16087	0.01699	0.57356	-0.67333
0.37828	1.16974	0.01603	0.57836	-0.69076
0.39526	1.17587	0.01604	0.58125	-0.70014
0.41228	1.17895	0.01652	0.58328	-0.70649
0.42939	1.18395	0.01647	0.58586	-0.71813
0.44668	1.18921	0.01663	0.58875	-0.72448
0.46395	1.19337	0.01653	0.59092	-0.73193
0.48149	1.19517	0.01669	0.59194	-0.73484
0.49924	1.19478	0.01643	0.59153	-0.73382
0.51723	1.19337	0.01648	0.59098	-0.73148
0.53552	1.19138	0.01668	0.58991	-0.72792
0.55412	1.19015	0.01636	0.58913	-0.72573
0.57307	1.19005	0.01636	0.58908	-0.72556
0.59241	1.18997	0.01618	0.58842	-0.72341
0.61217	1.18988	0.01631	0.58876	-0.71479
0.63239	1.17583	0.01631	0.58899	-0.69932
0.65318	1.16872	0.01682	0.57748	-0.68704
0.67434	1.16788	0.01617	0.57787	-0.68658
0.69614	1.16585	0.01636	0.57778	-0.68889
0.71863	1.16856	0.01871	0.57723	-0.68712
0.74155	1.16188	0.01443	0.57384	-0.67353
0.76523	1.13849	0.01874	0.55626	-0.61987
0.78968	1.03268	0.01832	0.50188	-0.43970
0.81478	0.89758	0.02869	0.41945	-0.17819
0.84057	0.83418	0.01598	0.37634	-0.03534
0.86723	0.82289	0.01768	0.37816	-0.01529
0.89471	0.80997	0.01874	0.36264	0.00912
0.92124	0.78936	0.01848	0.34924	0.05269
0.94363	0.76756	0.01728	0.33452	0.10038
0.96116	0.74784	0.01748	0.32155	0.14248
0.97488	0.72858	0.01497	0.29888	0.18642
0.98567	0.70892	0.01877	0.29468	0.22998
0.99395	0.68768	0.00019	0.27713	0.28657
1.00001	0.66804	0.01101	0.26284	0.33293
1.00339	0.66804	0.01101	0.26284	0.33293

Table 7-13

XC	MACH	1-PI/PINF	1-P/PINF	CP
1.02911	0.65389	0.00934	0.25664	0.35386
1.02703	0.63678	0.00458	0.24227	0.39960
1.02238	0.62987	-0.00108	0.23376	0.42733
1.01626	0.61869	0.00204	0.22974	0.44033
1.00853	0.61146	0.00098	0.22382	0.45952
0.99868	0.60360	0.00167	0.21957	0.47333
0.98683	0.60182	0.00144	0.21775	0.47922
0.96998	0.60508	0.00210	0.22003	0.46925
0.95803	0.61593	0.00207	0.22743	0.44701
0.93111	0.63154	0.00192	0.23783	0.41668
0.91202	0.65108	0.00241	0.25017	0.37485
0.89354	0.67558	0.00224	0.26502	0.32586
0.87563	0.70863	0.00237	0.28118	0.27341
0.85826	0.72784	0.00287	0.29987	0.21548
0.84148	0.75689	0.00329	0.31764	0.15514
0.82501	0.79241	0.00324	0.33468	0.09985
0.80886	0.80637	0.00348	0.35034	0.04902
0.79351	0.83883	0.00361	0.36502	-0.00119
0.77835	0.85422	0.00401	0.38171	-0.05274
0.76355	0.87783	0.00447	0.39719	-0.10296
0.74909	0.89982	0.00454	0.41088	-0.14712
0.73493	0.91784	0.00515	0.42313	-0.18714
0.72106	0.93401	0.00550	0.43356	-0.22097
0.72746	0.94622	0.00628	0.44152	-0.24681
0.69418	0.95357	0.00618	0.44619	-0.26194
0.68096	0.95788	0.00645	0.44852	-0.26953
0.66883	0.95783	0.00638	0.44981	-0.27189
0.65527	0.95695	0.00618	0.44838	-0.26888
0.64266	0.98789	0.00626	0.44847	-0.26936
0.63019	0.95927	0.00603	0.44971	-0.27337
0.61783	0.96315	0.00646	0.45236	-0.28197
0.60556	0.96736	0.00697	0.45527	-0.29141
0.59335	0.96056	0.00698	0.45681	-0.29383
0.58118	0.96643	0.00685	0.45462	-0.28938
0.56902	0.96468	0.00687	0.45355	-0.28582
0.55686	0.96685	0.00789	0.45451	-0.28896
0.54466	0.96989	0.00775	0.45727	-0.29789
0.53242	0.97245	0.00888	0.45899	-0.30347
0.52009	0.97128	0.00813	0.45828	-0.30119
0.50768	0.96784	0.00851	0.45641	-0.29512
0.49513	0.96452	0.00879	0.45458	-0.28892
0.48245	0.96178	0.00939	0.45313	-0.28446
0.46961	0.95782	0.00966	0.45092	-0.27697
0.45659	0.95875	0.01069	0.44698	-0.26453
0.44338	0.93755	0.01013	0.43842	-0.23674
0.43047	0.91999	0.01062	0.42766	-0.20102
0.41877	0.90536	0.01361	0.42017	-0.17754
0.40861	0.88722	0.01275	0.40817	-0.13861
0.39981	0.86879	0.01332	0.39169	-0.08511
0.39219	0.83758	0.01769	0.37961	-0.04592
0.38562	0.81242	0.01747	0.36339	0.00678
0.37998	0.77753	0.01869	0.34188	0.07658
0.37519	0.73974	0.02088	0.31928	0.14988
0.37116	0.69958	0.02157	0.29431	0.23883
0.36785	0.65888	0.01884	0.26148	0.33759
0.36525	0.59458	0.01689	0.22553	0.45397
0.36331	0.54647	0.01411	0.19527	0.55217
0.36195	0.51131	0.01160	0.17315	0.62394
0.36118	0.49341	0.01181	0.16329	0.65592
0.36062	0.49221	0.01289	0.16206	0.65738
0.36042	0.50439	0.01373	0.17099	0.63893
0.36037	0.50439	0.01373	0.17099	0.63893
0.36061	0.56298	0.01671	0.20703	0.51402
0.36107	0.61602	0.01846	0.24018	0.40646
0.36191	0.68969	0.02404	0.28994	0.24582
0.36326	0.70381	0.02017	0.35178	0.04462
0.36521	0.70668	0.03586	0.42169	-0.10247
0.36784	0.90986	0.03949	0.48587	-0.29878
0.37117	1.09838	0.03608	0.54352	-0.47773
0.37526	1.17607	0.03712	0.59841	-0.72987
0.38015	1.23891	0.03208	0.61782	-0.81628
0.38589	1.24092	0.03387	0.62648	-0.84698
0.39256	1.26848	0.02243	0.63102	-0.86423
0.40020	1.29189	0.02327	0.64319	-0.90113
0.40928	1.28141	0.02378	0.63865	-0.88639
0.41945	1.26624	0.01996	0.62978	-0.85768
0.43124	1.26229	0.01921	0.62752	-0.85029
0.44423	1.26246	0.01865	0.62748	-0.84988
0.45758	1.26388	0.01828	0.62783	-0.85038
0.47057	1.26163	0.01791	0.62678	-0.84762
0.48345	1.25935	0.01710	0.62528	-0.84382
0.49617	1.25745	0.01726	0.62436	-0.84083
0.50873	1.25719	0.01680	0.62488	-0.83913
0.52117	1.25935	0.01699	0.62621	-0.84279
0.53351	1.26251	0.01697	0.62678	-0.84789
0.54577	1.26567	0.01680	0.62633	-0.85291
0.55797	1.26715	0.01724	0.62928	-0.85674
0.57014	1.26836	0.01671	0.62961	-0.85784
0.58230	1.27086	0.01717	0.63062	-0.86035
0.59447	1.27178	0.01668	0.63123	-0.86238
0.60669	1.27292	0.01786	0.63288	-0.86482
0.61896	1.27236	0.01691	0.63167	-0.86374
0.63132	1.27225	0.01719	0.63172	-0.86389
0.64379	1.27483	0.01714	0.63283	-0.86758
0.65639	1.28028	0.01738	0.63573	-0.87698
0.66915	1.28781	0.01695	0.63889	-0.88717
0.68208	1.28932	0.01747	0.64021	-0.89146
0.69523	1.28568	0.01736	0.63836	-0.88544
0.70868	1.28288	0.01722	0.63659	-0.87968
0.72222	1.28248	0.01727	0.63678	-0.88031
0.73612	1.28481	0.01748	0.63881	-0.88431
0.75032	1.28535	0.01781	0.63844	-0.88557
0.76485	1.28314	0.01818	0.63742	-0.88241
0.77971	1.28111	0.01888	0.63639	-0.87986
0.79498	1.28119	0.01845	0.63668	-0.87973
0.81058	1.28367	0.01846	0.63781	-0.88368
0.82663	1.28968	0.01838	0.64069	-0.89381
0.84318	1.29784	0.01616	0.64349	-0.90288
0.86004	1.28452	0.02141	0.63932	-0.88856
0.87744	1.28717	0.02862	0.68316	-0.77124
0.89536	1.31267	0.04194	0.58133	-0.44886
0.91377	0.96724	0.03349	0.48015	-0.13655
0.93272	0.84268	0.03883	0.39859	-0.08156
0.95222	0.83214	0.03131	0.38470	-0.05278
0.97181	0.81364	0.03184	0.37295	-0.02432
0.99606	0.79123	0.03867	0.35856	0.02236
0.99926	0.76841	0.03134	0.34271	0.07379
1.00098	0.74148	0.02858	0.32566	0.12911
1.01663	0.71607	0.02999	0.31076	0.17758
1.02245	0.69198	0.02259	0.29828	0.24415
1.02708	0.66359	0.02597	0.26893	0.31317
1.02911	0.66359	0.02597	0.26893	0.31317

Table 7-14

XC	MACH	1-PI/PINF	1-P/PINF	CP
1.09412	0.66681	0.00706	0.28347	0.33898
1.09242	0.64726	-0.00024	0.24028	0.30999
1.08853	0.63372	-0.00402	0.23328	0.42894
1.08355	0.61799	-0.00338	0.22456	0.48713
1.07719	0.60502	-0.00322	0.21501	0.40812
1.06904	0.59208	-0.00504	0.20761	0.51214
1.05862	0.58558	-0.00538	0.20293	0.62730
1.04638	0.58504	-0.00476	0.20307	0.52608
1.02956	0.59176	-0.00484	0.20712	0.51370
1.01328	0.60439	-0.00504	0.21475	0.48095
0.99755	0.62292	-0.00451	0.22678	0.45810
0.98233	0.64567	-0.00461	0.24095	0.48394
0.96768	0.67062	-0.00439	0.25788	0.35107
0.95332	0.69806	-0.00386	0.27584	0.29335
0.93946	0.72732	-0.00318	0.29447	0.23038
0.92599	0.75581	-0.00292	0.31321	0.16961
0.91286	0.78257	-0.00278	0.33082	0.11237
0.90007	0.81013	-0.00186	0.34937	0.05219
0.88759	0.83987	-0.00121	0.36863	-0.01032
0.87548	0.86697	-0.00043	0.38721	-0.07059
0.86347	0.89182	-0.00008	0.40345	-0.12326
0.85170	0.91487	0.00043	0.41799	-0.17048
0.84033	0.93561	0.00125	0.43215	-0.21639
0.82909	0.95521	0.00217	0.44503	-0.25817
0.81805	0.96821	0.00244	0.45331	-0.28686
0.80719	0.97232	0.00243	0.45507	-0.29336
0.79649	0.97103	0.00258	0.45515	-0.29102
0.78593	0.96742	0.00228	0.45269	-0.28383
0.77551	0.96289	0.00147	0.44958	-0.27295
0.76519	0.96137	0.00133	0.44842	-0.26919
0.75497	0.96378	0.00166	0.45087	-0.27453
0.74481	0.96582	0.00162	0.45136	-0.27074
0.73471	0.96367	0.00163	0.45003	-0.27448
0.72465	0.95735	0.00184	0.44577	-0.26857
0.71460	0.95073	0.00058	0.44136	-0.24628
0.70454	0.94798	0.00027	0.43942	-0.23998
0.69445	0.94982	0.00047	0.44010	-0.24246
0.68433	0.95024	0.00066	0.44106	-0.24538
0.67413	0.94885	0.00073	0.43972	-0.24096
0.66386	0.94231	0.00007	0.43617	-0.22944
0.65349	0.93423	0.00037	0.43078	-0.21195
0.64300	0.92605	-0.00036	0.42517	-0.19375
0.63237	0.92102	-0.00048	0.42240	-0.18477
0.62158	0.92302	0.00235	0.42531	-0.19421
0.61062	0.91071	0.00858	0.42188	-0.18021
0.59991	0.90190	-0.00155	0.40984	-0.14141
0.59017	0.89756	0.00532	0.41033	-0.14561
0.58169	0.89619	0.00434	0.40887	-0.14087
0.57432	0.87214	0.00893	0.39138	-0.08412
0.56792	0.85693	0.01145	0.38087	-0.07336
0.56236	0.84473	0.00936	0.37894	-0.04376
0.55758	0.81264	0.01230	0.36023	0.01696
0.55348	0.77011	0.01757	0.34149	0.07774
0.55000	0.73704	0.01983	0.31679	0.15798
0.54712	0.67533	0.01513	0.27448	0.29543
0.54485	0.59228	0.00753	0.21728	0.48099
0.54312	0.51472	0.00589	0.17024	0.63337
0.54187	0.45207	-0.00161	0.12942	0.76679
0.54106	0.40804	-0.00350	0.10552	0.84336
0.54061	0.39378	-0.00405	0.09698	0.87185
0.54042	0.40398	-0.00391	0.10279	0.85228
0.54030	0.40398	-0.00391	0.10279	0.85228
0.54061	0.40418	-0.00051	0.10477	0.78652
0.54105	0.55073	0.00488	0.19426	0.55549
0.54185	0.65514	0.01114	0.25077	0.34614
0.54310	0.76262	0.01078	0.33236	0.10739
0.54485	0.85974	0.02788	0.39946	-0.11034
0.54711	0.95075	0.02682	0.45556	-0.29234
0.54998	1.06734	0.01078	0.52169	-0.50658
0.55338	1.10378	0.02834	0.50748	-0.72812
0.55737	1.24312	0.02884	0.61051	-0.82164
0.56213	1.25144	0.01758	0.62142	-0.83058
0.56765	1.28298	0.00413	0.63218	-0.86529
0.57404	1.31538	0.00686	0.64896	-0.91984
0.58142	1.30635	0.00669	0.64459	-0.90565
0.58989	1.29758	0.00234	0.63078	-0.88657
0.59962	1.29988	0.00208	0.64886	-0.89794
0.61035	1.30884	0.00298	0.64854	-0.89263
0.62131	1.30894	0.00284	0.64957	-0.89262
0.63210	1.30888	0.00260	0.64889	-0.89187
0.64273	1.29812	0.00340	0.63798	-0.88411
0.65323	1.28774	0.00338	0.63427	-0.87219
0.66361	1.28363	0.00414	0.63281	-0.86647
0.67388	1.28666	0.00416	0.63353	-0.86977
0.68408	1.29239	0.00478	0.63705	-0.88119
0.69421	1.29686	0.00532	0.63947	-0.88985
0.70438	1.29744	0.00511	0.63960	-0.88972
0.71436	1.29584	0.00538	0.63896	-0.88741
0.72442	1.29341	0.00537	0.63788	-0.88362
0.73449	1.29185	0.00563	0.63712	-0.88143
0.74468	1.29168	0.00572	0.63707	-0.88127
0.75476	1.29201	0.00627	0.63744	-0.88245
0.76499	1.29295	0.00636	0.63793	-0.88405
0.77531	1.29693	0.00661	0.63997	-0.89060
0.78578	1.30401	0.00678	0.64348	-0.90204
0.79632	1.31210	0.00648	0.64732	-0.91402
0.80704	1.31684	0.00713	0.64932	-0.92188
0.81793	1.31445	0.00688	0.64856	-0.91888
0.82901	1.31439	0.00702	0.64850	-0.91862
0.84030	1.31923	0.00677	0.65052	-0.92586
0.85182	1.32774	0.00706	0.65497	-0.93933
0.86369	1.33960	0.00714	0.65978	-0.95169
0.87563	1.34109	0.00734	0.66173	-0.96127
0.88795	1.34826	0.00698	0.66488	-0.97041
0.90080	1.35832	0.00771	0.66880	-0.98180
0.91384	1.36628	0.00811	0.67257	-0.99643
0.92683	1.37708	0.00918	0.67808	-1.01667
0.94040	1.39784	0.00326	0.68578	-1.03984
0.95451	1.41389	0.01152	0.69586	-1.06942
0.96893	1.43361	-0.00661	0.69033	-1.08003
0.98375	1.38224	0.03340	0.68061	-1.04849
0.99890	1.14397	0.04346	0.87588	-0.68327
1.01468	0.84078	0.05021	0.40836	-0.13921
1.03076	0.78724	0.04520	0.36878	-0.00895
1.04626	0.78869	0.04067	0.36716	-0.00584
1.05934	0.77126	0.04056	0.35992	0.02411
1.06958	0.74714	0.04005	0.34278	0.07367
1.07784	0.72511	0.04448	0.32662	0.12898
1.08378	0.70293	0.04564	0.31377	0.16760
1.08868	0.68036	0.03077	0.29498	0.22091
1.09246	0.64629	0.04114	0.27589	0.29088
1.09412	0.64629	0.04114	0.27589	0.29088

Table 7-15

XC	MACH	1-PI/PINF	1-P/PINF	CP
1.22821	0.66098	0.00778	0.26489	0.33688
1.21075	0.64956	-0.00144	0.24584	0.30078
1.21643	0.63612	-0.00606	0.23302	0.42718
1.21118	0.62177	-0.00396	0.22641	0.48118
1.20578	0.61012	-0.00506	0.21767	0.47040
1.19888	0.59038	-0.00533	0.21001	0.60174
1.18993	0.59148	-0.00542	0.20658	0.61672
1.17859	0.59113	-0.00436	0.20712	0.51371
1.16618	0.59777	-0.00401	0.21148	0.49967
1.15133	0.60994	-0.00378	0.21928	0.47492
1.13794	0.62799	-0.00276	0.23122	0.43561
1.12499	0.65818	-0.00246	0.24538	0.38958
1.11245	0.67308	-0.00191	0.26892	0.33916
1.10029	0.69958	-0.00118	0.27801	0.28371
1.08849	0.72622	-0.00055	0.29561	0.22666
1.07701	0.75191	-0.00007	0.31262	0.17141
1.06583	0.77648	0.00046	0.32858	0.11964
1.05494	0.80143	0.00073	0.34539	0.06589
1.04438	0.82838	0.00162	0.36343	0.00656
1.03391	0.85355	0.00225	0.38019	-0.04701
1.02375	0.87378	0.00218	0.39314	-0.08984
1.01379	0.89843	0.00264	0.40417	-0.12563
1.00403	0.92661	0.00386	0.41477	-0.16081
0.99446	0.92135	0.00356	0.42444	-0.19130
0.98505	0.93214	0.00393	0.43148	-0.21424
0.97588	0.93737	0.00412	0.43498	-0.22532
0.96668	0.93777	0.00414	0.43516	-0.22617
0.95768	0.93548	0.00413	0.43371	-0.22147
0.94888	0.93158	0.00352	0.43118	-0.21388
0.94081	0.93085	0.00365	0.43081	-0.20948
0.93129	0.93132	0.00378	0.43082	-0.21289
0.92264	0.93366	0.00426	0.43268	-0.21705
0.91403	0.93358	0.00422	0.43256	-0.21774
0.90545	0.93341	0.00427	0.43059	-0.21132
0.89688	0.92864	0.00418	0.42815	-0.20341
0.88831	0.92456	0.00427	0.42689	-0.19933
0.87972	0.92447	0.00464	0.42784	-0.19903
0.87108	0.92413	0.00401	0.42693	-0.19945
0.86244	0.92212	0.00534	0.42595	-0.19629
0.85364	0.91793	0.00544	0.42336	-0.18786
0.84488	0.91286	0.00862	0.41974	-0.17613
0.83586	0.90595	0.00534	0.41569	-0.16298
0.82688	0.90182	0.00550	0.41328	-0.15498
0.81768	0.90162	0.00888	0.41454	-0.15927
0.80826	0.89571	0.00600	0.41087	-0.14477
0.79912	0.88188	0.00560	0.40888	-0.11289
0.79002	0.87538	0.01078	0.39948	-0.11013
0.78058	0.87330	0.01143	0.39857	-0.10744
0.77128	0.85208	0.00760	0.38213	-0.05736
0.77181	0.83828	0.01734	0.37903	-0.04663
0.76706	0.82652	0.01561	0.37121	-0.01867
0.76256	0.79755	0.01830	0.35453	0.03544
0.75943	0.76802	0.02437	0.33964	0.08376
0.75642	0.72882	0.02302	0.31441	0.16568
0.75392	0.66841	0.02193	0.27518	0.29316
0.75191	0.59238	0.01538	0.22334	0.46188
0.75036	0.51627	0.01240	0.17662	0.61269
0.74922	0.45897	0.00467	0.13438	0.74997
0.74849	0.40514	0.00236	0.10988	0.83286
0.74808	0.39818	0.00894	0.10046	0.86976
0.74798	0.40351	0.00251	0.10033	0.83423
0.74787	0.40351	0.00251	0.10033	0.83423
0.74808	0.49623	0.00760	0.16136	0.66224
0.74849	0.57992	0.01147	0.21208	0.49502
0.74923	0.68587	0.02168	0.28526	0.26818
0.75037	0.79136	0.03864	0.35862	0.02216
0.75132	0.88393	0.03628	0.42019	-0.17761
0.75389	0.97603	0.03411	0.47586	-0.35023
0.75631	1.05664	0.02724	0.52281	-0.47448
0.75924	1.20433	0.02991	0.60221	-0.76016
0.76273	1.24731	0.02999	0.62417	-0.83942
0.76608	1.25148	0.02467	0.62417	-0.83941
0.77151	1.27917	0.01376	0.63306	-0.87008
0.77696	1.30266	0.01679	0.64642	-0.91161
0.78324	1.29872	0.01528	0.64018	-0.89118
0.79046	1.28389	0.01163	0.63581	-0.87458
0.79874	1.28486	0.01287	0.63684	-0.87793
0.80706	1.28519	0.01194	0.63616	-0.87831
0.81719	1.28613	0.01117	0.63634	-0.87889
0.82637	1.28678	0.01111	0.63664	-0.87986
0.83542	1.28473	0.01004	0.63583	-0.87626
0.84436	1.28158	0.01078	0.63591	-0.87102
0.85319	1.28074	0.01069	0.63588	-0.86968
0.86194	1.28517	0.01056	0.63664	-0.87662
0.87062	1.29278	0.01072	0.63942	-0.88950
0.87926	1.29863	0.01092	0.64236	-0.89843
0.88784	1.30133	0.01056	0.64384	-0.90236
0.89642	1.30105	0.01048	0.64376	-0.90230
0.90498	1.30121	0.01029	0.64338	-0.90178
0.91357	1.30095	0.01026	0.64328	-0.90131
0.92218	1.30117	0.01048	0.64342	-0.90188
0.93083	1.30380	0.01038	0.64433	-0.90481
0.93956	1.30601	0.01069	0.64624	-0.91102
0.94835	1.31222	0.01082	0.64878	-0.91926
0.95725	1.31948	0.01086	0.65227	-0.93007
0.96625	1.32501	0.01046	0.65524	-0.94021
0.97539	1.32846	0.01093	0.65652	-0.94436
0.98467	1.32723	0.01071	0.65608	-0.94287
0.99412	1.32773	0.01037	0.65611	-0.94308
1.00374	1.33368	0.01045	0.65895	-0.95228
1.01356	1.34224	0.01052	0.66298	-0.96531
1.02369	1.35015	0.01052	0.66664	-0.97721
1.03308	1.35544	0.01096	0.66921	-0.98583
1.04436	1.36127	0.01023	0.67165	-0.99348
1.05812	1.36849	0.01129	0.67529	-1.00528
1.06616	1.37563	0.00947	0.67971	-1.01960
1.07749	1.39225	0.01228	0.68619	-1.04063
1.08912	1.41116	0.00744	0.69297	-1.06262
1.10108	1.42850	0.01277	0.70206	-1.09212
1.11337	1.44341	0.00853	0.70867	-1.10858
1.12601	1.38494	0.03614	0.69864	-1.05106
1.13901	1.11162	0.05964	0.56589	-0.65833
1.15237	0.79439	0.07234	0.38004	-0.07328
1.16611	0.75162	0.05649	0.35132	0.04507
1.17934	0.76253	0.06297	0.36212	0.00906
1.19068	0.75149	0.06248	0.35838	0.03277
1.19922	0.72969	0.06148	0.34139	0.07889
1.20684	0.70929	0.05796	0.32649	0.12648
1.21137	0.68718	0.05078	0.31359	0.16827
1.21554	0.66462	0.05169	0.29487	0.22901
1.21879	0.63241	0.05374	0.27716	0.28647
1.22821	0.63241	0.05374	0.27716	0.28647

Table 7-16

XC	MACH	1-PI/PINF	1-P/PINF	CP
1.40857	0.71005	0.00246	0.20730	0.25386
1.40749	0.68771	-0.00723	0.26891	0.32296
1.40582	0.67184	-0.01030	0.29342	0.36349
1.40107	0.66700	-0.00803	0.24850	0.30910
1.39786	0.64574	-0.01091	0.33522	0.41704
1.39272	0.63345	-0.00971	0.32934	0.44162
1.38616	0.62562	-0.00982	0.32456	0.45717
1.37780	0.62923	-0.00796	0.32550	0.45407
1.36794	0.63121	-0.00700	0.32939	0.44145
1.35775	0.64239	-0.00737	0.33603	0.41732
1.34790	0.66023	-0.00671	0.34893	0.37005
1.33937	0.68213	-0.00599	0.36322	0.33171
1.32913	0.70400	-0.00546	0.37370	0.28277
1.32017	0.72795	-0.00404	0.29371	0.23277
1.31147	0.75111	-0.00410	0.38933	0.18210
1.30299	0.77341	-0.00306	0.32406	0.13430
1.29475	0.79531	-0.00339	0.33069	0.08604
1.28671	0.81929	-0.00255	0.35490	0.03425
1.27806	0.84566	-0.00189	0.37299	-0.02446
1.27120	0.86947	-0.00014	0.38988	-0.07639
1.26369	0.88550	-0.00020	0.39936	-0.11000
1.25635	0.89637	-0.00026	0.40626	-0.13239
1.24914	0.90764	-0.00042	0.41362	-0.16627
1.24207	0.91977	-0.00007	0.42134	-0.18131
1.23513	0.93016	-0.00018	0.42790	-0.20262
1.22830	0.93791	0.00005	0.43293	-0.21892
1.22157	0.94192	-0.00003	0.43542	-0.22701
1.21493	0.94069	-0.00004	0.43418	-0.22300
1.20837	0.93649	-0.00156	0.43112	-0.21304
1.20188	0.93300	-0.00246	0.42839	-0.20419
1.19545	0.93105	-0.00316	0.42726	-0.20051
1.18906	0.93262	-0.00306	0.42735	-0.20083
1.18270	0.93424	-0.00422	0.42817	-0.20350
1.17637	0.93542	-0.00479	0.42860	-0.20490
1.17004	0.93564	-0.00490	0.42863	-0.20497
1.16371	0.93447	-0.00550	0.42759	-0.20161
1.15737	0.93176	-0.00603	0.42556	-0.19501
1.15099	0.92805	-0.00647	0.42345	-0.18816
1.14458	0.92446	-0.00589	0.42160	-0.18243
1.13812	0.92113	-0.00741	0.41989	-0.17662
1.13159	0.92197	-0.00765	0.41836	-0.17166
1.12499	0.92031	-0.00753	0.41737	-0.16843
1.11830	0.91829	-0.00731	0.41619	-0.16463
1.11151	0.91469	-0.00659	0.41430	-0.15849
1.10462	0.90723	-0.00667	0.40946	-0.14276
1.09786	0.89642	-0.00720	0.40217	-0.11914
1.09173	0.89001	-0.00435	0.39972	-0.11119
1.08637	0.88501	-0.00251	0.39812	-0.10598
1.08178	0.87860	-0.00415	0.38720	-0.07002
1.07763	0.86774	0.00279	0.38323	-0.06767
1.07409	0.84740	0.00400	0.37790	-0.04039
1.07183	0.82851	0.00450	0.36022	0.01698
1.06837	0.80059	0.01029	0.35635	0.02953
1.06609	0.76872	0.01340	0.33272	0.10620
1.06417	0.70575	0.01629	0.29446	0.23033
1.06258	0.63054	0.01500	0.25141	0.37000
1.06129	0.56721	0.01140	0.20525	0.51979
1.06031	0.49305	0.00306	0.15600	0.67696
1.05966	0.43350	-0.00103	0.12027	0.79549
1.05929	0.40070	-0.00210	0.10601	0.83917
1.05913	0.42101	-0.00029	0.11493	0.81201
1.05910	0.42101	-0.00029	0.11493	0.81201
1.05929	0.53617	0.00920	0.18534	0.58439
1.05966	0.64102	0.01145	0.25019	0.37396
1.06031	0.75794	0.00831	0.33731	0.09132
1.06126	0.85300	0.03598	0.40079	-0.11466
1.06250	0.94260	0.03762	0.46709	-0.29732
1.06402	1.04494	0.03433	0.51629	-0.40930
1.06587	1.17170	0.02610	0.58343	-0.70722
1.06809	1.25621	0.03121	0.62988	-0.85533
1.07070	1.26124	0.02841	0.63050	-0.85995
1.07372	1.26417	0.02090	0.62911	-0.85542
1.07721	1.26710	0.01547	0.63043	-0.88560
1.08124	1.29693	0.01741	0.64309	-0.98330
1.08587	1.28452	0.01491	0.63692	-0.88079
1.09110	1.28019	0.01200	0.63401	-0.87134
1.09720	1.28033	0.01330	0.63430	-0.87227
1.10400	1.27696	0.01330	0.63260	-0.86676
1.11086	1.27386	0.01290	0.63094	-0.86139
1.11762	1.27233	0.01334	0.63031	-0.85934
1.12420	1.26949	0.01450	0.62934	-0.85617
1.13007	1.26495	0.01604	0.62765	-0.85071
1.13730	1.26219	0.01774	0.62692	-0.84831
1.14303	1.26270	0.01999	0.62803	-0.85193
1.15023	1.26367	0.02277	0.62957	-0.85691
1.15659	1.26396	0.02510	0.63059	-0.86024
1.16293	1.26276	0.02016	0.63116	-0.86209
1.16926	1.25891	0.03009	0.63029	-0.85928
1.17550	1.25224	0.03446	0.62836	-0.85299
1.18191	1.24333	0.03791	0.62526	-0.84296
1.18827	1.23715	0.04174	0.62360	-0.83702
1.19466	1.23594	0.04503	0.62469	-0.84149
1.20110	1.23757	0.05007	0.62716	-0.84918
1.20759	1.23841	0.05420	0.62919	-0.85570
1.21416	1.23582	0.05848	0.62960	-0.85703
1.22081	1.22920	0.06202	0.62811	-0.85210
1.22756	1.22007	0.06762	0.62549	-0.84360
1.23441	1.21052	0.07270	0.62286	-0.83515
1.24139	1.20489	0.07704	0.62214	-0.83283
1.24858	1.20447	0.08336	0.62410	-0.83904
1.25575	1.20574	0.08051	0.62693	-0.84836
1.26315	1.20255	0.09449	0.62703	-0.85127
1.27073	1.19449	0.09943	0.62595	-0.84817
1.27848	1.18687	0.10466	0.62442	-0.84823
1.28643	1.17962	0.10972	0.62302	-0.83569
1.29459	1.16320	0.11637	0.61810	-0.81990
1.30295	1.11624	0.12669	0.59917	-0.75830
1.31154	1.00358	0.13293	0.54305	-0.57801
1.32030	0.85277	0.13133	0.45993	-0.30693
1.32946	0.78319	0.12138	0.41397	-0.15748
1.33888	0.76725	0.11962	0.41013	-0.16119
1.34841	0.80415	0.12229	0.42650	-0.19832
1.35828	0.79993	0.12253	0.42432	-0.19188
1.36845	0.77632	0.12150	0.41813	-0.14497
1.37824	0.74889	0.11978	0.39328	-0.09818
1.38651	0.72624	0.11898	0.37977	-0.04645
1.39298	0.70143	0.11944	0.36599	-0.00173
1.39884	0.67562	0.11593	0.34803	0.05394
1.40199	0.64586	0.11681	0.33279	0.10896
1.40589	0.62461	0.10931	0.31305	0.17804
1.40751	0.50307	0.11343	0.29943	0.21421
1.40857	0.50307	0.11343	0.29943	0.21421

Table 7-17

7.5.8 Conclusions - NASA Ames Swept Wing

We recall that the objective of the Working Group has been to find solutions of whose numerical accuracy we can be reasonably confident, rather than to recommend the use of any particular method. Since for this case, only one result was obtained, recommendations are very difficult. There exists no comparisons, neither with theory nor with experimental data. A detailed analysis of the results is therefore not possible. We can only argue that based on experience with other solutions we believe the solution to be quite accurate from the engineering point of view. The spurious total pressure losses at the wing leading edge and the behaviour at the wing tip need finer numerical resolution to draw conclusions. If can be recommended to use the present solution as a guideline, but we hesitate to call it "exact" solution.

7.6 REFERENCES

7-1 VIVIAND H. and VEUILLOT J.P.
Méthodes Pseudo-instationnaires pour le calcul d'écoulements transsoniques
ONERA Pub. No. 1978-4 (english version ESA TT561), 1978

7-2 BROCHET J.
Calcul d'écoulements internes tridimensionnels transsoniques
Recherche Aérspatiale, Vol. 5, Sept. 1980, pp. 301,315
English translation ESA TT613

7-3 CHATTOT J.J., BOSCHIERO M. and KOECK C.
Méthodes numériques de prédiction de l'aérodynamique des missiles
AGARD-CCP 336

7-4 JAMESON A./SCHMIDT W./TURKEL E.
Numerical Solutions of the Euler Equations by Finite Volume Methods Using Runge-Kutta Time Stepping Schemes.
AIAA 81-1259 (1981)

7-5 SCHMIDT W./JAMESON A./WHITFIELD D.
Finite Volume-Solutions to the Euler Equations in Transonic Flow
JA Vol. 20 (1983), pp. 127 - 133.

7-6 ERIKSSON L.E.
Practical Three-Dimensional Mesh Generation Using Transfinite Interpolation.
In Computational Fluid Dynamics
Lecture Series Notes 1983-04, von Karman Inst., Brussels, 1983

7-7 RIZZI A. and ERIKSSON L.E.
Explicit Multistage Finite Volume Procedure to Solve the Euler Equations for Transsonic Flow.
In Computational Fluid Dynamics
Lecture Series Notes 1983-04, von Karman Inst., Brussels, 1983

7-8 RIZZI A.
Vector Coding the Finite Volume Procedure for the CYBER 205.
In Computational Fluid Dynamics
Lecture Series Notes 1983-04, von Karman Inst., Brussels, 1983

7-9 RIZZI A. and ERIKSSON L.E.
Numerical Solutions of the Euler Equations Simulating Vortex Flows Around Wings.
In Aerodynamics of Vortical Type Flows in Three Dimensions
AGARD-CPP-342, Paris, 1983

7-10 ERIKSSON L.E. and RIZZI, A
Analysis by Computer of the Convergence to Steady State of a Discrete Approximation to the Euler Equations
AIAA Paper No. 83-1951 presented at the 6th CFD Conf., Danvers, MA, 1983

7-11 EBERLE A.
MBB-EUFLEX
A New Flux Extrapolation Scheme Solving the EULER Equations for Arbitrary 3D Geometry and Speed
MB3/LKE122/S/PUB/140 (1984)

7-12 Schmidt, W., and Jameson, A.:
"Recent Development in Finite Volume Time Dependent Techniques for Two- and Three-Dimensional Transonic Flows"
VKI Lecture Series 1982-04, 1982, Brussels

7-13 Leicher, S.:
"Analysis of Transonic and Supersonic Flows around Wing-Body Combinations"
ICAS-84-1.2.2, ICAS Proceedings, Toulouse 1984, Vol. 1, pp. 157-167

7-14 Schmidt, W., Jameson, A., and MacCormack, R. W.:
AIAA Professional Study Seminar "Using Euler Solvers", Snowmass, June 1984

7-15 Jameson, A., and Schmidt, W.:
"Some Recent Developments in Numerical Methods for Transonic Flows"
FENOMECH 84 Conference, Sept. 1984, Stuttgart, to be published by North Holland Publishing Corp.

APPENDIX 7A

Test Case 11

Figure No.		
	ONERA/MATRA (1a): ONERA M6 (M = 0.84, alpha = 3.06°)	
7-A-1	tabulated values	y/b = 0.10
7-A-2	tabulated values	y/b = 0.50
7-A-3	tabulated values	y/b = 0.80
	ONERA/MATRA (2a): ONERA M6 (M = 0.84, alpha = 3.06°)	
7-A-4	tabulated values	y/b = 0.10
7-A-5	tabulated values	y/b = 0.50
7-A-6	tabulated values	y/b = 0.80
	RIZZI/FFA (3a): ONERA M6 (M = 0.84, alpha = 3.06°)	
7-A-7	tabulated values	y/b = 0.077
7-A-8	tabulated values	y/b = 0.468
7-A-9	tabulated values	y/b = 0.816
	EBERLE/MBB (4): ONERA M6 (M = 0.84, alpha = 3.06°)	
7-A-10	tabulated values	y/b = 0.122
7-A-11	tabulated values	y/b = 0.351
7-A-12	tabulated values	y/b = 0.776
	ONERA/MATRA (1a): ONERA M6 (M = 0.84, alpha = 3.06°)	
7-A-13	tabulated values for c_p	y/b = 0.20
	tabulated values for c_p	y/b = 0.44
	tabulated values for c_p	y/b = 0.80
	tabulated values for c_p	y/b = 0.96
	ONERA/MATRA (1a): ONERA M6 (M = 0.84, alpha = 3.06°)	
7-A-14	pressure distribution	y/b = 0.20
7-A-15	pressure distribution	y/b = 0.44
7-A-16	pressure distribution	y/b = 0.80
7-A-17	pressure distribution	y/b = 0.96

Test Case 12

Figure No.		
	ONERA/MATRA (1a): ONERA M6 (M = 0.92, alpha = 0°)	
7-A-18	tabulated values	y/b = 0.10 and 0.50
7-A-19	tabulated values	y/b = 0.80
	ONERA/MATRA (1b): ONERA M6 (M = 0.92, alpha = 0°)	
7-A-20	tabulated values	y/b = 0.10 and 0.50
7-A-21	tabulated values	y/b = 0.80
	RIZZI/FFA (3): ONERA M6 (M = 0.92, alpha = 0°)	
7-A-22	tabulated values	y/b = 0.077
7-A-23	tabulated values	y/b = 0.468
7-A-24	tabulated values	y/b = 0.816
	EBERLE/MBB (4): ONERA M6 (M = 0.92, alpha = 0°)	
7-A-25	tabulated values	y/b = 0.122
7-A-26	tabulated values	y/b = 0.531
7-A-27	tabulated values	y/b = 0.776
	ONERA/MATRA (1a): ONERA M6 (M = 0.92, alpha = 0°)	
7-A-28	pressure distribution	y/b = 0.20
7-A-29	pressure distribution	y/b = 0.44
7-A-30	pressure distribution	y/b = 0.80
7-A-31	pressure distribution	y/b = 0.96
	ONERA/MATRA (1b): ONERA M6 (M = 0.92, alpha 0°)	
7-A-32	pressure distribution	y/b = 0.20
7-A-33	pressure distribution	y/b = 0.44
7-A-34	pressure distribution	y/b = 0.80
7-A-35	pressure distribution	y/b = 0.96

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
ONERA/MATRA
y/b = 0.10

UPPER SURFACE

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.30600	.08794	.02455	-.90646
2	.00040	.39060	.12654	.02787	-.78241
3	.00179	.52456	.20023	.03402	-.54560
4	.00439	.67061	.28688	.03512	-.26712
5	.00830	.83004	.38690	.03623	.05430
6	.01361	.98456	.48372	.04010	.36545
7	.02043	1.11878	.56515	.05034	.62716
8	.02895	1.20566	.61271	.0554[illegible]	.77999
9	.03940	1.20432	.61283	.05765	.78037
10	.05210	1.11971	.57342	.06782	.65371
11	.06742	1.04070	.53095	.06890	.51735
12	.08583	1.01268	.51196	.06243	.45621
13	.10787	1.01102	.50827	.05712	.44434
14	.13422	1.01634	.50960	.05379	.44863
15	.16564	1.02087	.51029	.05007	.45085
16	.19720	1.02663	.51202	.04694	.45641
17	.22877	1.03159	.51342	.04405	.46092
18	.26033	1.03790	.51584	.04160	.46869
19	.29187	1.04641	.51974	.03956	.48121
20	.32336	1.05699	.52499	.03787	.49810
21	.35481	1.06924	.53131	.03645	.51841
22	.38621	1.08258	.53833	.03528	.54097
23	.41755	1.09642	.54567	.03428	.56456
24	.44883	1.10997	.55288	.03347	.58771
25	.48005	1.12253	.55951	.03273	.60903
26	.51120	1.13392	.56553	.03217	.62837
27	.54229	1.14545	.57136	.03111	.64710
28	.57331	1.15377	.57529	.02977	.65975
29	.60425	1.14513	.57125	.03117	.64675
30	.63513	1.10725	.55313	.03722	.58852
31	.66594	1.04814	.52306	.04434	.49188
32	.69667	.98492	.48796	.04779	.37907
33	.72734	.92667	.45227	.04624	.26440
34	.75793	.88391	.42326	.04130	.17116
35	.78844	.85563	.40297	.03678	.10596
36	.81889	.83827	.39076	.03460	.06670
37	.84926	.82131	.37987	.03421	.03171
38	.87955	.80016	.36574	.03294	-.01368
39	.90978	.76609	.34484	.03375	-.08087
40	.93993	.73674	.32197	.02740	-.15434
41	.97000	.65296	.27970	.04075	-.29019
42	1.00000	.66408	.24613	-.01339	-.39808

LOWER SURFACE

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.30600	.08794	.02455	-.90646
2	.00040	.27481	.06898	.01664	-.96737
3	.00179	.32734	.09745	.02657	-.87588
4	.00439	.43390	.14920	.03096	-.70958
5	.00830	.56106	.22059	.03446	-.48017
6	.01361	.68117	.29379	.03625	-.24493
7	.02043	.77033	.35089	.03861	-.06142
8	.02895	.80924	.37437	.03734	.01406
9	.03940	.80280	.36607	.03084	-.01262
10	.05210	.78959	.35388	.02504	-.05181
11	.06742	.79294	.35478	.02322	-.04891
12	.08583	.80454	.36166	.02248	-.02679
13	.10787	.81775	.36938	.02143	-.00201
14	.13422	83049	.37662	.02008	.02126
15	.16564	[illegible]4345	.38378	.01836	.04427
16	.19720	.85642	.39130	.01719	.06846
17	.22877	.86780	.39777	.01594	.08923
18	.26033	.87961	.40467	.01494	.11141
19	.29187	.89187	.41196	.01414	.13484
20	.32336	.90454	.41961	.01352	.15943
21	.35481	.91719	.42732	.01307	.18420
22	.38621	.92922	.43470	.01276	.20791
23	.41755	.93985	.44125	.01257	.22897
24	.44883	.94827	.44645	.01248	.24567
25	.48005	.95366	.44979	.01246	.25642
26	.51120	.95539	.45087	.01248	.25989
27	.54229	.95314	.44949	.01252	.25547
28	.57331	.94714	.44576	.01252	.24348
29	.60425	.93813	.44010	.01245	.22527
30	.63513	.92722	.43317	.01229	.20300
31	.66594	.91555	.42569	.01204	.17896
32	.69667	.90398	.41824	.01180	.15501
33	.72734	.89289	.41107	.01157	.13200
34	.75793	.88207	.40411	.01144	.10961
35	.78844	.87065	.39671	.01125	.08583
36	.81889	.85747	.38814	.01102	.05831
37	.84926	.84027	.37686	.01062	.02205
38	.87955	.81896	.36247	.00955	-.02420
39	.90978	.78772	.34228	.00949	-.08909
40	.93993	.75765	.31983	.00501	-.16123
41	.97000	.68526	.28038	.01475	-.28800
42	1.00000	.66408	.24613	-.01339	-.39808

Figure 7-A-1

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
ONERA/MATRA
y/b = 0.50

UPPER SURFACE

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.46412	.13693	-.00038	-.74903
2	.00040	.54973	.18923	.00437	-.58093
3	.00179	.68282	.27543	.01008	-.30393
4	.00439	.83199	.37251	.01215	.00808
5	.00830	1.00630	.48196	.01215	.35982
6	.01361	1.18938	.58576	.00928	.69339
7	.02043	1.37068	.67477	.00672	.97944
8	.02895	1.51283	.73060	-.00754	1.15884
9	.03940	1.56990	.74616	-.03197	1.20884
10	.05210	1.52397	.73168	-.01988	1.16232
11	.06742	1.45151	.71187	.01363	1.09867
12	.08583	1.39580	.69436	.03337	1.04239
13	.10787	1.33932	.66974	.03506	.96328
14	.13422	1.26206	.63296	.03485	.84508
15	.16564	1.18434	.59324	.03403	.71742
16	.19720	1.13977	.56751	.02956	.63474
17	.22877	1.12209	.55564	.02475	.59657
18	.26033	1.12192	.55431	.02202	.59232
19	.29187	1.13154	.55935	.02129	.60850
20	.32336	1.14677	.56786	.02151	.63586
21	.35481	1.16532	.57794	.02144	.66826
22	.38621	1.18436	.58799	.02101	.70056
23	.41755	1.20126	.59695	.02103	.72935
24	.44883	1.21244	.60331	.02228	.74980
25	.48005	1.20327	.60100	.02829	.74236
26	.51120	1.14615	.57719	.04341	.66585
27	.54229	1.03546	.52198	.05654	.48841
28	.57331	.92487	.45441	.05181	.27126
29	.60425	.87594	.41950	.04324	.15907
30	.63513	.86911	.41442	.04183	.14276
31	.66594	.86541	.41268	.04272	.13716
32	.69667	.85350	.40508	.04238	.11275
33	.72734	.84020	.39666	.04211	.08566
34	.75793	.82764	.38853	.04162	.05954
35	.78844	.81428	.38022	.04165	.03283
36	.81889	.80050	.37131	.04118	.00421
37	.84926	.78280	.36054	.04162	-.03039
38	.87955	.76370	.34802	.04074	-.07062
39	.90978	.73355	.33068	.04280	-.12637
40	.93993	.71020	.31331	.03873	-.18219
41	.97000	.63021	.27402	.05135	-.30843
42	1.00000	.66474	.24690	-.01293	-.39560

LOWER SURFACE

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.46412	.13693	-.00038	-.74903
2	.00040	.41880	.10592	-.00875	-.84868
3	.00179	.43177	.12443	.00475	-.78918
4	.00439	.50296	.16894	.01224	-.64613
5	.00830	.60823	.23584	.01897	-.43114
6	.01361	.72007	.30810	.02270	-.19894
7	.02043	.80709	.36477	.02483	-.01681
8	.02895	.84559	.38834	.02348	.05894
9	.03940	.84375	.38236	.01581	.03971
10	.05210	.83552	.37277	.00897	.00890
11	.06742	.84131	.37549	.00738	.01764
12	.08583	.85317	.38313	.00739	.04221
13	.10787	.86604	.39132	.00726	.06853
14	.13422	.87807	.39888	.00701	.09282
15	.16564	.89029	.40639	.00651	.11695
16	.19720	.90252	.41416	.00646	.14192
17	.22877	.91286	.42057	.00618	.16252
18	.26033	.92370	.42739	.00609	.18443
19	.29187	.93449	.43416	.00602	.20618
20	.32336	.94512	.44085	.00602	.22768
21	.35481	.95478	.44692	.00606	.24721
22	.38621	.96260	.45185	.00615	.26305
23	.41755	.96754	.45499	.00626	.27311
24	.44883	.96878	.45582	.00637	.27581
25	.48005	.96591	.45410	.00648	.27026
26	.51120	.95910	.44989	.00655	.25675
27	.54229	.94902	.44360	.00656	.23652
28	.57331	.93664	.43578	.00649	.21140
29	.60425	.92200	.42709	.00634	.18347
30	.63513	.90907	.41815	.00616	.15475
31	.66594	.89561	.40945	.00595	.12679
32	.69667	.88293	.40124	.00577	.10041
33	.72734	.87112	.39355	.00557	.07569
34	.75793	.85977	.38621	.00549	.05210
35	.78844	.84837	.37874	.00531	.02810
36	.81889	.83570	.37063	.00540	.00202
37	.84926	.82060	.36070	.00516	-.02987
38	.87955	.80190	.34879	.00545	-.06817
39	.90978	.77616	.33220	.00558	-.12147
40	.93993	.74952	.31443	.00481	-.17857
41	.97000	.68496	.27800	.01174	-.29567
42	1.00000	.66474	.24690	-.01293	-.39560

Figure 7-A-2

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
ONERA/MATRA
y/b = 0.80

UPPER SURFACE

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.47700	.14741	.00371	-.71534
2	.00040	.56310	.20173	.01006	-.54076
3	.00179	.69563	.28887	.01742	-.26073
4	.00439	.84449	.38724	.02284	.05539
5	.00830	1.01773	.49711	.02806	.40850
6	.01361	1.20094	.60048	.02999	.74068
7	.02043	1.38279	.68736	.02884	1.01988
8	.02895	1.53429	.74361	.01065	1.20066
9	.03940	1.60974	.76135	-.02911	1.25767
10	.05210	1.57035	.74751	-.02720	1.21320
11	.06742	1.49618	.72908	.01095	1.15398
12	.08583	1.44311	.71675	.04183	1.11434
13	.10787	1.41301	.70693	.05010	1.08278
14	.13422	1.40091	.69903	.04101	1.05738
15	.16564	1.38662	.69061	.03379	1.03033
16	.19720	1.36986	.68323	.03373	1.00663
17	.22877	1.34412	.67265	.03666	.97263
18	.26033	1.31783	.66038	.03643	.93319
19	.29187	1.25902	.63053	.04478	.85334
20	.32336	1.14754	.58622	.06202	.69487
21	.35481	1.03894	.53000	.06867	.51418
22	.38621	.97535	.49363	.06894	.39731
23	.41755	.94170	.47299	.06709	.33098
24	.44883	.90938	.45180	.06346	.26287
25	.48005	.88689	.43585	.05925	.21162
26	.51120	.88055	.43098	.05754	.19598
27	.54229	.87995	.43098	.05815	.19598
28	.57331	.87275	.42702	.05881	.18325
29	.60425	.85860	.41848	.05892	.15580
30	.63513	.84442	.40985	.05896	.12807
31	.66594	.83080	.40176	.05932	.10206
32	.69667	.81782	.39385	.05937	.07663
33	.72734	.80509	.38636	.05985	.05258
34	.75793	.79347	.37918	.05976	.02952
35	.78844	.78060	.37187	.06062	.00602
36	.81889	.76788	.36394	.06039	-.01948
37	.84926	.75057	.35432	.06177	-.05040
38	.87955	.73274	.34290	.06097	-.08708
39	.90978	.70290	.32684	.06381	-.13871
40	.93993	.68032	.31096	.06066	-.18972
41	.97000	.60070	.27192	.07079	-.31521
42	1.00000	.65809	.24860	-.00494	-.39016

LOWER SURFACE

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.47700	.14741	.00371	-.71534
2	.00040	.43018	.11560	-.00437	-.81757
3	.00179	.43900	.13160	.00870	-.76614
4	.00439	.50536	.17460	.01738	-.62795
5	.00830	.60626	.24095	.02705	-.41471
6	.01361	.71564	.31384	.03472	-.18048
7	.02043	.80356	.37155	.03863	.00498
8	.02895	.84557	.39702	.03738	.08684
9	.03940	.84683	.39186	.02786	.07025
10	.05210	.84174	.38289	.01871	.04142
11	.06742	.84949	.38615	.01602	.05190
12	.08583	.86325	.39478	.01580	.07963
13	.10787	.87789	.40394	.01555	.10906
14	.13422	.89188	.41256	.01515	.13678
15	.16564	.90597	.42104	.01444	.16404
16	.19720	.91986	.42962	.01415	.19159
17	.22877	.93116	.43638	.01358	.21331
18	.26033	.94227	.44308	.01315	.23486
19	.29187	.95232	.44909	.01271	.25418
20	.32336	.96110	.45435	.01235	.27106
21	.35481	.96780	.45834	.01208	.28390
22	.38621	.97177	.46072	.01195	.29154
23	.41755	.97234	.46106	.01193	.29264
24	.44883	.96906	.45906	.01198	.28622
25	.48005	.96174	.45455	.01200	.27171
26	.51120	.95089	.44778	.01196	.24996
27	.54229	.93769	.43948	.01185	.22329
28	.57331	.92348	.43051	.01174	.19445
29	.60425	.90918	.42144	.01166	.16532
30	.63513	.89526	.41259	.01155	.13686
31	.66594	.88208	.40417	.01152	.10980
32	.69667	.86984	.39633	.01146	.08460
33	.72734	.85855	.38907	.01139	.06127
34	.75793	.84777	.38217	.01140	.03910
35	.78844	.83702	.37520	.01129	.01670
36	.81889	.82503	.36760	.01146	-.00771
37	.84926	.81088	.35833	.01120	-.03749
38	.87955	.79277	.34706	.01179	-.07373
39	.90978	.76859	.33126	.01144	-.12450
40	.93993	.74151	.31441	.01224	-.17865
41	.97000	.68100	.27858	.01596	-.29379
42	1.00000	.65809	.24860	-.00494	-.39016

Figure 7-A-3

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°

DORNIER/JAMESON (2a) "MEDIUM GRID" y/b = 0.10

	XC	YC	MACH	1-PI/PINF	1-P/PINF
1	0.70644	0.13500	0.66220	0.01911	0.26914
2	0.69913	0.13500	0.65430	0.03081	0.27300
3	0.67997	0.13500	0.69942	0.02292	0.29523
4	0.65022	0.13500	0.73143	0.02729	0.31849
5	0.61434	0.13500	0.78430	0.02741	0.35202
6	0.57935	0.13500	0.82335	0.02551	0.37552
7	0.54631	0.13500	0.84957	0.02654	0.39277
8	0.51506	0.13500	0.87506	0.02589	0.40842
9	0.48541	0.13500	0.90066	0.02685	0.42503
10	0.45719	0.13500	0.92631	0.02668	0.44086
11	0.43023	0.13500	0.94761	0.02654	0.45392
12	0.40434	0.13500	0.96175	0.02540	0.46195
13	0.37935	0.13500	0.96722	0.02443	0.46475
14	0.35509	0.13500	0.96567	0.02324	0.46316
15	0.33138	0.13500	0.95789	0.02215	0.45779
16	0.30805	0.13500	0.94577	0.02136	0.44988
17	0.28492	0.13500	0.93118	0.02080	0.44052
18	0.26182	0.13500	0.91520	0.02051	0.43039
19	0.23857	0.13500	0.89864	0.02057	0.42005
20	0.21500	0.13500	0.88188	0.02089	0.40969
21	0.19094	0.13500	0.86504	0.02171	0.39955
22	0.16621	0.13500	0.84737	0.02296	0.38914
23	0.14249	0.13500	0.82738	0.02464	0.37752
24	0.12282	0.13500	0.80674	0.02656	0.36567
25	0.10783	0.13500	0.78986	0.02648	0.35492
26	0.09653	0.13500	0.78238	0.02710	0.35059
27	0.08831	0.13550	0.77286	0.01520	0.33654
28	0.08281	0.13500	0.68886	0.00200	0.27343
29	0.07961	0.13500	0.55388	0.00250	0.19016
30	0.07824	0.13500	0.44048	-0.00018	0.12460
31	0.07960	0.13520	0.50264	-0.00223	0.15659
32	0.08281	0.13500	0.64158	-0.00086	0.24121
33	0.08831	0.13500	0.83431	0.00210	0.36764
34	0.09653	0.13500	1.03396	0.01152	0.49831
35	0.10783	0.13500	1.10646	0.07959	0.57237
36	0.12281	0.13500	1.03461	0.11385	0.55060
37	0.14249	0.13500	0.96527	0.11468	0.51315
38	0.16621	0.13500	0.95773	0.11558	0.50950
39	0.19094	0.13500	0.95017	0.11414	0.50449
40	0.21500	0.13500	0.95135	0.11320	0.50462
41	0.23857	0.13500	0.95909	0.11301	0.50804
42	0.26182	0.13500	0.97096	0.11326	0.51557
43	0.28491	0.13500	0.98522	0.11352	0.52359
44	0.30804	0.13500	1.00064	0.11390	0.53224
45	0.33138	0.13500	1.01729	0.11402	0.54135
46	0.35508	0.13500	1.03430	0.11488	0.55095
47	0.37935	0.13500	1.05300	0.11460	0.56077
48	0.40434	0.13500	1.06987	0.11675	0.57071
49	0.43023	0.13500	1.08799	0.11482	0.57923
50	0.45719	0.13500	1.09603	0.11987	0.58576
51	0.48541	0.13500	1.09676	0.11471	0.58370
52	0.51506	0.13500	1.05146	0.12817	0.56670
53	0.54631	0.13500	0.96253	0.11907	0.51409
54	0.57935	0.13500	0.82082	0.13018	0.44117
55	0.61434	0.13500	0.74915	0.12575	0.39753
56	0.65022	0.13500	0.71185	0.12431	0.37538
57	0.67996	0.13500	0.66064	0.12759	0.34910
58	0.69913	0.13500	0.60337	0.12387	0.31493

Figure 7-A-4

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°

DORNIER/JAMESON (2a) "MEDIUM GRID" y/b = 0.50

	XC	YC	MACH	1-PI/PINF	1-P/PINF
1	0.81120	0.50250	0.67006	0.01531	0.27123
2	0.80514	0.50250	0.66290	0.02760	0.27589
3	0.78925	0.50250	0.70667	0.01900	0.29704
4	0.76459	0.50250	0.73584	0.02379	0.31883
5	0.73484	0.50250	0.76308	0.02327	0.34848
6	0.70583	0.50250	0.81661	0.02161	0.36874
7	0.67843	0.50250	0.83825	0.02270	0.38319
8	0.65252	0.50250	0.85702	0.02224	0.39480
9	0.62793	0.50250	0.87482	0.02284	0.40642
10	0.60454	0.50250	0.89377	0.02278	0.41830
11	0.58218	0.50250	0.91241	0.02321	0.43022
12	0.56071	0.50250	0.92925	0.02331	0.44076
13	0.53999	0.50250	0.94211	0.02377	0.44897
14	0.51988	0.50250	0.95017	0.02421	0.45419
15	0.50022	0.50250	0.95200	0.02462	0.45554
16	0.48087	0.50250	0.94802	0.02525	0.45345
17	0.46169	0.50250	0.93989	0.02593	0.44883
18	0.44254	0.50250	0.92893	0.02672	0.44251
19	0.42327	0.50250	0.91646	0.02765	0.43532
20	0.40372	0.50250	0.90332	0.02867	0.42776
21	0.38377	0.50250	0.88967	0.02983	0.41994
22	0.36327	0.50250	0.87469	0.03101	0.41129
23	0.34360	0.50250	0.85714	0.03213	0.40100
24	0.32729	0.50250	0.83797	0.03336	0.38974
25	0.31487	0.50250	0.82058	0.03351	0.37891
26	0.30549	0.50250	0.81085	0.03341	0.37273
27	0.29868	0.50250	0.79666	0.02100	0.35567
28	0.29412	0.50250	0.78658	0.00641	0.28790
29	0.29146	0.50250	0.57146	0.00899	0.28584
30	0.29033	0.50250	0.47937	0.00441	0.14929
31	0.29146	0.50250	0.55373	-0.00047	0.18765
32	0.29411	0.50250	0.78587	0.00201	0.28429
33	0.29867	0.50250	0.92409	0.00359	0.42619
34	0.30549	0.50250	1.16157	0.01338	0.57242
35	0.31486	0.50250	1.27815	0.10065	0.66566
36	0.32720	0.50250	1.19618	0.16949	0.65581
37	0.34360	0.50250	1.00323	0.16729	0.60184
38	0.36327	0.50250	1.07563	0.16442	0.59673
39	0.38377	0.50250	1.05610	0.15917	0.58445
40	0.40372	0.50250	1.03644	0.15551	0.57265
41	0.42326	0.50250	1.02592	0.15153	0.56523
42	0.44254	0.50250	1.02899	0.14841	0.56522
43	0.46169	0.50250	1.03905	0.14623	0.56930
44	0.48087	0.50250	1.05204	0.14357	0.57465
45	0.50022	0.50250	1.06772	0.14162	0.58171
46	0.51987	0.50250	1.08827	0.13792	0.59035
47	0.53999	0.50250	1.10497	0.13814	0.59883
48	0.56071	0.50250	1.11119	0.13417	0.60009
49	0.58218	0.50250	1.06780	0.14315	0.58249
50	0.60454	0.50250	0.96834	0.13784	0.52759
51	0.62793	0.50250	0.82144	0.14446	0.45068
52	0.65252	0.50250	0.74697	0.14067	0.40666
53	0.67843	0.50250	0.73191	0.14059	0.39814
54	0.70583	0.50250	0.71394	0.14020	0.38787
55	0.73484	0.50250	0.68827	0.14222	0.37514
56	0.76459	0.50250	0.65855	0.14095	0.35793
57	0.78925	0.50250	0.61122	0.14719	0.33729
58	0.80514	0.50250	0.55887	0.14622	0.30938
59	0.81120	0.50250	0.52916	0.14573	0.29406

Figure 7-A-5

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°

DORNIER/JAMESON (2a) "MEDIUM GRID" y/b = 0.80

	XC	YC	MACH	1-PI/PINF	1-P/PINF
1	0.88753	0.77000	0.68133	0.01196	0.27586
2	0.88238	0.77000	0.67325	0.02504	0.28041
3	0.86887	0.77000	0.71582	0.01610	0.30071
4	0.84791	0.77000	0.74247	0.02159	0.32151
5	0.82262	0.77000	0.78711	0.02884	0.34942
6	0.79796	0.77000	0.81768	0.01987	0.36830
7	0.77467	0.77000	0.83746	0.02078	0.38147
8	0.75264	0.77000	0.85468	0.02062	0.39231
9	0.73175	0.77000	0.87184	0.02128	0.40358
10	0.71186	0.77000	0.89077	0.02142	0.41561
11	0.69285	0.77000	0.91012	0.02196	0.42806
12	0.67460	0.77000	0.92802	0.02218	0.43935
13	0.65699	0.77000	0.94216	0.02266	0.44838
14	0.63989	0.77000	0.95161	0.02311	0.45446
15	0.62318	0.77000	0.95490	0.02352	0.45671
16	0.60674	0.77000	0.95231	0.02415	0.45547
17	0.59044	0.77000	0.94528	0.02485	0.45154
18	0.57416	0.77000	0.93507	0.02570	0.44572
19	0.55777	0.77000	0.92312	0.02671	0.43891
20	0.54116	0.77000	0.91031	0.02783	0.43161
21	0.52420	0.77000	0.89670	0.02900	0.42388
22	0.50677	0.77000	0.88136	0.03035	0.41507
23	0.49005	0.77000	0.86277	0.03149	0.40413
24	0.47618	0.77000	0.84180	0.03271	0.39174
25	0.46563	0.77000	0.82223	0.03296	0.37959
26	0.45766	0.77000	0.80932	0.03247	0.37115
27	0.45186	0.77000	0.79197	0.02959	0.35237
28	0.44799	0.77000	0.69981	0.00606	0.28331
29	0.44573	0.77000	0.56647	0.00977	0.20349
30	0.44477	0.77000	0.48512	0.00523	0.15314
31	0.44573	0.77000	0.76469	0.01467	0.33094
32	0.44799	0.77000	0.72341	0.00304	0.29632
33	0.45186	0.77000	0.95143	0.00110	0.44205
34	0.45766	0.77000	1.19924	0.01392	0.59296
35	0.46562	0.77000	1.33390	0.10374	0.69119
36	0.47618	0.77000	1.25043	0.19058	0.68770
37	0.49005	0.77000	1.12956	0.18603	0.63260
38	0.50677	0.77000	1.13000	0.18200	0.63099
39	0.52420	0.77000	1.12510	0.17508	0.62557
40	0.54116	0.77000	1.11385	0.17063	0.61820
41	0.55777	0.77000	1.09833	0.16667	0.60890
42	0.57415	0.77000	1.08854	0.16326	0.60251
43	0.59043	0.77000	1.08958	0.16004	0.60150
44	0.60673	0.77000	1.09190	0.15830	0.60181
45	0.62318	0.77000	1.08675	0.15504	0.59773
46	0.63989	0.77000	1.05713	0.15622	0.58350
47	0.65699	0.77000	0.98425	0.15209	0.54424
48	0.67460	0.77000	0.86539	0.15606	0.48220
49	0.69285	0.77000	0.78413	0.15680	0.43812
50	0.71186	0.77000	0.76662	0.15425	0.42678
51	0.73175	0.77000	0.75250	0.15437	0.41909
52	0.75264	0.77000	0.73406	0.15419	0.40884
53	0.77467	0.77000	0.71104	0.15483	0.39671
54	0.79796	0.77000	0.68655	0.15489	0.38343
55	0.82262	0.77000	0.65777	0.15736	0.36978
56	0.84790	0.77000	0.62619	0.15703	0.35278
57	0.86887	0.77000	0.57710	0.16436	0.33319
58	0.88238	0.77000	0.52334	0.16544	0.30754
59	0.88753	0.77000	0.49511	0.16546	0.29418

Figure 7-A-6

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°

FFA (3a) "MEDIUM GRID"

CHORD SECTION Y% = .077

I	X/C	1-P/PINF ,	CP	MACH	1-PI/PIINF	I	X/C	1-P/PINF ,	CP	MACH	1-PI/PIINF
1	.999150	.225547	-.464225	.813774	.010199	49	.000434	.125959	-.784272	.430014	.000805
2	.995821	.254697	-.370549	.624287	.009543	50	.002169	.218315	-.487470	.560892	.012377
3	.989339	.281097	-.285706	.665568	.007374	51	.005633	.326630	-.139379	.714917	.012499
4	.979913	.295486	-.239465	.706494	.002184	52	.010819	.434267	.206534	.865363	.007329
5	.967745	.306497	-.204078	.730421	.004245	53	.017712	.528212	.508442	1.004276	.002676
6	.953034	.318684	-.164915	.752624	.003285	54	.026295	.581181	.678668	1.099806	.012029
7	.935976	.331973	-.122208	.772673	.004270	55	.036544	.578475	.669972	1.119095	.027756
8	.916760	.345193	-.079723	.793554	.004215	56	.048433	.534215	.527734	1.063245	.033937
9	.895571	.357824	-.039131	.812808	.004724	57	.061930	.493295	.396230	1.004538	.029016
10	.872590	.369031	-.003116	.830363	.004884	58	.076999	.485024	.369650	.991224	.026861
11	.847994	.378896	.028590	.845604	.005328	59	.093599	.489058	.382614	.996917	.027725
12	.821954	.387715	.056931	.859256	.005762	60	.111685	.491738	.391226	1.002100	.027830
13	.794637	.396019	.083616	.871867	.006460	61	.131207	.493077	.395530	1.005532	.027315
14	.766207	.404226	.109989	.884238	.007250	62	.152112	.494902	.401395	1.009624	.026811
15	.736821	.412461	.136455	.896540	.008119	63	.174339	.497341	.409234	1.014569	.026426
16	.706633	.420517	.162346	.908577	.008886	64	.197826	.499979	.417709	1.019770	.026075
17	.675793	.428013	.186434	.919760	.009494	65	.222505	.502869	.426999	1.025345	.025608
18	.644445	.434623	.207676	.929599	.009905	66	.248304	.506381	.438284	1.031799	.025126
19	.612730	.440131	.225377	.937724	.010156	67	.275146	.510663	.452047	1.039446	.024609
20	.580782	.444392	.239071	.943894	.010311	68	.302950	.515845	.468699	1.048493	.024113
21	.548733	.447258	.248282	.947855	.010444	69	.331629	.521891	.488130	1.058960	.023637
22	.516710	.448498	.252266	.949270	.010587	70	.361093	.528695	.509995	1.070743	.023181
23	.484835	.447936	.250462	.947874	.010778	71	.391247	.536055	.533647	1.083566	.022779
24	.453224	.445487	.242589	.943584	.010986	72	.421992	.543678	.558146	1.097081	.022351
25	.421992	.441308	.229160	.936668	.011229	73	.453224	.551041	.581808	1.110340	.022026
26	.391247	.435758	.211324	.927723	.011467	74	.484835	.557431	.602345	1.122243	.021632
27	.361093	.429307	.190594	.917459	.011709	75	.516710	.562467	.618528	1.131707	.021585
28	.331629	.422409	.168425	.906576	.011930	76	.548733	.567159	.633605	1.141066	.021130
29	.302950	.415468	.146120	.895647	.012140	77	.580782	.574714	.657885	1.156300	.020110
30	.275146	.408769	.124590	.885078	.012332	78	.612730	.583164	.685040	1.173800	.018608
31	.248304	.402492	.104417	.875083	.012530	79	.644445	.580016	.674924	1.167598	.019611
32	.222505	.396627	.085570	.865660	.012699	80	.675793	.549157	.575753	1.106109	.025963
33	.197826	.391157	.067991	.856712	.012881	81	.706633	.488222	.379927	.998194	.028848
34	.174339	.385828	.050865	.847933	.013002	82	.736821	.435655	.210993	.918205	.022607
35	.152112	.380404	.033435	.838969	.013123	83	.766207	.410904	.131451	.884250	.017620
36	.131207	.374797	.015416	.829705	.013215	84	.794637	.399533	.094909	.868710	.015336
37	.111685	.368946	-.003389	.820038	.013292	85	.821954	.390340	.065365	.855357	.013916
38	.093599	.362959	-.022627	.810100	.013401	86	.847994	.380224	.032856	.839968	.013051
39	.076999	.355994	-.045013	.799324	.013248	87	.872590	.369188	-.002611	.822982	.012448
40	.061930	.349751	-.065075	.789984	.013104	88	.895571	.357282	-.040871	.804041	.012504
41	.048433	.353788	-.052101	.790532	.014348	89	.916760	.344193	-.082936	.783628	.012309
42	.036544	.364731	-.016934	.794066	.013280	90	.935976	.330718	-.126241	.761565	.012925
43	.026295	.360239	-.031369	.773498	.008327	91	.953034	.317109	-.169975	.740374	.012356
44	.017712	.320446	-.159251	.711701	.004362	92	.967745	.304804	-.209520	.716782	.014125
45	.010819	.252813	-.376603	.612965	.009503	93	.979913	.293066	-.247244	.691741	.012271
46	.005633	.177322	-.619206	.500140	.012401	94	.989339	.279144	-.291984	.650061	.018854
47	.002169	.112497	-.827532	.400854	.006434	95	.995821	.252902	-.376316	.608588	.021757
48	.000434	.086483	-.911136	.366325	-.002671	96	.999150	.230471	-.448402	.602480	.020867

Figure 7-A-7

AGARD WG07 TEST CASE 11
ONERA M6

FFA (3a) "MEDIUM GRID" **M = .84** $\alpha = 3.06°$

CHORD SECTION YX = .468

I	X/C	1-P/PINF ,	CP	MACH	1-PI/PIINF	I	X/C	1-P/PINF ,	CP	MACH	1-PI/PIINF
1	.999150	.225829	-.463319	.613455	.010441	49	.000434	.168118	-.648784	.506058	-.000636
2	.995821	.253253	-.375188	.624696	.008483	50	.002169	.274101	-.308191	.649224	.010057
3	.989339	.278516	-.294002	.663659	.006743	51	.005633	.392362	.071863	.816434	.006243
4	.979913	.291523	-.252201	.702480	.001272	52	.010819	.509022	.446771	.983877	-.001548
5	.967745	.301175	-.221182	.724333	.002990	53	.017712	.614593	.786044	1.152424	-.009164
6	.953034	.311769	-.187137	.744274	.001732	54	.026295	.687271	1.019608	1.301671	-.003374
7	.935976	.323294	-.150099	.761926	.002311	55	.036544	.719863	1.124347	1.409257	.006359
8	.916760	.334732	-.113341	.780337	.001862	56	.048433	.724920	1.140601	1.455124	.013858
9	.895571	.345790	-.077804	.797408	.001973	57	.061930	.712515	1.100732	1.441097	.013124
10	.872590	.355753	-.045786	.813270	.001751	58	.076999	.693729	1.040363	1.401626	.008262
11	.847994	.364600	-.017353	.827243	.001755	59	.093599	.673552	.975519	1.359036	.005649
12	.821954	.372310	.007422	.839643	.001615	60	.111685	.647050	.890348	1.302096	.009404
13	.794637	.379082	.029187	.850534	.001531	61	.131207	.607542	.763384	1.221007	.014961
14	.766207	.385297	.049159	.860575	.001370	62	.152112	.569288	.640449	1.150739	.014114
15	.736821	.391459	.068962	.870387	.001244	63	.174339	.548357	.573182	1.116139	.010309
16	.706633	.398083	.090248	.880759	.001138	64	.197826	.543050	.556127	1.108220	.008393
17	.675793	.405694	.114707	.892419	.001160	65	.222505	.546766	.568068	1.114765	.008350
18	.644445	.414751	.143815	.906070	.001373	66	.248304	.553295	.589052	1.125838	.008955
19	.612730	.425240	.177522	.921765	.001769	67	.275146	.559339	.608476	1.136091	.009533
20	.580782	.436022	.212172	.937941	.002172	68	.302950	.564521	.625128	1.144918	.009865
21	.548733	.445311	.242026	.952002	.002358	69	.331629	.569534	.641237	1.153477	.010067
22	.516710	.451802	.262886	.961958	.002256	70	.361093	.575133	.659233	1.163278	.010029
23	.484835	.455031	.273262	.967001	.001960	71	.391247	.582340	.682394	1.176175	.009886
24	.453224	.455188	.273768	.967380	.001563	72	.421992	.592936	.716445	1.196228	.008886
25	.421992	.452910	.266447	.964020	.001198	73	.453224	.608407	.766162	1.227224	.006552
26	.391247	.448950	.253720	.958076	.000906	74	.484835	.619183	.800795	1.249669	.005359
27	.361093	.443998	.237805	.950570	.000739	75	.516710	.603761	.751233	1.215758	.012760
28	.331629	.438583	.220404	.942304	.000679	76	.548733	.542264	.553603	1.091949	.028506
29	.302950	.433101	.202787	.933845	.000728	77	.580782	.458135	.283237	.950700	.027849
30	.275146	.427793	.185726	.925550	.000848	78	.612730	.410717	.130849	.882486	.019461
31	.248304	.422809	.169711	.917608	.001043	79	.644445	.399145	.093661	.866786	.017226
32	.222505	.418131	.154678	.910014	.001262	80	.675793	.399643	.095262	.867028	.018171
33	.197826	.413734	.140547	.902673	.001537	81	.706633	.396502	.085168	.861728	.018601
34	.174339	.409346	.126443	.895251	.001790	82	.736821	.389634	.063097	.851016	.018408
35	.152112	.404698	.111508	.887353	.002083	83	.766207	.382771	.041041	.840210	.018296
36	.131207	.399669	.095346	.878818	.002382	84	.794637	.376625	.021289	.830138	.018492
37	.111685	.394170	.077675	.869504	.002702	85	.821954	.370118	.000378	.819385	.018704
38	.093599	.388292	.058785	.859510	.003095	86	.847994	.362615	-.023735	.806935	.019017
39	.076999	.381022	.035421	.848051	.003229	87	.872590	.353878	-.051811	.792743	.019164
40	.061930	.374187	.013455	.837544	.003421	88	.895571	.344000	-.083556	.776540	.019561
41	.048433	.377572	.024333	.836603	.005152	89	.916760	.332970	-.119004	.759057	.019566
42	.036544	.386844	.054130	.837081	.004537	90	.935976	.321580	-.155607	.740140	.020181
43	.026295	.379476	.030451	.811815	.000433	91	.953034	.309996	-.192836	.721971	.019646
44	.017712	.336994	-.106072	.745487	-.001591	92	.967745	.299468	-.226670	.701343	.021155
45	.010819	.267772	-.328528	.644265	.005883	93	.979913	.289383	-.259079	.678904	.019339
46	.005633	.191742	-.572866	.533097	.009420	94	.989339	.276869	-.299293	.639779	.025337
47	.002169	.131094	-.767770	.444305	.004005	95	.995821	.251974	-.379299	.599732	.028046
48	.000434	.114978	-.819561	.427327	-.004313	96	.999150	.229880	-.450301	.596170	.025318

Figure 7-A-8

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°

FFA (3a) "MEDIUM GRID"

CHORD SECTION YX = .816

I	X/C	1-P/PINF	CP	MACH	1-PI/PIINF	I	X/C	1-P/PINF	CP	MACH	1-PI/PIINF
1	.999150	.230535	-.448197	.614497	.013981	49	.000434	.177548	-.618480	.521479	-.000786
2	.995821	.255249	-.368775	.628542	.008852	50	.002169	.285909	-.270244	.666541	.009916
3	.989339	.280632	-.287200	.665726	.008277	51	.005633	.404795	.111820	.834690	.005568
4	.979913	.293191	-.246840	.704377	.002224	52	.010819	.521598	.487188	1.003214	-.002048
5	.967745	.302671	-.216374	.725709	.004038	53	.017712	.627047	.826068	1.173907	-.009393
6	.953034	.312745	-.184001	.745155	.002522	54	.026295	.699644	1.059369	1.326457	-.002945
7	.935976	.323667	-.148902	.761947	.003061	55	.036544	.732961	1.166442	1.439450	.006675
8	.916760	.334261	-.114855	.779285	.002422	56	.048433	.739954	1.188915	1.491953	.014441
9	.895571	.344342	-.082456	.794956	.002442	57	.061930	.729590	1.155606	1.482212	.014145
10	.872590	.353182	-.054047	.809241	.002060	58	.076999	.712043	1.099218	1.442281	.010960
11	.847994	.360908	-.029218	.821531	.001980	59	.093599	.698212	1.054768	1.411930	.007352
12	.821954	.367670	-.007487	.832459	.001785	60	.111685	.691753	1.034011	1.398454	.006292
13	.794637	.373952	.012700	.842425	.001796	61	.131207	.689116	1.025535	1.393294	.006421
14	.766207	.380262	.032977	.852348	.001849	62	.152112	.686955	1.018593	1.388391	.007891
15	.736821	.387075	.054872	.862828	.002048	63	.174339	.684058	1.009283	1.383068	.007515
16	.706633	.394682	.079321	.874418	.002274	64	.197826	.681131	.999875	1.377373	.007319
17	.675793	.403141	.106505	.887207	.002527	65	.222505	.679673	.995189	1.376759	.004198
18	.644445	.412317	.135993	.901088	.002721	66	.248304	.678418	.991157	1.376773	.001170
19	.612730	.422066	.167322	.915858	.002869	67	.275146	.663278	.942503	1.343375	.004028
20	.580782	.432203	.199901	.931282	.002981	68	.302950	.615203	.788005	1.234494	.020742
21	.548733	.442087	.231665	.946426	.003022	69	.331629	.541758	.551973	1.087204	.035014
22	.516710	.450554	.258875	.959601	.002862	70	.361093	.482057	.360115	.984787	.033988
23	.484835	.456586	.278260	.969215	.002479	71	.391247	.449498	.255480	.933549	.030311
24	.453224	.459674	.288183	.974434	.001902	72	.421992	.431345	.197143	.906909	.026812
25	.421992	.459991	.289203	.975428	.001266	73	.453224	.423041	.170458	.895614	.024349
26	.391247	.458146	.283278	.973081	.000659	74	.484835	.423650	.172412	.896700	.024145
27	.361093	.454881	.272780	.968454	.000189	75	.516710	.429457	.191074	.904847	.025612
28	.331629	.450814	.259710	.962465	-.000111	76	.548733	.432929	.201910	.909183	.027300
29	.302950	.446385	.245477	.955726	-.000212	77	.580782	.429609	.191562	.903647	.028304
30	.275146	.441806	.230761	.948556	-.000150	78	.612730	.421300	.164861	.890545	.028603
31	.248304	.437176	.215880	.941081	.000055	79	.644445	.411698	.134004	.875578	.028632
32	.222505	.432441	.200664	.933274	.000325	80	.675793	.403252	.106860	.862307	.028745
33	.197826	.427603	.185117	.925114	.000661	81	.706633	.395962	.083433	.850687	.028935
34	.174339	.422472	.168628	.916415	.000970	82	.736821	.389233	.061809	.839840	.029096
35	.152112	.416875	.150639	.906930	.001316	83	.766207	.382802	.041142	.829393	.029193
36	.131207	.410770	.131022	.896636	.001656	84	.794637	.376397	.020558	.818882	.029289
37	.111685	.404131	.109686	.885476	.002016	85	.821954	.369618	-.001228	.807783	.029321
38	.093599	.397072	.087000	.873596	.002439	86	.847994	.362090	-.025422	.795423	.029412
39	.076999	.388586	.059728	.860214	.002597	87	.872590	.353565	-.052817	.781629	.029389
40	.061930	.380578	.033995	.847860	.002822	88	.895571	.344024	-.083479	.766040	.029576
41	.048433	.382625	.040572	.844848	.004566	89	.916760	.333460	-.117428	.749260	.029469
42	.036544	.390079	.064528	.842696	.003883	90	.935976	.322552	-.152483	.731142	.029888
43	.026295	.380900	.035028	.814919	-.000128	91	.953034	.311510	-.187968	.713695	.029321
44	.017712	.337316	-.105036	.747021	-.001830	92	.967745	.301400	-.220459	.693862	.030546
45	.010819	.267846	-.328292	.645518	.005737	93	.979913	.291918	-.250933	.671923	.028837
46	.005633	.192193	-.571415	.535774	.008681	94	.989339	.279617	-.290462	.633117	.034292
47	.002169	.133666	-.759504	.451011	.003146	95	.995821	.255332	-.368506	.591974	.037558
48	.000434	.120896	-.800542	.439311	-.004915	96	.999150	.230796	-.447360	.589099	.033443

Figure 7-A-9

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
MBB (4)

η = 0.122

$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M	$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M
0.9984	0.2845	0.0038	0.0002	0.2815	0.6995	0.0001	0.9407	-0.0473	-0.0017	0.0773	0.4293
0.9921	0.2759	0.0028	-0.0001	0.2841	0.7047	0.0008	0.8237	-0.0517	-0.0053	0.1137	0.5004
0.9797	0.2484	0.0025	-0.0002	0.2927	0.7185	0.0026	0.5448	-0.0331	-0.0059	0.2005	0.6163
0.9616	0.2080	0.0022	-0.0003	0.3053	0.7382	0.0060	0.1704	-0.0065	-0.0056	0.3170	0.7653
0.9380	0.1585	0.0019	-0.0004	0.3207	0.7623	0.0113	-0.2445	0.0208	-0.0053	0.4461	0.9402
0.9095	0.1053	0.0015	-0.0005	0.3372	0.7882	0.0188	-0.6419	0.0380	-0.0045	0.5697	1.1366
0.8766	0.0548	0.0009	-0.0006	0.3530	0.8129	0.0289	-0.9025	0.0250	-0.0014	0.6508	1.3057
0.8396	0.0114	0.0002	-0.0008	0.3665	0.8343	0.0416	-0.8931	-0.0008	0.0029	0.6479	1.3187
0.7993	-0.0244	-0.0003	-0.0010	0.3776	0.8520	0.0571	-0.5135	0.0105	0.0008	0.5298	1.0883
0.7562	-0.0558	-0.0007	-0.0011	0.3874	0.8674	0.0757	-0.3911	-0.0019	-0.0011	0.4917	1.0343
0.7109	-0.0870	-0.0009	-0.0012	0.3971	0.8827	0.0973	-0.4241	-0.0008	-0.0009	0.5020	1.0504
0.6638	-0.1204	-0.0010	-0.0013	0.4075	0.8989	0.1221	-0.4335	0.0038	0.0002	0.5049	1.0515
0.6157	-0.1551	-0.0011	-0.0014	0.4183	0.9159	0.1500	-0.4372	0.0077	0.0012	0.5061	1.0502
0.5670	-0.1870	-0.0010	-0.0014	0.4282	0.9314	0.1809	-0.4415	0.0097	0.0016	0.5074	1.0507
0.5184	-0.2103	-0.0008	-0.0014	0.4354	0.9426	0.2149	-0.4491	0.0106	0.0018	0.5098	1.0540
0.4702	-0.2198	-0.0002	-0.0013	0.4384	0.9468	0.2518	-0.4628	0.0114	0.0020	0.5140	1.0605
0.4230	-0.2147	0.0007	-0.0012	0.4368	0.9435	0.2912	-0.4842	0.0121	0.0021	0.5207	1.0712
0.3772	-0.1974	0.0017	-0.0010	0.4314	0.9341	0.3331	-0.5136	0.0127	0.0023	0.5298	1.0865
0.3331	-0.1727	0.0027	-0.0009	0.4237	0.9210	0.3772	-0.5494	0.0131	0.0024	0.5410	1.1055
0.2912	-0.1454	0.0036	-0.0007	0.4153	0.9069	0.4230	-0.5886	0.0133	0.0024	0.5531	1.1269
0.2518	-0.1189	0.0043	-0.0006	0.4070	0.8933	0.4702	-0.6265	0.0132	0.0025	0.5649	1.1481
0.2149	-0.0944	0.0049	-0.0006	0.3994	0.8809	0.5184	-0.6591	0.0130	0.0025	0.5751	1.1666
0.1809	-0.0716	0.0052	-0.0006	0.3923	0.8695	0.5670	-0.6825	0.0125	0.0025	0.5824	1.1806
0.1500	-0.0491	0.0053	-0.0008	0.3853	0.8586	0.6157	-0.7027	0.0124	0.0026	0.5887	1.1923
0.1221	-0.0252	0.0050	-0.0010	0.3779	0.8473	0.6638	-0.7064	0.0115	0.0026	0.5898	1.1952
0.0973	0.0014	0.0042	-0.0014	0.3696	0.8352	0.7109	-0.3813	0.0369	0.0033	0.4886	0.9957
0.0757	0.0293	0.0031	-0.0019	0.3609	0.8229	0.7562	-0.0312	0.0191	-0.0018	0.3797	0.8364
0.0571	0.0343	0.0044	-0.0019	0.3593	0.8192	0.7993	0.0058	0.0159	-0.0004	0.3682	0.8215
0.0416	-0.0220	0.0113	-0.0008	0.3769	0.8395	0.8396	0.0306	0.0158	0.0003	0.3605	0.8096
0.0289	-0.0359	0.0143	-0.0020	0.3812	0.8434	0.8766	0.0658	0.0164	0.0006	0.3495	0.7919
0.0188	0.1265	0.0066	-0.0059	0.3306	0.7727	0.9095	0.1116	0.0170	0.0007	0.3353	0.7689
0.0113	0.4172	-0.0128	-0.0087	0.2402	0.6541	0.9380	0.1617	0.0176	0.0008	0.3197	0.7440
0.0060	0.7141	-0.0340	-0.0099	0.1478	0.5329	0.9616	0.2086	0.0180	0.0010	0.3051	0.7206
0.0026	0.9391	-0.0513	-0.0101	0.0778	0.4367	0.9797	0.2470	0.0183	0.0012	0.2931	0.7013
0.0008	1.0423	-0.0585	-0.0084	0.0457	0.3876	0.9921	0.2733	0.0186	0.0014	0.2850	0.6880
0.0001	1.0080	-0.0489	-0.0032	0.0563	0.3916	0.9984	0.2814	0.0195	0.0018	0.2824	0.6836

Figure 7-A-10

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
MBB (4)

η = 0.531

$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M	$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M
0.9986	0.2988	0.0806	-0.0009	0.2770	0.6962	0.0001	0.8610	-0.0496	-0.0032	0.1021	0.4776
0.9921	0.2916	-0.0005	-0.0012	0.2793	0.7009	0.0008	0.7262	-0.0529	-0.0062	0.1440	0.5520
0.9797	0.2660	-0.0010	-0.0013	0.2872	0.7137	0.0026	0.4294	-0.0330	-0.0065	0.2364	0.6714
0.9616	0.2289	-0.0014	-0.0014	0.2988	0.7320	0.0060	0.0358	-0.0042	-0.0060	0.3588	0.8270
0.9380	0.1846	-0.0017	-0.0015	0.3126	0.7536	0.0113	-0.3998	0.0257	-0.0053	0.4941	1.0147
0.9095	0.1376	-0.0023	-0.0017	0.3271	0.7764	0.0188	-0.8189	0.0463	-0.0058	0.6248	1.2358
0.8766	0.0937	-0.0030	-0.0019	0.3409	0.7982	0.0289	-1.1226	0.0260	-0.0035	0.7193	1.4610
0.8396	0.0549	-0.0036	-0.0021	0.3529	0.8173	0.0416	-1.2419	-0.0257	0.0020	0.7564	1.5937
0.7993	0.0211	-0.0042	-0.0023	0.3634	0.8340	0.0571	-1.1831	-0.0399	0.0045	0.7381	1.5539
0.7562	-0.0107	-0.0046	-0.0025	0.3733	0.8496	0.0757	-1.0569	-0.0341	0.0027	0.6989	1.4536
0.7109	-0.0444	-0.0049	-0.0026	0.3838	0.8659	0.0973	-0.9378	-0.0294	0.0008	0.6618	1.3682
0.6638	-0.0872	-0.0051	-0.0027	0.3956	0.8842	0.1221	-0.7638	-0.0178	0.0005	0.6077	1.2511
0.6157	-0.1235	-0.0052	-0.0028	0.4084	0.9043	0.1500	-0.6140	-0.0114	0.0012	0.5610	1.1604
0.5670	-0.1643	-0.0054	-0.0029	0.4211	0.9243	0.1809	-0.6179	-0.0093	0.0019	0.5623	1.1610
0.5184	-0.1969	-0.0057	-0.0031	0.4313	0.9404	0.2149	-0.6424	-0.0059	0.0024	0.5699	1.1721
0.4702	-0.2134	-0.0060	-0.0032	0.4364	0.9488	0.2518	-0.6540	-0.0028	0.0026	0.5735	1.1762
0.4230	-0.2128	-0.0063	-0.0035	0.4362	0.9487	0.2912	-0.6650	0.0000	0.0028	0.5769	1.1802
0.3772	-0.1999	-0.0066	-0.0036	0.4322	0.9426	0.3331	-0.6883	0.0026	0.0030	0.5842	1.1916
0.3331	-0.1820	-0.0066	-0.0038	0.4266	0.9339	0.3772	-0.7253	0.0048	0.0032	0.5957	1.2114
0.2912	-0.1642	-0.0062	-0.0038	0.4211	0.9250	0.4230	-0.7724	0.0067	0.0033	0.6103	1.2379
0.2518	-0.1490	-0.0056	-0.0037	0.4164	0.9170	0.4702	-0.8241	0.0081	0.0034	0.6264	1.2685
0.2149	-0.1358	-0.0046	-0.0036	0.4123	0.9097	0.5184	-0.8328	0.0090	0.0038	0.6291	1.2733
0.1809	-0.1226	-0.0036	-0.0034	0.4082	0.9024	0.5670	-0.3776	0.0587	0.0041	0.4875	0.9739
0.1500	-0.1068	-0.0029	-0.0033	0.4032	0.8941	0.6157	0.0493	0.0258	-0.0037	0.3547	0.7902
0.1221	-0.0860	-0.0026	-0.0034	0.3968	0.8838	0.6638	0.0375	0.0227	-0.0013	0.3583	0.7992
0.0973	-0.0589	-0.0029	-0.0036	0.3883	0.8710	0.7109	0.0190	0.0243	0.0002	0.3641	0.8066
0.0757	-0.0278	-0.0036	-0.0039	0.3786	0.8567	0.7562	0.0302	0.0252	0.0006	0.3606	0.8001
0.0571	-0.0177	-0.0019	-0.0038	0.3755	0.8503	0.7993	0.0515	0.0261	0.0008	0.3540	0.7888
0.0416	-0.0623	0.0052	-0.0028	0.3894	0.8650	0.8396	0.0779	0.0272	0.0011	0.3458	0.7747
0.0289	-0.0529	0.0081	-0.0043	0.3865	0.8577	0.8766	0.1109	0.0282	0.0016	0.3355	0.7573
0.0188	0.1307	-0.0008	-0.0083	0.3293	0.7783	0.9095	0.1502	0.0291	0.0020	0.3233	0.7370
0.0113	0.4299	-0.0213	-0.0110	0.2362	0.6579	0.9380	0.1930	0.0296	0.0023	0.3100	0.7153
0.0060	0.7229	-0.0428	-0.0122	0.1451	0.5404	0.9616	0.2339	0.0298	0.0025	0.2972	0.6946
0.0026	0.9295	-0.0587	-0.0123	0.0808	0.4537	0.9797	0.2680	0.0302	0.0026	0.2866	0.6771
0.0008	1.0048	-0.0633	-0.0105	0.0573	0.4183	0.9921	0.2912	0.0307	0.0028	0.2794	0.6648
0.0001	0.9446	-0.0514	-0.0049	0.0761	0.4338	0.9984	0.2964	0.0320	0.0033	0.2778	0.6605

Figure 7-A-11

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
MBB (4)

η = 0.776

$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M	$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M
0.9984	0.2923	-0.0022	-0.0018	0.2791	0.7024	0.0001	0.8455	-0.0511	-0.0032	0.1069	0.4881
0.9921	0.2666	-0.0034	-0.0021	0.2808	0.7064	0.0008	0.7077	-0.0539	-0.0059	0.1498	0.5625
0.9797	0.2627	-0.0039	-0.0023	0.2882	0.7185	0.0026	0.4107	-0.0340	-0.0061	0.2422	0.6814
0.9616	0.2276	-0.0043	-0.0024	0.2992	0.7357	0.0060	0.0148	-0.0048	-0.0056	0.3654	0.8375
0.9380	0.1857	-0.0046	-0.0025	0.3122	0.7560	0.0113	-0.4235	0.0251	-0.0049	0.5018	1.0281
0.9095	0.1420	-0.0051	-0.0026	0.3258	0.7774	0.0188	-0.8424	0.0447	-0.0049	0.6321	1.2518
0.8766	0.1013	-0.0058	-0.0028	0.3385	0.7974	0.0289	-1.1807	0.0532	-0.0026	0.7281	1.4850
0.8396	0.0663	-0.0064	-0.0030	0.3494	0.8146	0.0416	-1.2808	-0.0324	0.0031	0.7685	1.6324
0.7993	0.0365	-0.0070	-0.0032	0.3586	0.8293	0.0571	-1.2411	-0.0487	0.0060	0.7562	1.6080
0.7562	0.0088	-0.0074	-0.0034	0.3673	0.8429	0.0757	-1.1340	-0.0418	0.0042	0.7229	1.5163
0.7109	-0.0206	-0.0077	-0.0035	0.3764	0.8572	0.0973	-1.0496	-0.0391	0.0014	0.6966	1.4518
0.6638	-0.0543	-0.0079	-0.0036	0.3869	0.8735	0.1221	-1.0031	-0.0365	0.0001	0.6821	1.4173
0.6157	-0.0931	-0.0081	-0.0037	0.3990	0.8923	0.1500	-0.9732	-0.0311	0.0003	0.6728	1.3931
0.5670	-0.1359	-0.0081	-0.0038	0.4123	0.9129	0.1809	-0.9224	-0.0228	0.0015	0.6570	1.3535
0.5184	-0.1794	-0.0079	-0.0038	0.4258	0.9339	0.2149	-0.8383	-0.0138	0.0026	0.6308	1.2935
0.4702	-0.2156	-0.0076	-0.0037	0.4371	0.9513	0.2518	-0.7705	-0.0085	0.0032	0.6098	1.2483
0.4230	-0.2352	-0.0073	-0.0037	0.4432	0.9606	0.2912	-0.7498	-0.0060	0.0035	0.6033	1.2341
0.3772	-0.2345	-0.0072	-0.0038	0.4430	0.9602	0.3331	-0.7434	-0.0044	0.0036	0.6013	1.2291
0.3331	-0.2184	-0.0074	-0.0039	0.4380	0.9525	0.3772	-0.7119	-0.0023	0.0035	0.5915	1.2091
0.2912	-0.1946	-0.0078	-0.0041	0.4306	0.9412	0.4230	-0.5797	0.0042	0.0042	0.5504	1.1293
0.2518	-0.1702	-0.0081	-0.0043	0.4230	0.9295	0.4702	-0.1608	0.0133	-0.0002	0.4200	0.9054
0.2149	-0.1481	-0.0081	-0.0044	0.4161	0.9188	0.5184	0.0003	-0.0011	-0.0022	0.3699	0.8409
0.1809	-0.1286	-0.0077	-0.0044	0.4100	0.9090	0.5670	-0.0360	0.0004	-0.0012	0.3812	0.8569
0.1500	-0.1098	-0.0069	-0.0043	0.4042	0.8993	0.6157	-0.0620	0.0039	-0.0001	0.3893	0.8661
0.1221	-0.0884	-0.0061	-0.0042	0.3975	0.8883	0.6638	-0.0435	0.0057	0.0002	0.3835	0.8554
0.0973	-0.0616	-0.0057	-0.0041	0.3892	0.8749	0.7109	-0.0153	0.0071	0.0004	0.3748	0.8404
0.0757	-0.0307	-0.0055	-0.0042	0.3795	0.8599	0.7562	0.0105	0.0086	0.0006	0.3667	0.8265
0.0571	-0.0204	-0.0030	-0.0037	0.3763	0.8526	0.7993	0.0357	0.0100	0.0009	0.3589	0.8129
0.0416	-0.0608	0.0046	-0.0026	0.3689	0.8649	0.8396	0.0645	0.0113	0.0011	0.3499	0.7978
0.0289	-0.0416	0.0074	-0.0041	0.3829	0.8529	0.8766	0.0999	0.0123	0.0013	0.3389	0.7796
0.0188	0.1500	-0.0022	-0.0079	0.3233	0.7706	0.9095	0.1416	0.0132	0.0015	0.3260	0.7584
0.0113	0.4516	-0.0237	-0.0107	0.2295	0.6502	0.9380	0.1863	0.0142	0.0018	0.3120	0.7357
0.0060	0.7409	-0.0458	-0.0120	0.1394	0.5352	0.9616	0.2289	0.0150	0.0020	0.2988	0.7140
0.0026	0.9374	-0.0612	-0.0121	0.0783	0.4533	0.9797	0.2646	0.0158	0.0022	0.2877	0.6956
0.0008	1.0009	-0.0652	-0.0104	0.0585	0.4237	0.9921	0.2888	0.0168	0.0024	0.2801	0.6825
0.0001	0.9326	-0.0529	-0.0048	0.0798	0.4429	0.9984	0.2943	0.0184	0.0028	0.2784	0.6779

Figure 7-A-12

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
ONERA/MATRA

N	X/C	y/b = 0.20 -CP	y/b = 0.20 -CP	y/b = 0.44 -CP	y/b = 0.44 -CP	y/b = 0.80 -CP	y/b = 0.80 -CP	y/b = 0.96 -CP	y/b = 0.96 -CP	X/C	N
1	0.00000	-.79785	-.79785	-.75470	-.75470	-.71534	-.71534	-.65587	-.65587	0.00000	1
2	.00040	-.65341	-.87809	-.58912	-.85288	-.54076	-.81757	-.48870	-.74674	.00040	2
3	.00179	-.39412	-.80113	-.31371	-.79156	-.26073	-.76614	-.21331	-.68744	.00179	3
4	.00439	-.09463	-.64442	-.00273	-.64699	.05539	-.62795	.10138	-.53919	.00439	4
5	.00830	.24933	-.41903	.34867	-.43088	.40850	-.41471	.44755	-.31541	.00830	5
6	.01361	.57757	-.18655	.68234	-.19860	.74068	-.18048	.77122	-.07006	.01361	6
7	.02043	.85429	-.00064	.96900	-.01711	1.01988	.00498	1.05052	.13106	.02043	7
8	.02895	1.01836	.05692	1.14776	.05729	1.20066	.08684	1.23213	.22665	.02895	8
9	.03940	1.03484	.02667	1.19617	.03695	1.25767	.07025	1.29783	.21773	.03940	9
10	.05210	.91926	-.01095	1.14880	.00542	1.21320	.04142	1.26105	.19072	.05210	10
11	.06742	.73589	-.00739	1.08101	.01353	1.15398	.05190	1.21050	.20879	.06742	11
12	.08583	.58516	.01248	1.00247	.03752	1.11434	.07963	1.18805	.24447	.08583	12
13	.10787	.51383	.03420	.88478	.06326	1.08278	.10906	1.18078	.27786	.10787	13
14	.13422	.49997	.05466	.73874	.08711	1.05738	.13678	1.16025	.30065	.13422	14
15	.16564	.50260	.07574	.62898	.11090	1.03033	.16404	1.12049	.30876	.16564	15
16	.19720	.50906	.09873	.58108	.13567	1.00663	.19159	1.02739	.30681	.19720	16
17	.22877	.51076	.11859	.57279	.15622	.97263	.21331	.72174	.29582	.22877	17
18	.26033	.31465	.14056	.58559	.17817	.93319	.23486	.28309	.28642	.26033	18
19	.29187	.52484	.16350	.60543	.20011	.85334	.25418	.07937	.27775	.29187	19
20	.32336	.54127	.18721	.62850	.22194	.69487	.27106	.12432	.26916	.32336	20
21	.35481	.56205	.21036	.65370	.24203	.51418	.28390	.20118	.25950	.35481	21
22	.38621	.58536	.23146	.68076	.25873	.39731	.29154	.22747	.24828	.38621	22
23	.41755	.60963	.24869	.70849	.26997	.33098	.29264	.23818	.23537	.41755	23
24	.44883	.63303	.26023	.73451	.27407	.26287	.28622	.23897	.22158	.44883	24
25	.48005	.65426	.26455	.74954	.26999	.21162	.27171	.22589	.20645	.48005	25
26	.51120	.67553	.26078	.72136	.25785	.19598	.24996	.20629	.18899	.51120	26
27	.54229	.69645	.24914	.60254	.23878	.19598	.22329	.18232	.16912	.54229	27
28	.57331	.68687	.23099	.39523	.21459	.18325	.19445	.15654	.14783	.57331	28
29	.60425	.60608	.20839	.21443	.18732	.15580	.16532	.13012	.12622	.60425	29
30	.63513	.45758	.18349	.14450	.15890	.12807	.13686	.10440	.10485	.63513	30
31	.66594	.30778	.15799	.13224	.13090	.10206	.10980	.08074	.08420	.66594	31
32	.69667	.20197	.13288	.11721	.10429	.07663	.08460	.06004	.06517	.69667	32
33	.72734	.13785	.10829	.09307	.07927	.05258	.06127	.04202	.04825	.72724	33
34	.75793	.09804	.08363	.06699	.05539	.02952	.03910	.02530	.03275	.75793	34
35	.78844	.06996	.05731	.03937	.03115	.00602	.01670	.00864	.01650	.78844	35
36	.81889	.04193	.02787	.00989	.00489	-.01948	-.00771	-.00881	-.00197	.81889	36
37	.84926	.00377	-.00823	-.02539	-.02722	-.05040	-.03749	-.03114	-.02531	.84926	37
38	.87955	-.04194	-.05086	-.06627	-.06576	-.08708	-.07373	-.05849	-.05424	.87955	38
39	.90978	-.10344	-.10776	-.12289	-.11938	-.13871	-.12450	-.10165	-.10082	.90978	39
40	.93993	-.16410	-.16798	-.17938	-.17693	-.18972	-.17865	-.11277	-.14470	.93993	40
41	.97000	-.29206	-.28369	-.30645	-.29396	-.31521	-.29379	-.26540	-.28031	.97000	41
42	1.00000	-.38510	-.38510	-.39425	-.39425	-.39016	-.39016	-.34113	-.34113	1.00000	42
		UPPER SURFACE	LOWER								

Figure 7-A-13

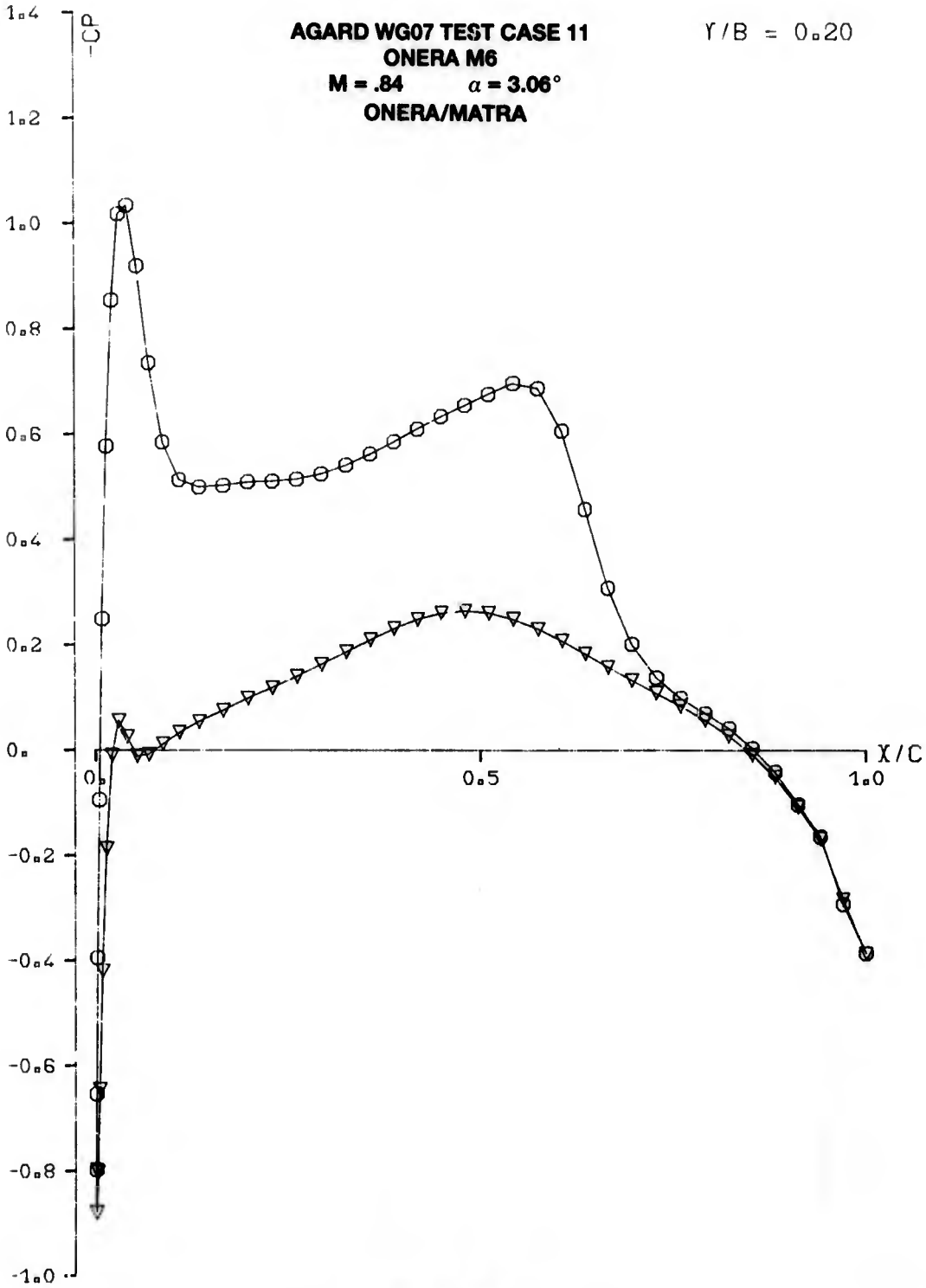

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
ONERA/MATRA
Y/B = 0.20
-CP
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.
-0.2
-0.4
-0.6
-0.8
-1.0
0.
0.5
1.0
X/C

Figure 7-A-14

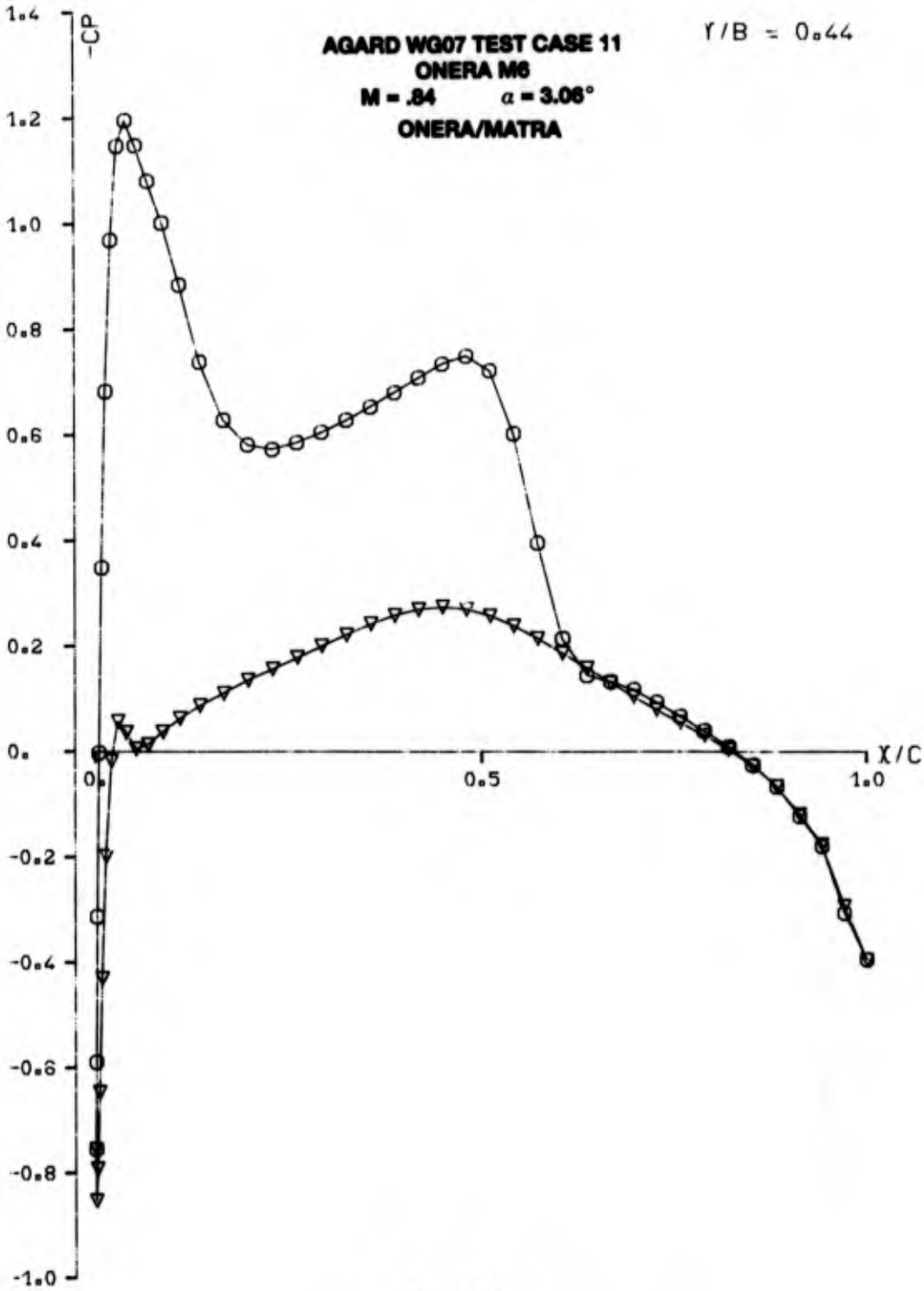

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
ONERA/MATRA
Y/B = 0.44
-CP
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.
-0.2
-0.4
-0.6
-0.8
-1.0
0.
0.5
1.0
X/C

Figure 7-A-15

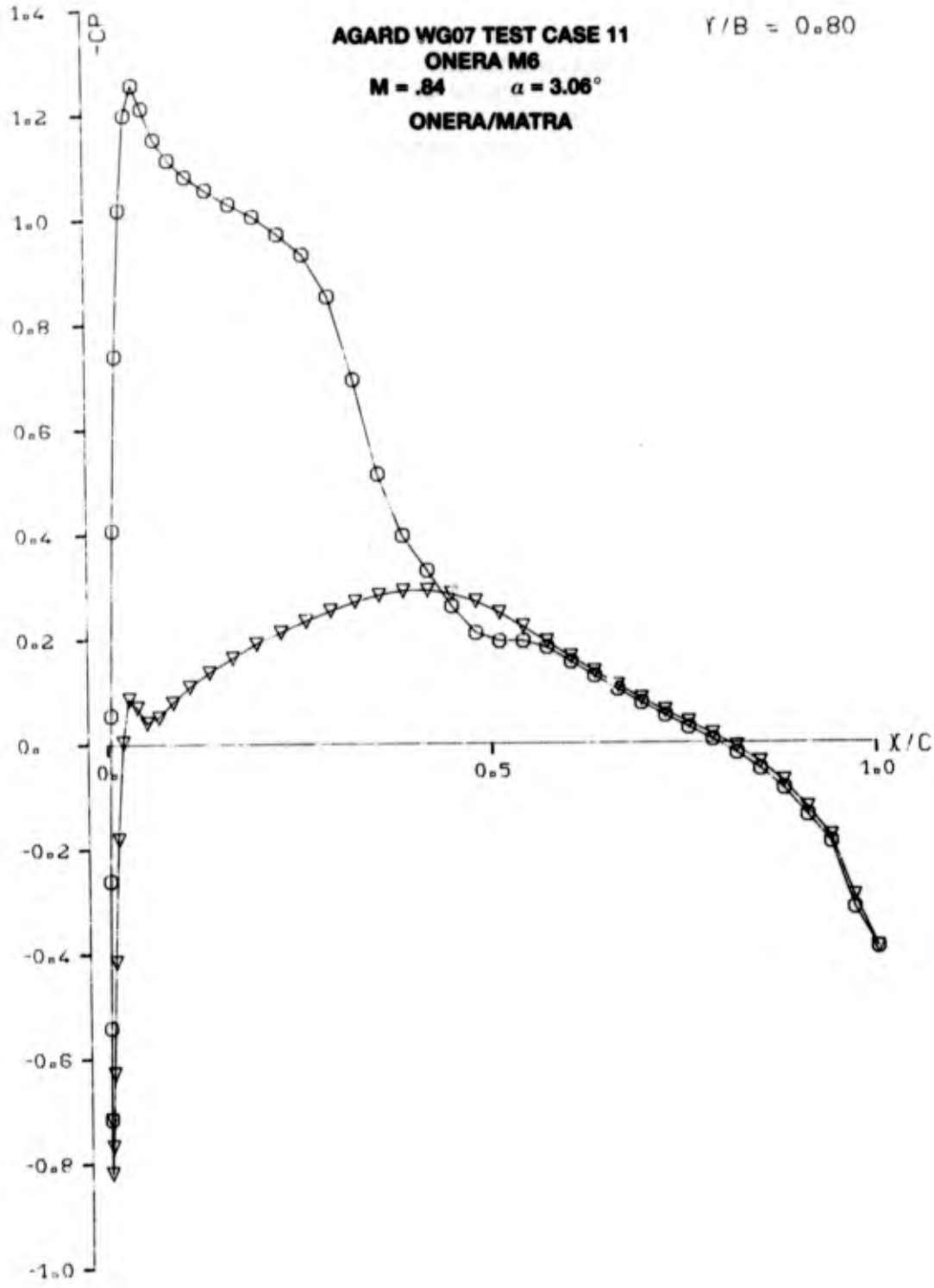

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
ONERA/MATRA
t/B = 0.80
-CP
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.
-0.2
-0.4
-0.6
-0.8
-1.0
0.5
1.0
X/C

Figure 7-A-16

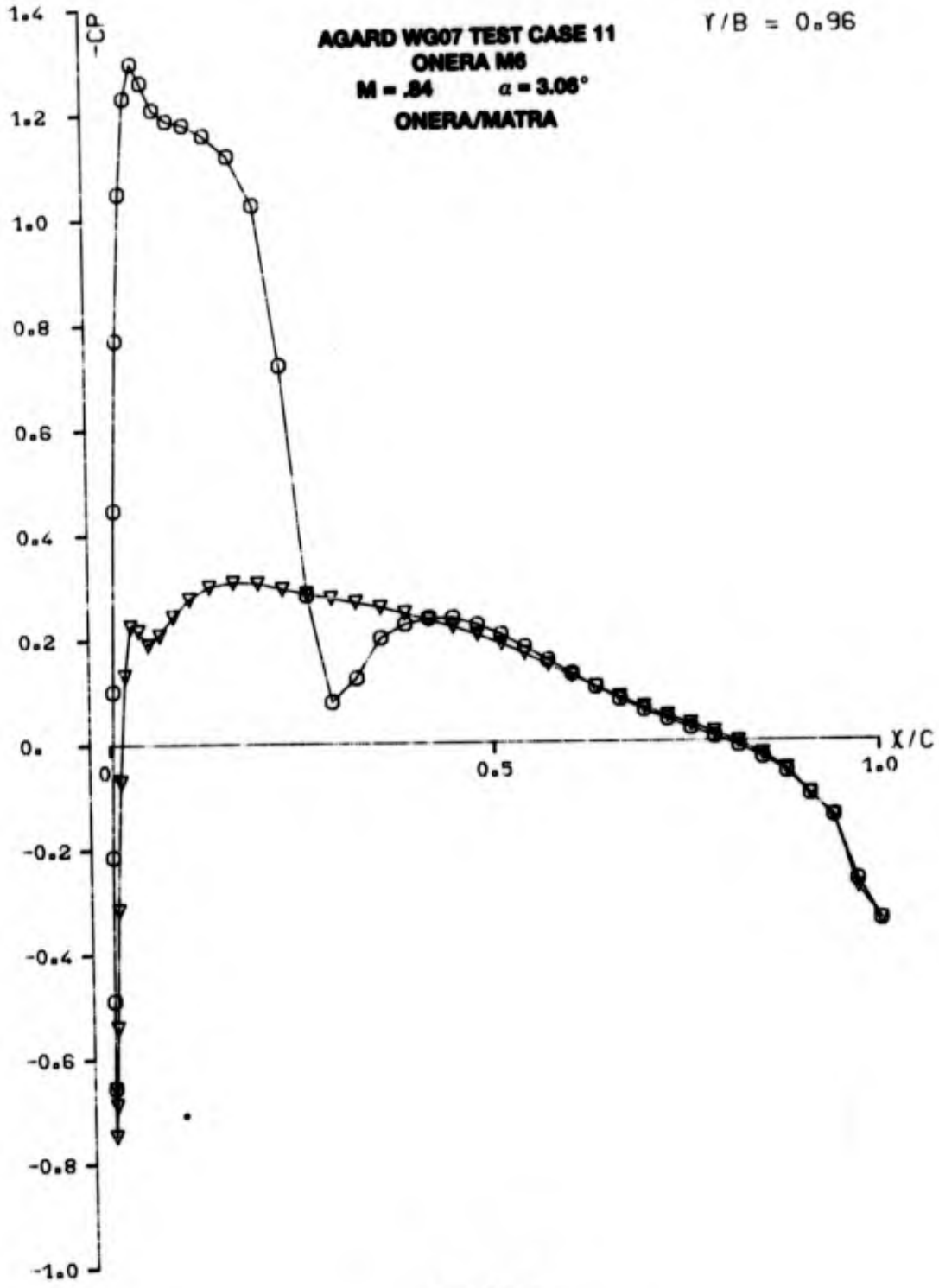

AGARD WG07 TEST CASE 11
ONERA M6
M = .84 α = 3.06°
ONERA/MATRA
Y/B = 0.96
-CP
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.
-0.2
-0.4
-0.6
-0.8
-1.0
0
0.5
1.0
X/C

Figure 7-A-17

AGARD WG07 TEST CASE 12
ONERA M6
M = .92 $\alpha = 0°$
ONERA/MATRA (1a)

y/b = .10

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.33301	.09298	.01931	-.95859
2	.00040	.36308	.10526	.01878	-.92276
3	.00178	.45736	.15788	.02712	-.76923
4	.00433	.58387	.23175	.03158	-.55371
5	.00814	.72790	.32231	.03539	-.28948
6	.01327	.87055	.41354	.03867	-.02330
7	.01983	.99532	.49100	.04171	.20270
8	.02796	1.05932	.52939	.04417	.31473
9	.03787	1.04251	.51840	.04131	.28266
10	.04983	.98477	.48320	.03869	.17994
11	.06416	.96208	.46909	.03780	.13879
12	.08126	.96465	.47059	.03772	.14317
13	.10160	.97204	.47461	.03696	.15488
14	.12573	.98154	.47972	.03589	.16981
15	.15433	.99155	.48497	.03453	.18512
16	.18817	1.00253	.49063	.03286	.20162
17	.22817	1.01471	.49691	.03107	.21996
18	.27544	1.03084	.50531	.02887	.24445
19	.32281	1.05279	.51733	.02725	.27954
20	.36905	1.07675	.53053	.02591	.31805
21	.41417	1.10123	.54395	.02479	.35719
22	.45818	1.12452	.55662	.02391	.39416
23	.50109	1.14521	.56769	.02310	.42648
24	.54294	1.16208	.57663	.02247	.45255
25	.58374	1.17495	.58324	.02171	.47184
26	.62352	1.18385	.58771	.02101	.48489
27	.66230	1.18980	.59048	.02004	.49296
28	.70010	1.19375	.59227	.01930	.49818
29	.73694	1.19819	.59420	.01828	.50381
30	.77285	1.20518	.59747	.01726	.51335
31	.80786	1.20823	.59875	.01646	.51710
32	.84197	1.17038	.58295	.02698	.47099
33	.87523	1.06865	.53493	.04545	.33088
34	.90763	.91929	.45334	.05664	.09282
35	.93922	.79623	.36943	.04253	-.15199
36	.97000	.68910	.30435	.04435	-.34187
37	1.00000	.66017	.26552	.01596	-.45518

y/b = .50

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.45255	.13880	.00889	-.82490
2	.00040	.47875	.15339	.00960	-.78234
3	.00178	.56572	.20878	.01688	-.62072
4	.00433	.70026	.29428	.02087	-.37125
5	.00814	.85821	.39481	.02105	-.07793
6	.01327	.99978	.48766	.03043	.19295
7	.01983	1.15857	.57709	.02795	.45390
8	.02796	1.26117	.62737	.02042	.60060
9	.03787	1.24859	.61869	.01444	.57528
10	.04983	1.13596	.56065	.01890	.40594
11	.06416	1.07171	.52449	.01948	.30041
12	.08126	1.07392	.52590	.01974	.30454
13	.10160	1.08502	.53198	.01907	.32227
14	.12573	1.09145	.53539	.01848	.33222
15	.15433	1.09652	.53804	.01784	.33994
16	.18817	1.10198	.54080	.01720	.34802
17	.22817	1.10863	.54428	.01654	.35817
18	.27544	1.12059	.55046	.01526	.37620
19	.32281	1.14193	.56205	.01448	.41002
20	.36905	1.16755	.57588	.01388	.45037
21	.41417	1.19440	.59020	.01353	.49215
22	.45818	1.22036	.60375	.01317	.53167
23	.50109	1.24331	.61559	.01317	.56624
24	.54294	1.26221	.62506	.01288	.59385
25	.58374	1.27646	.63220	.01300	.61470
26	.62352	1.28575	.63668	.01270	.62775
27	.66230	1.28996	.63890	.01312	.63423
28	.70010	1.29606	.64087	.01037	.63999
29	.73694	1.23114	.61584	.02945	.56696
30	.77285	1.06322	.53927	.05993	.34355
31	.80786	.88753	.43407	.05610	.03661
32	.84197	.80794	.37589	.04113	-.13315
33	.87523	.79034	.36371	.03928	-.16868
34	.90763	.76957	.35129	.04013	-.20493
35	.93922	.74365	.33464	.03945	-.25349
36	.97000	.67511	.29682	.04573	-.36384
37	1.00000	.65171	.26659	.02437	-.45207

Figure 7-A-18

AGARD WG07 TEST CASE 12
ONERA M6
M = .92 $\alpha = 0°$
ONERA/MATRA (1a)

y/b = .80

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.46340	.14768	.01254	-.79898
2	.00040	.48933	.16277	.01384	-.75497
3	.00178	.57543	.21656	.01944	-.59802
4	.00433	.71923	.30997	.02611	-.32548
5	.00814	.88678	.41645	.02702	-.01480
6	.01327	1.01054	.50251	.04660	.23630
7	.01983	1.17748	.59584	.04816	.50861
8	.02796	1.30261	.65379	.03735	.67768
9	.03787	1.33306	.66245	.02150	.70295
10	.04983	1.23401	.61513	.02413	.56488
11	.06416	1.11010	.55187	.03113	.38032
12	.08126	1.08975	.54048	.03121	.34706
13	.10160	1.11476	.55375	.02953	.38579
14	.12573	1.12985	.56168	.02857	.40894
15	.15433	1.13795	.56589	.02801	.42121
16	.18817	1.14513	.56947	.02722	.43166
17	.22817	1.15320	.57353	.02646	.44351
18	.27544	1.16585	.57975	.02500	.46166
19	.32281	1.18849	.59142	.02398	.49571
20	.36905	1.21731	.60608	.02288	.53846
21	.41417	1.24866	.62189	.02235	.58460
22	.45818	1.27979	.63709	.02163	.62895
23	.47902	1.29340	.64366	.02159	.64812
24	.50109	1.30798	.65069	.02157	.66863
25	.54294	1.33241	.66216	.02150	.70210
26	.58374	1.34812	.66971	.02241	.72413
27	.62352	1.35396	.67271	.02337	.73290
28	.66230	1.22747	.62799	.06548	.60241
29	.70010	.97600	.51111	.10146	.26139
30	.73694	.79466	.39510	.08298	-.07711
31	.77285	.75926	.36549	.07038	-.16350
32	.80786	.77055	.37406	.07296	-.13849
33	.84197	.76012	.36681	.07156	-.15964
34	.87523	.74809	.36030	.07264	-.17865
35	.90763	.72565	.34643	.07212	-.21911
36	.93922	.69978	.33198	.07356	-.26127
37	.97000	.63832	.29736	.07570	-.36227
38	1.00000	.61212	.27028	.06028	-.44128

Figure 7-A-19

AGARD WG07 TEST CASE 12
ONERA M6
M = .92 $\alpha = 0°$
ONERA/MATRA (1b)

y/b = 0.10

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.41288	.10776	-.00359	-.91548
2	.00040	.43939	.12136	-.00347	-.87579
3	.00178	.52443	.17398	.00354	-.72225
4	.00433	.64608	.24884	.00536	-.50384
5	.00814	.78937	.34050	.00513	-.23641
6	.01327	.93358	.43185	.00302	.03012
7	.01983	1.05805	.50678	-.00009	.24876
8	.02796	1.11331	.53791	-.00275	.33957
9	.03787	1.08016	.51726	-.00561	.27933
10	.04983	1.02068	.48008	-.00832	.17086
11	.06416	.99971	.46679	-.00897	.13208
12	.08126	1.00331	.46915	-.00872	.13897
13	.10160	1.01060	.47351	-.00903	.15168
14	.12573	1.01867	.47823	-.00953	.16546
15	.15433	1.02711	.48310	-.01016	.17966
16	.18817	1.03624	.48832	-.01091	.19488
17	.22817	1.04681	.49443	-.01156	.21272
18	.27544	1.06161	.50276	-.01285	.23701
19	.32281	1.08194	.51462	-.01350	.27163
20	.36905	1.10486	.52792	-.01402	.31044
21	.41417	1.12842	.54146	-.01442	.34992
22	.45818	1.15092	.55421	-.01469	.38714
23	.50109	1.17085	.56535	-.01491	.41963
24	.54294	1.18709	.57431	-.01504	.44579
25	.58374	1.19927	.58092	-.01526	.46506
26	.62352	1.20742	.58535	-.01527	.47799
27	.66230	1.21282	.58812	-.01566	.48607
28	.70010	1.21634	.59010	-.01545	.49186
29	.73694	1.22040	.59195	-.01630	.49726
30	.77285	1.22384	.59430	-.01505	.50412
31	.80786	1.23391	.59895	-.01681	.51767
32	.84197	1.26108	.61166	-.02093	.55475
33	.87523	1.25957	.60967	-.02344	.54896
34	.90763	1.08313	.52503	.00953	.30201
35	.93922	.85641	.38503	.00776	-.10649
36	.97000	.71940	.29541	.00540	-.36795
37	1.00000	.69938	.26566	-.01806	-.45478

y/b = .50

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.44966	.13154	.00227	-.84610
2	.00040	.47642	.14784	.00458	-.79853
3	.00178	.56376	.20422	.01265	-.63404
4	.00433	.69923	.28990	.01569	-.38404
5	.00814	.85757	.39130	.01602	-.08819
6	.01327	1.00346	.48606	.02322	.18829
7	.01983	1.16668	.57805	.02002	.45669
8	.02796	1.29129	.63564	.00255	.62471
9	.03787	1.27323	.62318	-.00646	.58836
10	.04983	1.13547	.55319	.00283	.38415
11	.06416	1.07124	.51705	.00170	.27873
12	.08126	1.08239	.52348	.00446	.29747
13	.10160	1.09573	.53062	.00315	.31830
14	.12573	1.10243	.53389	.00185	.32785
15	.15433	1.10782	.53639	.00052	.33514
16	.18817	1.11403	.53928	-.00096	.34358
17	.22817	1.12192	.54319	-.00233	.35498
18	.27544	1.13502	.54973	-.00440	.37408
19	.32281	1.15621	.56107	-.00583	.40715
20	.36905	1.18194	.57489	-.00693	.44747
21	.41417	1.20928	.58938	-.00783	.48976
22	.45818	1.23565	.60316	-.00844	.52995
23	.50109	1.25931	.61521	-.00910	.56512
24	.54294	1.27836	.62487	-.00927	.59330
25	.58374	1.29309	.63196	-.01012	.61399
26	.62352	1.30229	.63671	-.00959	.62786
27	.66230	1.30864	.63908	-.01176	.63475
28	.70010	1.30383	.63840	-.00702	.63278
29	.73694	1.32333	.64507	-.01504	.65223
30	.77285	1.36234	.65838	-.03107	.69108
31	.80786	1.13318	.56248	.02703	.41126
32	.84197	.86781	.39828	.01783	-.06783
33	.87523	.78828	.33646	.00017	-.24820
34	.90763	.79260	.34403	.00738	-.22610
35	.93922	.76387	.32521	.00698	-.28102
36	.97000	.69905	.28856	.01399	-.38795
37	1.00000	.67435	.25729	-.00727	-.47918

Figure 7-A-20

AGARD WG07 TEST CASE 12
ONERA M6
M = .92 $\alpha = 0°$

ONERA/MATRA (1b)

y/b = .80

N	X/C	MACH	1-P/PIINF	1-PI/PIINF	-CP
1	0.00000	.46212	.13694	.00089	-.83032
2	.00040	.48880	.15421	.00409	-.77996
3	.00178	.57571	.21071	.01191	-.61508
4	.00433	.72049	.30445	.01718	-.34159
5	.00814	.88858	.41218	.01800	-.02726
6	.01327	1.01481	.49912	.03526	.22639
7	.01983	1.17641	.59151	.03927	.49596
8	.02796	1.32963	.66099	.02183	.69868
9	.03787	1.41310	.68593	-.01806	.77145
10	.04983	1.27997	.62712	-.00509	.59987
11	.06416	1.10727	.54131	.01185	.34951
12	.08126	1.09052	.53208	.01258	.32258
13	.10160	1.12676	.55173	.01036	.37990
14	.12573	1.14717	.56235	.00854	.41088
15	.15433	1.15557	.56641	.00719	.42273
16	.18817	1.16219	.56935	.00555	.43131
17	.22817	1.17089	.57342	.00388	.44319
18	.27544	1.18530	.58025	.00144	.46312
19	.32281	1.20886	.59212	-.00057	.49775
20	.36905	1.23844	.60700	-.00242	.54116
21	.41417	1.27074	.62305	-.00387	.58800
22	.45818	1.30328	.63878	-.00532	.63388
23	.47902	1.31785	.64566	-.00588	.65395
24	.50109	1.33349	.65303	-.00644	.67547
25	.54294	1.35732	.66426	-.00646	.70824
26	.58374	1.37973	.67360	-.00953	.73548
27	.62352	1.38152	.67669	-.00251	.74451
28	.66230	1.42436	.68951	-.02237	.78190
29	.70010	1.40953	.68468	-.01568	.76780
30	.73694	1.02001	.51486	.06570	.27234
31	.77285	.75882	.33870	.03188	-.24165
32	.80786	.76282	.33868	.02793	-.24172
33	.84197	.78387	.35647	.03450	-.18982
34	.87523	.76388	.34197	.03166	-.23210
35	.90763	.74935	.33269	.03148	-.25919
36	.93922	.72471	.31786	.03239	-.30246
37	.97000	.66791	.28551	.03639	-.39685
38	1.00000	.64215	.25750	.02016	-.47858

Figure 7-A-21

AGARD WG07 TEST CASE 12
ONERA M6

FFA (3)

CHORD SECTION YZ = .077

M = .92 $\alpha = 0°$

I	X/C	1-P/PINF	CP	MACH	1-PI/PIINF	I	X/C	1-P/PINF	CP	MACH	1-PI/PIINF
1	.999150	.261206	-.467761	.644178	.030856	49	.000434	.105876	-.920967	.406667	-.003403
2	.995821	.288685	-.387587	.652148	.030877	50	.002169	.167135	-.742231	.497686	.004039
3	.989339	.319969	-.296307	.694912	.032454	51	.005633	.259995	-.471293	.631846	.006018
4	.979913	.337354	-.245583	.743659	.025330	52	.010819	.358279	-.184531	.768042	.002175
5	.967745	.354343	-.196015	.773778	.030137	53	.017712	.445497	.069945	.889810	-.000300
6	.953034	.378506	-.125514	.811799	.029892	54	.026295	.495839	.216830	.969782	.009622
7	.935976	.422660	.003315	.867150	.037109	55	.036544	.496805	.219647	.988920	.021735
8	.916760	.514029	.269900	1.007221	.044026	56	.048433	.469423	.139755	.962038	.025109
9	.895571	.600201	.521326	1.180239	.034181	57	.061930	.451921	.088692	.940672	.023509
10	.872590	.617875	.572893	1.238673	.019274	58	.076999	.454426	.095997	.943900	.023717
11	.847994	.604511	.533902	1.214352	.021588	59	.093599	.459772	.111596	.952335	.024066
12	.821954	.595387	.507280	1.194901	.023071	60	.111685	.464397	.125091	.960446	.024160
13	.794637	.594532	.504786	1.192835	.023168	61	.131207	.469258	.139273	.968914	.024265
14	.766207	.593304	.501204	1.190958	.023004	62	.152112	.474121	.153461	.977366	.024362
15	.736821	.589742	.490811	1.184336	.023014	63	.174339	.478933	.167501	.985740	.024414
16	.706633	.587701	.484854	1.179788	.023684	64	.197826	.483697	.181402	.994012	.024461
17	.675793	.586402	.481065	1.177116	.023560	65	.222505	.488712	.196033	1.002640	.024435
18	.644445	.584572	.475726	1.172841	.024002	66	.248304	.494314	.212380	1.012118	.024398
19	.612730	.581783	.467588	1.167004	.023991	67	.275146	.500551	.230576	1.022607	.024301
20	.580782	.577953	.456413	1.158937	.024324	68	.302950	.507563	.251037	1.034345	.024186
21	.548733	.572888	.441636	1.148938	.024331	69	.331629	.515326	.273687	1.047359	.024063
22	.516710	.566532	.423089	1.136617	.024550	70	.361093	.523762	.298299	1.061606	.023924
23	.484835	.559059	.401286	1.122712	.024599	71	.391247	.532661	.324263	1.076790	.023820
24	.453224	.550696	.376884	1.107467	.024766	72	.421992	.541752	.350789	1.092597	.023675
25	.421992	.541779	.350867	1.091666	.024866	73	.453224	.550672	.376816	1.108376	.023598
26	.391247	.532686	.324338	1.075837	.025022	74	.484835	.559038	.401224	1.123615	.023432
27	.361093	.523785	.298366	1.060612	.025158	75	.516710	.566516	.423042	1.137511	.023399
28	.331629	.515340	.273726	1.046317	.025321	76	.548733	.572875	.441595	1.149837	.023172
29	.302950	.507564	.251038	1.033232	.025490	77	.580782	.577945	.456390	1.159835	.023176
30	.275146	.500531	.230517	1.021414	.025646	78	.612730	.581777	.467569	1.167916	.022825
31	.248304	.494270	.212249	1.010824	.025804	79	.644445	.584567	.475711	1.173747	.022844
32	.222505	.488646	.195841	1.001249	.025904	80	.675793	.586389	.481027	1.178028	.022373
33	.197826	.483614	.181159	.992512	.026014	81	.706633	.587700	.484851	1.180716	.022507
34	.174339	.478829	.167198	.984122	.026056	82	.736821	.589790	.490949	1.185398	.021778
35	.152112	.474000	.153110	.975617	.026112	83	.766207	.593308	.501214	1.191898	.021800
36	.131207	.469123	.138878	.967032	.026131	84	.794637	.594320	.504168	1.193404	.021935
37	.111685	.464262	.124696	.958435	.026163	85	.821954	.595416	.507364	1.196037	.021742
38	.093599	.459639	.111206	.950190	.026211	86	.847994	.604938	.535148	1.216182	.020236
39	.076999	.454263	.095523	.941580	.026001	87	.872590	.617573	.572012	1.239064	.018125
40	.061930	.451921	.088688	.938443	.025985	88	.895571	.599591	.519547	1.180274	.032879
41	.048433	.469640	.140387	.959921	.027872	89	.916760	.514696	.271847	1.009742	.042712
42	.036544	.496371	.218380	.985924	.024404	90	.935976	.423824	.006710	.870109	.035946
43	.026295	.494549	.213066	.965997	.011872	91	.953034	.379141	-.123662	.813840	.028692
44	.017712	.444057	.065744	.886246	.001561	92	.967745	.354508	-.195533	.775477	.028660
45	.010819	.357553	-.186650	.765504	.003813	93	.979913	.337315	-.245699	.744992	.024001
46	.005633	.260188	-.470731	.630074	.007914	94	.989339	.319738	-.296982	.696181	.031250
47	.002169	.166691	-.743528	.496415	.004496	95	.995821	.289272	-.385873	.654272	.029647
48	.000434	.105450	-.922211	.406375	-.003704	96	.999150	.261225	-.467705	.645676	.029410

Figure 7-A-22

AGARD WG07 TEST CASE 12
ONERA M6

FFA (3)

M = .92 $\alpha = 0°$

CHORD SECTION YZ = .468

I	X/C	1-P/PINF +	CP	MACH	1-PI/PIINF
1	.999150	.250445	-.499157	.619304	.036299
2	.995821	.273773	-.431095	.624846	.036584
3	.989339	.300637	-.352714	.661905	.038031
4	.979913	.313174	-.316133	.703126	.031061
5	.967745	.322866	-.287856	.724580	.033541
6	.953034	.333579	-.256597	.746794	.030915
7	.935976	.345183	-.222741	.764645	.031900
8	.916760	.356932	-.188462	.785097	.030519
9	.895571	.367932	-.156365	.802565	.030895
10	.872590	.376710	-.130754	.816895	.029351
11	.847994	.407575	-.040699	.855959	.033992
12	.821954	.502558	.236431	.997856	.044989
13	.794637	.610297	.550784	1.209984	.029326
14	.766207	.641968	.643190	1.296011	.008443
15	.736821	.634606	.621709	1.280169	.011925
16	.706633	.632780	.616381	1.275060	.013256
17	.675793	.635511	.624350	1.280836	.012414
18	.644445	.633585	.618731	1.276554	.012212
19	.612730	.629944	.608106	1.268344	.012358
20	.580782	.627091	.599784	1.261675	.012537
21	.548733	.621790	.584316	1.250709	.012074
22	.516710	.614701	.563632	1.235826	.012538
23	.484835	.606520	.539762	1.219809	.012255
24	.453224	.597428	.513234	1.202020	.012647
25	.421992	.587730	.484940	1.183979	.012541
26	.391247	.577990	.456522	1.165913	.012954
27	.361093	.568602	.429128	1.149139	.012993
28	.331629	.559962	.403919	1.133621	.013460
29	.302950	.552343	.381692	1.120246	.013673
30	.275146	.545943	.363017	1.108777	.014214
31	.248304	.540842	.348135	1.099633	.014601
32	.222505	.536952	.336784	1.092270	.015237
33	.197826	.534090	.328434	1.086558	.015809
34	.174339	.531699	.321457	1.081354	.016549
35	.152112	.529356	.314621	1.076173	.017294
36	.131207	.527173	.308252	1.071018	.018254
37	.111685	.524873	.301540	1.065464	.019272
38	.093599	.520484	.288735	1.056371	.020234
39	.076999	.514835	.272254	1.046614	.020951
40	.061930	.523540	.297652	1.059976	.024554
41	.048433	.560418	.405251	1.113635	.028814
42	.036544	.589083	.488887	1.143698	.022503
43	.026295	.576040	.450832	1.099729	.007968
44	.017712	.512344	.264985	.990034	.001222
45	.010819	.414618	-.020151	.848469	.006009
46	.005633	.308046	-.331095	.699738	.012085
47	.002169	.208522	-.621476	.560604	.010122
48	.000434	.144504	-.808264	.471228	.002651

I	X/C	1-P/PINF +	CP	MACH	1-PI/PIINF
49	.000434	.145017	-.806765	.471346	.003157
50	.002169	.209012	-.620049	.561514	.009911
51	.005633	.307793	-.331834	.700802	.010593
52	.010819	.415136	-.018638	.850153	.004832
53	.017712	.513715	.268985	.992888	.000036
54	.026295	.577607	.455403	1.103534	.006201
55	.036544	.590059	.491735	1.147089	.020397
56	.048433	.559799	.403446	1.114617	.026354
57	.061930	.522491	.294592	1.060148	.022180
58	.076999	.514597	.271559	1.047902	.018872
59	.093599	.520548	.288921	1.058076	.018295
60	.111685	.524823	.301396	1.066920	.017411
61	.131207	.527104	.308050	1.072352	.016487
62	.152112	.529317	.314508	1.077491	.015605
63	.174339	.531671	.321376	1.082626	.014937
64	.197826	.534057	.328338	1.087773	.014251
65	.222505	.536918	.336684	1.093428	.013740
66	.248304	.540809	.348037	1.100753	.013146
67	.275146	.545913	.362930	1.109859	.012807
68	.302950	.552317	.381613	1.121299	.012297
69	.331629	.559939	.403854	1.134644	.012121
70	.361093	.568581	.429068	1.150137	.011677
71	.391247	.577974	.456475	1.166889	.011664
72	.421992	.587716	.484897	1.184935	.011268
73	.453224	.597417	.513204	1.202962	.011390
74	.484835	.606513	.539743	1.220742	.011010
75	.516710	.614700	.563629	1.236758	.011300
76	.548733	.621788	.584310	1.251628	.010844
77	.580782	.627086	.599769	1.262587	.011307
78	.612730	.629941	.608098	1.269250	.011138
79	.644445	.633641	.618893	1.277608	.010949
80	.675793	.635480	.624261	1.281659	.011226
81	.706633	.632726	.616224	1.275916	.011971
82	.736821	.634692	.621961	1.281277	.010673
83	.766207	.641891	.642966	1.296791	.007225
84	.794637	.611151	.553274	1.213007	.027723
85	.821954	.504698	.242676	1.002617	.043732
86	.847994	.408808	-.037101	.858811	.032944
87	.872590	.376818	-.130438	.818297	.028026
88	.895571	.367679	-.157105	.803742	.029364
89	.916760	.356919	-.188499	.786548	.029137
90	.935976	.345108	-.222960	.766203	.030326
91	.953034	.333489	-.256859	.748228	.029457
92	.967745	.322697	-.288347	.726185	.031854
93	.979913	.312982	-.316694	.704507	.029578
94	.989339	.300297	-.353706	.663468	.036489
95	.995821	.274362	-.429375	.627382	.034980
96	.999150	.249726	-.501255	.621170	.034352

Figure 7-A-23

AGARD WG07 TEST CASE 12
ONERA M6

FFA (3)

M = .92 $\alpha = 0°$

CHORD SECTION YZ = .816

I	X/C	1-P/PINF ,	CP	MACH	1-PI/PIINF
1	.999150	.250740	-.498299	.592445	.056567
2	.995821	.272245	-.435553	.597029	.057200
3	.989339	.296990	-.363355	.632396	.058540
4	.979913	.308043	-.331104	.671130	.052269
5	.967745	.316232	-.307210	.690523	.054407
6	.953034	.325179	-.281107	.710143	.052027
7	.935976	.334674	-.253403	.725218	.052871
8	.916760	.343524	-.227581	.741472	.051574
9	.895571	.351679	-.203787	.754535	.051939
10	.872590	.357883	-.185685	.765815	.051102
11	.847994	.363172	-.170254	.774310	.051445
12	.821954	.366457	-.160671	.780605	.051138
13	.794637	.363752	-.168562	.777330	.049880
14	.766207	.378615	-.125197	.795287	.053220
15	.736821	.453391	.092978	.898001	.070351
16	.706633	.587111	.483135	1.139383	.065801
17	.675793	.667853	.718715	1.341032	.020532
18	.644445	.680708	.756221	1.377774	.009988
19	.612730	.672522	.732336	1.355693	.014446
20	.580782	.669037	.722168	1.347483	.014027
21	.548733	.663967	.707375	1.336043	.013479
22	.516710	.655412	.682415	1.317302	.013274
23	.484835	.647301	.658751	1.299389	.013990
24	.453224	.637591	.630419	1.279714	.013387
25	.421992	.627137	.599917	1.258117	.014255
26	.391247	.616615	.569217	1.237725	.014139
27	.361093	.606414	.539453	1.217813	.014863
28	.331629	.596982	.511934	1.200110	.015081
29	.302950	.588641	.487597	1.184307	.015760
30	.275146	.581687	.467307	1.171352	.016182
31	.248304	.576133	.451104	1.160717	.016860
32	.222505	.571766	.438360	1.152199	.017445
33	.197826	.568246	.428089	1.144904	.018194
34	.174339	.565092	.418889	1.138131	.018915
35	.152112	.561943	.409702	1.131157	.019816
36	.131207	.558406	.399380	1.123310	.020781
37	.111685	.552827	.383102	1.111697	.021763
38	.093599	.544292	.358200	1.095404	.022543
39	.076999	.539804	.345104	1.087463	.023869
40	.061930	.556794	.394676	1.115172	.028668
41	.048433	.596411	.510268	1.176607	.031471
42	.036544	.617063	.570525	1.193110	.023230
43	.026295	.596030	.509157	1.132782	.008559
44	.017712	.527272	.308540	1.012399	.002318
45	.010819	.426541	.014639	.865580	.006827
46	.005633	.317840	-.302520	.714270	.012487
47	.002169	.217370	-.595661	.574701	.010552
48	.000434	.153050.	-.783328	.485953	.003217
49	.000434	.153562	-.781835	.486099	.003705
50	.002169	.217904	-.594105	.575631	.010373
51	.005633	.317633	-.303123	.715372	.011000
52	.010819	.427018	.016030	.867270	.005559
53	.017712	.528593	.312394	1.015258	.001045
54	.026295	.597663	.513921	1.136833	.006647
55	.036544	.618455	.574586	1.197393	.020972
56	.048433	.596328	.510025	1.178556	.028948
57	.061930	.555581	.391137	1.115014	.026251
58	.076999	.539041	.342879	1.087926	.021626
59	.093599	.544211	.357964	1.096886	.020500
60	.111685	.552897	.383306	1.113386	.019815
61	.131207	.558354	.399229	1.124716	.018917
62	.152112	.561835	.409386	1.132391	.018030
63	.174339	.564996	.418608	1.139319	.017202
64	.197826	.568166	.427856	1.146066	.016546
65	.222505	.571688	.438132	1.153312	.015857
66	.248304	.576052	.450867	1.161777	.015324
67	.275146	.581604	.467066	1.172365	.014691
68	.302950	.588559	.487358	1.185280	.014310
69	.331629	.596912	.511729	1.201066	.013666
70	.361093	.606362	.539301	1.218771	.013475
71	.391247	.616583	.569123	1.238691	.012775
72	.421992	.627126	.599884	1.259103	.012905
73	.453224	.637596	.630434	1.280710	.012057
74	.484835	.647325	.658819	1.300416	.012659
75	.516710	.655441	.682501	1.318316	.011973
76	.548733	.664020	.707532	1.337124	.012150
77	.580782	.669096	.722340	1.348536	.012752
78	.612730	.672532	.732366	1.356665	.013137
79	.644445	.680737	.756307	1.378741	.008735
80	.675793	.668217	.719775	1.342907	.019096
81	.706633	.589141	.489055	1.144780	.064014
82	.736821	.455959	.100471	.903012	.069597
83	.766207	.379539	-.122501	.797572	.052378
84	.794637	.363436	-.169484	.778177	.048575
85	.821954	.366150	-.161567	.781506	.049856
86	.847994	.363126	-.170388	.775663	.050141
87	.872590	.357814	-.185888	.767113	.049808
88	.895571	.351600	-.204019	.755981	.050520
89	.916760	.343497	-.227660	.742947	.050222
90	.935976	.334606	-.253602	.726854	.051343
91	.953034	.325127	-.281258	.711707	.050601
92	.967745	.316106	-.307578	.692278	.052749
93	.979913	.307916	-.331476	.672693	.050795
94	.989339	.296709	-.364175	.634153	.056971
95	.995821	.272843	-.433808	.599749	.055546
96	.999150	.249912	-.500714	.594446	.054585

Figure 7-A-24

AGARD WG07 TEST CASE 12
ONERA M6
M = .92 $\alpha = 0°$

$\eta = 0.122$

MBB (4)

$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M	$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M
0.9984	0.3236	0.0158	0.0001	0.3106	0.7317	0.0001	1.0724	-0.0652	0.0005	0.0540	0.4152
0.9921	0.3179	0.0150	-0.0002	0.3126	0.7356	0.0008	1.0295	-0.0721	-0.0047	0.0687	0.4529
0.9797	0.2965	0.0150	-0.0005	0.3199	0.7471	0.0026	0.8394	-0.0569	-0.0063	0.1338	0.5408
0.9616	0.2668	0.0153	-0.0009	0.3301	0.7627	0.0060	0.5429	-0.0318	-0.0064	0.2354	0.6666
0.9380	0.2341	0.0162	-0.0020	0.3413	0.7793	0.0113	0.1920	-0.0047	-0.0060	0.3557	0.8227
0.9095	0.1715	0.0217	-0.0041	0.3627	0.8071	0.0188	-0.1507	0.0179	-0.0060	0.4732	0.9869
0.8766	-0.2764	0.0366	0.0036	0.5163	1.0430	0.0289	-0.3743	0.0050	-0.0036	0.5498	1.1277
0.8396	-0.5277	-0.0027	-0.0003	0.6024	1.2298	0.0416	-0.2684	-0.0036	-0.0010	0.5135	1.0720
0.7993	-0.5109	-0.0024	-0.0003	0.5966	1.2187	0.0571	-0.1206	-0.0097	-0.0013	0.4629	0.9940
0.7562	-0.5002	-0.0022	-0.0002	0.5930	1.2116	0.0757	-0.1072	-0.0106	-0.0009	0.4583	0.9874
0.7109	-0.4975	-0.0019	-0.0002	0.5920	1.2096	0.0973	-0.1288	-0.0084	-0.0005	0.4657	0.9974
0.6638	-0.4932	-0.0015	-0.0001	0.5905	1.2066	0.1221	-0.1478	-0.0062	-0.0002	0.4722	1.0061
0.6157	-0.4832	-0.0010	-0.0001	0.5871	1.1999	0.1500	-0.1639	-0.0045	-0.0001	0.4777	1.0136
0.5670	-0.4647	-0.0005	-0.0001	0.5808	1.1878	0.1809	-0.1796	-0.0031	-0.0001	0.4831	1.0212
0.5184	-0.4368	-0.0001	-0.0001	0.5712	1.1700	0.2149	-0.1973	-0.0021	-0.0001	0.4891	1.0302
0.4702	-0.4009	0.0002	-0.0001	0.5589	1.1476	0.2518	-0.2189	-0.0013	-0.0002	0.4966	1.0418
0.4230	-0.3604	0.0003	-0.0001	0.5451	1.1231	0.2912	-0.2463	-0.0007	-0.0002	0.5059	1.0569
0.3772	-0.3189	0.0001	-0.0001	0.5308	1.0985	0.3331	-0.2800	-0.0002	-0.0002	0.5175	1.0760
0.3331	-0.2800	-0.0002	-0.0002	0.5175	1.0760	0.3772	-0.3189	0.0001	-0.0001	0.5308	1.0985
0.2912	-0.2463	-0.0007	-0.0002	0.5059	1.0569	0.4230	-0.3604	0.0003	-0.0001	0.5451	1.1231
0.2518	-0.2189	-0.0013	-0.0002	0.4966	1.0418	0.4702	-0.4009	0.0002	-0.0001	0.5589	1.1476
0.2149	-0.1973	-0.0021	-0.0001	0.4891	1.0302	0.5184	-0.4368	-0.0001	-0.0001	0.5712	1.1700
0.1809	-0.1796	-0.0031	-0.0001	0.4831	1.0212	0.5670	-0.4647	-0.0005	-0.0001	0.5808	1.1878
0.1500	-0.1639	-0.0045	-0.0001	0.4777	1.0136	0.6157	-0.4832	-0.0010	-0.0001	0.5871	1.1999
0.1221	-0.1478	-0.0062	-0.0002	0.4722	1.0061	0.6638	-0.4932	-0.0015	-0.0001	0.5905	1.2066
0.0973	-0.1288	-0.0084	-0.0005	0.4657	0.9974	0.7109	-0.4975	-0.0019	-0.0002	0.5920	1.2096
0.0757	-0.1072	-0.0106	-0.0009	0.4583	0.9874	0.7562	-0.5002	-0.0022	-0.0002	0.5930	1.2116
0.0571	-0.1206	-0.0097	-0.0013	0.4629	0.9940	0.7993	-0.5109	-0.0024	-0.0003	0.5966	1.2187
0.0416	-0.2684	-0.0036	-0.0010	0.5135	1.0720	0.8396	-0.5277	-0.0027	-0.0003	0.6024	1.2298
0.0289	-0.3743	0.0050	-0.0036	0.5498	1.1277	0.8766	-0.2763	0.0366	0.0036	0.5162	1.0429
0.0188	-0.1507	0.0179	-0.0060	0.4732	0.9869	0.9095	0.1715	0.0217	-0.0041	0.3627	0.8070
0.0113	0.1920	-0.0047	-0.0060	0.3557	0.8227	0.9380	0.2341	0.0162	-0.0020	0.3413	0.7795
0.0060	0.5429	-0.0318	-0.0064	0.2354	0.6686	0.9616	0.2668	0.0153	-0.0009	0.3301	0.7627
0.0026	0.8394	-0.0569	-0.0063	0.1338	0.5408	0.9797	0.2965	0.0150	-0.0005	0.3199	0.7471
0.0008	1.0295	-0.0721	-0.0047	0.0687	0.4529	0.9921	0.3179	0.0151	-0.0002	0.3126	0.7356
0.0001	1.0724	-0.0652	0.0005	0.0540	0.4152	0.9984	0.3236	0.0158	0.0001	0.3106	0.7317

Figure 7-A-25

AGARD WG07 TEST CASE 12
ONERA M6
M = .92 $\alpha = 0°$

η = 0.531

MBB (4)

$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M	$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M
0.9984	0.3347	0.0319	0.0009	0.3068	0.7076	0.0001	1.0087	-0.0658	0.0005	0.0758	0.4559
0.9921	0.3295	0.0313	0.0006	0.3086	0.7112	0.0008	0.9659	-0.0730	-0.0045	0.0905	0.4917
0.9797	0.3074	0.0316	0.0004	0.3162	0.7228	0.0026	0.7760	-0.0585	-0.0062	0.1556	0.5774
0.9616	0.2767	0.0322	0.0002	0.3267	0.7390	0.0060	0.4716	-0.0325	-0.0064	0.2599	0.7064
0.9380	0.2415	0.0329	0.0001	0.3388	0.7575	0.0113	0.1021	-0.0027	-0.0061	0.3865	0.8680
0.9095	0.2062	0.0336	-0.0002	0.3508	0.7759	0.0188	-0.2716	0.0217	-0.0057	0.5146	1.0528
0.8766	0.1803	0.0344	-0.0008	0.3597	0.7892	0.0289	-0.5446	0.0184	-0.0048	0.6082	1.2248
0.8396	0.1868	0.0342	-0.0028	0.3575	0.7858	0.0416	-0.5946	-0.0104	-0.0020	0.6253	1.2801
0.7993	0.1893	0.0396	-0.0065	0.3566	0.7787	0.0571	-0.3005	-0.0052	-0.0017	0.5245	1.0920
0.7562	-0.3483	0.0700	0.0052	0.5409	1.0571	0.0757	-0.2409	-0.0126	-0.0011	0.5041	1.0636
0.7109	-0.6819	-0.0037	-0.0002	0.6552	1.3361	0.0973	-0.2885	-0.0112	-0.0005	0.5204	1.0898
0.6638	-0.6600	-0.0027	-0.0001	0.6477	1.3197	0.1221	-0.3136	-0.0090	-0.0001	0.5290	1.1027
0.6157	-0.6417	-0.0019	-0.0001	0.6414	1.3062	0.1500	-0.3252	-0.0069	0.0001	0.5330	1.1079
0.5670	-0.6178	-0.0011	-0.0001	0.6333	1.2890	0.1809	-0.3343	-0.0051	0.0002	0.5361	1.1118
0.5184	-0.5846	-0.0004	-0.0001	0.6219	1.2659	0.2149	-0.3455	-0.0036	0.0002	0.5399	1.1172
0.4702	-0.5440	0.0000	-0.0002	0.6080	1.2385	0.2518	-0.3615	-0.0024	0.0001	0.5454	1.1259
0.4230	-0.4999	0.0000	-0.0002	0.5929	1.2098	0.2912	-0.3850	-0.0015	0.0000	0.5535	1.1393
0.3772	-0.4562	-0.0003	-0.0002	0.5779	1.1822	0.3331	-0.4170	-0.0008	-0.0001	0.5644	1.1582
0.3331	-0.4169	-0.0008	-0.0001	0.5644	1.1582	0.3772	-0.4562	-0.0003	-0.0002	0.5779	1.1822
0.2912	-0.3850	-0.0015	0.0000	0.5535	1.1393	0.4230	-0.4999	0.0000	-0.0002	0.5929	1.2098
0.2518	-0.3615	-0.0024	0.0001	0.5454	1.1259	0.4702	-0.5440	0.0000	-0.0002	0.6080	1.2385
0.2149	-0.3455	-0.0036	0.0002	0.5399	1.1172	0.5184	-0.5847	-0.0004	-0.0001	0.6219	1.2659
0.1809	-0.3343	-0.0051	0.0002	0.5361	1.1118	0.5670	-0.6178	-0.0011	-0.0001	0.6333	1.2890
0.1500	-0.3252	-0.0069	0.0001	0.5330	1.1078	0.6157	-0.6417	-0.0019	-0.0001	0.6414	1.3062
0.1221	-0.3136	-0.0090	-0.0001	0.5290	1.1027	0.6638	-0.6600	-0.0027	-0.0001	0.6477	1.3197
0.0973	-0.2885	-0.0112	-0.0005	0.5204	1.0898	0.7109	-0.6820	-0.0037	-0.0002	0.6553	1.3361
0.0757	-0.2408	-0.0126	-0.0011	0.5041	1.0636	0.7562	-0.3485	0.0700	0.0052	0.5410	1.0572
0.0571	-0.3005	-0.0052	-0.0017	0.5245	1.0920	0.7993	0.1894	0.0396	-0.0065	0.3566	0.7787
0.0416	-0.5946	-0.0105	-0.0020	0.6253	1.2801	0.8396	0.1868	0.0342	-0.0028	0.3575	0.7858
0.0289	-0.5446	0.0184	-0.0048	0.6082	1.2248	0.8766	0.1804	0.0344	-0.0008	0.3597	0.7891
0.0188	-0.2716	0.0217	-0.0057	0.5146	1.0528	0.9095	0.2063	0.0336	-0.0002	0.3508	0.7759
0.0113	0.1021	-0.0027	-0.0061	0.3865	0.8680	0.9380	0.2415	0.0329	0.0001	0.3387	0.7575
0.0060	0.4716	-0.0325	-0.0064	0.2599	0.7064	0.9616	0.2768	0.0322	0.0002	0.3266	0.7389
0.0026	0.7760	-0.0585	-0.0062	0.1556	0.5774	0.9797	0.3075	0.0316	0.0004	0.3161	0.7228
0.0008	0.9659	-0.0730	-0.0045	0.0905	0.4917	0.9921	0.3296	0.0313	0.0006	0.3086	0.7111
0.0001	1.0087	-0.0658	0.0005	0.0758	0.4559	0.9984	0.3347	0.0320	0.0009	0.3068	0.7075

Figure 7-A-26

AGARD WG07 TEST CASE 12
ONERA M6
M = .92 $\alpha = 0°$
MBB (4)

η = 0.776

$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M	$\frac{x}{c}$	c_p	$\frac{1-P_i}{P_{i_\infty}}$	$\frac{1-T_i}{T_{i_\infty}}$	$\frac{1-P}{P_{i_\infty}}$	M
0.9984	0.3229	0.0357	0.0019	0.3109	0.7097	0.0001	0.9994	-0.0676	0.0008	0.0790	0.4642
0.9921	0.3169	0.0349	0.0018	0.3129	0.7139	0.0008	0.9582	-0.0748	-0.0040	0.0931	0.4987
0.9797	0.2941	0.0351	0.0019	0.3207	0.7263	0.0026	0.7728	-0.0609	-0.0056	0.1567	0.5821
0.9616	0.2622	0.0353	0.0019	0.3317	0.7435	0.0060	0.4698	-0.0347	-0.0058	0.2605	0.7097
0.9380	0.2246	0.0356	0.0018	0.3445	0.7637	0.0113	0.0961	-0.0035	-0.0056	0.3886	0.8720
0.9095	0.1859	0.0359	0.0016	0.3578	0.7845	0.0188	-0.2856	0.0224	-0.0052	0.5194	1.0605
0.8766	0.1525	0.0362	0.0014	0.3693	0.8024	0.0289	-0.5744	0.0203	-0.0044	0.6184	1.2433
0.8396	0.1309	0.0357	0.0011	0.3767	0.8138	0.0416	-0.6713	-0.0120	-0.0019	0.6516	1.3345
0.7993	0.1326	0.0370	0.0002	0.3761	0.8125	0.0571	-0.4185	-0.0054	-0.0011	0.5650	1.1628
0.7562	0.1806	0.0355	-0.0022	0.3596	0.7879	0.0757	-0.2623	-0.0138	-0.0009	0.5114	1.0768
0.7109	0.1350	0.0494	-0.0041	0.3752	0.7981	0.0973	-0.3355	-0.0130	-0.0005	0.5365	1.1188
0.6638	-0.4543	0.0596	0.0065	0.5772	1.1327	0.1221	-0.3792	-0.0112	-0.0001	0.5515	1.1434
0.6157	-0.7208	-0.0042	-0.0001	0.6686	1.3649	0.1500	-0.3991	-0.0093	0.0002	0.5583	1.1540
0.5670	-0.7025	-0.0021	-0.0002	0.6623	1.3499	0.1809	-0.4119	-0.0075	0.0004	0.5627	1.1604
0.5184	-0.6664	-0.0013	-0.0002	0.6499	1.3232	0.2149	-0.4268	-0.0059	0.0004	0.5678	1.1683
0.4702	-0.6267	-0.0010	-0.0002	0.6363	1.2951	0.2518	-0.4463	-0.0045	0.0004	0.5745	1.1793
0.4230	-0.5847	-0.0011	-0.0002	0.6219	1.2664	0.2912	-0.4717	-0.0033	0.0002	0.5832	1.1944
0.3772	-0.5427	-0.0015	-0.0001	0.6075	1.2388	0.3331	-0.5042	-0.0023	0.0001	0.5943	1.2143
0.3331	-0.5042	-0.0023	0.0001	0.5943	1.2143	0.3772	-0.5427	-0.0015	-0.0001	0.6075	1.2388
0.2912	-0.4717	-0.0033	0.0002	0.5832	1.1944	0.4230	-0.5847	-0.0011	-0.0002	0.6219	1.2664
0.2518	-0.4462	-0.0045	0.0004	0.5745	1.1793	0.4702	-0.6267	-0.0010	-0.0002	0.6363	1.2951
0.2149	-0.4268	-0.0059	0.0004	0.5678	1.1683	0.5184	-0.6664	-0.0013	-0.0002	0.6499	1.3232
0.1809	-0.4119	-0.0075	0.0004	0.5627	1.1604	0.5670	-0.7025	-0.0021	-0.0002	0.6623	1.3499
0.1500	-0.3991	-0.0093	0.0002	0.5583	1.1540	0.6157	-0.7209	-0.0042	-0.0001	0.6686	1.3650
0.1221	-0.3792	-0.0112	-0.0001	0.5515	1.1434	0.6638	-0.4547	0.0596	0.0065	0.5774	1.1330
0.0973	-0.3355	-0.0130	-0.0005	0.5365	1.1188	0.7109	0.1349	0.0495	-0.0041	0.3753	0.7982
0.0757	-0.2623	-0.0138	-0.0009	0.5114	1.0768	0.7562	0.1807	0.0355	-0.0022	0.3596	0.7878
0.0571	-0.4185	-0.0054	-0.0011	0.5650	1.1628	0.7993	0.1328	0.0369	0.0002	0.3760	0.8124
0.0416	-0.6713	-0.0120	-0.0019	0.6516	1.3345	0.8396	0.1311	0.0366	0.0011	0.3766	0.8137
0.0289	-0.5744	0.0203	-0.0044	0.6184	1.2433	0.8766	0.1526	0.0362	0.0014	0.3692	0.8024
0.0188	-0.2856	0.0224	-0.0052	0.5194	1.0605	0.9095	0.1861	0.0359	0.0016	0.3577	0.7844
0.0113	0.0961	-0.0035	-0.0056	0.3886	0.8720	0.9380	0.2247	0.0356	0.0018	0.3445	0.7636
0.0060	0.4698	-0.0347	-0.0058	0.2605	0.7097	0.9616	0.2622	0.0353	0.0019	0.3316	0.7435
0.0026	0.7728	-0.0609	-0.0056	0.1567	0.5821	0.9797	0.2941	0.0350	0.0019	0.3207	0.7263
0.0008	0.9582	-0.0748	-0.0040	0.0931	0.4987	0.9921	0.3169	0.0349	0.0018	0.3129	0.7139
0.0001	0.9994	-0.0676	0.0008	0.0790	0.4642	0.9984	0.3229	0.0357	0.0019	0.3109	0.7098

Figure 7-A-27

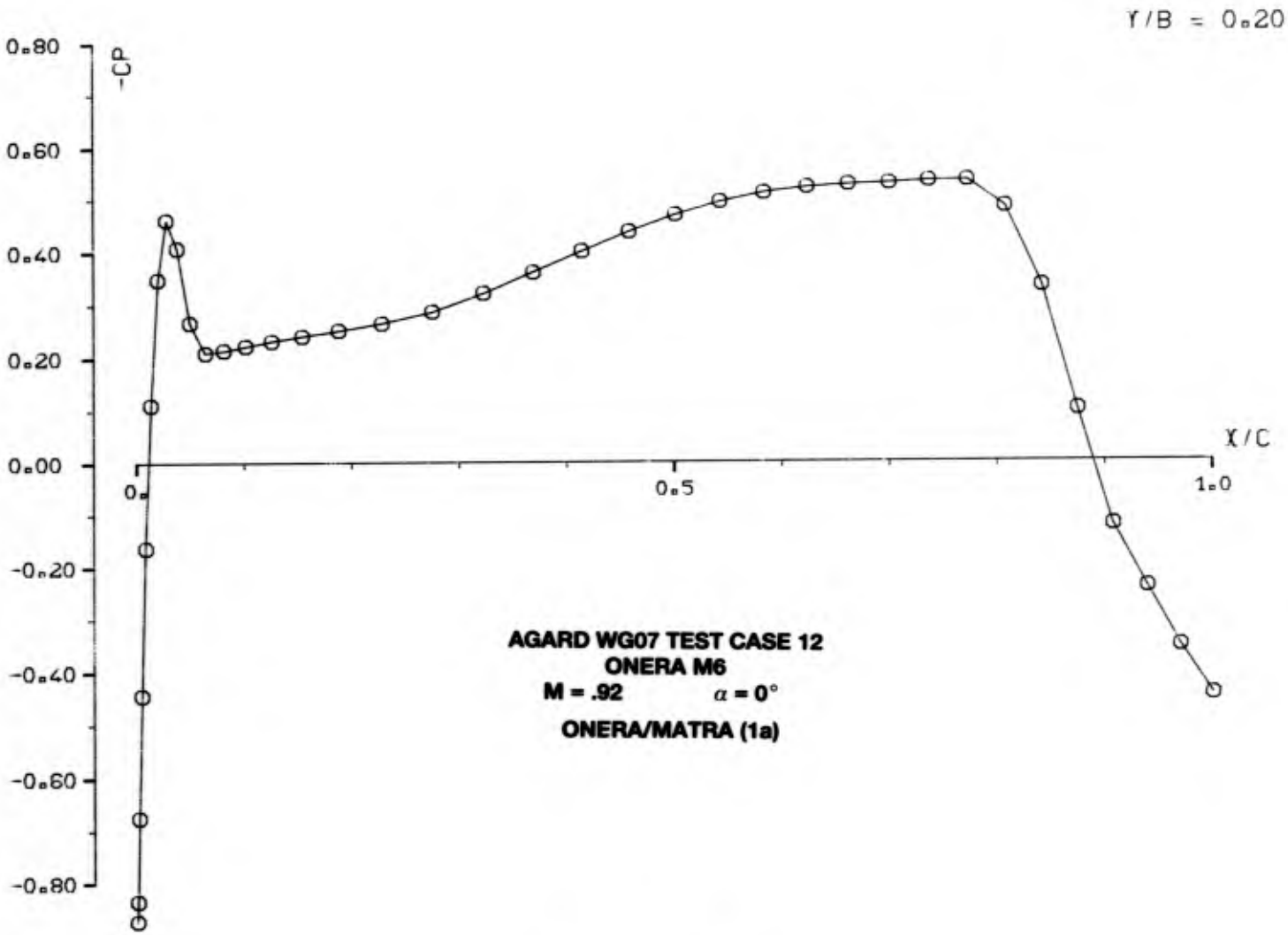

Y/B = 0.20
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-CP
0.
0.5
1.0
X/C
AGARD WG07 TEST CASE 12
ONERA M6
M = .92 α = 0°
ONERA/MATRA (1a)

Figure 7-A-28

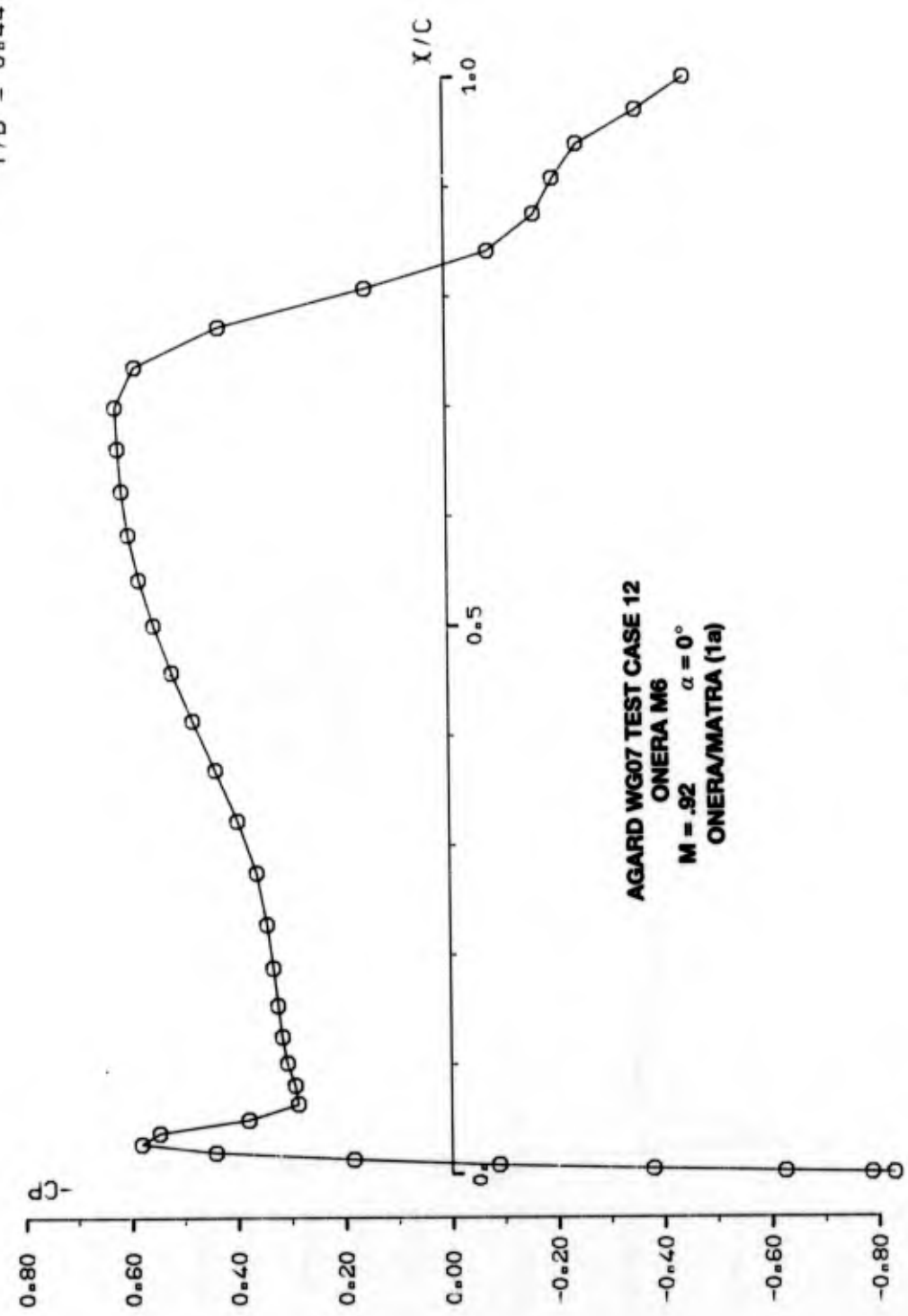

Y/B = 0.44
X/C
1.0
0.5
0
-Cp
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
AGARD WG07 TEST CASE 12
ONERA M6
M = .92 α = 0°
ONERA/MATRA (1a)

Figure 7-A-29

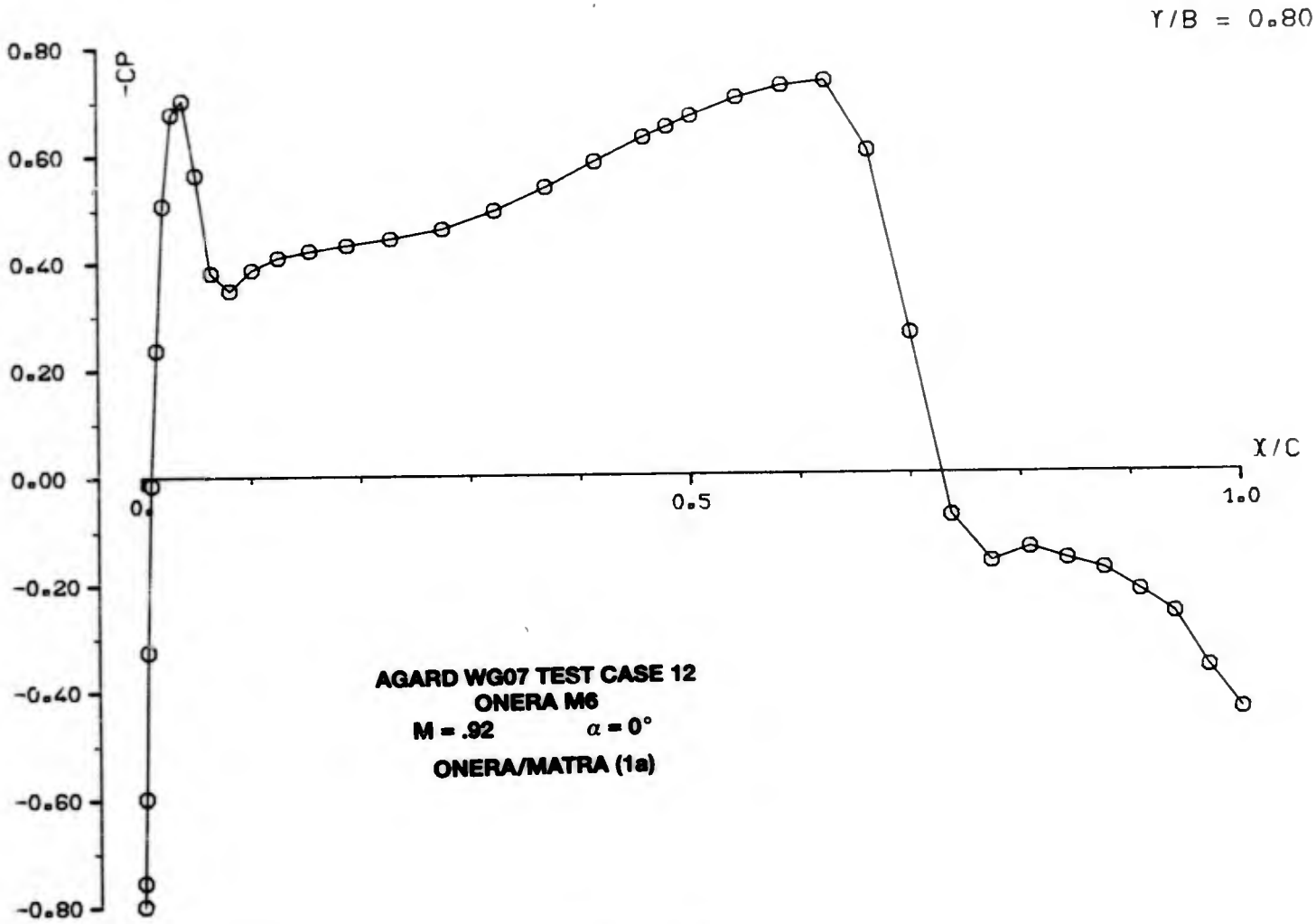

Y/B = 0.80
-CP
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
0.
0.5
1.0
X/C
AGARD WG07 TEST CASE 12
ONERA M6
M = .92
α = 0°
ONERA/MATRA (1a)

Figure 7-A-30

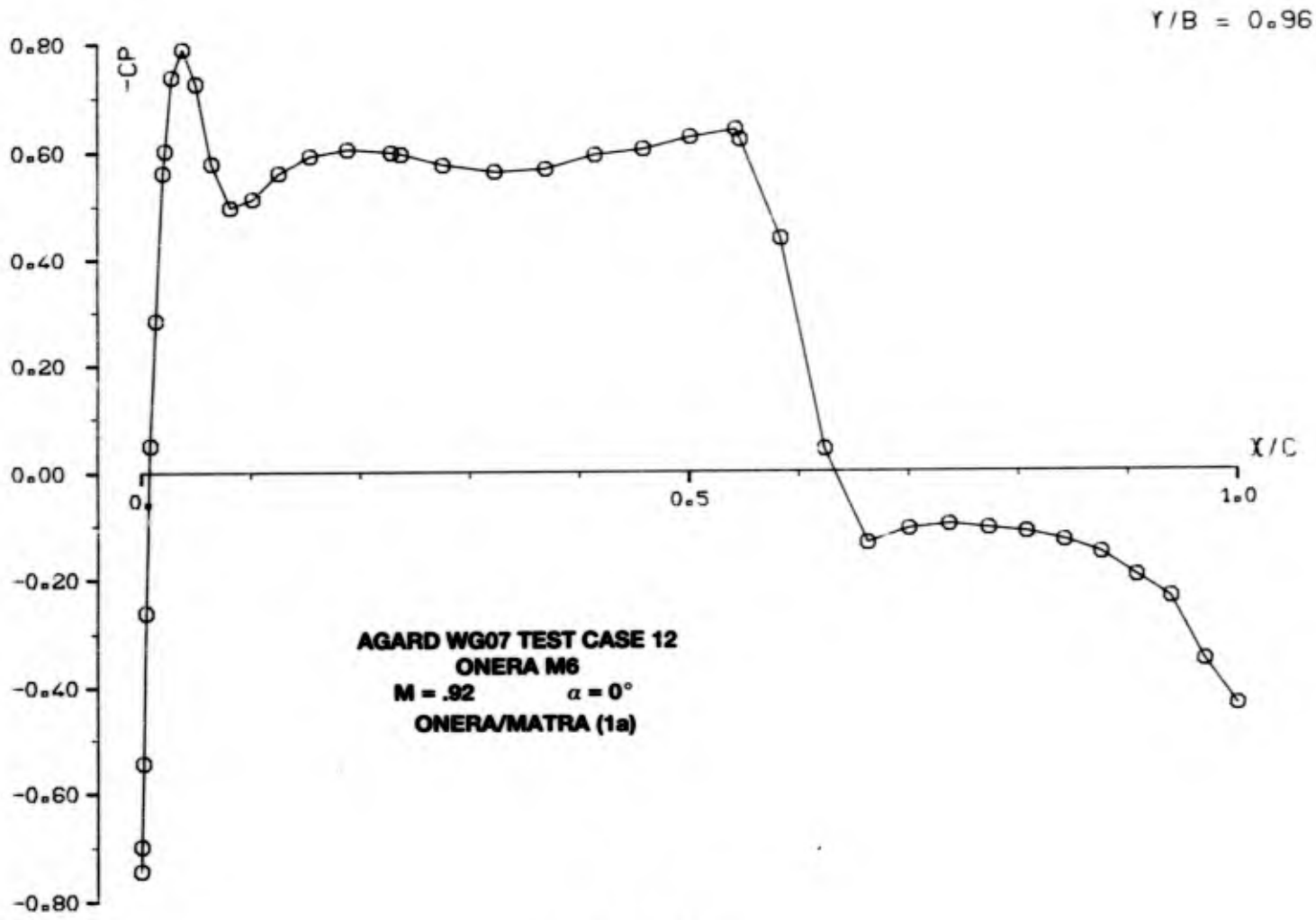

Y/B = 0.96
-CP
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
0.
0.5
1.0
X/C
AGARD WG07 TEST CASE 12
ONERA M6
M = .92 α = 0°
ONERA/MATRA (1a)

Figure 7-A-31

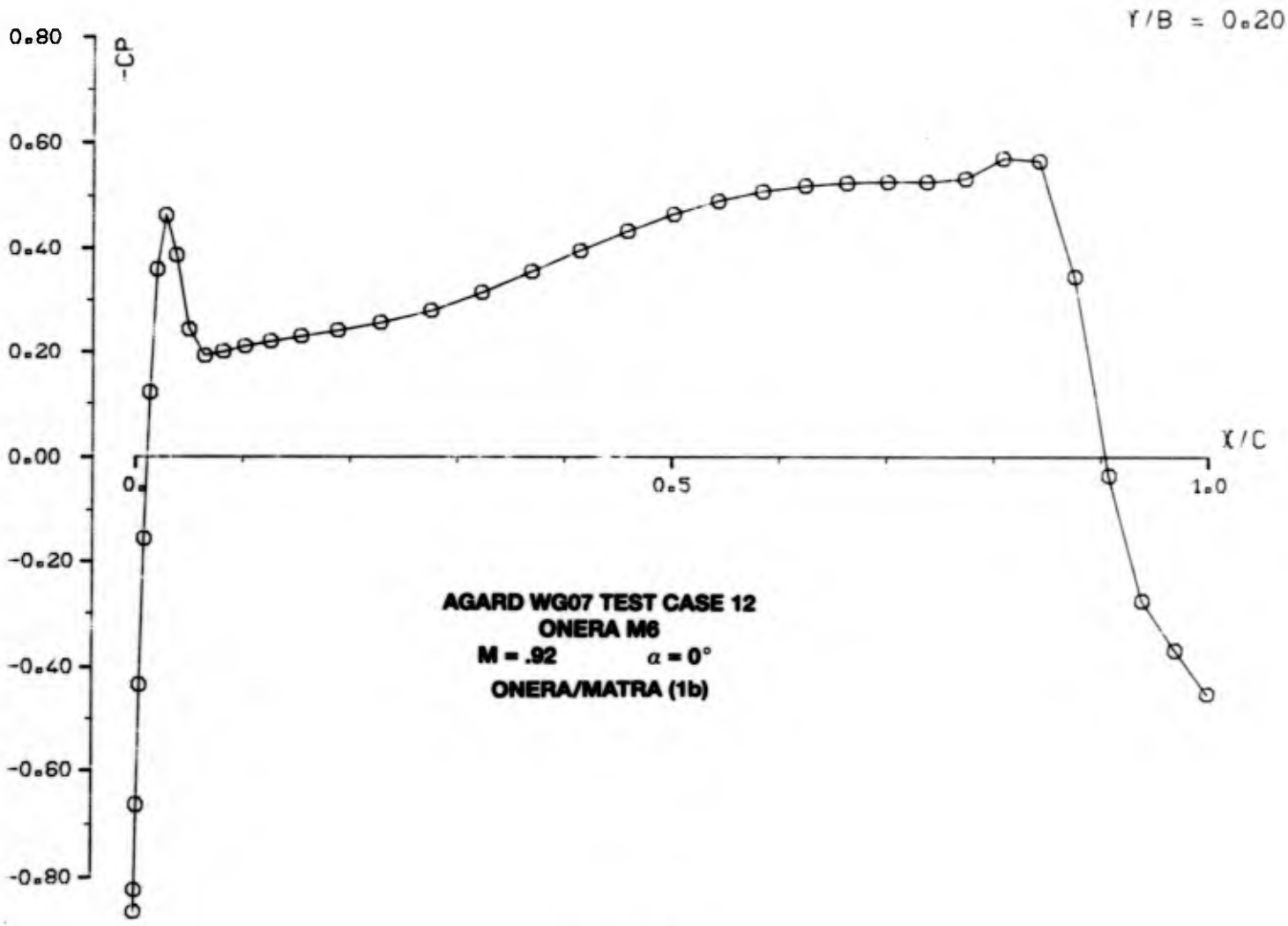

Y/B = 0.20
-CP
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
0.
0.5
1.0
X/C
AGARD WG07 TEST CASE 12
ONERA M6
M = .92 α = 0°
ONERA/MATRA (1b)

Figure 7-A-32

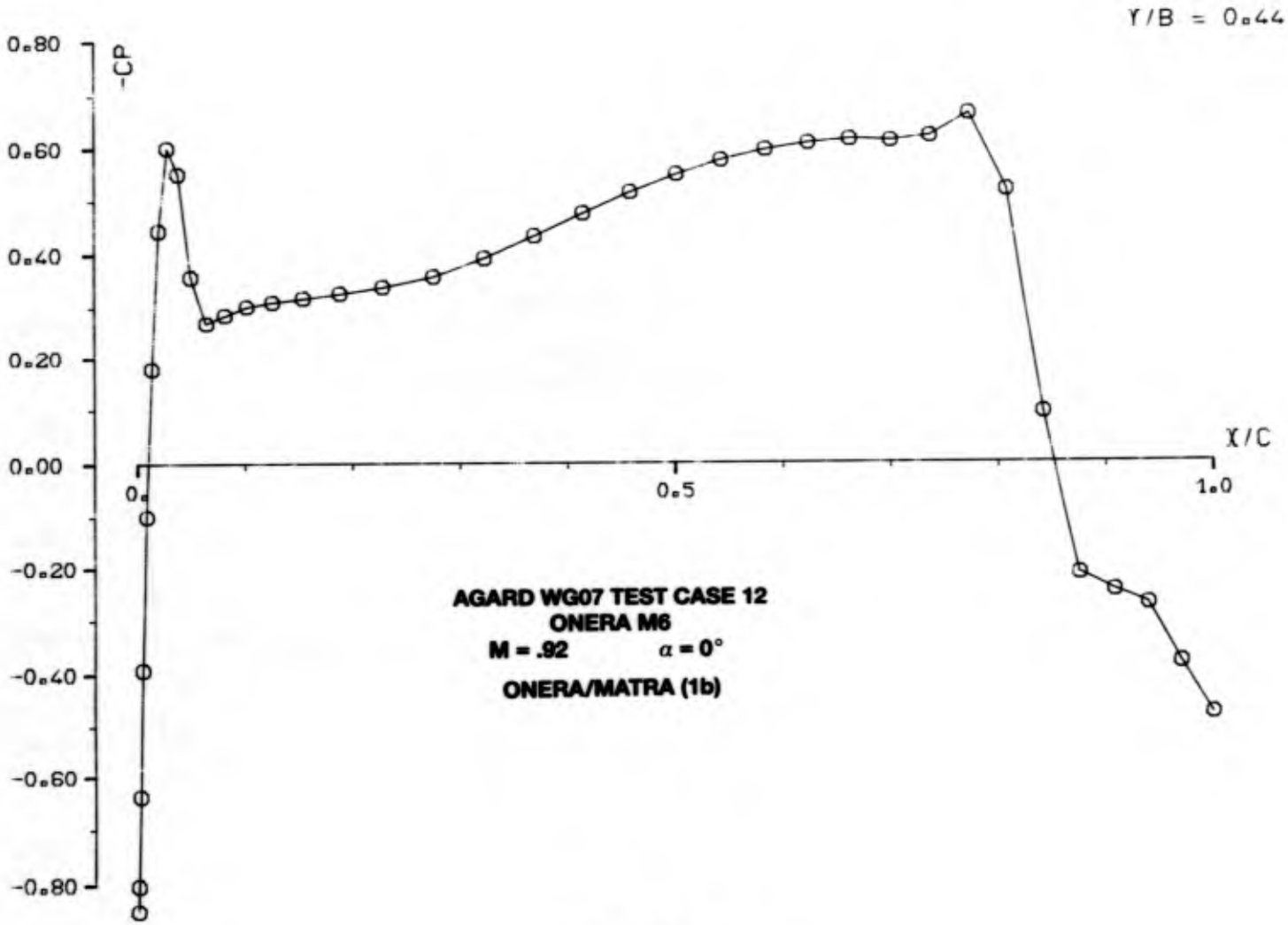

Y/B = 0.44
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-CP
0.
0.5
1.0
X/C
AGARD WG07 TEST CASE 12
ONERA M6
M = .92 α = 0°
ONERA/MATRA (1b)

Figure 7-A-33

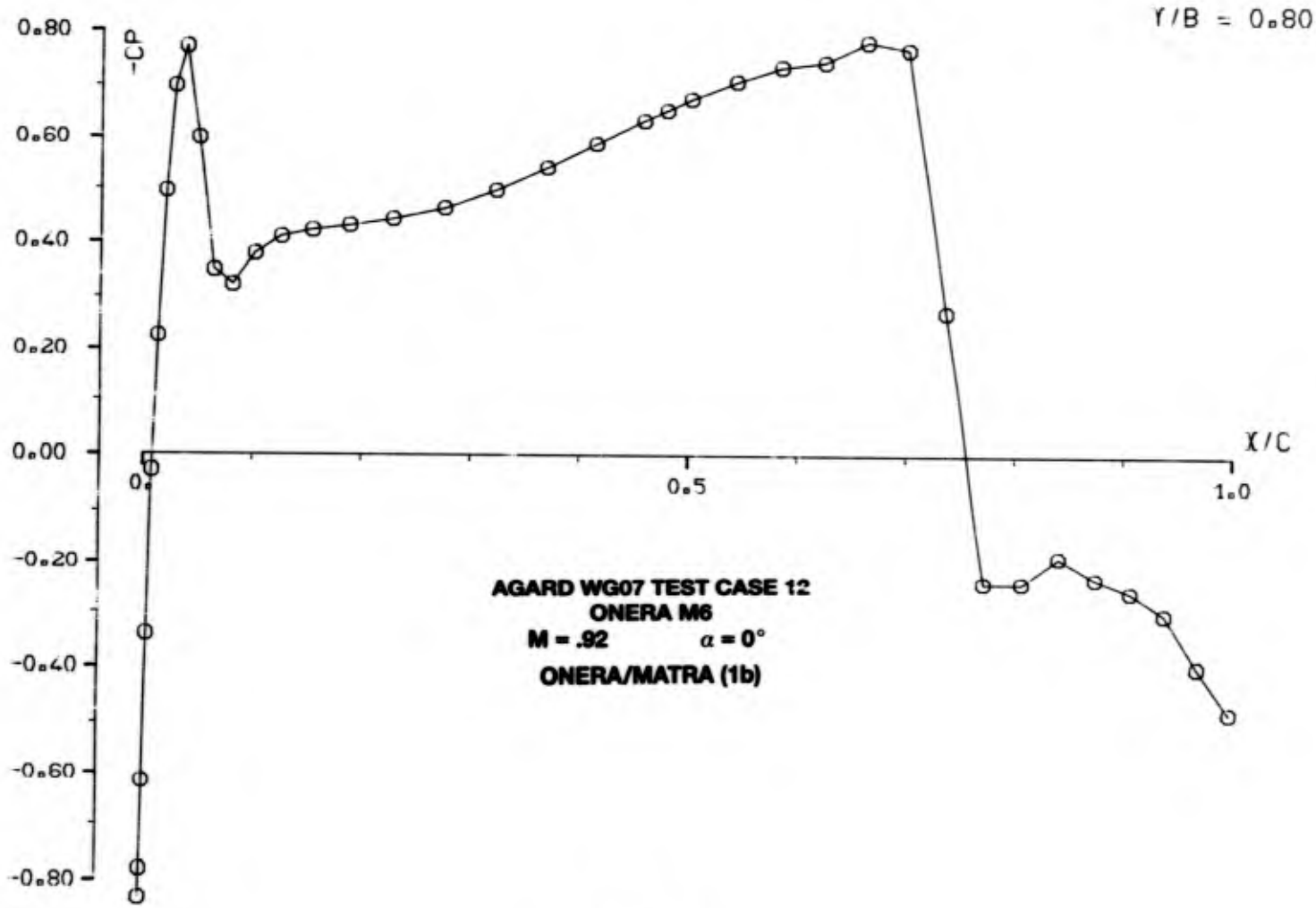

Y/B = 0.80
-CP
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
0.
0.5
1.0
X/C
AGARD WG07 TEST CASE 12
ONERA M6
M = .92 α = 0°
ONERA/MATRA (1b)

Figure 7-A-34

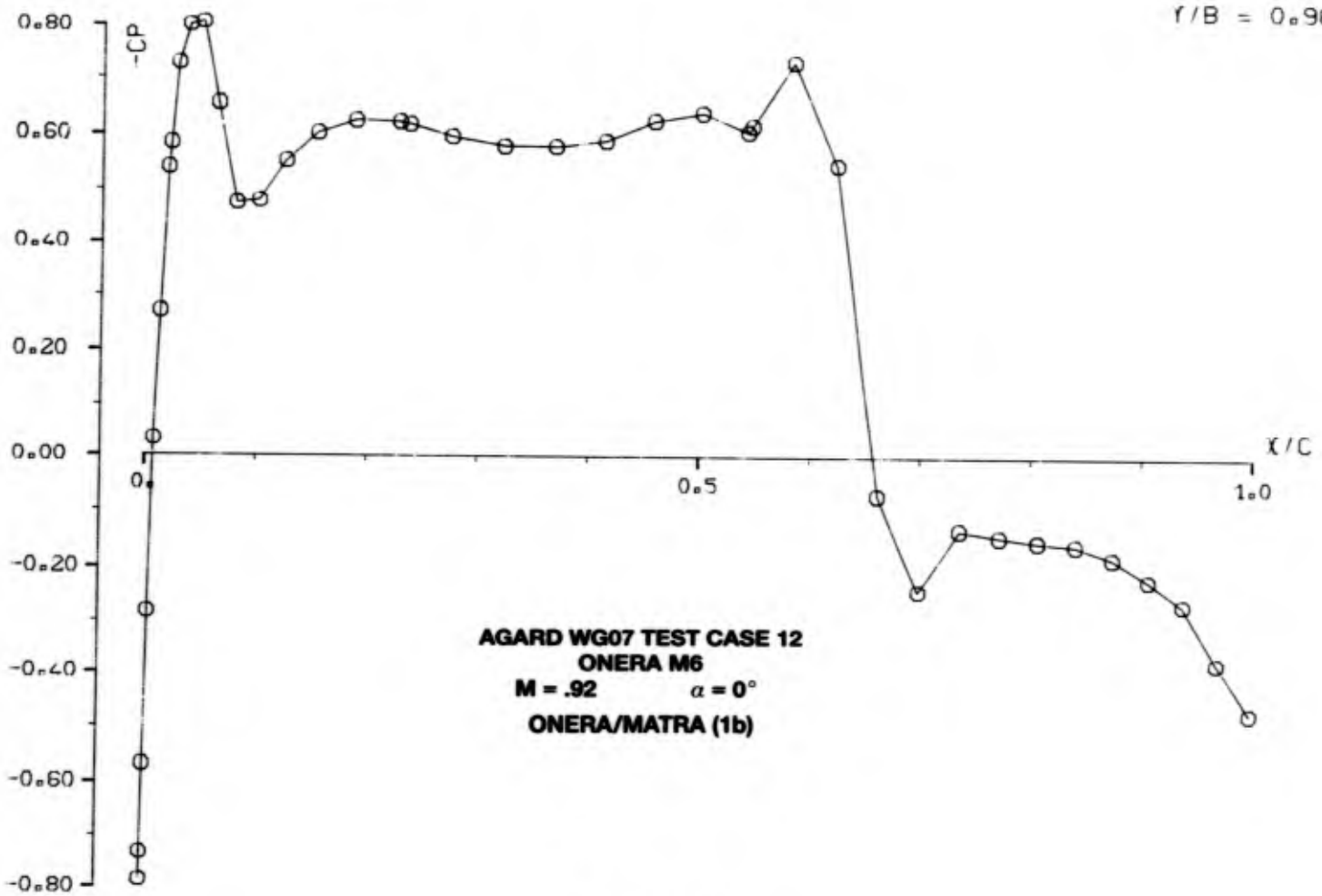

Y/B = 0.96
-CP
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
0.
0.5
1.0
X/C
AGARD WG07 TEST CASE 12
ONERA M6
M = .92 α = 0°
ONERA/MATRA (1b)

Figure 7-A-35

8 NUMERICAL SOLUTIONS FOR THREE-DIMENSIONAL CASES - DELTA WINGS (J.H.B. SMITH)

8.1 Motivation

The problems of the design of swept wings for transport aircraft flying at transonic speeds can be approached through the study of aerofoil sections and through the use of the potential flow approximation. In contrast, there are two specific aspects of the design of combat aircraft which are essentially three-dimensional, and for which the representation of rotational flow and of shock waves of finite strength are necessary. These aspects are the estimation of supersonic wave drag and the prediction of vortex flows. In principle, both aspects may arise together in predicting the performance of an aircraft at its limits of Mach number and lift coefficient; but in practice the two aspects tend to arise separately, since the manoeuvres which give rise to strongly rotational flows are not sustainable at Mach numbers much above unity, and when they are executed the vortex drag is usually much greater than the wave drag. It is therefore not unrealistic to consider these two aspects of the solution of the Euler equations separately, and the cases selected by the Working Group reflect this approach. What must be remembered in examining the outcome is that the potential of the numerical solution of the Euler equations for predicting wave drag has been recognised for fifteen years, while its potential for describing vortex flows has only become apparent in as many months. It would therefore be entirely unrealistic to expect to find calculations of vortex flows which approach the accuracy achievable in calculations of flows about symmetrical, non-lifting bodies.

Wings of delta planform present the real problems of estimating wave drag and representing vortex flows in their simplest form. Any method of calculation aiming to contribute to these problems should be capable of performing well on such simple shapes. On the other hand, there is no evidence that reliable solutions for such simple shapes already exist. The Group therefore decided to seek solutions for wings of delta planform for conditions which are relevant to wave-drag estimation and vortex-flow prediction.

For a shape which is reasonably slender, at a Mach number sufficiently greater than unity, the flow is supersonic everywhere, so that there is no upstream influence, and the flow can, in principle, be calculated by a space-marching method. Slightly more restrictive assumptions of the same kind ensure that the component of the flow parallel to some fixed axis is also supersonic, so that the flow in each plane normal to this axis is independent of the flow in all planes further downstream. This means that the evolution of the flow in the direction of the axis can be calculated plane by plane, with an effort and an accuracy comparable to those needed for, and provided by, two-dimensional time-accurate calculations. Since the purpose of the Group was to seek solutions of high quality, to which reference would be made by future developers of methods, it was decided to include at least one flow of this kind.

The final considerations affecting the choice of case are that the shape should be simple, and that experimental measurements should exist. The first makes it easy to ensure that the description of the shape is complete and unambiguous, and makes it possible for all potential computors to represent the shape in their programs. The second, while not strictly necessary and perhaps even irrelevant to the assessment of the accuracy of inviscid calculations, does provide an assurance that solutions judged to be mathematically accurate are not in serious conflict with physical reality.

The choice of cases can now be viewed in the light of these criteria. Number 13, the Butler wing (see Fig 5-8) at zero incidence at a Mach number of 2.5, presents a very simple problem related to the prediction of wave drag at a Mach number likely to be of practical concern. Its shape is analytically described, and has been the subject of earlier calculations, see Refs 8-1 to 8-3, at a higher Mach number. Measurements of surface pressure exist at both Mach numbers in Refs 8-1 and 8-4. The velocity component parallel to its axis is everywhere supersonic, so space-marching techniques can be used. The apex of the wing is a circular cone, so starting conditions for the marching process are readily obtained. However, the accurate prediction of the complete flow is far from simple, as demonstrated in Ref 8-2, largely because the transverse component of the surface curvature increases indefinitely as the trailing edge is approached along the leading edge. (Note that there is a typographical error in the definition of the wing shape in Ref 8-2.)

Number 14, the Dillner wing (see Fig 5-9) at 15° incidence and a Mach number of 1.5, presents a simple problem relevant to the prediction of vortex flows. The shape is analytically described. Measurements of pressure on the surface and velocity in the field have been made, together with oil-flow observations of the skin-friction lines on the surface, see Ref 8-5. The sharp leading edges of the wing define the origins of the free shear layers in the real flow, and provide an unambiguous signal to a numerical method capable of representing separation phenomena. The velocity is probably just supersonic everywhere, so that a space-marching solution might be possible. The angle of incidence is large enough for the structure of the leading-edge vortex to be approximated on a grid fine enough to represent the shape of the wing. Number 15 is the Dillner wing again at 15° incidence, but at a Mach number of 0.7. The points made above still apply, except that space-marching is ruled out. Comparative calculations using the vortex-sheet model in the Prandtl-Glauert framework, as implemented at Boeing, Ref 8-6, and NLR, Ref 8-7, become possible.

Numbers 17-20 all involve AGARD model B (see Fig 5-12) at supersonic speeds and small angles of incidence. This is a simple combination of a delta wing and an axially symmetric fuselage, which has been tested in several wind tunnels. It represents the next stage in complexity after the isolated wing. Preliminary estimates suggested that the axial component of velocity is supersonic at $M = 2$ and $\alpha = 0$ (case 19).

8.2 Butler wing - case 13

8.2.1 Solutions received

Solutions were received from five contributors: Dr D.S. Chaussee from NASA-Ames; M.M. Fenain and M.J. Lordon from ONERA and Aerospatiale respectively; Prof G. Moretti from the Polytechnic Institute of New York; Prof F. Walkden from the University of Salford; and Dr C. Weiland from MBB, München. All the solutions are by space-marching methods. Consequently, when a grid has been chosen in a cross-flow plane (normal to the wing axis), the marching interval in the streamwise direction is determined, in terms of the solution, by some form of the Courant-Friedrichs-Lewy criterion. The grids used can therefore be discussed in terms of their form in the cross-flow plane. All contributors used O-grids, and all found the bow shock by fitting. The cross-sections of the body and the bow shock form grid lines of one family.

Dr Chaussee provided a single solution, which will be referred to as C. MM. Fenain and Lordon provided three solutions on increasingly fine grids of the same proportions; these will be referred to as FL1, FL2 and FL3. Prof Moretti provided two solutions, the second being on a grid formed by sub-dividing the first in one direction; these will be referred to as Mo1 and Mo2. Prof Walkden provided four solutions: in two of them the original grid is sub-divided in the two possible ways separately, and in the final solution these two sub-divisions are effected at once. The notation Wa1 to Wa4 will be used. Dr Weiland provided two solutions, but withdrew the first; the other will be referred to as We. Of these solutions, only FL1, FL2, FL3, Wa1, Wa2 and We include values of the drag coefficient. All the values of drag quoted have been modified from the original submissions as a result of correspondence. The modifications appear to have arisen from changes in integration or book-keeping procedures, rather than from revision of the pressure calculations.

The numbers of grid lines are detailed in the adjacent table. Here m is the number of grid lines meeting one-half of the cross-section of the body, including the two parts of the vertical plane of symmetry; and n is the number of grid lines between the bow shock and the body, including both of them.

	C	FL1	FL2	FL3	Mo1	Mo2	Wa1	Wa2	Wa3	Wa4	We
m	61	60	84	140	49	97	41	41	81	81	73
n	30	15	21	35	13	13	25	49	25	49	33
m/n	2.0	4.0	4.0	4.0	3.8	7.5	1.6	0.8	3.2	1.7	2.2

Moretti uses more grid lines over the rear part of the wing: the values of m shown refer to the region downstream of $x/c = 0.6$. Values of the ratio m/n are tabulated and show a strikingly large range. The aerofoil solutions in chapter 6 cover a smaller range, perhaps reflecting the greater experience that has been acquired with aerofoil calculations. Fig 8-1 shows samples of the grids used for cases C, FL1, Mo1, Wa1 and We over the rear part of the wing. There are two major differences to be seen: one is the degree of orthogonality achieved, the other is the extent to which grid lines are concentrated near the wing. All the grids are approximately orthogonal further forward.

8.2.2 Description of methods used

Dr Chaussee writes:

"In the present work, a non-iterative implicit finite-difference algorithm, analogous to that developed by Schiff and Steger, Ref 8-8, and Chaussee et al, Ref 8-9, for steady Navier-Stokes marching solutions, has been applied to the Euler equations. The algorithm is conservative, first- or second-order accurate in the marching direction, and can have second-order accuracy in the marching plane.

"Implicit boundary conditions are used at all boundaries. These procedures use the theory of characteristics to update the boundary points and are spatially second-order accurate. The outer boundary consists of the bow-shock wave, which is fitted in these calculations. More details may be found in Ref 8-10. The initial conditions consist of two starting planes which are normal to the body axis. The present procedure then marches away from these planes. The planes were created by calculating a conical solution for the present flow conditions. These conditions, along with the shock wave location and slope, are all that are needed to march the initial value planes.

"The mesh is analytically created at each marching step in the following manner.

(i) A circle with a radius corresponding to the maximum body radius is constructed.

(ii) A y-value is then obtained from where the radius at constant ϕ angles intersects the circle. This allows for automatic clustering of the points near the tip as the body is flattened.

(iii) A y-value is obtained from where the radius at constant ϕ angles intersects the outer boundary (bow shock). Since the bow wave is circular, the points are located at equal arc length.

(iv) The corresponding points on the body and the shock are connected by straight lines.

(v) Equispaced points are distributed along the straight lines of step (iv).

(vi) At the next marching step, steps (i) through (v) are repeated."

MM. Fenain and Lordon write:

"A finite-volume method has been used to compute the inviscid stationary flow around the Butler wing at zero incidence and a Mach number equal to 2.5. The basic ideas consist in solving the steady Euler equations written in conservative form. The hyperbolicity of the system permits a marching technique in space.

"The computational field, bounded by the wing and the bow shock, is divided into hexahedral elementary volumes. Each of these volumes is analytically defined in a reduced coordinate system ξ, η, ζ, which only depends on the location of its eight vertices. The coordinate surfaces are in general hyperbolic paraboloids. The ξ, η, ζ coordinates, varying between 0 and 1, are chosen so that the ξ direction is time-like while the other two, η and ζ, are space-like. Under such conditions, the flow in a plane ξ = const is independent of the downstream flow and the solution can be calculated explicitly along the marching direction from the $\xi = 0$ to the $\xi = 1$ surface.

"A predictor-corrector scheme of MacCormack type is used for all the elementary volumes. The calculated points are the central points of the downstream faces of the volumes, while the flow is known at the central points of the upstream faces. The facets discretizing the bow shock belong to a mesh surface. The bow shock is computed with a predictor-corrector finite-difference scheme which takes into account the Rankine-Hugoniot equations. The tangency condition requires a special treatment of the elementary hexahedral volumes lying on the wing. The velocity components and the pressure are calculated at their vertices with a finite-difference scheme by using the compatibility equations. Once more, we use a predictor-corrector scheme. The accuracy is good only if the faces lying on the wing have no tangential discontinuity. To achieve that, we have defined volumes known by their eight vertices and respecting the tangency at the four points belonging to the wing.

"Given the geometrical definition of the Butler wing apex, we used a special program for axisymmetric conical flow to calculate the flow field up to x/c = 0.2. The conical solution is asymptotically computed, starting from an analytical initial solution which is a good approximation. From x/c = 0.2 to x/c = 1, in a computational plane x/c = const, the mesh is made of hyperbolae orthogonal to the elliptical section of the wing and of quasi-elliptical curves surrounding the wing. The hyperbolae intersect the cross-section of the bow shock at points in equally-spaced meridional planes. Several meshes with different distributions of curves between the wing and the bow shock were tried. The step sizes along the marching direction were either constant or not. Finally, we used 60 x 15, 84 x 21 and 140 x 35 elementary volumes in the semi-space between the wing and the bow shock. The results are not very different from one case to the other.

"A slight asymmetry of the results appears near the leading edge. It becomes larger near the trailing edge and should be attributed to the asymmetry of the MacCormack scheme. This defect could be cured in the future. The pressure ratio p_i/p_{i_∞} which should be constant on the wing, in the absence of embedded shocks, varies very little up to x/c = 0.8, and more and more afterwards as the leading edge is approached. This discrepancy is certainly related to the symmetry defect which has to be corrected. Nevertheless, with the finer mesh the discrepancy appears later."

More details will appear in Ref 8-11.

The following account of Prof Moretti's method is based on Ref 8-3.

The method used is a space-marching technique, using a particular predictor-corrector method, the λ-scheme, described in Ref 8-12. This is believed to combine second-order accuracy with a maximum of consistency with the domain-of-dependence principle. The Euler equations are reduced to a set of four equations for the streamwise derivatives of: a pressure variable, $P = \ln(p/p_{ref})$; an entropy variable, $S = \gamma \ln(\theta/\theta_{ref}) - (\gamma - 1)P$, where θ denotes temperature; and a non-dimensional cross-flow velocity vector. The physical space in each cross-flow plane between the body and the bow shock, and between the upper and lower halves of the vertical symmetry plane, is mapped on to a rectangle in the computing space. The mapping is a combination of a conformal mapping in which the body cross-section becomes circular with a stretching which can concentrate grid lines near the body.

The external boundary is the bow shock, which is fitted. At it, the Rankine-Hugoniot conditions are applied, together with one characteristic equation. The treatment at shock and body points follows the method of Ref 8-13. More details, together with calculated examples, are given in Ref 8-3.

Prof Walkden writes:

"The method used has been described in Ref 8-14. It is an explicit marching technique for computing steady, inviscid, three-dimensional supersonic flows. Equations based on characteristic relations derived from the equations of motion after splitting the three-dimensional operator are used as the basis of a finite-difference approximation. General coordinate systems specified by subroutines defining a transformation between physical and working space are allowed. The energy equation is not used explicitly in the method. The numerical approximation is to first order. The bow shock, which is the outer boundary of the calculation, is fitted as a discontinuity. The appropriate Taylor-Maccoll solution for flow past a cone has been used to provide initial data to start the marching process.

"The mesh used in the calculation (Wal) is the same as that used for a detailed study of the Butler wing at a Mach number of 3.5. The results of this study are described in Ref 8-2. There is no reason to suspect that the solution is so different in the present case that further detailed examination would be necessary. Mesh intervals have been halved in both directions without noticeable effect on the results. Also, the distribution of points between body and shock has been varied without effect. The mesh consists of a uniform computation space bounded by symmetry planes, body surface and bow shock. An algebraic transformation between the working space and a cylindrical polar space is defined for $0.2 < x/c < 0.6$. In the region $0.6 < x/c < 1$ a transformation between working space and a Cartesian space is used. In the calculation (Wal) the total number of points in each cross-section, consisting of one quadrant, is 525. The number of mesh points on the body surface is 7140."

Details of Dr Weiland's method may be found in Refs 8-15 and 8-16. His complete solution has been issued as Ref 8-17.

8.2.3 Assessment of solutions

Contributors were asked to present their solutions in tabular and graphical form. The graphical presentation serves to draw attention to major features of the solution and to summarize large quantities of information. The solutions received are, in general, very close, so that assessment requires the use of the tabulated data. This was requested in planes 20%, 60% and 95% of the length from the apex. All contributors supplied data in planes sufficiently close to these for direct comparisons to be meaningful.

The quantities requested were static pressure (in the form $1 - p/p_{i_\infty}$, where subscript i denotes the total, or isentropically-achieved stagnation, value, and subscript ∞ denotes the value in the undisturbed stream), the pressure coefficient ($C_p = (p - p_\infty)/\frac{1}{2}\rho_\infty U_\infty^2$), the Mach number, the total pressure (in the form $1 - p_i/p_{i_\infty}$), and the total temperature. There should be no variation in the total temperature, neither across the shock nor in the isentropic flow downstream of it. Of the five contributors, only Walkden and Weiland quoted values for the total temperature. Walkden found a variation which increased along the length of the wing to about 1% of the freestream total temperature; Weiland's variation is about ten times smaller. No further account will be taken of the values of total temperature.

Upstream of the 20% station, the wing takes the form of a circular cone at zero incidence, so the flow field depends on a single coordinate only, and it should be possible to obtain it accurately. Guidance is available from the tables of Kopal (Ref 8-18) and Jones (Ref 8-19) and the charts (Ref 8-20) based on Kopal's tables. All contributors did obtain similar values, which will be examined in detail later.

Further downstream errors will be larger, partly because the solution depends on the other coordinates and partly because the thinner cross-sections of the wing towards the rear impose a more severe test on the adequacy of the computing grid. Nonetheless, all contributors produced results for the static pressure and Mach number which are in reasonable agreement. To illustrate this, the entire range of values of $1 - p/p_{i_\infty}$ from the eleven solutions of the five contributors is shown in Fig 8-2. In order to display the values near the leading edge, they are plotted against the eccentric angle, arc $\cos(y/a(x))$. Fig 8-2a, for the 60% section, shows a very encouraging situation, with only a small spread of values. At the 95% station, Fig 8-2b, the situation is not as good, particularly near the leading edge, where the cross-section of the wing is very highly curved, as is clear from Fig 8-1. Fig 8-3 shows, in the same way, the range of values of the local Mach number at the same two stations. Again, the agreement is closer at 60% than at 95%. There is more difference between contributors' estimates of the Mach number than between their estimates of the static pressure, measuring the difference in each case in terms of the total variation of the quantity across the span. The same trend, to incur larger errors in Mach number than in static pressure, can be seen in the two-dimensional results discussed in chapter 6. A more detailed examination of these results is deferred until the drag predictions have been examined.

Drag values have been provided by three of the five contributors. A drag coefficient $C_D = D/q_\infty S$ was sought, where D = drag, q_∞ = freestream kinetic pressure, and S = planform area. The values contributed are, using the nomenclature introduced in section 8.2.2:

FL1	FL2	FL3	Wa1	Wa2	We
0.05918	0.05942	0.05956	0.0593	0.0597	0.05939

The overall range of these values is less than 1%, which is extremely satisfactory. Moreover, the availability of results by the same method on grids of different sizes encourages attempts at extrapolation to the limit of zero grid spacing, and the 'exact' result. Clearly, the values from Fenain and Lordon on three grids of the same proportions offer the best chance of successful extrapolation.

How is the extrapolation to be performed? Standard analysis of the local error introduced by replacing a continuous operator by a discrete one assumes the regularity of the exact solution, leading to a representation of the local error as a power series in the discretization interval (or grid spacing). It therefore seems inevitable that, if we consider a sequence of solutions on geometrically similar grids of typical dimension h, each approximate solution at a point $\underline{x}$ will be representable in the form

$$f(\underline{x},h) = f(\underline{x},0) + a_1(\underline{x})h + a_2(\underline{x})h^2 + a_3(\underline{x})h^3 + \ldots \quad , \tag{8-1}$$

if h is sufficiently small. No claim is made that the series on the right converges uniformly with respect to $\underline{x}$; indeed, it may not be convergent at all, but only valid in an asymptotic sense. Since for practical purposes it is impossible to consider more than a very few terms, the distinction is of little importance. If the method is mth-order accurate, the first $(m-1)$ of the coefficients $a_i(\underline{x})$ vanish identically. However, it is not always easy to determine the order of accuracy of a method *a priori*.

When considering the drag, we see that the integration process eliminates the dependence on $\underline{x}$, and Eq.(8-1) becomes:

$$F(h) = F(0) + a_1h + a_2h^2 + a_3h^3 + \ldots \quad .$$

The results FL provide values of $F(h)$ for three values of h: $h_1 > h_2 > h_3$. These are just enough to determine the limit $F(0)$ and two coefficients, once the form of the expression is specified. The forms to be considered are therefore:

$$F(h) = F(0) + a_mh^m + a_nh^n \quad , \qquad m < n \quad . \tag{8-2}$$

It is suggested that the following considerations should motivate the choice of m and n.

(a) m and n should be as small as is consistent with the other considerations.

(b) The contribution of $F(h)$ from a_nh^n should be less than that from a_mh^m for as many as possible of h_1, h_2, h_3, and at least for $h = h_3$.

(c) The variation of $F(h)$ from $h = 0$ to $h = h_1$ should be monotonic.

(d) The coefficients a_m and a_n should be of the same sign.

(e) The same values of m and n should apply to all the elements (such as drag, pressure, etc) of a particular set of solutions.

It will not, in general, be possible to meet all these considerations, and it is not proposed to offer a formal justification for them. (a) is based on the improbability of encountering a method of a high order of accuracy. (b) arises because, for the representation to be meaningful, the omitted terms must be negligible, so that successive terms should become smaller. (c), and its stronger form (d), are based on experience with numerical methods. (e) is a property which would hold if the process truly reflected the orders of the errors in the calculation.

Reference to the table in section 8.2.1 shows that, in some suitable scale, values $h_1 = 7$, $h_2 = 5$, $h_3 = 3$ may be associated with the solutions FL1, FL2, FL3. Then a little algebra produces the following relations for the three smallest pairs of values for m and n.

If $m = 1$, $n = 2$:

$$\begin{pmatrix} F(0) \\ a_1 \\ a_2 \end{pmatrix} = \frac{1}{8}\begin{pmatrix} 15 & -42 & 35 \\ -8 & 20 & -12 \\ 1 & -2 & 1 \end{pmatrix}\begin{pmatrix} F(7) \\ F(5) \\ F(3) \end{pmatrix} = \begin{pmatrix} 5.9583 \\ 0.003 \\ -0.00125 \end{pmatrix}$$

using for F the values of C_D tabulated above multiplied by 100.

If m = 2, n = 3:

$$\begin{pmatrix} F(0) \\ a_2 \\ a_3 \end{pmatrix} = \frac{1}{568}\begin{pmatrix} 225 & -882 & 1225 \\ -49 & 158 & -109 \\ 8 & -20 & 12 \end{pmatrix}\begin{pmatrix} F(7) \\ F(5) \\ F(3) \end{pmatrix} = \begin{pmatrix} 5.9627 \\ -0.000616 \\ -0.0000423 \end{pmatrix} .$$

If m = 2, n = 4:

$$\begin{pmatrix} F(0) \\ a_2 \\ a_4 \end{pmatrix} = \frac{1}{1920}\begin{pmatrix} 450 & -2205 & 3675 \\ -68 & 290 & -222 \\ 2 & -5 & 3 \end{pmatrix}\begin{pmatrix} F(7) \\ F(5) \\ F(3) \end{pmatrix} = \begin{pmatrix} 5.9632 \\ -0.000769 \\ -0.0000031 \end{pmatrix} . \qquad (8\text{-}3)$$

The considerations (b), (c) and (d) above rule out the case m = 1, n = 2. Both cases with m = 2 satisfy (b), (c) and (d). However, the case with n = 4 leads to a smaller contribution from $a_n h^n$, so it is to be preferred. It also produces satisfactory results for other elements of the solution for which m = 2, n = 3 fails. Consequently, in view of considerations (a) and (e), the form Eq.(8.2) with its outcome Eq.(8-3), is accepted for the extrapolation of the FL solutions.

The estimate of drag provided by Eq.(8-3) appears to be the best that can be made from the FL calculations. However, it can be supplemented by a minimum error band based on the round-off error implied by the form of the numbers on which the extrapolation is based, viz 0.0005 in 100 C_D, and the amplification introduced by the extrapolation. Writing $\Delta F(7) = -\Delta F(5) = \Delta F(3) = 0.0005$ in Eq.(8-3), we find $\Delta F(0) = 0.0016$. Hence the best estimate based on the FL calculations is:

$$C_D = (5.9632 \pm 0.0016) \times 10^{-2} . \qquad (8\text{-}4)$$

The drag values Wa1, Wa2 and We cannot be expected to lie within this tiny error band of 0.03%, since they are based on non-zero grid spacings. Reference to the table in section 8.2.1 shows that the numbers of grid lines in the two directions in the We grid are closest to those in the FL2 grid, so the best that can be expected is that the drag values will be similar. In fact, the difference is 0.05%, so it appears that We is consistent with the estimate Eq.(8-4). The proportions of the grids Wa1, Wa2 are both quite different from FL and We, so direct comparisons are dubious. Wa1 has about the same number of grid points as FL1 and the drag values differ by 0.2%. Wa2 has about the same number of grid points as FL2, but the proportions are totally different: the drag values differ by 0.5%. Since the grid in Wa2 is only refined in one direction from Wa1, it is not possible to extrapolate to zero grid spacing from these two solutions. In fact it will be seen later that Wa2 is not significantly more accurate than Wa1. Accordingly, it appears that the evidence from Wa1 and Wa2 does not conflict with Eq.(8-4), though it cannot be said to support it.

From this detailed study of the contributed drag values, it is provisionally concluded that Eq.(8-4) is a reference value; and that the method FL is second-order accurate over most of the wing, with Eq.(8-3) being a suitable extrapolation formula for the results.

Let us now return to our examination of the results in the stations at 20%, 60% and 95%, starting with a more detailed examination of the 'conical' solutions at 20%. The adjacent table shows the values quoted. No evidence of grid dependency was

	C	FL	Mo	Wa	We
$1 - p/p_{i_\infty}$	0.8847	0.8856	0.8857	0.8856	0.8855
C_p	0.2219	0.2182		0.2182	
M	2.061	2.064	2.079	2.064	2.056
$1 - p_i/p_{i_\infty}$	0.006	0.0116	-0.0116	0.0114	0.0116

provided. The solutions C, FL, Mo and Wa are axisymmetric. We shows small variations round the surface, changing the value of $1 - p_i/p_{i_\infty}$ by 1 in the last figure quoted. The value of $1 - p_i/p_{i_\infty}$ for C has been read from a plot.

Because the differences between these tabulated values are small and because the Working Group omitted to specify the value of the adiabatic index, γ, it is necessary

to consider the possibility that the differences arise from the use of different values of γ . The use of $\gamma = 1.4$ is now almost universal, but the cone-flow tables (8-18) are for $\gamma = 1.405$. The values of C_p and $1 - p/p_{i_\infty}$ quoted by C, FL and Wa are consistent with $\gamma = 1.4$, but not with $\gamma = 1.405$, so it is clear that those solutions were obtained with $\gamma = 1.4$. Moretti, in Ref 8-3, makes comparison with Jones (Ref 8-19), who used $\gamma = 1.4$, rather than with Kopal (Ref 8-18), who used $\gamma = 1.405$, which suggests he also uses $\gamma = 1.4$. The effect of a change in γ from 1.4 to 1.405 can be assessed by comparing Refs 8-18 and 8-19. It is very small. As will be shown below, the discrepancies in the table above appear to originate elsewhere.

The differences between the solutions FL, Wa and We are small, and all are consistent with interpolation procedures applied to the published tables and charts, Ref 8-18 to 8-20. Coincidentally, at the time this assessment was being undertaken, a first-order calculation method somewhat resembling that of Moretti was being developed by K. Taylor at RAE, Farnborough. The first solutions, for cone flow, showed that the results of Ref 8-18 could be reproduced by a linear extrapolation of Taylor's results to zero grid spacing. It therefore appears justifiable to quote, and use as a reference, the same extrapolation of Taylor's results for the cone which forms the apex of the Butler wing at a Mach number of 2.5. These are:

$$1 - \frac{\rho}{p_{i_\infty}} = 0.885585 , \quad 1 - \frac{p_i}{p_{i_\infty}} = 0.01143 , \quad M = 2.0636 ;$$

and the associated shock angle is 29.695°, all for $\gamma = 1.4$.

All the contributors provided contour plots in cross-flow planes close to the 20% station, and by measuring these, values of the shock angle can be obtained as: 29.6° (C), 29.7° (FL), 29.9° (Mo), 29.9° (Wa), 29.8° (We).

In view of the limited accuracy of plotting and measuring, these values are consistent with all the contributors having found the shock angle correctly. Chaussee's contour plot at the 22% station shows a variation in $1 - p_i/p_{i_\infty}$ from a level between 0.011 and 0.012 at the shock to a level close to 0.006 on the wing. The solutions FL, Mo, Wa and We indicate no variation in total pressure between shock and wing, so it appears that the change in total pressure across the shock has been found with considerable accuracy by all the contributors, but that the Mo value has been quoted with the wrong sign. However, in the isentropic flow downstream of the shock, the relation:

$$\frac{p}{p_i} = \left(1 + \frac{\gamma - 1}{2} M^2\right)^{-\gamma/(\gamma-1)} \qquad (8\text{-}5)$$

should apply. From this (with $\gamma = 1.4$), and the values of M and p_i/p_{i_∞} quoted in the table above, values of $1 - p/p_{i_\infty}$ are obtained which agree exactly with those tabulated for FL, Mo and Wa. For C the value is 0.8845 instead of 0.8847, and for We it is 0.8842 instead of 0.8855. The agreement for FL and Wa supports the accuracy of these solutions. The agreement for Mo shows that the sign error in $(1 - p_i/p_{i_\infty})$ is not just at the output stage, but affects the relationship between the quoted values of Mach number and static pressure. Comparison with other solutions, in particular with Taylor's, suggests the Mach number is more affected than the static pressure. The small discrepancy of C is not surprising, since, as mentioned above, the flow downstream of the shock is not isentropic. The discrepancy for We cannot be explained further. His contour plots of Mach number and static pressure at the 20% station are consistent with the quoted values on the wing and with values deduced from the shock relations, but they are not sufficiently detailed to establish whether the error occurs across the shock or between the shock and the wing. Comparison with the other solutions suggests that the error, as with Mo, is in the Mach number rather than the static pressure.

From this examination of the results at the 20% station it is concluded that there are features of the solutions C, Mo and We which make them inferior to FL and Wa. However, the effects of these deficiencies are very small, particularly on the static pressure. It is also concluded that all the solutions are consistent with the use of $\gamma = 1.4$.

Further downstream the flow remains isentropic and, since the entropy should be uniform over the conical nose, the entropy should be uniform over the whole wing surface. It is therefore important to examine the values of the total pressure quoted by the contributors. Since the discrepancies differ by orders of magnitude, a tabular presentation is most convenient. Since increases as well as decreases in total pressure arise, a useful indication of solution accuracy is provided by the variation in total pressure across the span at the two specified stations, 60% and 95%. Another useful indication is the maximum difference from the best estimate of $(1 - p_i/p_{i_\infty}) = 0.0114$.

Both quantities are shown in the adjacent table.

	Variation in p_i/p_{i_∞}		$\left(1 - p_i/p_{i_\infty}\right)_{max} - 0.0114$	
Station	60%	95%	60%	95%
C	0.085	0.227	0.125	0.352
FL1	0.0005	0.0568	0.0006	0.0258
FL2	0.0003	0.0363	0.0004	0.0234
FL3	0.0001	0.0196	0.0002	0.0120
Mo1 & 2	<0.0001	0.0001	-0.0230	-0.0230
Wa1	0.0056	0.0417	0.0043	0.0401
Wa2	0.0051	0.0418	0.0044	0.0409
Wa3	0.0033	0.0287	0.0023	0.0275
Wa4	0.0029	0.0296	0.0023	0.0288
We	0.0018	0.0335	0.0011	0.0316

It is clear that the error in C is substantially larger than those in the other solutions, so it will not be considered further. The absence of variation in Mo is striking. It arises because Morretti treats the entropy as a primary variable, and the equation he solves for it is in conservation form. It is unfortunate that the surface value is conserved at its wrong initial level. The other three sets of solutions, FL, Wa and We, show a rather similar type of behaviour. Among them, FL3 has the lowest error levels at both stations. At the 60% station, the FL solutions are very good in themselves and, in addition, show a convincing convergence behaviour as the grid spacing is reduced. A marked deterioration has occurred by the 95% station. The values for the overall variation are affected by errors near the leading edge, which will be discussed later. The error in the maximum loss of total pressure, in the last column, does show a reasonable convergence - Eq.(8-3) yields an extrapolated value at zero grid size of 0.0021. The error in Wa shows no consistent improvement with an increase in the number of grid lines between the wing and the shock, ie between Wa1 and Wa2 and between Wa3 and Wa4. This explains why no attempt was made above to extrapolate the corresponding drag values from Wa1 and Wa2. The reduction of the error by about a half between Wa1 and Wa3 and between Wa2 and Wa4 at the 60% station is what would be expected from a first-order method if the error were dominated by the grid spacing round the cross-section. Walkden describes the method as first-order in section 8.2.2. Some additional source of error appears to affect the results at 95%. One feature of the Wa results not brought out by the tabulation is that the total pressure is correct at the leading edge, where other calculations have significant errors. A final connection between the grid and the error in total pressure is also brought out by the Wa1 results. These were supplied at closely spaced lengthwise stations, so the growth of the error can be examined. In the adjacent table are shown the variation in p_i/p_{i_∞} across the section, multiplied by 10^4; and below, the differences, which indicate the increase in error from

x/c	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
Error	0	2	5	9	19	34	56	106	160	218	278	335	383	417
Increase	0	2	3	4	10	15	22	50	54	58	60	57	48	34

the previous station. There is clearly an increase in growth rate at $x/c = 0.6$. This is the station at which there is a change in the way the grid is constructed, see section 8.2.2.

From this examination of total pressure it is concluded that Moretti's method has the potential to predict total pressure correctly; that the solution FL3 appears to be accurate at the 60% station; that all solutions have significant errors at the 95% station; and that extrapolation of the FL and Wa solutions to zero grid spacing has possibilities.

Let us now look again at the static pressure and Mach number at the 60% and 95% stations, but now omit the results C, FL1, FL2, Mo1, Wa1, Wa2 and Wa3, each of which is known to be inferior to one of the other results. Fig 8-4 shows the plot for $1 - p/p_{i_\infty}$ at 60% and 95%, while Fig 8-5 shows the corresponding plot for Mach number. On each, the complete curves are shown for Wa4 and We; Mo2 is shown where it differs from both these two; and FL3 where it differs from all the previous three. As expected, in comparison with the plots of the same quantities in Figs 8-2 and 8-3, the spread of the solutions has been reduced. (Note that Fig 8-5a is on a larger scale than Fig 8-3a.) It is also clear that, as before, the agreement is closer on pressure than on Mach number, and closer at 60% than at 95% (note that Fig 8-5a is on a larger scale than Fig 8-5b). Figs 8-4b and 8-5b suggest that the slopes of the curves for We do not vanish at the centre line and leading edge, as regularity and symmetry require. Examination of the values in the adjacent table confirms this impression. On the other hand, away from the centre line and leading edge, the FL, Mo and We solutions lie close together, with the Wa solution significantly different.

arc cos y/a(x)	90°	87.5°	85.0°	0°	1.8°	3.7°
$1 - p/p_{i_\infty}$	0.9721	0.9726	0.9735	0.9435	0.9477	0.9565
M	2.972	2.986	3.008	2.518	2.572	2.692

The spread between the curves in Figs 8-4 and 8-5 is still rather large, and some other approach is needed in order to generate confidence in the accuracy of one or more of the solutions. In view of the success achieved so far, extrapolation to zero grid spacing is worth attempting. Three contributors provided results on different grids. Moretti's two grids are the same up to the 60% station, and beyond that the number of grid lines is doubled in one direction only. Systematic extrapolation from Mo1 and Mo2 is therefore impossible, but since the differences between them are small, this is not a serious disadvantage. The FL and Wa solutions will now be examined.

With the FL solutions there are two difficulties: there are no points common to all three of the solutions; and the solutions behave in an irregular way near the leading edge at the 95% station. The absence of common points means that an interpolation in the spanwise direction is needed before the extrapolation to zero grid spacing is possible. This process will be carried out for the extreme values: the pressure maxima at the centre line and the leading edge, and the pressure minimum which lies between them. The difficulty at the leading edge of the 95% station is apparent from Fig 8-6, in which the symbols show the calculated static pressure values very near the leading edge. The calculated values are slightly different at corresponding points on the upper and lower surfaces, given by positive and negative values of the abscissa. The pressure maximum therefore lies just below the symmetry plane, though there is only a very small difference between the pressure at the leading edge and the maximum. More serious for the present purpose is the irregular variation, most obvious in Fig 8-6 for FL2 on the positive (upper) side. FL1 behaves similarly, as is apparent over a rather larger range of values. FL3 behaves smoothly to graphical accuracy, but it must be assumed that a similar latent irregularity is present. It is clear from Fig 8-6 that the best that can be done is to extrapolate either the leading-edge values or the pressure maxima as read from a plot of this kind, with the understanding that there is a degree of arbitrariness in the way it is drawn.

Interpolation for the other extreme values is a much more reliable process. The first three lines in the adjacent table show the values obtained.

$1 - p/p_{i_\infty}$

Station	60%			95%		
Location	Centre line	Suction peak	Leading edge	Centre line	Suction peak	Leading edge
FL1	0.96527	0.96717	0.90973	0.97290	0.98973	0.9540
FL2	0.96532	0.96728	0.90913	0.97298	0.99000	0.9510
FL3	0.96532	0.96729	0.90867	0.97301	0.99011	0.9463
FL∞	0.96532	0.96729	0.90839	0.97302	0.99015	0.9427
Wa1	0.9647	0.9663	0.9109	0.9744	0.9882	0.9434
Wa2	0.9651	0.9668	0.9097	0.9738	0.9888	0.9435
Wa3	0.9648	0.9665	0.9113	0.9737	0.9886	0.9442
Wa4	0.9651	0.9669	0.9099	0.9734	0.9892	0.9436
Wa∞	0.9653	0.9673	0.9085	0.9730	0.9902	0.9424
Mo2	0.9652	0.9672	0.9088	0.9731	0.9901	0.9413
We	0.9657	0.9677	0.9082	0.9721	0.9901	0.9435

Except for the leading edge at 95%, they are believed to be accurate interpolations to the number of figures shown. The fourth line, labelled "FL∞" represents an extrapolation of the first three lines to zero grid spacing. It is based on Eq.(8-3), previously found suitable for the FL solutions, except that some small overshoots have been suppressed.

In the discussion above of the errors in total pressure, it emerged that the error in the Wa solutions is first order, at least at the 60% station. This suggests that, if h_1 and h_2 are characteristic dimensions of the grid spacings in the two directions, an element, f , of the solution should be written:

$$f(h_1,h_2) = f(0,0) + ah_1 + bh_2 + ch_1h_2 \quad .$$

It then follows that, if f_1 to f_4 are the values in the solutions Wa1 to Wa4, the value at zero grid spacing is:

$$f(0,0) = f_1 - 2(f_2 + f_3) + 4f_4 \quad . \qquad (8\text{-}6)$$

The values of $1 - p/p_{i_\infty}$ for the four solutions are given in the adjacent table, the peak values being obtained by simple interpolation. Below them, labelled 'Wa∞', are the values obtained by using Eq.(8-6).

We can now compare the extrapolated values FL∞ and Wa∞. On the centre line and at the suction peak, agreement is obtained to the number of figures quoted in the Wa solution. At the leading edge, there is a small discrepancy, increasing from 0.0001 at 60% to 0.0003 at 95%. This comparison greatly increases confidence in these two methods. There are two criteria by which a choice could be made between these extrapolations at the leading edge: the accuracy of the basic solutions and the distance of the extrapolations. The FL solutions are weakest at the leading edge, where the Wa solutions are strong (in terms of error in total pressure and regularity of behaviour). At 60%, the FL solutions require the shorter extrapolation, so the criteria are opposed, and a choice cannot be made. Fortunately, the difference is very small. At 95%, the Wa solutions require the shorter extrapolation, so the criteria agree, and the Wa∞ solution is to be preferred.

The solutions Mo2 and We are also included in the table. We can now pick out the contributed solutions which come nearest to the preferred limit, Wa∞. If the leading edge point at 95% is excluded, FL3 is closest. Since that point depends on how Fig 8-6 is drawn, such a basis for comparison has some validity. If that point is included, FL3 is the furthest from Wa∞. The closest is then We if the comparison is based on the maximum discrepancy, and the closest is Mo2 if the comparison is based on the standard deviation.

It appears from sample checks that the three quantities $1 - p/p_{i_\infty}$, M, and $1 - p_i/p_{i_\infty}$ in the solutions, FL, M, Wa and We are not independent. The relation:

$$\frac{1 - \left(1 - p_i/p_{i_\infty}\right)}{1 - \left(1 - p/p_{i_\infty}\right)} = \left(1 + \frac{M^2}{5}\right)^{3.5} , \qquad (8\text{-}7)$$

based on Eq.(8-5), holds between sample values. It might therefore seem pointless to examine the values of Mach number in addition to those of total and static pressure. However, it is not clear how the errors manifest in the total pressure are distributed between the estimates of static pressure and Mach number. The indications from the solutions for the 20% station are that the errors appear predominantly in the Mach number; but, since the contributors used somewhat different techniques to generate the 'conical' part of their solutions, it seems worth examining the values of Mach number at the downstream stations. Exactly the same procedures as were used above for $1 - p/p_{i_\infty}$ have been applied to the contributed values of M, including the use of a plot resembling Fig 8-6. The results are shown in the adjacent table.

M

Station	60%			95%		
Location	Centre line	Suction peak	Leading edge	Centre line	Suction peak	Leading edge
FL1	2.831	2.868	2.215	2.995	3.662	2.637
FL2	2.832	2.870	2.211	2.997	3.683	2.592
FL3	2.832	2.871	2.208	2.998	3.692	2.561
FL∞	2.832	2.871	2.206	2.998	3.695	2.543
Wa1	2.822	2.852	2.224	3.034	3.543	2.514
Wa2	2.828	2.860	2.215	3.018	3.580	2.515
Wa3	2.823	2.855	2.226	3.016	3.577	2.523
Wa4	2.828	2.862	2.216	3.009	3.613	2.517
Wa∞	2.832	2.870	2.206	3.000	3.680	2.505
Mo2	2.846	2.884	2.224	3.016	3.707	2.505
We	2.836	2.877	2.210	2.972	3.685	2.518

At the 60% station, the two extrapolations FL∞ and Wa∞ agree. This is to be expected from the foregoing comparisons. The agreement is less good at the 95% station, as would be expected from the poor convergance of the error in the total pressure in Wa, and the uncertainty near the leading edge in FL. The tables give the impression that the spread of values of Mach number between the contributors is rather larger than the spread of values of static pressure. To make a real comparison possible, like must be compared with like, so the tabulated values of Mach number were converted to pressure ratios, using Eq.(8-5), for the best solution from each contributor: FL3, Mo2, Wa4 and We. The mean and standard deviation (based on one fewer than the number of points) were computed for $(1 - p/p_{i_\infty})$ and $(1 - p/p_i)$ and are shown in the adjacent table. The standard deviation varies markedly from point to point, in the way we should expect, but

	60%			95%		
	Centre line	Suction peak	Leading edge	Centre line	Suction peak	Leading edge
$1 - \frac{p}{p_{i_\infty}}$ mean	0.9653	0.9673	0.9089	0.9729	0.9899	0.9437
sd × 10^3	0.263	0.330	0.719	0.560	0.452	2.047
$1 - \frac{p}{p_i}$ mean	0.9651	0.9671	0.9086	0.9727	0.9897	0.9437
sd × 10^3	0.386	0.465	1.034	0.787	0.629	2.137

at each point it is significantly greater for $(1 - p/p_i)$. Contributors calculations of Mach number are therefore more widely spread than their calculations of static pressure. This is an indication that the Mach numbers are less accurate than the static pressures. Consequently, the best approach to obtaining an accurate solution is to use the best estimate of static pressure $(1 - p/p_{i_\infty})$, together with the exact value of total pressure $(1 - p_i/p_{i_\infty} = 0.0114)$, and derive other quantities from these.

As to the best estimate of static pressure, the discussion above leads to the recommendation of the extrapolated values Wa∞. If the idea of using extrapolated values is rejected, the solution FL3 should be taken at the 60% station and inboard of the suction peak at the 95% station. Outboard of the suction peak at 95%, either Mo2 or We should be taken. Finally, if the idea of using elements of more than one solution is rejected, the choice between FL3, Mo2 and We is open.

8.2.4 Summary and reference solutions for case 13, the Butler wing

All the contributed solutions for the static pressure and Mach number on the wing lie reasonably close together, as indicated by the plots in Figs 8-2 and 8-3. Dr Chaussee's solution has a significantly larger error in the total pressure than the others, and is set aside for this reason. Prof Moretti's solutions are very close, suggesting convergence with respect to grid spacing has been achieved. However, his grid is only refined in one direction, so we cannot be sure of convergence; and his value for the total pressure on the wing surface has the wrong sign, introducing an unknown error. The three solutions of MM. Fenain and Lordon, on grids which are refined simultaneously in both directions, show little variation over the forward part of the wing. At the rear, there is more variation, but a satisfactory trend with reducing grid spacing is established everywhere except close to the leading edge. The four solutions of Prof Walkden are rather further from convergence with respect to grid spacing, as would be expected with a first-order method. However they, like the solutions of Fenain and Lordon, provide a firm basis for extrapolation to zero grid spacing. These two extrapolations lead to very nearly the same values for the static pressure over the whole wing and to very nearly the same values for the Mach number over the forward part of the wing. Towards the leading edge at the rear of the wing, the extrapolation of Walkden's results appears a little more reliable. It is also rather easier to perform since his finer grids are subdivisions of his coarse grid. The error which appears in the total pressure variations on the wing surface appears to affect the calculations of Mach number rather than those of static pressure, so the latter are assumed to be more nearly correct. Dr Weiland's solution looks good, apart from some doubts near the planes of symmetry, but the single solution offers no prospect for exploring sensitivity to grid spacing, or extrapolation to zero grid spacing.

The above considerations suggest that the best approach to obtaining definitive values at the 60% and 95% stations would be to extrapolate Walkden's solutions for static pressure to zero grid spacing and then use the known value of the total pressure on the wing surface (with constant total temperature) to obtain corresponding distributions of Mach number. This process provides the reference solution 'Wa∞' given in Table 8-1.

The largest number of grid points is used by Fenain and Lordon in solution FL3. In combination with a second-order algorithm, this provides a solution of great potential accuracy. At the 60% station, this potential accuracy seems to be realized, and the same is true over the inboard part of the 95% station. Consequently, the solution FL3 is given as a reference solution in Table 8-2. Because values are slightly different on the upper and lower surfaces, both are included in the table. The calculation is by a finite-volume method, with the corners of the volumes lying on the wing surface. The pressure is evaluated at a mid-point, which is therefore just inside the wing. Consequently the quoted values of y and z do not exactly satisfy the equation of the wing surface, and the approximations $\arccos(y/a)$ and $\arcsin(z/b)$ to the eccentric angle, θ, are slightly different. The column headed θ gives the eccentric angle of the closest point on the true surface to the mid-point of the grid at which the pressure is evaluated, and this should be regarded as the identifier of the point.

Near the leading edge at the 95% station, the FL solutions encounter a difficulty, so that FL3 remains further from the extrapolated solution than the solutions of Moretti and Weiland. These solutions are therefore listed as reference solutions in

Table 8-3 and 8-4. In Table 8-3, the values are at constant increments of eccentric angle: 3.75° at 60% in Mo1, 1.875° at 95% in Mo2.

Contributors did not indicate any grid dependence in their solutions at the 20% station, but it must be assumed that small truncation errors are present in all of them. The recommended solution for the 20% station is therefore one obtained outside the field of the Working Group's investigation, by K. Taylor at RAE, Farnborough, in which the extrapolation to zero grid spacing has been carried out. The results are:

$$1 - p/p_i = 0.8856 , \quad C_p = 0.2183 , \quad M = 2.064 , \quad 1 - p_i/p_{i_\infty} = 0.0114 .$$

Four of the contributed solutions lie within 0.0001 of this value for the static pressure and within 0.0002 of this value for the total pressure (with Moretti's sign error corrected).

The best result for the drag is obtained by extrapolating the solutions of Fenain and Lordon to zero grid spacing, to give:

$$C_D = 0.05963 ,$$

where the uncertainty is at least 2 in the last figure. The three contributors (FL, Wa and We) who calculated the drag all provided values within 0.00024 of this value.

Contributors were also asked to produce their solutions in graphical form. The plots by MM. Fenain and Lordon, in indian ink on tracing paper, are of high quality. Since their solution is in many ways the most accurate, their plots are reproduced. Since the other solutions differ so little, the plots of the other contributors are not reproduced.

Figs 8-7 and 8-8 present graphically the results of Table 8-2 for the solution FL3. All the plots are, as requested, against the distance from the centre line, expressed as a fraction of the local semi-span. Details near the leading edge, particularly at the 95% station, are therefore not resolved. The plots of static pressure and Mach number are typical of all the solutions received. The plots of total pressure show in general less variation, and levels closer to the exact value, than the other solutions; except that Moretti achieves an almost constant level over the whole surface, and Walkden achieves almost the correct level along the leading edge.

Fig 8-9 shows the contour lines of the same quantities, static pressure, Mach number, and total pressure, on the surface of the wing, as seen from above. These are for the solution FL2. When the plots of static pressure and Mach number contours are superimposed, it is clear they belong to a single family, as would be expected from the small variation in total pressure. In particular, the contours for $M = 3.2$ and $1 - p/p_{i_\infty} = 0.98$ coincide. Fig 8-9c illustrates clearly how the error in total pressure is concentrated near the tip. All the solutions except Moretti's show the largest errors in total pressure in this region. Moretti calculates virtually uniform total pressure over the wing surface.

In Figs 8-10 and 8-11 are shown contours of quantities in the flow field, between the wing and the bow shock, in the 60% and 95% planes, taken from solution FL3. Again the contour lines of static pressure and Mach number form a single family. The contours of total pressure show how the shock weakens from the plane of the wing round to the vertical plane of symmetry, and also from the 60% to the 95% station. The contours of static pressure and Mach number suggest the same variation of shock strength. For comparison, the value of $1 - p/p_{i_\infty}$ upstream of the shockwave is 0.9415. The contours of total pressure suggest that the errors in total pressure only arise close to the wing surface.

For comparison with the total pressure contours from FL3 shown in Figs 8-10c and 8-11c, the corresponding plots from Mo1 are shown in Fig 8-12. Correcting the obvious error in sign, we see there is a close similarity in the values away from the wing surface and Moretti's solution avoids the irregularities near the surface apparent in FL3. More detailed examination shows that corresponding contours in Mo1 lie a little closer to the wing, so that the total pressure is a little higher than that of FL3 at corresponding points. The intersections of the contours with the shocks show the shock in Mo1 is a little weaker than in FL3. Refining the grid in the FL solutions has very little effect on the shock strength, and it becomes stronger as the grid is refined. Examination of the corresponding plots for Wa1 and We shows the coarse mesh solution of Walkden produces the weakest of the four shocks, while in Weiland's solution the strength is intermediate between those in Mo1 and FL3. The greatest difference, that between FL3 and Wa1, is about 0.001 in p_i/p_{i_∞}. It represents a significant difference in the strength of the rather weak shock; but is only 0.1% of p_{i_∞}, corresponding to about 0.2° in shock angle.

8.3 Dillner wing - cases 14 and 15

8.3.1 Solutions received

Two test cases were proposed based on the Dillner wing (see Fig 5-9), the angle of incidence for both being 15°. For case 14, the onset Mach number is 1.5, and for case 15 it is 0.7. At the time of the last meeting of the Working Group, in September 1983, only one solution had been received for the two cases, calculated by Dr Rizzi of FFA. Since there was the promise of a solution from Dr Schmidt of Dornier, the deadline was extended. By mid-November, solutions for the two cases had been received from Dornier, Dr Rizzi had recalculated his solutions, and a solution for case 15 had been received from Dr C. Koeck of Matra. As a result of the extended deadline, this presentation has the advantage of extra material, but lacks the benefit of the opinions and scrutiny of the whole Group, being the work of Dr Rizzi and Mr Smith. All the solutions were obtained by time-marching methods, and all show the presence of leading-edge vortices, in qualitative agreement with the observations reported in Ref 8-5.

Not all of the details requested were provided by all the contributors, and time was too short to pursue enquiries. In particular, only Rizzi provided convergence histories, quoted final residuals, indicated the location of the outer boundary of the computed field, and presented contours of the vorticity. Only Koeck found the centre of pressure. Only Koeck and Rizzi showed details of their grids, calculated the overall lift and drag, and presented results downstream of the wing. The only evidence of convergence with respect to grid spacing comes from Rizzi's values for the overall forces calculated on a coarser grid. However, the results that were provided by all the contributors, in particular the static pressure, Mach number, and total pressure in cross-sectional planes, enable useful comparisons to be made. The complete set of results gives a good impression of the present capabilities of methods of this type.

The three contributors use grids of different kinds. Consider first the pattern of grid lines on the wing surface. Koeck and Rizzi use lines $x = \text{const}$ of constant distance downstream of the apex and rays $y/x = \text{const}$ through the wing apex. The Dornier tabulated values are at the intersections of lines $y = \text{const}$ at constant spanwise distance from the apex and rays $(s - y)/(c - x) = \text{const}$ through the wing tip. No detail is provided of the grid off the wing surface, but it is described as C-H type. In the cross-flow planes, $x = \text{const}$, downstream of the apex, both Koeck and Rizzi have O-grids. In the vertical plane of symmetry, Koeck has a C-grid and Rizzi an O-grid. Figs 8-13 and 8-14 illustrate the grids of Koeck and Rizzi. In view of the lateral symmetry only one half of the flow field is computed by all contributors.

In considering the grid densities used, it must be noted that, although all the methods are of finite-volume type, Koeck's method computes values at the corners of his volumes, while the methods of Dornier and Rizzi compute average, or cell-centre, values. So, if there are N cells along a particular line, Koeck will provide values at $N + 1$ points, while the others provide values at N points. Koeck has 36 cells along the length of the wing and 56 round the cross-section of the half-wing, making 2016 cells on the half-wing surface. There are a further 8 cells of the C-grid downstream of the trailing edge, and 16 cells between the wing and wake and the outer boundary of the computing space, making 39424 cells in the computing space. Rizzi has 28 cells along the length of the wing and 64 round the cross-section, making 1792 cells on the half-wing. There are 20 cells to the outer boundary, making 35840 in all. In the Dornier tabulations there are 23 spanwise stations and 102 rays through the tip, making 2346 points on the wing. So far as the average spacing on the wing is concerned, all three grids are similar, and all provide a concentration of grid lines near the leading edge. The Dornier grid provides a greater density of lines near the trailing edge, while the Koeck and Rizzi grids provide closer definition in the apex region.

Rizzi describes his computing space as extending five spans from the wing. This is less than four root-chords, which would be inadequate for a two-dimensional aerofoil, as is clear from section 6. However, the disturbance introduced by a wing of small aspect ratio decays much more rapidly both upstream and laterally. In the downstream direction, the disturbances do not decay. However, the upstream influence of the omitted portion of the vortex wake on the wing seems likely to be small in incompressible flow, and it will certainly be less at $M_\infty = 0.7$ and non-existent at $M_\infty = 1.5$.

Rizzi also provides a convergence history of his calculations. These start on a coarse grid, and are then interpolated to a fine grid and iterated to the steady state. At $M_\infty = 0.7$, the first 400 cycles on the fine grid sees the number of supersonic cells grow from zero to 689, the lift and drag increase by 10%, and the residual (defined as $\Delta\rho/\Delta t$) decrease by a factor of 63. In the second 400 cycles, the number of supersonic cells appears to level off at 848, the lift and drag change by less than 1%, and the residual decreases by a further factor of 5. The final maximum residual is below 10^{-4} and the average residual over the whole grid is just over 10^{-5}. The convergence is faster when the free-stream is supersonic. At $M_\infty = 1.5$, the final 400 cycles on the fine grid reduce the residual by a factor of 700, the levels of 3×10^{-5} for the maximum and 1.5×10^{-6} for the average. The lift and drag change by less than 1%. At this stage, only 17 of the mesh cells are subsonic.

Tabulated results were presented by all the contributors. The tabulations given by Koeck and Rizzi at the lengthwise stations close to those requested are reproduced as

Tables 8-5 to 8-7. The grid used in the Dornier calculation does not include lines of constant x, so interpolation was needed to produce data at the specified lengthwise stations. This data was presented graphically, but the tabulated data supplied by Dornier is along the 23 spanwise stations of the grid used. The differences between the contributed solutions are large enough to be seen in the graphical presentation, significantly larger than for the Butler wing. Reproduction of the very extensive Dornier tabulation has therefore not been attempted in the text, but is included in microfiche form.

8.3.2 Methods used

Dr Koeck writes of his method:

"The Euler equations are solved by a pseudo-unsteady type of method, with constant total enthalpy. The numerical scheme is that of Ron-Ho Ni, Ref 8-21. It is a one-step finite-volume scheme of the same type as the Lax-Wendroff scheme. Multiple-grid convergence speeding-up is used, with 3 grids (H-2H-4H). Inflow and outflow boundaries are treated using the compatability relations technique of ONERA. The artificial dissipation model is linear and of the second order." More details are given in Ref 8-22.

The method used by Dornier is the Jameson-Schmidt method, as used for the ONERA M-6 wing discussed in section 7, and similar to that used for the aerofoil sections discussed in section 6. An early version is described in Ref 8-23 and 8-24.

Rizzi's method is also the same as he used for the ONERA M-6 wing discussed in section 7. It is described in more detail in Refs 8-25 and 8-26. The common origins of Rizzi's method and the Jameson-Schmidt method are apparent from Ref 8-27. He writes:

"All the calculations have been carried out by A. Rizzi using mesh-generating and flow-solving software developed by Lars-Erik Eriksson and Arthur Rizzi at FFA. The isoenergetic (T_i = constant) Euler equations are stepped forward in time by an explicit three-stage Runge-Kutta type time-integration scheme using the local time step. All spatial derivatives are approximated by a centered finite-volume scheme. On solid walls a normal-momentum-equation technique determines the boundary pressure. At the farfield inflow/outflow boundary the First Approximation of Engquist's Nonreflecting Boundary Theory is implemented.

"The rationale for our artificial viscosity model is given in Ref 8-41 where we describe a combination of switched second-difference and (in 2D only so far) nonswitched fourth-difference dissipation added to the convective terms at the same time level. An important property of this model is that it is negative definite at each and every cell in the mesh. In other words if you consider only the dissipative operator Du in the absence of the convective terms, you can establish that the time decay of the "energy":

$$\frac{d}{dt} u^2 = u^T \frac{du}{dt} = u^T Du < 0$$

summed over all cells including those at the boundaries.

"Another important feature of our integration scheme is that if a steady state is reached, we can show that the original steady total-difference operator must be equal to zero independent of the time step (Ref 8-26).

"In all my calculations initial conditions are the uniform free stream. The solution in the ultimate fine mesh is approached by starting in a much coarser mesh and successively refining it to the fine mesh. Our method is a cell-centred one, and Mach number and $1 - p_i/p_{i_\infty}$ are extrapolated from the middle of the adjacent cells to the airfoil surface."

8.3.3 Assessment of results for test cases 14 and 15 (Dillner wing)

It is difficult to evaluate the results for these two cases, in part because our understanding of the physics of the flow field is still incomplete, and in part because they are among the first inviscid vortex-flow solutions of their type. In a sense we are just coming to grips with this class of problem. However, the solutions are compared, and those aspects that seem correct and others that are obviously incorrect are pointed out. The dominant feature of these two flow fields about the Dillner wing is the vortex over the upper surface of the wing, created by the rolling-up of the vortex sheet that is shed from the leading edge. Both fields contain regions of subsonic and supersonic flow, but, although shock waves are present in case 14, they are of secondary importance.

All the solutions are qualitatively realistic. A vorticity field above the wing is obtained, fed by a smeared sheet separating from the leading edge. Some limited experimental pressure measurements show that the static pressure distribution on the wing is being computed reasonably well, although the effects of secondary separation in the experiment cloud the comparison.

A qualitative impression of the flow field over the wing is given by Fig 8-15, taken from Rizzi's solution for case 15. The figure shows a view of the starboard half-wing from above, behind, and to the side, together with parts of three of the curved

grid surfaces which intersect the wing along lines of constant x/c . On each of the grid surfaces are drawn contours of the magnitude of $\underline{\Omega}$. If the vortex grew in a conical fashion, the vorticity would decrease linearly along its length from the apex; so, to produce more uniform values, the actual vorticity vector has been scaled-up in proportion to the distance from the apex to produce the vector $\underline{\Omega}$ whose magnitude is displayed in Fig 8-15. The approximately conical shape of the vortex is apparent, in accordance with observation. High levels of vorticity occur in the shear layer close to the leading edge, as can be seen most clearly at the 90% station. A further peak in the vorticity is present in the core of the vortex at 60% and 90%. At the 20% station the core is not distinguishable from the shear layer in this presentation.

A different kind of presentation of the kinematics of the whole flow is given in Fig 8-16, taken from Koeck's solution for the same case. Here it is the streamlines which pass through the leading edge that are shown. Fig 8-16a is a view of the starboard half-wing from above, and Fig 8-16b is a view of the port half-wing from above, ahead, and to the side. (Note that the curved line in Fig 8-16b is the upper side of the centre-section of the wing.) Again the approximately conical shape over the wing is apparent, but an impression is also given of the violent distortion of the vortex downstream of the trailing edge.

A third type of kinematic presentation is given in Fig 8-17, once more for case 15, and taken from the Dornier solution. Here the velocity vectors in the cross-flow plane are represented in magnitude and direction by arrows. The rapid variation in the magnitude and direction of the cross-flow velocity above and just outboard of the leading edge indicates the presence of a shear layer very clearly in Fig 8-17a. The elliptic shape of the core suggested by Fig 8-15 is confirmed by these pictures. A further departure from axial symmetry is the presence of much larger velocities beneath the core than above it.

To show the difference in the kinematics at $M_\infty = 1.5$, case 14, Fig 8-18 presents contours of the scaled velocity magnitude at the same lengthwise station, from Rizzi's solution. The distribution in Fig 8-18a is part of that depicted in Fig 8-15, but that in Fig 8-18b is for $M_\infty = 1.5$. It is clear that, with the supersonic free stream, the vortex extends further inboard and lies closer to the wing. There is also a difference in structure, with no indication of a peak of vorticity in the core. A similar shift in vortex position between subsonic and supersonic speeds has been osberved in real flows. The same shift of the vortex inboard and towards the wing is apparent in Fig 8-19, taken from the Dornier solution at the same station as Fig 8-18. Fig 8-19a is from the same sequence as Fig 8-17, with Fig 8-19b at the higher Mach number. The shear layer is equally marked in the two cases and it is clear that a vigorous vortex is present in both.

At this point it may be asked why it is that these solutions of the Euler equations include vortex structures at all, and it must be admitted that no satisfactory explanation can be given. It would be expected that there are other solutions of the exact equations in which the flow remains attached round the sharp leading edge of the wing, and no vortices are generated above it. If we attempt to describe the local behaviour of such a flow in terms of a uniform stream along the leading edge and a two-dimensional flow normal to it, we are led to a centred expansion to limiting conditions, followed, probably closely, by a shock. The shock strength must fall rapidly away from the surface, leading to an entropy gradient and vortical flow inboard of it. This local flow must be embedded in a more slowly varying outer flow, which is always subsonic in the plane normal to the leading edge. If such a flow does exist it would scarcely be possible to describe it on a grid as coarse as those in use, so it may be thought that the solutions obtained are the only ones representable on the grids used. A similar argument can be used to suggest why it is unnecessary to impose a Kutta condition at the trailing edge of a two-dimensional aerofoil. The situation seems to be quite different from the familiar one which arises with a linear governing differential equation, where attached and separated (vortex-sheet) solutions can be obtained, depending on the introduction of a Kutta condition. The question is considered further in Refs 8-29 and 8-30.

Further views of the overall flow are presented in Figs 8-20 to 8-22. These have the same structure as Fig 8-15, and also relate to case 15. They show contours of static pressure, Mach number, and total pressure respectively. The impression of geometric conicality given earlier is confirmed, and a close approach to conicality of the pressure and Mach number fields is revealed. The static pressure has a well-defined minimum along the axis of the vortex, though pressures almost as low extend to the wing surface. The Mach number has two maxima, one in the vortex and one on the wing. The flow is locally supersonic near both maxima. Rizzi finds no indication of a shock in the return to subsonic flow downstream of the trailing edge. The double peak in the Mach number is considered further below. The contours of total pressure in Fig 8-22 show minima of total pressure in the core of the vortex, with sharp fluctuations near the leading edge. The total pressure loss in the core is about a quarter of the free stream total pressure. This very large loss is discussed in detail later.

Similar pictures to these for case 14, with $M_\infty = 1.5$, reflect the features noted earlier, with the vortex lying closer to the wing. For this reason, they are less clear, and have not been reproduced. Instead, Fig 8-23, taken from the Dornier solution, is used to illustrate the difference in the static pressure field between the two cases. In the supersonic case, the static pressure levels are much lower, in terms of

the free stream total pressure, so that there are no contour levels common to Figs 8-21a&b. The pressure variation and gradients are also much smaller, with the level so close to zero. There is no defined minimum of the static pressure in the core at this 80% station, and the contours are squeezed closer to the wing.

To show more clearly the relation between the contours of Mach number and static and total pressure, Fig 8-24a has been drawn from the Dornier results for case 15 at $x/c = 0.6$. The solid curves show contours of $1 - p/p_{i_\infty}$ at 0.6, 0.5 and 0.4; the broken lines show the $M = 1$ contour; and the chain-dotted lines are the contours of $1 - p_i/p_{i_\infty}$ equal to 0.28 and 0.07. It is clear that the minima of static and total pressure lie close together: they may be taken as defining, in some sense, the axis of the vortex. The maxima of the Mach number are displaced symmetrically above and below this axis. A simple explanation is possible in terms of the isentropic relation Eq.(8-5)

$$\left(1 + \frac{\gamma - 1}{2} M^2\right)^{\frac{\gamma}{\gamma-1}} = \frac{p_i}{p} \quad .$$

From this we expect M to be high where p is low, unless p_i is also low. In Fig 8-24a the hole in the total pressure distribution superimposed on a slowly-varying static pressure distribution lowers the Mach number in the region of the hole. If the pressure contours had been axisymmetric, the Mach number would have peaked on a concentric circle. The actual pattern arises because the static and total pressure contours are flattened in perpendicular directions. To make the point more precisely, the variation of the three quantities along the normal to the wing passing through the vortex axis (indicated in Fig 8-24a) is shown in Fig 8-24b. The points in this figure have been read from contour plots and smooth curves have been drawn near them. The abscissa is the distance, n, from the wing, referred to the local semi-span, s. As n/s increases from zero, the static pressure is almost constant, so the Mach number falls and rises in sympathy with the total pressure. Away from the wing, the total pressure is almost constant, and the Mach number falls in sympathy with $1 - p/p_{i_\infty}$.

The origin of the loss in total pressure must now be considered. In a real laminar flow, or in the mean motion of a turbulent flow, vorticity is produced at solid boundaries (and at shocks of varying strength). At high Reynolds number and moderate Mach number, significant levels of vorticity are confined to thin boundary layers, the free shear layers that result from the separation of boundary layers, and the vortices which result from the rolling-up of the shear layers. These high levels of vorticity involve large gradients, so that in laminar flow viscous forces act, degrading mechanical energy and lowering the total pressure. In turbulent flow, energy is taken from the mean motion and added to the fluctuating motion, again lowering the total pressure of the mean flow. Thus, in real flows, regions of high vorticity usually coincide with regions of reduced total pressure. The exception is the recirculating or dead-water region, where the total pressure is reduced by the prolonged action of small viscous forces without an associated high level of vorticity. Such regions do not arise in the highly three-dimensional flow over a delta wing, so the association of low total pressure and high vorticity is justified for real flows of this kind.

However, this is not the case for inviscid flows, ie for exact solutions of the Euler equations. The connection between entropy and vorticity in steady inviscid flow is described by Crocco's equation:

$$\underline{V} \times \underline{\Omega} = - T \nabla s \quad , \tag{8-8}$$

where $\underline{V}$ is velocity, $\underline{\Omega}$ is vorticity, T is temperature, and s is specific entropy. From this it appears that a gradient of entropy or, equivalently, a gradient of total pressure, is associated with vorticity. In plane flow, for which $\underline{V} \times \underline{\Omega} = |\underline{V}||\underline{\Omega}|$, this is indeed the case. However, in three-dimensional flow $\underline{\Omega}$ may be parallel to $\underline{V}$, so that non-zero vorticity is compatible with uniform total pressure. This is the behaviour shown by the inviscid incompressible conical vortex solution of Hall (8-31) and Ludweig (8-32), and by the inviscid compressible conical vortex solution of Brown (8-33).

There is no doubt that, in the exact solution of the Euler equations to which the present numerical solutions approximate, the vorticity vector should be almost parallel to the velocity vector almost everywhere, with ∇s very small, corresponding to the production of entropy through weak shocks. No other mechanism for the production of entropy exists, so from uniform upstream conditions no large variations in entropy or total pressure are possible. The qualification 'almost everywhere' is needed because small differences in entropy over very small distances can make ∇s significant. Such small differences arise in flows past pointed bodies, because the stream surfaces which wet the upper and lower surfaces of the body originate from different lines on the bow shock, at which the shock strength is different. Subsequently these stream surfaces run together, leading to a singularity in the entropy. It is hard to believe that the present calculations are reproducing this behaviour, and, if they were, the associated variation in total pressure would be very small. In other words, the appearance of significant variations in total pressure in these calculations is the result of errors.

However important they are depends on how large they are, what they affect, and for what the calculations are to be used.

As will be seen in more detail later, the maximum losses in total pressure in these calculations lie between 25% and 35% of the free stream total pressure at $M_\infty = 0.7$, and between 50% and 65% at $M_\infty = 1.5$. In measurements of low-speed vortex flows, such as those of Hummel (8-34), the loss of total pressure in the core, due to the effects of viscosity, can be as large as the free stream kinetic pressure ($\frac{1}{2}\rho_\infty V_\infty^2$). At $M_\infty = 0.7$, the kinetic pressure is 25% of the total pressure, and at $M_\infty = 1.5$ it is 43%. The losses in the inviscid calculations therefore exceed the kinetic pressure, which is the level of loss produced by frictional forces in the real flow. An alternative measure of the size of the loss is the change in total pressure across a normal shock. For an upstream Mach number of 1.5, this is 7%; losses of 25% and 50% require Mach numbers of 1.9 and 2.5. Another assessment of the significance of the error is obtained by assuming the isentropic relation (8-5) holds; and supposing first that the static pressure is correct, so the whole error appears in the Mach number, and second that the Mach number is correct and the whole error appears in the static pressure. Consider a point on the axis of the vortex illustrated in Fig 8-24. If p/p_{i_∞} is correct and p_i were equal to p_{i_∞}, the isentropic relation gives a Mach number of 1.23, in comparison with the value of 0.89 actually calculated. If, on the other hand, the Mach number is correct at 0.89, with p_i equal to p_{i_∞}, the value of $1 - p/p_{i_\infty}$ would be 0.4 from the isentropic relation, instead of 0.6 from the numerical solution. It is hard to imagine any purpose for which such crude estimates would be useful.

However, these errors may well be confined to the core of the vortex. Indeed, since viscous forces do produce local changes of this magnitude, and inviscid models do yield useful agreement with real flows elsewhere (see, eg Ref 8-35), it is certainly quite possible for the effects of the errors to be localized. It must, of course, be established that this is the case; and this can only be done by comparison with solutions of a different kind, or by comparison with experimental data. Such a comparison with experimental data will be presented below. Before this, the examination of the vortex properties is completed*.

The adjacent tables show the coordinates of the apparent axis of the vortex, referred to the local semi-span, s, as determined by various criteria from the results of the three contributors. The first table is for case 14, for which only two solutions are available. The second table is for case 15, with results from all three contributors. The criteria are:

the location of the minimum in the static pressure, denoted by 'p';

the location of the minimum in the total pressure, denoted by 'p_i';

the point at which the cross-flow velocity vanishes, denoted by 'velocity';

the location of the maximum in the scaled vorticity, denoted by '$|\underline{\Omega}|$'

and the axis about which the streamlines spiral (Fig 8-16), denoted by 'streamlines'.

As explained above, the maxima in the Mach number are known to be displaced from the axis, so the Mach number maximum is not used as a criterion. A particular criterion does not always determine a location at a particular station in a particular solution: 'not det.' then appears in the table. Sometimes the determination is speculative: a '?' qualifies these. The absence of an entry simply means that no plot was available from which a determination could be made.

Of the different criteria, 'p' is unsatisfactory in the supersonic case, because no closed contours of static pressure appear in the core. The total pressure provides a well-defined centre, but its significance is not obvious in view of the above discussion of the origin of total pressure variations. The contours of the magnitude of the vorticity form a ridge, with no peak, at 20% and at $M_\infty = 1.5$, so their utility is limited. The point of zero cross-flow velocity is easily found from plots like Fig 8-17, but it clearly does not correspond to any physical property of the vortex core. The kinematic property of the core is that the velocity vector normal to it vanishes, but this only defines it as a streamline. Its characteristic feature is that is a streamline of small curvature (and torsion). This can be used to provide the 'streamline' criterion, but detailed plan and side views would be needed to give full information. If the axis is assumed to be a conical ray through the apex, then a plot like Fig 8-17 can be used to find the axis if the velocity scale is given. In its absence all that can be said is that the true axis is somewhat below and outboard of the position tabulated against 'velocity', at least over the wing, where the axis is approximately a conical ray.

---

* See Appendix 8-A for additional results from Rizzi with more refined grid.

Position of vortex axis, case 14, $M_\infty = 1.5$

	Station	20%	60%	80%	95%	150%
Source	Criterion	Coordinate				
Dornier	p	y/s	0.815	0.775	0.74	0.71	
		z/s	not det.	not det.	not det.	not det.	
	p_i	y/s	0.815	0.74	0.69	0.67	
		z/s	0.130	0.185	0.185	0.17	
	velocity	y/s	not det.	0.605	0.60	0.645	
		z/s		0.23	0.22	0.19	
Rizzi	p	y/s	0.80	0.72	0.685	0.69	
		z/s	not det.	not det.	0.165(?)	0.175(?)	
	p_i	y/s	0.76	0.685	0.62	0.615	0.615
		z/s	0.18	0.19	0.18	0.16	0.275
	$\underline{\Omega}$	y/s	not det.	not det.	not det.	0.58(?)	0.57
		z/s				0.16	0.215

Position of vortex axis, case 15, $M_\infty = 0.7$

	Station	20%	60%	80%	95%	115%	150%
Source	Criterion	Coordinate					
Dornier	p	y/s	0.81	0.80	0.755	0.75		
		z/s	0.27	0.21	0.22	0.22		
	p_i	y/s	0.82	0.77	0.76	0.755		
		z/s	0.22	0.21	0.22	0.20		
	velocity	y/s	0.60	0.74	0.74	0.73		
		z/s	0.35	0.26	0.25	0.245		
Koeck	p	y/s		0.71	0.72	0.72	0.775	
		z/s		0.205	0.19	0.185	0.30	
	p_i	y/s		0.725	0.72	0.73	0.79	
		z/s		0.205	0.185	0.18	0.305	
	velocity	y/s		0.69	0.69	0.70	0.79	
		z/s		0.25	0.23	0.20	0.285	
	streamlines	y/s				0.72		
Rizzi	p	y/s	0.825	0.775	0.77	0.77		
		z/s	0.21	0.20	0.18	0.165		
	p_i	y/s	0.80	0.76	0.755	0.755		0.765
		z/s	0.23	0.205	0.19	0.195		0.265
	Ω	y/s	not det.	0.81	0.79	0.785		0.830
		z/s		0.20	0.185	0.165		0.250

With these considerations in mind, let us see how far the different determinations agree. We concentrate on case 15, for which the definition is better, and neglect the 'velocity' criterion in the first place. Consider first the dynamic criteria 'p' and 'p_i'. In the Dornier solution, these determinations agree within 3%, apart from the effect of rather poor resolution at 20%, and the differences are not systematic. In Koeck's solution, the determinations agree within 1.5%. In Rizzi's solution, they agree within 3.5%, and again the differences are not systematic. It therefore appears that these two dynamic definitions agree. Are the kinematic determinations significantly different? The 'streamline' criterion in Koeck's solution gives the same lateral position. The '$|\underline{\Omega}|$' criterion in Rizzi's solution gives the same vertical position, but seems to place the axis a little too far outboard. This may be the effect of the high values of $|\Omega|$ in the shear layer. Finally, we see that the 'velocity' criterion does place the vortex above and inboard of the other determinations. It therefore appears that the dynamic and kinematic axes are not significantly different.

We can now look for variations in the position of the vortex axis along its length. The Dornier results show an inboard displacement of the vortex, relative to the

semi-span, from front to rear of the wing. Most of this takes place between the 20% and 60% stations. Rizzi's results are less clear cut, but show a trend in the same direction, particularly for case 14. Koeck's results are not available at the 20% station, and the results further back over the wing show no definite trend in lateral movement. They do show a vertical movement towards the mean plane of the wing. This is supported by Rizzi's results and, to some extent, by Dornier's. These variations are consistent with a pattern which is basically conical, somewhat modified by effects of wing thickness. Observations, Ref 8-36, and calculations, Ref 8-37, show that small amounts of thickness on conical wings do displace the vortex cores upwards and outwards. Behind the trailing edge the axis, referred to the maximum semi-span of the wing, maintains its lateral position. Koeck's results show it moving rapidly upwards, relative to the plane of the wing, in case 15, while Rizzi's results suggest a subsequent movement back towards the wing plane, although the height above the wing plane remains much greater than it was at the trailing edge. As would be expected from earlier discussions, there is general agreement that the vortex axis is further inboard and nearer the wing when the freestream is supersonic.

As a comparison between the predictions of the different contributors, we choose the most sensitive common criterion 'p_i' in case 15. The largest difference is then 4.5% semi-span, in lateral position, with Koeck's vortex lying further inboard than those of Dornier and Rizzi. This discrepancy is similar to, but rather smaller than, the discrepancy between low-speed measurements and vortex-sheet calculations, which has been attributed to the neglect of secondary separation in the vortex-sheet calculations.

The actual peak values of the flow variables in the vortex core are displayed in the adjacent tables, according to the solutions of the three contributors. The values are taken from contour plots, so a range is usually quoted. Gaps mean either that no contour plot was supplied, or that the core is not distinguishable from the shear layer. The values of static and total pressure and vorticity magnitude correspond to more or less the same point in the flow, but the Mach number values are taken at the peak which lies above the vortex axis, as shown in Fig 8-24. For the supersonic free stream, the static pressure falls from front to rear over the wing, and the Mach number increases. A real effect of wing thickness may be involved, but there may also be an effect of the rather sparse grid used by Dornier near the apex. The very large total pressure loss is noteworthy, as is the large increase in Mach number between the 80% and 95% stations in Rizzi's results. Except at 20%, the solutions agree quite closely.

Peak values in the vortex, case 14

Source	Station	$1 - p/p_{i_\infty}$	M	$1 - p_i/p_{i_\infty}$	$\lvert\Omega\rvert$
Dornier	20%	0.875-0.9	1.8 -1.85	0.6 -0.64	
	60%	0.925-0.95	2.15-2.2	0.64	
	80%	0.925-0.95	2.3	0.64-0.68	
	95%	0.925-0.95	2.3 -2.35	0.64-0.68	
Rizzi	20%	0.9 -0.95	2.0 -2.1	0.5 -0.6	
	60%	0.9 -0.95	2.2 -2.3	0.5 -0.6	
	80%	0.95 -1.0	2.4 -2.5	0.5 -0.6	
	95%	0.95 -1.0	3.0 -3.1	0.5 -0.6	0.8-0.9
	150%		2.0 -2.1	0.65-0.7	0.5-0.6

Peak values in the vortex, case 15

Source	Station	$1 - p/p_{i_\infty}$	M	$1 - p_i/p_{i_\infty}$	$\lvert\Omega\rvert$
Dornier	20%	0.5 -0.525	0.9 - 0.95	0.22 -0.24	
	60%	0.6 -0.625	1.05-1.1	0.32 -0.34	
	80%	0.625-0.65	1.0 -1.05	0.36 -0.38	
	95%	0.525-0.55	0.85-0.9	0.36 -0.38	
Koeck	61%	0.625-0.65	1.05-1.1	0.225-0.25	
	79%	0.65 -0.675	1.1 -1.15	0.25 -0.275	
	94%	0.625-0.65	1.05-1.1	0.25 -0.275	
	115%	0.525-0.55	0.9 -0.95	0.25 -0.275	
Rizzi	20%	0.55 -0.6	0.95-1.0	0.3 -0.35	
	60%	0.6 -0.65	1.05-1.1	0.25 -0.3	0.5-0.6
	80%	0.6 -0.65	1.05-1.1	0.3 -0.35	0.7-0.8
	95%	0.55 -0.6	0.85-0.9	0.3 -0.35	0.6-0.7
	150%		0.75-0.8	0.3 -0.35	0.4-0.5

For the subsonic free stream, there is a much greater departure from conical flow, with the upstream influence of the trailing edge increasing the static pressure and reducing the Mach number at the 95% station. This is most marked in the Dornier results and, since their grid is relatively dense near the trailing edge, it is to be expected

that their prediction is correct. On the other hand, near the apex their grid is less dense, and Rizzi's lower pressure and higher Mach number are to be preferred. At 60% and 80% all three solutions for the static pressure and Mach number agree quite closely. Koeck and Rizzi have almost constant levels of total pressure loss, with Koeck's being smaller. The Dornier loss of total pressure increases from front to rear, straddling the values from the other solutions. It appears that the total pressure loss in the vortex may vary inversely with the grid spacing. Vorticity values increase back to the 80% station, perhaps as a result of better resolution, and then fall, perhaps because a decrease in velocity produces 'vortex contraction', the opposite process to vortex stretching.

The flow field close behind the wing is illustrated by the four parts of Fig 8-25, showing conditions in a plane 15% of the root chord behind the trailing edge, taken from Koeck's solution for case 15. Fig 8-25a shows the cross-flow velocity vectors, where here the cross-flow is defined as normal the the free stream, rather than to the wing centre line, as it is in the earlier pictures of flow over the wing. The straight line is a section through a constant-span extension of the mean plane of the wing. The leading-edge vortex is clearly visible, with a more complicated structure below and outboard of it. This latter structure is the major part of the vortex wake shed from the trailing edge, swept outwards and upwards by the leading-edge vortex. Its sense of rotation is clockwise, in this view from behind. Fig 8-25b shows the contours of static pressure. The low pressure region centred on the leading-edge vortex is drawn out sideways and downwards by the presence of the trailing edge vortex. Fig 8-25c is the corresponding picture for the total pressure. The two vortices now appear quite distinct, with the remains of the shear layer joining them. It is remarkable that the total pressure has dropped nearly as low in the trailing-edge vortex as in the leading-edge vortex, despite its more recent formation. If this had been a picture of the real flow, we might have expected to see just such regions of reduced total pressure; but there would also have been a band of low total pressure in the viscous wake from the trailing edge. The small region of increased total pressure is a product of numerical error with no analogue in a real flow. The unlabelled Mach number contours of Fig 8-25d can be interpreted with the help of the two previous parts. The two islands which lie within the M = 0.8 contour also lie within the low static pressure region of part b, one on each side of the inboard region of low total pressure in part c. Consequently they represent Mach number peaks, rising above 0.9 in each case. The outboard island in part d lies in the outskirts of the low static pressure region and approximately coincides with the outboard region of low total pressure. It is therefore almost certain that this represents a hole in the Mach number distribution, going down below 0.6.

Plots of the flow further downstream, 50% of the root chord behind the trailing edge, are shown in Fig 8-26, taken from Rizzi's solution for case 15. Again the straight line represents a downstream constant-span extension of the wing plane. The 'profile' surrounding it should be ignored. The two parts of the figure show the total pressure and vorticity magnitude contours. Both these quantities indicate the leading and trailing-edge vortices, as seen in Fig 8-25. However the total pressure loss in the trailing-edge vortex is now much less than in the leading-edge vortex. It is not clear whether this is a feature of the different numerical solution or of the different downstream station. The peak levels of vorticity magnitude in the two vortices, on the other hand, are the same, though the dominant, streamwise component of the vorticity should have the opposite sign in the two vortices. The larger area of the leading-edge vortex indicates that its circulation is greater, as indeed it must be if the wing is to produce positive lift. The relative orientation of the two vortices is rather surprising. The stronger leading-edge vortex should be driving the weaker trailing-edge vortex round it, in an anti-clockwise sense, yet the orientation in Fig 26 is almost the same as that further upstream in Fig 8-25. Either the solutions of Koeck and Rizzi behave somewhat differently, or the relative rotation of the vortices is very much slower at M_∞ = 0.7 than it is in the familiar low-speed context of Ref 8-34.

For case 14, Fig 8-27 shows the contours corresponding to Fig 8-26. There is a qualitative similarity between the figures, but some significant differences. As we expect by now, the leading-edge vortex is further inboard at the higher Mach number, and the total pressure loss is twice as large. The total pressure loss in the trailing-edge vortex is now as large as it is in the leading-edge vortex. The vorticity magnitude in the leading-edge vortex is a little larger than it is in the subsonic case, but that in the trailing-edge vortex is smaller.

Another view of the flow field of case 14 is the plot of static pressure contours in the plane of symmetry, taken from Rizzi's solution, and shown in Fig 8.28. The bow shock below the wing is apparent, weakening as it extends further from the wing. The much stronger trailing-edge shock above the wing is also clear. It also weakens, on account of the three-dimensionality of the flow, as it extends further from the wing. In the absence of wing thickness, the flow field forward of the trailing edge would be conical and the pressure on the centre-line of the wing would be constant. As it is, there are smooth expansions on both the upper and lower surfaces. The amount of pressure adjustment downstream of the trailing-edge wave systems is unexpected. From its symmetrical form it appears to be associated with the wing thickness.

Contours of static pressure on the wing surface were provided by all contributors. Fig 8-29 is taken from the Dornier solution for case 15. The other contributors' plots are similar. The principal common feature is the ridge of suction running beneath the leading-edge vortex. The variation in pressure along this ridge shows that, despite the

conical shape of the vortex and the small variation of properties along its axis, the overall flow over the wing is far from being conical. There are at least three causes of this, two of them physical and one numerical. The first physical cause is the non-conical thickness distribution. This has a direct effect, visible in the pressures along the centre line in Fig 8-29, and on the lower surface in Fig 8-30. It also has an indirect effect in that the angle included between the upper and lower surfaces of the wing at the leading edge is greatest near the apex, resulting in a weaker vortex there, according to the calculations of Ref 8-37 The second physical cause is the elliptic nature of the flow equations in most of the flow field, so that, in particular, the presence of the trailing edge is felt upstream of it and the suction falls off before the trailing edge is reached. The importance of this is brought out by comparison with Fig 8-31, taken from the Dornier solution for case 14. Here the governing equations are hyperbolic almost everywhere and the upper surface suction ridge is maintained until it terminates in a cliff at the trailing edge shock shown in Fig 8-28. The non-physical cause is the inability of the finite grid to represent the detail of the flow near the apex, which is a singular point of the exact solution.

Contours of total pressure and Mach number on the wing were also provided by all the contributors. These are not very informative, since the total pressure variation is complex, with much of it occurring very near the leading edge, while the variation of Mach number parallels that of the static pressure, except very near the leading edge. Consequently these plots are not reproduced.

To see the variation of the flow quantities on the surface in more detail, comparative plots of the static pressure, Mach number, and total pressure at the various lengthwise stations have been prepared. These are presented in Figs 8-32 to 8-37. The first three relate to case 14, for which $M_\infty = 1.5$, and for which two solutions are available. The second three relate to case 15, at Mach number 0.7, for which all three contributors provided solutions.

Fig 8-32 shows the static pressure variation, as calculated by Dornier and Rizzi, at the 20%, 60%, 80% and 95% stations, for case 14. Agreement between the solutions is very good, with the prospect that agreement on the overall lift could be even better, since some of the lift lost from the suction peak in the Dornier solution is recovered further inboard. At the 20% station the Dornier distribution looks crude. This arises from the type of grid used. The line x = const. is not a grid line on the surface and relatively few grid lines cross it. Consequently some care is needed to produce a smooth variation along the line. The effect is that the plotted points, which appear as corners on the curves, are more accurate than the lines connecting them. The stations further downstream are also affected near the leading edge.

Fig 8-33 shows the Mach number variation. Agreement on the lower surface remains very good, when the comments above about the Dornier data handling are borne in mind. This is certainly not the case on the upper surface, where the maximum discrepancy in Mach number exceeds 0.3. Moreover, the spikes in both solutions look extremely unphysical. (Rizzi's spikes look sharper because his data points are spaced more closely.) By now, we know to look for the explanation in the values of total pressure, shown in Fig 8-34. This figure has been prepared on a scale which is appropriate for the small losses in total pressure on the lower surface, but which turns out to be rather large for the losses on the upper surface. At the 20% station, in particular, most of the upper surface distribution in the Dornier calculation is off the plot; and there are spikes running off the plots, both up and down, at all stations. Throughout, the lower surface values are small and fairly smooth, except at the leading edge itself. (It is worth pointing out that the smallness of the errors in total pressure is related to what seems achievable. In the Butler wing solutions, case 13, errors of 0.01 were treated seriously.) On the upper surface, at 20%, the larger total pressure loss in the Dornier solution explains the lower values of the Mach number. Two upward spikes, with a downward spike between them, in Rizzi's total pressure distribution correspond to the two downward spikes, with an upward spike between them, in his Mach number distribution. Further aft, the level of total pressure loss in the Dornier solution reduces and the Mach number levels come closer together. This reduction in total pressure loss on the wing from front to rear is opposite to the increase described above in the total pressure loss along the axis of the vortex. It must be remembered that the losses in the vortex are greater than those on the wing. We may guess that they spread out from the core by a process of numerical diffusion, so that the loss on the wing is greatest near the apex, where the vortex is closest to the wing. Near the leading edge, where a low total pressure on the upper surface meets a high total pressure on the lower surface, a ringing oscillation appears, with resemblance to Gibb's phenomenon. This tentative explanation is based on the behaviour of the Dornier solution. In Rizzi's solution, the upper surface total pressure is actually above the lower surface value (and above the free-stream level) towards the rear of the wing, and this defies explanation at present. The relation between the spikes in Mach number and total pressure can be followed throughout the plots. In particular, the outboard hump on the Mach number peak in the Dornier solution at 95% corresponds with the downward-going spike which runs from top to bottom of the total pressure plot.

It appears from these comparisons that the erroneous total pressure losses are affecting the Mach number more than the static pressure: firstly because the two methods produce different total pressure losses and different Mach number distributions, but about the same distribution of static pressure; and secondly because within each solution violent local changes in total pressure are associated with violent local changes in Mach number, but smooth distributions of static pressure are obtained.

We now turn to the more complex three-way comparison for case 15 at Mach number 0.7. The static pressures are shown in Fig 8-35. The solutions of Dornier and Rizzi are in good agreement over the first 60% of the wing, and this persists further aft on the lower surface. At 95% the suction peak in the Dornier solution seems more affected by the proximity of the trailing edge, and this effect seems to extend forward to 80%. The solution of Koeck contains a peak on the upper surface just inboard of the leading edge at 20% and 60%. This has vanished at 95% and, as will be seen in Fig 8-39, it is very small at 80%. It seems unlikely to correspond to any behaviour of the exact inviscid solution or of the real flow. Otherwise, Koeck's solution agrees with the other two on the lower surface. At the 95% station it is closer to Rizzi's solution than to Dornier's. This last feature seems likely to be related to the grids used, and so the Dornier solution is preferred because the grid on the wing is denser near the trailing edge.

The Mach number variations in Fig 8-36 are again explicable in terms of the static pressure and total pressure variations, Fig 8-37. The total pressure losses in both the Rizzi and Dornier solutions are consistently lower than at $M_\infty = 1.5$, and the levels are also closer together. Agreement in Mach number between the two solutions is also better at $M_\infty = 0.7$. The sharp leading edge peaks in Koeck's static pressure do not appear in the Mach number, apparently because of peaks in the total pressure loss. The loss of total pressure in Koeck's solution decreases away from the apex, until it is the lowest of the three at the 95% station. It is also the lowest of the three in the vortex core and along the centre line of the wing. Rizzi again finds total pressure values above free-stream level on the upper surface over the rear of the wing.

The results for case 15 support the view that, in the calculations of Dornier and Rizzi, the error in total pressure affects the Mach number rather than the static pressure. This is not clear in Koeck's solution, where the large total pressure loss at the 20% station is associated with static pressure and Mach number distributions which both appear to be unphysical. Unfortunately, Koeck did not supply flow field information at the 20% station.

It has to be remembered that the static pressure plays a special role in methods of the Jameson-Rizzi-Schmidt family, in that the smoothing operators are based on variations in pressure. It would seem therefore that sharp pressure variations are likely to be inhibited. Moreover, if sharp variations in a quantity appear anywhere in the time-evolution of a solution, such as a variation in density across a shear layer, sympathetic variations in pressure are likely to emerge. These will invoke the smoothing operator, and the static pressure will be smoothed at the cost of a truncation error which appears as a loss in total pressure. Clearly a loss in total pressure in the shear layer shed from the leading edge will be convected into the core of the vortex.

The plots in Figs 8-32 to 8-37 do not reveal what is happening very close to the leading edge, in particular in the Dornier solution. Fig 8-38 has therefore been prepared from the tabulated solutions for case 15. To obtain the Dornier curve, values have been transferred from the constant y stations to the $x/c = 0.6$ station of the plot along rays through the apex, exploiting the approximate conicality of the flow. A proper interpolation scheme could have been used, but seemed unnecessary. Only the static and total pressures are shown, since the Mach number appears to follow from them, and only a very small part of the section near the leading edge is covered. The section is unfolded, so that the plots run from lower surface to upper surface across the page. The curves are based on 30 points from the Dornier solution, 14 points from Rizzi's solution and 11 from Koeck's. There is some arbitrariness about how the curves of static pressure are drawn. A discontinuity in slope at the leading edge is strongly indicated in the distributions of Koeck and Rizzi, and would be expected in an exact solution in which a vortex sheet leaves the edge tangentially to the lower surface. A second slope discontinuity has been admitted in the Rizzi curve, without physical justification, because the numerical values suggest its presence. It is not peculiar to this station.

The Dornier results suggest that an attempt to reproduce a discontinuity in slope has been confused by a small oscillation. The previously remarked agreement on the lower surface, in both static and total pressure, appears again, as does the agreement between Dornier and Rizzi about the static pressure on the upper surface. All three solutions predict the total pressure on the upper surface differently. Away from the immediate neighbourhood of the edge, Dornier shows a constant loss of total pressure relative to the lower surface, Rizzi shows a small and roughly constant gain in total pressure, and Koeck has a loss which increases steadily to a value greater than Dornier's. The transition between the two levels in the Dornier result is by a step change, only slightly perturbed by oscillations. Rizzi has an oscillation as large as the total change in the Dornier solution, and Koeck has a larger oscillation than this. These results suggest that Rizzi and Koeck may be suppressing a tendency towards an oscillation in static pressure at the cost of a larger oscillation in total pressure. The leading edge is the obvious place for a jump in total pressure, with the flow leaving the wing on two sides of a vortex sheet. The Dornier solution reproduces just such a discontinuity. However, since we do not believe there should be variations in total pressure, it is not clear how we should wish the methods to perform. There is no suggestion that the losses in total pressure originate at the leading edge: in this Dornier solution the step at the leading edge is only 10% of the overall loss in total pressure.

Some confirmation of the view that the static pressure is being computed correctly comes from a comparison with the experimental measurements of Ref 8-5. Only the upper surface of the 80% station was instrumented. The comparison is shown in Fig 8-39 for C_p ($= (p - p_\infty)/\frac{1}{2}\rho_\infty V_\infty^2$) for the two cases. The measurements at $M_\infty = 0.7$ are typical of a flow in which the boundary layer flowing outboard under the primary vortex is turbulent, and is therefore able to withstand a considerable rise in pressure from the suction peak before separating to form a secondary vortex. Previous experience (Ref 8-38) with vortex-sheet models at low speeds suggests that such measurements agree more closely with inviscid flow models than do measurements made with laminar boundary layers. The latter separate after a smaller pressure rise, and the interaction produces a broader, lower peak. The inboard shift of the suction peak from its calculated position has previously been attributed (Ref 8-38) to a displacement effect of the secondary vortex. It should be added that attempts to introduce an inviscid model of the secondary vortex (Ref 8-39) have not led to more realistic pressure distributions: instead of the constant pressure level apparent outboard of the suction peak in Fig 8-39, a further narrow peak is calculated. This may be because, at wind-tunnel Reynolds numbers, the height of the secondary vortex above the wing is little more than the boundary layer thickness, so an inviscid model is inappropriate. The problem of the representation of the secondary separation remains the chief obstacle to the reproduction of measured pressure distributions, as it has been since 1968.

Fewer detailed experiments have been carried out at supersonic speeds. Observed suction peaks usually resemble that shown in Fig 8-39 for $M_\infty = 1.5$, but it is not known whether the state of the boundary layer under the primary vortex has any significant effect. The oil-flow picture in Ref 8-5 does show an outboard shift of the secondary separation line between 30% and 40% of the length from the apex. This is almost certainly a sign of transition in the boundary layer, well ahead of the pressure measuring station. The distributions in Fig 8-39 can therefore both be taken to be associated with turbulent secondary separation.

At $M_\infty = 0.7$, the calculated results agree with the measurements inboard, and straddle the height of the measured suction peak. Presumably, small changes to the methods would bring about much closer agreement. As explained above, it is doubtful whether any inviscid method can reproduce the observed pressure distribution between the suction peak and the leading edge. At $M_\infty = 1.5$, the agreement is not quite so satisfactory. Both calculated peaks are too low and too broad, missing the shape of the observed peak. We may guess that this is associated with the total pressure loss in the vortex core, for which the Dornier prediction is somewhat greater than Rizzi's.

Finally, the overall force data is presented. The adjacent table shows the contributed values of the lift and drag coefficients. The only calculation of the centre of lift is by Koeck, for case 15. He finds it at x/c = 0.6055. Rizzi's coarse grid has half as many cells along the length of the wing as his fine grid. Use of it underestimates the lift and drag by about 10%. The agreement between the results of Koeck and Rizzi for case 15 is very striking, but in view of the sensitivity to grid spacing and the differences in upper surface pressure distribution apparent in Fig 8-35, the closeness of the agreement must be regarded as somewhat coincidental. Rizzi's lift for case 14 is comparable with the value from supersonic linearized theory:

	Case 14, $M_\infty = 1.5$		Case 15, $M_\infty = 0.7$		
	Rizzi (coarse)	Rizzi (fine)	Rizzi (coarse)	Rizzi (fine)	Koeck
C_L	0.482	0.526	0.604	0.676	0.678
C_D	0.135	0.147	0.156	0.171	0.171
$C_L \tan\alpha$	0.129	0.141	0.162	0.181	0.182

$$C_L = \tfrac{1}{2}\pi A\alpha \Big/ E\left(\sqrt{1 - \beta^2 A^2/16}\right) = 0.519 \ .$$

There is some evidence in Ref 8-28 that the measured lift is close to the linearized theory estimate for a Mach number and aspect ratio close to the present. In the subsonic case, the drag is about 5% less than $C_L \tan\alpha$, which is consistent with a favourable axial force arising from the interaction between the vortex flow and the wing thickness distribution. In the supersonic case, C_D is about 5% greater than $C_L \tan\alpha$; this is consistent with a wave drag due to wing thickness which outweighs any favourable interaction with the vortex flow.

8.3.4 Conclusions and recommendations - vortex flow calculations

Three methods of broadly similar type, but with significant differences, using grids of similar overall density, but of different types, have all produced vortex flows

with the same principal features, but with significant differences of level. Differences with measured values of static pressure are comparable with differences between the predictions at the 80% lengthwise station, where agreement between the methods is closest. Very large losses in total pressure, greater than the free-stream kinetic pressure, are calculated in the cores of the vortices. Although these are comparable with those produced by viscous forces in real flows, they represent large errors in the inviscid solutions. Oscillations in total pressure arise near the leading edge on the upper surface, with sympathetic oscillations in the Mach number. The calculated static pressure appears to be more reliable than the calculated Mach number. A better estimate of the Mach number in an inviscid flow would be obtained from the calculated static pressure and an assumption of homentropic flow, at least upstream of the trailing edge shock.

The methods all show great potential, but, in view of the magnitude of the errors, there is a need to validate them by further comparisons, both between calculated solutions and with measured values. No one solution is clearly superior to the others. Koeck produces the lowest overall loss in total pressure, but his static pressure over the forward half of the wing has unrealistic features. The static pressure distributions of Dornier and Rizzi are in close agreement, except near the trailing edge in case 15, where it is not clear which is better.

All the presented results have great value to users and developers of methods, but their value is seen more as establishing a base line from which advances can be made, than as providing a reference against which subsequent work can be judged.

Among the developments that ought to follow the present exercise are:

(a) For some three-dimensional vortex flows, convergence with respect to grid spacing needs to be established. It is unlikely that this can be achieved with current computers for cases like those of the present exercise. Possibilities are: to limit the extent of the flow field, either by confining a low Mach number flow or by computing that part of a supersonic flow between the bow shock and the upstream characteristic surfaces through the trailing edge; or to study conical flows with only two independent space variables; or even just to calculate the vortex core solution of Ref 8-33.

(b) The existing calculations should be repeated, if possible, for simple delta wings for which detailed flow field measurements are available. These are usually the result of experiments in low-speed wind tunnels, but laser velocimetry is being used for transonic vortex flows over wings (Ref 8-40). The results of calculations in which the nonlinear effects of compressibility are insignificant could also be compared with results from existing panel methods, Ref 8-6 and 8-7.

(c) Since it appears from Ref 8-40 that there are real and little understood interactions between vortex flows and nonlinear compressibility effects on configurations of practical interest, detailed flow field measurements of pressure, as well as velocity, are needed at transonic conditions.

(d) The important role of streamlines as characteristics of vortex flows needs emphasis, in view of their relatively minor significance in most applications of the Euler equations considered hitherto. Numerical solutions like those contributed to this exercise should be analyzed to display information along selected streamlines, most simply the variation of total pressure, but perhaps also the terms governing the evolution of vorticity. This may reveal the sources of error.

(e) The presentation of surface streamlines in calculations like the present ones is recommended, in order to provide clear evidence of where the inviscid separation is taking place, as well as locating the attachment lines from which the streamlines diverge to cover the wing surface.

(f) Different algorithms should be exercised on the same grid and the same algorithm exercised on different grids. Without this, the effects of choice of algorithm and grid cannot be separated with confidence.

(g) In any future exercise of this kind, details of smoothing operators, or artificial viscosity, should be requested, including values of coefficients used.

8.4 Wing-fuselage - AGARD B - cases 17 to 20

8.4.1 Solutions received

Four test cases were proposed for the AGARD B configuration, angles of incidence of 0 and 2°, at Mach numbers of 1.5 and 2.0. Details of the configuration are shown in Fig 5-12. The only solutions received are for the two cases at $M_\infty = 1.5$, number 17 at zero incidence and number 18 at 2°, both supplied by Dornier. These were received after the final meeting of the Working Group in September, 1983. Consequently, no comparisons could be made, and there has been no opportunity for the Group to express views. The presentation of the solutions has been prepared by Prof Norstrud.

The contributed solutions are in graphic form, without estimates of overall forces. The only information about the grid used is that conveyed by Fig 8-40.

8.4.2 Method used

The method used appears to be same Jameson-Schmidt program used for the Dillner wing, cases 14 and 15, as described in section 8.3.2.

8.4.3 Presentation of results

The configuration is a delta wing mounted on a body of revolution which is cylindrical over a portion extending both upstream and downstream of the wing root. The wing has a 4% thick biconvex section, with a leading-edge sweep of 60°. The aspect ratio of the exposed wing, see Fig 8.40, is 2.31.

All the results contributed by Dornier are reproduced in microfiche form. A selection is presented in the text. Fig 8-41 shows the upper surface Mach number distribution for case 17, at zero incidence. The lower surface distribution is almost identical. The corresponding distribution of static pressure is shown in Fig 8-42, as contours of $1 - p/p_{i_\infty}$. Plots on the body surface are not included. The total pressure distribution, as $1 - p_i/p_{i_\infty}$, for wing upper (and lower) surface is shown in Fig 8-43.

The distribution of the pressure coefficient, C_p, across the semi-span of the exposed wing at the station x/(root chord) = 0.95 is given in Fig 8-44. The term 'exposed wing' is explained in Fig 8-40. The symbol s in Fig 8-44 is used to denote twice the semi-span of the exposed wing.

Next, we turn to case 18, for which $M_\infty = 1.5$ and the incidence is 2°. Fig 8-45 shows the spanwise distribution of pressure coefficient at the same station and in the same form as Fig 8-44. Fig 8-46 shows the contours of the Mach number for the upper and lower surfaces of the wing in parts (a) and (b). Note that the Mach numbers listed in the key to Fig 8-46b appear to be too small a factor of 10. Finally, Fig 8-47 depicts the distribution of total pressure in the cross-flow plane at x/(root chord) = 0.6, in the form of contours of $1 - p_i/p_{i_\infty}$, also for case 18.

8.5 Conclusions - delta wing solutions

We recall that the objective of the Working Group has been to find solutions of whose numerical accuracy we can be reasonably confident, rather than to recommend the use of any particular technique or individual program. The outcome has been very different for the three different configurations on which the test cases are based, which is very much what the Group expected when it chose problems of varying difficulty.

The difficulty of obtaining a solution increases through the cases, from the relative simplicity of case 13, the Butler wing at zero incidence and a Mach number of 2.5, for which space-marching methods are suitable, through the two cases, 14 and 15, of the Dillner wing at 15° incidence and Mach numbers 1.5 and 0.7, for which time-marching methods are needed, to the four cases, 17-20, of the AGARD B wing-fuselage combination at incidences of zero and 2° and Mach numbers of 1.5 and 2.0. The difficulty of obtaining a solution is related in part to the number of independent variables involved, and in part to the difficulty of generating an appropriate grid. It is reflected in the number of contributors attempting the solution, and the number of solutions they submitted. For case 13, five contributors submitted 11 solutions in all, for case 14, two contributors submitted one solution each and, for case 15, three contributors submitted one solution each, there was one solution for cases 17 and 18 and none for cases 19 and 20.

The difficulty of assessing the solutions involves two other aspects: the number of solutions available for comparison, particularly those using the same method on different grids, and the nature of the solutions found. For the Butler wing, many solutions are available, with three contributors showing effects of grid spacing. The exact solution is not very different from a potential flow, and the maximum loss of total pressure can be found accurately from conical flow calculations. A detailed analaysis of the results* is therefore possible, and is presented in section 8.2.3. For the two

---

* Since completion and typing of section 8.2, further details have been received from Prof Walkden. These are the values of the drag coefficient calculated on his grids 3 and 4. The complete set of values is:

	Wa1	Wa2	Wa3	Wa4
$100C_D$	5.928	5.967	5.904	5.948

Extrapolation to zero grid-spacing, using Eq.(8-6), yields $100C_D = 5.978 \pm 0.0045$, where the error band is solely due to the extrapolation process. It would have been extremely satisfactory to find that this range of values overlapped that derived from the solutions of MM. Fenain and Lordon, Eq.(8-4). In fact, there is a discrepancy of unity in the third significant figures, but this is small enough to confirm the validity of the treatment given in section 8.2.3.

cases involving the Dillner wing only a few solutions are available; all show large vortices lying above the wing surface, and all show very substantial losses in total pressure. It appears that the solutions found are approximations to exact solutions of the Euler equations in which a vortex sheet is shed from each leading edge and rolls up into a spiral above the wing; and that differences between such an exact solution and the approximations are attributable, in a qualitative sense, to numerical diffusion. A lengthy discussion of these features is presented in section 8.3.3, but the lack of quantitative information about the influence of numerical diffusion limits the conclusions that can be drawn. For the wing-fuselage configuration, the single solutions received for two of the test cases are presented in section 8.4.3.

The outcome of the detailed analysis of the results for case 13, on the Butler wing, is summarized in section 8.2.4. In brief:

(a) plausible extrapolations of the results of Fenain and Lordon and of Walkden to zero-grid spacing are possible;

(b) these extrapolations agree very closely except near the wing tip;

(c) consequently an extrapolation of this kind can be regarded as being very close to an exact solution of the Euler equations, and forming a reference solution;

(d) several of the solutions submitted come close enough to such an extrapolation to be quoted as reference solutions;

(e) the errors in the calculated total pressure on the surface are easily identifiable;

(f) these errors apparently effect the calculated Mach number more than the calculated static pressure;

(g) for the single quantity of greatest interest, the drag coefficient, the total spread of the best results from the three contributors who calculated it and the two possible extrapolations to zero grid-spacing is less than 1% of the value.

The outcome of the discussion of the results obtained for cases 14 and 15 on the Dillner wing is given in section 8.3.4. Apart from recommendations for further work, the conclusions are:

(a) all the solutions are of vortex flows with the same principal features, but with significant differences of level;

(b) where a comparison with measured static pressure is available (at the station 80% of the length from the apex), the differences between the solutions are similar in size to their individual differences from the measured values;

(c) elsewhere, the differences between the solutions are larger;

(d) no one solution is clearly superior to the others;

(e) the losses of total pressure in the core of the vortex, exceeding the free stream kinetic pressure, are very significant;

(f) the errors in total pressure seem to affect the Mach number more than the static pressure; and

(g) the value of the solutions lies in establishing a base line from which advances can be made, rather as providing a reference against which other work can be judged.

Only one solution was received for each of cases 17 and 18 on the AGARD B wing-fuselage combination. No comparisons could therefore be undertaken, and the results, contributed in graphical form, are presented without evaluation. Two main causes can be seen as contributing to the poor response: constructing a grid for such a configuration is not easy, and potential contributors had already expended a good deal of effort on the other configurations.

Table 8-1

REFERENCE SOLUTION Wa= FOR CASE 13, THE BUTLER WING

	x/c = 0.6			x/c = 0.95		
arc cos y/a(x)	$1 - p/p_{i_\infty}$	C_p	M	$1 - p/p_{i_\infty}$	C_p	M
0	0.9085	0.1287	2.207	0.9426	-0.0044	2.505
4.5	0.9100	0.1229	2.217	0.9571	-0.0610	2.693
9	0.9139	0.1076	2.246	0.9695	-0.1096	2.918
13.5	0.9200	0.0840	2.292	0.9765	-0.1369	3.092
18	0.9270	0.0565	2.351	0.9809	-0.1538	3.230
22.5	0.9344	0.0277	2.419	0.9838	-0.1653	3.344
27	0.9414	0.0004	2.491	0.9858	-0.1733	3.438
31.5	0.9476	-0.0240	2.564	0.9874	-0.1795	3.522
36	0.9530	-0.0452	2.635	0.9887	-0.1844	3.596
40.5	0.9575	-0.0624	2.699	0.9894	-0.1872	3.643
45	0.9610	-0.0762	2.755	0.9899	-0.1893	3.681
49.5	0.9637	-0.0867	2.802	0.9901	-0.1898	3.690
54	0.9655	-0.0940	2.836	0.9897	-0.1885	3.666
58.5	0.9667	-0.0985	2.859	0.9887	-0.1844	3.596
63	0.9672	-0.1006	2.870	0.9863	-0.1752	3.463
67.5	0.9672	-0.1005	2.869	0.9824	-0.1599	3.288
72	0.9668	-0.0991	2.862	0.9789	-0.1463	3.165
76.5	0.9664	-0.0974	2.853	0.9763	-0.1359	3.084
81	0.9658	-0.0951	2.842	0.9745	-0.1288	3.035
85.5	0.9654	-0.0936	2.835	0.9734	-0.1248	3.009
90	0.9653	-0.0931	2.832	0.9731	-0.1235	3.000

Table 8-2

REFERENCE SOLUTION FL3 FOR CASE 13, BUTLER WING

x/c = 0.6, upper surface

y/c	z/c	$1 - \frac{p}{p_{t_\infty}}$	C_p	M	$1 - \frac{p_t}{p_{t_\infty}}$	$\cos^{-1}\frac{y}{a}$	$\sin^{-1}\frac{z}{b}$	θ
.001829	.092705	.965321	-.093139	2.832186	.011549	89.413	89.170	89.413
.005487	.092666	.965341	-.093216	2.832562	.011550	88.240	88.145	88.240
.009144	.092589	.965380	-.093370	2.833305	.011551	87.066	87.008	87.066
.012798	.092472	.965438	-.093596	2.834406	.011552	85.892	85.850	85.892
.016448	.092316	.965514	-.093892	2.835847	.011554	84.718	84.685	84.718
.020093	.092122	.965606	-.094252	2.837604	.011556	83.543	83.516	83.543
.023733	.091889	.965713	-.094670	2.839650	.011558	82.367	82.344	82.367
.027365	.091616	.965833	-.095138	2.841951	.011561	81.190	81.170	81.190
.030989	.091305	.965964	-.095648	2.844466	.011563	80.012	79.994	80.012
.034604	.090954	.966103	-.096190	2.847150	.011566	78.832	78.816	78.832
.038209	.090565	.966247	-.096753	2.849953	.011570	77.652	77.637	77.651
.041802	.090137	.966394	-.097327	2.852818	.011573	76.469	76.456	76.469
.045383	.089669	.966540	-.097898	2.855686	.011577	75.285	75.273	75.285
.048950	.089162	.966682	-.098455	2.858493	.011580	74.099	74.088	74.099
.052502	.088617	.966818	-.098983	2.861171	.011584	72.911	72.900	72.911
.056038	.088031	.966943	-.099471	2.863649	.011588	71.721	71.711	71.721
.059556	.087407	.967053	-.099904	2.865858	.011592	70.529	70.519	70.528
.063056	.086744	.967147	-.100268	2.867725	.011597	69.334	69.324	69.333
.066537	.086041	.967219	-.100552	2.869179	.011601	68.136	68.127	68.135
.069996	.085298	.967268	-.100741	2.870151	.011605	66.935	66.927	66.935
.073433	.084516	.967289	-.100823	2.870572	.011609	65.732	65.723	65.731
.076847	.083695	.967279	-.100786	2.870380	.011612	64.525	64.517	64.525
.080235	.082834	.967237	-.100619	2.869513	.011616	63.315	63.307	63.315
.083598	.081934	.967157	-.100309	2.867918	.011620	62.102	62.094	62.101
.086932	.080994	.967039	-.099846	2.865544	.011623	60.885	60.877	60.884
.090238	.080015	.966879	-.099220	2.862348	.011626	59.664	59.657	59.664
.093513	.078995	.966674	-.098421	2.858290	.011629	58.440	58.432	58.439
.096756	.077936	.966422	-.097438	2.853339	.011631	57.211	57.204	57.210
.099966	.076838	.966121	-.096263	2.847467	.011634	55.978	55.971	55.977
.103140	.075700	.965769	-.094885	2.840656	.011636	54.741	54.733	54.740
.106278	.074522	.965362	-.093296	2.832890	.011639	53.499	53.492	53.498
.109378	.073304	.964898	-.091486	2.824161	.011641	52.252	52.245	52.251
.112437	.072046	.964376	-.089445	2.814464	.011643	51.000	50.993	50.999
.115455	.070749	.963791	-.087164	2.803802	.011644	49.744	49.737	49.743
.118430	.069413	.963143	-.084634	2.792182	.011646	48.482	48.475	48.481
.121359	.068037	.962429	-.081843	2.779617	.011648	47.215	47.208	47.214
.124241	.066621	.961646	-.078783	2.766123	.011650	45.943	45.936	45.941
.127073	.065166	.960790	-.075444	2.751722	.011651	44.665	44.658	44.663
.129855	.063673	.959861	-.071814	2.736441	.011653	43.381	43.374	43.379
.132584	.062140	.958855	-.067885	2.720309	.011654	42.091	42.084	42.090
.135258	.060568	.957770	-.063647	2.703364	.011656	40.796	40.789	40.794
.137874	.058958	.956603	-.059089	2.685644	.011658	39.495	39.487	39.492
.140431	.057309	.955352	-.054204	2.667194	.011659	38.187	38.179	38.185
.142927	.055623	.954015	-.048984	2.648066	.011661	36.873	36.865	36.871
.145359	.053899	.952591	-.043422	2.628312	.011662	35.553	35.545	35.550
.147724	.052139	.951078	-.037514	2.607993	.011664	34.227	34.219	34.224
.150021	.050341	.949476	-.031258	2.587173	.011665	32.894	32.886	32.891

Table 8-2 (continued)

x/c = 0.6, lower surface

y/c	z/c	$1 - \frac{p}{p_{i_\infty}}$	C_p	M	$1 - \frac{p_i}{p_{i_\infty}}$	$\cos^{-1}\frac{y}{a}$	$\sin^{-1}\frac{z}{b}$	θ
.152248	.048508	.947785	-.024653	2.565927	.011666	31.555	31.546	31.552
.154401	.046639	.946006	-.017704	2.544327	.011667	30.210	30.201	30.206
.156479	.044735	.944140	-.010419	2.522460	.011668	28.858	28.849	28.854
.158479	.042797	.942192	-.002812	2.500413	.011668	27.500	27.490	27.495
.160398	.040826	.940167	.005098	2.478284	.011668	26.136	26.126	26.131
.162234	.038823	.938071	.013285	2.456177	.011668	24.766	24.755	24.760
.163985	.036789	.935912	.021715	2.434201	.011667	23.389	23.378	23.383
.165648	.034725	.933702	.030345	2.412475	.011665	22.007	21.995	22.000
.167221	.032631	.931455	.039123	2.391122	.011662	20.620	20.607	20.611
.168701	.030510	.929185	.047986	2.370273	.011659	19.226	19.213	19.217
.170087	.028363	.926912	.056862	2.350064	.011654	17.828	17.813	17.817
.171376	.026190	.924658	.065668	2.330636	.011649	16.424	16.408	16.412
.172565	.023995	.922445	.074310	2.312133	.011643	15.016	14.999	15.003
.173654	.021778	.920300	.082686	2.294702	.011636	13.604	13.585	13.588
.174639	.019540	.918251	.090687	2.278488	.011628	12.188	12.167	12.170
.175520	.017285	.916328	.098198	2.263635	.011619	10.769	10.745	10.748
.176294	.015014	.914560	.105103	2.250280	.011610	9.347	9.319	9.322
.176961	.012729	.912977	.111286	2.238556	.011600	7.924	7.891	7.893
.177518	.010431	.911606	.116638	2.228580	.011590	6.500	6.460	6.462
.177965	.008123	.910475	.121057	2.220460	.011580	5.078	5.027	5.028
.178301	.005808	.909604	.124458	2.214282	.011570	3.663	3.592	3.593
.178526	.003487	.909012	.126771	2.210116	.011561	2.272	2.155	2.156
.178638	.001163	.908711	.127946	2.208011	.011553	1.016	.719	.719
.178638	-.001163	.908707	.127961	2.207989	.011546	1.016	-.719	-.719
.178526	-.003487	.909001	.126813	2.210053	.011540	2.272	-2.155	-2.156
.178301	-.005808	.909586	.124528	2.214179	.011535	3.663	-3.592	-3.593
.177965	-.008123	.910451	.121151	2.220320	.011532	5.078	-5.027	-5.028
.177518	-.010431	.911577	.116752	2.228408	.011530	6.500	-6.460	-6.462
.176961	-.012729	.912943	.111418	2.238355	.011529	7.924	-7.891	-7.893
.176294	-.015014	.914523	.105247	2.250056	.011530	9.347	-9.319	-9.322
.175520	-.017285	.916289	.098351	2.263392	.011531	10.769	-10.745	-10.748
.174639	-.019540	.918211	.090845	2.278232	.011533	12.188	-12.167	-12.170
.173654	-.021778	.920259	.082846	2.294437	.011536	13.604	-13.585	-13.588
.172565	-.023995	.922404	.074469	2.311864	.011540	15.016	-14.999	-15.003
.171376	-.026190	.924618	.065824	2.330365	.011543	16.424	-16.408	-16.412
.170087	-.028363	.926874	.057013	2.349795	.011547	17.828	-17.813	-17.817
.168701	-.030510	.929148	.048131	2.370008	.011551	19.226	-19.213	-19.217
.167221	-.032631	.931419	.039260	2.390862	.011555	20.620	-20.607	-20.611
.165648	-.034725	.933669	.030475	2.412222	.011559	22.007	-21.995	-22.000
.163985	-.036789	.935881	.021837	2.433956	.011563	23.389	-23.378	-23.383
.162234	-.038823	.938041	.013399	2.455940	.011567	24.766	-24.755	-24.760
.160398	-.040826	.940140	.005204	2.478056	.011570	26.136	-26.126	-26.131
.158479	-.042797	.942167	-.002713	2.500192	.011573	27.500	-27.490	-27.495
.156479	-.044735	.944117	-.010327	2.522248	.011576	28.858	-28.849	-28.854
.154401	-.046639	.945984	-.017618	2.544123	.011579	30.210	-30.201	-30.206
.152248	-.048508	.947765	-.024573	2.565730	.011582	31.555	-31.546	-31.552
.150021	-.050341	.949457	-.031184	2.586986	.011584	32.894	-32.886	-32.891
.147724	-.052139	.951061	-.037446	2.607812	.011587	34.227	-34.219	-34.224
.145359	-.053899	.952575	-.043358	2.628137	.011589	35.553	-35.545	-35.550
.142927	-.055623	.954000	-.048925	2.647896	.011591	36.873	-36.865	-36.871
.140431	-.057309	.955338	-.054149	2.667034	.011593	38.187	-38.179	-38.185
.137874	-.058958	.956590	-.059038	2.685490	.011594	39.495	-39.487	-39.492
.135258	-.060568	.957757	-.063599	2.703216	.011596	40.796	-40.789	-40.794
.132584	-.062140	.958844	-.067841	2.720168	.011598	42.091	-42.084	-42.090
.129855	-.063673	.959851	-.071773	2.736306	.011599	43.381	-43.374	-43.379
.127073	-.065166	.960781	-.075406	2.751593	.011600	44.665	-44.658	-44.663
.124241	-.066621	.961636	-.078748	2.766001	.011601	45.943	-45.936	-45.941
.121359	-.068037	.962421	-.081811	2.779502	.011602	47.215	-47.208	-47.214
.118430	-.069413	.963136	-.084603	2.792073	.011603	48.482	-48.475	-48.481
.115455	-.070749	.963784	-.087136	2.803700	.011604	49.744	-49.737	-49.743
.112437	-.072046	.964369	-.089420	2.814368	.011604	51.000	-50.993	-50.999
.109378	-.073304	.964892	-.091462	2.824072	.011604	52.252	-52.245	-52.251
.106278	-.074522	.965356	-.093275	2.832808	.011604	53.499	-53.492	-53.498
.103140	-.075700	.965763	-.094866	2.840581	.011604	54.741	-54.733	-54.740
.099966	-.076838	.966117	-.096245	2.847398	.011603	55.978	-55.971	-55.977
.096756	-.077936	.966418	-.097422	2.853276	.011603	57.211	-57.204	-57.210
.093513	-.078995	.966670	-.098406	2.858233	.011601	58.440	-58.432	-58.439
.090238	-.080015	.966875	-.099207	2.862297	.011600	59.664	-59.657	-59.664
.086932	-.080994	.967036	-.099834	2.865499	.011598	60.885	-60.877	-60.884
.083598	-.081934	.967154	-.100298	2.867878	.011596	62.102	-62.094	-62.101
.080235	-.082834	.967234	-.100609	2.869478	.011594	63.315	-63.307	-63.315
.076847	-.083695	.967277	-.100777	2.870348	.011591	64.525	-64.517	-64.525
.073433	-.084516	.967287	-.100815	2.870545	.011588	65.732	-65.723	-65.731
.069996	-.085298	.967266	-.100734	2.870127	.011585	66.935	-66.927	-66.935

Table 8-2 (continued)

x/c 0.95, upper surface

y/c	z/c	$1 - \frac{p}{p_{t_\infty}}$	C_p	M	$1 - \frac{p_t}{p_{t_\infty}}$	$\cos^{-1}\frac{y}{a}$	$\sin^{-1}\frac{z}{b}$	θ
.002801	.014803	.973020	-.123203	2.998241	.011548	89.433	89.198	89.433
.008401	.014797	.973065	-.123381	2.999367	.011550	88.299	88.207	88.299
.014000	.014785	.973156	-.123737	3.001625	.011551	87.165	87.109	87.165
.019595	.014768	.973293	-.124272	3.005033	.011554	86.030	85.990	86.030
.025186	.014745	.973476	-.124986	3.009616	.011558	84.895	84.863	84.895
.030770	.014716	.973705	-.125882	3.015408	.011564	83.759	83.733	83.759
.036347	.014681	.973982	-.126961	3.022458	.011571	82.622	82.600	82.622
.041916	.014640	.974306	-.128226	3.030826	.011579	81.484	81.464	81.484
.047474	.014594	.974678	-.129681	3.040590	.011588	80.344	80.327	80.344
.053021	.014541	.975101	-.131330	3.051846	.011599	79.203	79.188	79.203
.058555	.014483	.975574	-.133180	3.064714	.011611	78.060	78.046	78.060
.064075	.014419	.976101	-.135238	3.079346	.011624	76.916	76.903	76.916
.069579	.014349	.976684	-.137513	3.095931	.011640	75.769	75.757	75.769
.075065	.014273	.977325	-.140018	3.114708	.011658	74.620	74.609	74.620
.080533	.014191	.978029	-.142767	3.135980	.011681	73.469	73.459	73.469
.085981	.014104	.978800	-.145776	3.160121	.011708	72.315	72.305	72.315
.091407	.014010	.979641	-.149063	3.187583	.011741	71.159	71.149	71.159
.096810	.013910	.980557	-.152638	3.218861	.011781	69.999	69.990	69.999
.102188	.013805	.981542	-.156487	3.254366	.011829	68.836	68.827	68.836
.107540	.013693	.982584	-.160555	3.294169	.011885	67.670	67.661	67.670
.112863	.013575	.983650	-.164719	3.337665	.011944	66.500	66.491	66.500
.118157	.013452	.984695	-.168802	3.383388	.011998	65.326	65.318	65.326
.123419	.013322	.985671	-.172613	3.429236	.012042	64.148	64.140	64.148
.128647	.013186	.986542	-.176011	3.473072	.012073	62.966	62.958	62.966
.133841	.013043	.987290	-.178934	3.513306	.012095	61.779	61.772	61.779
.138997	.012895	.987918	-.181386	3.549090	.012116	60.588	60.581	60.588
.144114	.012740	.988436	-.183411	3.580198	.012139	59.392	59.384	59.392
.149190	.012580	.988860	-.185066	3.606767	.012166	58.190	58.183	58.190
.154223	.012412	.989203	-.186406	3.629089	.012199	56.983	56.976	56.983
.159210	.012239	.989478	-.187478	3.647502	.012239	55.771	55.764	55.771
.164150	.012059	.989693	-.188320	3.662321	.012286	54.553	54.546	54.553
.169040	.011873	.989858	-.188962	3.673841	.012340	53.328	53.321	53.328
.173877	.011680	.989977	-.189428	3.682312	.012402	52.097	52.090	52.097
.178659	.011481	.990056	-.189736	3.687952	.012471	50.860	50.853	50.860
.183384	.011275	.990098	-.189900	3.690947	.012549	49.616	49.609	49.616
.188049	.011063	.990106	-.189931	3.691455	.012636	48.364	48.357	48.364
.192650	.010844	.990082	-.189836	3.689627	.012732	47.106	47.099	47.106
.197185	.010619	.990027	-.189623	3.685601	.012840	45.840	45.832	45.840
.201650	.010387	.989943	-.189297	3.679501	.012959	44.566	44.558	44.566
.206044	.010148	.989831	-.188859	3.671432	.013091	43.284	43.276	43.284
.210361	.009903	.989691	-.188311	3.661480	.013240	41.993	41.986	41.993
.214599	.009651	.989522	-.187652	3.649707	.013405	40.695	40.687	40.695
.218754	.009393	.989325	-.186880	3.636179	.013590	39.387	39.380	39.387
.222822	.009127	.989097	-.185992	3.620954	.013796	38.071	38.063	38.071
.226799	.008855	.988840	-.184986	3.604120	.014023	36.746	36.738	36.746
.230681	.008576	.988551	-.183859	3.585760	.014273	35.411	35.403	35.411
.234463	.008291	.988230	-.182606	3.565923	.014543	34.067	34.059	34.067

Table 8-2 (concluded)

x/c 0.95, lower surface

y/c	z/c	$1 - \frac{p}{p_{t_\infty}}$	C_p	M	$1 - \frac{p_t}{p_{t_\infty}}$	$\cos^{-1}\frac{y}{a}$	$\sin^{-1}\frac{z}{b}$	θ
.282989	-.000195	.947403	-.023162	2.566348	.003790	1.069	-.756	-.779
.282792	-.000586	.952253	-.042104	2.623989	.011252	2.391	-2.268	-2.314
.282399	-.000976	.957974	-.064446	2.702173	.018247	3.854	-3.779	-3.825
.281810	-.001364	.962757	-.083124	2.778473	.021987	5.341	-5.287	-5.328
.281027	-.001751	.966621	-.098213	2.848988	.023949	6.835	-6.793	-6.828
.280054	-.002136	.969765	-.110492	2.913657	.024805	8.329	-8.294	-8.325
.278891	-.002518	.972355	-.120607	2.972985	.024891	9.821	-9.792	-9.818
.277544	-.002897	.974519	-.129060	3.027610	.024500	11.309	-11.284	-11.307
.276014	-.003272	.976353	-.136222	3.078105	.023856	12.792	-12.770	-12.791
.274307	-.003644	.977928	-.142371	3.125032	.023087	14.269	-14.249	-14.268
.272427	-.004011	.979295	-.147710	3.168678	.022235	15.739	-15.721	-15.739
.270377	-.004374	.980495	-.152398	3.210105	.021322	17.202	-17.186	-17.202
.268164	-.004732	.981560	-.156558	3.249068	.020409	18.658	-18.642	-18.657
.265792	-.005085	.982511	-.160270	3.285935	.019566	20.105	-20.091	-20.104
.263266	-.005433	.983362	-.163595	3.320793	.018822	21.543	-21.530	-21.543
.260592	-.005775	.984129	-.166590	3.353859	.018165	22.973	-22.960	-22.972
.257773	-.006111	.984826	-.169310	3.385392	.017577	24.393	-24.381	-24.393
.254817	-.006441	.985460	-.171789	3.415501	.017042	25.804	-25.793	-25.804
.251728	-.006766	.986038	-.174046	3.444164	.016549	27.205	-27.195	-27.205
.248511	-.007084	.986563	-.176096	3.471346	.016087	28.597	-28.587	-28.597
.245171	-.007395	.987040	-.177959	3.497056	.015654	29.979	-29.969	-29.979
.241713	-.007700	.987473	-.179650	3.521303	.015253	31.351	-31.342	-31.351
.238142	-.007999	.987866	-.181185	3.544100	.014888	32.714	-32.705	-32.714
.234463	-.008291	.988223	-.182577	3.565462	.014561	34.067	-34.059	-34.067
.230681	-.008576	.988545	-.183836	3.585383	.014272	35.411	-35.403	-35.411
.226799	-.008855	.988835	-.184967	3.603809	.014018	36.746	-36.738	-36.746
.222822	-.009127	.989093	-.185975	3.620665	.013793	38.071	-38.063	-38.071
.218754	-.009393	.989320	-.186863	3.635887	.013592	39.387	-39.380	-39.387
.214599	-.009651	.989518	-.187637	3.649426	.013410	40.695	-40.687	-40.695
.210361	-.009903	.989688	-.188298	3.661231	.013244	41.993	-41.986	-41.993
.206044	-.010148	.989828	-.188848	3.671228	.013094	43.284	-43.276	-43.284
.201650	-.010387	.989941	-.189288	3.679332	.012958	44.566	-44.558	-44.566
.197185	-.010619	.990025	-.189615	3.685448	.012836	45.840	-45.832	-45.840
.192650	-.010844	.990079	-.189828	3.689473	.012726	47.106	-47.099	-47.106
.188049	-.011063	.990103	-.189922	3.691292	.012629	48.364	-48.357	-48.364
.183384	-.011275	.990096	-.189891	3.690782	.012542	49.616	-49.609	-49.616
.178660	-.011481	.990054	-.189728	3.687801	.012465	50.860	-50.853	-50.860
.173877	-.011680	.989975	-.189421	3.682187	.012398	52.097	-52.090	-52.097
.169040	-.011873	.989856	-.188957	3.673750	.012339	53.328	-53.321	-53.328
.164150	-.012059	.989692	-.188317	3.662267	.012289	54.553	-54.546	-54.552
.159210	-.012239	.989477	-.187477	3.647484	.012246	55.771	-55.764	-55.771
.154223	-.012412	.989204	-.186407	3.629107	.012209	56.983	-56.976	-56.983
.149190	-.012580	.988861	-.185070	3.606821	.012180	58.190	-58.183	-58.190
.144114	-.012740	.988438	- 183417	3.580287	.012157	59.392	-59.384	-59.392
.138997	-.012895	.987920	-.181395	3.549210	.012139	60.588	-60.581	-60.588
.133841	-.013043	.987293	-.178946	3.513450	.012123	61.779	-61.772	-61.779
.128647	-.013186	.986545	-.176025	3.473228	.012103	62.966	-62.958	-62.966
.123419	-.013322	.985675	-.172627	3.429388	.012074	64.148	-64.140	-64.148
.118157	-.013452	.984699	-.168816	3.383525	.012030	65.326	-65.318	-65.326

Table 8-3

REFERENCE SOLUTIONS Mo1 AND Mo2 FOR CASE 13, BUTLER WING

x/c = 0.6, Mo1 and 2

y/a	M	$1 - \frac{p}{p_{i_\infty}}$	$1 - \frac{p_i}{p_{i_\infty}}$
0.0000	2.8457	0.9652	-0.0116
0.0654	2.8474	0.9653	-0.0116
0.1305	2.8526	0.9656	-0.0116
0.1951	2.8598	0.9660	-0.0116
0.2588	2.8691	0.9664	-0.0116
0.3214	2.8767	0.9668	-0.0116
0.3827	2.8833	0.9672	-0.0116
0.4423	2.8836	0.9672	-0.0116
0.5000	2.8791	0.9670	-0.0116
0.5556	2.8655	0.9663	-0.0116
0.6088	2.8442	0.9652	-0.0116
0.6593	2.8139	0.9635	-0.0116
0.7071	2.7754	0.9613	-0.0116
0.7518	2.7299	0.9585	-0.0116
0.7933	2.6777	0.9550	-0.0116
0.8315	2.6213	0.9509	-0.0116
0.8660	2.5610	0.9461	-0.0116
0.8969	2.5000	0.9408	-0.0116
0.9239	2.4392	0.9349	-0.0116
0.9469	2.3814	0.9288	-0.0116
0.9659	2.3293	0.9227	-0.0116
0.9808	2.2845	0.9171	-0.0116
0.9914	2.2515	0.9127	-0.0116
0.9979	2.2305	0.9098	-0.0116
1.0000	2.2236	0.9088	-0.0116

x/c = 0.95, Mo1

y/a	M	$1 - \frac{p}{p_{i_\infty}}$	$1 - \frac{p_i}{p_{i_\infty}}$
0.0000	3.0165	0.9731	-0.0116
0.0654	3.0228	0.9734	-0.0116
0.1305	3.0416	0.9741	-0.0116
0.1951	3.0737	0.9753	-0.0116
0.2588	3.1226	0.9771	-0.0116
0.3214	3.1973	0.9795	-0.0116
0.3827	3.3103	0.9826	-0.0116
0.4423	3.4516	0.9858	-0.0116
0.5000	3.5735	0.9880	-0.0116
0.5556	3.6524	0.9893	-0.0116
0.6088	3.6946	0.9899	-0.0116
0.6593	3.7089	0.9901	-0.0116
0.7071	3.7013	0.9900	-0.0116
0.7518	3.6764	0.9896	-0.0116
0.7934	3.6374	0.9891	-0.0116
0.8315	3.5868	0.9883	-0.0116
0.8660	3.5268	0.9872	-0.0116
0.8969	3.4590	0.9859	-0.0116
0.9239	3.3848	0.9844	-0.0116
0.9469	3.3037	0.9824	-0.0116
0.9659	3.2103	0.9798	-0.0117
0.9808	3.0909	0.9760	-0.0117
0.9914	2.9276	0.9693	-0.0117
0.9978	2.7213	0.9579	-0.0117
1.0000	2.5137	0.9420	-0.0117

x/c = 0.95, Mo2

y/a	M	$1 - \frac{p}{p_{i_\infty}}$	$1 - \frac{p_i}{p_{i_\infty}}$
0.0000	3.0165	0.9731	-0.0116
0.0327	3.0180	0.9732	-0.0116
0.0654	3.0224	0.9734	-0.0116
0.0980	3.0297	0.9737	-0.0116
0.1305	3.0401	0.9741	-0.0116
0.1629	3.0540	0.9746	-0.0116
0.1951	3.0717	0.9753	-0.0116
0.2271	3.0939	0.9761	-0.0116
0.2588	3.1215	0.9770	-0.0116
0.2903	3.1552	0.9781	-0.0116
0.3214	3.1966	0.9794	-0.0116
0.3523	3.2478	0.9809	-0.0116
0.3827	3.3100	0.9826	-0.0116
0.4127	3.3814	0.9843	-0.0116
0.4423	3.4546	0.9859	-0.0116
0.4714	3.5209	0.9871	-0.0116
0.5000	3.5760	0.9881	-0.0116
0.5281	3.6196	0.9888	-0.0116
0.5556	3.6530	0.9893	-0.0116
0.5825	3.6773	0.9897	-0.0116
0.6088	3.6937	0.9899	-0.0116
0.6344	3.7033	0.9900	-0.0116
0.6594	3.7068	0.9901	-0.0116
0.6836	3.7051	0.9901	-0.0116
0.7071	3.6985	0.9900	-0.0116
0.7299	3.6877	0.9898	-0.0116
0.7518	3.6730	0.9896	-0.0116
0.7730	3.6549	0.9893	-0.0116
0.7934	3.6336	0.9890	-0.0116
0.8129	3.6093	0.9886	-0.0116
0.8315	3.5842	0.9882	-0.0116
0.8492	3.5530	0.9877	-0.0116
0.8660	3.5214	0.9871	-0.0116
0.8819	3.4876	0.9865	-0.0116
0.8969	3.4518	0.9858	-0.0116
0.9109	3.4141	0.9850	-0.0116
0.9239	3.3744	0.9841	-0.0116
0.9359	3.3327	0.9831	-0.0116
0.9469	3.2890	0.9820	-0.0116
0.9569	3.2428	0.9808	-0.0116
0.9659	3.1938	0.9793	-0.0116
0.9739	3.1409	0.9777	-0.0117
0.9808	3.0826	0.9757	-0.0117
0.9866	3.0159	0.9731	-0.0117
0.9914	2.9371	0.9697	-0.0117
0.9952	2.8390	0.9649	-0.0117
0.9979	2.7208	0.9579	-0.0117
0.9995	2.5870	0.9483	-0.0117
1.0000	2.5052	0.9413	-0.0117

Table 8-4

REFERENCE SOLUTION We FOR CASE 13, BUTLER WING

x/c = 0.6				x/c = 0.95			
y/a(x)	$1 - \frac{p}{p_{i_\infty}}$	M	$1 - \frac{p_i}{p_{i_\infty}}$	y/a(x)	$1 - \frac{p}{p_{i_\infty}}$	M	$1 - \frac{p_i}{p_{i_\infty}}$
0	0.9657	2.836	0.0112	0	0.9721	2.972	0.0125
0.0579	0.9657	2.837	0.0113	0.0443	0.9726	2.986	0.0114
0.1156	0.9660	2.842	0.0114	0.0885	0.9735	3.008	0.0104
0.1729	0.9663	2.848	0.0115	0.1325	0.9471	3.024	0.0113
0.2295	0.9667	2.856	0.0117	0.1763	0.9749	3.046	0.0124
0.2853	0.9671	2.864	0.0117	0.2197	0.9760	3.075	0.0131
0.3401	0.9675	2.872	0.0120	0.2627	0.9773	3.114	0.0134
0.3937	0.9677	2.876	0.0123	0.3052	0.9790	3.165	0.0128
0.4458	0.9677	2.876	0.0123	0.3472	0.9809	3.233	0.0125
0.4963	0.9674	2.871	0.0123	0.3884	0.9831	3.317	0.0122
0.5449	0.9669	2.861	0.0124	0.4289	0.9851	3.407	0.0117
0.5915	0.9660	2.844	0.0124	0.4686	0.9869	3.491	0.0122
0.6360	0.9648	2.821	0.0125	0.5074	0.9881	3.562	0.0138
0.6781	0.9632	2.792	0.0125	0.5453	0.9890	3.615	0.0152
0.7176	0.9612	2.757	0.0121	0.5820	0.9896	3.652	0.0168
0.7545	0.9587	2.718	0.0118	0.6177	0.9899	3.674	0.0182
0.7886	0.9559	2.676	0.0117	0.6522	0.9901	3.684	0.0187
0.8198	0.9528	2.631	0.0114	0.6854	0.9900	3.684	0.0180
0.8482	0.9493	2.585	0.0111	0.7173	0.9899	3.675	0.0177
0.8735	0.9455	2.538	0.0110	0.7478	0.9897	3.656	0.0186
0.8960	0.9415	2.493	0.0109	0.7768	0.9893	3.631	0.0188
0.9156	0.9374	2.450	0.0108	0.8044	0.9888	3.600	0.0186
0.9325	0.9333	2.409	0.0107	0.8304	0.9882	3.562	0.0206
0.9468	0.9294	2.372	0.0107	0.8547	0.9875	3.520	0.0215
0.9588	0.9257	2.340	0.0107	0.8774	0.9867	3.474	0.0217
0.9686	0.9224	2.312	0.0109	0.8983	0.9856	3.422	0.0229
0.9765	0.9194	2.288	0.0110	0.9173	0.9845	3.366	0.0237
0.9827	0.9170	2.268	0.0110	0.9345	0.9831	3.305	0.0255
0.9876	0.9149	2.252	0.0110	0.9498	0.9814	3.238	0.0272
0.9914	0.9132	2.240	0.0111	0.9631	0.9795	3.167	0.0312
0.9942	0.9120	2.230	0.0112	0.9742	0.9770	3.089	0.0363
0.9963	0.9110	2.223	0.0112	0.9832	0.9740	2.996	0.0372
0.9978	0.9103	2.218	0.0112	0.9901	0.9699	2.899	0.0418
0.9988	0.9098	2.215	0.0112	0.9949	0.9644	2.806	0.0430
0.9995	0.9094	2.212	0.0112	0.9979	0.9565	2.692	0.0268
0.9999	0.9092	2.211	0.0113	0.9995	0.9477	2.572	0.0121
1	0.9092	2.210	0.0113	1	0.9435	2.518	0.0095

Table 8-5

SOLUTION BY KOECK FOR CASE 15 (DILLNER WING, $\alpha = 15°$, $M_\infty = 0.7$)

X/C = 0.20 UPPER SURFACE

N	y/s	$1 - \frac{p}{p_{i_\infty}}$	M	$1 - \frac{p_i}{p_{i_\infty}}$
1	0.00000	.34564	.80106	.00148
2	.05506	.34661	.80129	.00274
3	.10787	.34863	.80112	.00598
4	.15853	.35109	.80134	.00952
5	.20720	.35449	.80272	.01335
6	.25398	.35924	.80596	.01744
7	.29901	.36585	.81186	.02182
8	.34239	.37493	.82150	.02640
9	.38423	.38740	.83656	.03104
10	.42464	.40372	.85839	.03526
11	.46370	.42425	.88811	.03864
12	.50150	.45086	.92778	.04250
13	.53813	.47550	.96686	.04439
14	.57365	.47824	.97155	.04428
15	.60815	.47032	.94093	.06277
16	.64253	.46943	.90189	.10077
17	.67611	.46861	.87449	.12555
18	.71002	.46646	.87328	.12311
19	.74292	.46376	.88117	.11126
20	.77483	.46350	.87540	.11624
21	.80579	.46645	.86850	.12752
22	.83582	.47319	.86581	.14093
23	.86490	.48328	.86691	.15634
24	.89300	.47596	.84172	.16585
25	.92022	.47638	.75842	.23247
26	.94591	.52538	.69445	.34441
27	.96955	.59809	.72124	.43137
28	.98941	.53113	.71324	.34174
29	1.00000	.36380	.83410	-.00374

X/C = 0.20 LOWER SURFACE

N	y/s	$1 - \frac{p}{p_{i_\infty}}$	M	$1 - \frac{p_i}{p_{i_\infty}}$
1	0.00000	.19925	.57207	.00031
2	.05506	.19932	.57227	.00024
3	.10787	.19935	.57253	.00008
4	.15853	.19937	.57265	.00002
5	.20720	.19939	.57272	-.00001
6	.25398	.19940	.57279	-.00006
7	.29901	.19941	.57287	-.00010
8	.34239	.19943	.57297	-.00014
9	.38423	.19947	.57308	-.00017
10	.42464	.19954	.57323	-.00020
11	.46370	.19965	.57342	-.00022
12	.50150	.19979	.57369	-.00023
13	.53813	.19999	.57403	-.00024
14	.57365	.20025	.57448	-.00026
15	.60815	.20058	.57505	-.00028
16	.64253	.20102	.57581	-.00030
17	.67611	.20158	.57679	-.00034
18	.71002	.20233	.57808	-.00038
19	.74292	.20327	.57973	-.00046
20	.77483	.20449	.58188	-.00056
21	.80579	.20605	.58465	-.00071
22	.83582	.20811	.58831	-.00093
23	.86490	.21080	.59325	-.00134
24	.89300	.21479	.60010	-.00162
25	.92022	.22064	.60982	-.00182
26	.94591	.22774	.62591	-.00561
27	.96955	.23904	.66294	-.02193
28	.98941	.27495	.73345	-.03680
29	1.00000	.36380	.83410	-.00374

X/C = 0.60 UPPER SURFACE

N	y/s	$1 - \frac{p}{p_{i_\infty}}$	M	$1 - \frac{p_i}{p_{i_\infty}}$
1	0.00000	.36276	.83073	-.00192
2	.06838	.36257	.83057	-.00205
3	.13279	.36190	.82934	-.00184
4	.19346	.36106	.82727	-.00105
5	.25061	.36086	.82624	-.00032
6	.30446	.36230	.82877	.00015
7	.35520	.36909	.83832	.00028
8	.40304	.38221	.85859	.00026
9	.44814	.40404	.89227	.00044
10	.49069	.43479	.93982	.00119
11	.53082	.47233	.99879	.00256
12	.56870	.51281	1.06404	.00471
13	.60447	.55109	1.12766	.00781
14	.63824	.58163	1.17983	.01168
15	.67015	.59961	1.21058	.01554
16	.70200	.60212	1.21232	.01949
17	.73243	.59064	1.18589	.02537
18	.76239	.57010	1.14278	.03152
19	.79090	.54690	1.09455	.03907
20	.81801	.52441	1.05039	.04430
21	.84379	.50666	1.02096	.04286
22	.86829	.49265	1.00576	.03313
23	.89156	.48329	.98033	.04395
24	.91364	.47643	.95793	.05573
25	.93483	.47726	.97393	.03987
26	.95470	.46411	.97153	.01842
27	.97325	.49867	1.07378	-.03639
28	.98975	.49506	.89121	.15405
29	1.00000	.37269	.80801	.03610

X/C = 0.60 LOWER SURFACE

N	y/s	$1 - \frac{p}{p_{i_\infty}}$	M	$1 - \frac{p_i}{p_{i_\infty}}$
1	0.00000	.24479	.64515	.00090
2	.06838	.24469	.64503	.00086
3	.13279	.24433	.64458	.00076
4	.19346	.24379	.64378	.00072
5	.25061	.24310	.64272	.00069
6	.30446	.24228	.64146	.00064
7	.35520	.24135	.64002	.00061
8	.40304	.24034	.63845	.00059
9	.44814	.23927	.63678	.00057
10	.49069	.23816	.63504	.00054
11	.53082	.23703	.63326	.00052
12	.56870	.23589	.63148	.00049
13	.60447	.23477	.62971	.00046
14	.63824	.23367	.62798	.00043
15	.67015	.23263	.62635	.00041
16	.70200	.23159	.62476	.00035
17	.73243	.23068	.62332	.00033
18	.76239	.22986	.62210	.00025
19	.79090	.22927	.62118	.00022
20	.81801	.22892	.62076	.00011
21	.84379	.22898	.62089	.00009
22	.86829	.22947	.62189	-.00008
23	.89156	.23070	.62395	-.00016
24	.91364	.23279	.62781	-.00057
25	.93483	.23663	.63401	-.00063
26	.95470	.24289	.64416	-.00079
27	.97325	.25357	.66307	-.00252
28	.98975	.27425	.71631	-.02159
29	1.00000	.37269	.80801	.03610

Table 8-5 (concluded)

X/C = 0.95 UPPER SURFACE					X/C = 0.95 LOWER SURFACE				
N	y/s	$1 - \frac{p}{p_{i_\infty}}$	M	$1 - \frac{p_i}{p_{i_\infty}}$	N	y/s	$1 - \frac{p}{p_{i_\infty}}$	M	$1 - \frac{p_i}{p_{i_\infty}}$
1	0.00000	.26627	.68316	-.00288	1	0.00000	.24305	.64099	.00195
2	.06943	.26638	.68381	-.00330	2	.06943	.24327	.64144	.00187
3	.13476	.26670	.68498	-.00390	3	.13476	.24393	.64248	.00188
4	.19622	.26683	.68541	-.00408	4	.19622	.24499	.64417	.00188
5	.25404	.26692	.68571	-.00422	5	.25404	.24649	.64648	.00194
6	.30844	.26764	.68701	-.00437	6	.30844	.24849	.64977	.00185
7	.35963	.27071	.69220	-.00473	7	.35963	.25114	.65404	.00180
8	.40778	.27871	.70502	-.00506	8	.40778	.25448	.65972	.00150
9	.45309	.29445	.72956	-.00524	9	.45309	.25859	.66670	.00111
10	.49572	.31962	.76805	-.00505	10	.49572	.26330	.67502	.00033
11	.53582	.35379	.81974	-.00431	11	.53582	.26853	.68431	-.00065
12	.57356	.39409	.88081	-.00314	12	.57356	.27386	.69394	-.00191
13	.60906	.43623	.94570	-.00187	13	.60906	.27918	.70349	-.00328
14	.64246	.47491	1.00675	-.00060	14	.64246	.28393	.71209	-.00471
15	.67389	.50349	1.05167	.00202	15	.67389	.28808	.71944	-.00587
16	.70532	.51375	1.06621	.00477	16	.70532	.29145	.72517	-.00661
17	.73525	.50115	1.04394	.00524	17	.73525	.29400	.72912	-.00677
18	.76399	.47886	1.00667	.00534	18	.76399	.29508	.73094	-.00693
19	.79136	.45555	.96813	.00620	19	.79136	.29555	.73084	-.00609
20	.81743	.43001	.92562	.00827	20	.81743	.29425	.72869	-.00578
21	.84225	.40319	.88253	.00921	21	.84225	.29274	.72470	-.00404
22	.86587	.37804	.84179	.01079	22	.86587	.28906	.71933	-.00410
23	.88834	.35560	.80505	.01266	23	.88834	.28595	.71265	-.00221
24	.90971	.33729	.77140	.01763	24	.90971	.27959	.70460	-.00067
25	.93018	.32196	.74848	.01665	25	.93018	.27618	.69465	.00058
26	.94957	.31266	.72762	.02237	26	.94957	.26370	.68290	-.00607
27	.96795	.30073	.73149	.00169	27	.96795	.26741	.67093	.00937
28	.98512	.30706	.72494	.01687	28	.98512	.23713	.66256	-.02411
29	1.00000	.27419	.67651	.01384	29	1.00000	.27419	.67651	.01384

Table 8-6

SOLUTION BY RIZZI FOR CASE 14 (DILLNER WING, α = 15°, M_∞ = 1.5)

SPAN SECTION X% = 0.201

I	y/s	$1 - \frac{p}{p_{i_\infty}}$	CP	M	$1 - \frac{p_i}{p_{i_\infty}}$
1	.030707	.586518	-.328829	1.190958	.009053
2	.090847	.586384	-.329140	1.190988	.008693
3	.148241	.586225	-.329512	1.190207	.009316
4	.202578	.585887	-.330300	1.188805	.010310
5	.253716	.585711	-.330709	1.187122	.012049
6	.301647	.585229	-.331834	1.185555	.012905
7	.346467	.584986	-.332399	1.184180	.014085
8	.388355	.584467	-.333609	1.183032	.014318
9	.427551	.584202	-.334227	1.182056	.014933
10	.464335	.583714	-.335365	1.181246	.014809
11	.499012	.583456	-.335965	1.180568	.015063
12	.531899	.583027	-.336967	1.180015	.014751
13	.563310	.582796	-.337505	1.179571	.014771
14	.593547	.582438	-.338338	1.179230	.014362
15	.622892	.582254	-.338768	1.178991	.014231
16	.651589	.581987	-.339389	1.178847	.013785
17	.679846	.581883	-.339632	1.178817	.013578
18	.707817	.581748	-.339948	1.178914	.013134
19	.735598	.581792	-.339844	1.179192	.012886
20	.763223	.581879	-.339642	1.179697	.012446
21	.790650	.582212	-.338866	1.180529	.012170
22	.817763	.582715	-.337692	1.181804	.011734
23	.844368	.583624	-.335575	1.183719	.011439
24	.870195	.584970	-.332437	1.186552	.011012
25	.894901	.587073	-.327536	1.190741	.010661
26	.918079	.590267	-.320090	1.196961	.010340
27	.939273	.595129	-.308757	1.207069	.009094
28	.957998	.603191	-.289966	1.221683	.010012
29	.973760	.615928	-.260279	1.250038	.005095
30	.986090	.640912	-.202046	1.297348	.008640
31	.994576	.681999	-.106281	1.392781	-.001744
32	.998906	.751510	.055738	1.560539	.003553
33	.998906	.809805	.191612	1.675625	.095020
34	.994576	.820498	.216536	1.599206	.237940
35	.986090	.819079	.213228	1.733399	.060719
36	.973760	.842434	.267663	2.071069	-.377251
37	.957998	.852709	.291614	1.948539	-.063941
38	.939273	.858587	.305313	1.835190	.142457
39	.918079	.870959	.334150	1.913402	.117244
40	.894901	.885111	.367137	1.961012	.153900
41	.870195	.899419	.400485	2.026015	.180485
42	.844368	.908416	.421457	2.075646	.193750
43	.817763	.914453	.435526	2.108402	.207359
44	.790650	.916894	.441216	2.123316	.211821
45	.763223	.917350	.442278	2.120542	.219534
46	.735598	.915857	.438799	2.107207	.221826
47	.707817	.913176	.432551	2.082762	.227115
48	.679846	.908960	.422724	2.052055	.227500
49	.651589	.903147	.409175	2.011623	.228350
50	.622892	.895292	.390866	1.964840	.224281
51	.593547	.885697	.368501	1.913068	.218470
52	.563310	.874537	.342490	1.861737	.207488
53	.531899	.862185	.313700	1.812170	.193260
54	.499012	.848685	.282234	1.766077	.174435
55	.464335	.834434	.249017	1.723986	.152605
56	.427551	.819734	.214755	1.687273	.127110
57	.388355	.805573	.181747	1.656780	.100665
58	.346467	.792649	.151624	1.632960	.074423
59	.301647	.782254	.127396	1.616060	.052170
60	.253716	.774751	.109908	1.605055	.035399
61	.202578	.770573	.100168	1.599234	.025945
62	.148241	.768672	.095739	1.598377	.019122
63	.090847	.768366	.095024	1.603770	.009942
64	.030707	.768273	.094808	1.611271	-.001539

Table 8-6 (continued)

SPAN SECTION X% = 0.598

I	y/s	$1 - \frac{p}{p_{t_\infty}}$	CP	M	$1 - \frac{p_t}{p_{t_\infty}}$
1	.030712	.636281	-.212840	1.288180	.008265
2	.090862	.636051	-.213377	1.287573	.008453
3	.148264	.635508	-.214642	1.286176	.008849
4	.202610	.634780	-.216339	1.284119	.009629
5	.253757	.633812	-.218594	1.281806	.010105
6	.301695	.632697	-.221194	1.279433	.010266
7	.346522	.631439	-.224126	1.276944	.010204
8	.388416	.630085	-.227282	1.274323	.010069
9	.427618	.628655	-.230616	1.271567	.009922
10	.464408	.627159	-.234103	1.268723	.009726
11	.499090	.625621	-.237686	1.265782	.009562
12	.531982	.624033	-.241388	1.262771	.009369
13	.563398	.622415	-.245158	1.259676	.009223
14	.593641	.62074[illegible]	-.249045	1.256515	.009047
15	.622991	.619050	-.253002	1.253272	.008914
16	.651694	.617300	-.257080	1.249962	.008749
17	.679956	.615524	-.261221	1.246582	.008623
18	.707932	.613703	-.265466	1.243151	.008463
19	.735719	.611883	-.269708	1.239705	.008341
20	.763347	.610059	-.273959	1.236294	.008180
21	.790775	.608327	-.277996	1.233037	.008064
22	.817888	.606711	-.281762	1.230052	.007897
23	.844490	.605409	-.284797	1.227624	.007800
24	.870311	.604498	-.286921	1.226006	.007631
25	.895005	.604358	-.287247	1.225817	.007527
26	.918168	.605226	-.285223	1.227712	.007225
27	.939345	.607877	-.279046	1.233152	.006771
28	.958051	.613279	-.266455	1.243278	.007207
29	.973795	.623351	-.242978	1.266282	.002986
30	.986109	.644965	-.192599	1.308337	.005053
31	.994584	.682675	-.104704	1.399770	-.009486
32	.998908	.761093	.078073	1.598679	-.013469
33	.998908	.835746	.252075	1.764578	.105884
34	.994584	.853792	.294137	1.700208	.278092
35	.986109	.861689	.312544	2.083872	-.233346
36	.973795	.877840	.350189	2.312968	-.558828
37	.958051	.877338	.349018	2.090875	-.105834
38	.939345	.877688	.349835	1.959239	.101708
39	.918168	.885908	.368994	2.046480	.040276
40	.895005	.899294	.400195	2.140219	.019330
41	.870311	.909881	.424871	2.206026	.027257
42	.844490	.917916	.443597	2.263097	.031190
43	.817888	.925216	.460613	2.320348	.034631
44	.790775	.930704	.473406	2.365748	.039678
45	.763347	.934828	.483018	2.402805	.043009
46	.735719	.937735	.489792	2.429128	.047345
47	.707932	.939540	.493999	2.445363	.051242
48	.679956	.940119	.495349	2.448530	.055679
49	.651694	.938824	.492331	2.431610	.060378
50	.622991	.934991	.483397	2.388979	.065789
51	.593641	.928151	.467454	2.321498	.070851
52	.563398	.918553	.445084	2.238964	.074351
53	.531982	.906677	.417403	2.151615	.074883
54	.499090	.892488	.384330	2.063704	.070998
55	.464408	.875979	.345850	1.978175	.061973
56	.427618	.857528	.302844	1.899114	.046651
57	.388416	.838429	.258330	1.831350	.025976
58	.346522	.821276	.218348	1.781374	.001891
59	.301695	.808961	.189644	1.751507	-.019449
60	.253757	.802517	.174625	1.739127	-.034212
61	.202610	.801038	.171178	1.737881	-.039989
62	.148264	.801902	.173192	1.739263	-.037645
63	.090862	.803055	.175878	1.736878	-.027882
64	.030712	.803285	.176415	1.732154	-.019355

Table 8-6 (concluded)

SPAN SECTION X% = 0.939

I	y/s	$1 - \frac{p}{p_{i_\infty}}$	CP	M	$1 - \frac{p_i}{p_{i_\infty}}$
1	.030729	.694743	-.076577	1.407969	.017614
2	.090914	.695035	-.075896	1.408216	.018212
3	.148349	.695407	-.075029	1.408511	.019001
4	.202727	.695766	-.074191	1.408895	.019627
5	.253903	.696071	-.073482	1.409437	.019858
6	.301869	.696319	-.072903	1.409992	.019890
7	.346722	.696499	-.072483	1.410383	.019932
8	.388641	.696602	-.072242	1.410586	.019984
9	.427865	.696605	-.072237	1.410726	.019797
10	.464674	.696495	-.072493	1.410850	.019271
11	.499376	.696269	-.073019	1.410842	.018553
12	.532286	.695930	-.073810	1.410605	.017785
13	.563721	.695475	-.074869	1.410098	.017020
14	.593983	.694899	-.076214	1.409290	.016282
15	.623353	.694188	-.077871	1.408138	.015592
16	.652076	.693319	-.079896	1.406593	.014945
17	.680359	.692261	-.082361	1.404598	.014327
18	.708354	.690969	-.085373	1.402094	.013675
19	.736158	.689392	-.089049	1.398986	.012970
20	.763799	.687455	-.093563	1.395136	.012181
21	.791235	.685095	-.099064	1.390373	.011359
22	.818347	.682200	-.105812	1.384513	.010435
23	.844937	.678698	-.113974	1.377328	.009543
24	.870733	.674434	-.123913	1.368594	.008558
25	.895389	.669515	-.135378	1.358361	.007808
26	.918497	.663777	-.148753	1.346979	.006383
27	.939607	.658324	-.161461	1.335728	.005838
28	.958242	.653186	-.173437	1.327018	.002911
29	.973920	.653716	-.172202	1.329441	.001113
30	.986178	.664302	-.147530	1.344128	.011839
31	.994612	.681455	-.107547	1.438737	-.070866
32	.998913	.753384	.060105	1.652337	-.133175
33	.998913	.883099	.362446	1.832487	.294035
34	.994612	.928468	.468193	1.742318	.623572
35	.986178	.922180	.453537	2.116982	.269225
36	.973920	.914116	.434740	2.288774	-.055222
37	.958242	.910284	.425808	2.223525	.004707
38	.939607	911823	.429397	2.198993	.058634
39	.918497	.915952	.439020	2.295472	-.043544
40	.895389	.920885	.450519	2.367730	-.099797
41	.870733	.928252	.467690	2.415903	-.075317
42	.844937	.935519	.484627	2.467249	-.046964
43	.818347	.944050	.504513	2.554078	-.039734
44	.791235	.951835	.522657	2.649447	-.037403
45	.763799	.957658	.536229	2.728955	-.030690
46	.736158	.962329	.547116	2.808926	-.036353
47	.708354	.967245	.558574	2.903062	-.039681
48	.680359	.971104	.567569	2.989676	-.045113
49	.652076	.971697	.568952	3.003584	-.045244
50	.623353	.969081	.562853	2.944869	-.045384
51	.593983	.964288	.551683	2.848806	-.043962
52	.563721	.957445	.535733	2.733887	-.043735
53	.532286	.948125	.514009	2.604791	-.042820
54	.499376	.935661	.484958	2.465354	-.041574
55	.464674	.919371	.446990	2.319085	-.038760
56	.427865	.898897	.399269	2.171541	-.033976
57	.388641	.875668	.345126	2.039020	-.033770
58	.346722	.856880	.301335	1.952537	-.040244
59	.301869	.846313	.276706	1.911520	-.048296
60	.253903	.842564	.267966	1.899193	-.053609
61	.202727	.842502	.267821	1.900351	-.055912
62	.148349	.843425	.269973	1.902726	-.053580
63	.090914	.843867	.271004	1.898321	-.043481
64	.030729	.843589	.270356	1.890905	-.033436

Table 8-7

SOLUTION BY RIZZI FOR CASE 15 (DILLNER WING, $\alpha = 15°$, $M_\infty = 0.7$)

SPAN SECTION X% = 0.201

I	y/s	$1 - \frac{p}{p_{i_\infty}}$	CP	M	$1 - \frac{p_i}{p_{i_\infty}}$
1	.030707	.202635	-.309112	.575792	.001516
2	.090847	.202653	-.309040	.575956	.001451
3	.148241	.202606	-.309233	.576013	.001378
4	.202578	.202582	-.309327	.575975	.001397
5	.253716	.202623	-.309163	.575857	.001559
6	.301647	.202594	-.309279	.575744	.001626
7	.346467	.202656	-.309029	.575669	.001775
8	.388355	.202661	-.309009	.575655	.001806
9	.427551	.202747	-.308660	.575711	.001881
10	.464335	.202821	-.308362	.575836	.001888
11	.499012	.202946	-.307855	.576042	.001894
12	.531899	.203117	-.307165	.576325	.001900
13	.563310	.203297	-.306436	.576710	.001835
14	.593547	.203600	-.305212	.577191	.001855
15	.622892	.203860	-.304159	.577812	.001708
16	.651589	.204352	-.302170	.578563	.001759
17	.679846	.204737	-.300612	.579523	.001510
18	.707817	.205522	-.297437	.580671	.001625
19	.735598	.206114	-.295043	.582154	.001238
20	.763223	.207380	-.289923	.583925	.001486
21	.790650	.208329	-.286087	.586276	.000887
22	.817763	.210424	-.277616	.589091	.001392
23	.844368	.212004	-.271224	.593001	.000419
24	.870195	.215603	-.256670	.597669	.001446
25	.894901	.218338	-.245611	.604631	-.000318
26	.918079	.224828	-.219363	.612716	.001939
27	.939273	.229849	-.199061	.626880	-.002032
28	.957998	.244752	-.138790	.641542	.003843
29	.973760	.256476	-.091380	.673335	-.007465
30	.986090	.291326	.049556	.711466	.006818
31	.994576	.325627	.188267	.785992	-.013872
32	.998906	.384433	.426082	.854138	.008477
33	.998906	.391984	.456617	.871158	.002959
34	.994576	.393099	.461128	.829662	.046826
35	.986090	.430926	.614103	.941122	-.007094
36	.973760	.424205	.586920	.927057	-.003155
37	.957998	.431371	.615901	.886045	.052639
38	.939273	.440379	.652330	.899055	.054481
39	.918079	.459989	.731631	.931979	.054035
40	.894901	.479443	.810305	.960368	.058562
41	.870195	.499091	.889760	.986640	.064769
42	.844368	.514900	.953693	1.011055	.068730
43	.817763	.527174	1.003330	1.029481	.072661
44	.790650	.534522	1.033047	1.040353	.075222
45	.763223	.537166	1.043738	1.043092	.077249
46	.735598	.534918	1.034647	1.038254	.077741
47	.707817	.528802	1.009912	1.026934	.077671
48	.679846	.519250	.971288	1.010872	.076208
49	.651589	.507342	.923128	.991335	.074287
50	.622892	.493484	.867088	.969812	.071253
51	.593547	.478502	.806501	.947086	.067921
52	.563310	.462636	.742336	.924107	.063774
53	.531899	.446499	.677080	.901321	.059452
54	.499012	.430221	.611248	.879376	.054506
55	.464335	.414521	.547759	.858701	.049661
56	.427551	.399484	.486950	.839780	.044511
57	.388355	.385917	.432083	.823102	.039778
58	.346467	.373805	.383104	.809018	.035007
59	.301647	.363922	.343134	.798001	.030829
60	.253716	.355868	.310563	.790195	.026418
61	.202578	.350217	.287712	.785860	.022303
62	.148241	.345907	.270281	.784552	.017279
63	.090847	.343686	.261300	.785434	.013206
64	.030707	.341890	.254038	.786345	.009635

Table 8-7 (continued)

SPAN SECTION X% = 0.598

I	y/s	$1 - \frac{p}{p_{i_\infty}}$	CP	M	$1 - \frac{p_i}{p_{i_\infty}}$
1	.030712	.248129	-.125133	.650520	.000126
2	.090862	.247931	-.125934	.650286	.000057
3	.148264	.247559	-.127439	.649798	-.000021
4	.202610	.247055	-.129477	.648995	-.000004
5	.253757	.246415	-.132068	.647947	.000037
6	.301695	.245695	-.134978	.646758	.000097
7	.346522	.244884	-.138256	.645488	.000104
8	.388416	.244035	-.141690	.644164	.000109
9	.427618	.243132	-.145342	.642791	.000086
10	.464408	.242222	-.149021	.641380	.000088
11	.499090	.241275	-.152853	.639942	.000063
12	.531982	.240344	-.156617	.638487	.000076
13	.563398	.239374	-.160542	.637023	.000046
14	.593641	.238444	-.164303	.635553	.000076
15	.622991	.237460	-.168282	.634088	.000032
16	.651694	.236555	-.171939	.632631	.000086
17	.679956	.235577	-.175894	.631209	.000018
18	.707932	.234755	-.179221	.629833	.000114
19	.735719	.233841	-.182916	.628569	.000003
20	.763347	.233237	-.185357	.627449	.000176
21	.790775	.232537	-.188188	.626631	-.000016
22	.817888	.232464	-.188485	.626183	.000301
23	.844490	.232306	-.189122	.626456	-.000064
24	.870311	.233416	-.184634	.627552	.000547
25	.895005	.234443	-.180483	.630316	-.000250
26	.918168	.238106	-.165669	.634788	.001032
27	.939345	.241660	-.151294	.643431	-.000977
28	.958051	.251989	-.109525	.654795	.002382
29	.973795	.262084	-.068699	.679009	-.004798
30	.986109	.290817	.047495	.715879	.002118
31	.994584	.327564	.196102	.786170	-.011134
32	.998908	.397816	.480205	.888938	-.006385
33	.998908	.415536	.551863	.886980	.025280
34	.994584	.418985	.565810	.859688	.058682
35	.986109	.442725	.661815	1.004641	-.060619
36	.973795	.444405	.668610	.983426	-.031672
37	.958051	.450866	.694737	.966725	-.000329
38	.939345	.460055	.731899	.994362	-.015390
39	.918168	.472048	.780401	1.011261	-.012641
40	.895005	.488165	.845578	1.030875	-.004770
41	.870311	.510122	.934374	1.059408	.001308
42	.844490	.534093	1.031310	1.095176	.007336
43	.817888	.557070	1.124231	1.132375	.011371
44	.790775	.575289	1.197910	1.163050	.014650
45	.763347	.586347	1.242628	1.182477	.016644
46	.735719	.589186	1.254107	1.187274	.018082
47	.707932	.584114	1.233597	1.177755	.018865
48	.679956	.572239	1.185576	1.156200	.019016
49	.651694	.555168	1.116540	1.126149	.018458
50	.622991	.534368	1.032422	1.090845	.017091
51	.593641	.511171	.938615	1.052965	.014957
52	.563398	.486690	.839611	1.014553	.012058
53	.531982	.461964	.739620	.977303	.008403
54	.499090	.438065	.642970	.942715	.004129
55	.464408	.416129	.554263	.912104	-.000410
56	.427618	.397067	.477173	.886515	-.005031
57	.388416	.381763	.415283	.866685	-.009268
58	.346522	.370595	.370122	.852772	-.012857
59	.301695	.363595	.341811	.844291	-.015364
60	.253757	.360097	.327668	.839940	-.016554
61	.202610	.359183	.323969	.837834	-.015942
62	.148264	.359622	.325747	.836157	-.013585
63	.090862	.360408	.328923	.834179	-.010327
64	.030712	.360894	.330890	.832753	-.008080

Table 8-7 (concluded)

SPAN SECTION X% = 0.949

I	y/s	$1 - \frac{p}{p_{i_\infty}}$	CP	M	$1 - \frac{p_i}{p_{i_\infty}}$
1	.030729	.252212	-.108625	.657073	.000072
2	.090914	.252627	-.106944	.657724	.000051
3	.148349	.253327	-.104115	.658818	.000037
4	.202727	.254291	-.100215	.660295	.000055
5	.253903	.255493	-.095353	.662129	.000093
6	.301869	.256931	-.089541	.664336	.000132
7	.346722	.258575	-.082890	.666905	.000144
8	.388641	.260407	-.075481	.669777	.000152
9	.427865	.262386	-.067480	.672878	.000161
10	.464674	.264472	-.059045	.676138	.000179
11	.499376	.266615	-.050378	.679494	.000190
12	.532286	.268770	-.041663	.682868	.000200
13	.563721	.270886	-.033104	.686179	.000206
14	.593983	.272916	-.024894	.689347	.000215
15	.623353	.274802	-.017267	.692292	.000214
16	.652076	.276486	-.010457	.694922	.000204
17	.680359	.277901	-.004734	.697134	.000184
18	.708354	.278970	-.000411	.698806	.000155
19	.736158	.279606	.002160	.699814	.000108
20	.763799	.279710	.002581	.700009	.000039
21	.791235	.279184	.000454	.699244	-.000056
22	.818347	.277914	-.004683	.697328	-.000163
23	.844937	.275803	-.013219	.694088	-.000259
24	.870733	.272731	-.025644	.689342	-.000341
25	.895389	.268708	-.041911	.683138	-.000430
26	.918497	.263763	-.061909	.675653	-.000636
27	.939607	.258172	-.084520	.667462	-.001047
28	.958242	.252309	-.108229	.659117	-.000846
29	.973920	.248200	-.124847	.653650	-.001703
30	.986178	.247872	-.126174	.655964	-.004100
31	.994612	.254075	-.101091	.657801	.002631
32	.998913	.252264	-.108413	.692536	-.030329
33	.998913	.297377	.074023	.681257	.041381
34	.994612	.290288	.045358	.725463	-.007411
35	.986178	.295400	.066032	.772214	-.045213
36	.973920	.302823	.096047	.758973	-.021148
37	.958242	.313074	.137504	.769393	-.016227
38	.939607	.325551	.187962	.792169	-.020157
39	.918497	.341422	.252146	.813470	-.017501
40	.895389	.361421	.333023	.840390	-.014025
41	.870733	.386742	.435420	.874412	-.011926
42	.844937	.415941	.553501	.916377	-.008831
43	.818347	.448041	.683314	.966250	-.008437
44	.791235	.482051	.820851	1.019386	-.006606
45	.763799	.511611	.940394	1.068719	-.006519
46	.736158	.528950	1.010512	1.100265	-.008042
47	.708354	.530968	1.018474	1.106200	-.009877
48	.680359	.518871	.969753	1.087156	-.010806
49	.652076	.496434	.879018	1.050360	-.011054
50	.623353	.467729	.762935	1.003723	-.010987
51	.593983	.435976	.634522	.953239	-.011005
52	.563721	.403405	.502804	.902931	-.011650
53	.532286	.372412	.377468	.856185	-.012796
54	.499376	.345124	.267115	.815598	-.014042
55	.464674	.322508	.175657	.782471	-.015454
56	.427865	.305096	.105242	.757324	-.016866
57	.388641	.292864	.055774	.739978	-.018176
58	.346722	.285175	.024680	.729407	-.019323
59	.301869	.281056	.008022	.723998	-.020183
60	.253903	.279359	.001158	.721752	-.020525
61	.202727	.279023	-.000200	.720396	-.019742
62	.148349	.279172	.000403	.717796	-.017099
63	.090914	.279198	.000509	.713518	-.013086
64	.030729	.279086	.000056	.709884	-.009881

REFERENCES

8-1 D.S. Butler. "The numerical solution of hyperbolic systems of partial differential equations in three independent variables." Proc. Roy. Soc. Lond. A, 255, 232-252, 1960.

8-2 F. Walkden, P. Caine, G. Moretti. "Pressure distribution on a simple delta wing." Computers and Fluids, 10, 4, 295-305, 1982.

8-3 G. Moretti. "Calculation of three-dimensional inviscid supersonic steady flows." NASA CR 3573, 1982.

8-4 L.C. Squire. "Measured pressure distributions and shock shapes on a simple delta wing." Aeronautical Quarterly, 32, 3, 188-198, 1981.

8-5 - "Undersökning av strömningen kring deltavingar vid transsoniska hastigheter." FFA Rep. No. AU-295, 1955.

8-6 F.T. Johnson, P. Lu, E.N. Tinoco, M.A. Epton. "An improved panel method for the solution of three-dimensional vortex flows." NASA CR-3278, 1980.

8-7 H.W.M. Hoeijmakers, B. Bennekers. "A computational model for the calculation of the flow about wings with leading-edge vortices." AGARD CP-247, 1979.

8-8 L.B. Schiff, J.L. Steger. "Numerical simulation of steady supersonic viscous flows." AIAA Paper 79-0130, 1979.

8-9 D.S. Chaussee, J.L. Patterson, P. Kutler, T.H. Pulliam, J.L. Steger. "A numerical simulation of hypersonic viscous flows over arbitrary geometries at high angle of attack." AIAA Paper 81-0050, 1981.

8-10 M.M. Rai, D.S. Chaussee. "New implicit boundary procedures: theory and application." AIAA Paper 83-0123, 1983.

8-11 M. Fenain. "Calculs d'écoulements supersoniques tridimensionels par la méthode des volumes finis." ONERA (to be published).

8-12 G. Moretti. "The λ-scheme." Computers and Fluids, 7, 191-205, 1979.

8-13 T. de Neef. "Treatment of boundaries in unsteady inviscid flow computations." Delft Univ. of Technology, Rep. No. LR-262, 1978.

8-14 F. Walkden, P. Caine, G.T. Laws. "A locally two-dimensional numerical method for calculating three-dimensional supersonic flows." J. Comp. Phys., 27, 1, 103-122, 1978.

8-15 C. Weiland. "Calculation of three-dimensional stationary supersonic flow fields by applying the 'Progonka' process to a conservative formulation of the governing equations." J. Comp. Phys., 29, 2, 173-198, 1978.

8-16 C. Weiland. "Erfahrungen bei der Anwendung numerischer Verfahren zur Lösung nichtlinearer hyperbolischer Differentialgleichungssysteme, Lecture Notes in Mathematics, 953, Springer Verlag, 1982.

8-17 C. Weiland. "Results of the Euler solution for the Butler wing with M_∞ = 2.5 and α = 0 (AGARD WG07 Test Case)." MBB-UFE 122-Aero-MT-680, 1983.

8-18 Z. Kopal (ed). "Tables of supersonic flow around cones, by the staff of the computing section." MIT Dept. of Elect. Eng. Center of Analysis, Tech. Rep.1, 1947.

8-19 D.J. Jones. "Tables of inviscid supersonic flow about circular cones at incidence, γ = 1.4." AGARDograph No.137, 1969.

8-20 Ames Staff. "Equations, tables and charts for compressible flow." NACA Rep.1135, 1953.

8-21 Ron-Ho Ni. "A multiple-grid scheme for solving the Euler equations." AIAA Journal, 20, 11, 1565-1571, 1982.

8-22 C. Koeck, M. Néron. "Computations of three-dimensional transonic inviscid flows on a wing by pseudo-unsteady resolution of the Euler equations." Fifth GAMM Conference on Numerical Methods in Fluid Mechanics, Rome, 1983. Proceedings to be published by Vieweg, editors M. Pandolfi and R. Piva.

8-23 A. Jameson, W. Schmidt, E. Turkel. "Numerical solution of the Euler equations by finite volume methods using Runge-Kutta time-stepping schemes." AIAA Paper 81-1259, 1981.

8-24 W. Schmidt, A. Jameson, D. Whitfield. "Finite volume solution for the Euler equation for transonic flow over airfoils and wings including viscous effects." AIAA Paper 81-1265, 1981.

REFERENCES (concluded)

8-25 A. Rizzi. "Damped Euler-equation method to compute transonic flow around wing-body combinations." AIAA Journal, 20, 10, 1321-1328, 1982.

8-26 A. Rizzi, L-E. Eriksson. "Practical 3d mesh generation and explicit schemes to solve the Euler equations." *In* Advances in Computational Transonics, ed. W.G. Habashi, Pineridge Press, Swansea, 1983.

8-27 A. Rizzi, L-E. Eriksson, W. Schmidt, S. Hitzel. "Numerical solutions of the Euler equations simulating vortex flows around wings." *In* Aerodynamics of Vortical-Type Flows in Three Dimensions, Paper 21 of AGARD CP-342, 1983.

8-28 L.C. Squire. "A review of experimental work on the aerodynamics of integrated slender wings for supersonic flight." RAE Technical Report 80069, 1980.

8-29 H.W.M. Hoeijmakers. "Computational vortex flow aerodynamics." *In* Aerodynamics of Vortical-Type Flow in Three Dimensions, Paper 18 of AGARD CP 342, 1983.

8-30 C. Weiland. "Vortex flow simulations past wings using the Euler-equations". Paper 19 of AGARD CP-342, 1983.

8-31 M.G. Hall. "A theory for the core of a leading edge vortex." J. Fluid. Mech. 11, 209, 1961.

8-32 H. Ludwieg. "Zur Erklärung der Instabilität der über angestellten Deltaflügeln auftretenden freien Wirbelkerne." Zeit. Flugwissenschaft 10, 242, 1962.

8-33 S.N. Brown. "The compressible inviscid leading-edge vortex". J. Fluid Mech. 22, 17-32, 1965.

8-34 D. Hummel. "On the vortex formation over a slender wing at large angles of incidence." *In* High Angle of Attack Aerodynamics, Paper 15 of AGARD CP-247, 1979.

8-35 J.H.B. Smith. "Achievements and problems in modelling highly-swept flow separations." *In* Numerical Methods in Aeronautical Fluid Dynamics, ed. P.L. Roe, Academic Press, 1982.

8-36 D.L.I. Kirkpatrick, J.D. Field. "Experimental investigation of the positions of leading-edge vortices above slender delta wings with various rhombic cross-sections in subsonic conical flow." Brit. ARC CP-925, 1966.

8-37 J.H.B. Smith. "Calculations of the flow over thick, conical slender wings with leading-edge separation." Brit. ARC R&M 3694, 1971.

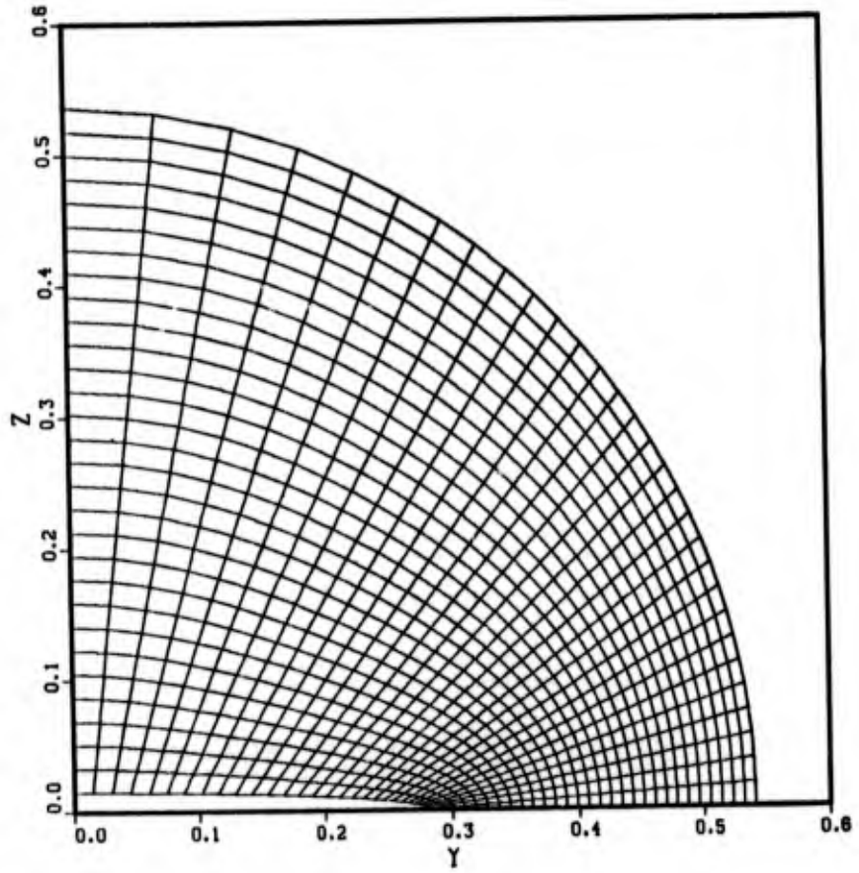
8-38 J.H.B. Smith. "Improved calculations of leading-edge separation from slender thin, delta wings." Proc. Roy. Soc. Lond. A 306, 67-90, 1968.

8-39 J. Nutter. "Secondary separation." PhD Thesis, Univ. of East Anglia, Norwich, 1979. (Quoted in 'Vortical flows and their computation', RAE Technical Memorandum Aero 1866, J.H.B. Smith, 1980.)

8-40 G. Varropoulos, J.F. Wendt. "Laser velocimetry study of compressibility effects on the flow field of a delta wing." *In* Aerodynamics of Vortical-Type Flows in Three Dimensions, Paper 9 of AGARD CP-342, 1983.

8-41 L.E. Eriksson, A. Rizzi. "Analysis by computer of the convergence to steady state of a discrete approximation to the Euler equations." AIAA Paper No.83-1951, 1983.

(a)



(b)

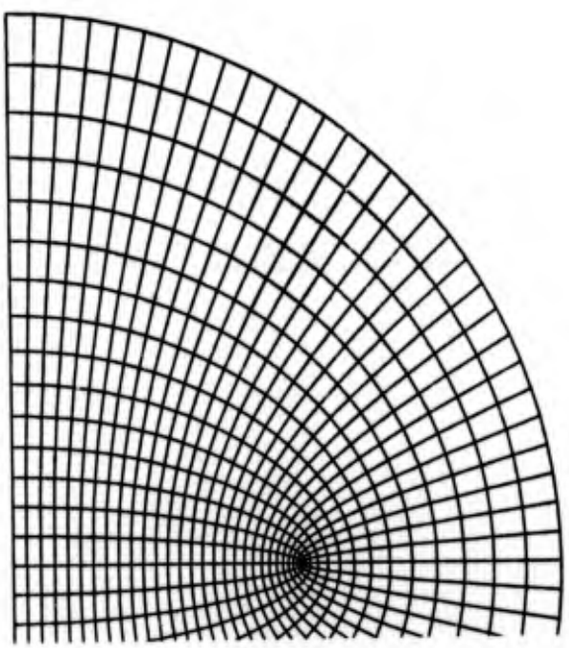
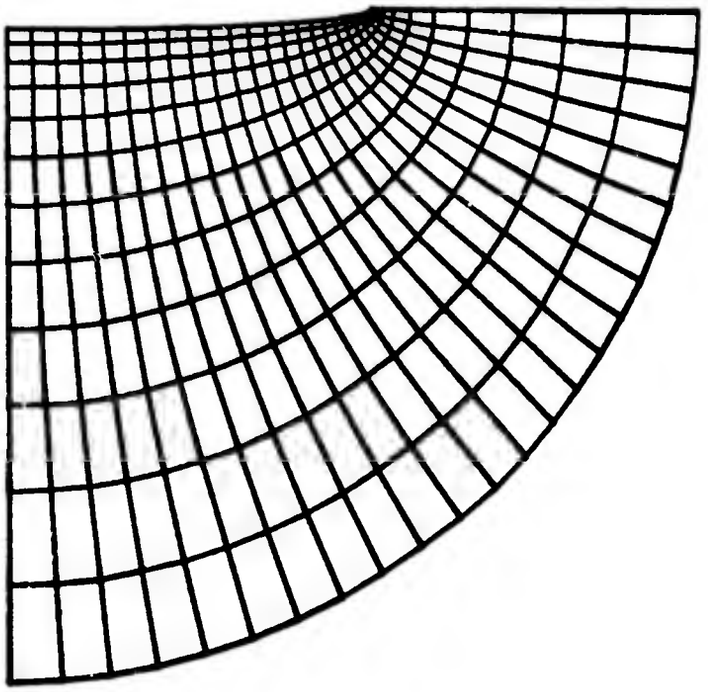
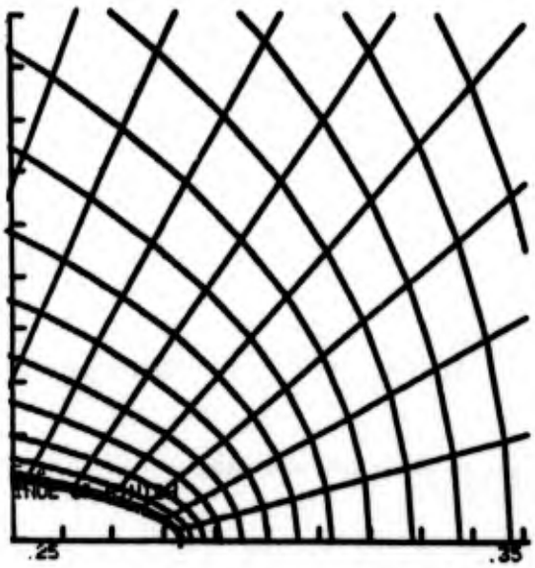


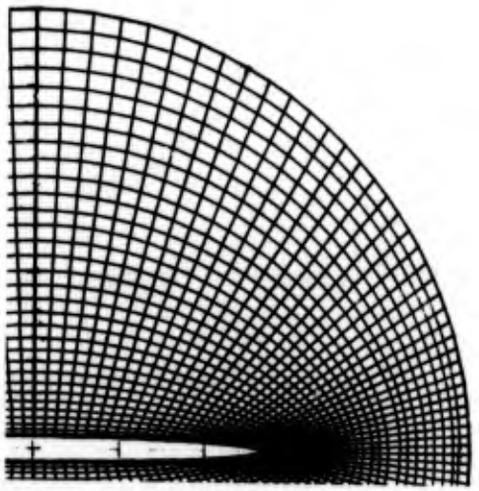
Fig 8-1 Computing grids used by contributors near trailing edge of Butler wing: (a) C at x/c = 0.955, (b) FL1 at x/c = 1, (c) Mol at x/c = 0.940, (d) Detail from Wal at x/c = 0.95, (e) We at x/c = 0.95

(c)



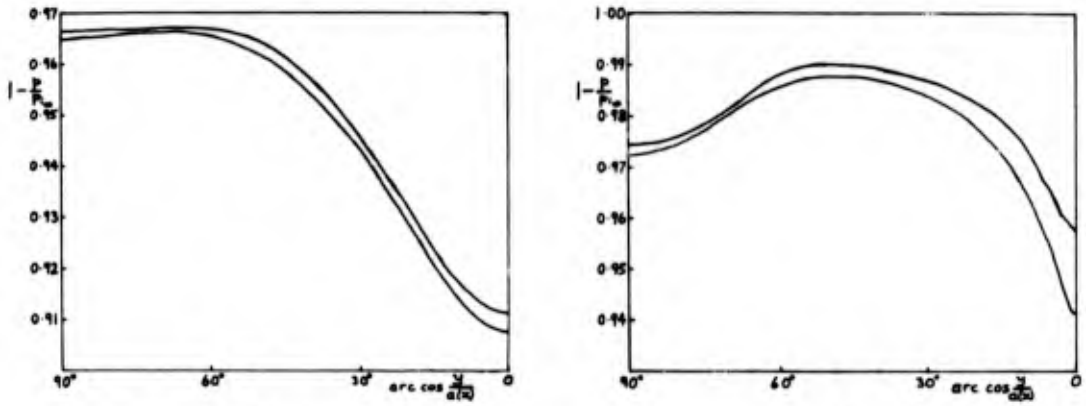


(d)



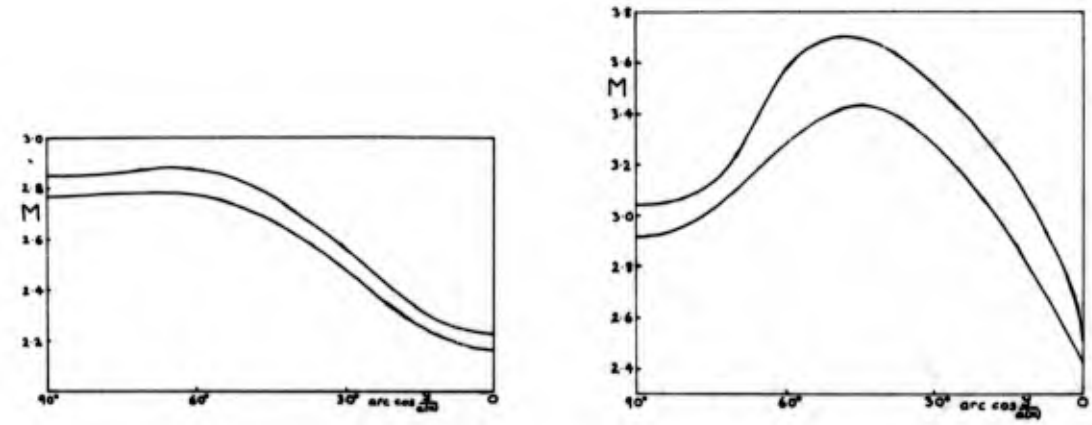
(e)

Fig 8-1 (concluded)



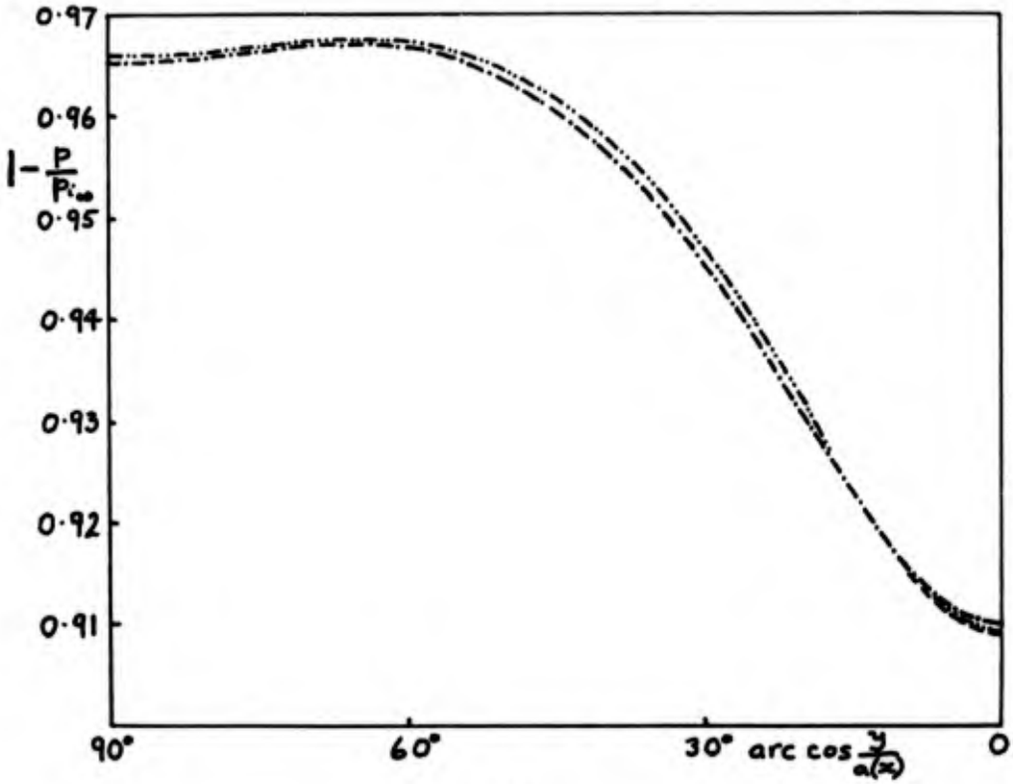
(a) (b)

Fig 8-2(a&b) Spread of contributed solutions for Butler wing: static pressure;
(a) at x/c = 0.6, (b) at x/c = 0.95

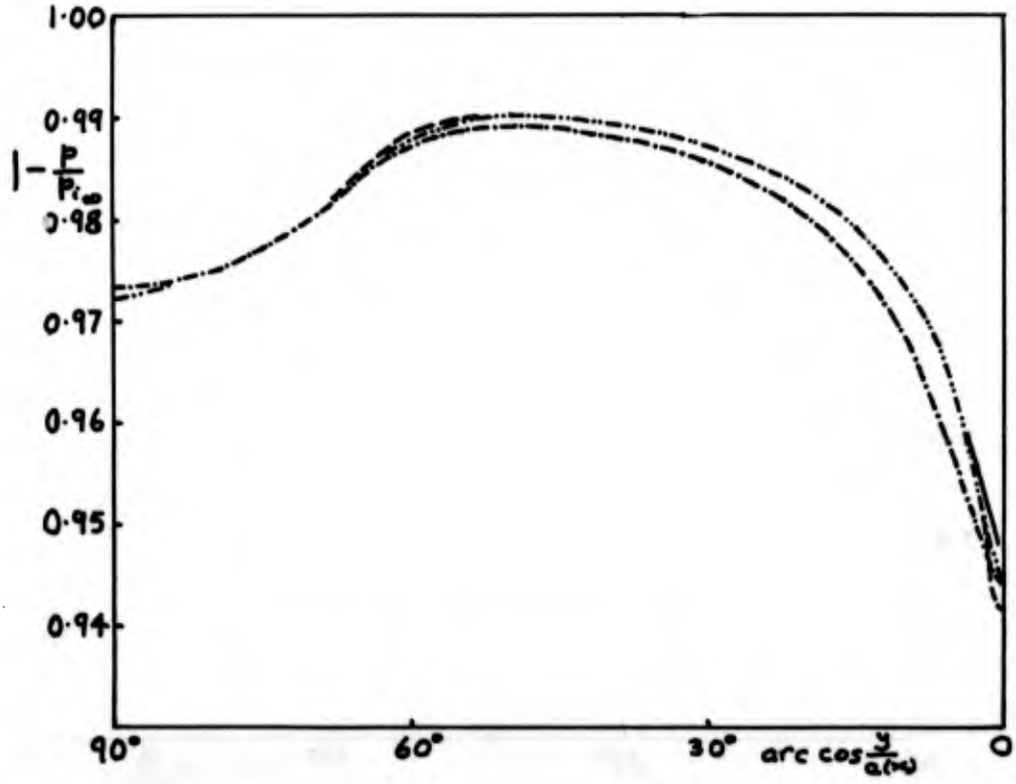


(a) (b)

Fig 8-3(a&b) Spread of contributed solutions for Butler wing: Mach number;
(a) at x/c = 0.6, (b) at x/c = 0.95

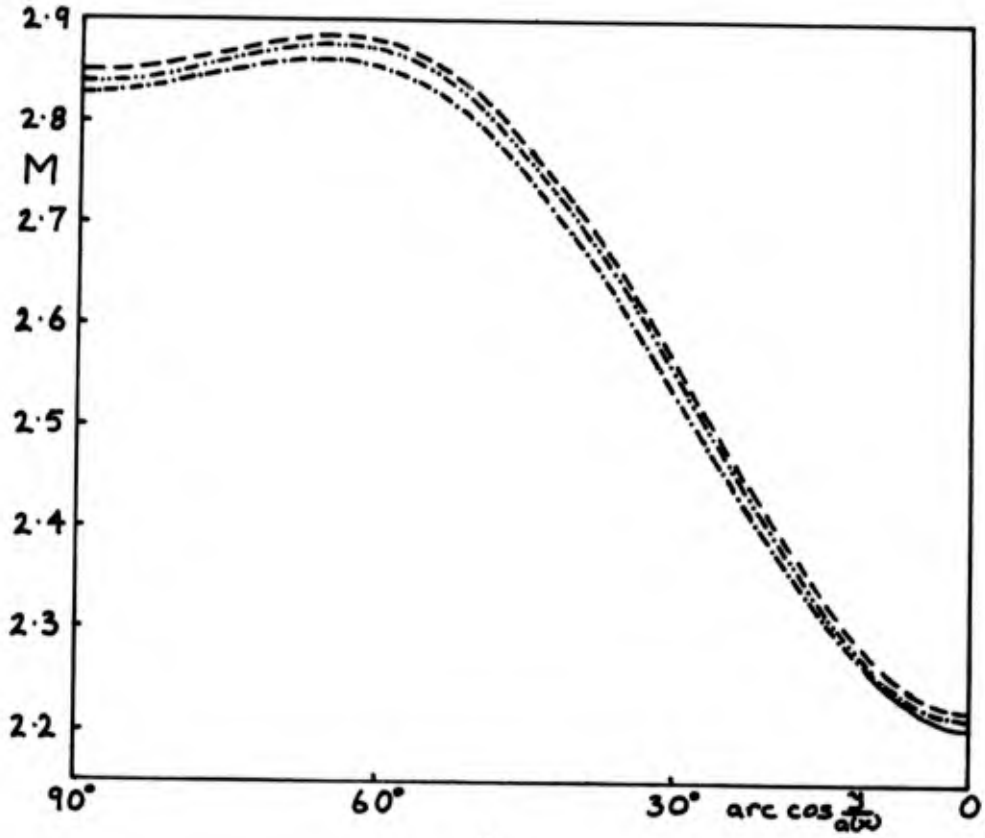


(a)

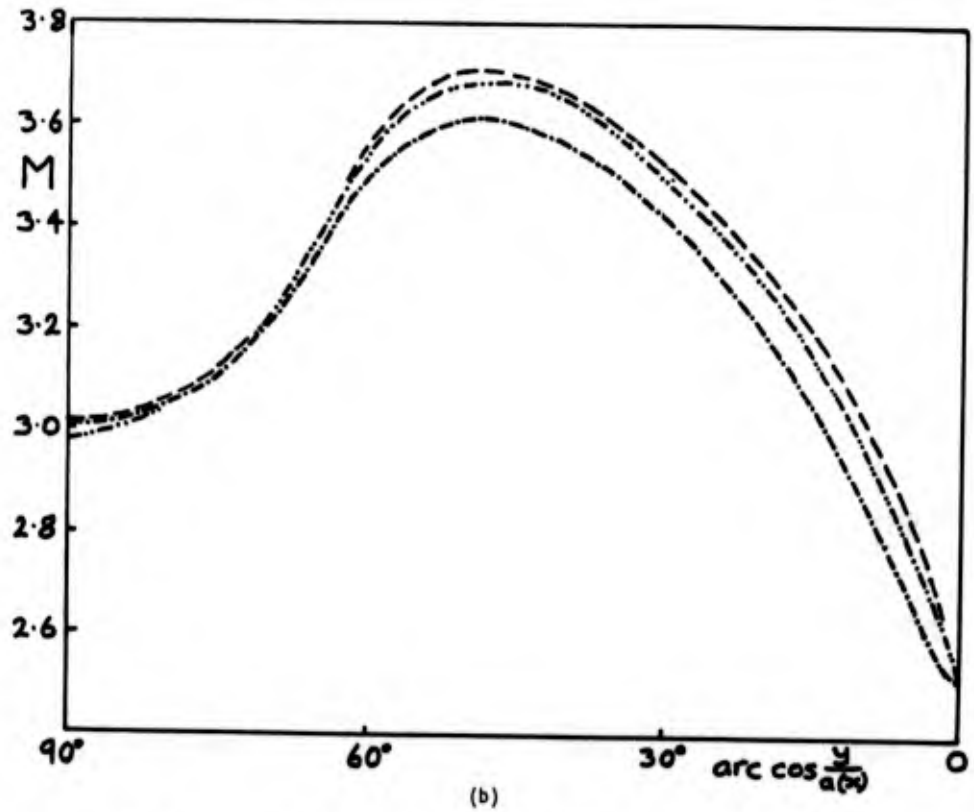


(b)

Fig 8-4(a&b) Static pressure variation on Butler wing: better solutions; (a) at x/c = 0.6, (b) at x/c = 0.95



(a)



(b)

Fig 8-5(a&b) Mach number variation on Butler wing: better solutions;
(a) at x/c = 0.6, (b) at x/c = 0.95

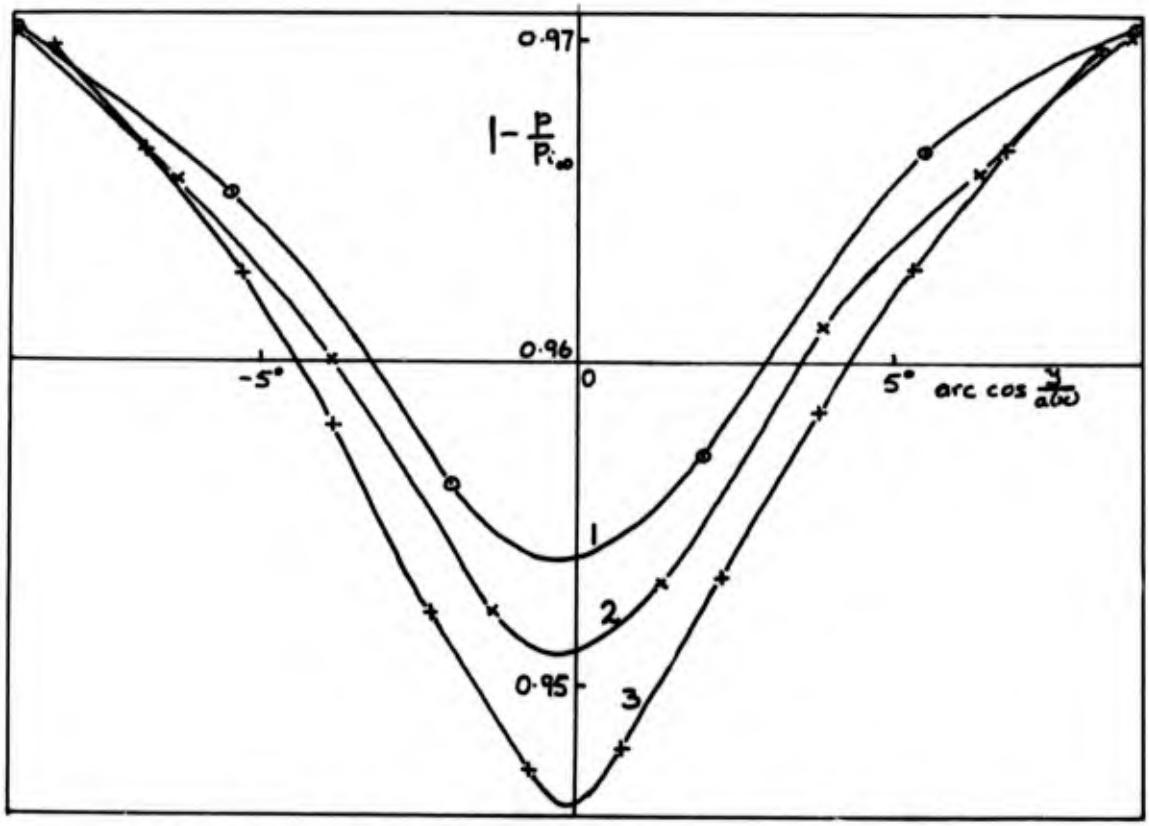


Fig 8-6 Detail of FL solutions for Butler wing near leading edge at x/c = 0.95

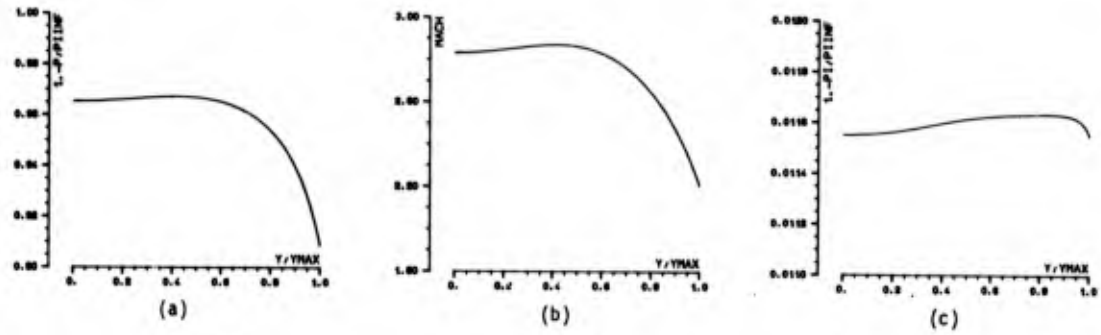


Fig 8-7(a-c) The solution FL3 for the Butler wing at x/c = 0.6:
(a) static pressure, (b) Mach number, (c) total pressure

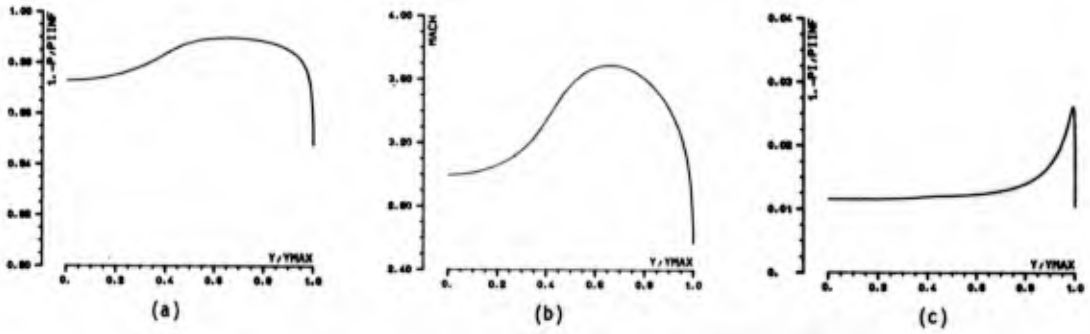


Fig 8-8(a-c) The solution FL3 for the Butler wing at x/c = 0.95:
(a) static pressure, (b) Mach number, (c) total pressure

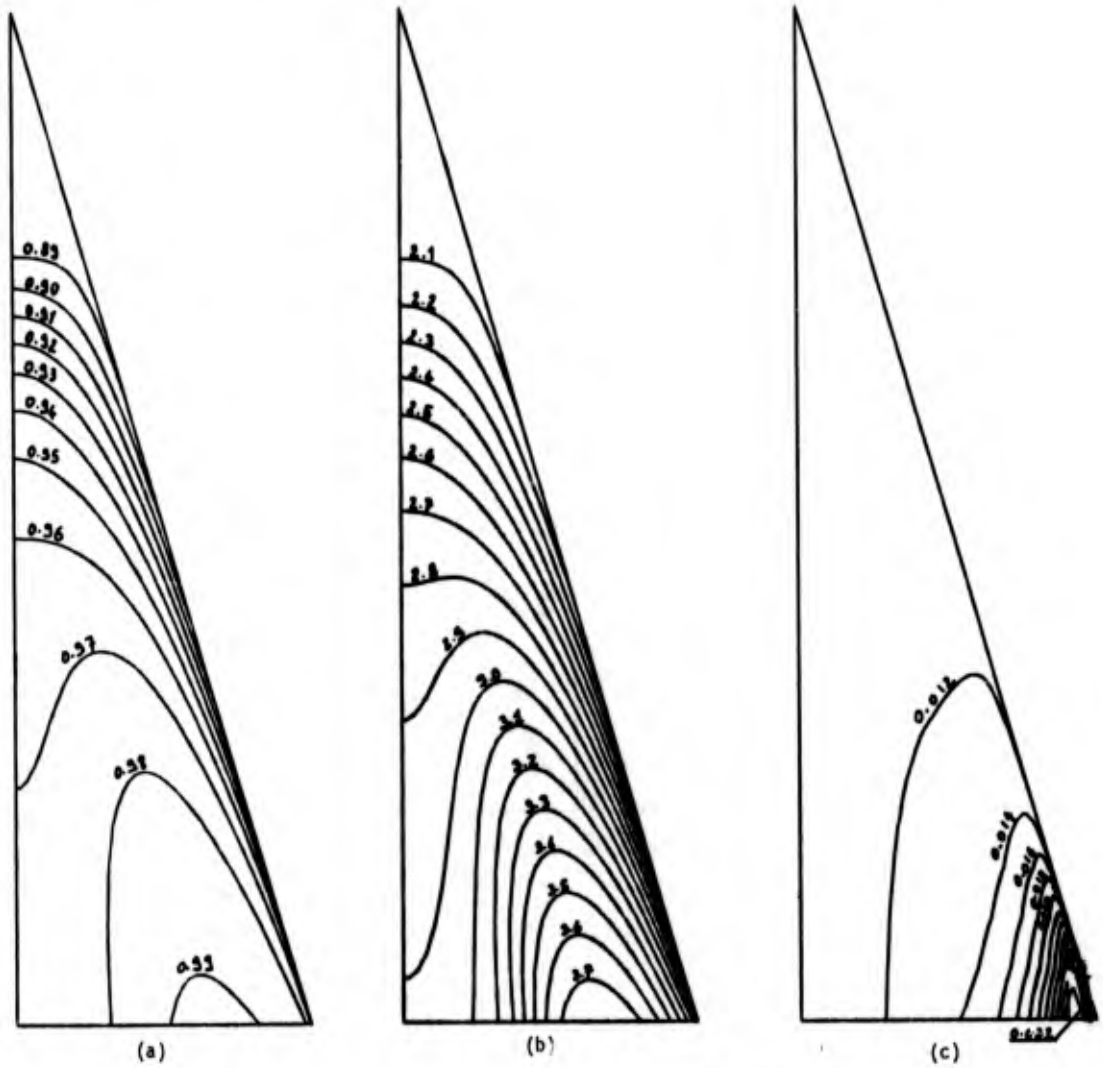


Fig 8-9(a-c) Projections on to the plane z = 0 of contours on the surface of the Butler wing, solutions FL2: (a) static pressure, (b) Mach number, (c) total pressure

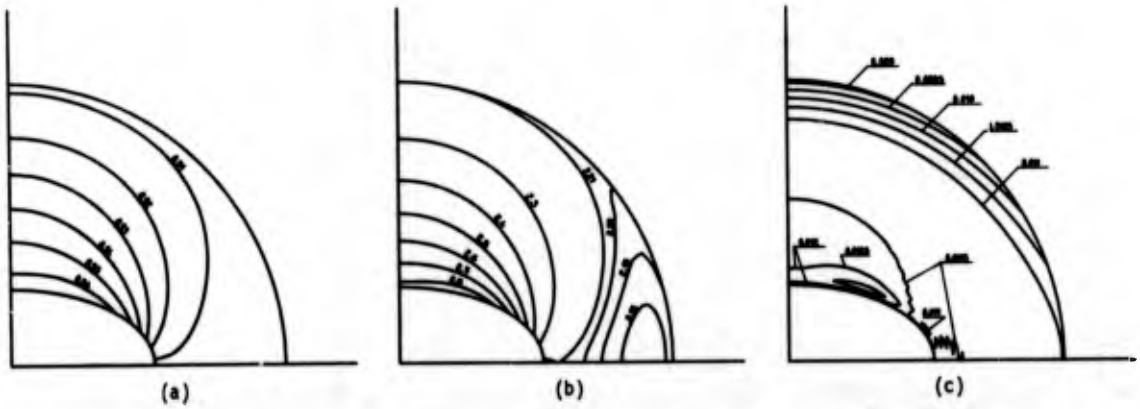
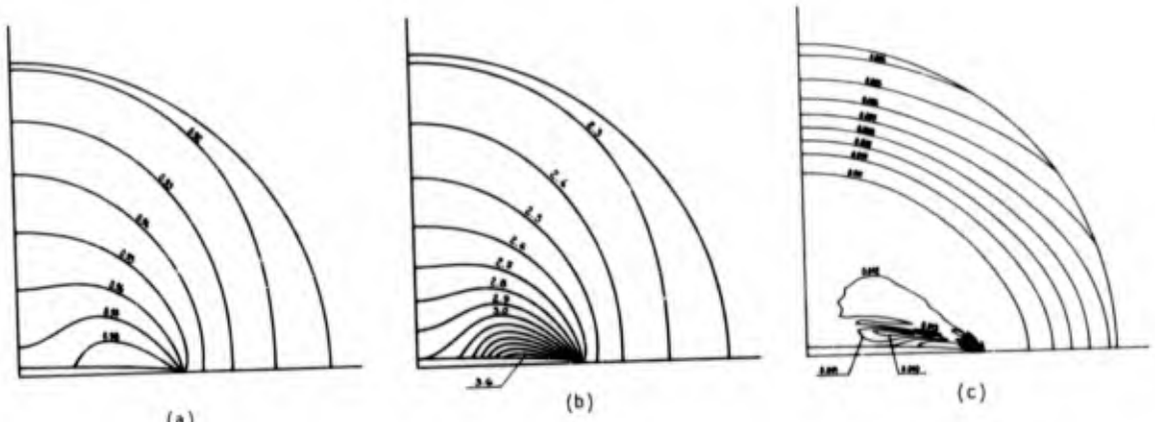
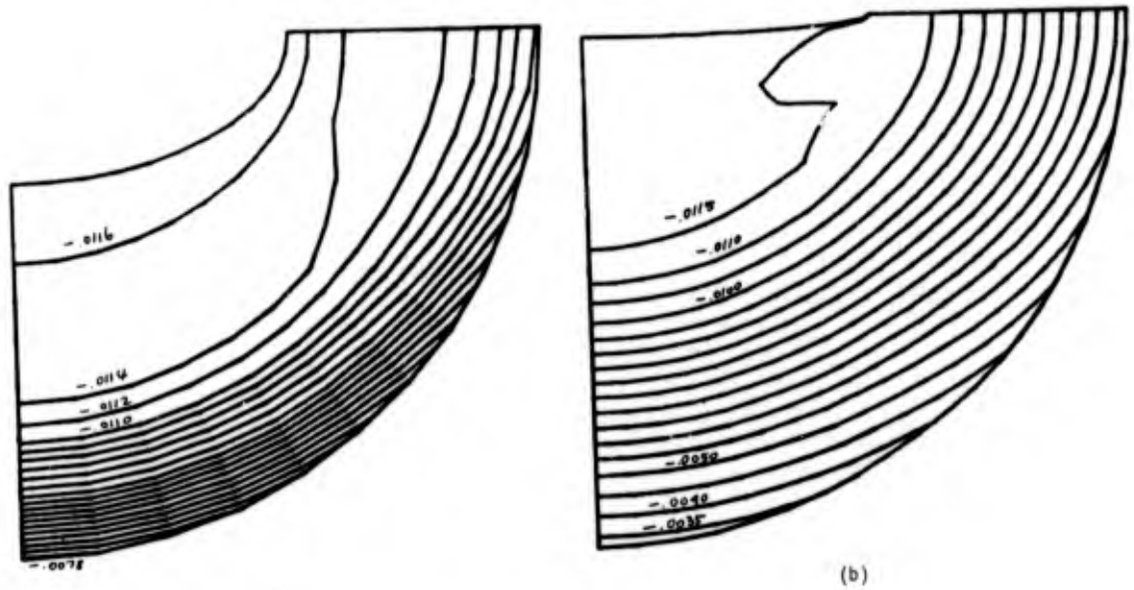


Fig 8-10(a-c) Contours in the flow field of the Butler wing, solution FL3, at x/c = 0.6: (a) static pressure, (b) Mach number, (c) total pressure



(a) (b) (c)

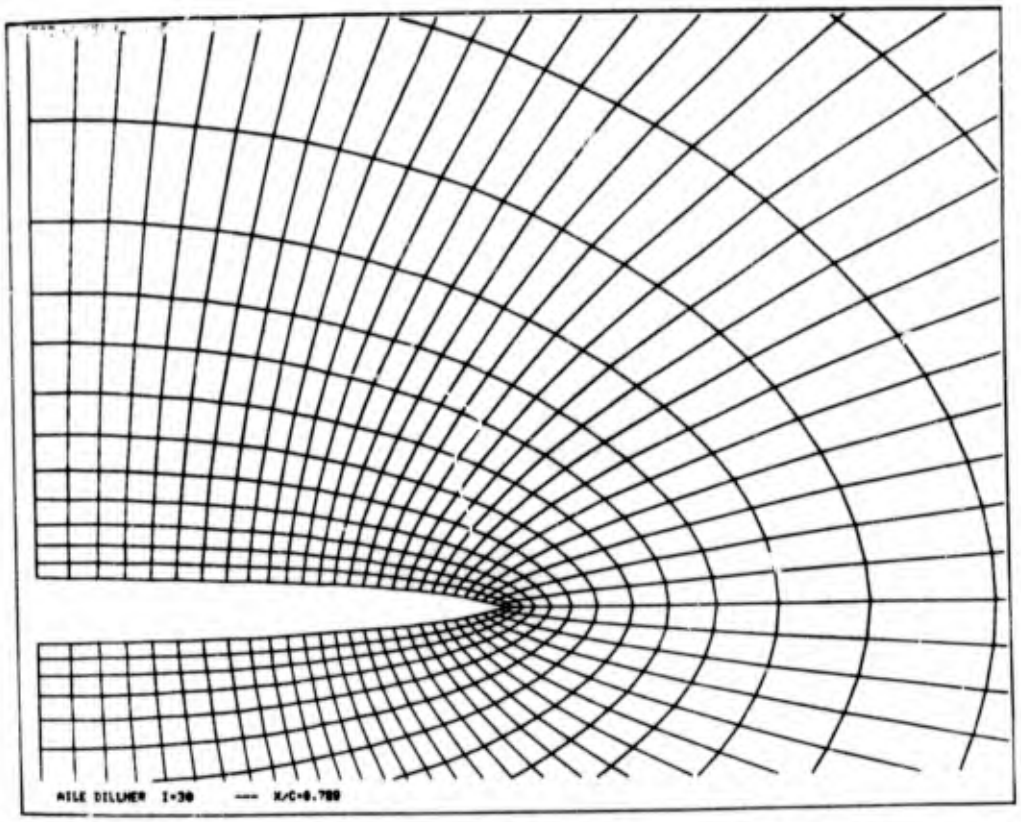
Fig 8-11(a-c) Contours in the flow field of the Butler wing, solution FL3, at x/c = 0.95: (a) static pressure, (b) Mach number, (c) total pressure



(a) (b)

Fig 8-12(a&b) Contours of total pressure $(1 - p_i/p_{i_\infty})$ in flow field of Butler wing, solution Mol: (a) at x/c = 0.6, (b) at x/c = 0.95

(a)



(b)

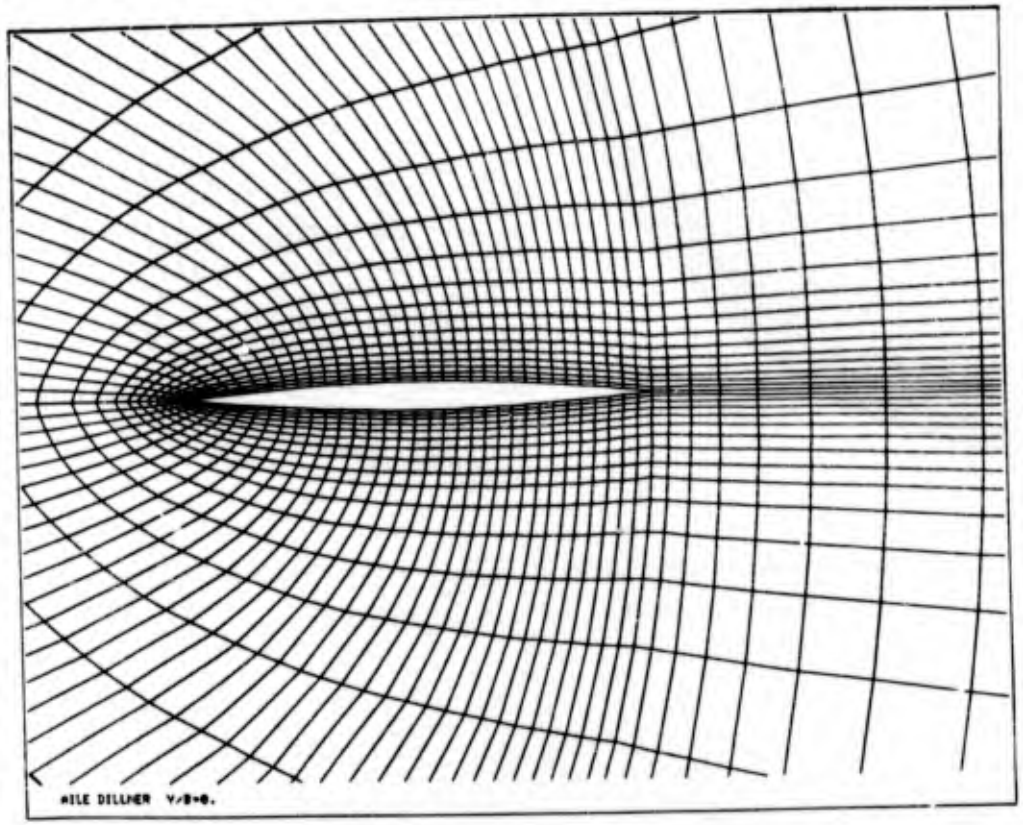
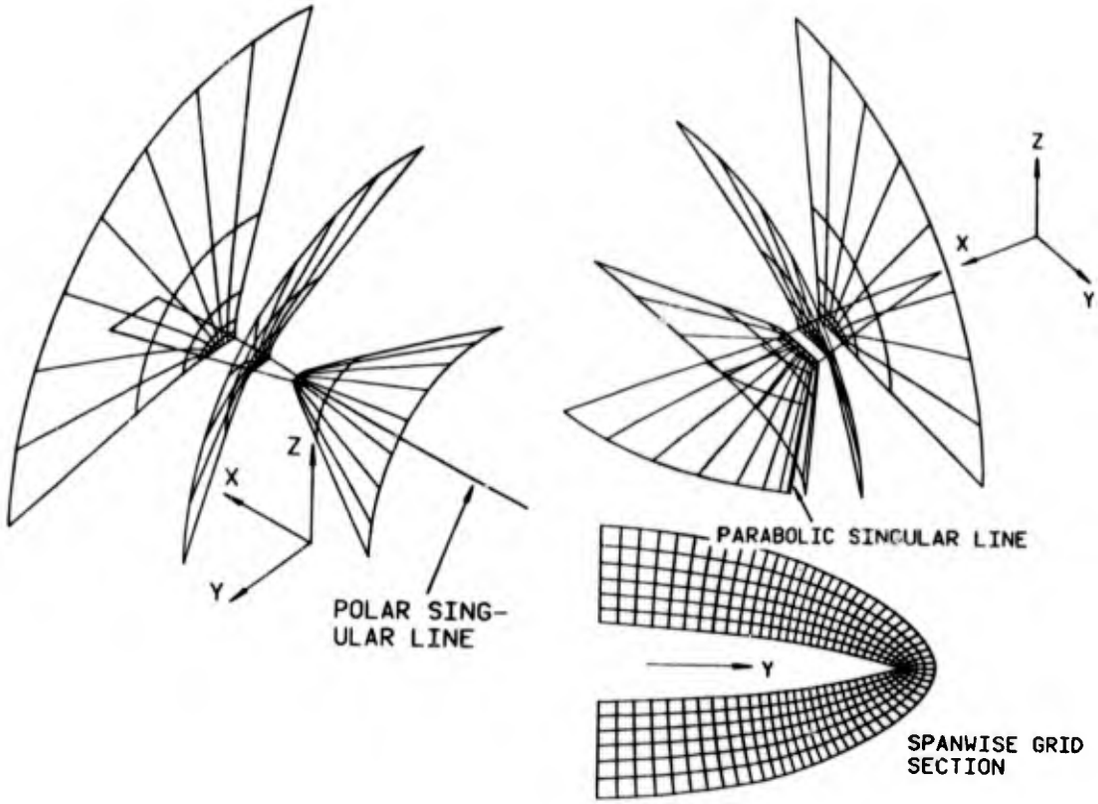


Fig 8-13(a&b) Koeck's grid for Dillner wing
(a) cross-section at x/c = 0.789, (b) plane of symmetry



DILLNER DELTA WING MESH TYPE 0-0

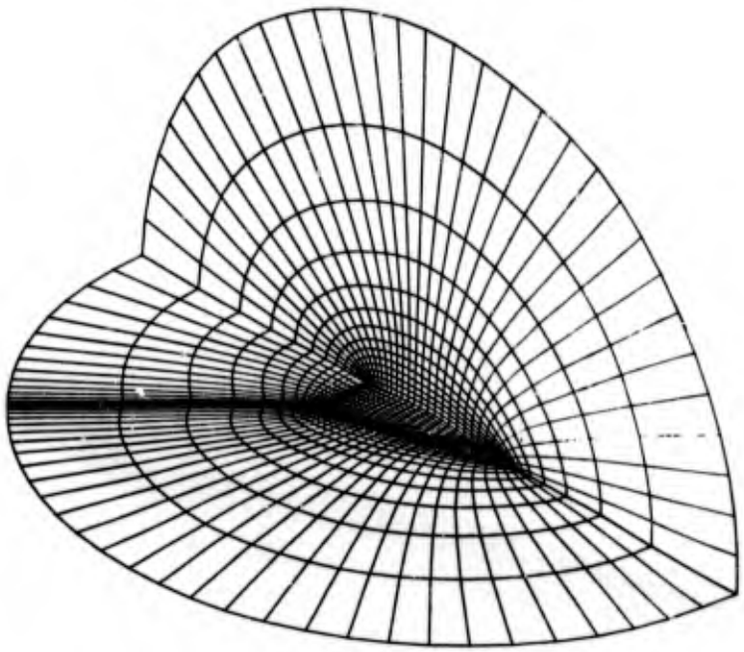


Fig 8-14 Rizzi's grid for Dillner wing

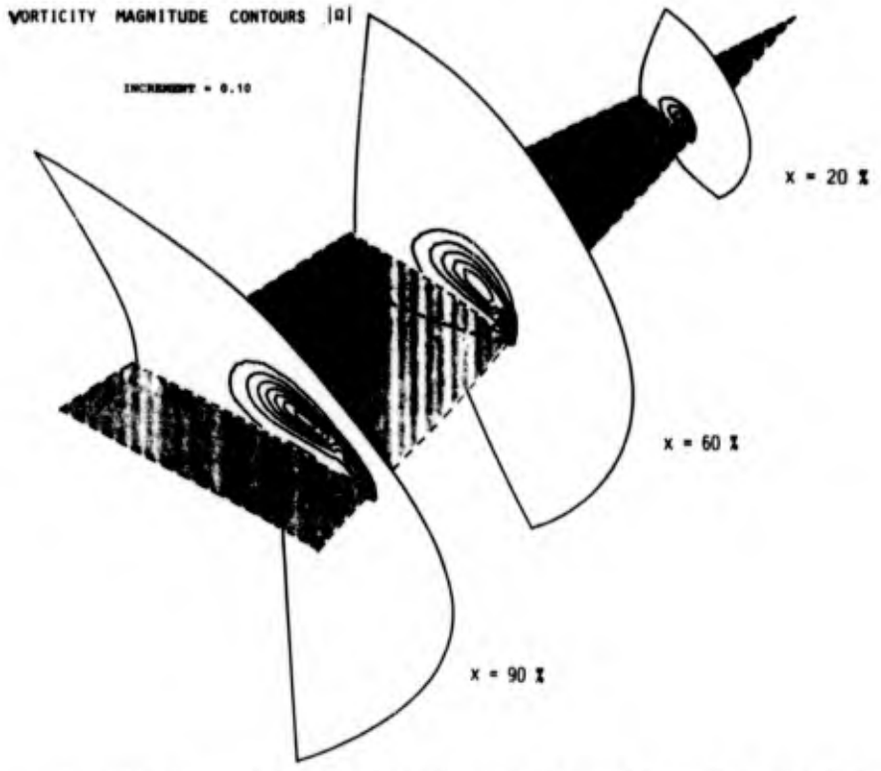
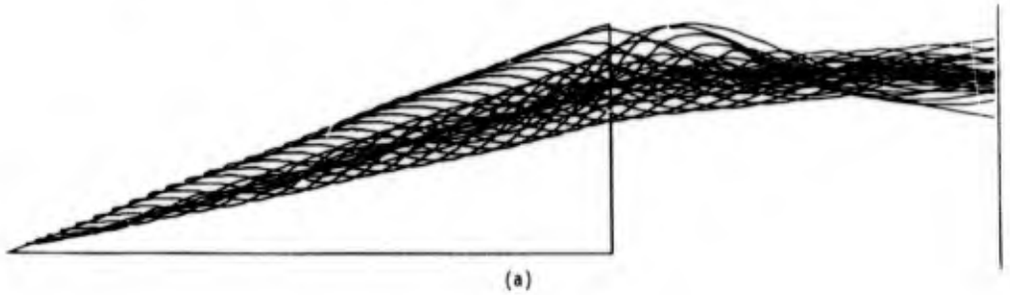
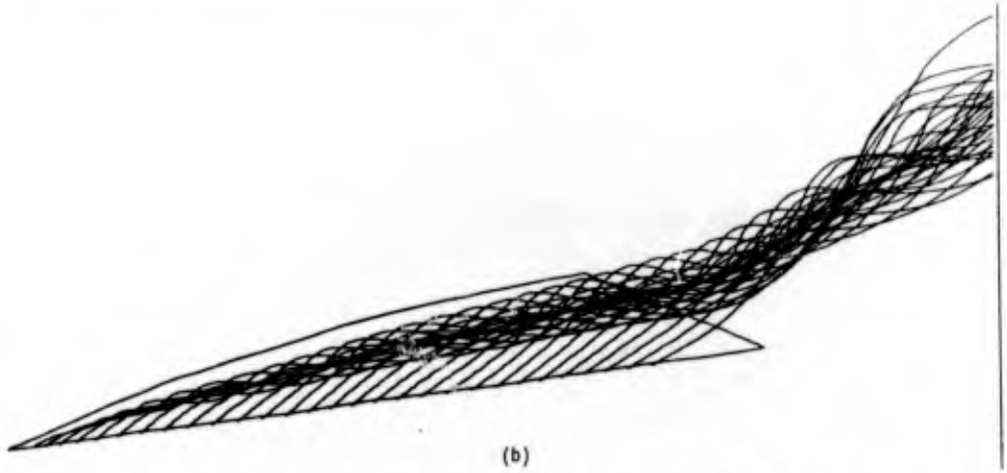


Fig 8-15 Contours of scaled vorticity magnitude above wing, case 15, by Rizzi



(a)



(b)

Fig 8-16(a&b) Streamlines through leading edge, case 15, by Koeck
(a) view from above, (b) oblique view

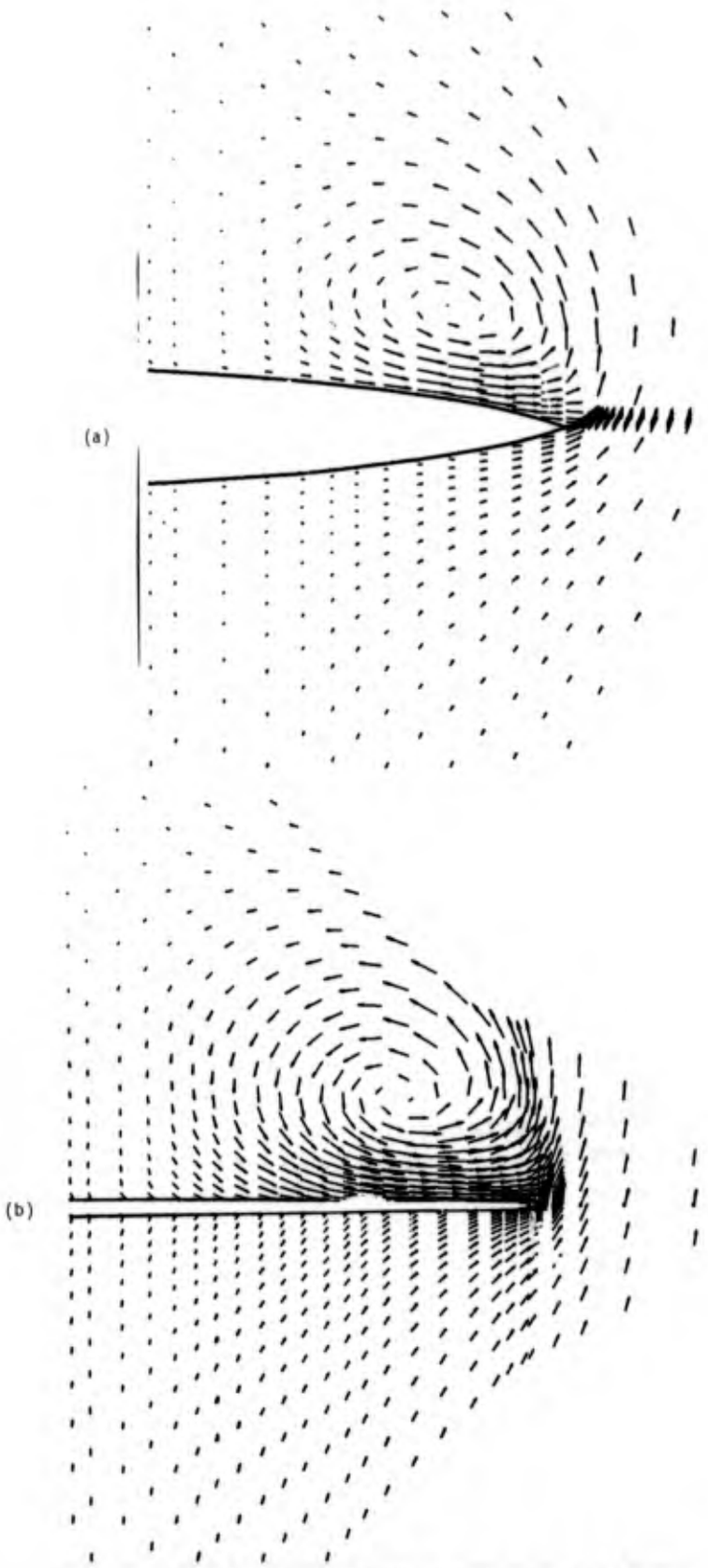
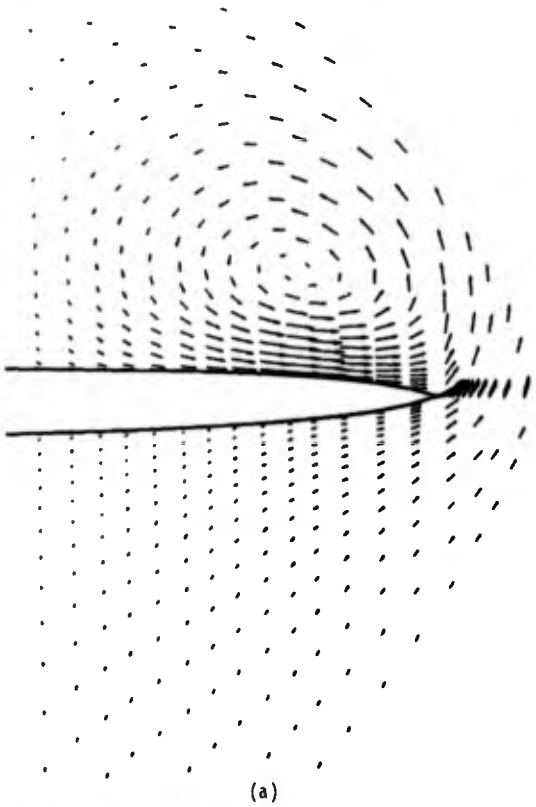
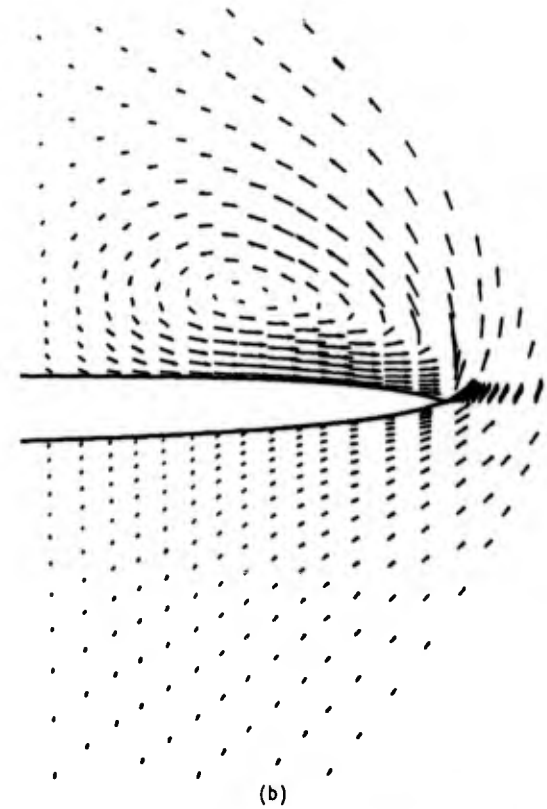


Fig 8-17(a&b) Cross-flow velocity vectors, case 15, by Dornier
(a) x/c = 0.6, (b) x/c = 0.95

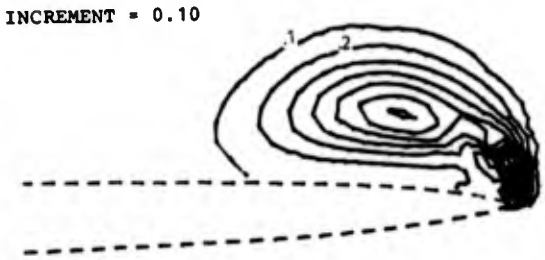


(a)

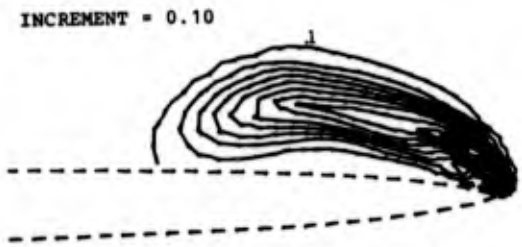


(b)

Fig 8-19(a&b) Cross-flow velocity vectors at x/c = 0.8, by Dornier
(a) case 15, (b) case 14



(a)



(b)

Fig 8-18(a&b) Contours of magnitude of vorticity vector at x/c = 0.8, by Rizzi
(a) case 15, (b) case 14

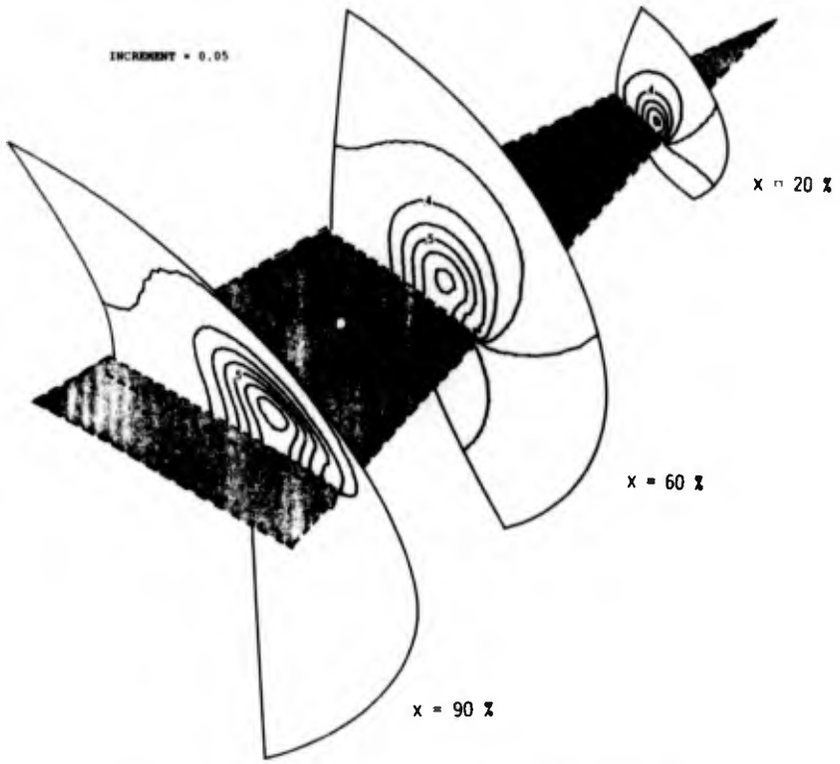


Fig 8-20 Contours of $1 - p/p_{i_\infty}$ over wing, case 15, by Rizzi

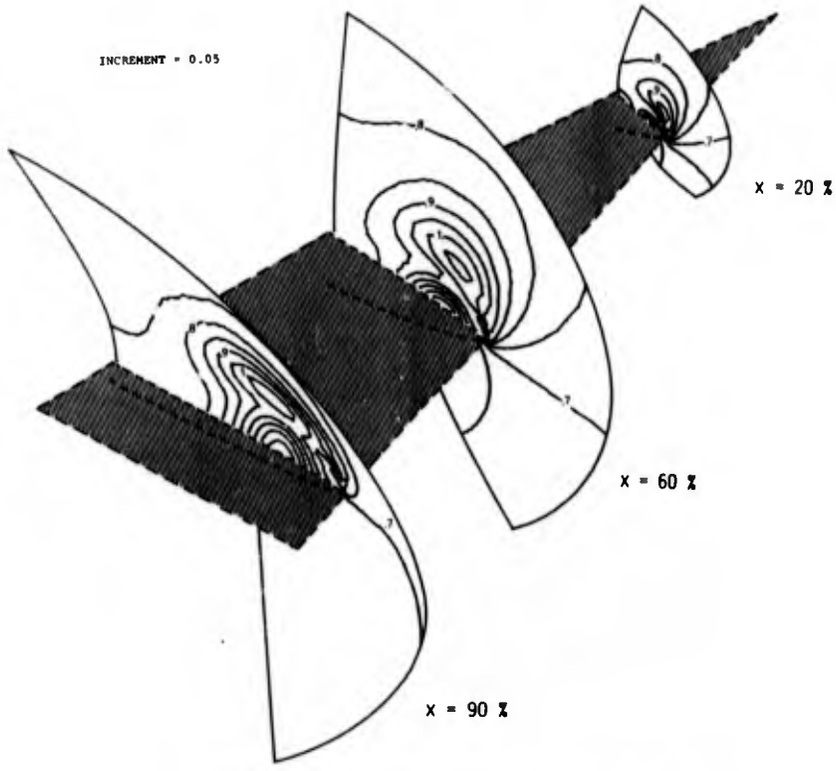


Fig 8-21 Contours of Mach number over wing, case 15, by Rizzi

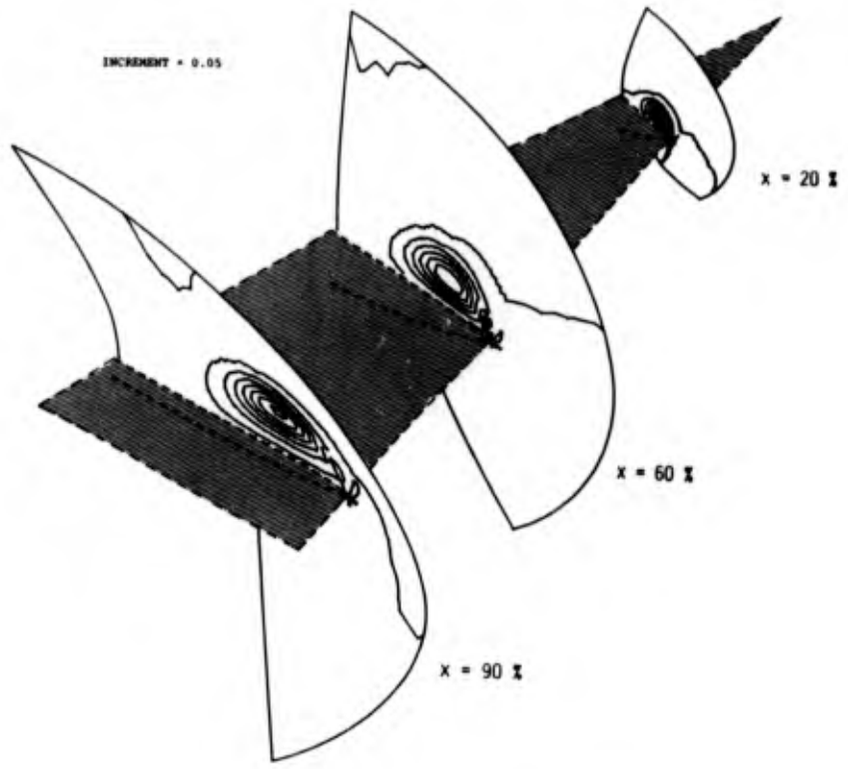


Fig 8-22 Contours of $1 - p_i/p_{i_\infty}$ over wing, case 15, by Rizzi

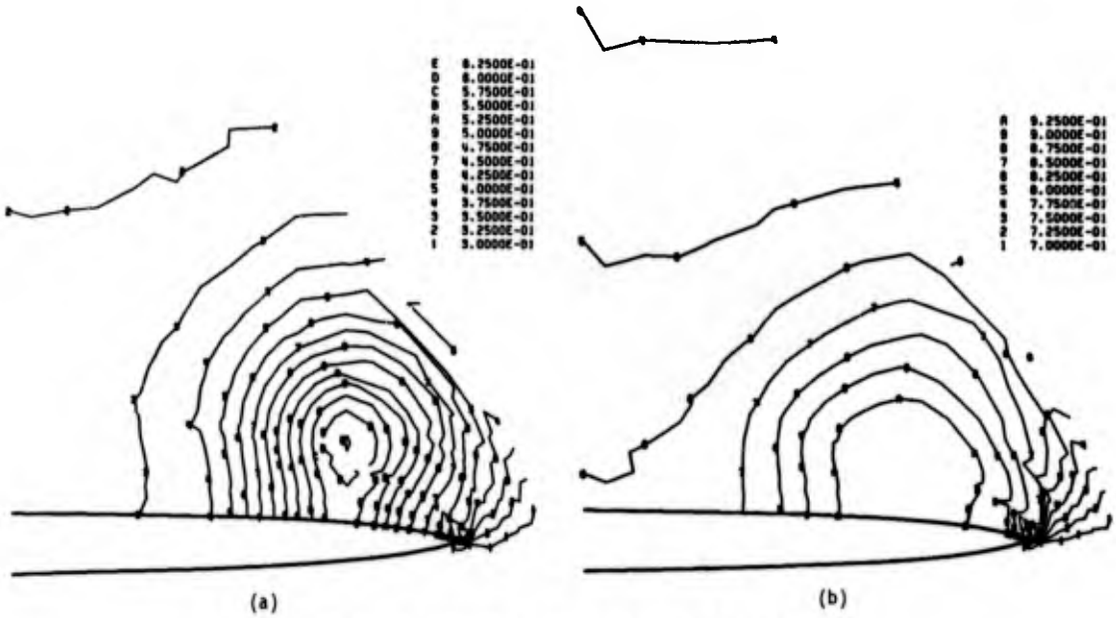


Fig 8-23(a&b) Contours of $1 - p/p_{i_\infty}$ at x/c = 0.8, by Dornier

(a) case 15, (b) case 14

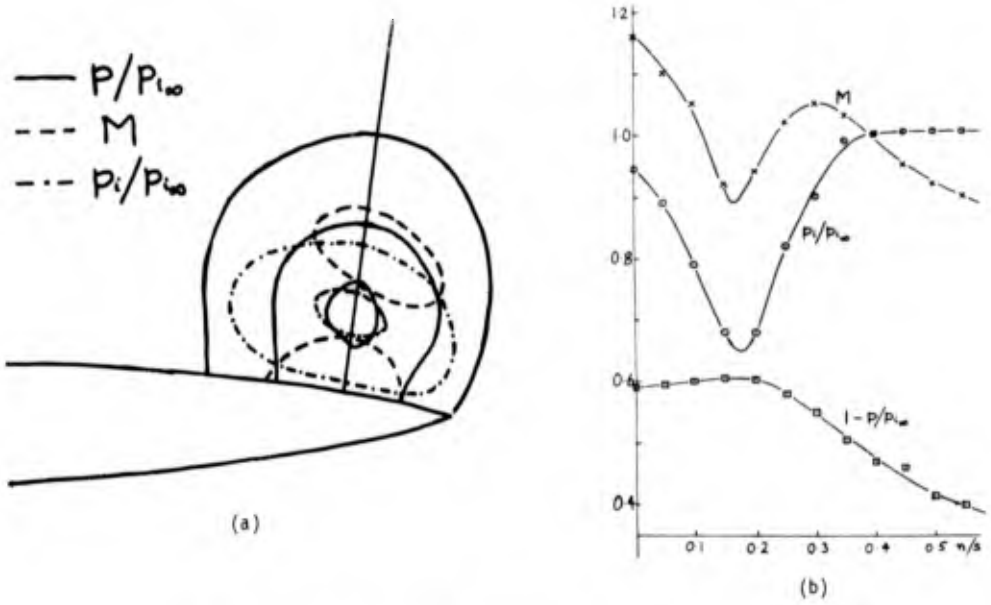


Fig 8-24(a&b) Solution for vortex in case 15, at x/c = 0.6, after Dornier
(a) contours, (b) variation along normal through axis

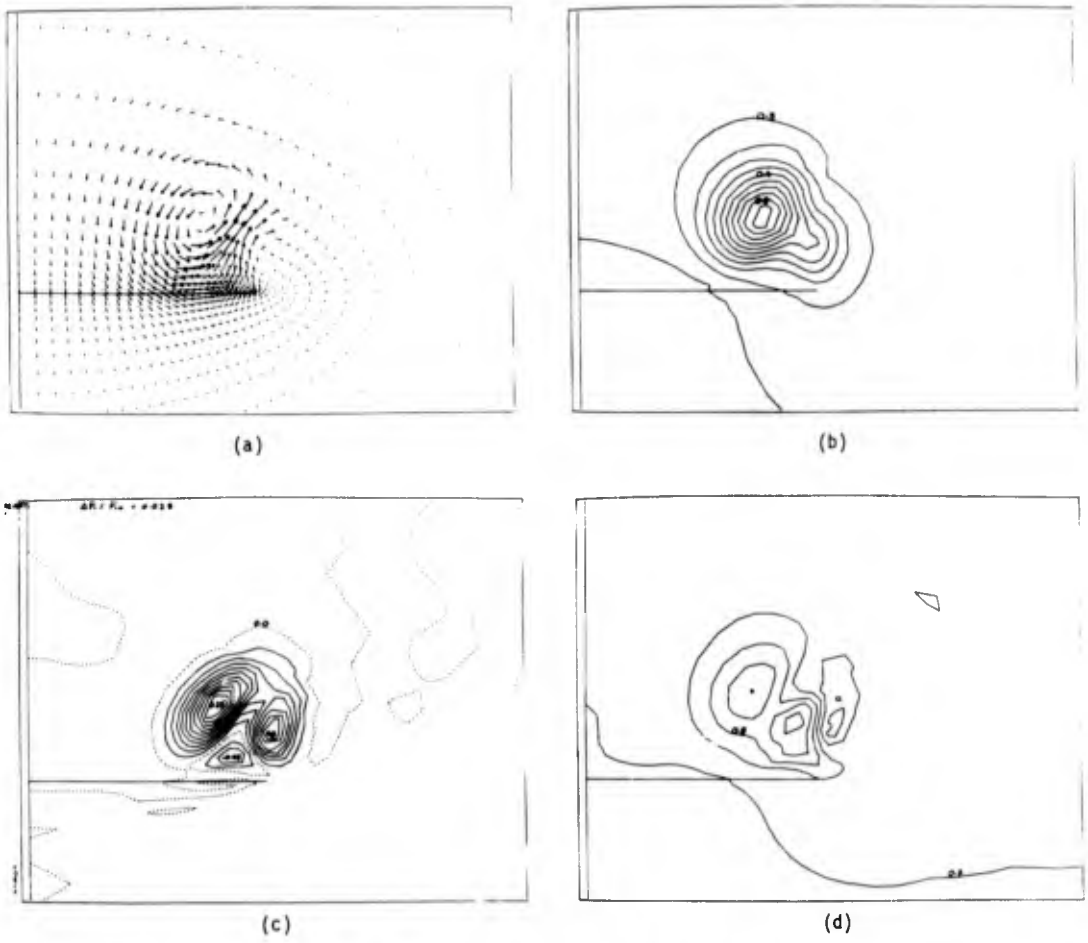


Fig 8-25(a-d) Solution in wake, x/c = 1.15, for case 15, by Koeck
(a) velocity vectors normal to free stream, (b) contours of $1 - p/p_{i_\infty}$
(c) contours of $1 - p_i/p_{i_\infty}$, (d) contours of Mach number

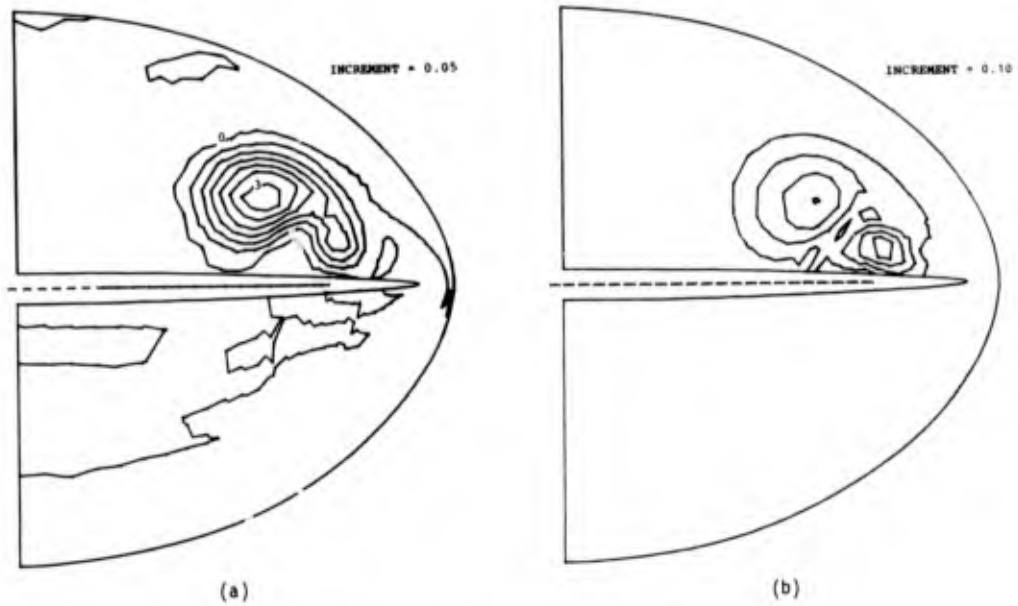


Fig 8-26(a&b) Solution in wake, x/c = 1.5, for case 14, by Rizzi
(a) contours of $1 - p_i/p_{i_\infty}$, (b) contours of magnitude of vorticity vector

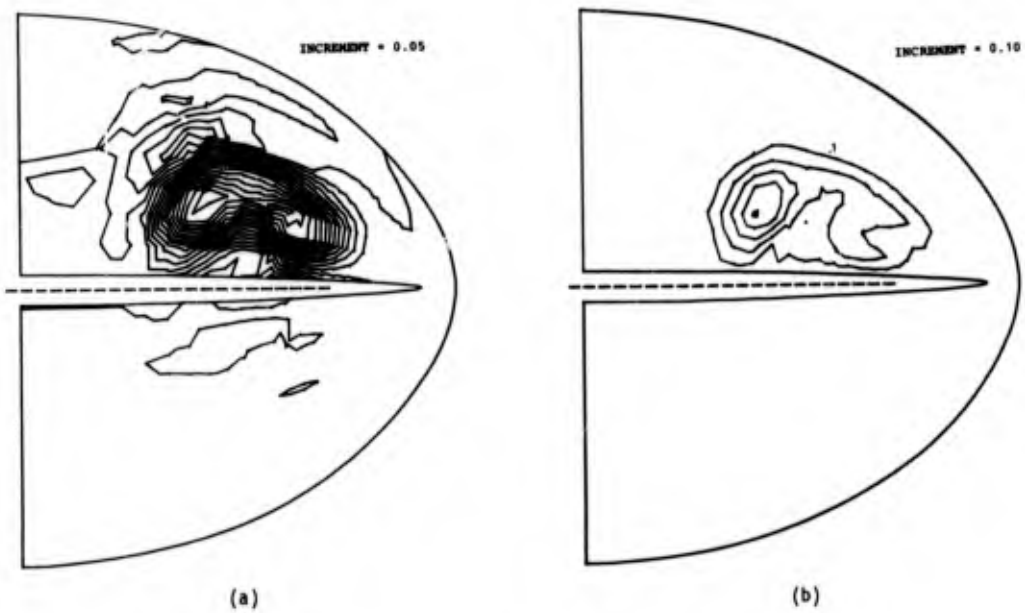


Fig 8-27(a&b) Solution in wake, x/c = 1.5, for case 14, by Rizzi
(a) contours of $1 - p_i/p_{i_\infty}$, (b) contours of magnitude of vorticity vector

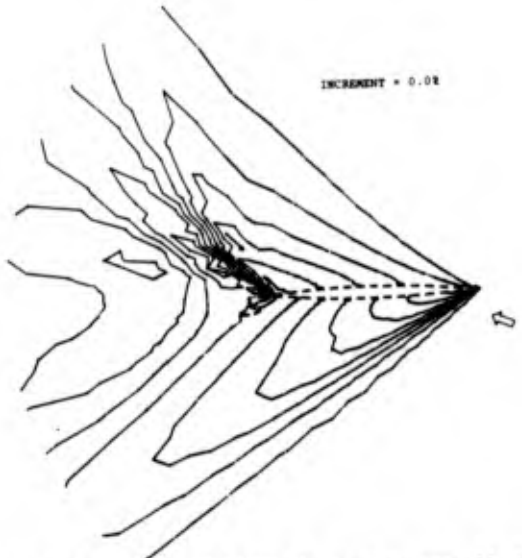


Fig 8-28 Contours of $1 - p/p_{i_\infty}$ in plane of symmetry, case 14, by Rizzi

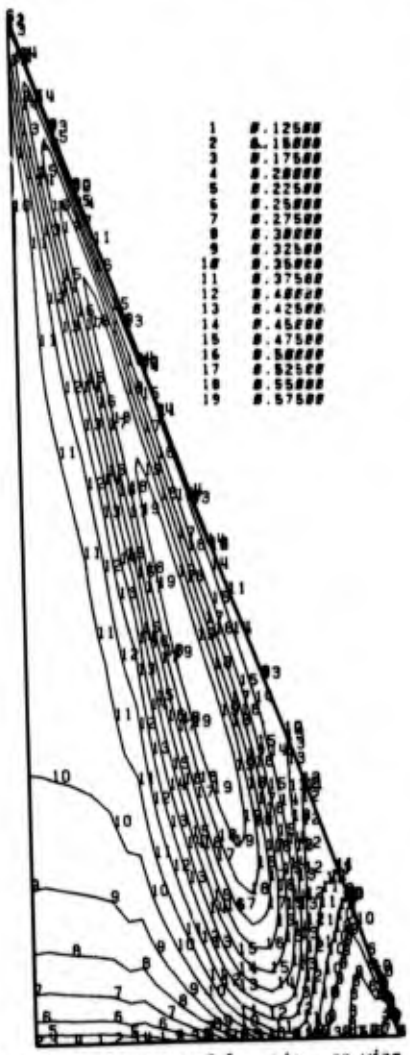


Fig 8-29 Contours of $1 - p/p_{i_\infty}$ on wing upper surface, case 15, by Dornier

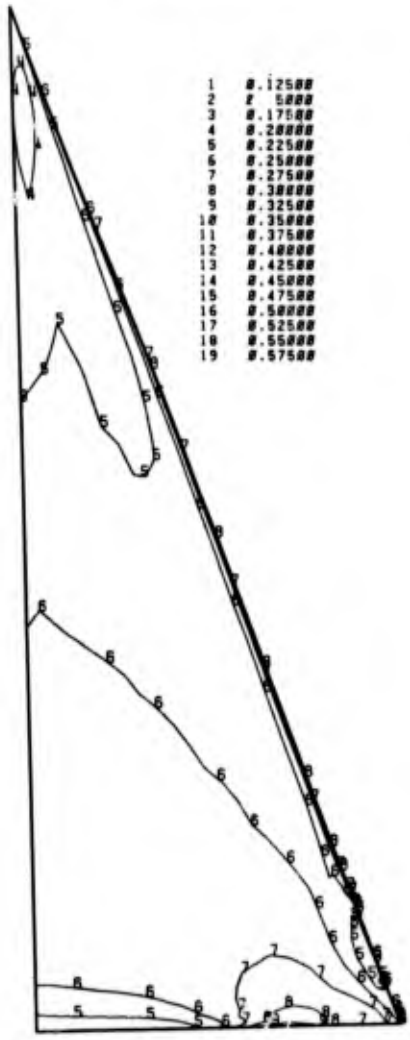
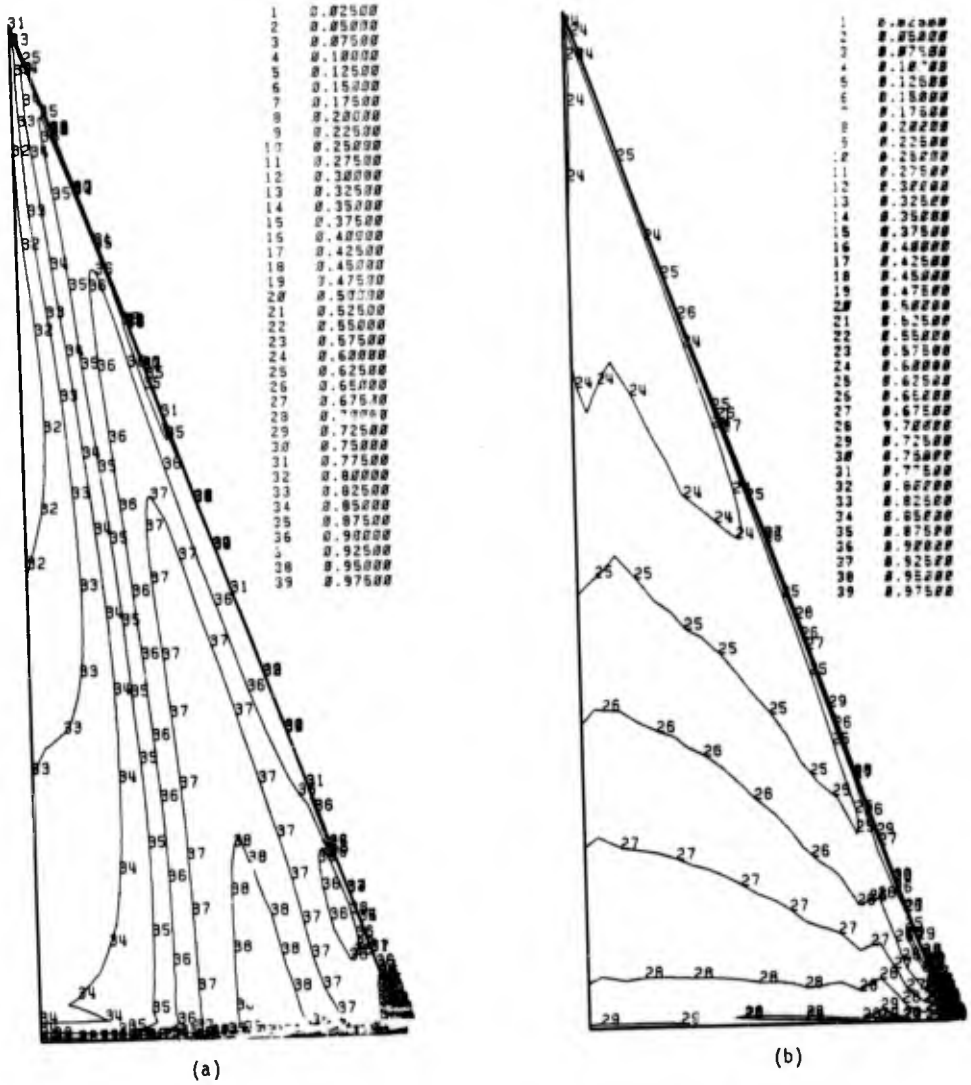


Fig 8-30 Contours of $1 - p/p_{i_\infty}$ on wing lower surface, case 15, by Dornier



(a) (b)

Fig 8-31(a&b) Contours of 1 - p/p_{i_∞} on wing, case 14, by Dornier

(a) upper surface, (b) lower surface

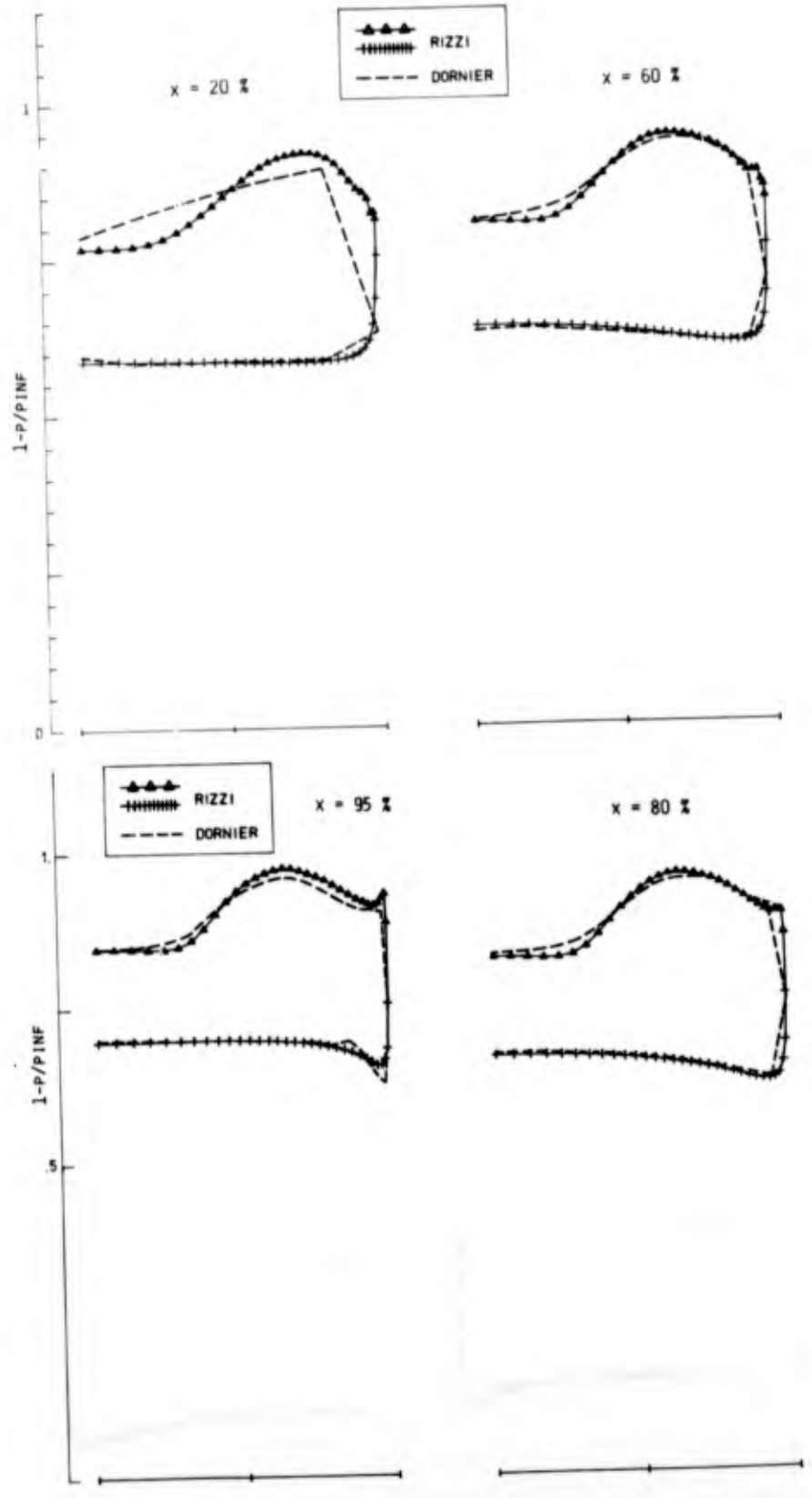


Fig 8-32 Comparative plot for case 14, static pressure

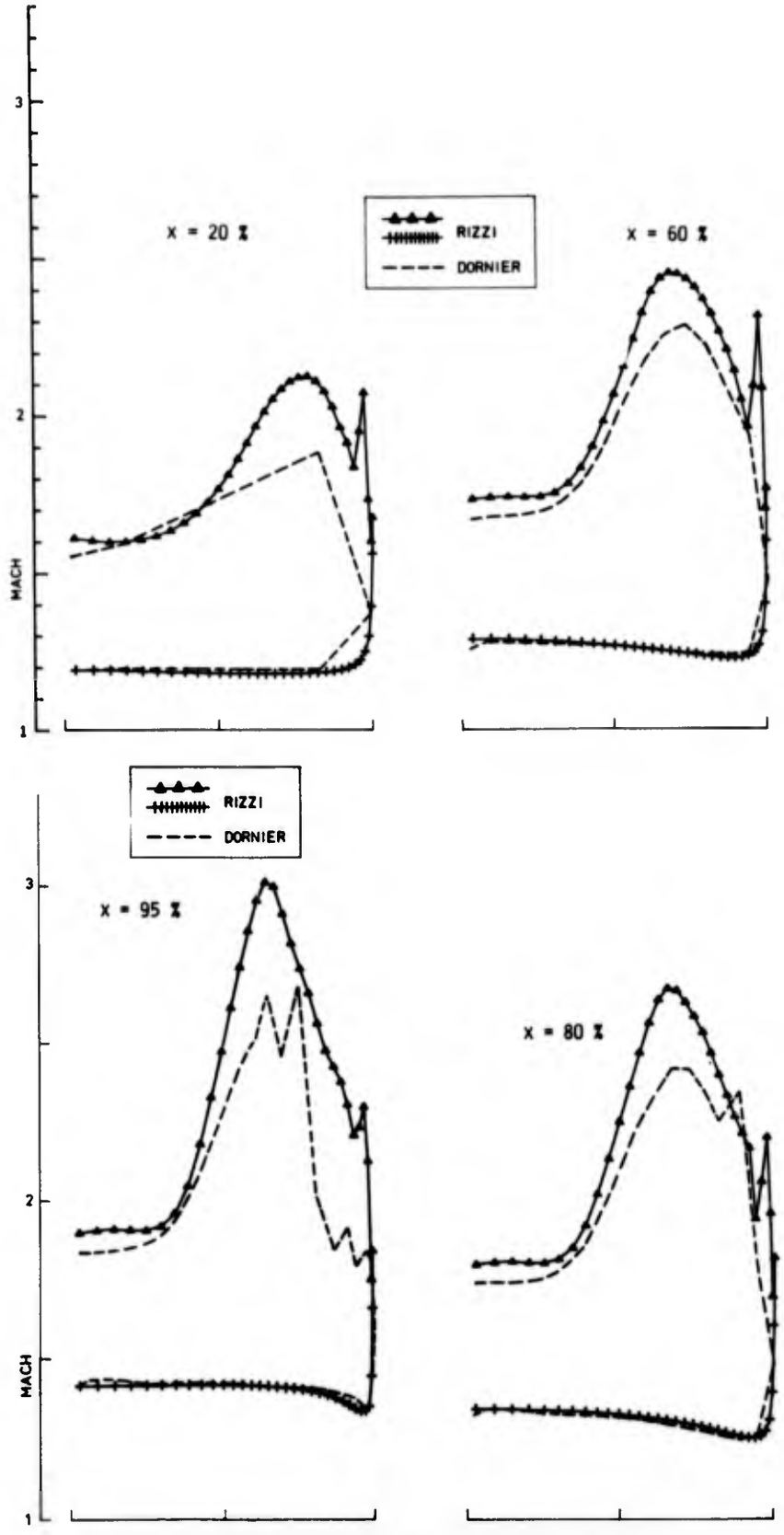


Fig 8-33 Comparative plot for case 14, Mach number

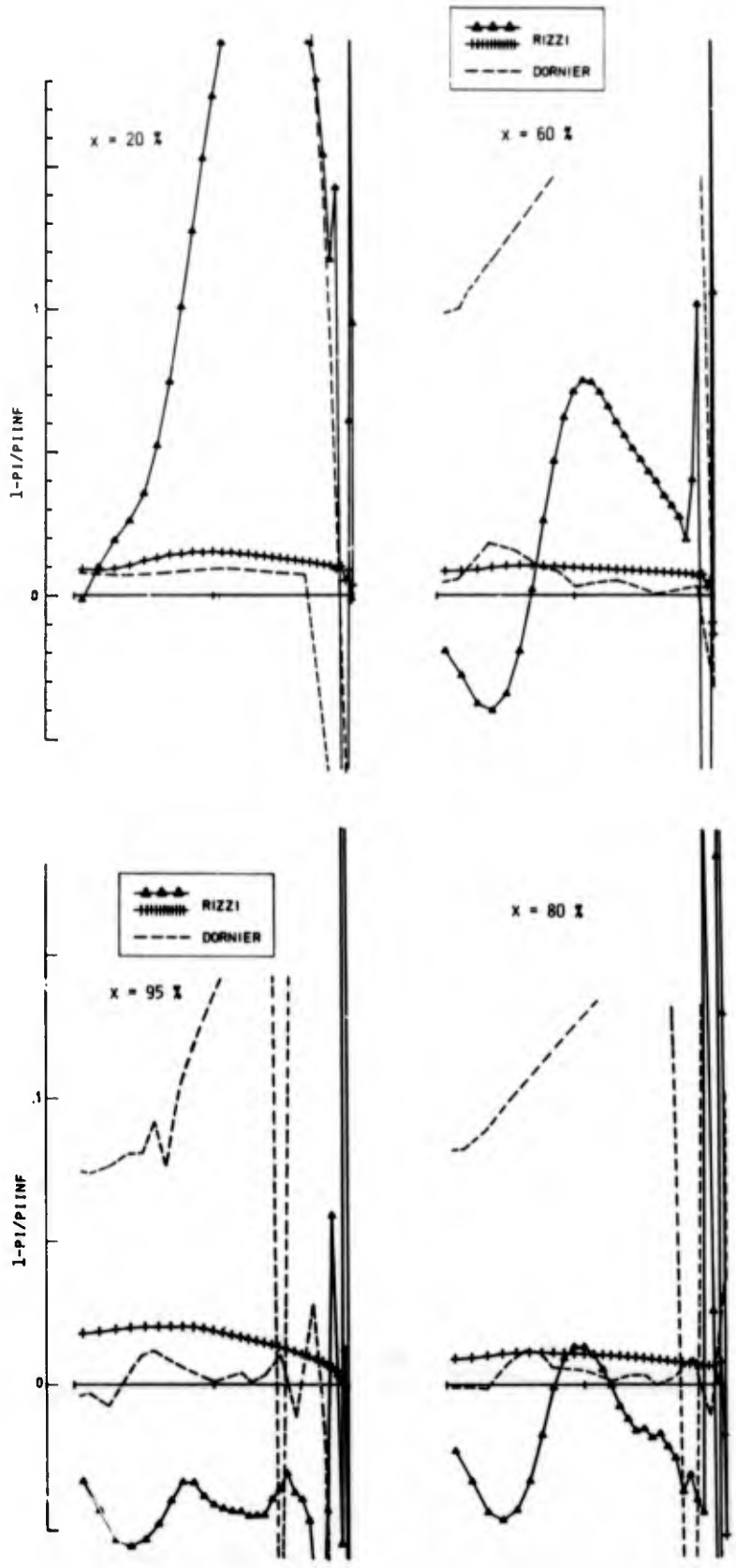


Fig 8-34 Comparative plot for case 11, total pressure

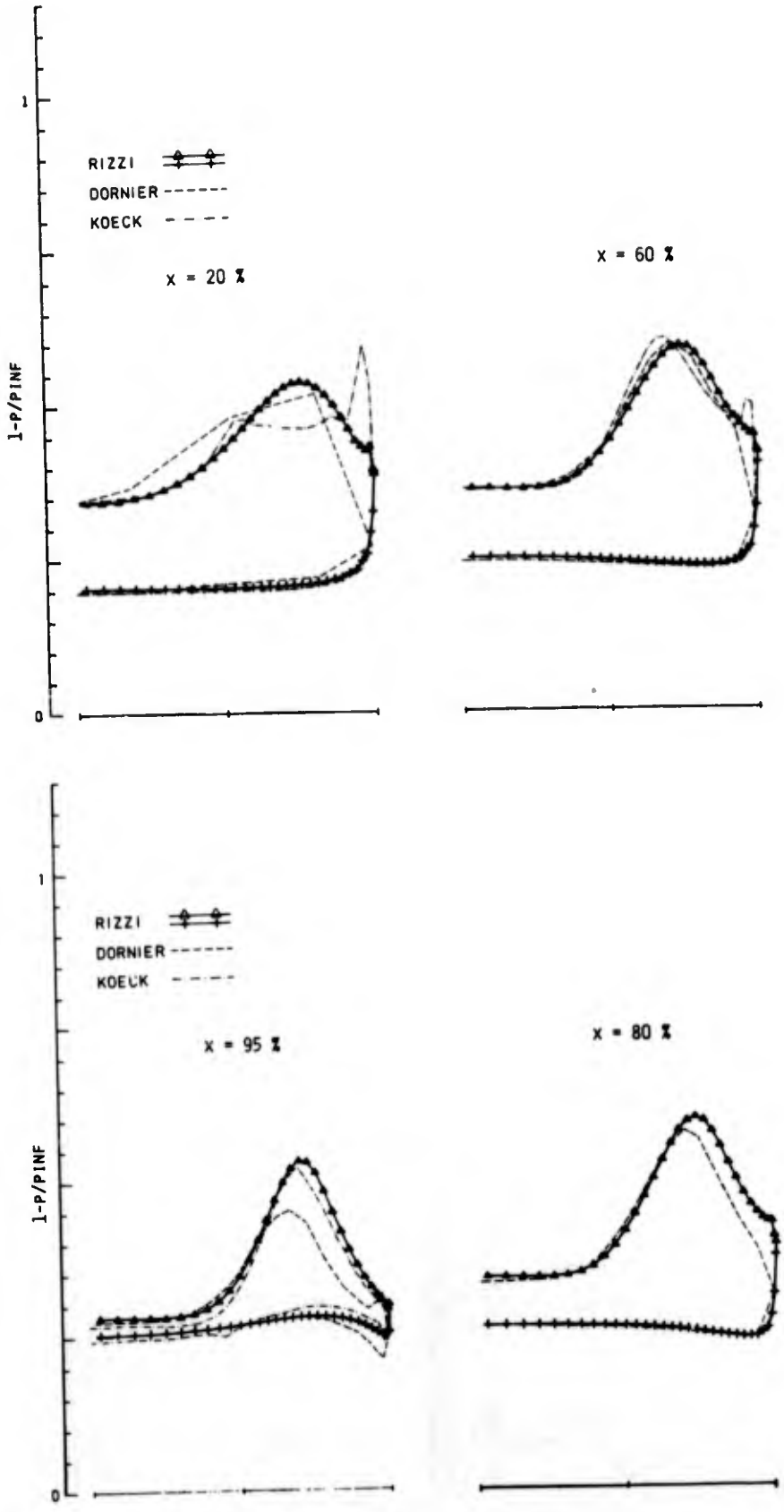


Fig 8-35 Comparative plot for case 15, static pressure

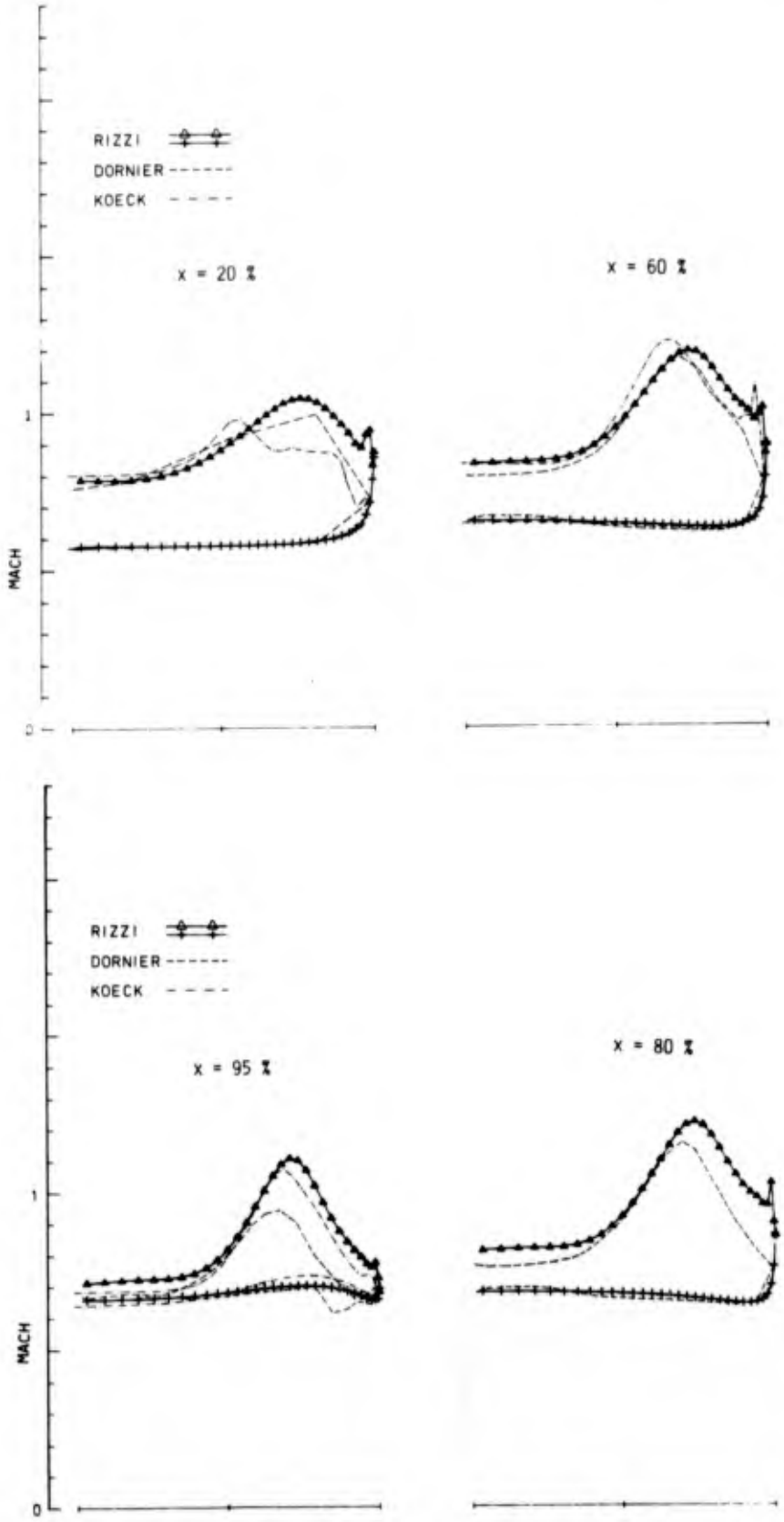


Fig 8-36 Comparative plot for case 15, Mach number

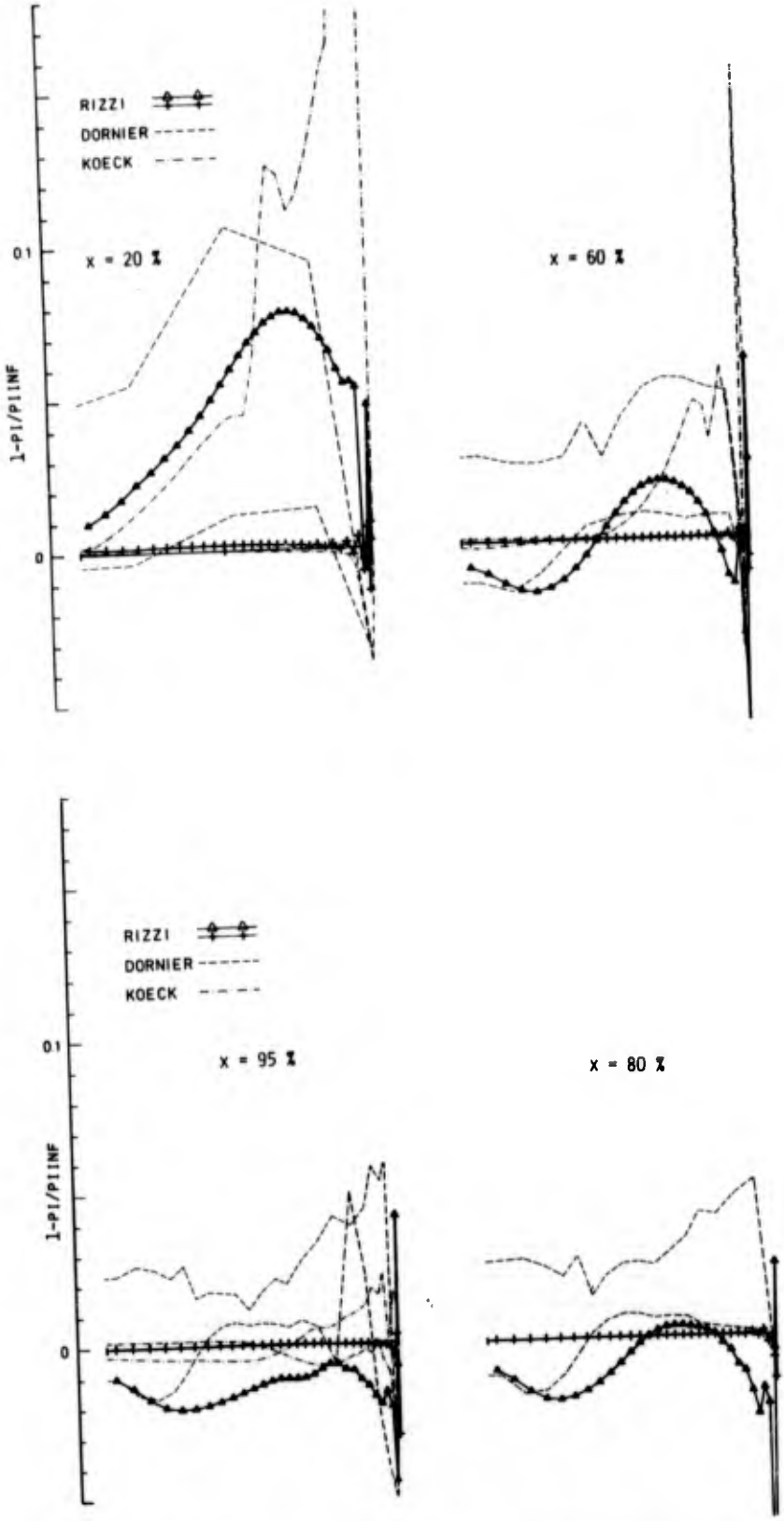


Fig 8-37 Comparative plot for case 15, total pressure

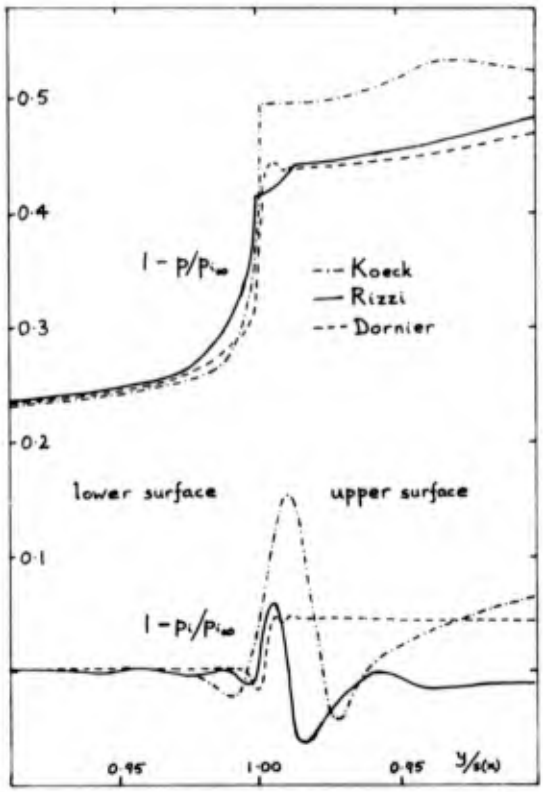


Fig 8-38 Variation of static and total pressure near leading edge at x/c = 0.6, case 15

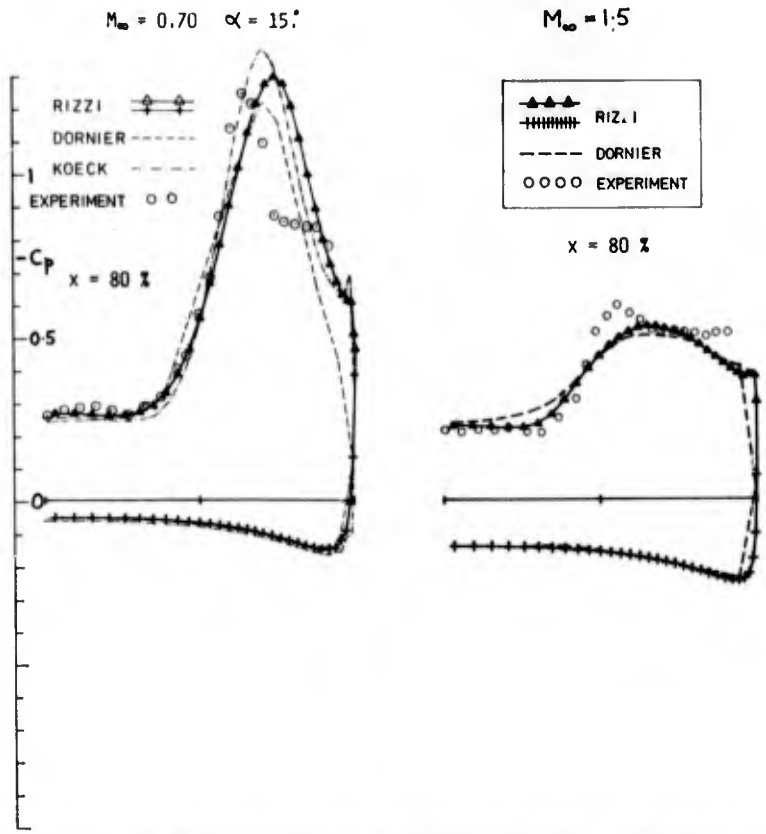


Fig 8-39 Calculated and measured pressure coefficients for cases 15 and 14, at x/c = 0.8

Explanation for the term

EXPOSED WING

for the AGARDB test case

Due to the demands for the evaluation teams the presentation of the AGARDB depicts the wing plus body in the cross-sections.

Some restrictions in the plot-procedures for the last cross-section at x/c = 0.95 allowed only the presentation of the exposed wing

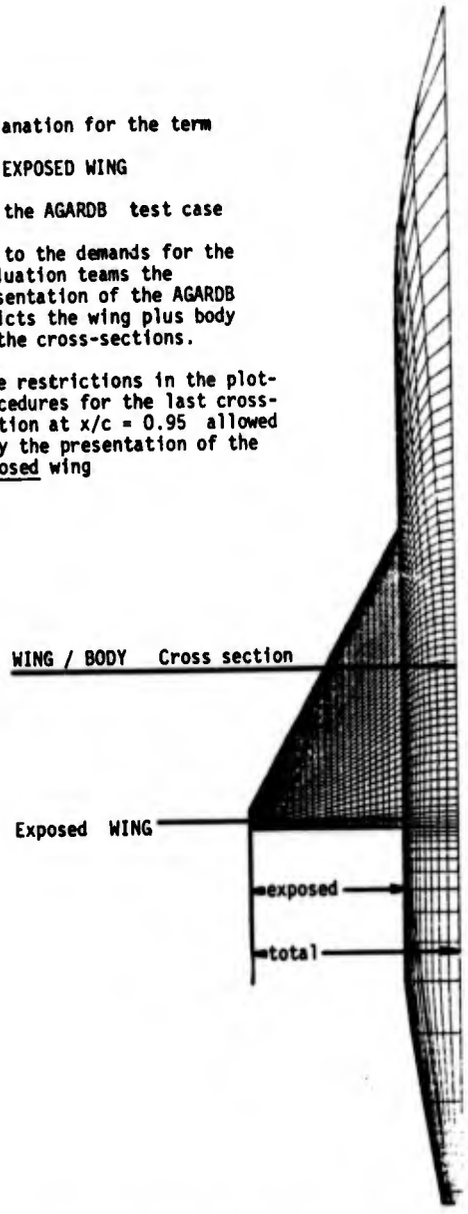


Fig 8-40 Configuration with surface grid for cases 17 and 18, by Dornier

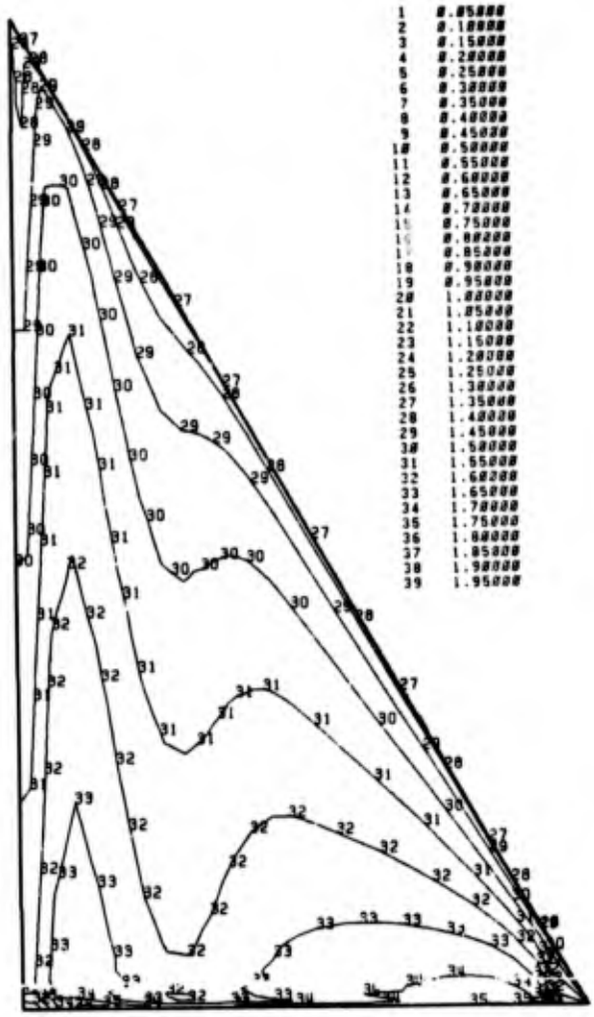


Fig 8-41 Contours of Mach number on wing for case 17, by Dornier

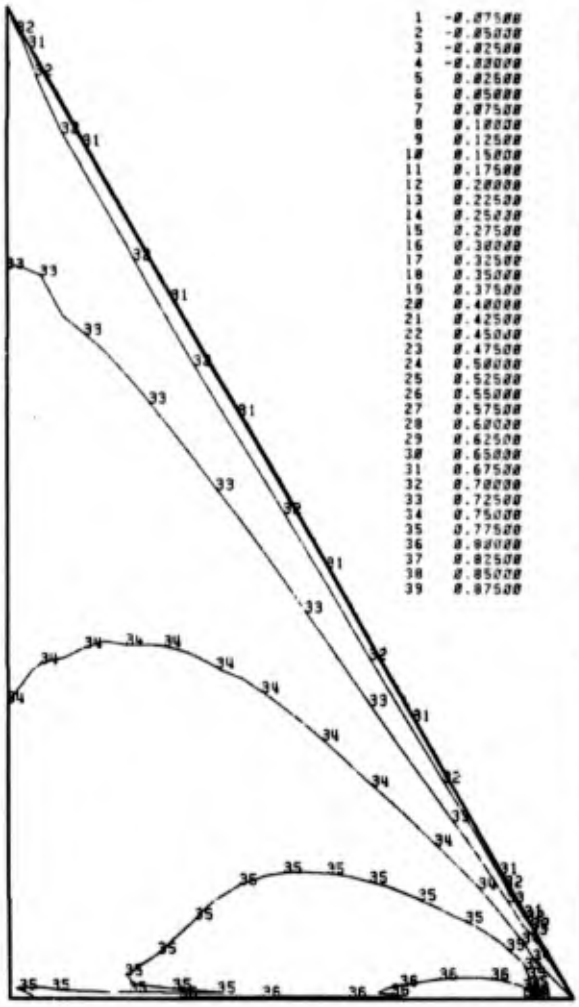


Fig 8-42 Contours of $1 - p/p_{i_\infty}$ on wing surface for case 17, by Dornier

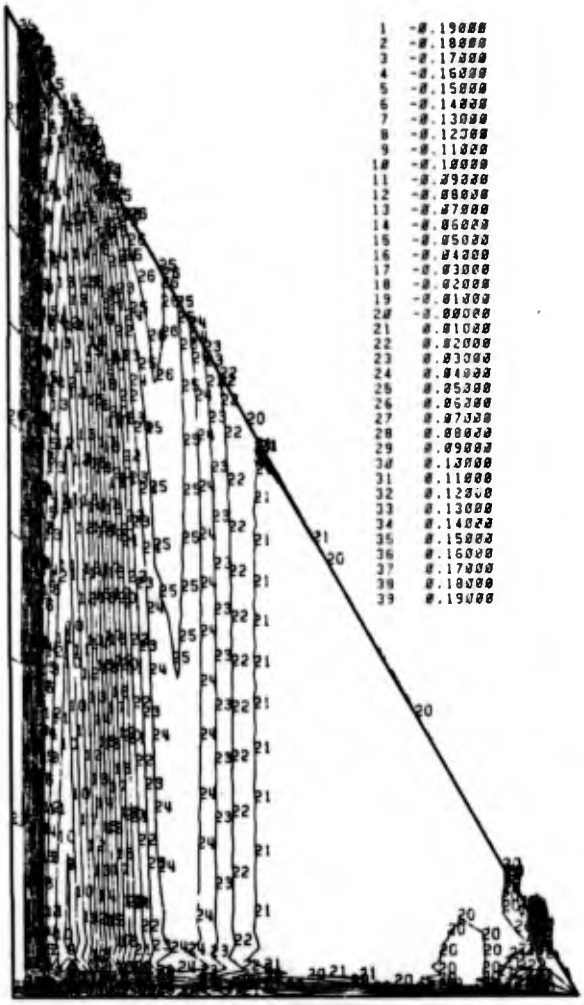


Fig 8-43 Contours of $1 - p_i/p_{i_\infty}$ on wing surface for case 17, by Dornier

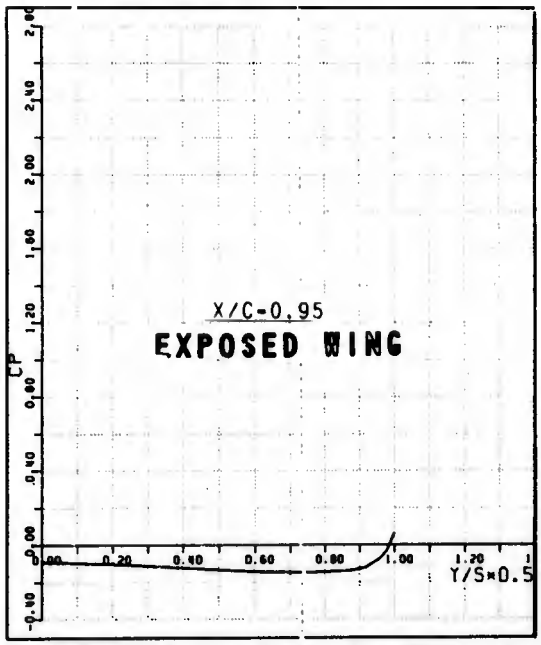
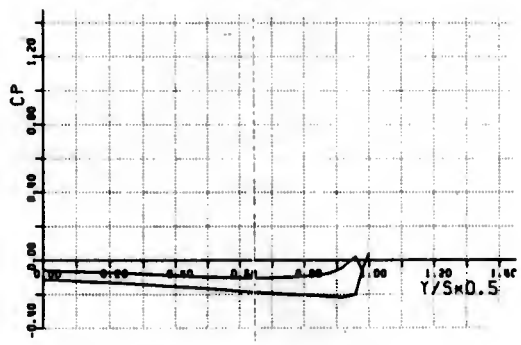


Fig 8-44 Distribution of pressure coefficient at x/c = 0.95 for case 17, by Dornier



EXPOSED WING

X/C-0.95

Fig 8-45 Distribution of pressure coefficient at x/c = 0.95 for case 18, by Dornier

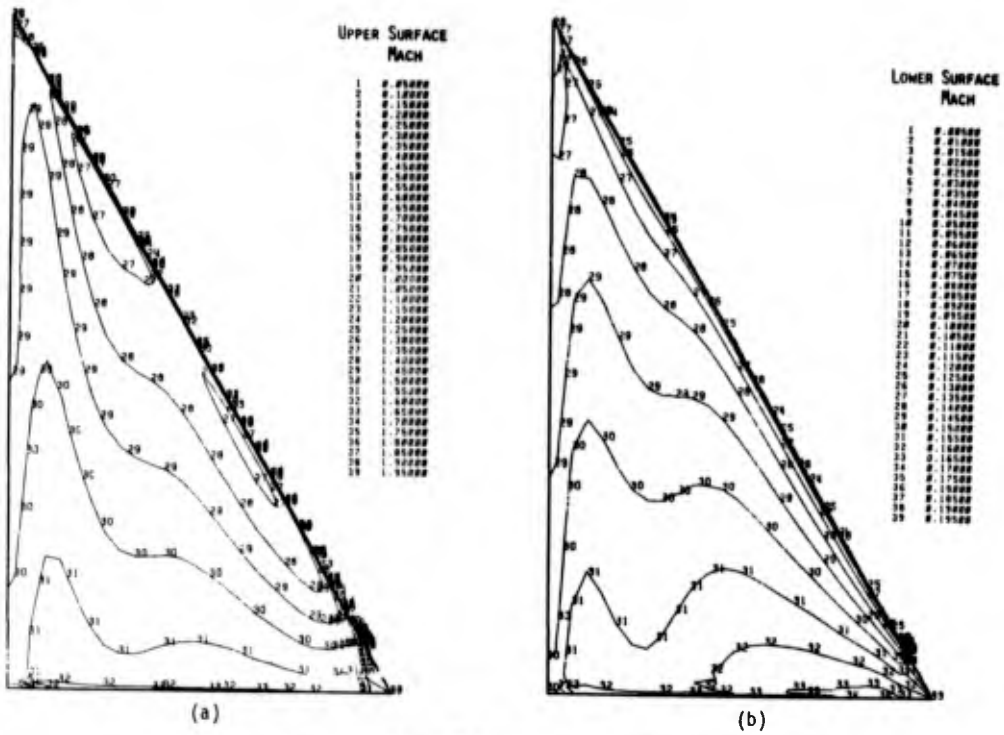


Fig 8-46(a&b) Contours of Mach number on wing for case 18, by Dornier
(a) upper surface, (b) lower surface

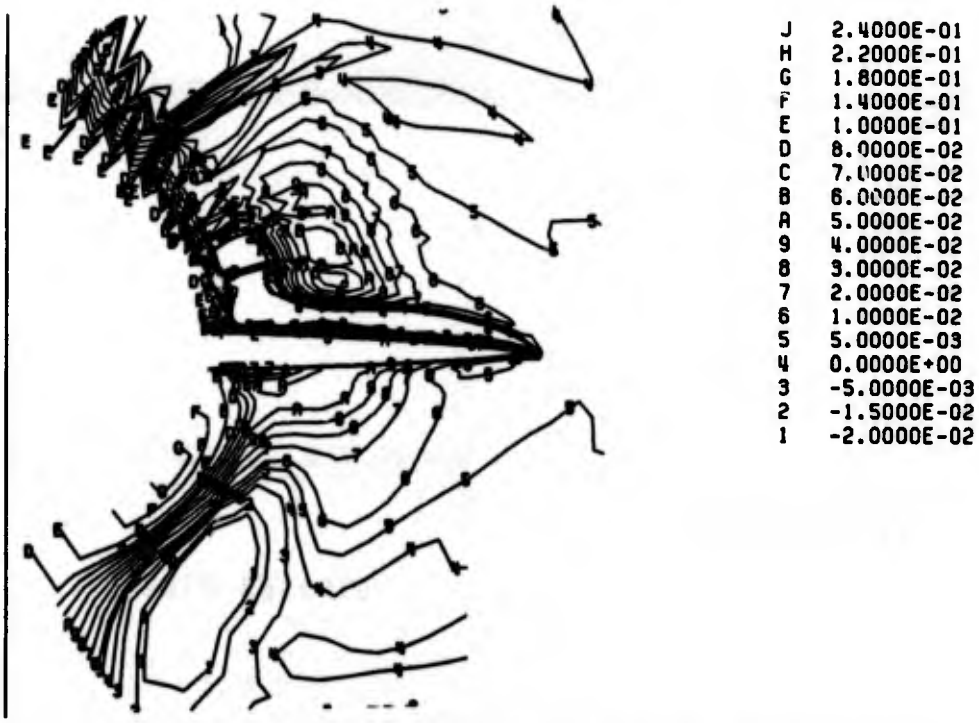


Fig 8-47 Contours of $1 - p_i/p_{i_\infty}$ in plane x/c = 0.6 for case 18, by Dornier

APPENDIX 8-A: DENSE-MESH SOLUTIONS TO THE M6 AND DILLNER WING CASES (A.RIZZI)

1. INTRODUCTION

The goal of this Working Group was to produce definitive, or at least as accurate as possible, reference solutions for a number of representative aerodynamic flow problems. The accuracy of a computed solution is related directly to the number of grid points that discretize the problem. And comparing a given solution with another one obtained with the same numerical method but on a denser mesh is one of the most certain ways to judge how near the given solution is to the ultimate accuracy of a converged sequence of solutions using successively refined meshes. In evaluating the contributed solutions the Working Group was able to use this measure for the two-dimensional results but not the three-dimensional ones because the computer resources (primarily memory) of even supercomputers (1M og 2M words of memory) do not allow refinement beyond the standard mesh. Recently however Control Data Corporation has built a CYBER 205 with 16M 64-bit words of memory and very generously gave me time on the machine to compute some of the M6 wing and Dillner wing test cases using meshes that contain double and even triple the number of cells in each of the three coordinate directions of the standard meshes that I used previously. Although these dense-mesh solutions have been computed (May 1984) at the close of the Working Group, they are of such interest to warrant being included as an appendix to this report.

Three dense-mesh solutions are presented here. The first was carried out for the M6 wing at conditions $M_\infty = 0.84$ and $\alpha = 3.06$ deg. and shows only small improvements in accuracy compared to my earlier standard-mesh solution. But the other two for the Dillner wing cases reveal much richer detail in the vortex-shock-wave structure of these flowfields than was seen before. These computations confirm what, based on windtunnel measurements, aerodynamicists recently have claimed must exist in real flowfields[1,2].

2. ONERA M6 WING $M_\infty = 0.84$ $\alpha = 3.06$ deg.

With double the number of cells in all the directions of my standard mesh[3], I had 192 cells around the chord, 40 on the span, and 40 outward from the wing to the farfield. The variation in computed lift and drag with mesh density given in Table A1 indicates the very small overall change achieved with the last mesh refinement. The solution is presented

MESH	C_L	C_D
coarse 49x11x11	0.275	0.0122
standard 97x 21x21	0.286	0.0116
dense 193x41x41	0.283	0.0111

Table A1 - Variation in lift and drag with mesh density
M6 wing $M_\infty = 0.84$ $\alpha = 3.06$ deg.

in Figs. A1-A7 which show that the suction peaks are nearer to the measured values, the pressure on the lower surface is in better agreement with the experiment, the shock waves are sharper, and the losses in total pressure are more localized to the shocks. The isobars on the upper surface run together at the trailing corner of the tip exactly as in the standard-mesh solution, ratifying our earlier belief in the reality of this striking feature[3].

3. 70 deg. SWEPT DILLNER DELTA WING

The two solutions obtained with a much denser grid for subsonic and supersonic flows around the Dillner wing reveal flowfields of much more complex expansion and compression phenomena than the standard-mesh solutions do. In both cases weak and local shock waves interact with the vortex over the wing.

Test cases included in this appendix are additional data related to that discussed in Chapter 7 (2. ONERA M6) and Chapter 8 (3. 70° Swept Dillner Wing).

MESH	C_L	C_D
coarse 33x11x15	0.563	0.147
standard 65x21x29	0.639	0.161
dense 161x49x81	0.681	0.171

Table A2 - Variation in lift and drag with mesh density Dillner wing. $M_\infty = 0.7$ $\alpha = 15$ deg.

MESH	C_L	C_D
coarse 33x11x15	0.482	0.135
standard 65x21x29	0.525	0.146
dense 193x57x97	0.532	0.147

Table A3 - Variation of lift and drag with mesh density Dillner wing. $M_\infty = 1.5$ $\alpha = 15$ deg.

Tables A2 and A3 show the sequence of lift and drag coefficients for the three levels of grid density.

3.1 Subsonic Case $M_\infty = 0.7$ $\alpha = 15$ deg.

The solution computed for this case on a mesh of 160 cells around the semi-span, 80 on the chord, and 48 from the wing outward to the farfield is presented in a variety of views in Figs. A8-A13. The most striking feature -- not seen in the standard-mesh solution but clearly visible here in the isobars, Mach number, and total pressure contours -- is the small shock wave situated between the vortex and the upper surface of the wing just outboard of the vortex core. From observations of windtunnel experiments Wendt[1] recently has suggested the existence of just such a shock wave. In overall comparison with my previous solution, the suction peak under the vortex is markedly stronger and produces the shock wave, the smearing of vorticity across the vortex sheet at the leading edge is significantly reduced, and the total pressure losses are confined to a tighter region centered on the core of the vortex. In the wake the interaction of the leading and trailing edge vortices also is represented better.

3.2 Supersonic Case $M_\infty = 1.5$ $\alpha = 15$ deg.

A similar set of Figs. A14-A19 display the solution computed for this case on a mesh of 192 cells around the semi-span, 96 on the chord, and 56 from the wing outward to the farfield. The variation in pressure throughout this supersonic flowfield is not very great, but the distortion in the isobars and the coalescing of the Mach contours indicates the presence of a small shock wave intersecting the coiling vortex sheet just inboard of and above the core of the vortex. This feature of the flowfield is consistent with the findings of Miller and Wood (see fig. 12 of Ref. 2). Furthermore we see in the Mach number and total pressure contours at least two distinct shock waves between the suction peak and leading edge, forming a complex system of shocks and expansion waves being reflected from the apex to the trailing edge. Such phenomena should be expected because the flow has to turn abruptly where the vortex sheet leaves the leading edge. And accompanying these phenomena are heavy losses in total pressure.

4. CONCLUSIONS

The dense-mesh solutions presented here have shown that the flowfield around a trapezoidal wing like the M6 can be represented with reasonable accuracy on a standard-size mesh of say 50,000 grid points. But if the wing is one of low aspect ratio, like the Dillner delta wing, a much denser grid is required to capture the rich structure of rotating flow interacting with shock waves.

Acknowledgement

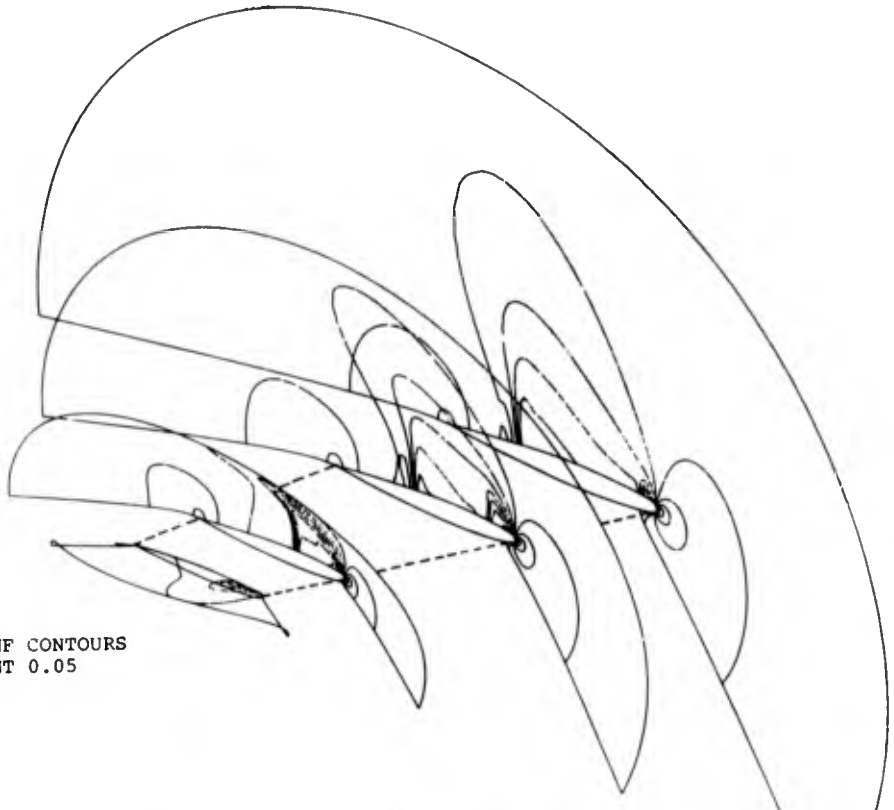
Many thanks to both Chuck Purcell of Control Data, who invited me to Minneapolis, and Mike Hodous of Control Data, who put in many hours helping me to produce these solutions.

5. REFERENCES

1. Vorropoulos, G. and Wendt, J.F., "Laser Velocimetry Study of Compressibility Effects on the Flow Field of a Delta Wing", AGARD-CP-342, 1983.

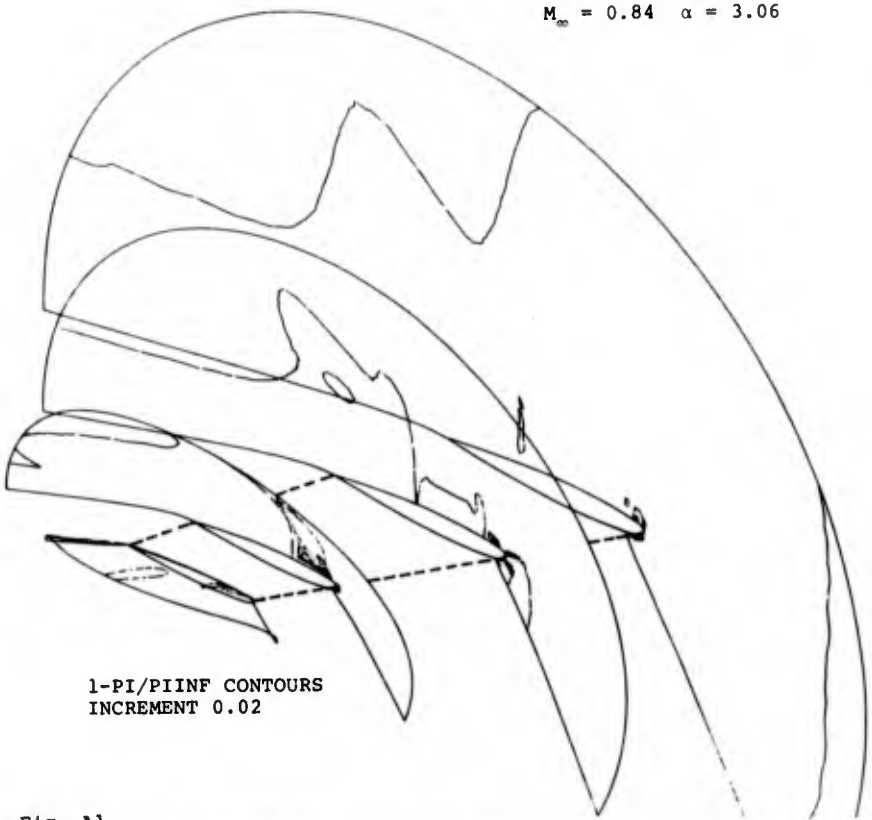
2. Miller, D.S. and Wood, R.M., "An Investigation of Wing Leading-Edge Vortices at Supersonic Speeds", AIAA Paper No. 83-1816, 1983.

3. Rizzi, A.W. and Eriksson, L.E., "Computation of Flow Around Wings Based on the Euler Equations", Journal Fluid Mechanics, (in press).



1-P/PIINF CONTOURS
INCREMENT 0.05

ONERA M6 WING
$M_\infty = 0.84$ $\alpha = 3.06$



1-PI/PIINF CONTOURS
INCREMENT 0.02

Fig. A1 -
Contours of 1-P/PIINF and 1-PI/PIINF plotted in 4 mesh surfaces for flow past M6 wing.
$M_\infty = 0.84$ and $\alpha = 3.06$ deg.

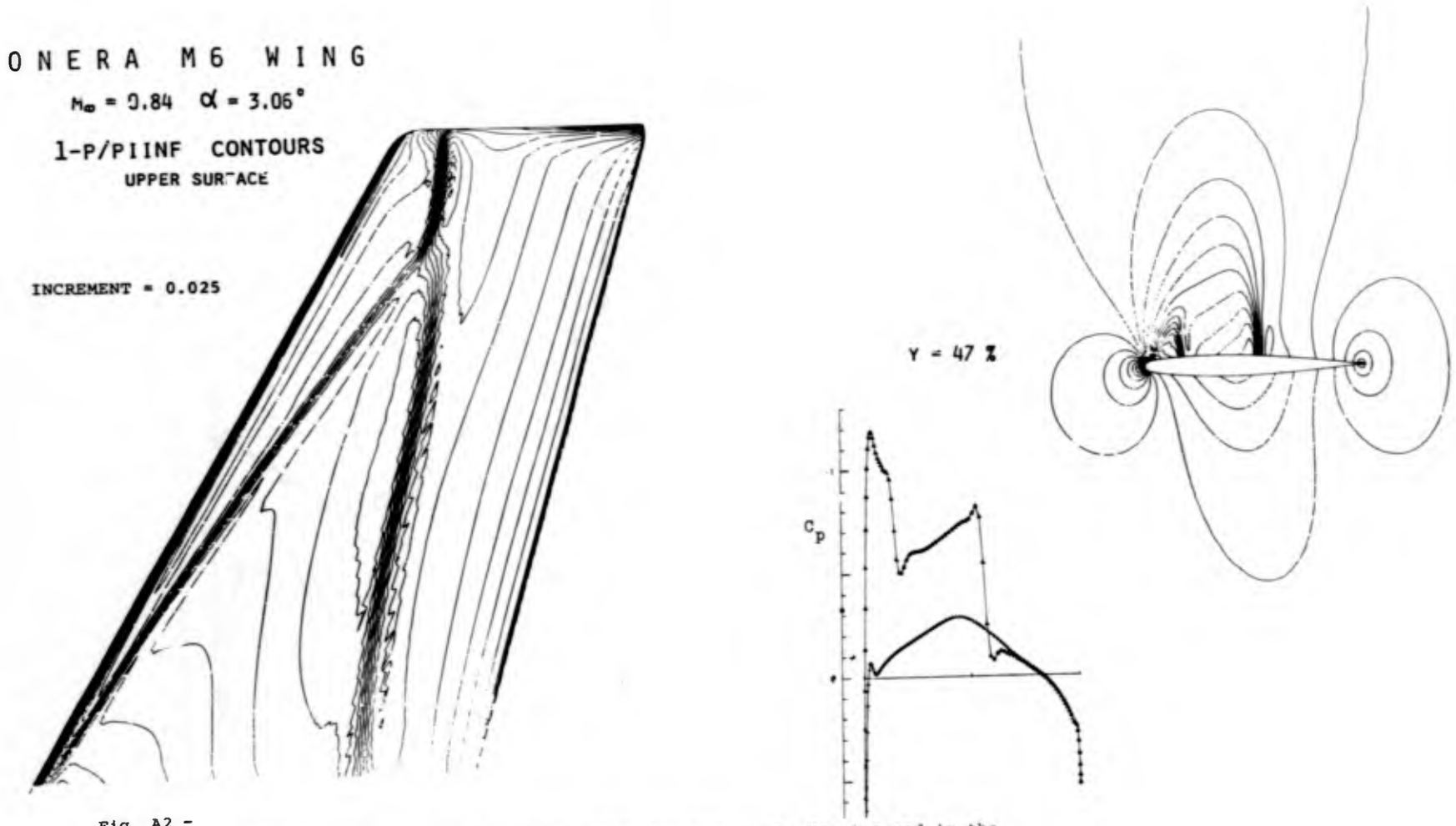


Fig. A2 -
Contours of computed 1-P/PIINF plotted on the upper surface of the M6 wing and in the 47% span station together with the surface C_p on the section.
M_∞ = 0.84 α = 3.06 deg. Contour increment 0.025.

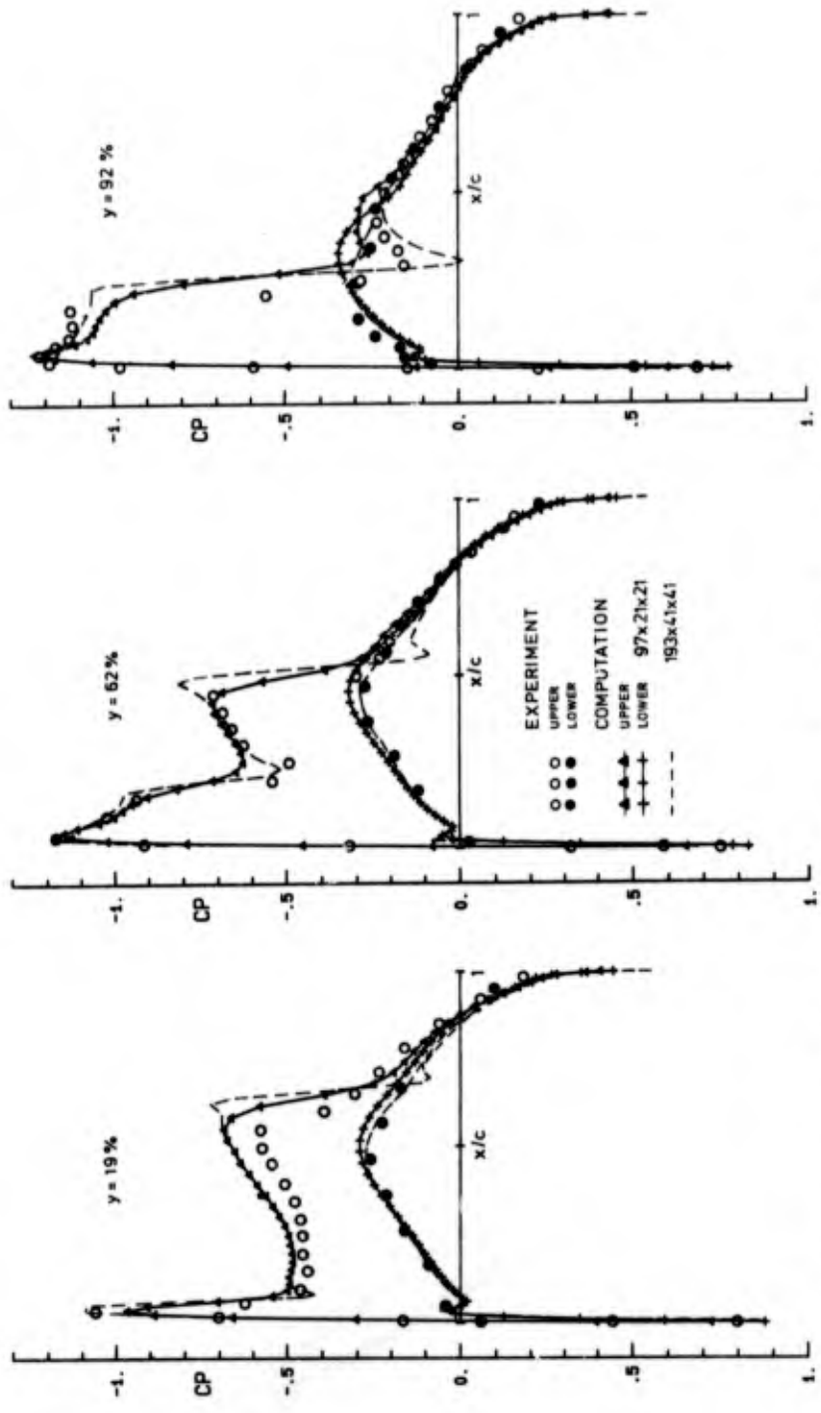


Fig. A3 - Comparison of measured and computed c_p in three chordwise sections of the M6 wing.
$M_\infty = 0.84$ $\alpha = 3.06$.

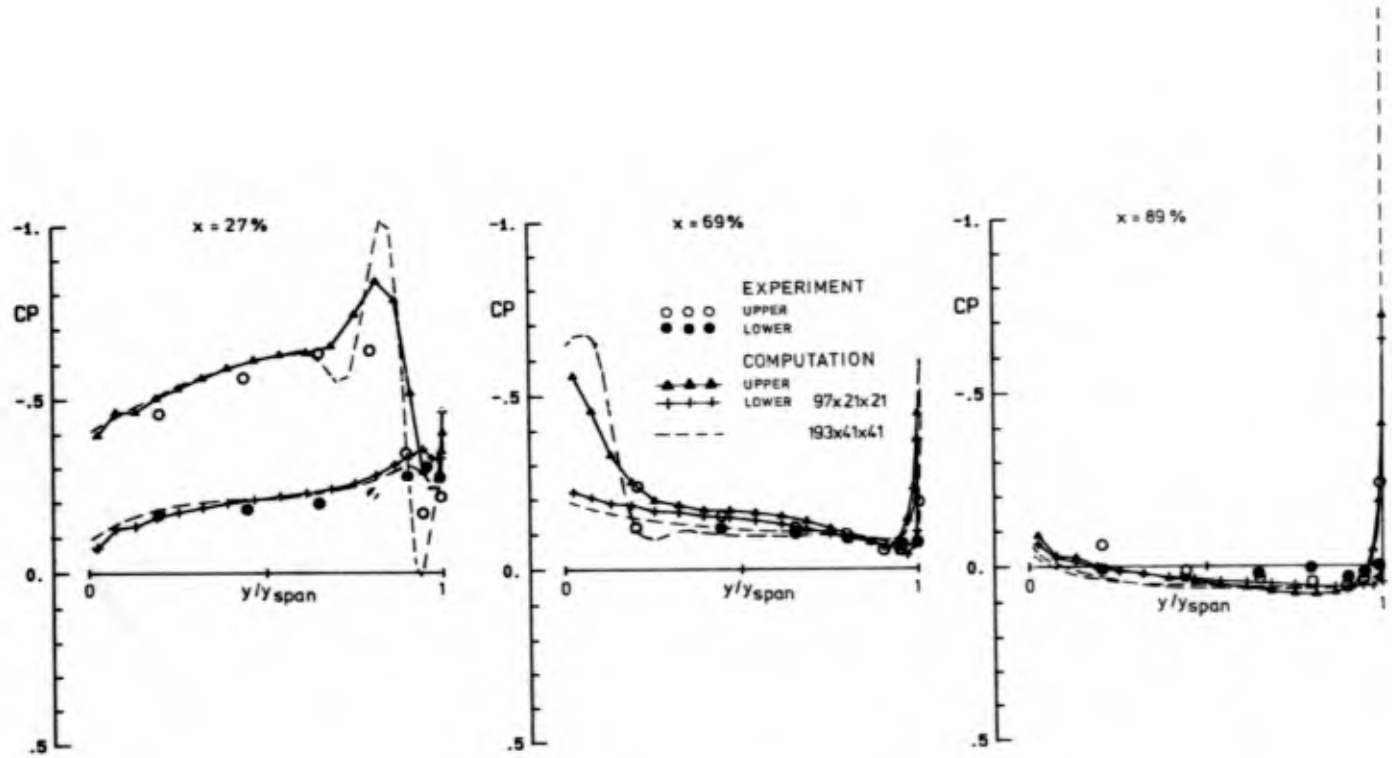


Fig. A4 - Comparison of measured and computed c_p in three spanwise sections (constant percent local chord) of the M6 wing.
$M_\infty = 0.84 \quad \alpha = 3.06$.

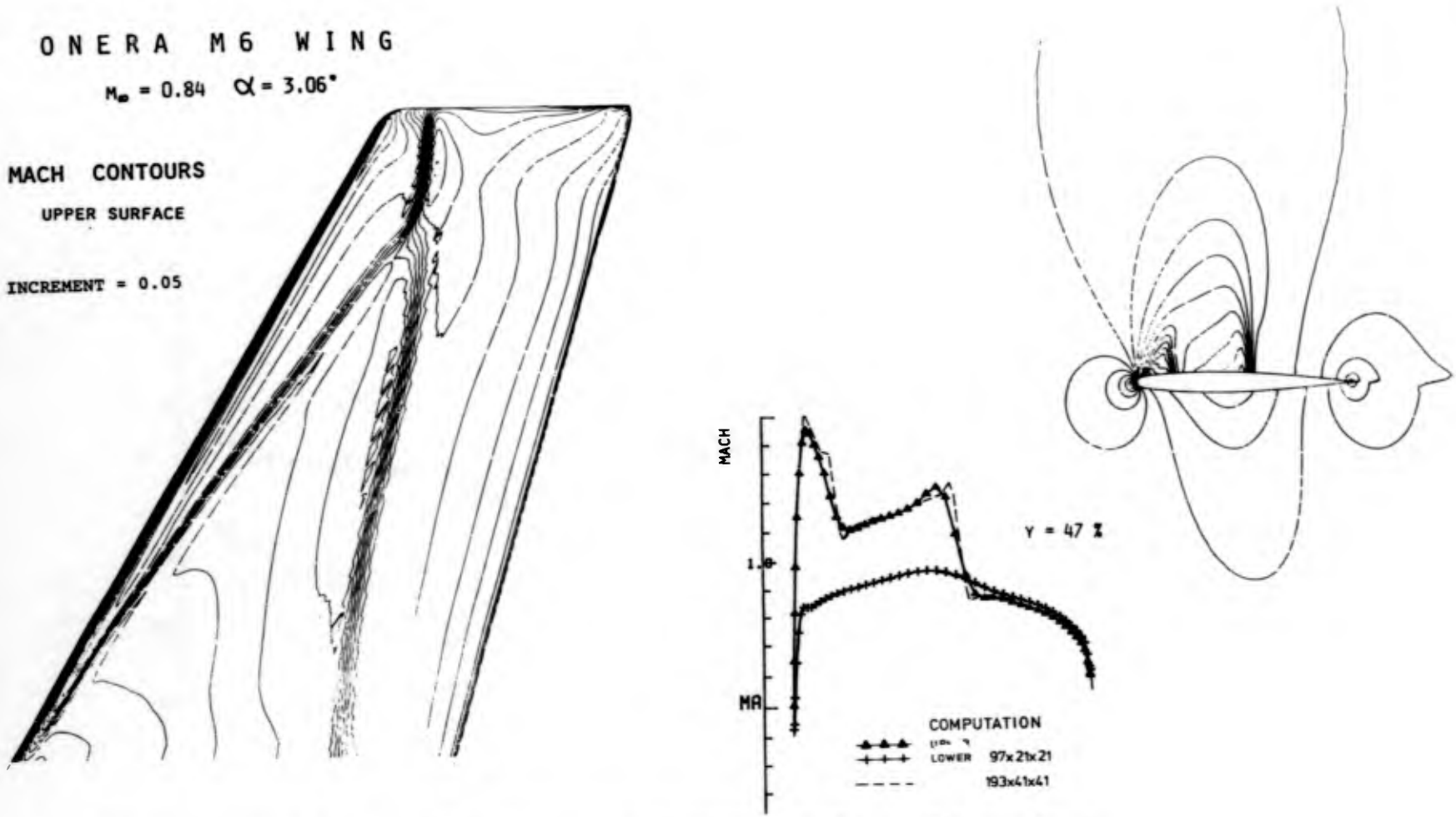


Fig. A5 - Contours of computed Mach number plotted on the upper surface of the M6 wing and in the 47% span station together with the comparison graph of the dense-mesh and standard-mesh Mach number distributions on the section surface.
M_∞ = 0.84 α = 3.06 deg. Contour increment 0.05.

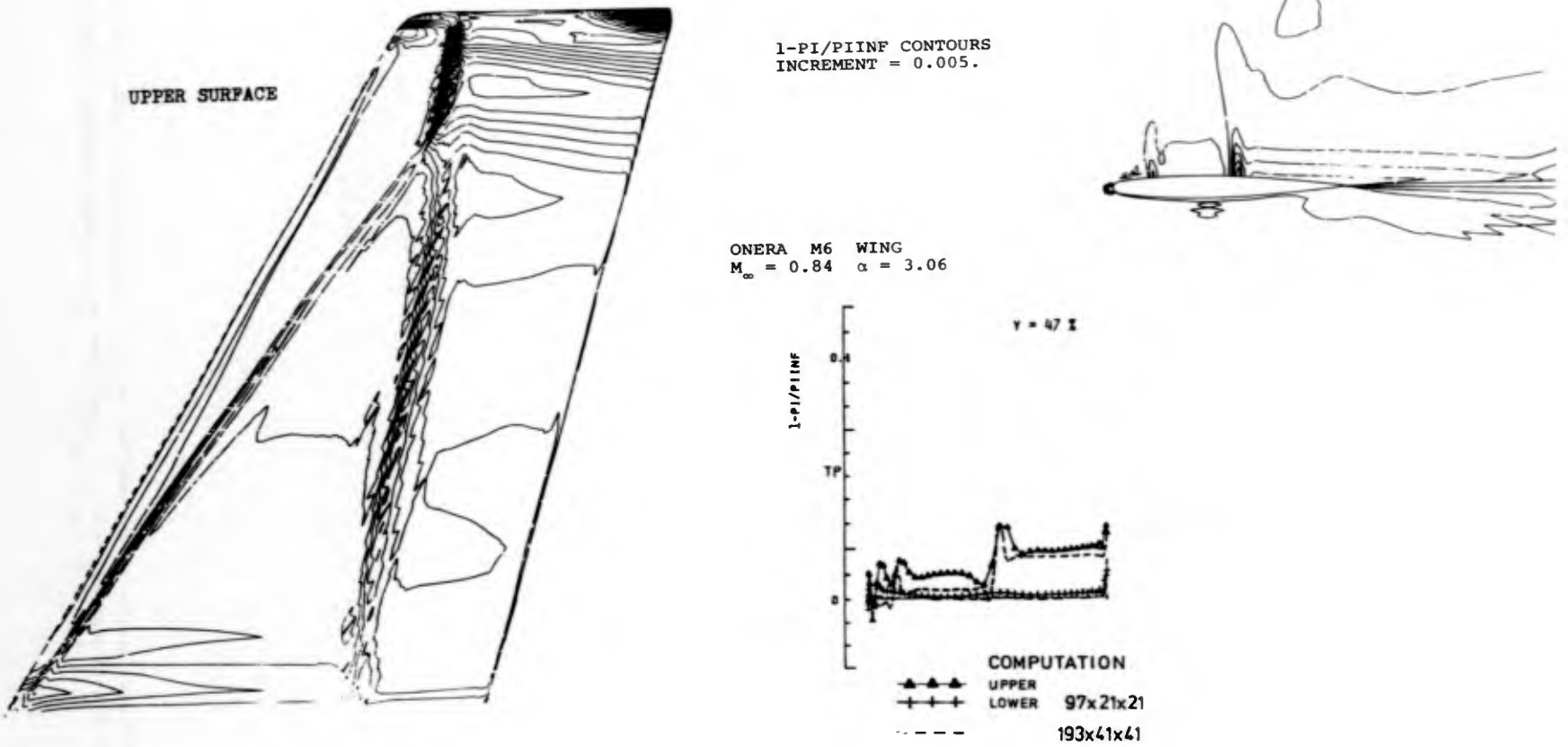
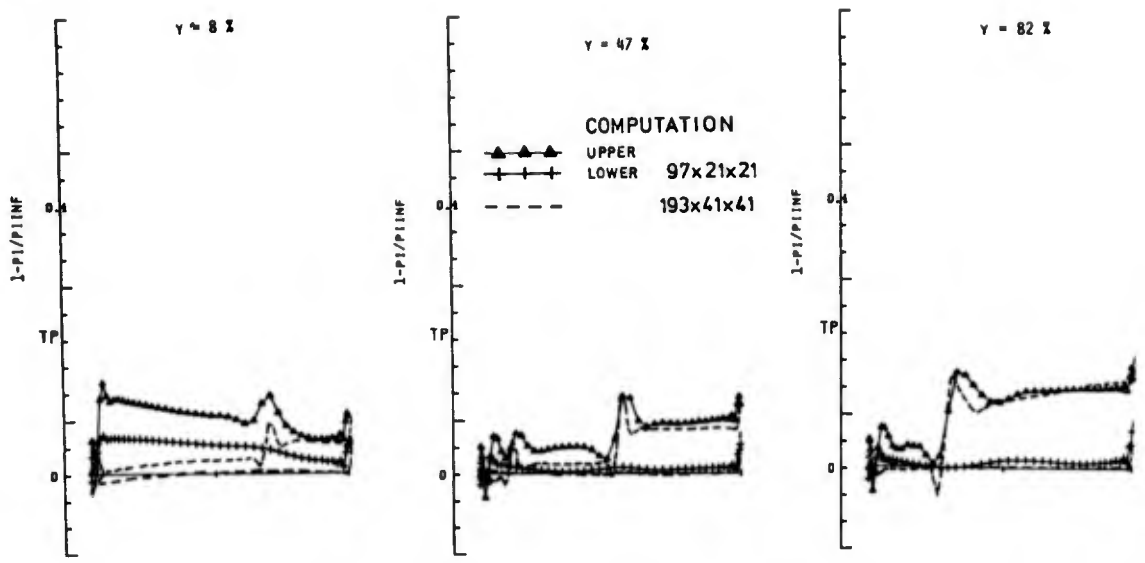
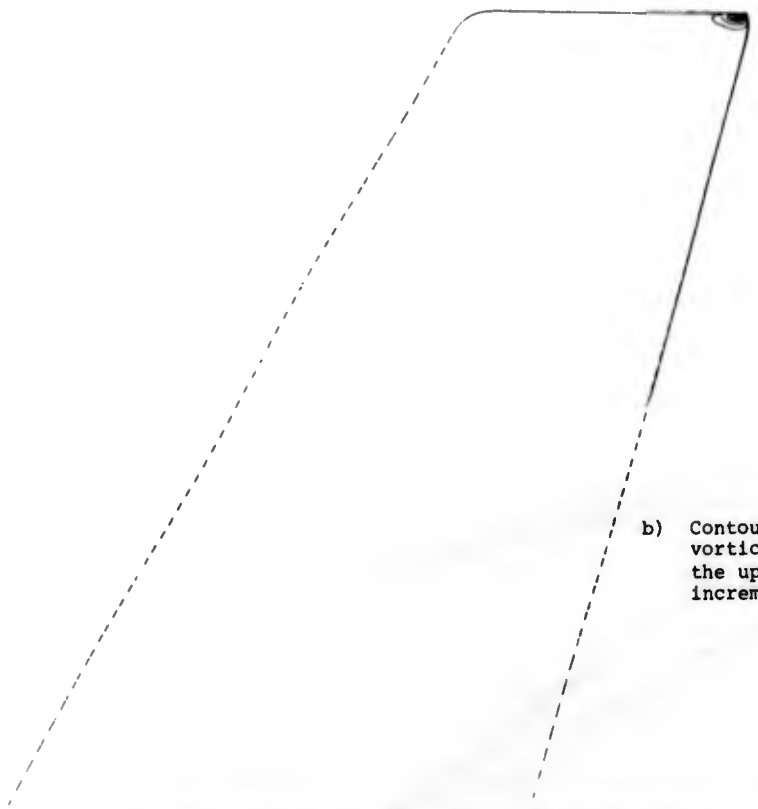


Fig. A6 - Contours of computed 1-PI/PIINF plotted on the upper surface of the M6 wing and in the 47% span station together with the comparison graph of the dense-mesh and standard-mesh distribution of 1-PI/PIINF on the section surface.
M_∞ = 0.84 α = 3.06 deg. Contour increment 0.005.

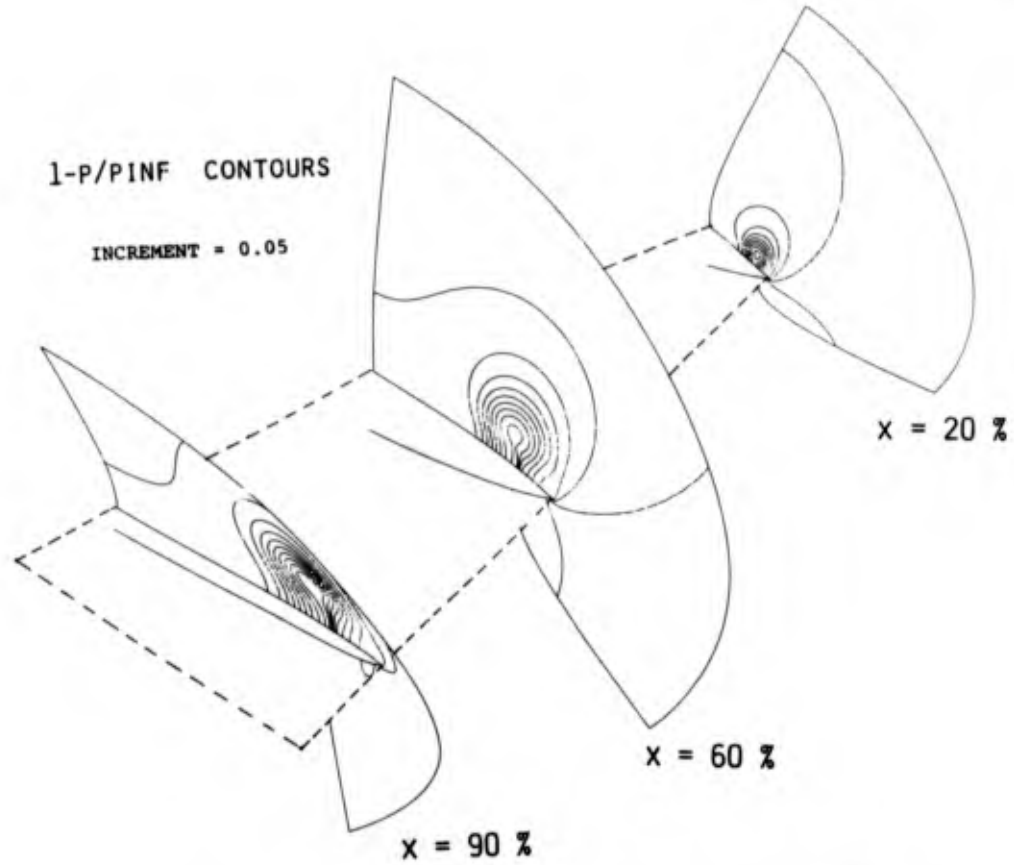


a) Comparison of the dense-mesh and standatd-mesh surface distribution of 1-PI/PIINF in 3 span stations.



b) Contours of computed vorticity magnitude on the upper surface increment 0.05.

Fig. A7 - Comparison graphs of the computed surface distribution of 1-PI/PIINF and contours of constant vorticity magnitude on the upper surface of the M6 wing. $M_\infty = 0.84$ $\alpha = 3.06$ deg.



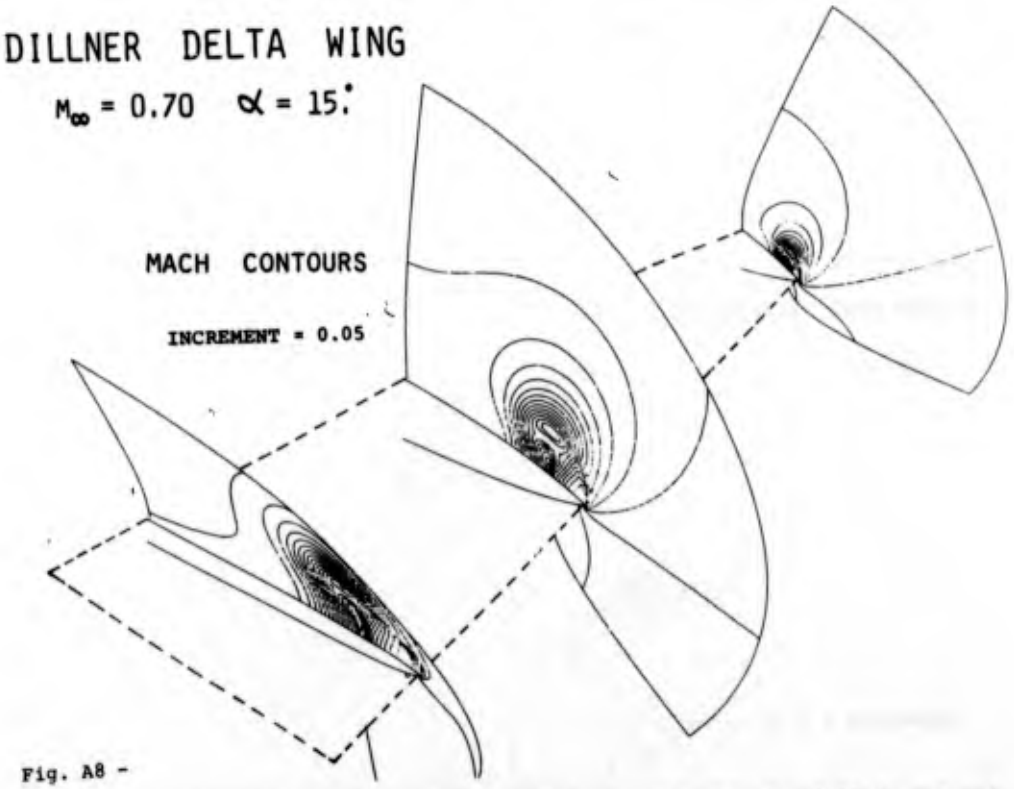
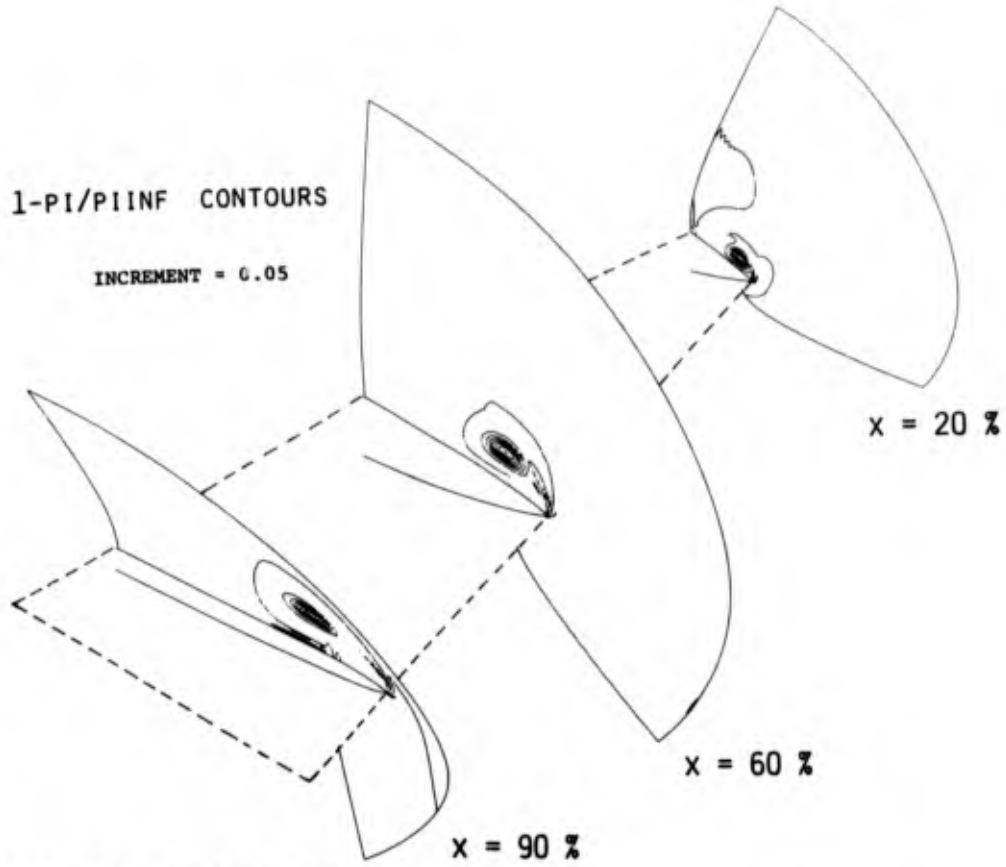


Fig. A8 -

Contours of 1-P/PIINF and Mach number plotted in three mesh surfaces at the 20%, 60% and 90% chord stations of the Dillner wing. $M_\infty = 0.7$ $\alpha = 15$ deg.



DILLNER DELTA WING

$M_\infty = 0.70$ $\alpha = 15°$

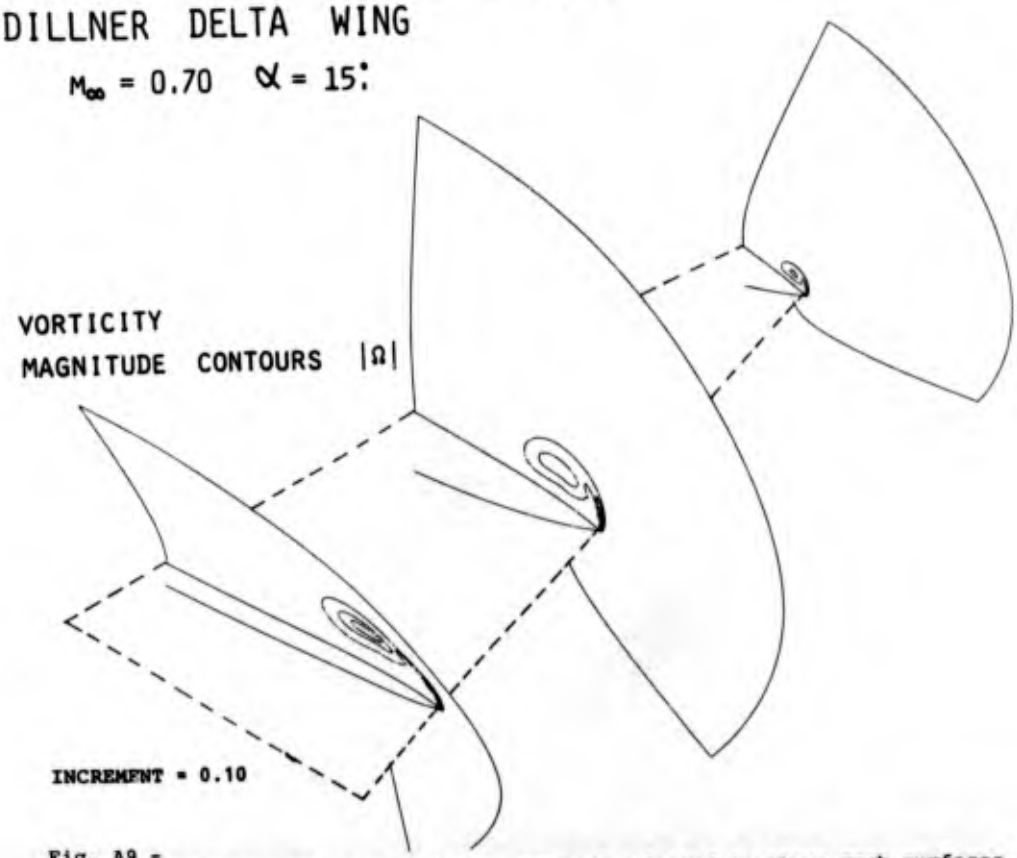


Fig. A9 -
Contours of 1-PI/PIINF and vorticity magnitude plotted in three mesh surfaces at the 20%, 60% and 90% chord stations of the Dillner wing. $M_\infty = 0.7$ $\alpha = 15$ deg.

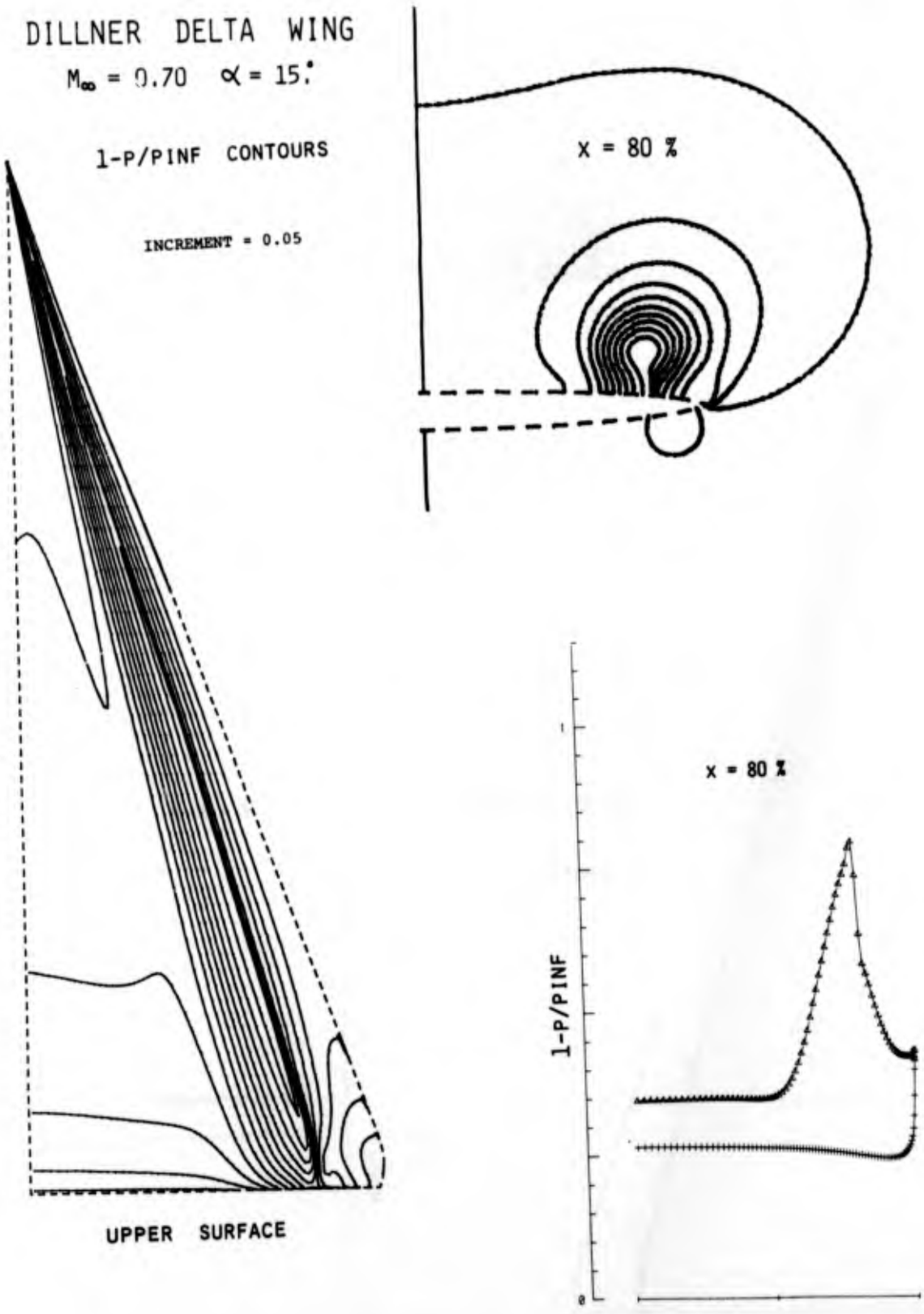


Fig. A10 -
Contours of computed 1-P/PIINF plotted in the upper surface of the Dillner wing and in the 80% chord station together with the surface distribution on the section.
M_∞ = 0.7 α = 15 deg. Contour increment 0.05.

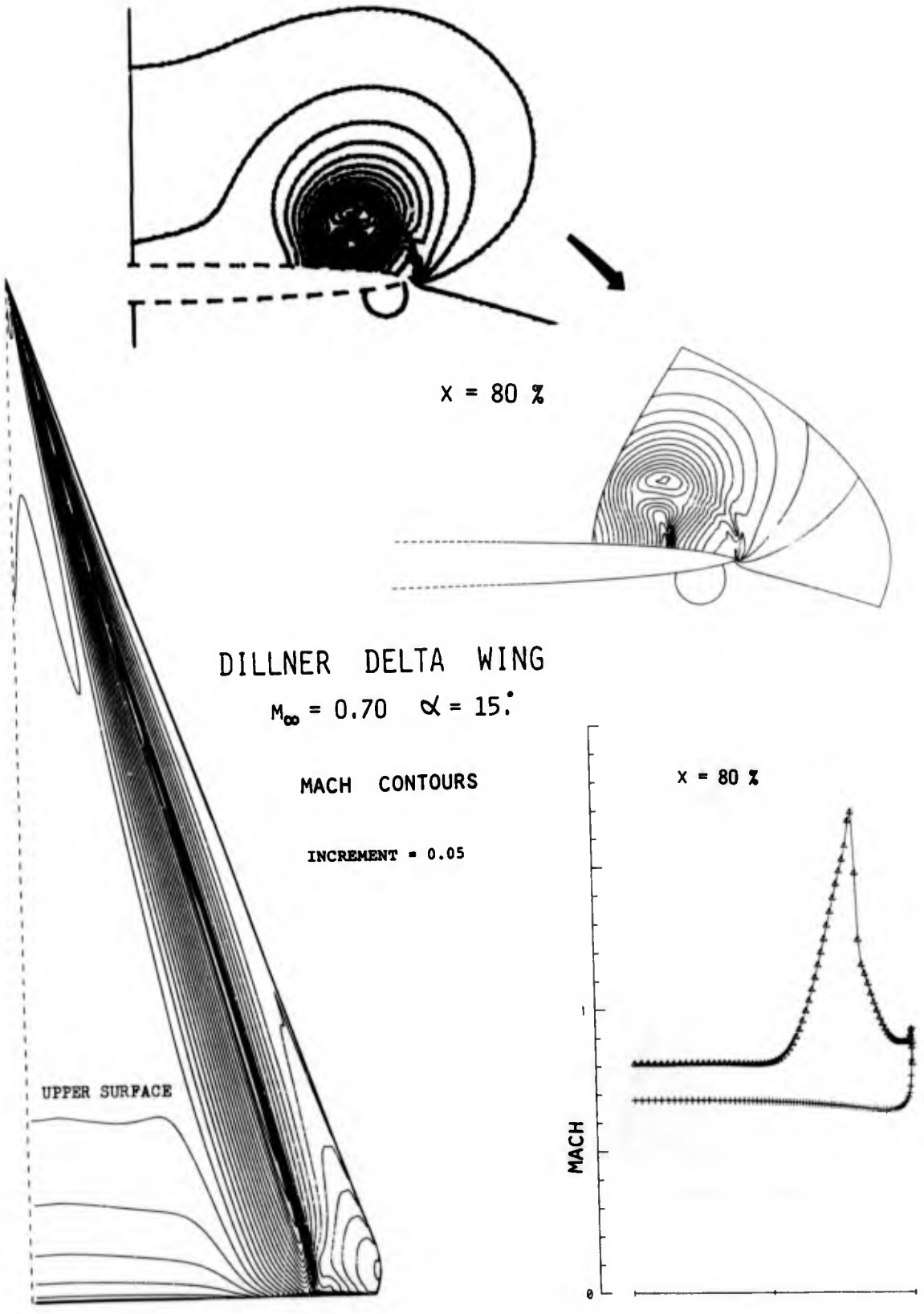


Fig. All -
Contours of computed Mach number plotted in the upper surface of the Dillner wing and in the 80% chord station together with the surface distribution on the section.
M_∞ = 0.7 α = 15 deg. Contours increment 0.05.

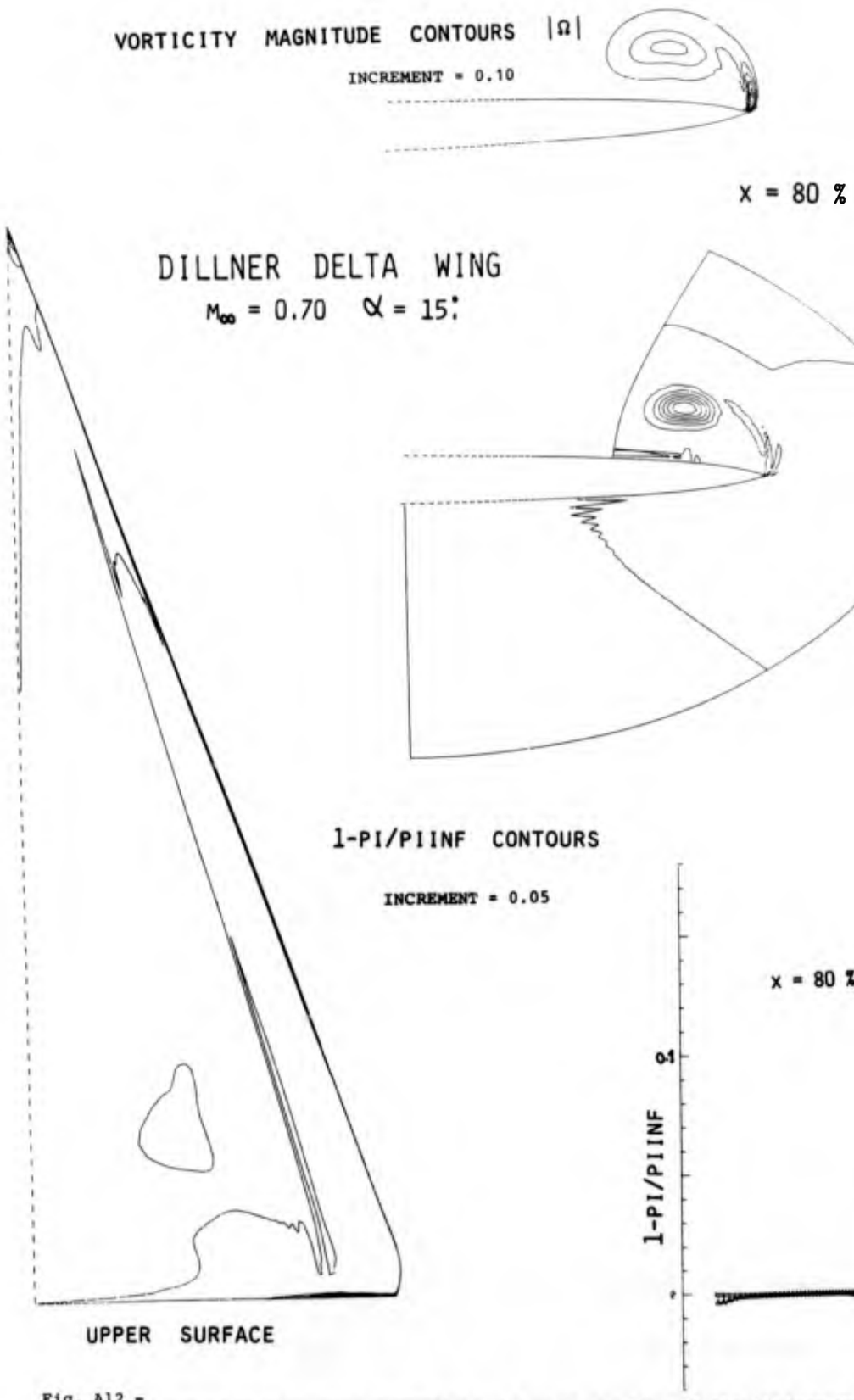


Fig. A12 -
Contours of computed 1-PI/PIINF plotted on the upper surface of the Dillner wing and in the 80% chord station together with the vorticity magnitude contours and the surface distribution on the section. $M_\infty = 0.7$ $\alpha = 15$ deg. Contour increment 0.05.

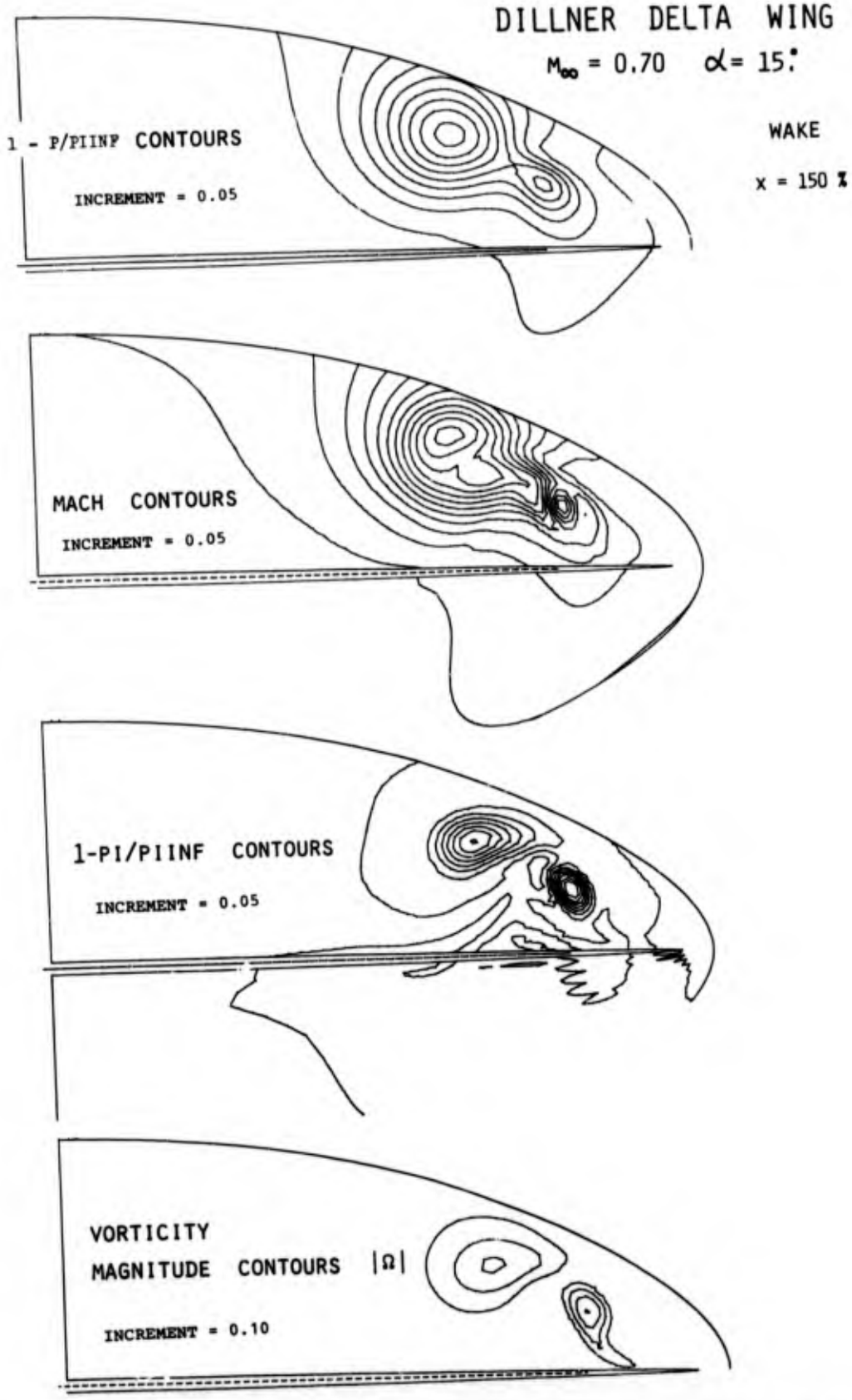


Fig. A13 -
Contours of 1-P/PIINF, Mach number, 1-PI/PIINF and vorticity magnitude in the wake behind the Dillner wing at the 150% chord station. M_∞ = 0.7 α = 15 deg.

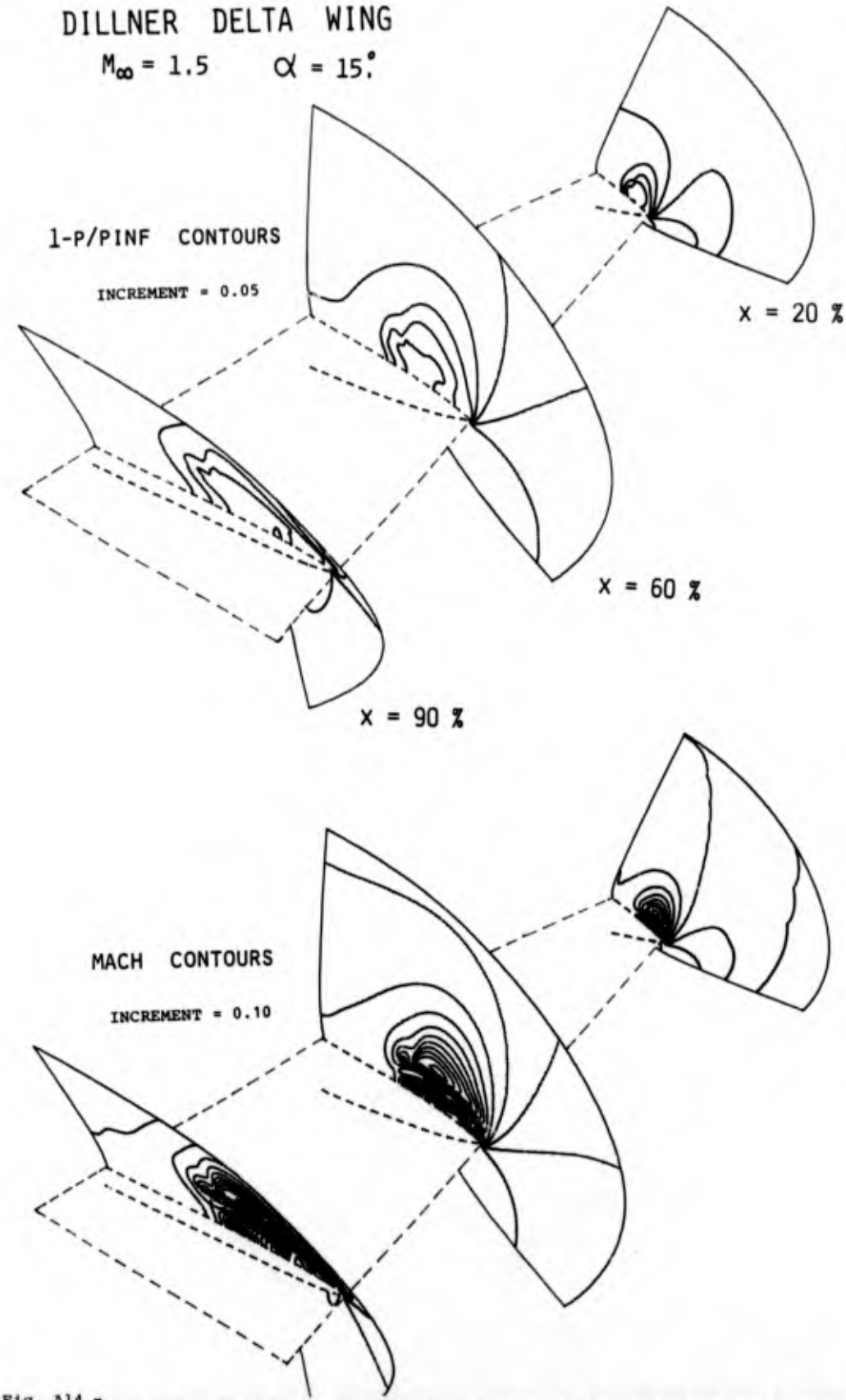
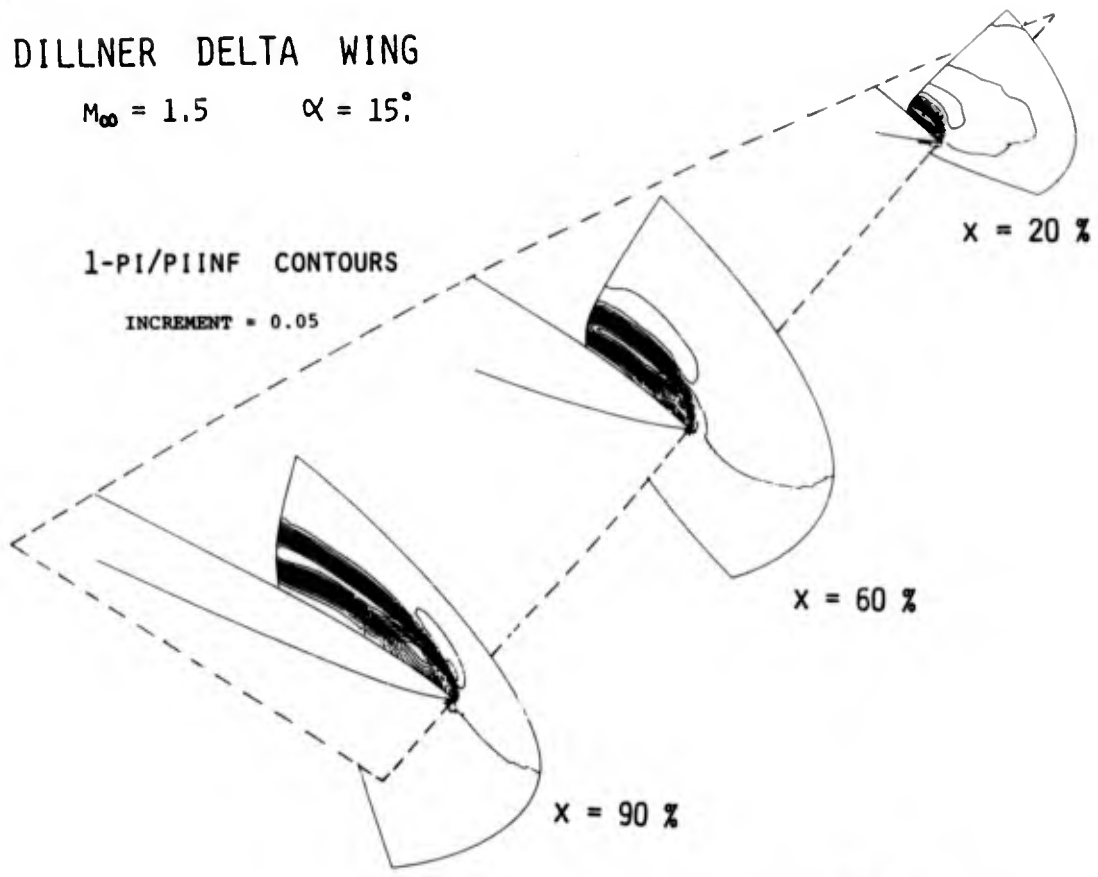


Fig. A14 -
Contours of 1-P/PIINF and Mach number plotted in three mesh surfaces at the 20%, 60% and 90% chord stations of the Dillner wing. $M_\infty = 1.5$ $\alpha = 15$ deg.



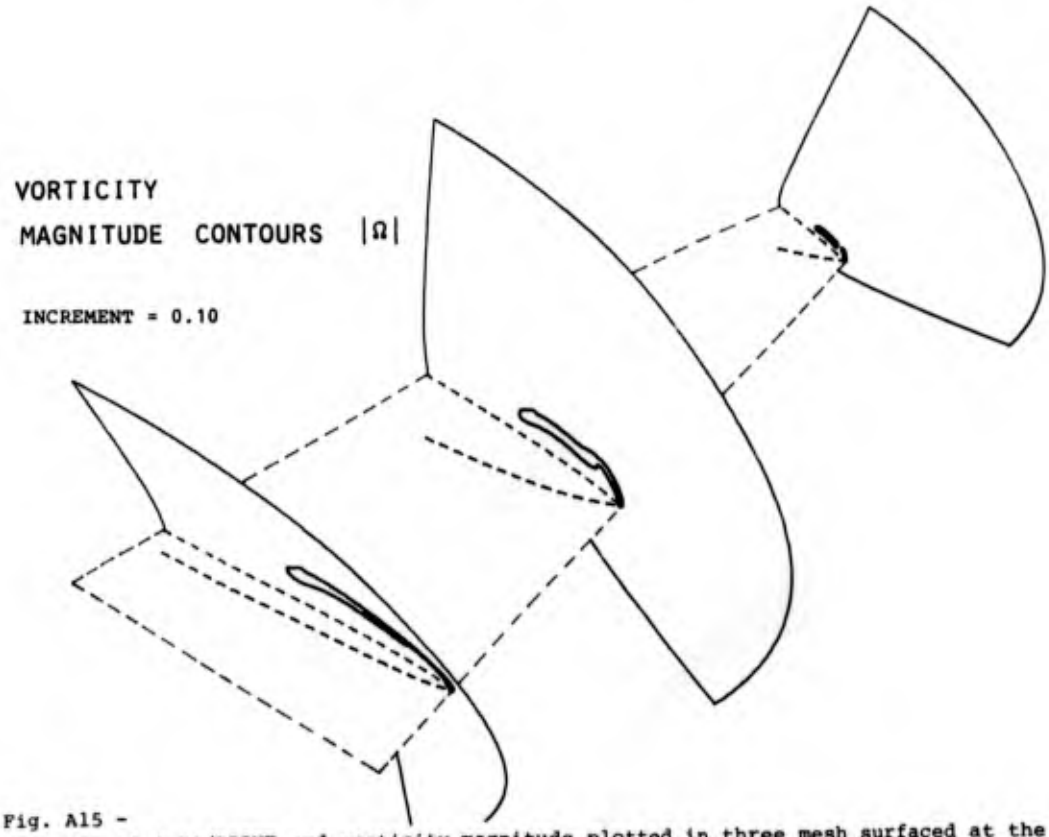


Fig. A15 -
Contours of 1-PI/PIINF and vorticity magnitude plotted in three mesh surfaced at the 20%, 60% and 90% chord stations of the Dillner wing. M_∞ = 1.5 α = 15 deg.

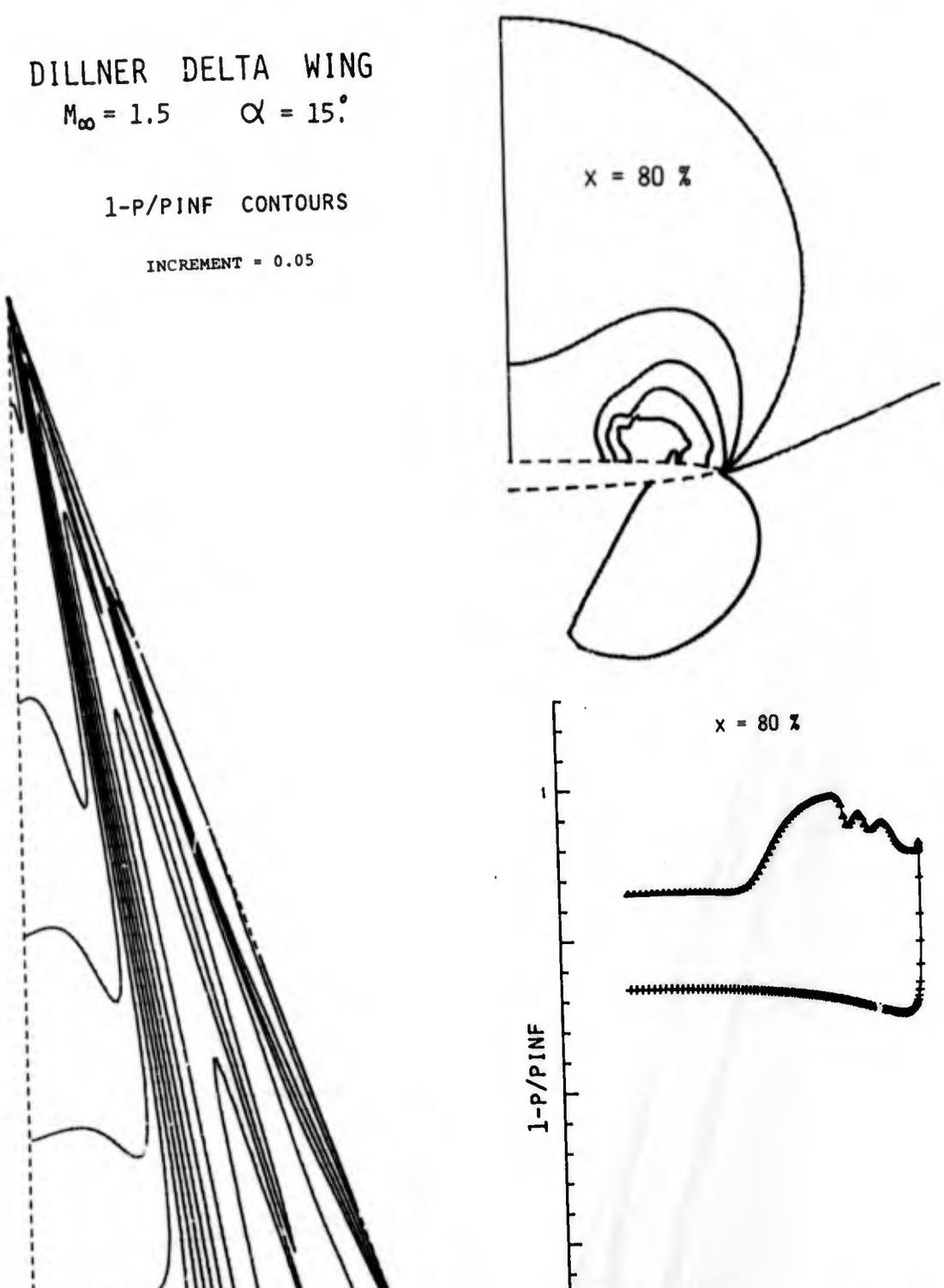


Fig. A16 -
Contours of computed 1-P/PINF plotted on the upper surface of the Dillner wing and in the 80% chord station together with the surface distribution on the section.
$M_\infty = 1.5$ $\alpha = 15$ deg. Contour increment 0.05.

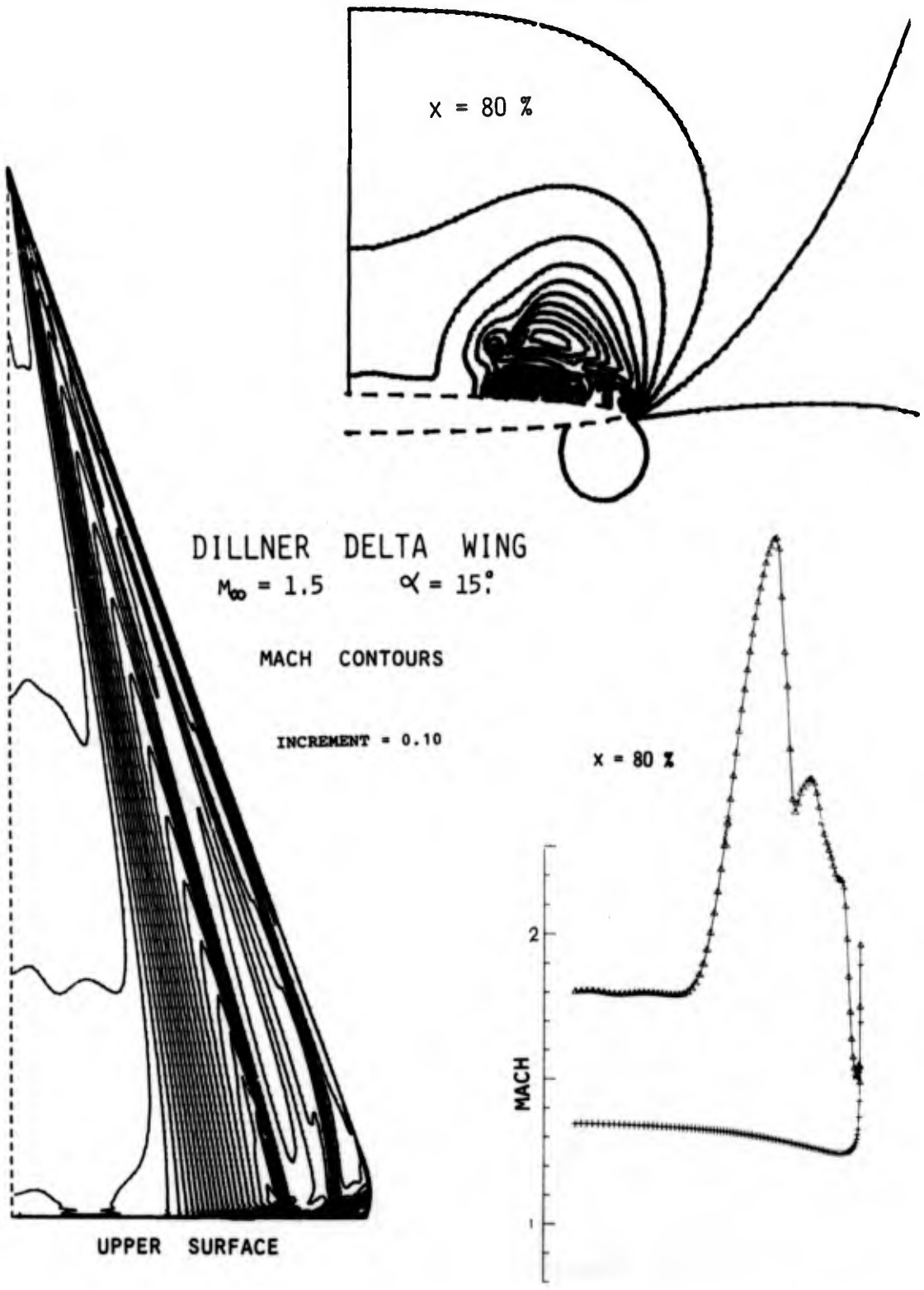


Fig. A17 -
Contours of computed Mach number plotted on the upper surface of the Dillner wing and in the 80% chord station together with the surface distribution on the section.
M_∞ = 1.5 α = 15 deg. Contour increment 0.10.

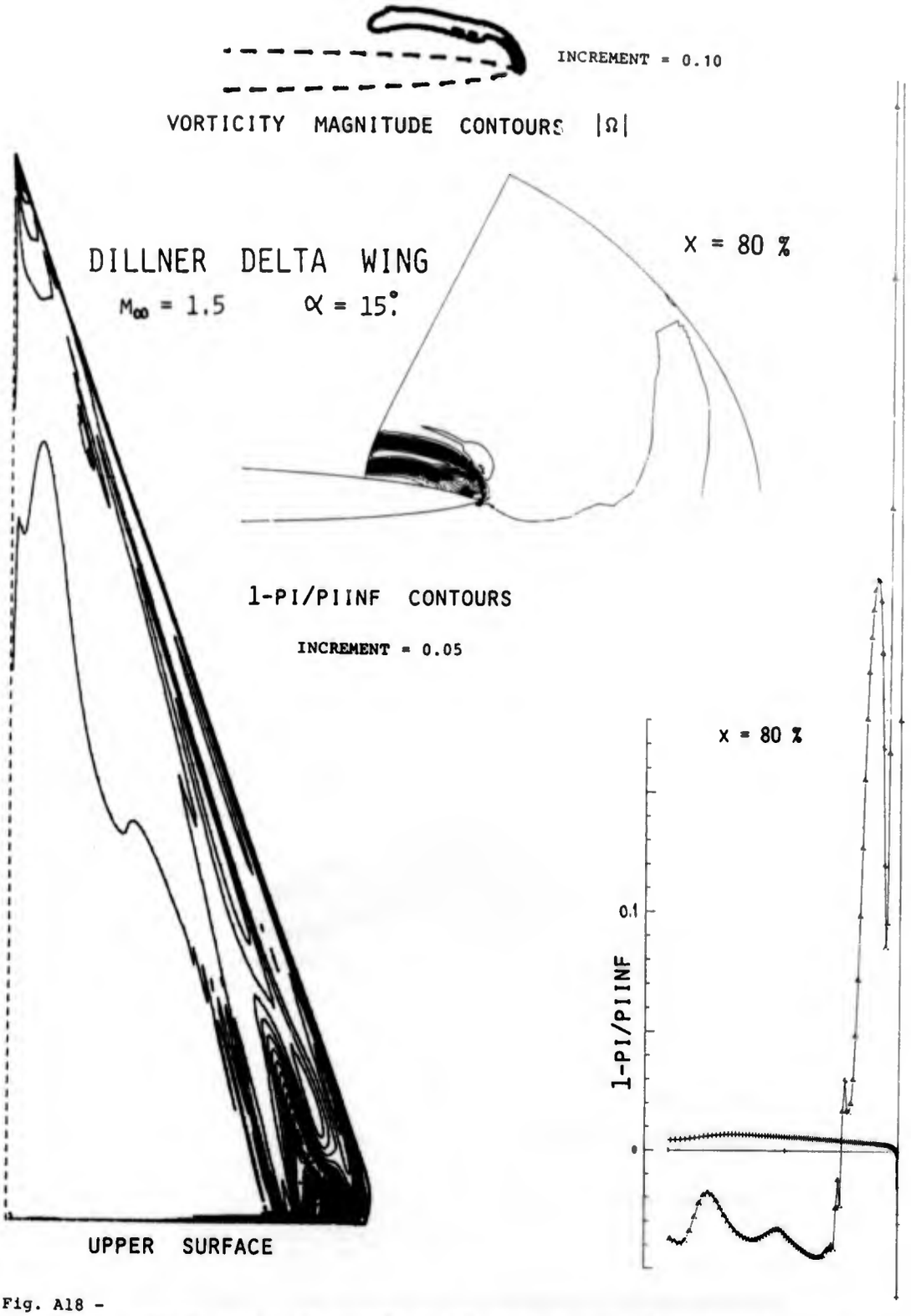


Fig. A18 -
Contours of computed 1-PI/PIINF plotted on the upper surface of the Dillner wing and in the 80% chord station together sith the vorticity magnitude contours and the surface distribution on the section. M_∞ = 1.5 α = 15 deg. Contour increment 0.05.

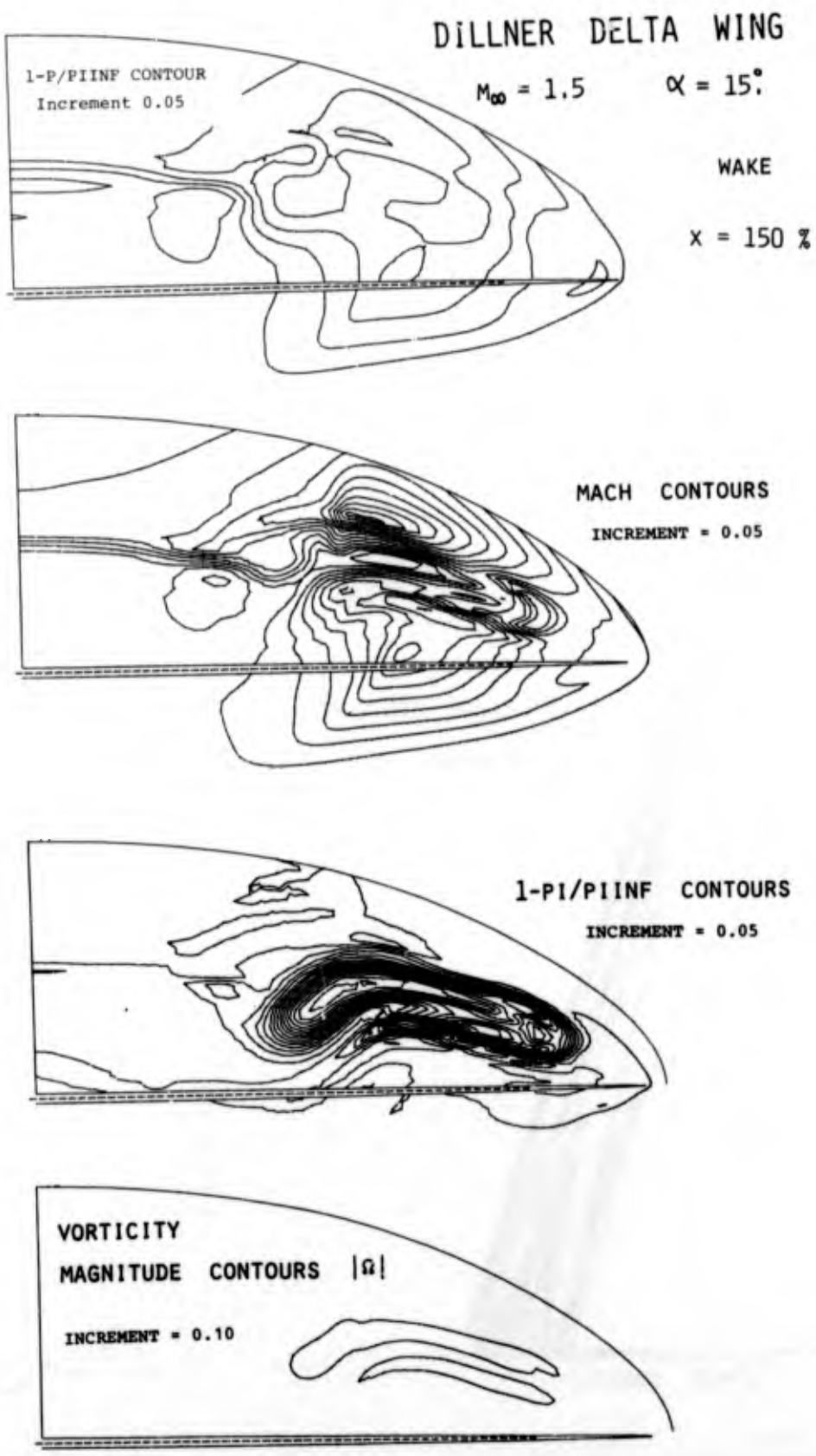


Fig. A19 -
Contours of 1-P/PIINF, Mach number, 1-PI/PIINF and vorticity magnitude in the wake behind the Dillner wing at the 150% chord station. M_∞ = 1.5 α = 15 deg.

9. CONCLUDING REMARKS (H. YOSHIHARA)

Since detailed summarizing and concluding remarks were given in the previous chapters for the various classes of configurations, only general remarks will be made here.

It may be recalled that the primary purpose of the WG07 was the generation of relevant Euler solutions, both planar and 3D, to serve as Reference Test Cases which developers of Euler methods could use to assess their codes. Since such Reference Test Cases in most cases must themselves be generated numerically, there was initial concern as to the meaningfulness of this objective. The quality of the results produced by the many dedicated contributors has largely dispelled this concern.

Except for a few instances, the numerical algorithms used by the contributors within the flow field and at the boundaries were sound. The relative accuracies of the various contributions were due in large part to the density and extent of the mesh used, though the quality of the artificial viscosity used was also an important factor.

The planar airfoil solutions recommended herein should serve as reliable Reference Test Cases. The 3D cases understandably are relatively less reliable and must at present be considered as interim Test Cases to serve as approximate guides. It is hoped that the latter cases can be upgraded by future improved calculations. To monitor such activities as well as possibly to extent the scope to viscous solutions, the AGARD Fluid Dynamics Panel has established a Computational Fluid Dynamics Subcommittee.

Finally the FDP and the WG07 wish to express their appreciation and gratitude to the many contributors for their valuable time and resources.

APPENDIX A1

Numerical data

The complete sets of data provided by the contributors, concerning the solutions of group 2, are given in microfiche form. The solutions are grouped according to test cases, and are listed below for each test case. The summary description of the numerical method provided by each contributor together with the numerical data is included with the first set of data appearing in Appendix A1 for this contributor.

Test case			Solution
01 NACA 0012,	$M_\infty = 0.8$,	$\alpha = 1.25°$	1, 2, 3, 5, 6, 8, 9
02 NACA 0012,	$M_\infty = 0.85$,	$\alpha = 1°$	1, 2, 3, 5, 6, 8, 9
03 NACA 0012,	$M_\infty = 0.95$,	$\alpha = 0°$	1, 3, 6, 8, 9, 10
04 NACA 0012,	$M_\infty = 1.2$,	$\alpha = 0°$	1, 3, 6, 9
05 NACA 0012,	$M_\infty = 1.2$,	$\alpha = 7°$	1, 3, 5, 6, 8, 9, 10
06 RAE 2822,	$M_\infty = 0.75$,	$\alpha = 3°$	1, 2, 3, 6, 9
07 NLR 7301,	$M_\infty = 0.720957$,	$\alpha = -0.194°$	1, 2, 3, 6, 8, 9
08 CHIOCCHIA-NOCILLA profile	$M_\infty = 0.769041$,	$\alpha = 0°$	7, 9.1, 9.2*, 11 (*obtained for $M_\infty = 0.785$)
09 HOBSON1 cascade	$M_\infty = 0.476$,	$\alpha = 43.544°$	12, 13
10 HOBSON2 cascade	$M_\infty = 0.575$,	$\alpha = 46.123°$	12

Also included in microfiche form are numerical data relating to the solutions for three-dimensional cases discussed in Chapters 7 and 8.

Test case			Solution
11 Data included in chapter 7 of the main volume			
12 Data included in chapter 7 of the main volume			
13 Data included in chapter 8 of the main volume			
14 DILLNER wing	$M_\infty = 1.50$,	$\alpha = 15°$	9
15 DILLNER wing	$M_\infty = 0.70$,	$\alpha = 15°$	9
16 Data included in chapter 7 of the main volume			
17 AGARD B	$M_\infty = 1.50$,	$\alpha = 0°$	9
18 AGARD B	$M_\infty = 1.50$,	$\alpha = 2°$	9

REPORT DOCUMENTATION PAGE

1. Recipient's Reference	2. Originator's Reference	3. Further Reference	4. Security Classification of Document
	AGARD-AR-211	ISBN 92-835-1497-1	UNCLASSIFIED

5. Originator Advisory Group for Aerospace Research and Development
North Atlantic Treaty Organization
7 rue Ancelle, 92200 Neuilly sur Seine, France

6. Title

TEST CASES FOR INVISCID FLOW FIELD METHODS

7. Presented at

8. Author(s)/Editor(s)	9. Date
Various	May 1985
10. Author's/Editor's Address	**11. Pages**
Various	336 1440 opp 1776

12. Distribution Statement This document is distributed in accordance with AGARD policies and regulations, which are outlined on the Outside Back Covers of all AGARD publications.

13. Keywords/Descriptors

Inviscid flow
Flow distribution
Aerodynamics
Computation
Mathematical models
Military aircraft
Design

14. Abstract

The escalating costs and the continuing limitations of wind tunnel testing together with the growing imperative to achieve the "optimal" design have rapidly increased the importance of computational fluid dynamics in the design of military aircraft. At relevant Reynolds numbers, inviscid flow methods continue to play an essential role in this design process. This document specifies,

In recognition of this, the AGARD Fluid Dynamics Panel established Working Group 07 to specify relevant reference test cases to serve as validation bases for those developing new methods with improved accuracy and cost-effectiveness. These cases further serve as check cases for those learning to use existing production codes.

This report presents the recommendations of the Working Group.

AGARD Advisory Report No.211 Advisory Group for Aerospace Research and Development, NATO TEST CASES FOR INVISCID FLOW FIELD METHODS published May 1985 336 pages The escalating costs and the continuing limitations of wind tunnel testing together with the growing imperative to achieve the "optimal" design have rapidly increased the importance of computation fluid dynamics in the design of military aircraft. At relevant Reynolds numbers, inviscid flow methods continue to play an essential role in this design process. P.T.O	AGARD-AR-211 Inviscid flow Flow distribution Aerodynamics Computation Mathematical models Military aircraft Design	AGARD Advisory Report No.211 Advisory Group for Aerospace Research and Development, NATO TEST CASES FOR INVISCID FLOW FIELD METHODS published May 1985 336 pages The escalating costs and the continuing limitations of wind tunnel testing together with the growing imperative to achieve the "optimal" design have rapidly increased the importance of computation fluid dynamics in the design of military aircraft. At relevant Reynolds numbers, inviscid flow methods continue to play an essential role in this design process. P.T.O	AGARD-AR-211 Inviscid flow Flow distribution Aerodynamics Computation Mathematical models Military aircraft Design
AGARD Advisory Report No.211 Advisory Group for Aerospace Research and Development, NATO TEST CASES FOR INVISCID FLOW FIELD METHODS published May 1985 336 pages The escalating costs and the continuing limitations of wind tunnel testing together with the growing imperative to achieve the "optimal" design have rapidly increased the importance of computation fluid dynamics in the design of military aircraft. At relevant Reynolds numbers, inviscid flow methods continue to play an essential role in this design process. P.T.O	AGARD-AR-211 Inviscid flow Flow distribution Aerodynamics Computation Mathematical models Military aircraft Design	AGARD Advisory Report No.211 Advisory Group for Aerospace Research and Development, NATO TEST CASES FOR INVISCID FLOW FIELD METHODS published May 1985 336 pages The escalating costs and the continuing limitations of wind tunnel testing together with the growing imperative to achieve the "optimal" design have rapidly increased the importance of computation fluid dynamics in the design of military aircraft. At relevant Reynolds numbers, inviscid flow methods continue to play an essential role in this design process. P.T.O	AGARD-AR-211 Inviscid flow Flow distribution Aerodynamics Computation Mathematical models Military aircraft Design

In recognition of this, the AGARD Fluid Dynamics Panel established Working Group 07 to specify relevant reference test cases to serve as validation bases for those developing new methods with improved accuracy and cost-effectiveness. These cases further serve as check cases for those learning to use existing production codes.

This report presents the recommendations of the Working Group.

This Advisory Report was prepared at the request of the AGARD Fluid Dynamics Panel.

ISBN 92-835-1497-1

In recognition of this, the AGARD Fluid Dynamics Panel established Working Group 07 to specify relevant reference test cases to serve as validation bases for those developing new methods with improved accuracy and cost-effectiveness. These cases further serve as check cases for those learning to use existing production codes.

This report presents the recommendations of the Working Group.

This Advisory Report was prepared at the request of the AGARD Fluid Dynamics Panel.

ISBN 92-835-1497-1

In recognition of this, the AGARD Fluid Dynamics Panel established Working Group 07 to specify relevant reference test cases to serve as validation bases for those developing new methods with improved accuracy and cost-effectiveness. These cases further serve as check cases for those learning to use existing production codes.

This report presents the recommendations of the Working Group.

This Advisory Report was prepared at the request of the AGARD Fluid Dynamics Panel.

ISBN 92-835-1497-1

In recognition of this, the AGARD Fluid Dynamics Panel established Working Group 07 to specify relevant reference test cases to serve as validation bases for those developing new methods with improved accuracy and cost-effectiveness. These cases further serve as check cases for those learning to use existing production codes.

This report presents the recommendations of the Working Group.

This Advisory Report was prepared at the request of the AGARD Fluid Dynamics Panel.

ISBN 92-835-1497-1

APPENDIX A1

Numerical data

The complete sets of data provided by the contributors, concerning the solutions of group 2, are given in microfiche form. The solutions are grouped according to test cases, and are listed below for each test case. The summary description of the numerical method provided by each contributor together with the numerical data is included with the first set of data appearing in Appendix A1 for this contributor.

Test case			Solution
01 NACA 0012,	$M_\infty = 0.8$,	$\alpha = 1.25°$	1, 2, 3, 5, 6, 8, 9
02 NACA 0012,	$M_\infty = 0.85$,	$\alpha = 1°$	1, 2, 3, 5, 6, 8, 9
03 NACA 0012,	$M_\infty = 0.95$,	$\alpha = 0°$	1, 3, 6, 8, 9, 10
04 NACA 0012,	$M_\infty = 1.2$,	$\alpha = 0°$	1, 3, 6, 9
05 NACA 0012,	$M_\infty = 1.2$,	$\alpha = 7°$	1, 3, 5, 6, 8, 9, 10
06 RAE 2822,	$M_\infty = 0.75$,	$\alpha = 3°$	1, 2, 3, 6, 9
07 NLR 7301,	$M_\infty = 0.720957$,	$\alpha = -0.194°$	1, 2, 3, 6, 8, 9
08 CHIOCCHIA-NOCILLA profile	$M_\infty = 0.769041$,	$\alpha = 0°$	7, 9.1 , 9.2*, 11 (*obtained for $M_\infty = 0.785$)
09 HOBSON1 cascade	$M_\infty = 0.476$,	$\alpha = 43.544°$	12, 13
10 HOBSON2 cascade	$M_\infty = 0.575$,	$\alpha = 46.123°$	12

Also included in microfiche form are numerical data relating to the solutions for three-dimensional cases discussed in Chapters 7 and 8.

Test case			Solution
11 Data included in chapter 7 of the main volume			
12 Data included in chapter 7 of the main volume			
13 Data included in chapter 8 of the main volume			
14 DILLNER wing	$M_\infty = 1.50$,	$\alpha = 15°$	9
15 DILLNER wing	$M_\infty = 0.70$,	$\alpha = 15°$	9
16 Not available at time of printing.			
17 AGARD B	$M_\infty = 1.50$,	$\alpha = 0°$	9
18 AGARD B	$M_\infty = 1.50$,	$\alpha = 2°$	9

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 01

NACA 0012: MACH = 0.80, ALPHA = 1.25

Contributor No 1

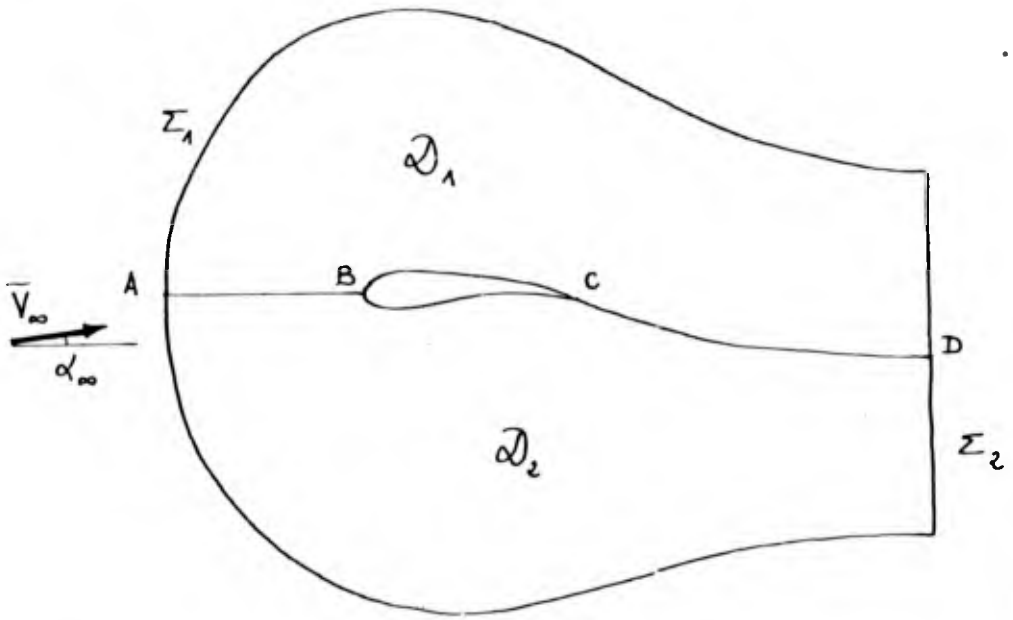
J.P.Veuillot and A.M.Vuillot

(O.N.E.R.A., France)

PRINCIPLES OF THE NUMERICAL METHOD

The Euler equations are numerically solved by a pseudo-unsteady type method assuming that the stagnation enthalpy is constant ($T_{i} = T_{i\infty}$). The continuity and momentum equations are integrated step by step in time using an explicit predictor-corrector scheme with a local time step technique. The spatial derivatives are discretized directly in the physical plane (x,y) by means of finite difference formulae. The treatment of the boundary conditions is achieved by a technique based on compatibility relations. The main features of the numerical method are described in /1/ and /2/.

The computational domain is divided into and upper subdomain ($\mathcal{D}_1$) and a lower subdomain ($\mathcal{D}_2$) by means of two cut lines: the upstream one is the horizontal mesh line (AB) issued from the leading edge, and the downstream one is the mesh line (CD) issued from the trailing edge. In this method, the stream line leaving the trailing edge is fitted as this mesh line (CD), whether or not it is a real slip line (it is a slip line if the stagnation pressure is different above and below). The global mesh is of C-type and details on its generation are given in /3/.



Artificial viscosity terms are added to the equations in order to insure the stability of the scheme and in order to correctly capture shocks. Two extra-terms are added after the computation of the corrector step, noted $f^{\overline{m+1}}$, and the final value of the variable f , noted f^{m+1} , is given by :

$$f^{m+1} = f^{\overline{m+1}} + D_1(f^m) + D_2(f^m)$$

The first term is a smoothing term added both to the continuity equation and to the momentum equation. It is of the form :

$$D_1(f^m) = -\left(Q_{1i}\, \delta_i^{(4)} f^m + Q_{1j}\, \delta_j^{(4)} f^m \right)$$

with, $\delta_i^{(4)} f = f_{i+2,j} - 4 f_{i+1,j} + 6 f_{i,j} - 4 f_{i-1,j} + f_{i-2,j}$

and where Q_{1i} and Q_{1j} are two constants.

The second term is added only to the momentum equation and is directly expressed in the computational plane (i,j). For instance, the x-component of $\mathcal{D}_2$ has the following form :

$$(\mathcal{D}_2)_x = \Delta t_{ij} \left\{ \frac{Q_{2i}}{4h} \left[(\rho_{i+1,j} + \rho_{ij}) \left| u_{i+1,j} - u_{ij} \right| (u_{i+1,j} - u_{ij}) - (\rho_{ij} + \rho_{i-1,j}) \left| u_{ij} - u_{i-1,j} \right| (u_{ij} - u_{i-1,j}) \right] + \frac{Q_{2j}}{4k} \left[\text{-----} \right] \right\}$$

Δt_{ij} is the local time step, h (resp. k) is the inverse of the number of mesh points along a mesh line of index i (resp. j), Q_{2i} and Q_{2j} are two constants.

The boundary conditions on the external boundary (Σ) of the computational domain ($\mathcal{D}$) are the following :
i) On the part (Σ_1) of the boundary (Σ) (see figure),
- all the unknowns are given ($\rho = \rho_\infty$ and $\vec{V} = \vec{V}_\infty$) if the flow is entering the domain ($\mathcal{D}$) with a supersonic normal velocity,
- the direction of the velocity and the stagnation pressure are prescribed ($\alpha = \alpha_\infty$ and $\pi_i = \pi_{i\infty}$) if the flow is entering the domain ($\mathcal{D}$) with a subsonic normal velocity,
- only the direction of the velocity is prescribed ($\alpha = \alpha_\infty$) if the flow is leaving the domain ($\mathcal{D}$) with a subsonic normal velocity.
ii) On the part (Σ_2) of the boundary (Σ),
- there is no boundary condition if the flow is leaving the domain ($\mathcal{D}$) with a supersonic normal velocity,
- the static pressure is given ($\pi = \pi_\infty$) if the flow is leaving the domain ($\mathcal{D}$) with a subsonic velocity.

REFERENCES

/1/ VIVIAND H. et VEUILLOT J.P., Méthodes pseudo-instationnaires pour le calcul d'écoulements transsoniques, ONERA Pub. 1978-4 (English version ESA TT561), 1978.

/2/ CAMBIER L., GHAZZI W., VEUILLOT J.P. et VIVIAND H., Une approche par domaines pour le calcul d'écoulements compressibles, Computing Methods in Applied Sciences and Engineering V, Ed. Glowinski R. and Lions J.L., North Holland, 1982.

/3/ LE BALLEUR J.C., Strong Matching Method for Computing Transonic Viscous Flows Including Wakes and Separations. Lifting Airfoils, La Rech. Aerosp. 1981-3 (English version p. 21-43), May 1981.

COMMENTS ON CALCULATION FOR TEST CASE 01

* The computational domain is inscribed in the rectangle

  $-\ 3.96 \leqslant x/c \leqslant 6.94\ ,\ -\ 5.95 \leqslant z/c \leqslant 5.95$

* Number of mesh points : 189 x 25 = 4 725 (147 mesh points on the profile)

* Artificial viscosity ;

  D_1 term : $Q_{1i} = Q_{1j} = 0.1\ 10^{-2}$

  D_2 term : $Q_{2i} = 1.6\ ,\ Q_{2j} = 0.8$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-4
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

WALL VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	.010458	1.134818	.114248	.001387
2	.000138	.001961	.031854	1.062017	.208323	.002122
3	.000529	.003956	.065745	.946702	.304724	.003596
4	.001201	.006021	.109257	.798651	.401764	.004485
5	.002226	.008176	.158876	.629819	.496065	.004853
6	.003674	.010431	.207914	.462967	.583093	.002825
7	.005596	.012817	.258098	.292211	.666438	.000682
8	.008099	.015326	.306104	.128871	.742067	-.000246
9	.011281	.017946	.346786	-.009553	.805714	-.001400
10	.015223	.020682	.384309	-.137228	.863242	-.001226
11	.020026	.023494	.416338	-.246206	.912457	-.000642
12	.025753	.026373	.443740	-.339444	.955047	.000040
13	.032467	.029276	.467833	-.421420	.993138	.000659
14	.040192	.032181	.488990	-.493408	1.027132	.001302
15	.048942	.035036	.507367	-.555936	1.057416	.001625
16	.058692	.037826	.523702	-.611519	1.084670	.002106
17	.069411	.040495	.537866	-.659711	1.108991	.002192
18	.081035	.043050	.551185	-.705029	1.132098	.002462
19	.093511	.045423	.562849	-.744717	1.152756	.002593
20	.106753	.047649	.573522	-.781033	1.171978	.002685
21	.120700	.049662	.583240	-.814100	1.189708	.002817
22	.135267	.051507	.591960	-.843767	1.205908	.002851
23	.150395	.053132	.600085	-.871415	1.221160	.002949
24	.166011	.054580	.607414	-.896353	1.235140	.002979
25	.182063	.055813	.614283	-.919724	1.248371	.003050
26	.198492	.056870	.620464	-.940756	1.260425	.003104
27	.215256	.057725	.626227	-.960364	1.271800	.003136
28	.232310	.058413	.631516	-.978358	1.282311	.003215
29	.249621	.058912	.636303	-.994647	1.291961	.003231
30	.267155	.059261	.640827	-1.010041	1.301117	.003311
31	.284889	.059431	.644817	-1.023616	1.309296	.003333
32	.302795	.059472	.648632	-1.036597	1.317147	.003399
33	.320860	.059343	.651950	-1.047888	1.324038	.003443
34	.339062	.059106	.655152	-1.058784	1.330735	.003483
35	.357393	.058707	.658031	-1.068578	1.336779	.003541
36	.375835	.058215	.660555	-1.077167	1.342114	.003588
37	.394381	.057578	.663051	-1.085659	1.347430	.003617
38	.413009	.056853	.664984	-1.092236	1.351514	.003714
39	.431708	.056008	.667064	-1.099313	1.356039	.003666
40	.450471	.055074	.668591	-1.104509	1.359195	.003880
41	.469291	.054044	.670202	-1.109989	1.362872	.003641
42	.488165	.052924	.671573	-1.114656	1.365489	.004165
43	.507088	.051725	.672610	-1.118184	1.368328	.003373
44	.526055	.050440	.673794	-1.122213	1.369806	.004930
45	.545063	.049088	.675106	-1.126676	1.374731	.002096
46	.564108	.047654	.673515	-1.121262	1.367102	.007824
47	.583186	.046163	.682491	-1.151805	1.396936	-.006052
48	.602295	.044594	.660523	-1.077056	1.324261	.027690
49	.621430	042973	.584534	-.818500	1.127575	.081831
50	.640590	.041282	.466990	-.418553	.918274	.080345
51	.659771	.039541	.361627	-.060050	.781980	.044009
52	.678972	.037737	.334309	.032900	.750240	.033012
53	.698180	.035886	.351987	-.027248	.771458	.039429
54	.717356	.033979	.342767	.004123	.759757	.036638
55	.736446	.032039	.345355	-.004682	.762393	.038012
56	.755403	.030054	.341245	.009299	.756541	.037359
57	.774175	.028051	.339700	.014557	.753669	.037727
58	.792703	.026017	.336210	.026431	.748197	.037629
59	.810912	.023982	.332910	.037659	.742830	.037709
60	.828722	.021942	.329026	.050877	.736555	.037758
61	.846040	.019920	.324744	.065445	.729683	.037765
62	.862771	.017927	.320213	.080862	.722319	.037845
63	.878819	.015976	.315218	.097859	.714306	.037829
64	.894091	.014092	.310130	.115172	.706007	.037918
65	.908505	.012273	.304478	.134402	.696858	.037937
66	.922002	.010549	.298584	.154457	.687280	.037966
67	.934543	.008918	.292410	.175463	.677154	.038048
68	.946126	.007391	.285694	.198315	.666134	.038104
69	.956782	.005969	.278640	.222318	.654421	.038229
70	.966585	.004641	.270775	.249076	.640930	.038655
71	.975646	.003402	.261690	.279990	.625326	.039061
72	.984112	.002231	.251889	.313337	.605750	.041455
73	.992164	.001106	.232615	.378918	.570720	.042933
74	1.000000	0.000000	.200009	.489861	.533439	.028998

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-5
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

SLIP LINE VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
75	1.007828	.000084	.218662	.426395	.563089	.031060
76	1.015906	.000167	.250769	.317148	.604353	.041078
77	1.024786	.000257	.255135	.302293	.615286	.038347
78	1.035642	.000364	.267188	.261282	.634232	.039253
79	1.050236	.000504	.273518	.239743	646086	.038155
80	1.070633	.000695	.283100	.207142	.661295	.038591
81	1.099238	.000957	.290816	.180887	.674286	.038275
82	1.139116	.001319	.299297	.152029	.687820	.038488
83	1.194260	.001824	.307057	.125625	.700265	.038591
84	1.269817	.002542	.314416	.100587	.711828	.038863
85	1.372359	.003580	.321074	.077932	.722107	.039251
86	1.510196	.005101	.326897	.058122	.730876	.039774
87	1.693716	.007340	.331761	.041571	.737981	.040407
88	1.935752	.010599	.335616	028452	.743487	.041022
89	2.251987	.015271	.338578	.018374	.747642	.041563
90	2.661443	.021883	.340769	.010921	.750636	.042037
91	3.187124	.031060	.342242	.005907	.752615	.042389
92	3.856852	.043523	.343138	.002861	.753807	.042612
93	4.703481	.060053	.343627	.001195	.754457	.042735
94	5.742961	.080986	.343877	.000344	.754729	.042854
95	6.944488	.105448	.343978	.000001	.754998	.042756

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-6
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

WALL VALUES - LOWER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	.010458	1.134818	.114248	.001387
2	.000138	-.001961	-.000384	1.171709	.020985	-.000693
3	.000529	-.003956	.005948	1.150165	.074566	.002073
4	.001201	-.006021	.024664	1.086481	.169632	.004877
5	.002226	-.008176	.053119	.989663	.262074	.006808
6	.003674	-.010431	.087282	.873422	.349573	.006792
7	.005596	-.012817	.125843	.742215	.432473	.005944
8	.008099	-.015326	.166160	.605034	.508534	.005202
9	.011281	-.017946	.203915	.476571	.575375	.003653
10	.015223	-.020682	.240221	.353040	.635314	.003011
11	.020026	-.023494	.272975	.241594	.687430	.002710
12	.025753	-.026373	.302535	.141011	.733392	.002702
13	.032467	-.029276	.329235	.050166	.774413	.002859
14	.040192	-.032181	.353178	-.031303	.810965	.003174
15	.048942	-.035036	.374438	-.103641	.843620	.003327
16	.058692	-.037826	.393547	-.168659	.872917	.003667
17	.069411	-.040495	.410414	-.226050	.899206	.003689
18	.081035	-.043050	.426039	-.279216	.923503	.003964
19	.093511	-.045423	.439588	-.325316	.944884	.004045
20	.106753	-.047649	.451925	-.367292	.964493	.004137
21	.120700	-.049662	.462939	-.404770	.982105	.004262
22	.135267	-.051507	.472687	-.437937	.997902	.004272
23	.150395	-.053132	.481551	-.468098	1.012286	.004387
24	.166011	-.054579	.489199	-.494120	1.024860	.004399
25	.182063	-.055813	.496131	-.517705	1.036293	.004457
26	.198492	-.056870	.502050	-.537847	1.046121	.004501
27	.215256	-.057724	.507032	-.554798	1.054438	.004537
28	.232310	-.058413	.511145	-.568783	1.061331	.004573
29	.249621	-.058911	.514578	-.580473	1.067133	.004573
30	.267155	-.059261	.517179	-.589321	1.071600	.004501
31	.284889	-.059431	.515500	-.583609	1.068624	.004657
32	.302795	-.059472	.506290	-.552274	1.052475	.005398
33	.320860	-.059343	.492093	-.503966	1.028653	.005571
34	.339062	-.059106	.478972	-.459322	1.007399	.005160
35	.357393	-.058707	.470506	-.430517	.993857	.004849
36	.375835	-.058215	.465757	-.414356	.986213	.004777
37	.394381	-.057578	.461055	-.398357	.978429	.004987
38	.413009	-.056852	.454847	-.377235	.968476	.004937
39	.431708	-.056008	.448846	-.356817	.958790	.005010
40	.450471	-.055074	.442765	-.336126	.949126	.004958
41	.469291	-.054043	.437132	-.316958	.940099	.005029
42	.488165	-.052924	.431399	-.297453	.931037	.004996
43	.507088	-.051725	.425999	-.279078	.922452	.005049
44	.526055	-.050440	.420523	-.260447	.913836	.005032
45	.545063	-.049088	.415280	-.242608	.905562	.005066
46	.564108	-.047654	.410052	-.224819	.897370	.005057
47	.583186	-.046163	.405008	-.207658	.889453	.005084
48	.602295	-.044593	.399922	-.190352	.881499	.005096
49	.621430	-.042973	.394931	-.173367	.873718	.005096
50	.640590	-.041281	.390032	-.156700	.866068	.005125
51	.659771	-.039541	.385085	-.139867	.858382	.005124
52	.678972	-.037736	.380239	-.123380	.850843	.005144
53	.698180	-.035886	.375351	-.106747	.843254	.005157
54	.717356	-.033979	.370460	-.090105	.835673	.005167
55	.736446	-.032039	.365536	-.073350	.828034	.005190
56	.755403	-.030054	.360526	-.056305	.820286	.005196
57	.774175	-.028051	.355512	-.039242	.812523	.005214
58	.792703	-.026017	.350342	-.021653	.804510	.005247
59	.810912	-.023981	.345012	-.003518	.796295	.005236
60	.828722	-.021941	.339658	.014699	.787979	.005288
61	.846040	-.019919	.334050	.033782	.779348	.005265
62	.862771	-.017927	.328442	.052862	.770621	.005332
63	.878819	-.015976	.322484	.073136	.761448	.005304
64	.894091	-.014092	.316562	.093287	.752223	.005370
65	.908506	-.012273	.310174	.115022	.742313	.005392
66	.922002	-.010548	.303556	.137537	.732050	.005399
67	.934543	-.008917	.296776	.160607	.721443	.005471
68	.946126	-.007390	.289495	.185383	.710060	.005516
69	.956782	-.005968	.281910	.211190	.698092	.005630
70	.966585	-.004640	.273471	.239905	.684426	.006015
71	.975646	-.003401	.263793	.272835	.668785	.006353
72	.984112	-.002231	.253376	.308279	.649577	.008595
73	.992164	-.001105	.233019	.377544	.614943	.010066
74	1.000000	.000001	.199434	.491819	.577056	-.003231

AL VEUILLOT

SLIP LINE VALUES - LOWER SILE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
75	1.007828	.000085	.218662	.426395	.605591	-.000993
76	1.015906	.000168	.250769	.317148	.645704	.008352
77	1.024786	.000258	.255135	.302293	.655798	.005736
78	1.035642	.000365	.267188	.261282	.673971	.006504
79	1.050236	.000505	.273518	.239743	.685146	.005453
80	1.070533	.000696	.283100	.207142	.699706	.005848
81	1.099238	.000958	.290816	.180887	.712109	.005525
82	1.139116	.001320	.299297	.152029	.725110	.005700
83	1.194260	.001825	.307057	.125625	.737097	.005752
84	1.269817	.002543	.314416	.100587	.748287	.005947
85	1.372359	.003581	.321074	.077932	.758291	.006230
86	1.510196	.005102	.326897	.058122	.766890	.006617
87	1.693716	.007341	.331761	.041571	.773923	.007085
88	1.935752	.010600	.335616	.028452	.779427	.007528
89	2.251987	.015273	.338578	.018374	.783617	.007908
90	2.681443	.021885	.340769	.010921	.786666	.008239
91	3.187124	.031062	.342242	.005907	.788718	.008462
92	3.856852	.043526	.343138	.002861	.789992	.008571
93	4.703481	.060056	.343627	.001195	.790753	.008568
94	5.742961	.080990	.343877	.000344	.791286	.008426
95	6.944488	.105453	.343978	.000001	.791412	.008455

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-8
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

UPPER SURFACE

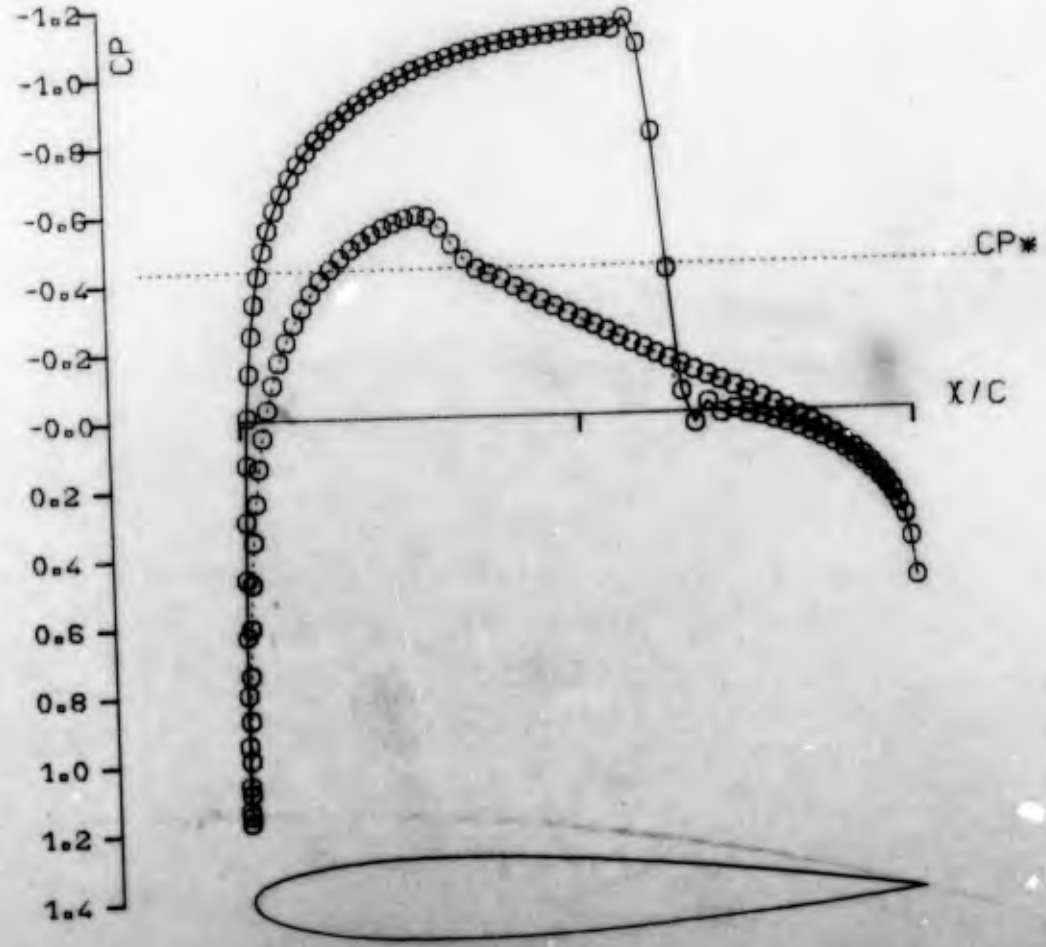
LOWER SURFACE

CL= 0.3642

CD= 0.0225

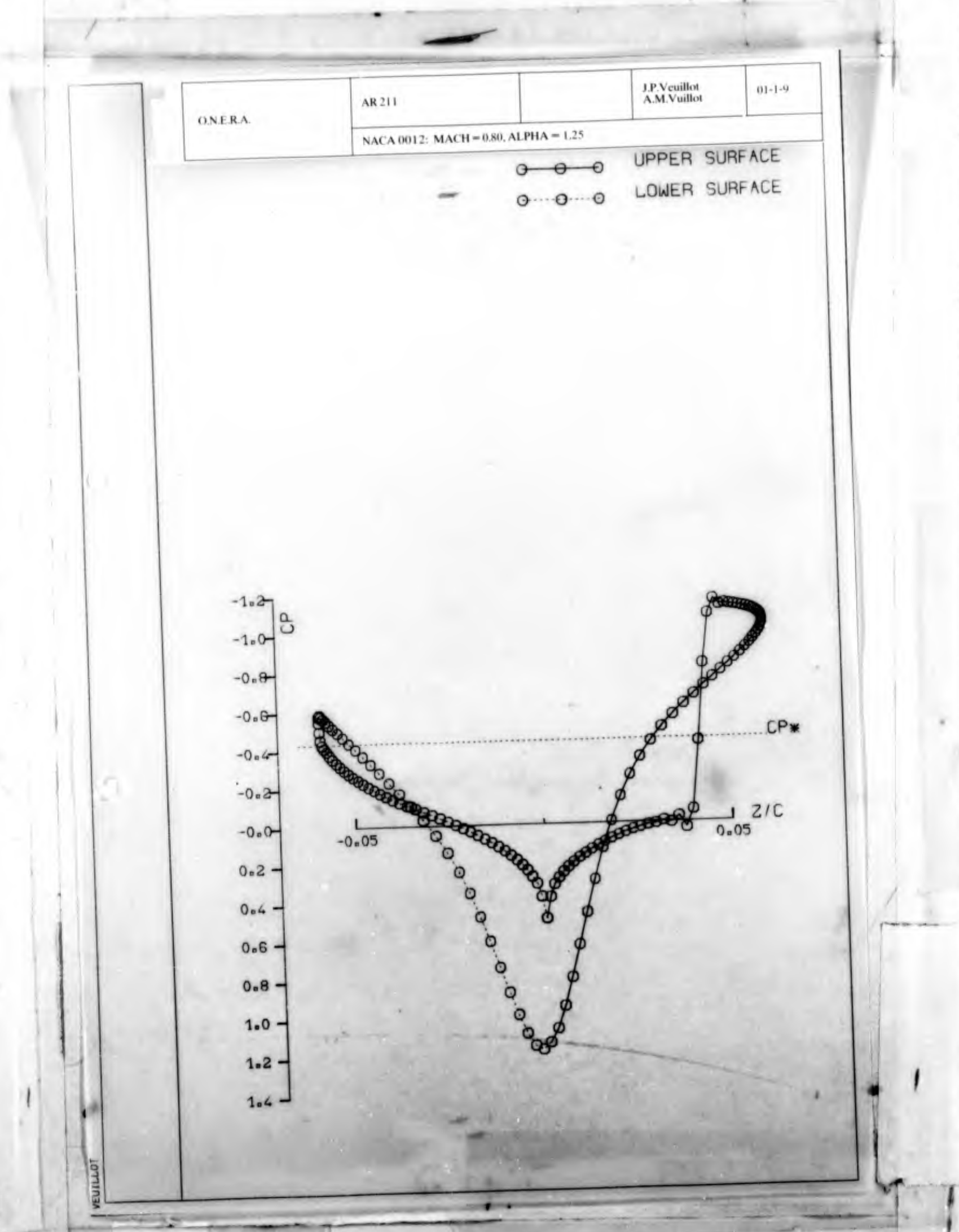
CM= -0.0376

Γ = 0.1692

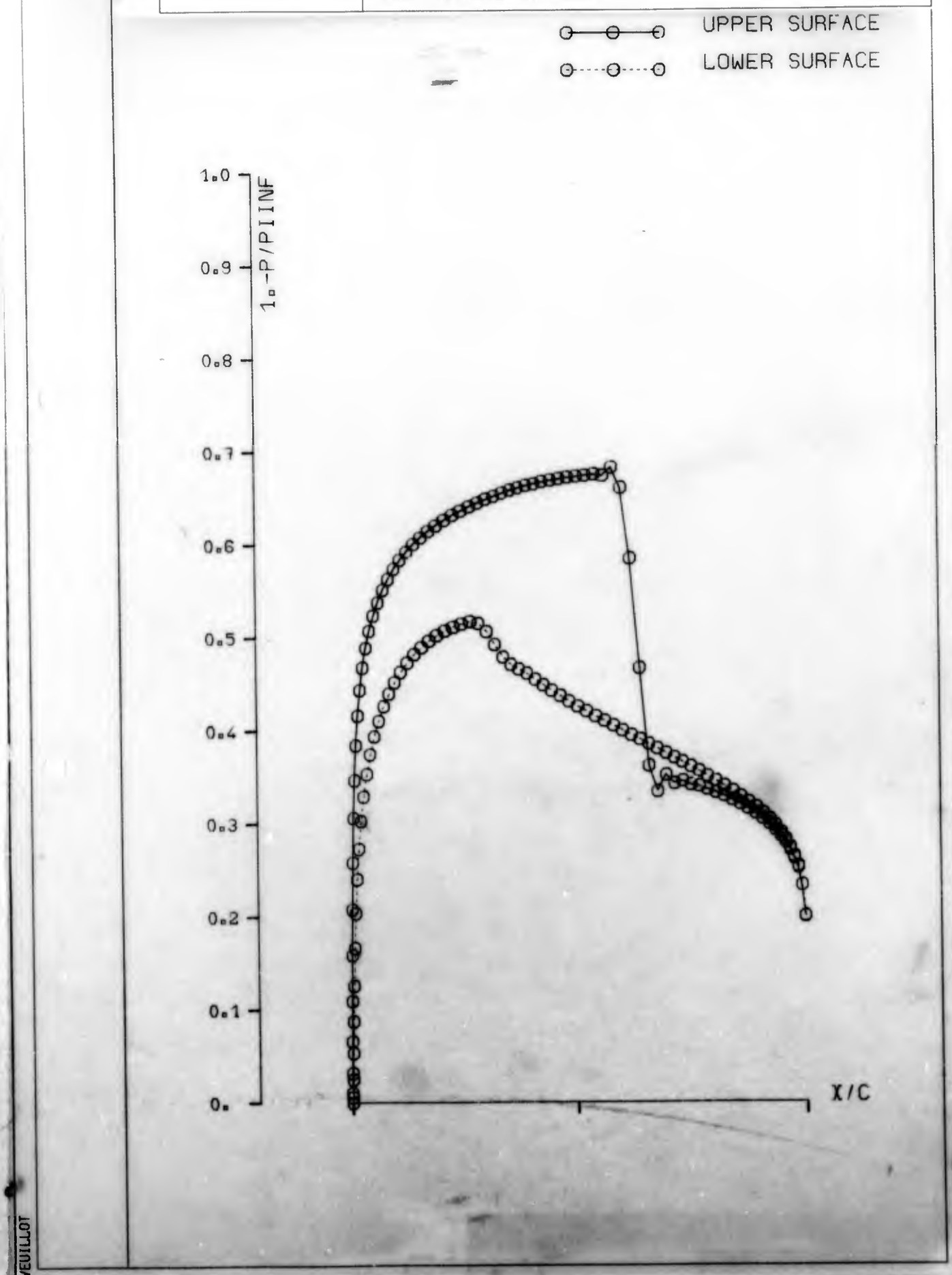


VEUILLOT

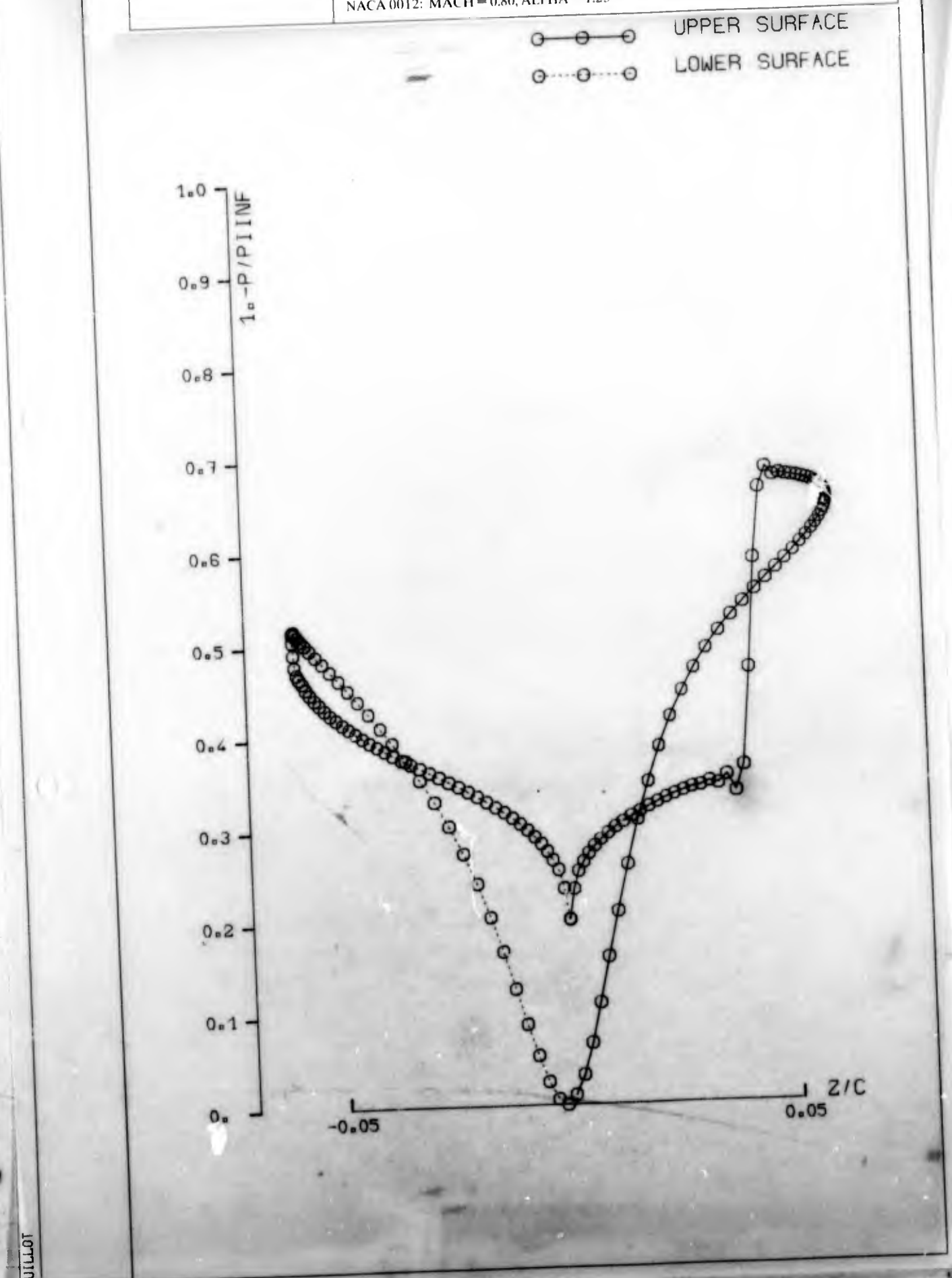
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-9
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



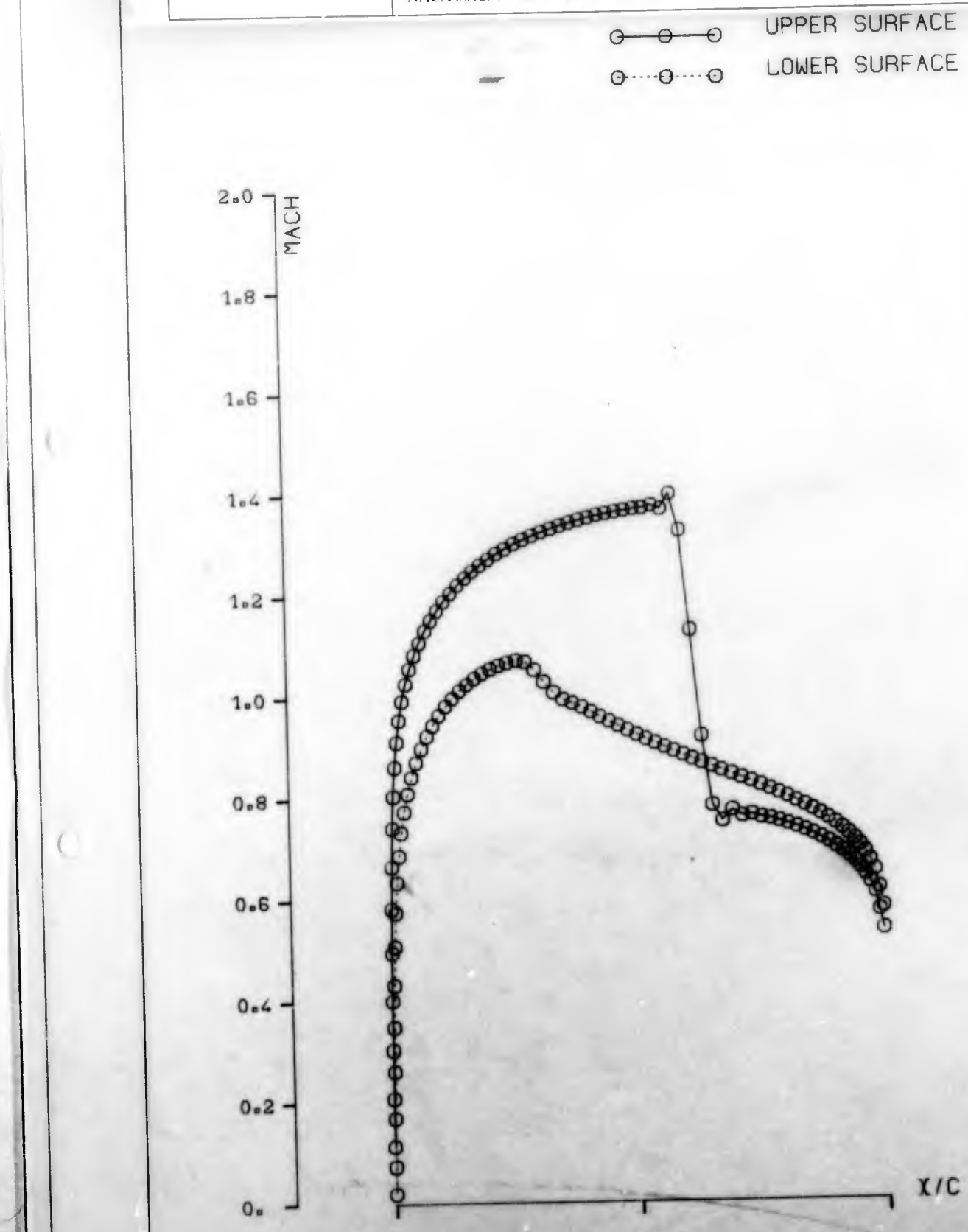
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-10
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-11
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

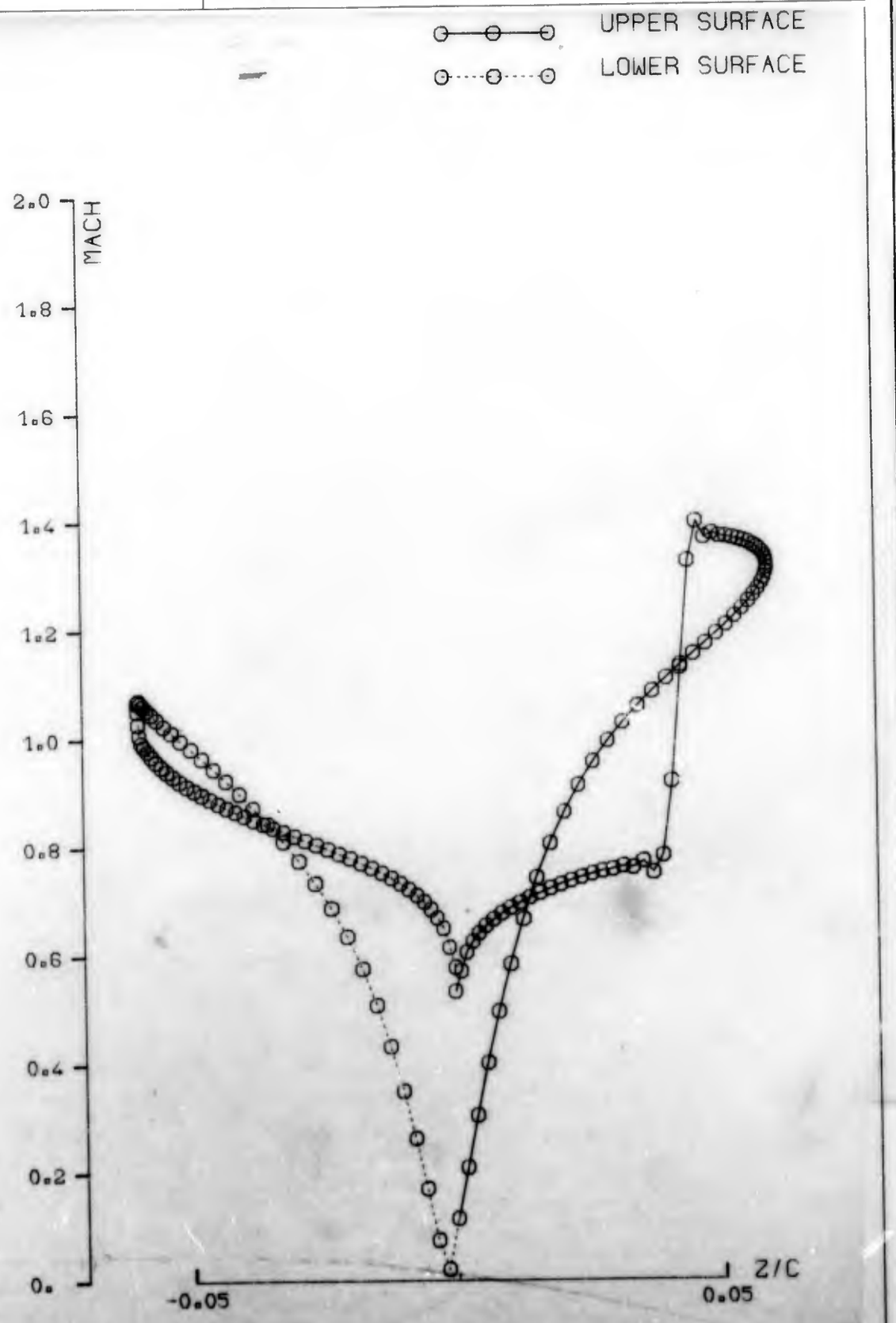


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-12
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



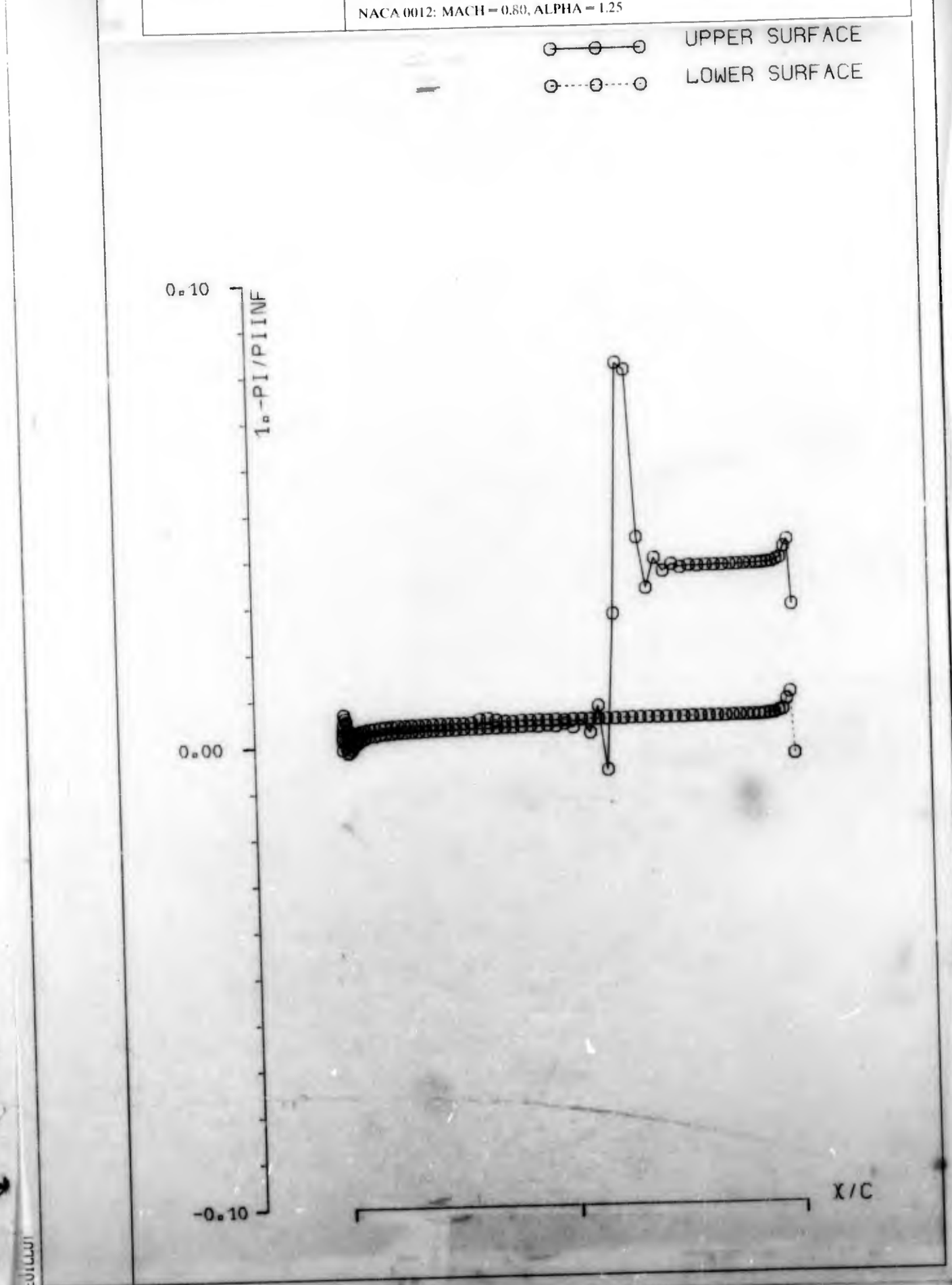
VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-13
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

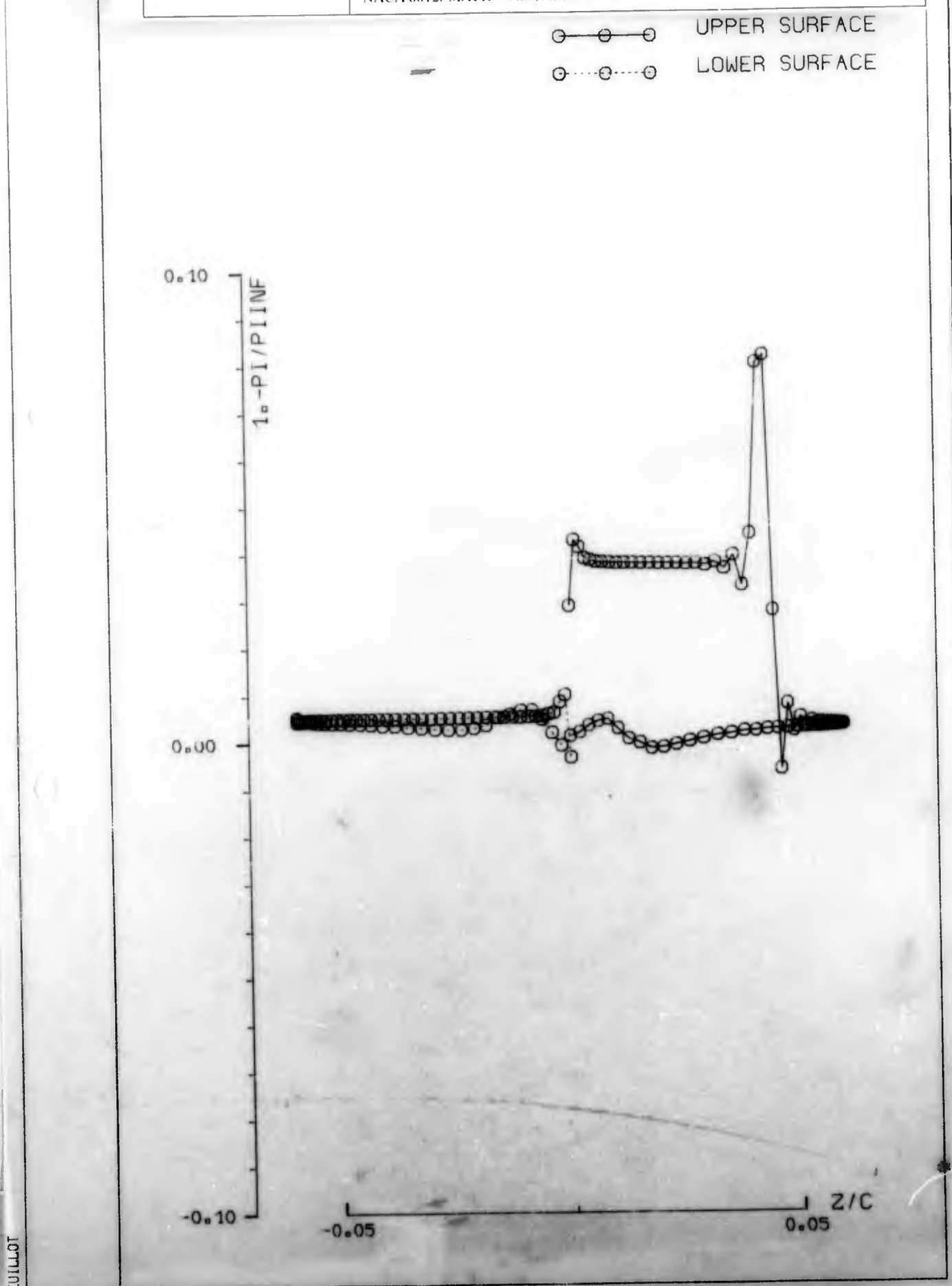


VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-14
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-15
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-16
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

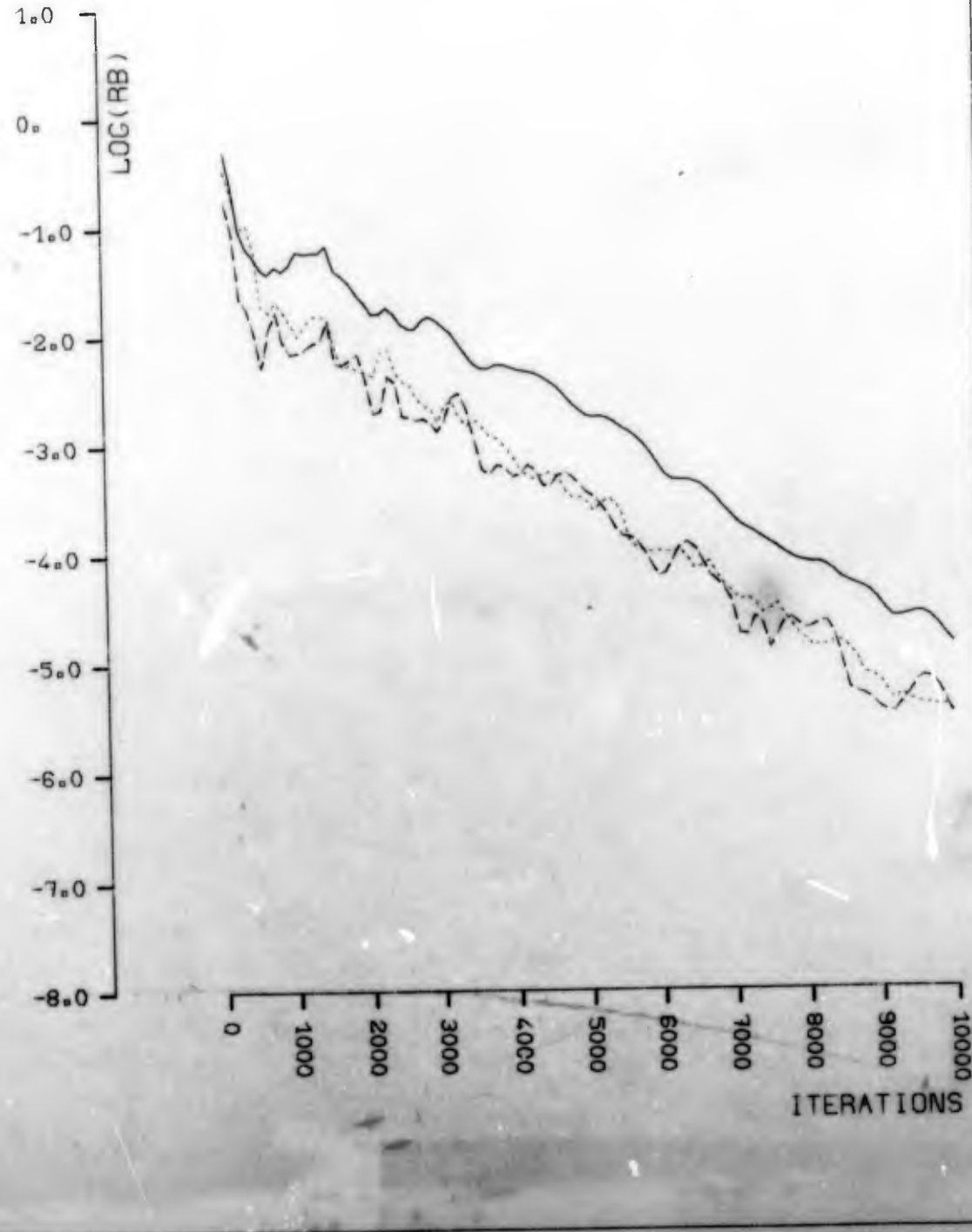
RESIDUAL MEAN

RB=R.M.S. OF $(F^{N+1} - F^{N})/DT$

——— $F = \rho$

..... $F = \rho u$

– – – – $F = \rho v$



VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-17
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

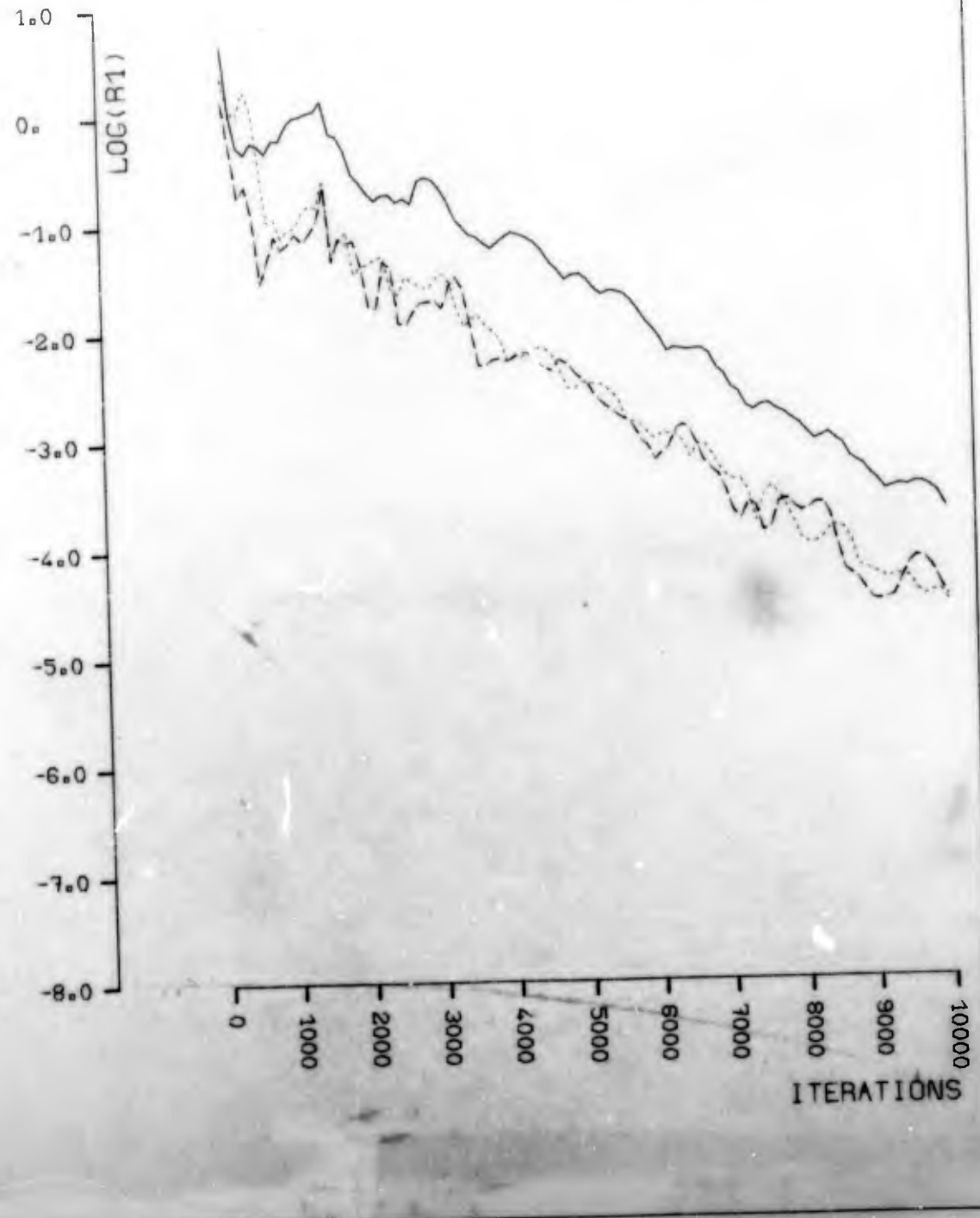
RESIDUAL MAXIMUM

R1=MAX OF $(F^{N+1} - F^{N})/DT$

——— $F = \rho$

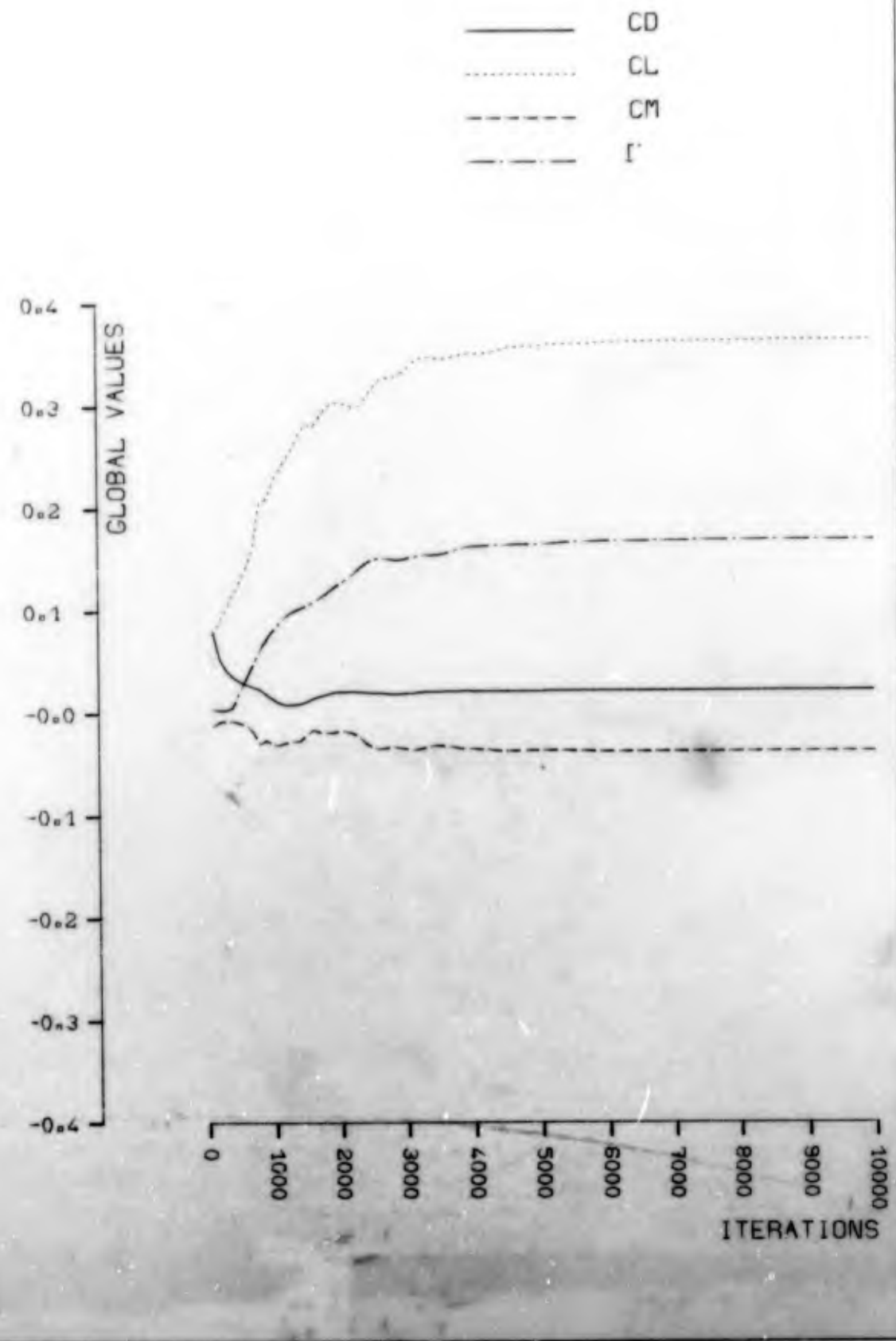
..... $F = \rho U$

– – – – $F = \rho V$



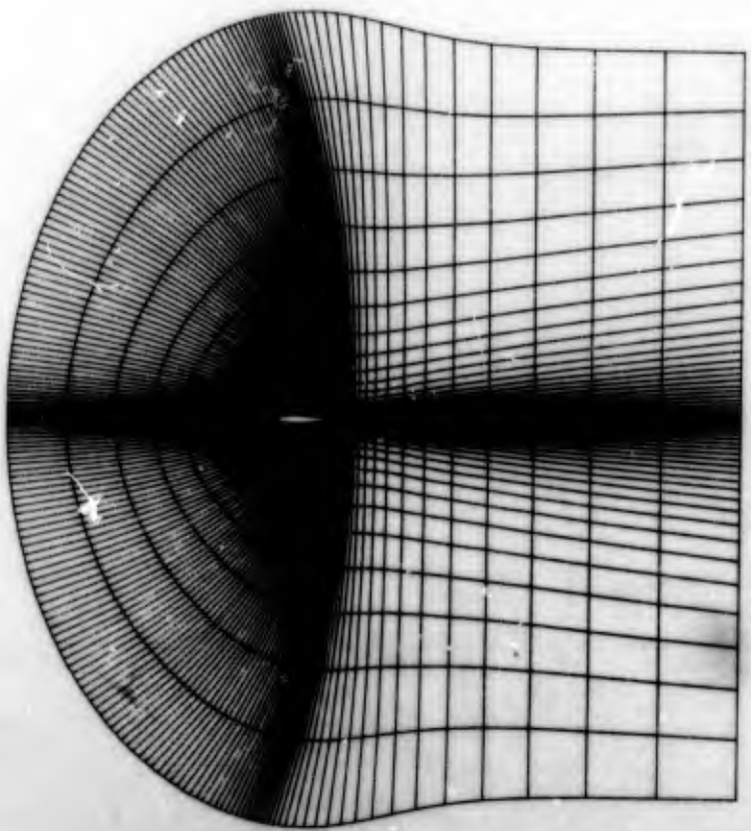
VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-18
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



VEUILLOT

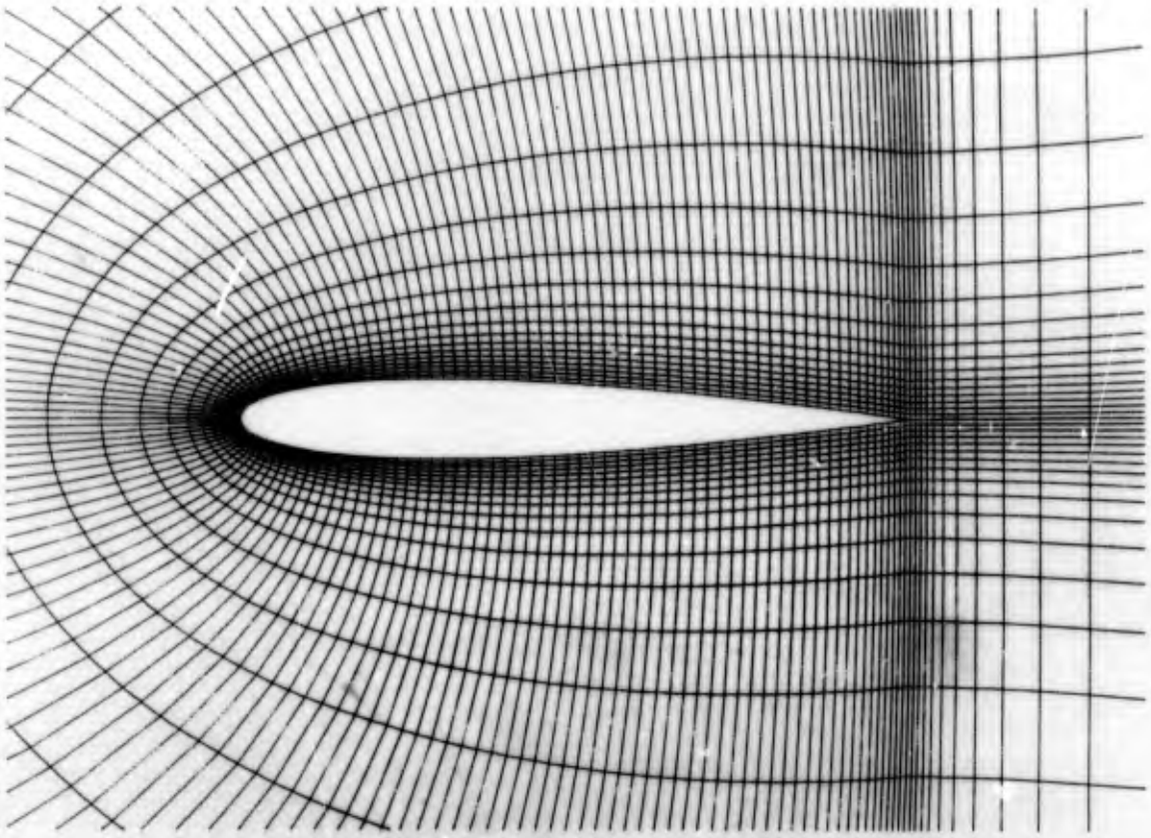
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-19
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



189X25 MESH

VEUILLOT

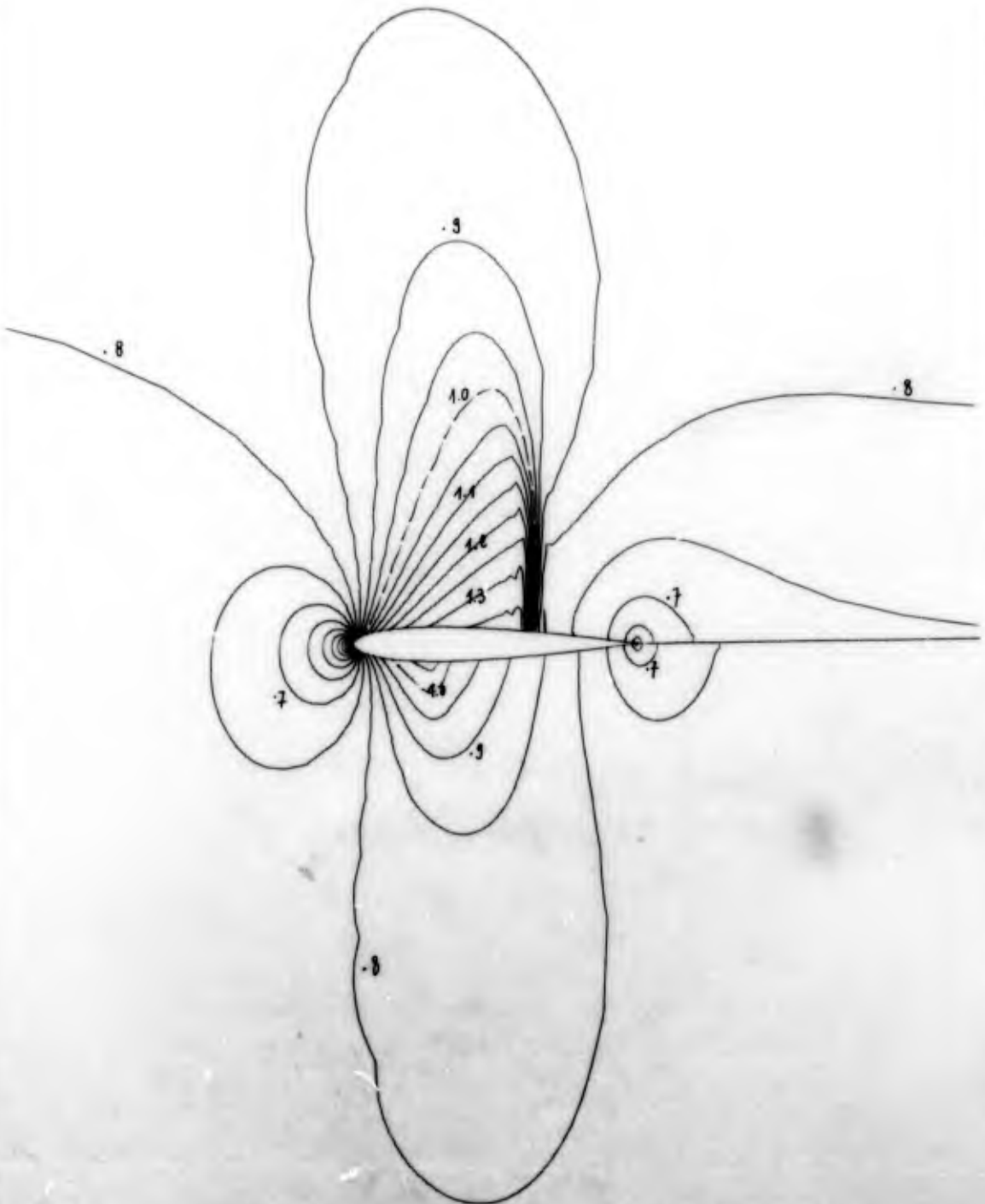
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-20
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



189X25 MESH (PARTIAL VIEW)

VEUILLOT

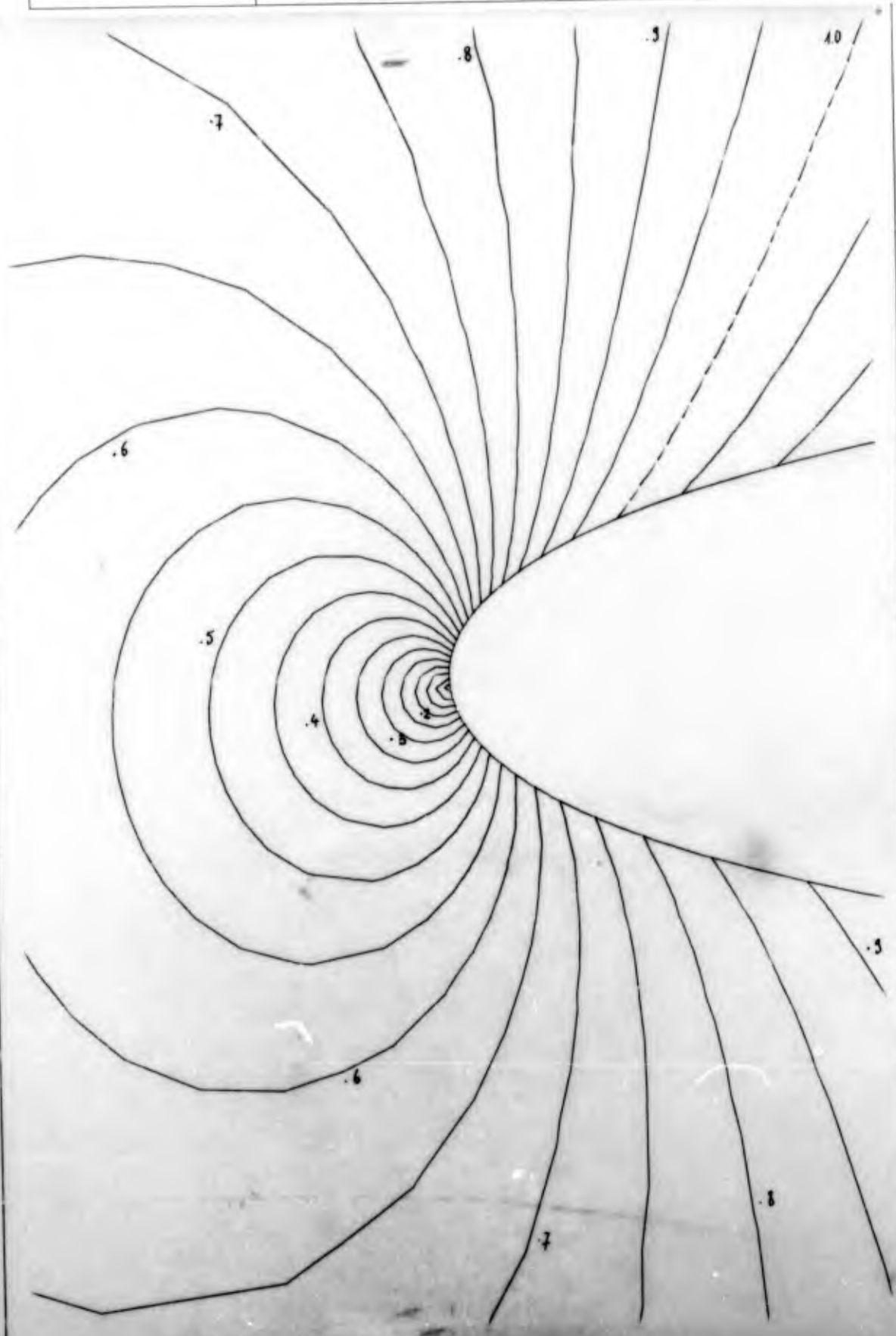
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-21
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



ISO-MACH LINES

VEUILLOT

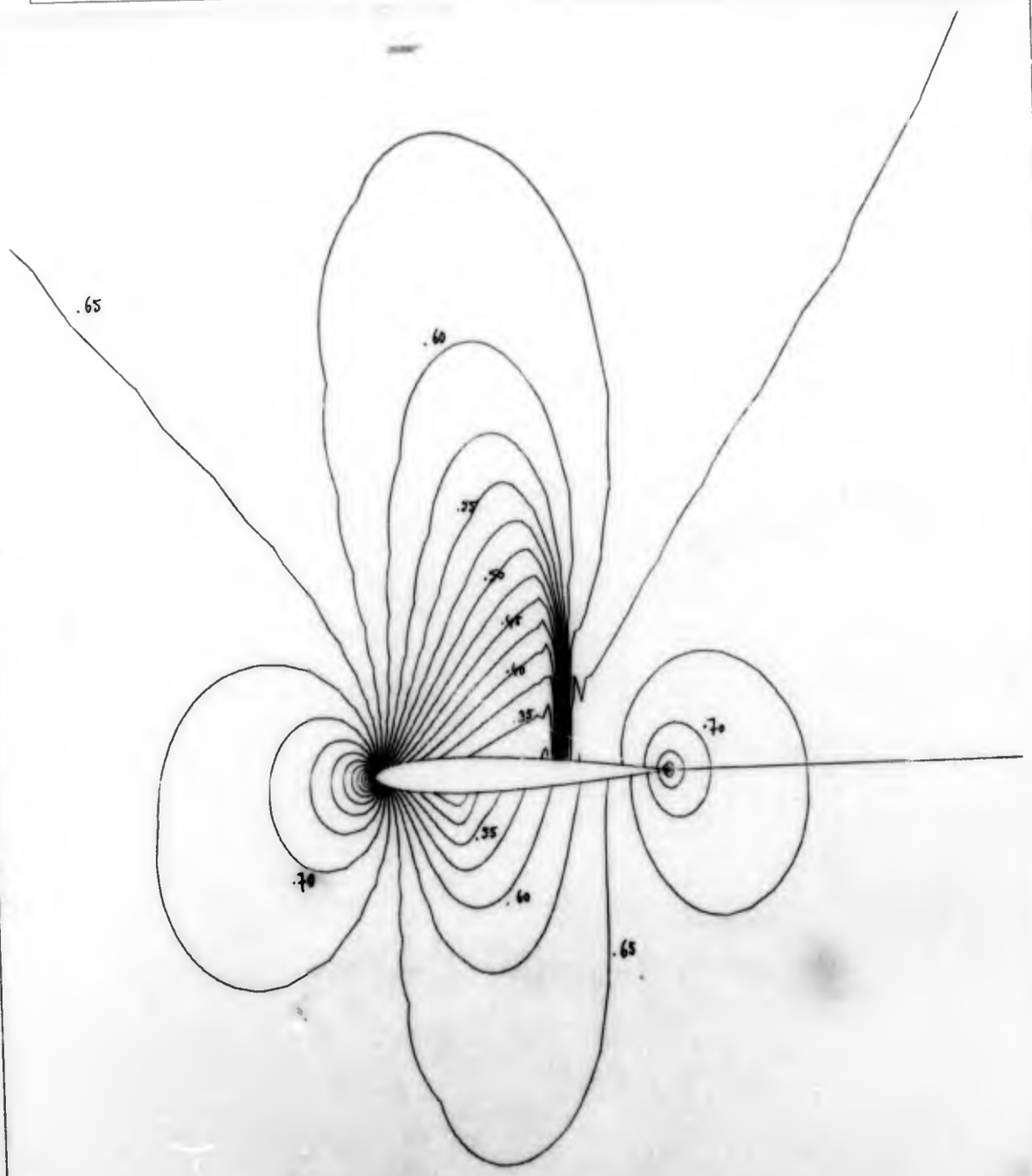
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-22
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



ISO-MACH LINES

VEUILLOT

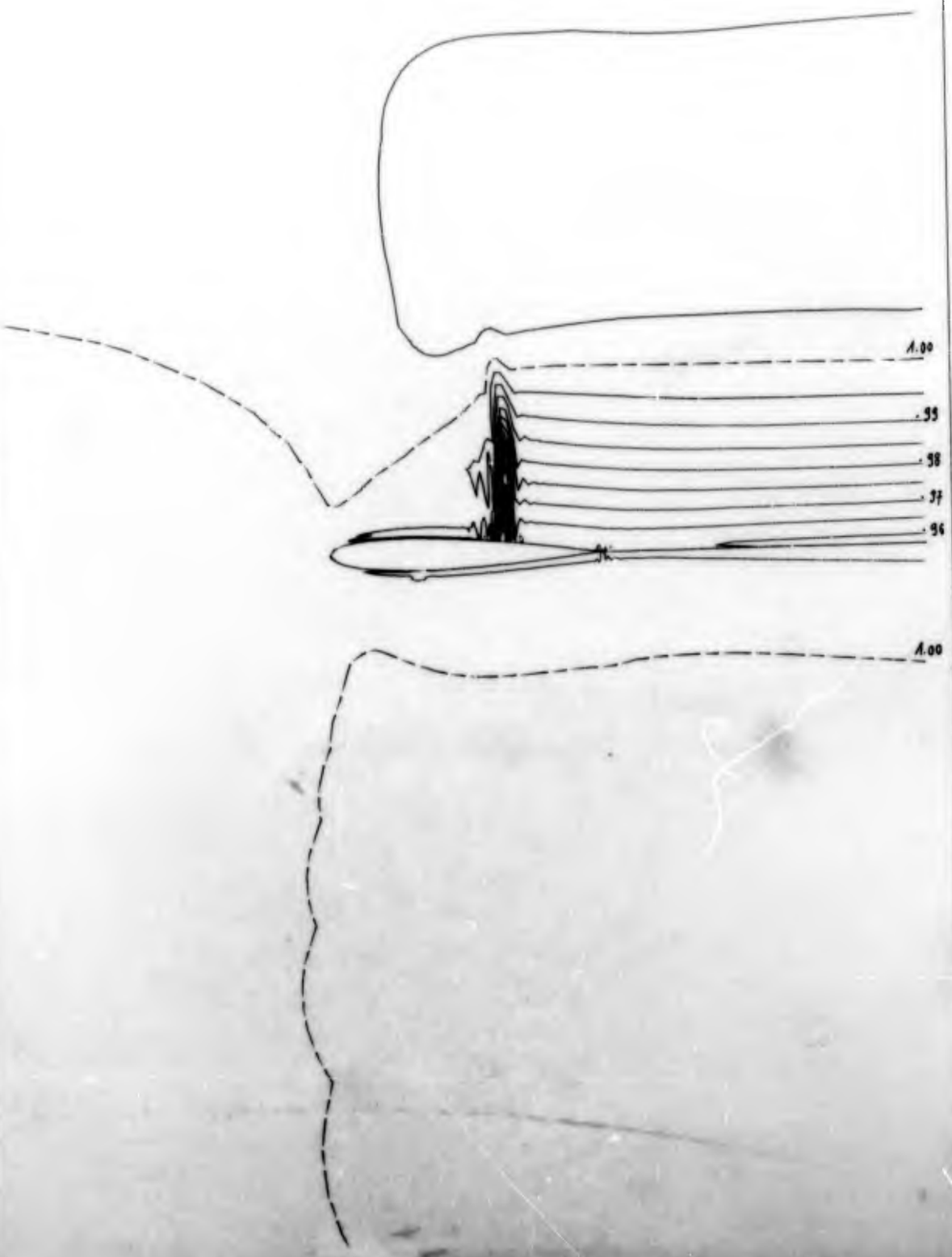
O.N.E.R.A.	AR 211		J.P Veuillot A.M.Vuillot	01-1-23
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



ISO-P/PIINF LINES

VEUILLOT

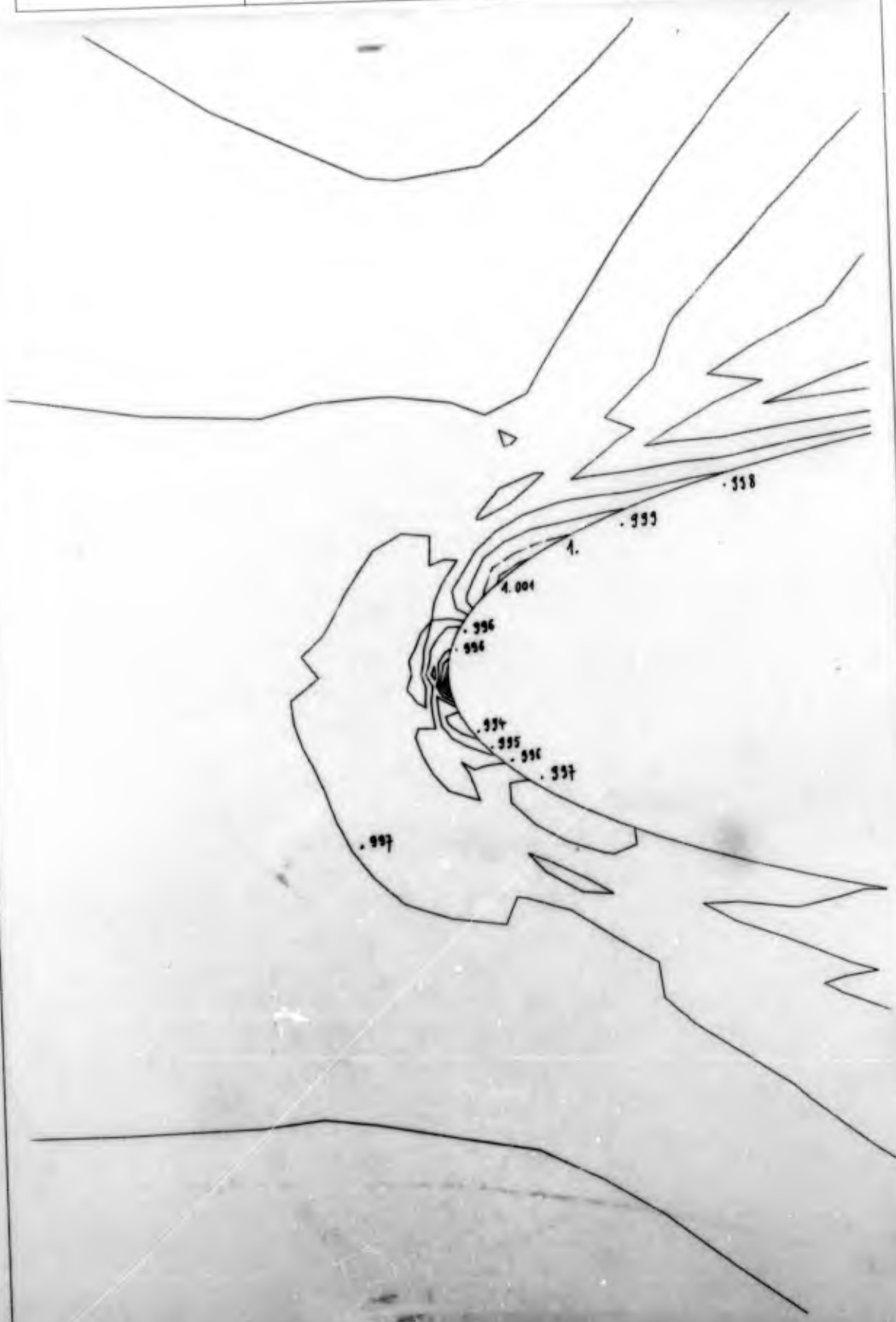
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-24
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



ISO-PI/PIINF LINES

VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-25
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



ISO-PI/PIINF LINES

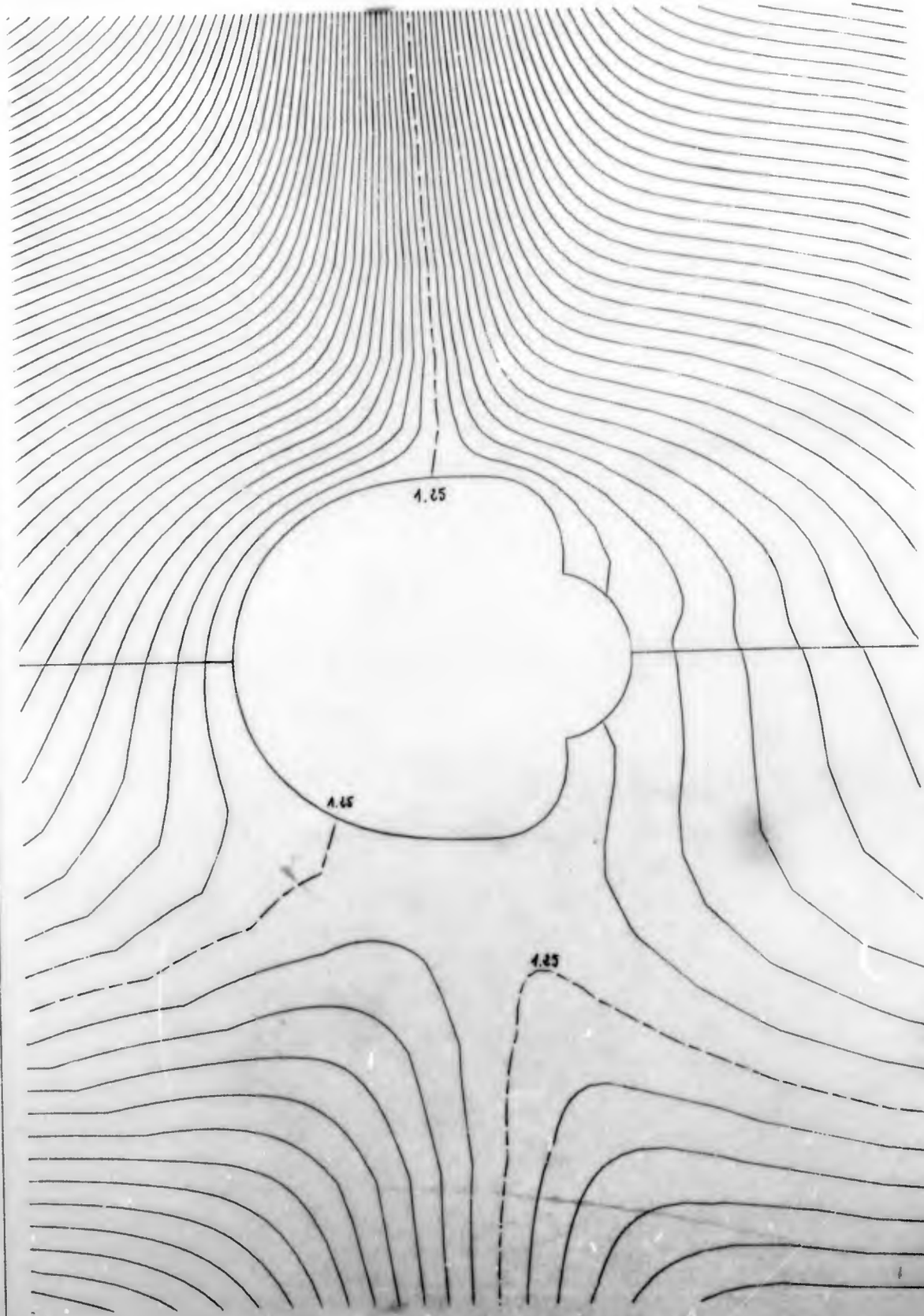
VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-26
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ISO-TETA LINES

VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	01-1-27
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



ISO-TETA LINES

VEUILLOT

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 01

NACA 0012: MACH = 0.80, ALPHA = 1.25

Contributor No 2

J.Sidès

(O.N.E.R.A., France)

SOLUTION OF EULER EQUATIONS BY AN IMPLICIT FINITE-VOLUME METHOD

by J. SIDÈS

NUMERICAL METHOD

The pseudo-unsteady Euler equations assuming total enthalpy constant and using the local time step technique are solved in the finite-volume approach by means of a non iterative and second order accurate implicit method.We only recall here the major features of the method.A complete exposition of the implicit algorithm and its application to both steady and unsteady transonic flow problems are reported in /1/.

For the simplicity of implementation the method is splitted into two successive stages at each time step.The first stage or "physical stage" is the explicit finite-volume method described in /2/ based on a nine-point symetrical scheme of second order accuracy.This scheme was selected in a general class of predictor-corrector schemes for its optimal dispersive and dissipative properties.The second stage or "mathematical stage" is implicit and is added only to ensure unconditional linear stability.

The implicit terms are of the same order of the truncation error of the global method.This important feature of the method has allowed some simplifications leading to an easy treatment of the physical boundary conditions which are only applied in the explicit stage,and also to a reduction of the number of algebric operations.Using the A.D.I. technique,in the mathematical stage we need only to solve two simple tridiagonal linear systems successively in each space direction.

The method is strictly in conservation form and the flow discontinuities (shock waves,slip lines) are captured without particular treatment.However an artificial viscosity is added in order to smooth the oscillations in the numerical shock profiles.In all the test cases computed we have used the non linear artificial viscosity described in /3/ which preserves the conservation form and the second order of accuracy.

40 911-120

The solution is calculated at the center of cells of a C-type mesh.In most of the test cases considered,we have used the mesh-code described in /4/.We have also done some calculations with a mesh-code generating a family of lines normal to the airfoil surface /5/.

The physical boundary conditions are implemented in the explicit stage of the method.We note that the scheme is applied without modification accross the mesh cut-line starting from the trailing edge to downstream infinity. The scheme being symetrical,conservation is maintained without particular treatment. The modifications introduced into the finite-volume method for the calculation of the cells near the airfoil surface and near the trailing edge are detailed in /2/.The slip condition appears in the calculation of the fluxes accross the airfoil surface. In the finite-volume approach we need only to know the value of the pressure on the body.This value is obtained from a parabolic extrapolation of the pressure values in interior cells near the airfoil surface.

For the numerical treatment of the far-field,we have recently adapted the compatibility relations technique developped at ONERA in the finite-difference approach /6/.On a subsonic inflow boundary the direction of the freestream velocity and the stagnation pressure are given;on a subsonic outflow boundary only the static pressure is prescribed.

CONVERGENCE OF THE NUMERICAL METHOD

The following features of the implicit method are constant in all the test case calculations :

-the pseudo-unsteady process is started setting in the whole computational domain the uniform flow defined by the upstream infinity conditions.

-The local time step used is 5 times greater than the maximal value allowed by the stability of the explicit finite-volume method /2/.

-In the expression of the residuals the density and the velocity components are respectively nondimensionalized by the free stream density and the free stream velocity.The time is nondimensionalized by C/V_∞.

40.911 120

REFERENCES

/1/ LERAT A., SIDÈS J. and DARU V. (1982)
An implicit finite-volume method for solving the Euler equations.
In "Lectures Notes in Physics",Vol. 170, p. 343-349
Springer Verlag Editor.

/2/ LERAT A. and SIDÈS J. (1982)
A new finite-volume method for the Euler equations with applications to transonic flows.
In "Numerical Methods in Aeronautical Fluid Dynamics", ed. by P.L. ROE , Academic Press, p. 245-288.

/3/ LERAT A. and SIDÈS J. (1979)
Numerical simulation of unsteady transonic flows using the Euler equations in integral form.
ISRAEL J. Techn. 17 , p. 302-310 .

/4/ LE BALLEUR J.C. (1981)
Strong matching method for computing transonic viscous flows including wakes and separations over lifting airfoils.
Rech. Aerosp. N° 1981-3 (English version p. 21-45).

/5/ BREDIF M. (1983)
A fast finite element method for transonic potential flow calculations.
AIAA Paper 83-0507 .

/6/ VIVIAND H. and VEUILLOT J.P. (1978)
Méthodes pseudo-instationnaires pour le calcul d'écoulements transsoniques.
ONERA pub. n° 1978-4 (English version ESA TT 561) .

O.N.E.R.A.	AR 211		J.Sides	01-2-4
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

COMMENTS ON CALCULATION FOR TEST CASE OI

C-Mesh

The mesh is constructed algebrically from the data of points on the airfoil surface , on a cut-line and on an arbitrary external boundary. One family of mesh-lines is composed of parabolas starting from the airfoil surface and from the cut-line. The second family of lines is obtained by the application of a stretching function between the airfoil surface and the external boundary along each parabola.

The total number of cells is : 188 x 24.

There are 146 points on the airfoil surface:

73 on the lower surface,

73 on the upper surface.

In a parallel direction to the x-axis:

the distance between the leading edge and the external boundary is: 4 C (where C is the chord length),

the distance between the trailing edge and the external boundary is 6 C.

In a paralel direction to the z-axis:

the distance between the airfoil surface and the external boundary is : about 6 C.

Convergence

The numerical results are reported after 3000 time steps of the implicit method but no doubt that about 1500 steps would be sufficient to reach the converged solution.

40-911-120

O.N.E.R.A.	AR 211		J.Sidès	01-2-5
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

LOWER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.996075	-.000554	.223658	.409396	.601948	.008258
2	.988118	-.001671	.243395	.342240	.644816	-.000668
3	.979851	-.002821	.257713	.293521	.663016	.003085
4	.971086	-.004027	.268467	.256931	.678346	.004466
5	.961660	-.005309	.277490	.226231	.692238	.004692
6	.951446	-.006682	.285546	.198817	.704820	.004696
7	.940353	-.008154	.292983	.173514	.716407	.004690
8	.928329	-.009728	.299988	.149681	.727285	.004690
9	.915361	-.011400	.306650	.127010	.737615	.004687
10	.901469	-.013163	.313032	.105295	.747500	.004679
11	.886701	-.015006	.319179	.084379	.757013	.004669
12	.871129	-.016915	.325113	.064192	.766188	.004655
13	.854837	-.018876	.330859	.044639	.775069	.004642
14	.837919	-.020872	.336424	.025705	.783667	.004628
15	.820468	-.022891	.341819	.007348	.792001	.004614
16	.802577	-.024917	.347098	-.010615	.800153	.004604
17	.784331	-.026939	.352231	-.028079	.808084	.004590
18	.765805	-.028946	.357284	-.045273	.815888	.004585
19	.747065	-.030930	.362234	-.062114	.823541	.004573
20	.728166	-.032883	.367147	-.078831	.831134	.004571
21	.709153	-.034798	.371995	-.095329	.838640	.004562
22	.690062	-.036671	.376826	-.111764	.846120	.004558
23	.670922	-.038497	.381655	-.128196	.853609	.004553
24	.651754	-.040271	.386501	-.144684	.861130	.004549
25	.632575	-.041992	.391363	-.161229	.868689	.004545
26	.613400	-.043656	.396274	-.177939	.876334	.004542
27	.594238	-.045259	.401242	-.194842	.884082	.004538
28	.575101	-.046798	.406282	-.211992	.891957	.004535
29	.555995	-.048270	.411402	-.229413	.899974	.004531
30	.536923	-.049672	.416617	-.247157	.908159	.004526
31	.517891	-.051000	.421934	-.265248	.916525	.004521
32	.498901	-.052250	.427363	-.283721	.925090	.004517
33	.479957	-.053419	.432908	-.302586	.933866	.004510
34	.461065	-.054502	.438573	-.321863	.942860	.004503
35	.442229	-.055494	.444348	-.341512	.952063	.004493
36	.423458	-.056389	.450237	-.361549	.961484	.004482
37	.404760	-.057183	.456187	-.381793	.971039	.004471
38	.386145	-.057870	.462143	-.402061	.980659	.004446
39	.367623	-.058443	.465275	-.412717	.985814	.004339
40	.349204	-.058896	467456	-.420137	.989268	.004429
41	.330901	-.059222	.481901	-.469286	1.012302	.005039
42	.312727	-.059414	.504399	-.545838	1.049412	.005267
43	.294698	-.059466	.520364	-.600158	1.077307	.004147
44	.276834	-.059369	.520287	-.599897	1.077064	.004284
45	.259155	-.059116	.518388	-.593435	1.073921	.004176
46	.241688	-.058699	.515531	-.583716	1.069110	.004132
47	.224461	-.058112	.511649	-.570507	1.062608	.004057
48	.207508	-.057346	.506788	-.553367	1.054489	.003983
49	.190867	-.056395	.501151	-.534785	1.045126	.003893
50	.174584	-.055254	.494611	-.512536	1.034337	.003783
51	.158708	-.053917	.487025	-.486721	1.021904	.003656
52	.143294	-.052363	.478622	-.458131	1.008232	.003518
53	.128406	-.050651	.469022	-.425465	.992761	.003328
54	.114109	-.048722	.458436	-.389446	.975818	.003145
55	.100476	-.046603	.446499	-.348831	.956931	.002875
56	.087579	-.044303	.433319	-.303987	.936225	.002614
57	.075493	-.041838	.418504	-.253577	.913219	.002240
58	.064285	-.039227	.402075	-.197677	.887886	.001861
59	.054018	-.036494	.383633	-.134926	.859750	.001343
60	.044737	-.033670	.363022	-.064796	.828480	.000794
61	.036471	-.030786	.339919	.013813	.793651	.000115
62	.029225	-.027879	.313995	.102021	.754620	-.000636
63	.022982	-.024983	.285015	.200627	.710825	-.001447
64	.017696	-.022133	.252794	.310258	.661550	-.002269
65	.013305	-.019356	.217436	.430567	.606095	-.002963
66	.009726	-.016675	.179266	.560441	.543521	-.003362
67	.006870	-.014107	.139500	.695748	.473325	-.003177
68	.004641	-.011659	.099934	.830371	.395415	-.002486
69	.002949	-.009332	.063389	.954716	.310481	-.001350
70	.001711	-.007118	.033028	1.058022	.220047	-.000146
71	.000853	-.005004	.011827	1.130161	.126087	.000786
72	.000318	-.002969	.001912	1.163896	.030659	.001255
73	.000062	-.000984	.004143	1.156307	.064716	.001220

40-911 120

O.N.E.R.A.	AR 211		J.Sidès	01-2-6
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

UPPER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
74	.000062	.000984	.018315	1.108085	.159971	.000617
75	.000318	.002969	.044238	1.019879	.256010	-.000334
76	.000853	.005004	.080666	.895933	.352137	-.001638
77	.001711	.007118	.125194	.744424	.446634	-.003176
78	.002949	.009332	.174529	.576561	.537282	-.004663
79	.004641	.011659	.225159	.404287	.622034	-.005799
80	.006870	.014107	.274094	.237786	.699245	-.006228
81	.009726	.016675	.319094	.084669	.768048	-.006017
82	.013305	.019356	.359515	-.052863	.829064	-.005306
83	.017696	.022133	.394945	-.173416	.882686	-.004430
84	.022982	.024983	.425845	-.278554	.929955	-.003517
85	.029225	.027879	.452659	-.369792	.971626	-.002659
86	.036471	.030786	.475984	-.449155	1.008542	-.001888
87	.044737	.033670	.496309	-.518312	1.041322	-.001197
88	.054018	.036494	.514165	-.579068	1.070726	-.000645
89	.064285	.039227	.530040	-.633083	1.097341	-.000129
90	.075493	.041838	.544084	-.680868	1.121367	.000267
91	.087579	.044304	.556816	-.724191	1.143523	.000635
92	.100476	.046603	.568182	-.762864	1.163664	.000926
93	.114109	.048722	.578613	-.798354	1.182443	.001192
94	.128406	.050651	.587979	-.830225	1.199579	.001413
95	.143294	.052383	.596668	-.859788	1.215714	.001606
96	.158708	.053917	.604493	-.886412	1.230447	.001780
97	.174584	.055254	.611762	-.911147	1.244326	.001924
98	.190867	.056395	.618393	-.933708	1.257142	.002057
99	.207508	.057346	.624459	-.954347	1.269006	.002176
100	.224461	.058112	.630092	-.973515	1.280155	.002274
101	.241688	.058699	.635243	-.991041	1.290454	.002367
102	.259155	.059116	.639960	-1.007092	1.299981	.002448
103	.276834	.059369	.644291	-1.021827	1.308808	.002522
104	.294698	.059466	.648269	-1.035362	1.316990	.002585
105	.312727	.059415	.651909	-1.047749	1.324534	.002647
106	.330901	.059222	.655260	-1.059149	1.331536	.002695
107	.349204	.058896	.658298	-1.069487	1.337925	.002745
108	.367623	.058443	.661069	-1.078916	1.343793	.002786
109	.386145	.057870	.663588	-1.087487	1.349155	.002828
110	.404760	.057184	.665879	-1.095281	1.354064	.002857
111	.423458	.056390	.667942	-1.102301	1.358494	.002902
112	.442229	.055494	.669821	-1.108695	1.362573	.002907
113	.461065	.054502	.671477	-1.114330	1.366134	.002978
114	.479957	.053419	.673021	-1.119582	1.369557	.002918
115	.498901	.052251	.674288	-1.123894	1.372207	.003103
116	.517891	.051000	.675612	-1.128398	1.375346	.002794
117	.536923	.049672	.676425	-1.131163	1.376625	.003513
118	.555995	.048270	.677764	-1.135719	1.380695	.001972
119	.575101	.046798	.677820	-1.135910	1.377943	.005979
120	.594238	.045259	.680022	-1.143404	1.389765	-.003711
121	.613400	.043656	.675277	-1.127259	1.363799	.017709
122	.632575	.041993	.579786	-.802345	1.113570	.087504
123	.651754	.040272	.422132	-.265920	.856142	.067250
124	.670922	.038497	.330595	.045539	.740553	.036423
125	.690062	.036671	.347570	-.012221	.763930	.039857
126	.709153	.034799	.342987	.003374	.757535	.038997
127	.728166	.032884	.343226	.002560	.757630	.039259
128	.747065	.030931	.341288	.009155	.754565	.039225
129	.765805	.028947	.339073	.016690	.750999	.039244
130	.784331	.026940	.336353	.025946	.746616	.039267
131	.802577	.024917	.333161	.036806	.741481	.039284
132	.820468	.022891	.329568	.049031	.735696	.039304
133	.837919	.020873	.325598	.062541	.729298	.039323
134	.854837	.018876	.321268	.077273	.722313	.039344
135	.871129	.016916	.316586	.093205	.714753	.039361
136	.886701	.015007	.311582	.110230	.706660	.039379
137	.901469	.013164	.306254	.128357	.698029	.039394
138	.915361	.011401	.300602	.147592	.688854	.039404
139	.928329	.009729	.294601	.168009	.679093	.039408
140	.940353	.008155	.288207	.189764	.668662	.039406
141	.951446	.006683	.281347	.213107	.657416	.039409
142	.961660	.005310	.273849	.238617	.645085	.039395
143	.971086	.004027	.265401	.267364	.631417	.039131
144	.979851	.002821	.255278	.301807	.616468	.037620
145	.988118	.001672	.241715	.347955	.599015	.033551
146	.996075	.000554	.223055	.411448	.555622	.041795

40-911 120

O.N.E.R.A.	AR 211		J.Sidès	01-2-7
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

UPPER SURFACE

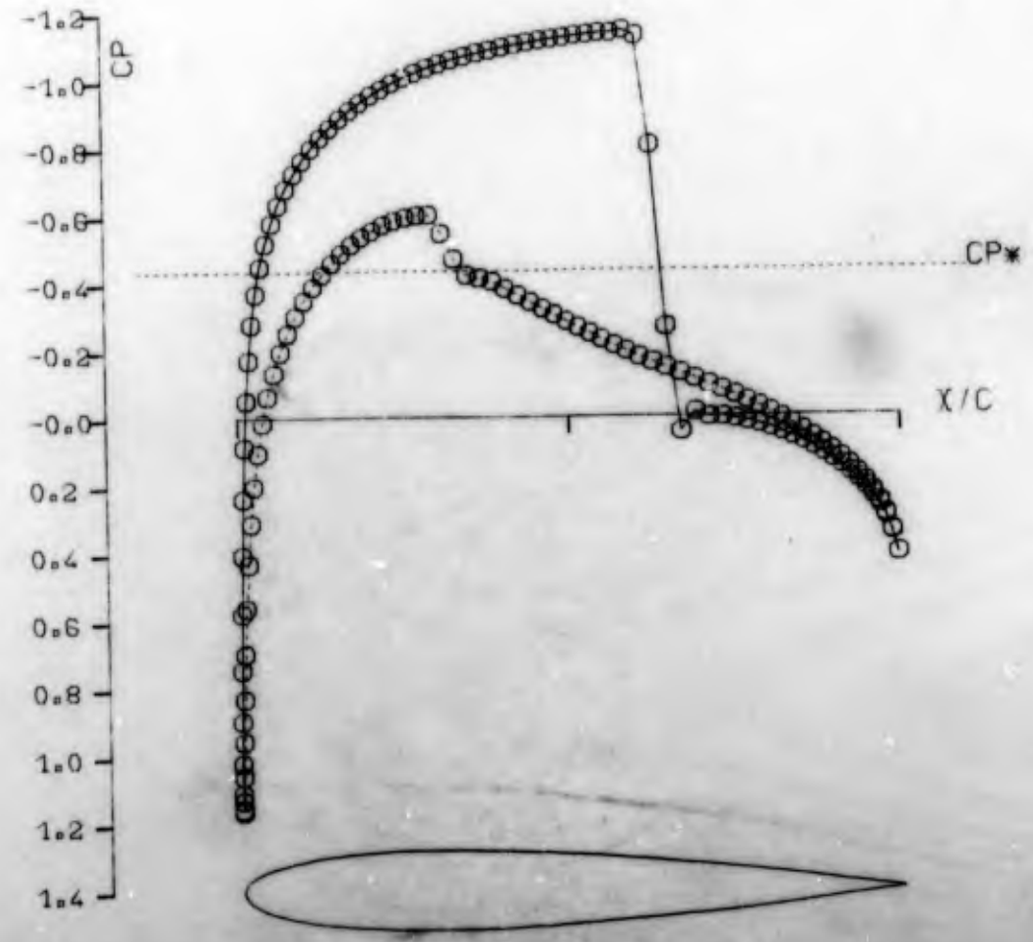
LOWER SURFACE

CL= 0.3736

CD= 0.0244

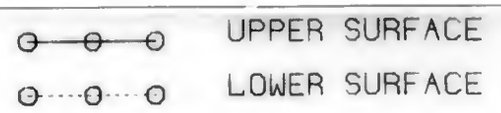
CM= -0.0411

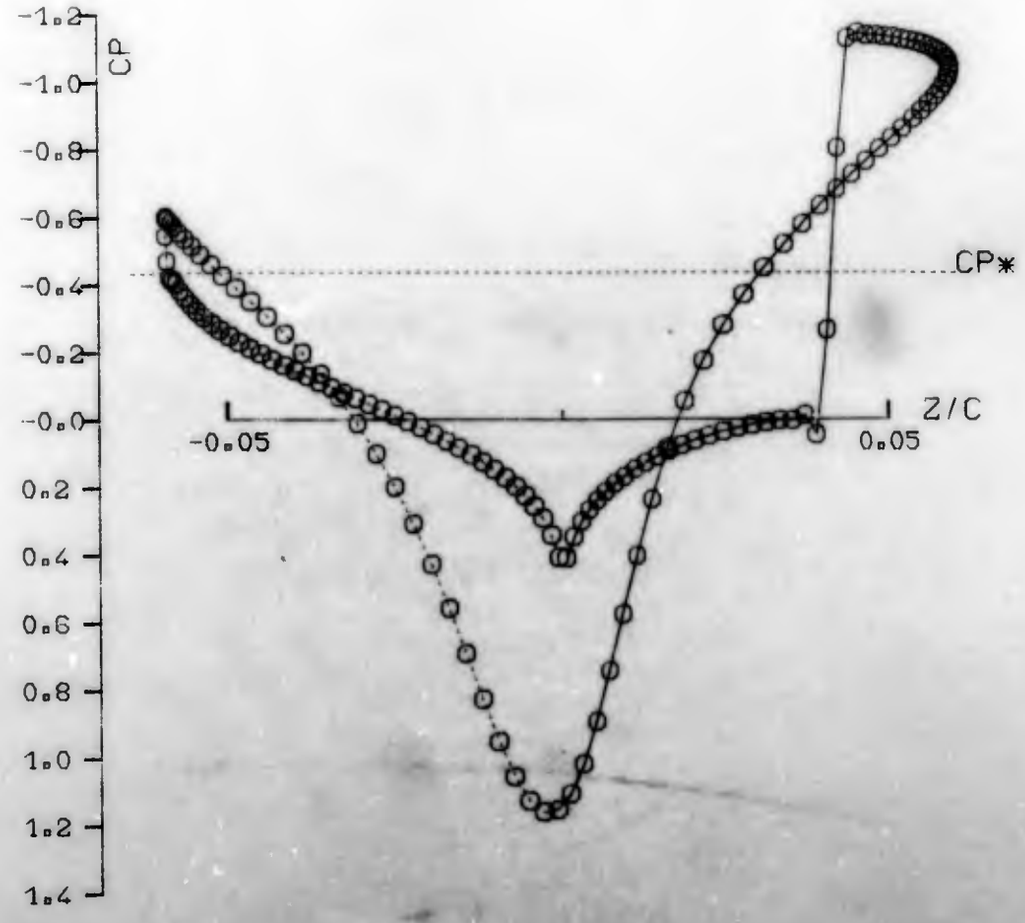
Γ = 0.1733



J SIDES

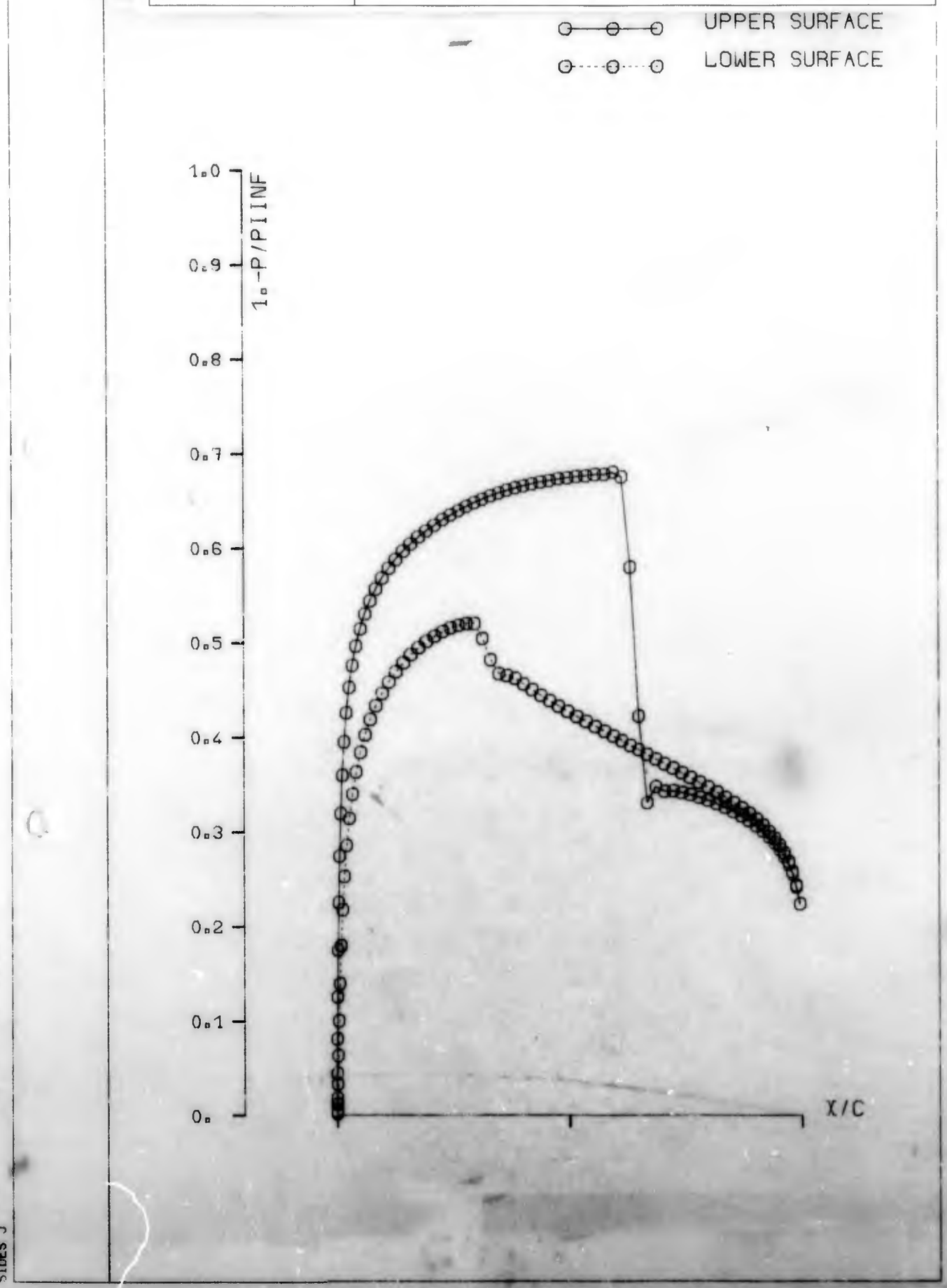
O.N.E.R.A.	AR 211		J.Sidès	01-2-8
	NACA 0012: MACH = 0.80, ALPHA = 1.25			





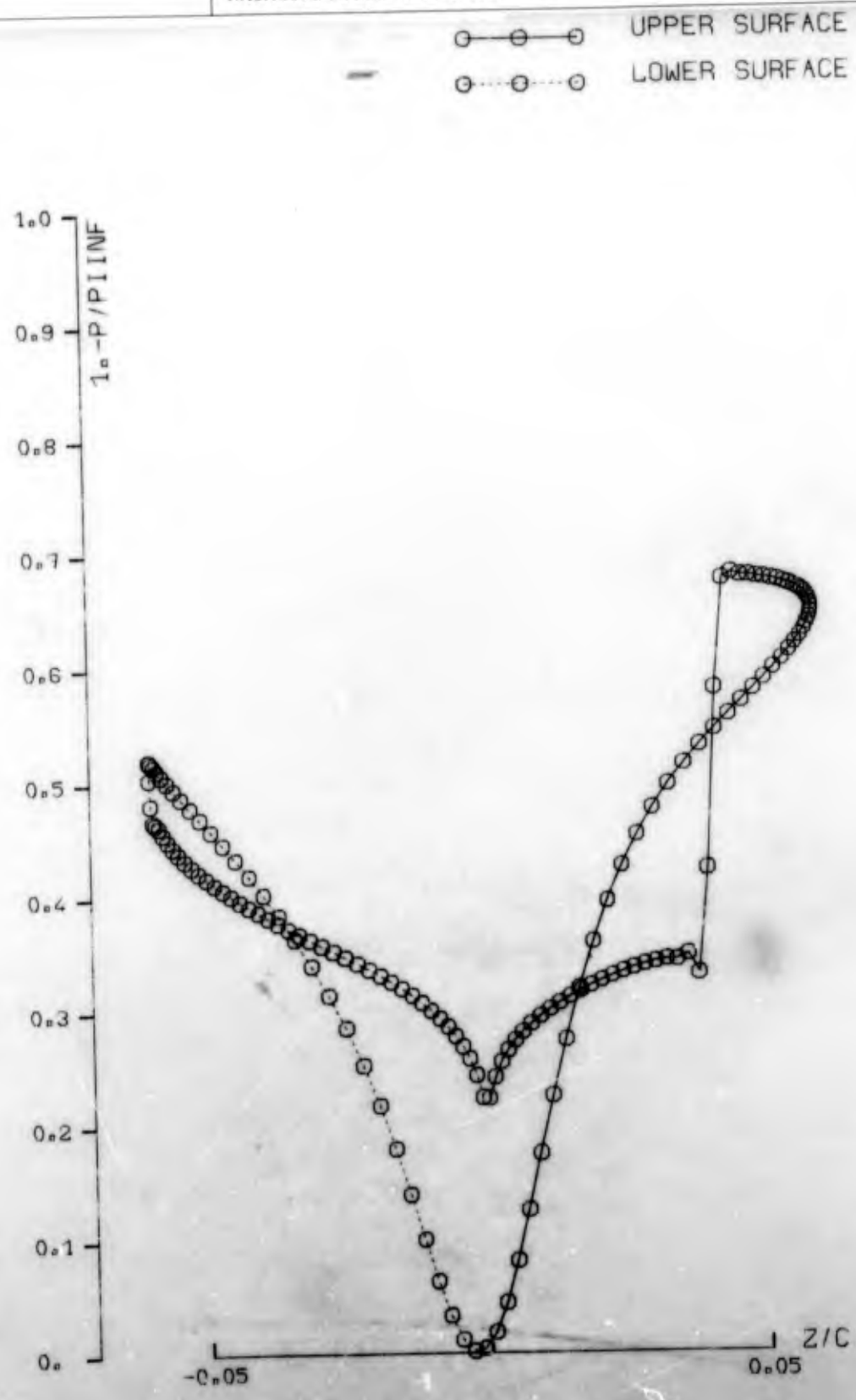
SIDES J

O.N.E.R.A.	AR 211		J.Sidès	01-2-9
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



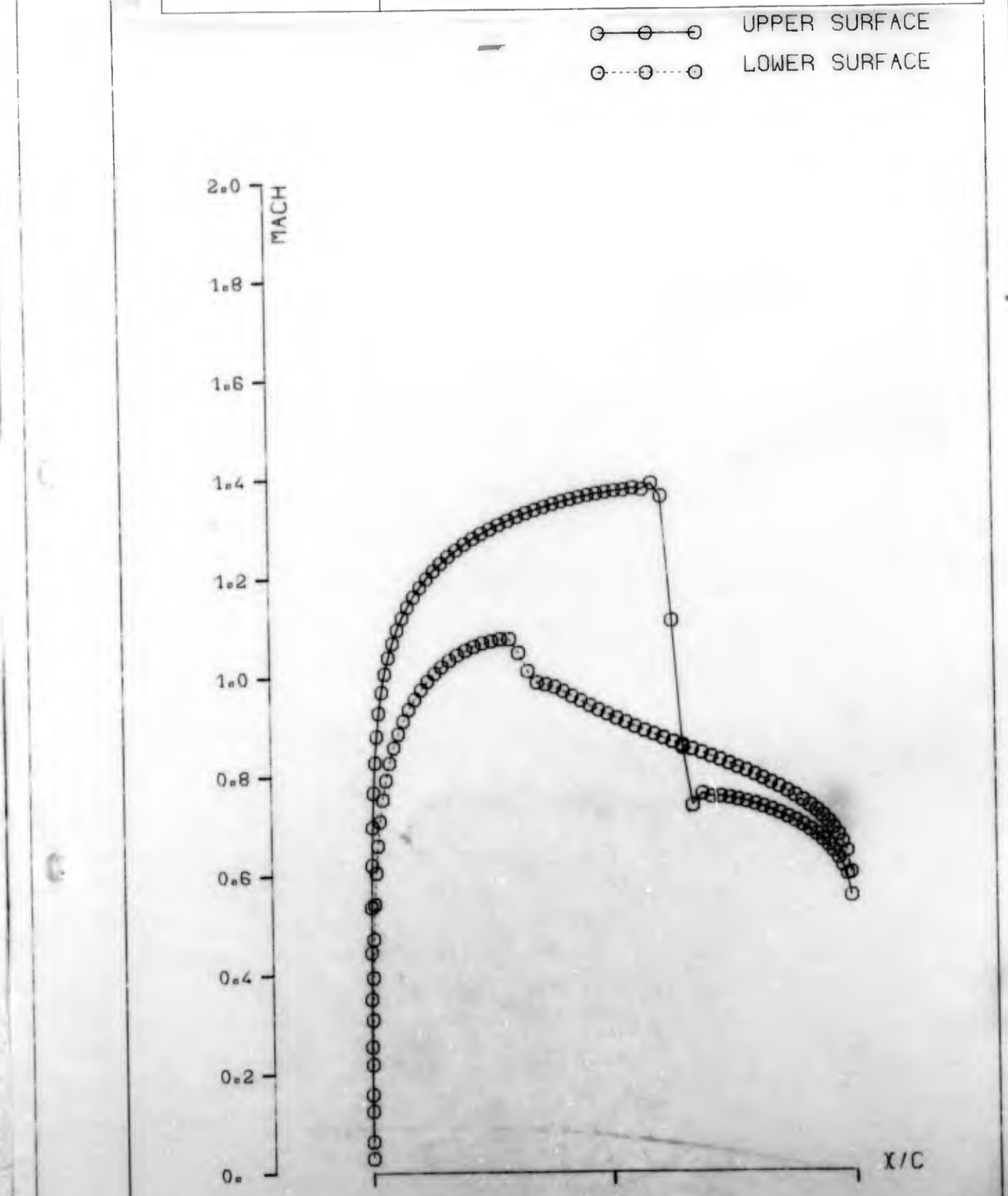
SIDES J

O.N.E.R.A.	AR 211		J.Sidès	01-2-10
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



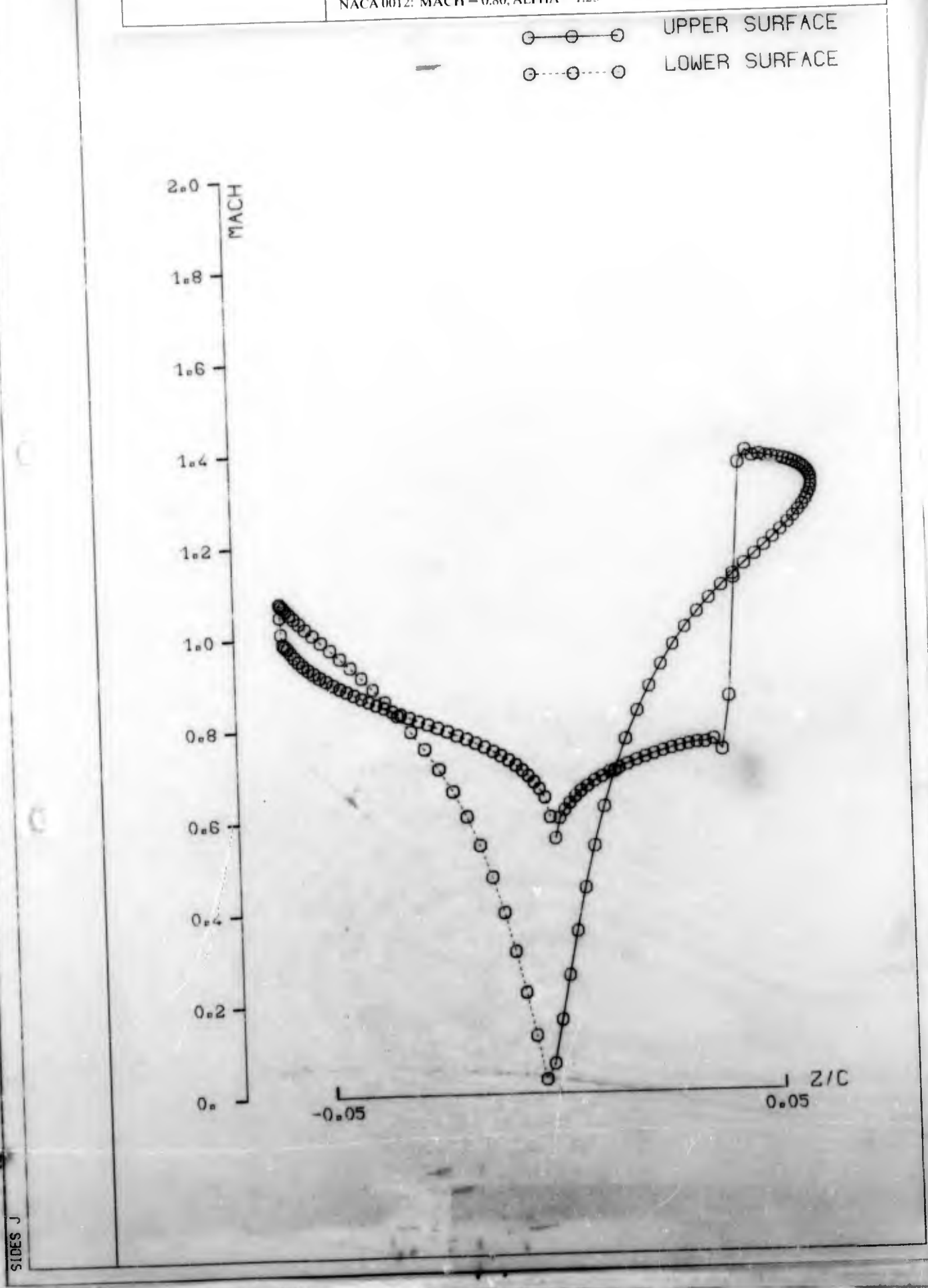
J S3ONS

O.N.E.R.A.	AR 211		J.Sidès	01-2-11
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



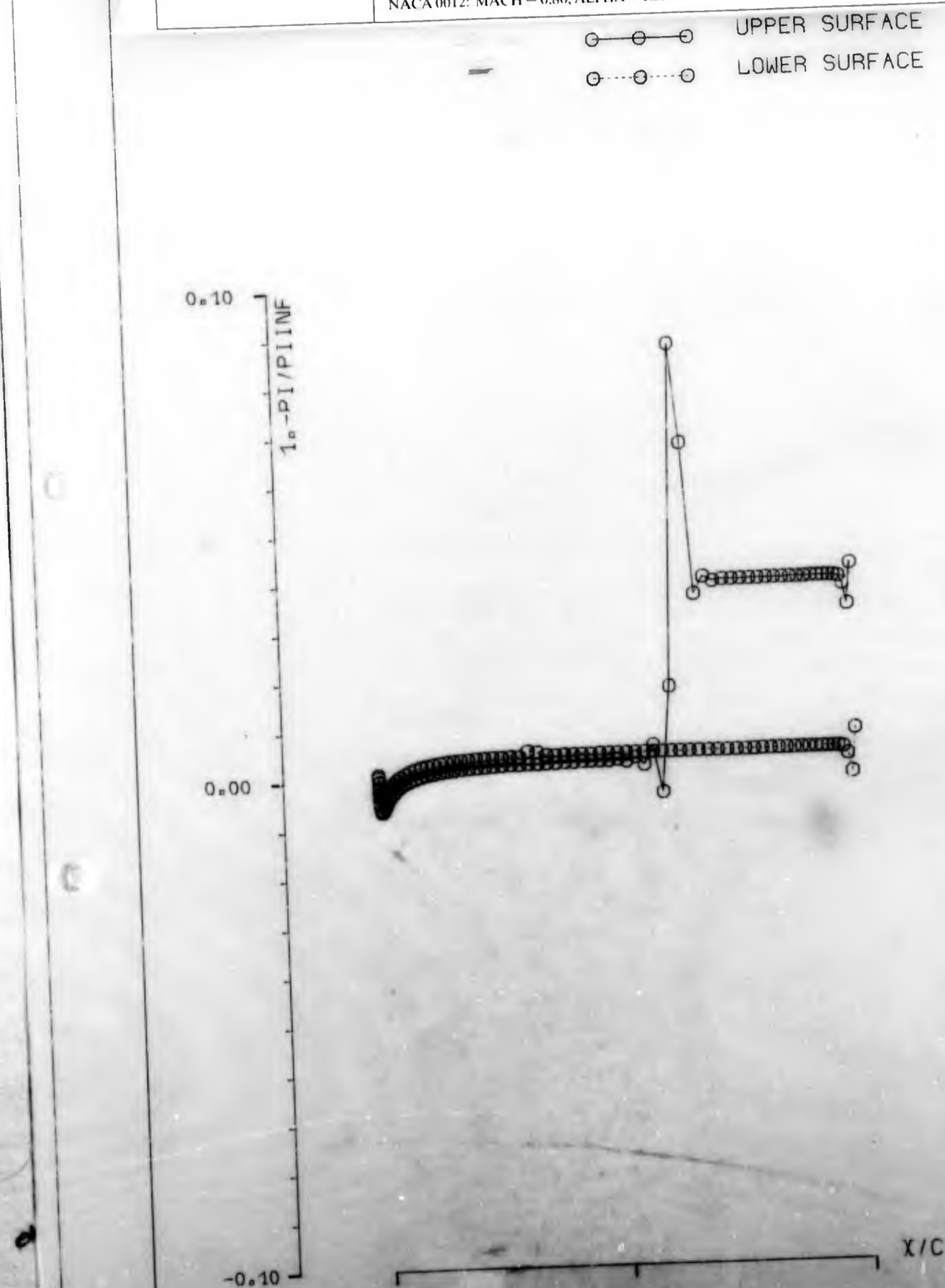
SIDES J

O.N.E.R.A.	AR 211		J.Sidès	01-2-12
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



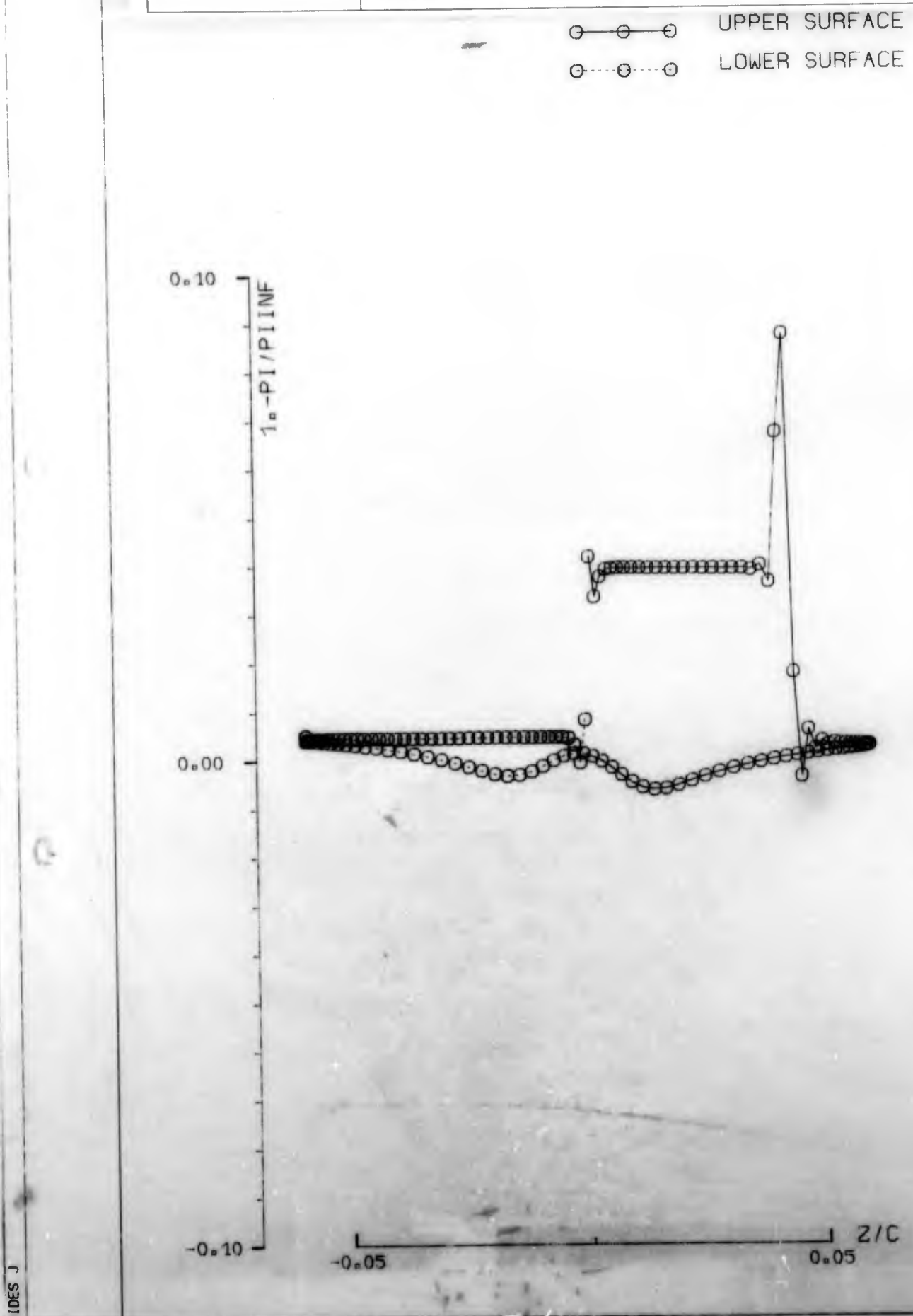
SIDES J

O.N.E.R.A.	AR 211		J.Sidès	01-2-13
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



SIDES J

O.N.E.R.A.	AR 211		J.Sidès	01-2-14
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



SIDÈS J

O.N.E.R.A.	AR 211		J.Sidès	01-2-15
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

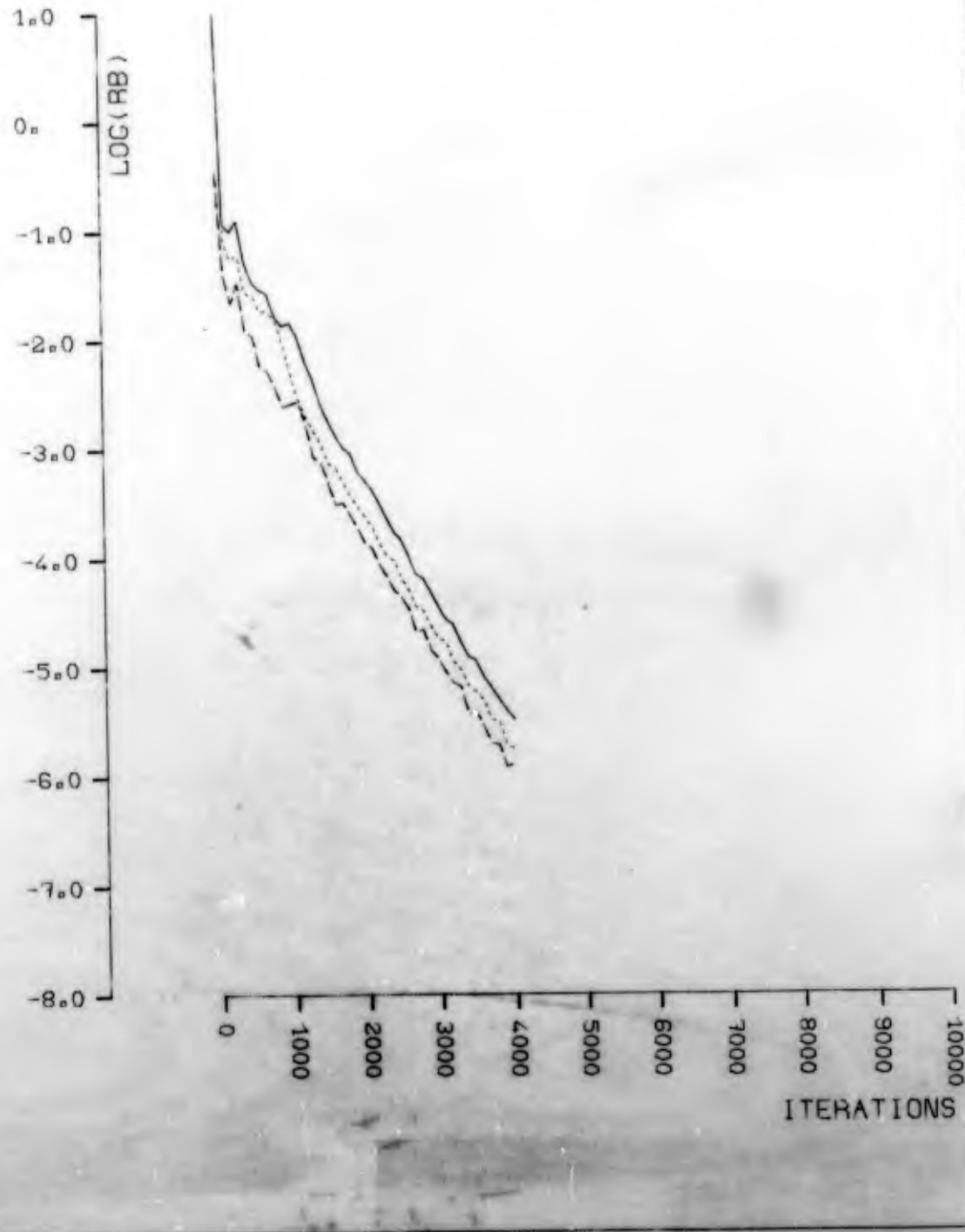
RESIDUAL MEAN

RB=R.M.S. OF $(F^{N+1} - F^{N})/DT$

——— $F = \rho$

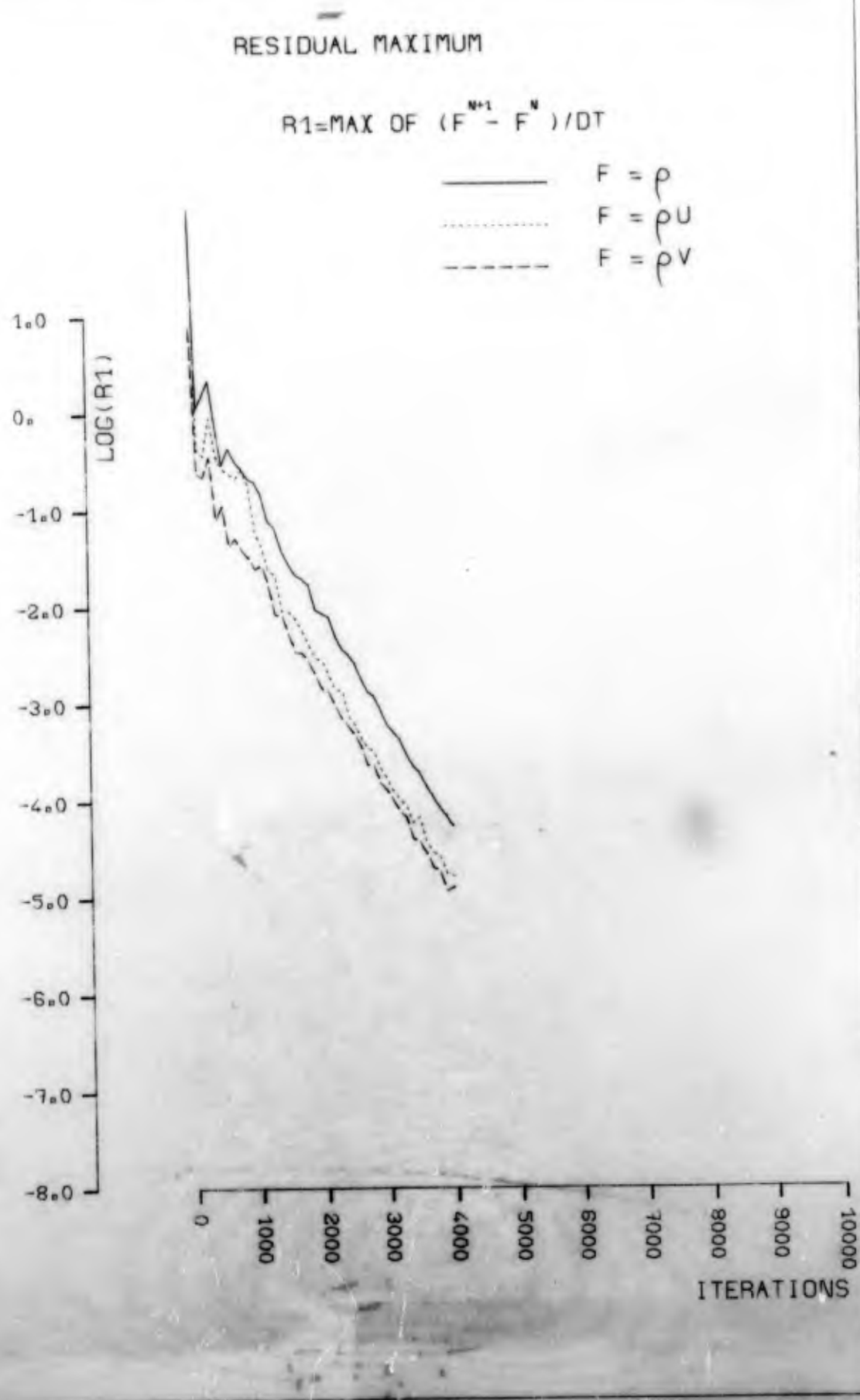
..... $F = \rho U$

– – – – – $F = \rho V$



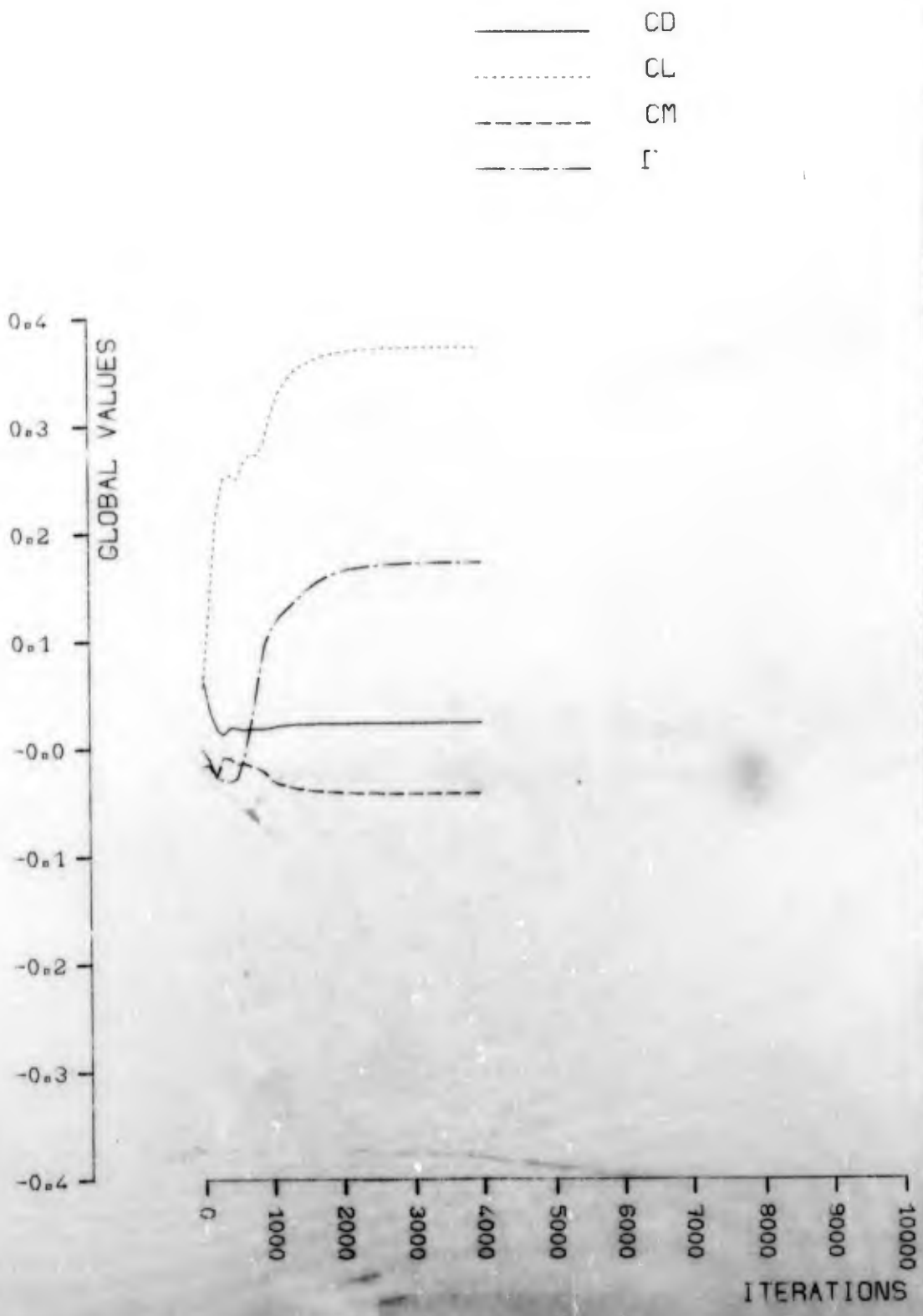
SIDES J

O.N.E.R.A.	AR 211		J.Sidès	01-2-16
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

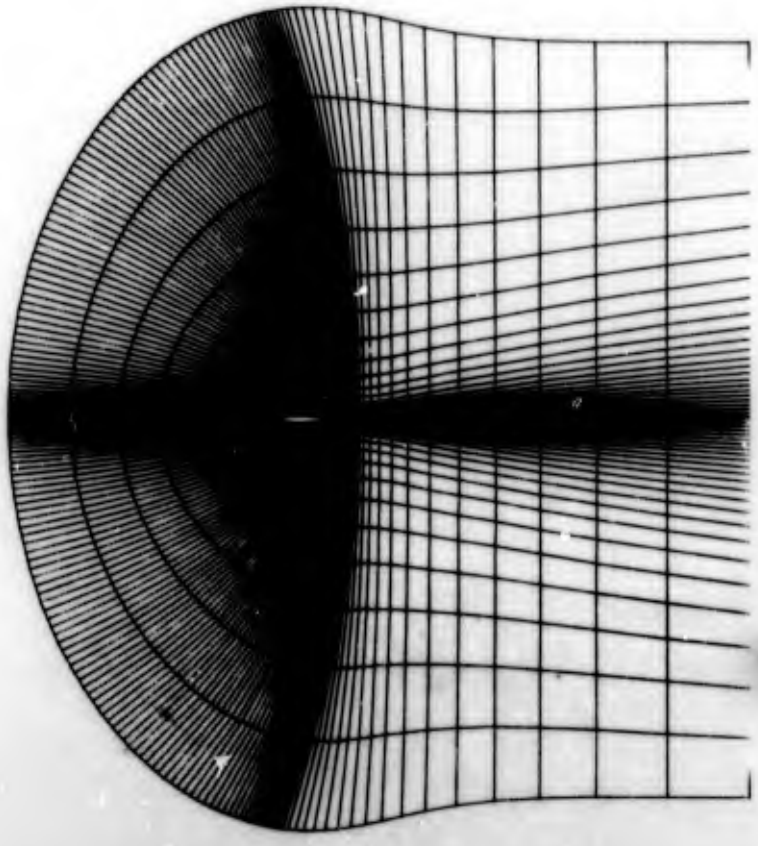


SIDES J

O.N.E.R.A.	AR 211		J.Sides	01-2-17
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



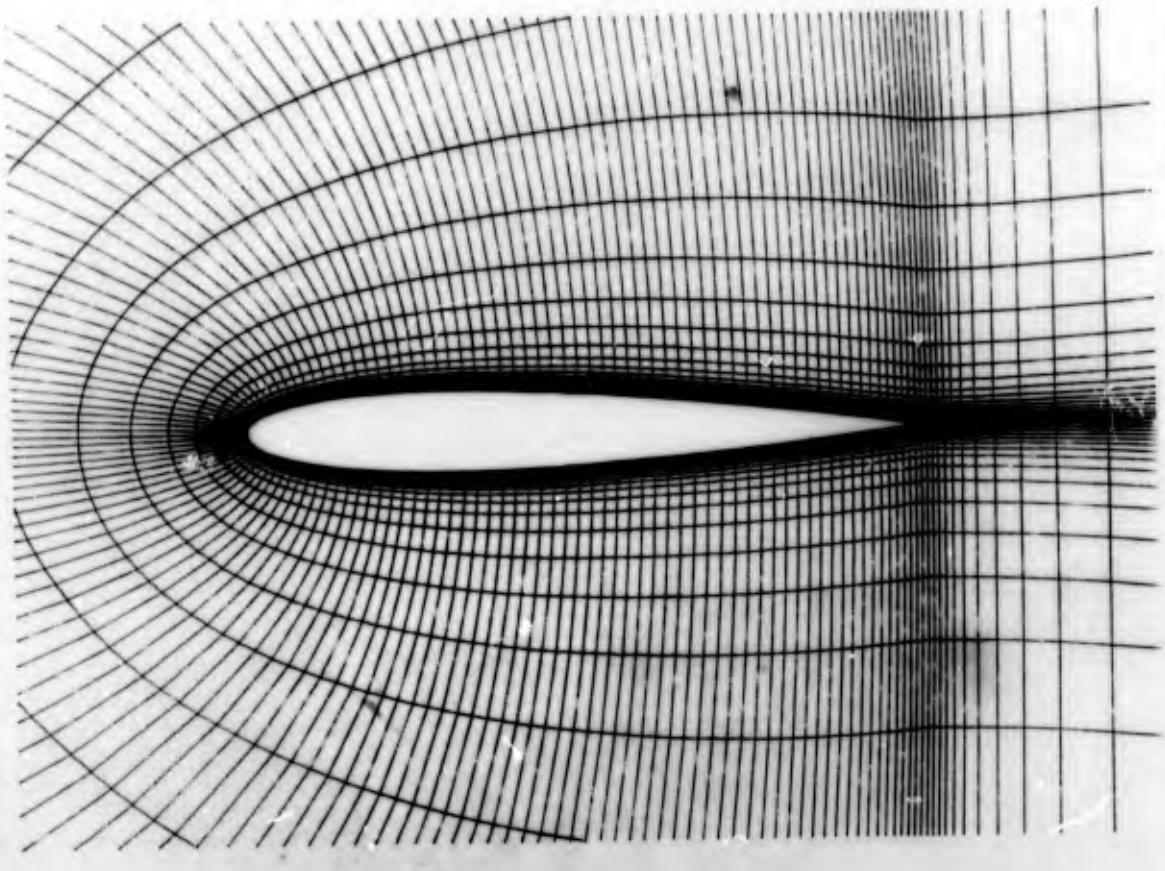
O.N.E.R.A.	AR 211		J.Sidès	01-2-18
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



189X25 MESH CHORD = 1 CM

AG-SIDES

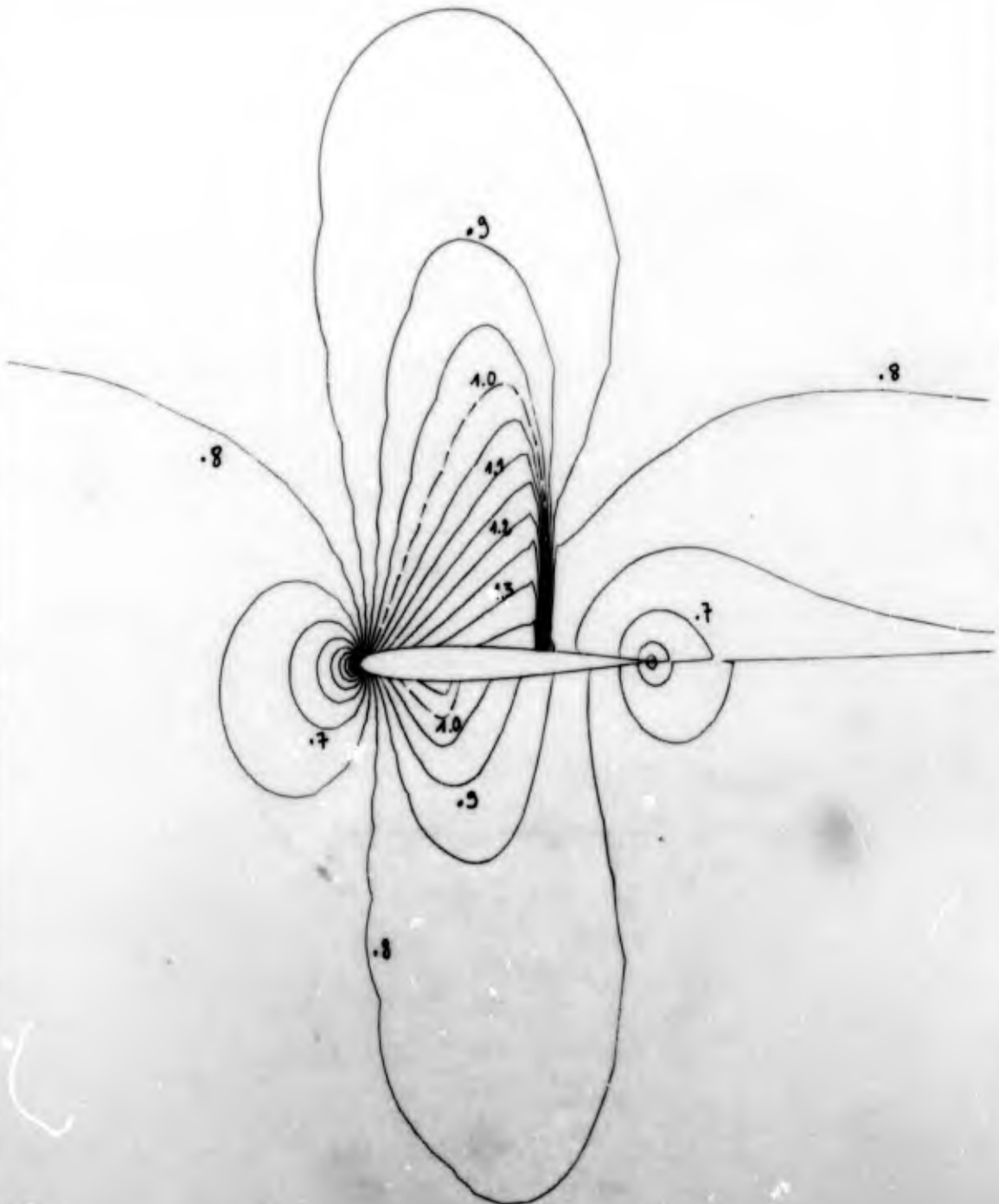
O.N.E.R.A.	AR 211		J.Sides	01-2-19
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



189X25 MESH (PARTIAL VIEW)

J.SIDES 84

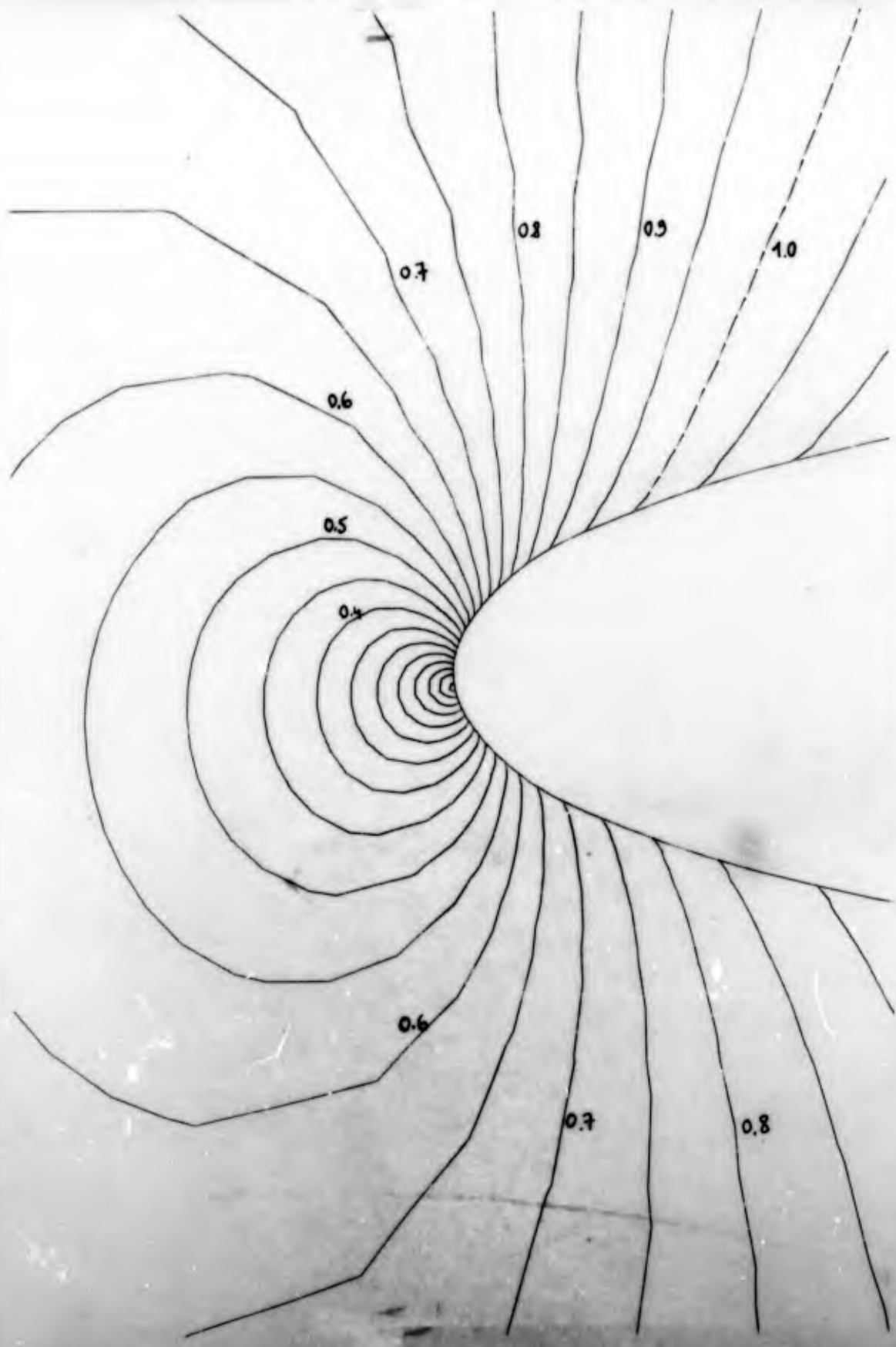
O.N.E.R.A.	AR 211		J.Sidès	01-2-20
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



ISO-MACH LINES DM=0.050 CHORD = 5 CM

AB-SIDES

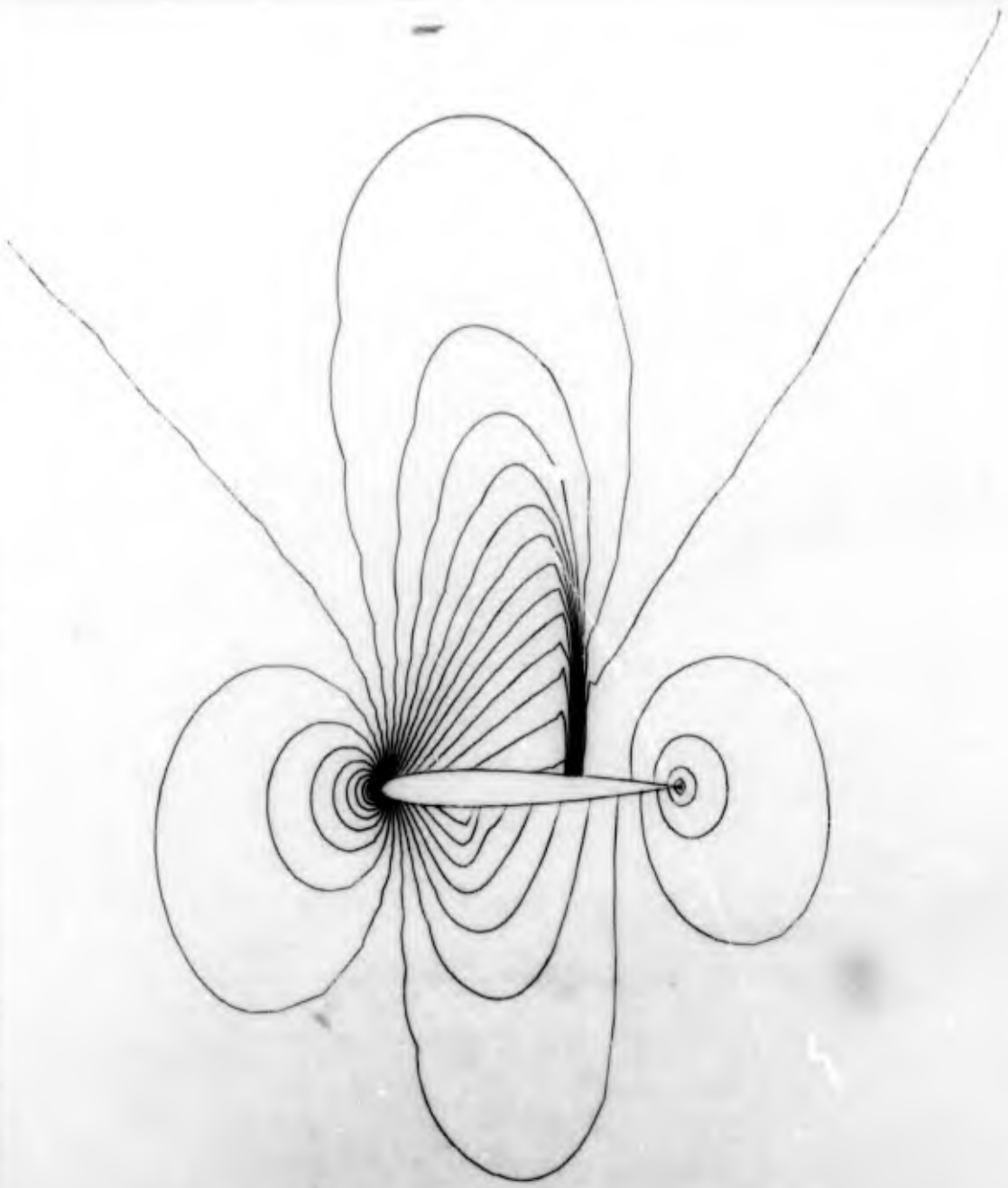
O.N.E.R.A.	AR 211		J.Sidès	01-2-21
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



ISO-MACH LINES DM=0.050 CHORD=100 CM

AB-SIDES

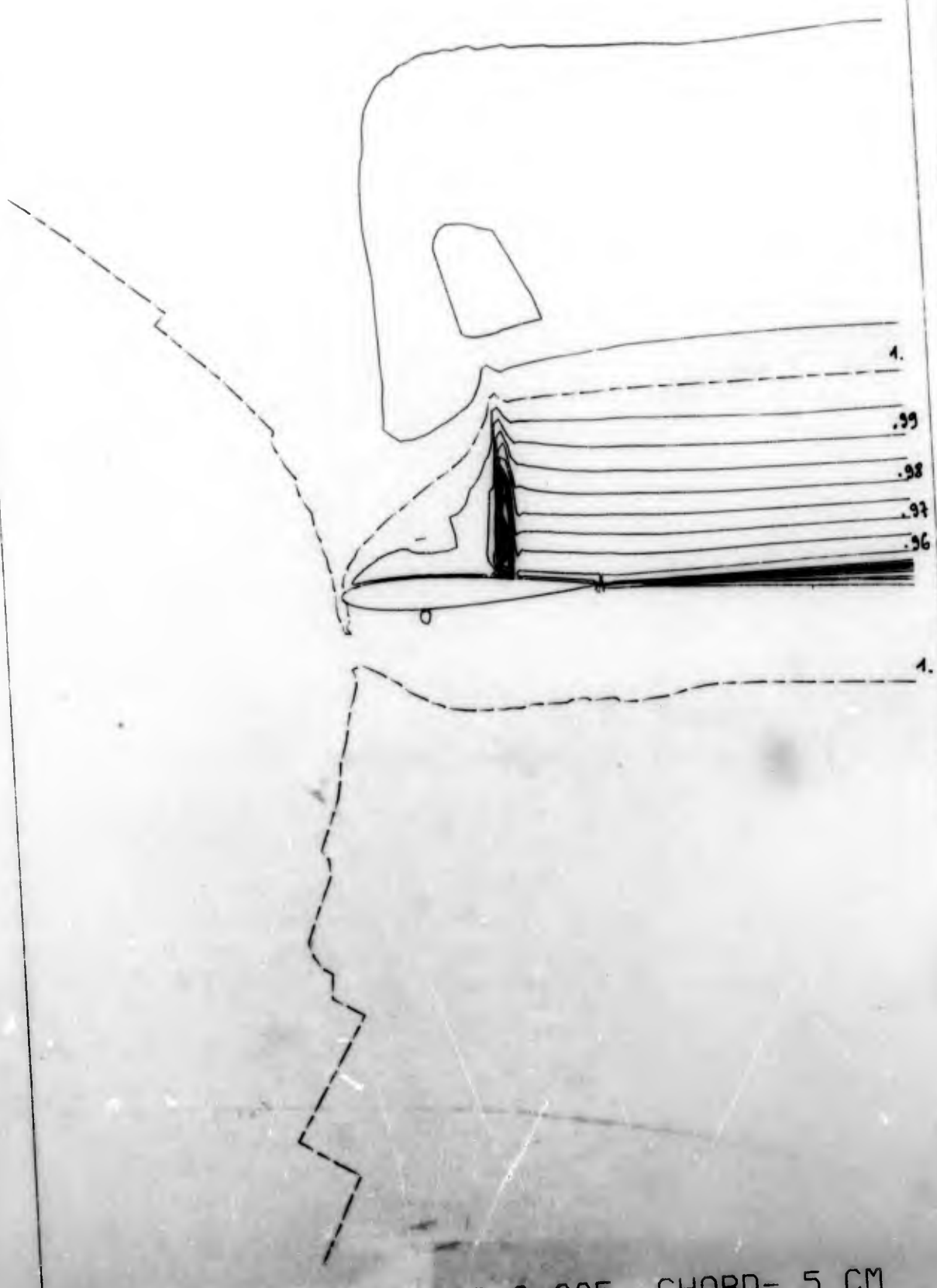
O.N.E.R.A.	AR 211		J.Sidès	01-2-22
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



ISO-P/PIINF DP=0.025 CHORD= 5 CM

NB-SIDES

O.N.E.R.A.	AR 211		J.Sides	01-2-23
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



ISO-PI/PIINF ; DPI=0.005 CHORD= 5 CM

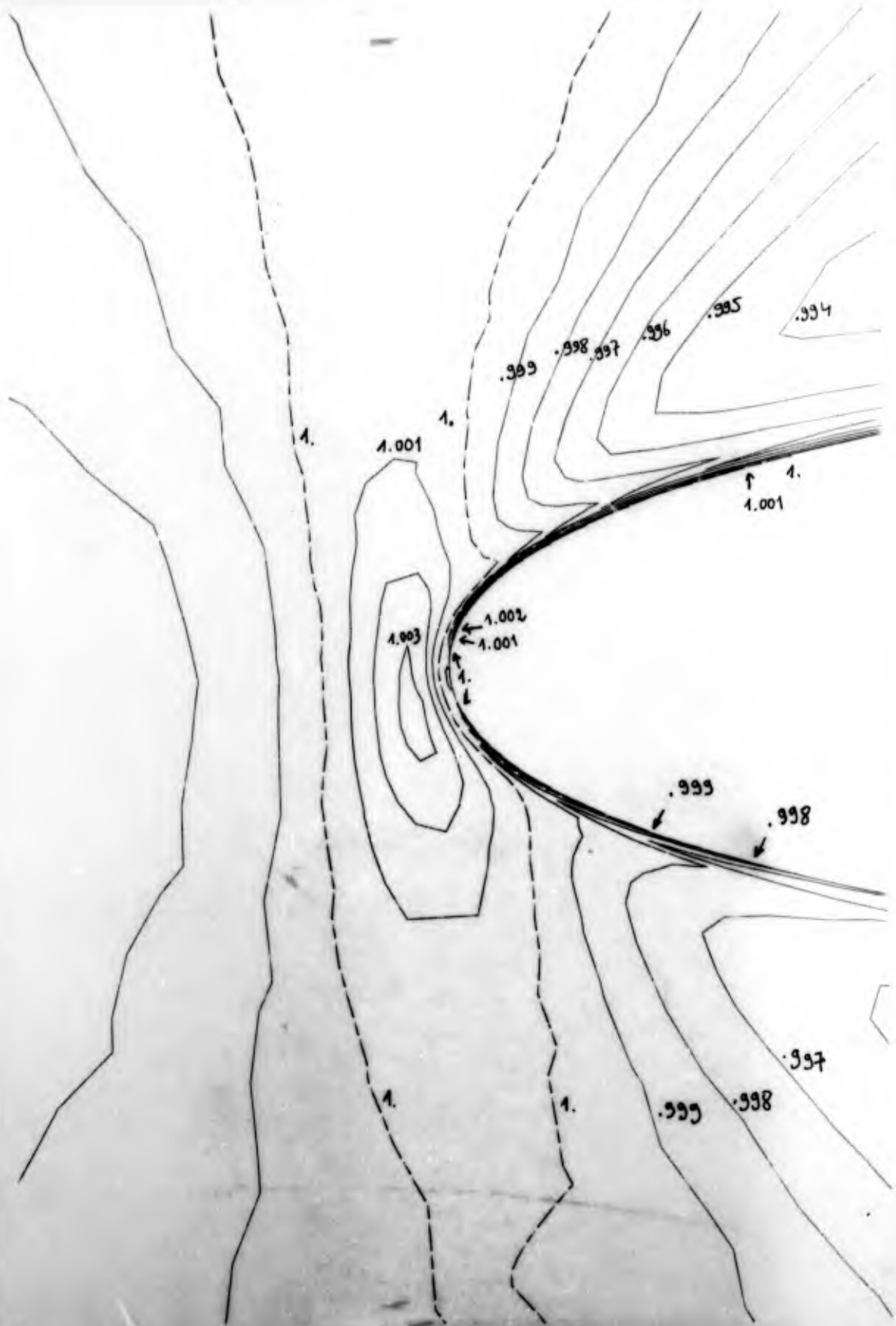
AB-SIDES

O.N.E.R.A.	AR 211		J.Sidès	01-2-24
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ISO-PI/PIINF DPI=0.005 CHORD= 100CM

AB-SIDES

O.N.E.R.A.	AR 211		J.Sides	01-2-25
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



AB-SIDES

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 01

NACA 0012: MACH = 0.80, ALPHA = 1.25

Contributor No 3

C.C.Lytton

(R.A.E., G.B.)

R.A.E.	AR 211		C.C.Lytton	01-3-1
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

THE METHOD OF C.C.LYTTON FOR EULER EQUATIONS

Ref.1. C.C.L.Sells: Solution of the Euler equations for transonic flow past a lifting aerofoil. RAE TR 80065, 1980.

2. A.Rizzi,H.Viviand (eds): Numerical methods for the computation of inviscid transonic flows with shock waves. Notes on Numerical Fluid Mechanics, Vol.3, Vieweg, 1981.

The present method builds on that of Sells (Ref.1,2), which is a finite-volume method employing Roe's flux-difference-splitting techniques. Since the Stockholm 1979 GAMM Workshop,

- the Euler-Bernoulli (constant enthalpy) formulation has been adopted;
- the MacCormack-Roe 2-step method has been replaced by Roe's one-step method;
- at the computational outer boundary, the correct number of characteristics are employed from within the region, and at subsonic upstream boundaries the remaining characteristics from outside are used, at subsonic downstream boundaries the pressure is prescribed;
- the far-field compressible vortex is included, both in the velocity fields and in the prescribed downstream pressure;
- a non-time-split (non-fractional-step) operator sequence allows the use of local-timesteps only, so that on the author's 160 x 24 grid, the steady-state can be reached in 6000 timesteps or less (around 24 hours cpu time on a DECsystem-10).

R.A.E.	AR 211		C.C.Lytton	01-3-2
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

	MACH	ALPHA		
NACA0012	0.800	1.250	BY FORMULA	0<X<1:

VERSION 87: KEEPS WALL CELLS ROUGHLY SAME ASPECT RATIO

AFTER K=1, CELL DEPTHS INCREASE IN GEOMETRIC PROGRESSION

TOTAL CELL DEPTH =16.0*CHORD

JL	KL	NEND	NPRNT
160	24	0	0

CP*	P(CR)	CPS	P(ST)
-0.4346	0.8988	1.1704	1.7013

J	X/C	Z/C	1-P/H	CP	M	1-PI/H
2	1.000	-0.0000	0.1754	0.5737	0.5315	0.0004
3	0.999	-0.0001	0.1937	0.5114	0.5635	-0.0002
4	0.997	-0.0004	0.2107	0.4534	0.5925	-0.0009
5	0.995	-0.0007	0.2242	0.4076	0.6143	-0.0008
6	0.992	-0.0011	0.2355	0.3691	0.6328	-0.0011
7	0.988	-0.0017	0.2453	0.3359	0.6484	-0.0012
8	0.983	-0.0024	0.2540	0.3063	0.6621	-0.0011
9	0.978	-0.0031	0.2619	0.2794	0.6744	-0.0011
10	0.972	-0.0040	0.2693	0.2542	0.6860	-0.0011
11	0.965	-0.0049	0.2762	0.2305	0.6968	-0.0011
12	0.957	-0.0060	0.2828	0.2081	0.7070	-0.0011
13	0.948	-0.0071	0.2890	0.1871	0.7166	-0.0011
14	0.939	-0.0083	0.2949	0.1671	0.7257	-0.0011
15	0.930	-0.0096	0.3005	0.1480	0.7344	-0.0012
16	0.919	-0.0109	0.3059	0.1296	0.7427	-0.0012
17	0.908	-0.0124	0.3112	0.1117	0.7509	-0.0012
18	0.896	-0.0138	0.3163	0.0942	0.7588	-0.0013
19	0.884	-0.0154	0.3213	0.0772	0.7666	-0.0014
20	0.871	-0.0170	0.3262	0.0606	0.7742	-0.0015
21	0.857	-0.0186	0.3310	0.0443	0.7816	-0.0015
22	0.843	-0.0203	0.3357	0.0283	0.7889	-0.0016
23	0.828	-0.0220	0.3403	0.0126	0.7960	-0.0017
24	0.813	-0.0238	0.3448	-0.0030	0.8031	-0.0018
25	0.797	-0.0255	0.3494	-0.0184	0.8102	-0.0019
26	0.781	-0.0273	0.3539	-0.0338	0.8172	-0.0019
27	0.764	-0.0291	0.3584	-0.0491	0.8241	-0.0020
28	0.747	-0.0309	0.3629	-0.0644	0.8311	-0.0021
29	0.730	-0.0327	0.3674	-0.0798	0.8381	-0.0021
30	0.712	-0.0345	0.3720	-0.0953	0.8453	-0.0023
31	0.694	-0.0363	0.3766	-0.1111	0.8525	-0.0024
32	0.675	-0.0381	0.3813	-0.1269	0.8597	-0.0025
33	0.656	-0.0399	0.3860	-0.1430	0.8671	-0.0025
34	0.637	-0.0416	0.3908	-0.1594	0.8746	-0.0026
35	0.618	-0.0433	0.3957	-0.1761	0.8822	-0.0027
36	0.599	-0.0449	0.4007	-0.1932	0.8901	-0.0027
37	0.579	-0.0465	0.4059	-0.2107	0.8981	-0.0028
38	0.559	-0.0480	0.4112	-0.2286	0.9064	-0.0029
39	0.540	-0.0495	0.4165	-0.2468	0.9148	-0.0029
40	0.520	-0.0509	0.4220	-0.2655	0.9234	-0.0029
41	0.500	-0.0522	0.4277	-0.2848	0.9323	-0.0030
42	0.480	-0.0534	0.4335	-0.3045	0.9415	-0.0030
43	0.460	-0.0545	0.4394	-0.3248	0.9510	-0.0031
44	0.441	-0.0556	0.4455	-0.3454	0.9606	-0.0031
45	0.421	-0.0565	0.4516	-0.3664	0.9704	-0.0031

R.A.E.	AR 211		C.C.Lytton	01-3-3
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

46	0.401	-0.0573	0.4577	-0.3870	0.9802	-0.0032
47	0.382	-0.0580	0.4633	-0.4059	0.9891	-0.0032
48	0.363	-0.0586	0.4660	-0.4153	0.9932	-0.0028
49	0.344	-0.0590	0.4624	-0.4028	0.9865	-0.0019
50	0.325	-0.0593	0.5107	-0.5674	1.0687	-0.0052
51	0.306	-0.0594	0.5205	-0.6006	1.0845	-0.0044
52	0.288	-0.0594	0.5214	-0.6038	1.0858	-0.0040
53	0.270	-0.0593	0.5203	-0.6000	1.0837	-0.0037
54	0.253	-0.0590	0.5181	-0.5926	1.0801	-0.0039
55	0.236	-0.0585	0.5151	-0.5824	1.0750	-0.0039
56	0.219	-0.0579	0.5112	-0.5690	1.0684	-0.0040
57	0.203	-0.0571	0.5061	-0.5517	1.0599	-0.0040
58	0.187	-0.0562	0.5002	-0.5316	1.0502	-0.0041
59	0.172	-0.0551	0.4950	-0.5138	1.0417	-0.0043
60	0.157	-0.0538	0.4872	-0.4872	1.0288	-0.0043
61	0.143	-0.0524	0.4801	-0.4633	1.0178	-0.0048
62	0.129	-0.0508	0.4715	-0.4340	1.0037	-0.0047
63	0.116	-0.0491	0.4622	-0.4023	0.9891	-0.0052
64	0.104	-0.0472	0.4528	-0.3704	0.9740	-0.0051
65	0.092	-0.0452	0.4410	-0.3300	0.9554	-0.0053
66	0.081	-0.0430	0.4291	-0.2896	0.9368	-0.0054
67	0.070	-0.0407	0.4154	-0.2431	0.9156	-0.0057
68	0.061	-0.0383	0.4006	-0.1926	0.8927	-0.0058
69	0.052	-0.0358	0.3835	-0.1344	0.8665	-0.0060
70	0.043	-0.0331	0.3644	-0.0696	0.8372	-0.0060
71	0.035	-0.0304	0.3431	0.0030	0.8043	-0.0056
72	0.028	-0.0275	0.3190	0.0850	0.7672	-0.0053
73	0.022	-0.0246	0.2908	0.1808	0.7239	-0.0052
74	0.017	-0.0216	0.2575	0.2941	0.6719	-0.0047
75	0.012	-0.0184	0.2175	0.4303	0.6081	-0.0045
76	0.008	-0.0153	0.1700	0.5919	0.5298	-0.0048
77	0.005	-0.0120	0.1166	0.7736	0.4343	-0.0056
78	0.003	-0.0086	0.0593	0.9685	0.3113	-0.0060
79	0.001	-0.0052	0.0080	1.1431	0.1634	-0.0106
80	0.000	-0.0018	-0.0055	1.1890	0.0664	-0.0086
81	0.000	0.0018	0.0153	1.1185	0.1887	-0.0095
82	0.001	0.0052	0.0809	0.8953	0.3507	-0.0008
83	0.003	0.0086	0.1610	0.6225	0.5039	0.0022
84	0.005	0.0120	0.2301	0.3876	0.6199	0.0023
85	0.008	0.0153	0.2963	0.1623	0.7231	0.0032
86	0.012	0.0184	0.3482	-0.0143	0.8045	0.0019
87	0.017	0.0216	0.3895	-0.1550	0.8687	0.0016
88	0.022	0.0246	0.4210	-0.2621	0.9188	0.0005
89	0.028	0.0275	0.4493	-0.3582	0.9651	-0.0014
90	0.035	0.0304	0.4705	-0.4305	0.9988	-0.0010
91	0.043	0.0331	0.4904	-0.4984	1.0320	-0.0016
92	0.052	0.0358	0.5068	-0.5540	1.0587	-0.0010
93	0.061	0.0383	0.5222	-0.6065	1.0848	-0.0011
94	0.070	0.0407	0.5339	-0.6462	1.1043	-0.0005
95	0.081	0.0430	0.5470	-0.6907	1.1270	-0.0005
96	0.092	0.0452	0.5569	-0.7246	1.1442	0.0000
97	0.104	0.0472	0.5673	-0.7599	1.1624	0.0005
98	0.116	0.0491	0.5762	-0.7902	1.1785	0.0006
99	0.129	0.0508	0.5839	-0.8164	1.1923	0.0011
100	0.143	0.0524	0.5917	-0.8429	1.2062	0.0019
101	0.157	0.0538	0.5990	-0.8677	1.2198	0.0020
102	0.172	0.0551	0.6054	-0.8897	1.2320	0.0021
103	0.187	0.0562	0.6114	-0.9099	1.2431	0.0026
104	0.203	0.0571	0.6172	-0.9295	1.2542	0.0028
105	0.219	0.0579	0.6225	-0.9477	1.2646	0.0029

R.A.E.	AR 211		C.C.Lytton	01-3-4
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

106	0.236	0.0585	0.6275	-0.9646	1.2743	0.0031
107	0.253	0.0590	0.6322	-0.9806	1.2836	0.0033
108	0.270	0.0593	0.6365	-0.9955	1.2924	0.0033
109	0.288	0.0594	0.6405	-1.0091	1.3006	0.0033
110	0.306	0.0594	0.6443	-1.0217	1.3083	0.0032
111	0.325	0.0593	0.6478	-1.0336	1.3157	0.0030
112	0.344	0.0590	0.6510	-1.0446	1.3225	0.0028
113	0.363	0.0586	0.6539	-1.0545	1.3286	0.0028
114	0.382	0.0580	0.6566	-1.0636	1.3342	0.0028
115	0.401	0.0573	0.6590	-1.0718	1.3392	0.0030
116	0.421	0.0565	0.6612	-1.0794	1.3438	0.0031
117	0.441	0.0556	0.6632	-1.0863	1.3481	0.0033
118	0.460	0.0545	0.6651	-1.0925	1.3520	0.0033
119	0.480	0.0534	0.6667	-1.0982	1.3555	0.0034
120	0.500	0.0522	0.6683	-1.1034	1.3588	0.0034
121	0.520	0.0509	0.6696	-1.1080	1.3617	0.0034
122	0.540	0.0495	0.6708	-1.1121	1.3644	0.0034
123	0.559	0.0480	0.6719	-1.1158	1.3668	0.0033
124	0.579	0.0465	0.6726	-1.1183	1.3686	0.0030
125	0.599	0.0449	0.6740	-1.1230	1.3711	0.0039
126	0.618	0.0433	0.6747	-1.1254	1.3749	0.0007
127	0.637	0.0416	0.3662	-0.0757	0.7896	0.0438
128	0.656	0.0399	0.3451	-0.0037	0.7594	0.0403
129	0.675	0.0381	0.3475	-0.0121	0.7635	0.0402
130	0.694	0.0363	0.3480	-0.0137	0.7642	0.0403
131	0.712	0.0345	0.3472	-0.0108	0.7631	0.0400
132	0.730	0.0327	0.3459	-0.0065	0.7612	0.0399
133	0.747	0.0309	0.3441	-0.0004	0.7584	0.0398
134	0.764	0.0291	0.3418	0.0073	0.7549	0.0397
135	0.781	0.0273	0.3393	0.0161	0.7509	0.0396
136	0.797	0.0255	0.3364	0.0259	0.7464	0.0395
137	0.813	0.0238	0.3332	0.0366	0.7415	0.0394
138	0.828	0.0220	0.3298	0.0482	0.7362	0.0392
139	0.843	0.0203	0.3262	0.0605	0.7305	0.0391
140	0.857	0.0186	0.3224	0.0735	0.7245	0.0390
141	0.871	0.0170	0.3183	0.0872	0.7182	0.0388
142	0.884	0.0154	0.3141	0.1017	0.7115	0.0387
143	0.896	0.0138	0.3097	0.1168	0.7045	0.0386
144	0.908	0.0124	0.3050	0.1326	0.6972	0.0384
145	0.919	0.0109	0.3002	0.1491	0.6896	0.0382
146	0.930	0.0096	0.2951	0.1663	0.6816	0.0380
147	0.939	0.0083	0.2898	0.1843	0.6733	0.0377
148	0.948	0.0071	0.2843	0.2030	0.6647	0.0375
149	0.957	0.0060	0.2786	0.2226	0.6556	0.0372
150	0.965	0.0049	0.2725	0.2431	0.6460	0.0369
151	0.972	0.0040	0.2660	0.2652	0.6357	0.0365
152	0.978	0.0031	0.2590	0.2891	0.6245	0.0362
153	0.983	0.0024	0.2514	0.3151	0.6122	0.0359
154	0.988	0.0017	0.2429	0.3438	0.5984	0.0356
155	0.992	0.0011	0.2335	0.3760	0.5824	0.0355
156	0.995	0.0007	0.2226	0.4131	0.5637	0.0355
157	0.997	0.0004	0.2096	0.4574	0.5417	0.0349
158	0.999	0.0001	0.1925	0.5153	0.5118	0.0346
159	1.000	0.0000	0.1754	0.5736	0.4788	0.0353

R.A.E.	AR 211		C.C.Lytton	01-3-5
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

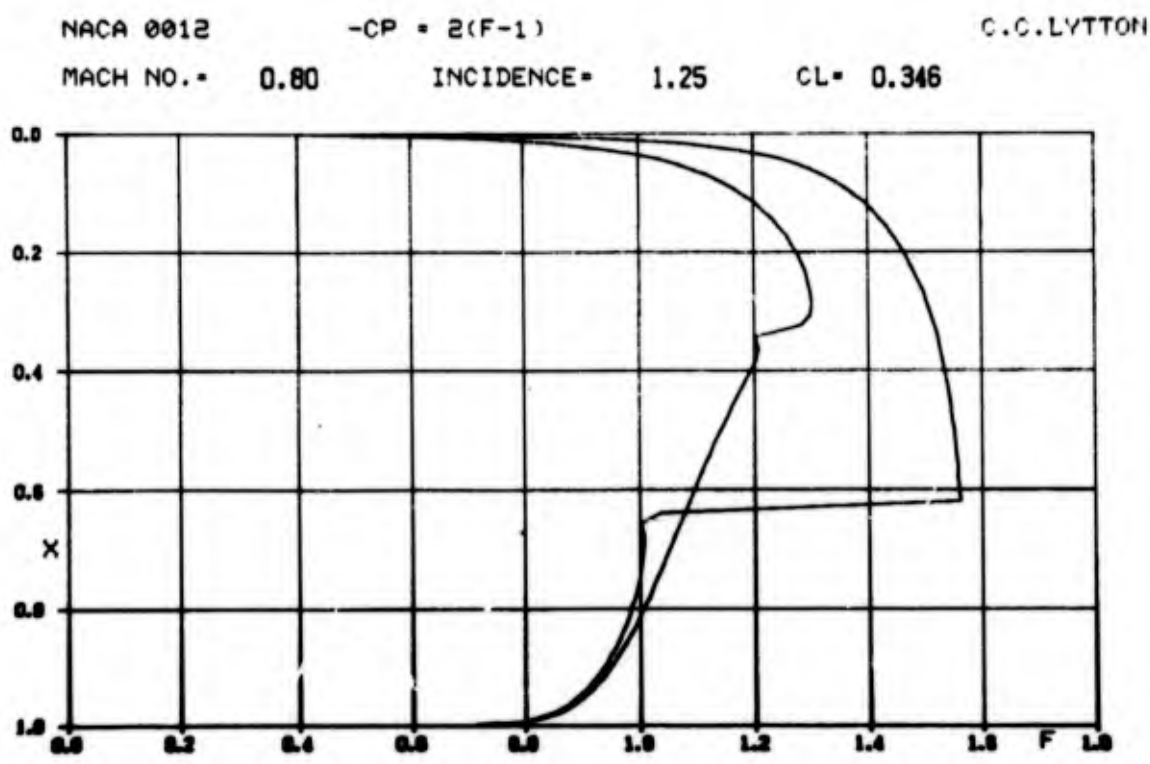
CL= 0.34633 CD= 0.02230 CM= -0.03582

GAMMA AROUND PROFILE = 0.15339

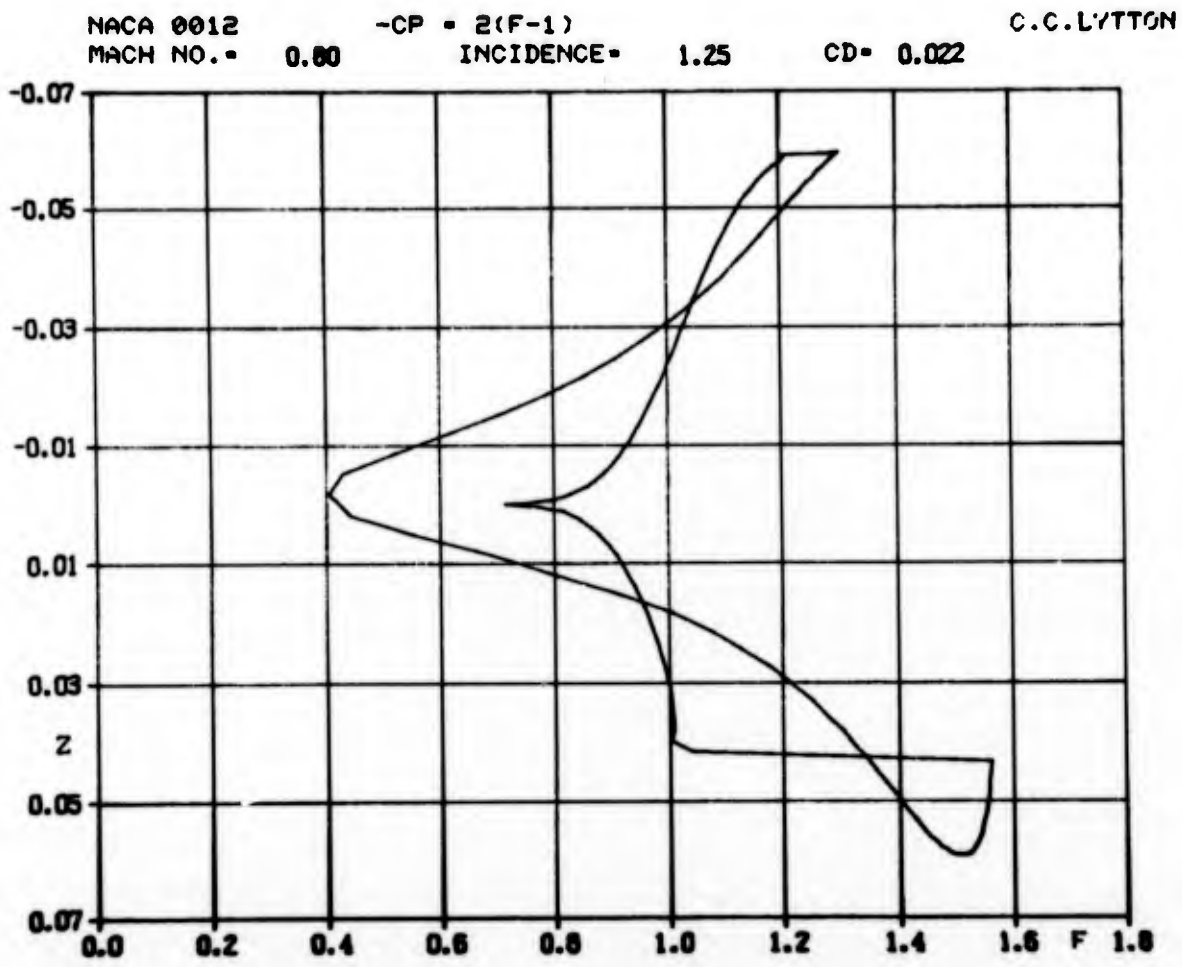
K	GAMMA
1	0.15673
2	0.16403
3	0.16420
4	0.16333
5	0.16180
6	0.16116
7	0.16312
8	0.16366
9	0.16574
10	0.16680
11	0.16934
12	0.17047
13	0.17110
14	0.17225
15	0.17295
16	0.17356
17	0.17390
18	0.17423
19	0.17477
20	0.17510
21	0.17578
22	0.17622
23	0.17914

CD (SHOCK INTEGRAL - Mk.2) = 0.02133

R.A.E.	AR 211		C.C.Lytton	01-3-6
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



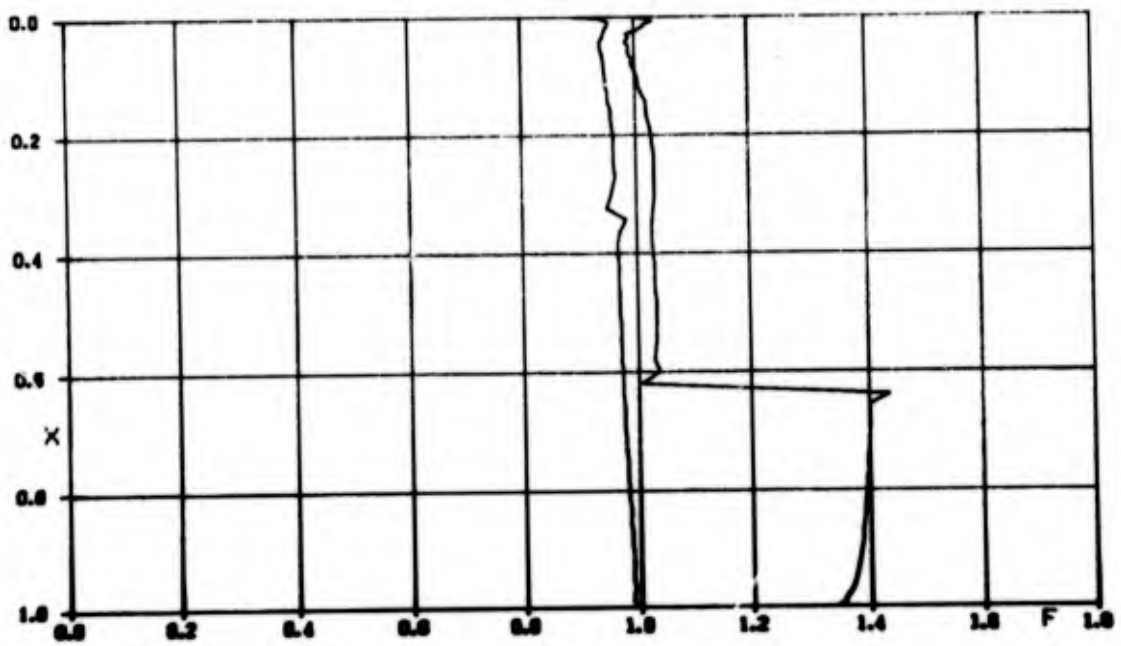
R.A.E.	AR 211		C.C.Lytton	01-3-7
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



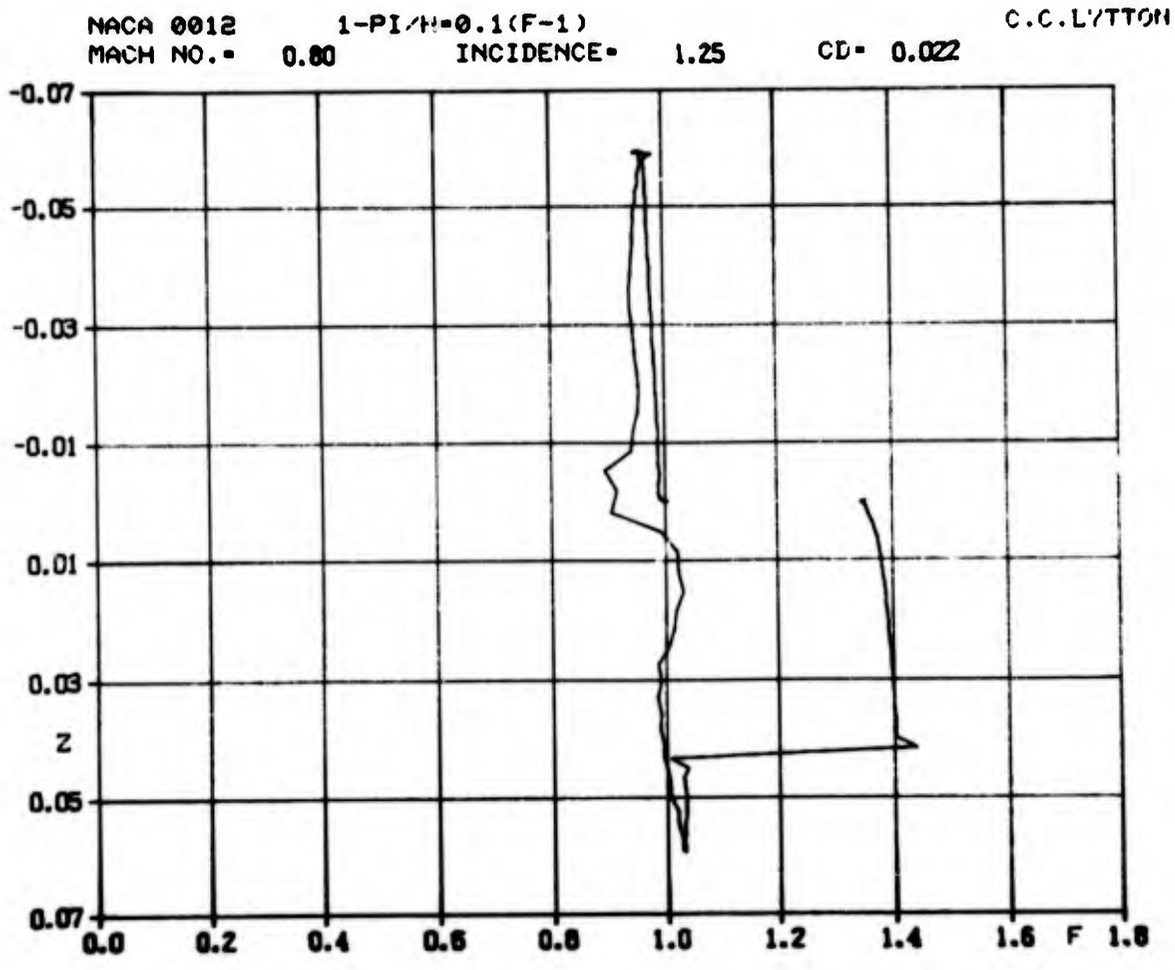
R.A.E.	AR 211		C.C.Lytton	01-3-8
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NACA 0012 1-PI/H=0.1(F-1) C.C.LYTTON

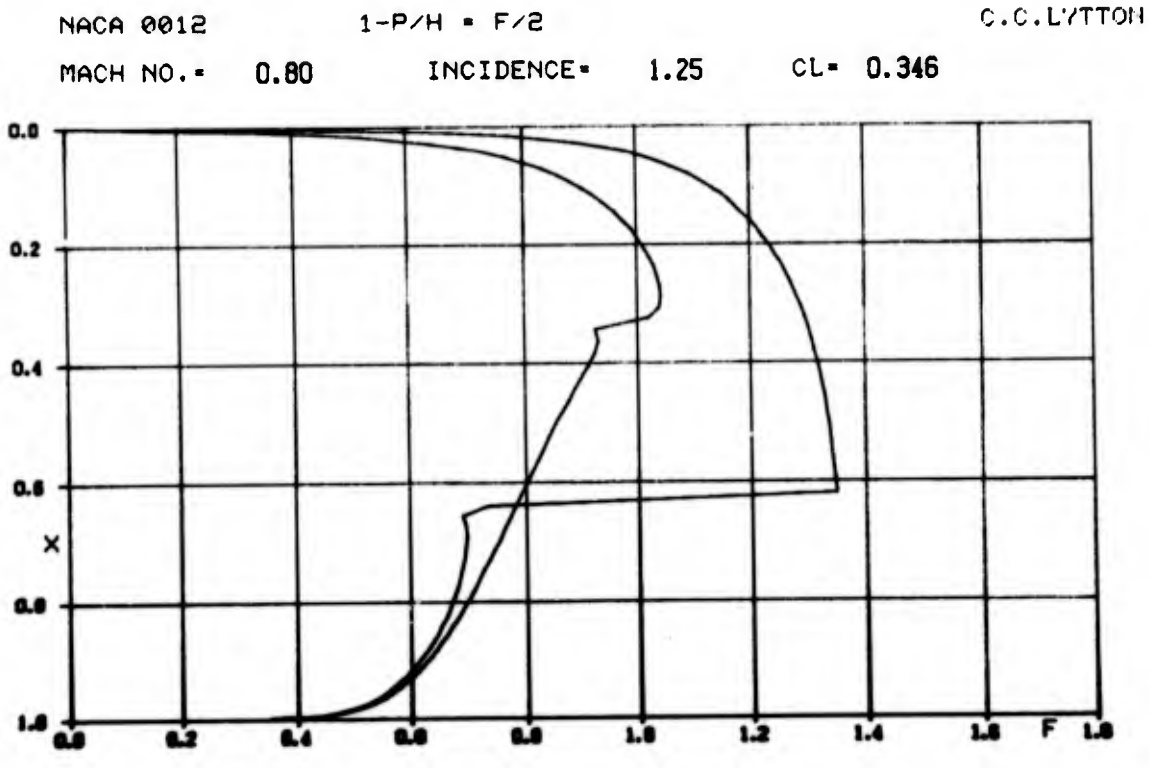
MACH NO.= 0.80 INCIDENCE= 1.25 CL= 0.346



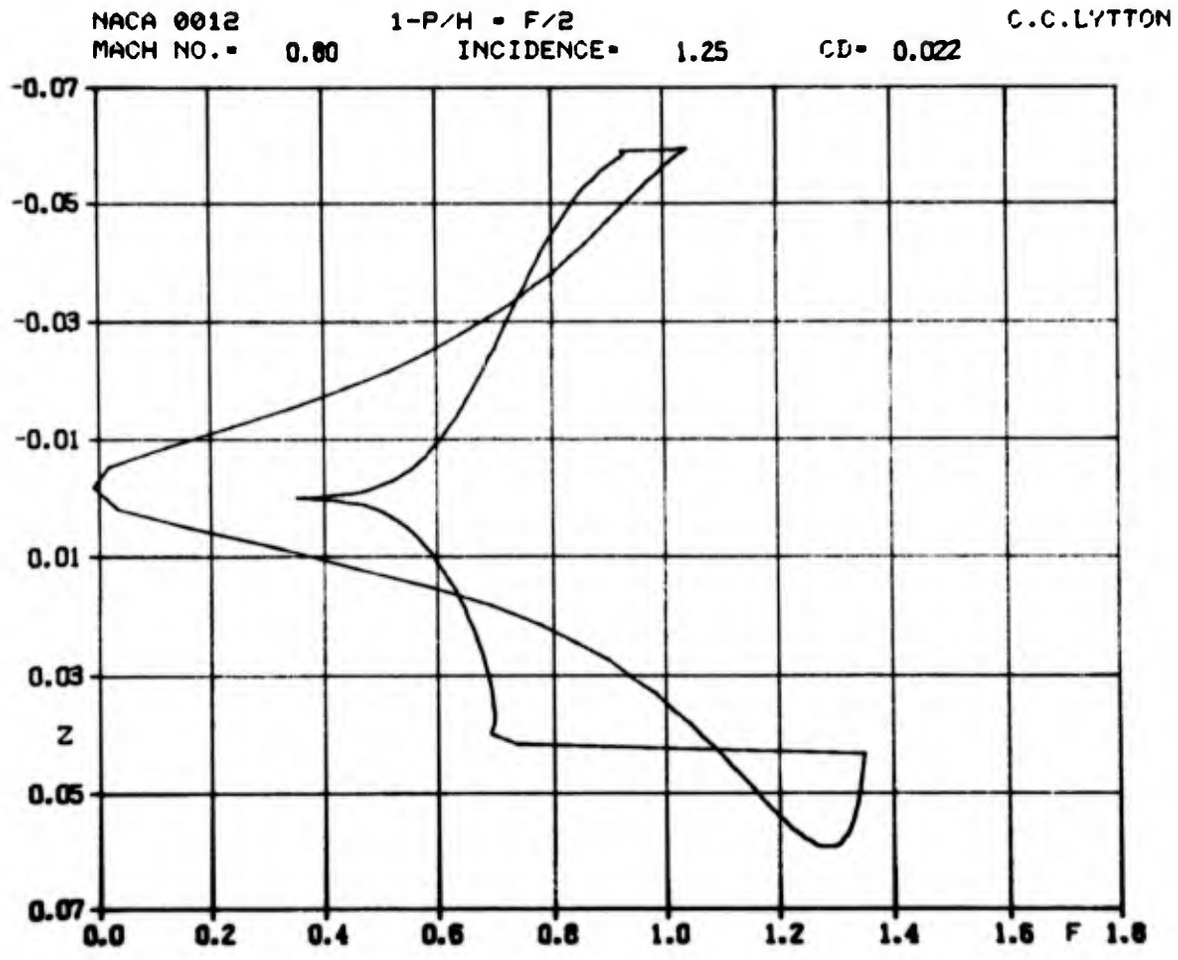
R.A.E.	AR 211		C.C.Lytton	01-3-9
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



R.A.E.	AR 211		C.C.Lytton	01-3-10
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



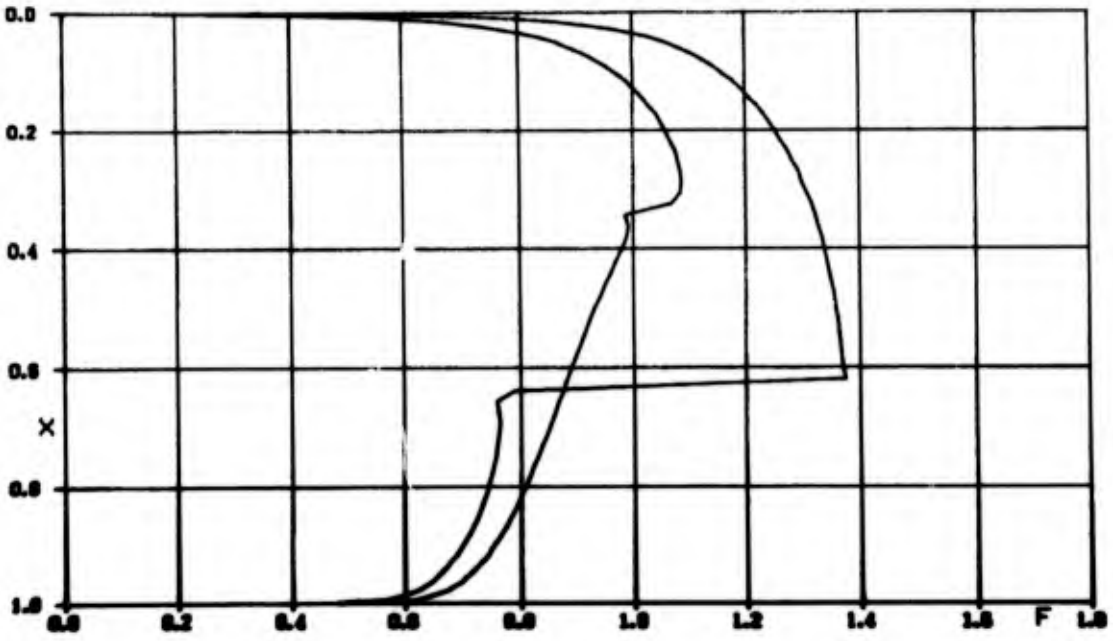
R.A.E.	AR 211		C.C.Lytton	01-3-11
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



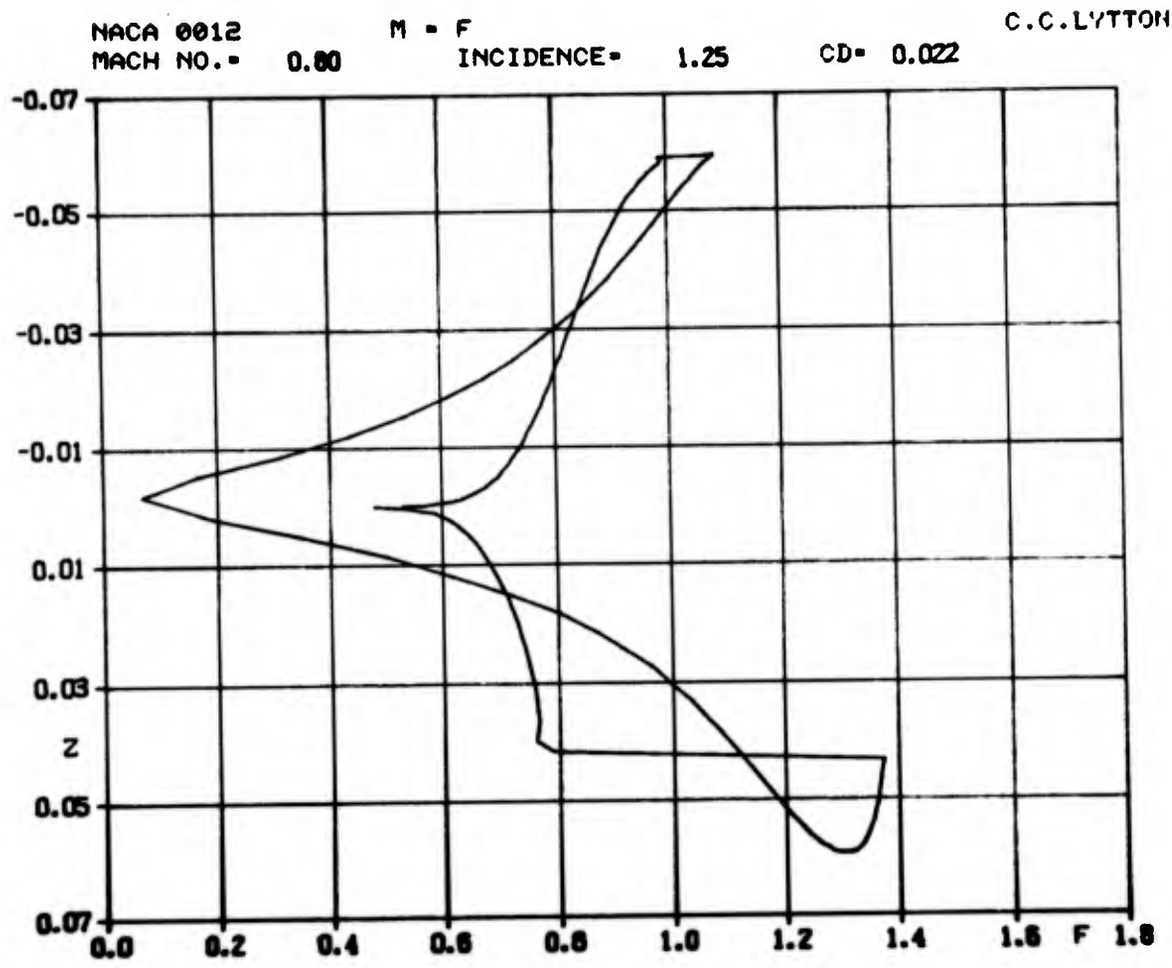
R.A.E.	AR 211		C.C.Lytton	01-3-12
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NACA 0012 M = F C.C.LYTTON

MACH NO.= 0.80 INCIDENCE= 1.25 CL= 0.346

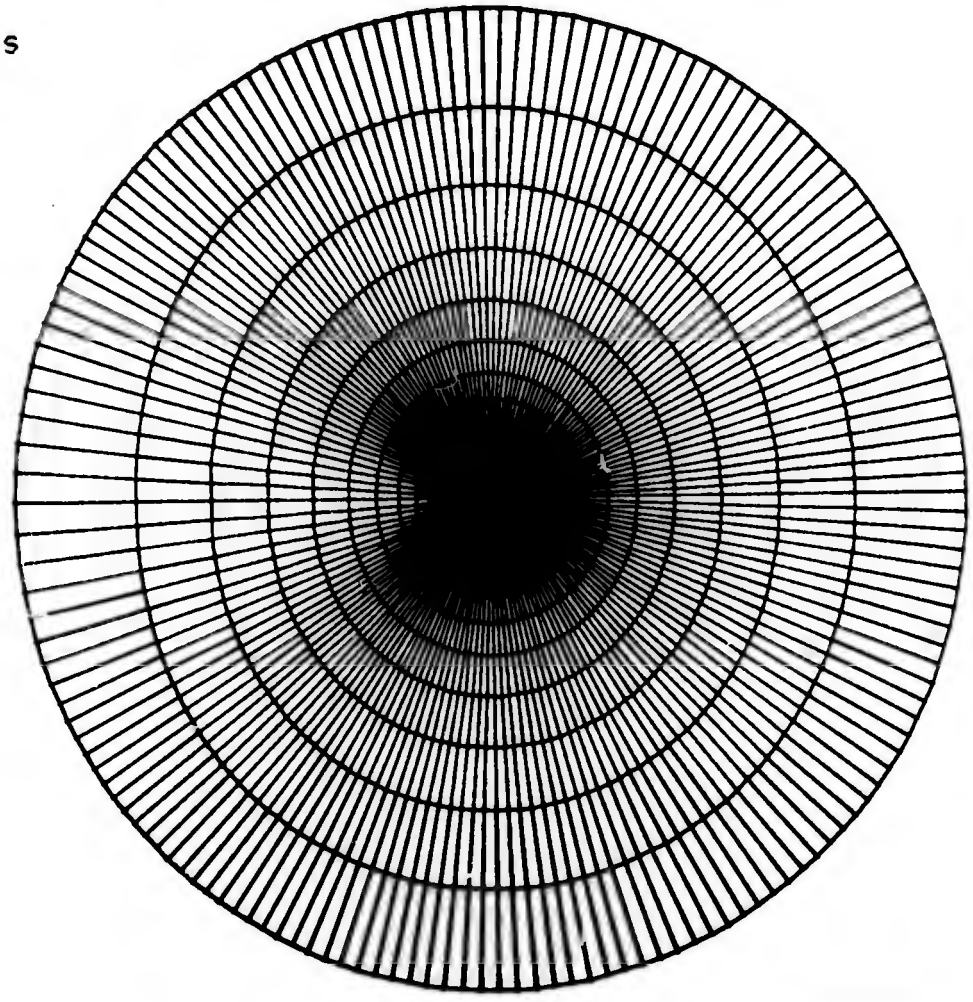


R.A.E.	AR 211		C.C.Lytton	01-3-13
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



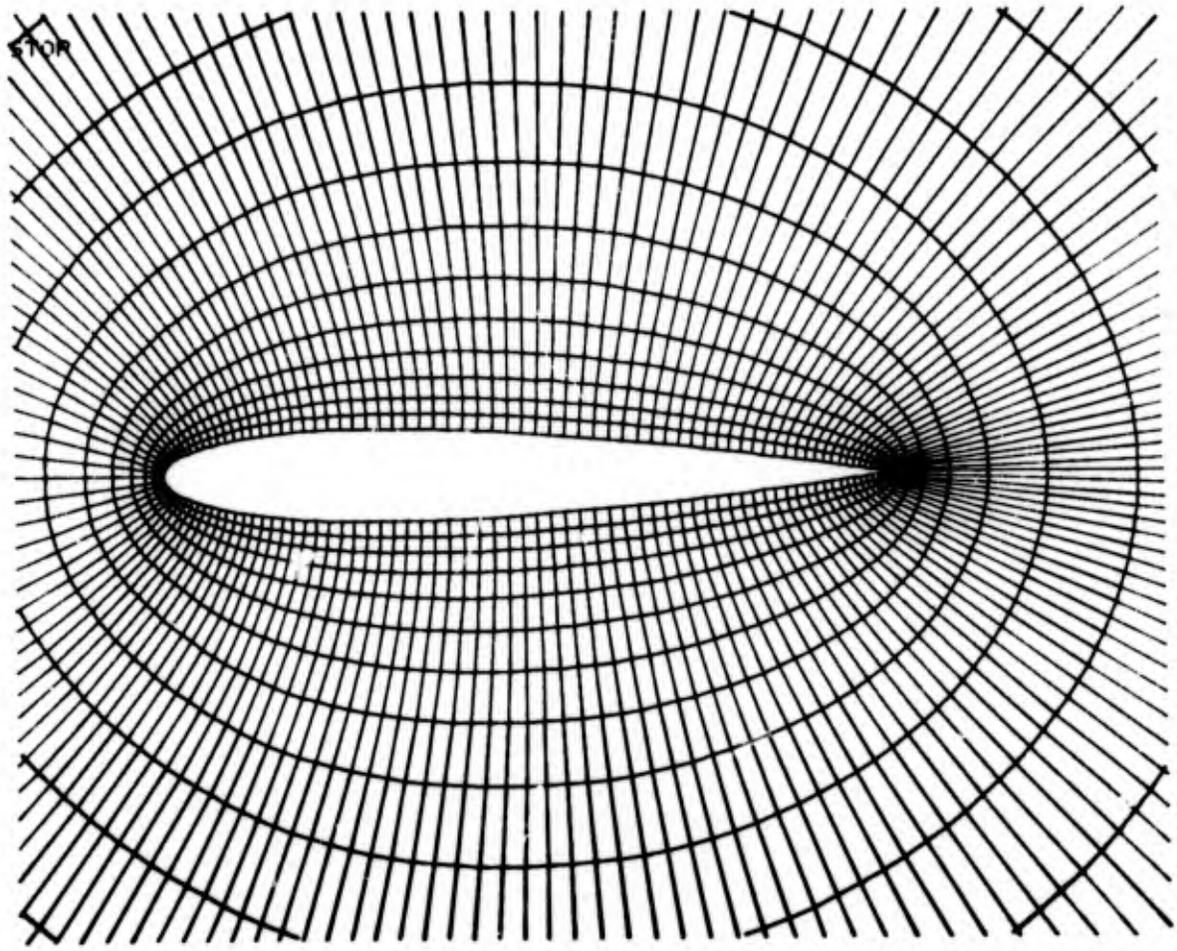
R.A.E.	AR 211		C.C.Lytton	01-3-14
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NACA 0012 GRID: 160 × 24, field depth = 16.0 chords all normal



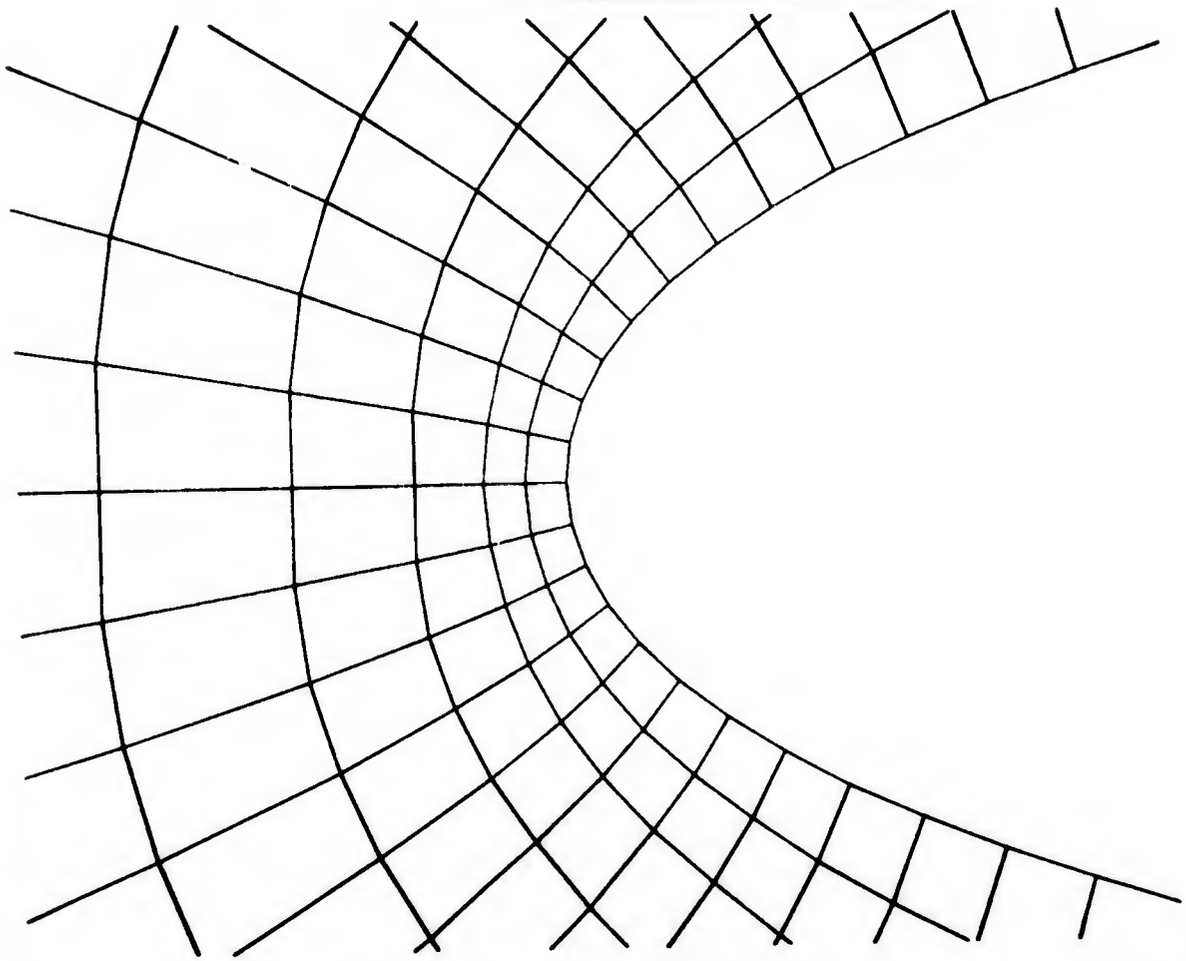
R.A.E.	AR 211		C.C.Lytton	01-3-15
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NACA 0012 GRID: $-0.2 < x < 1.2, -0.6 < y < 0.6$



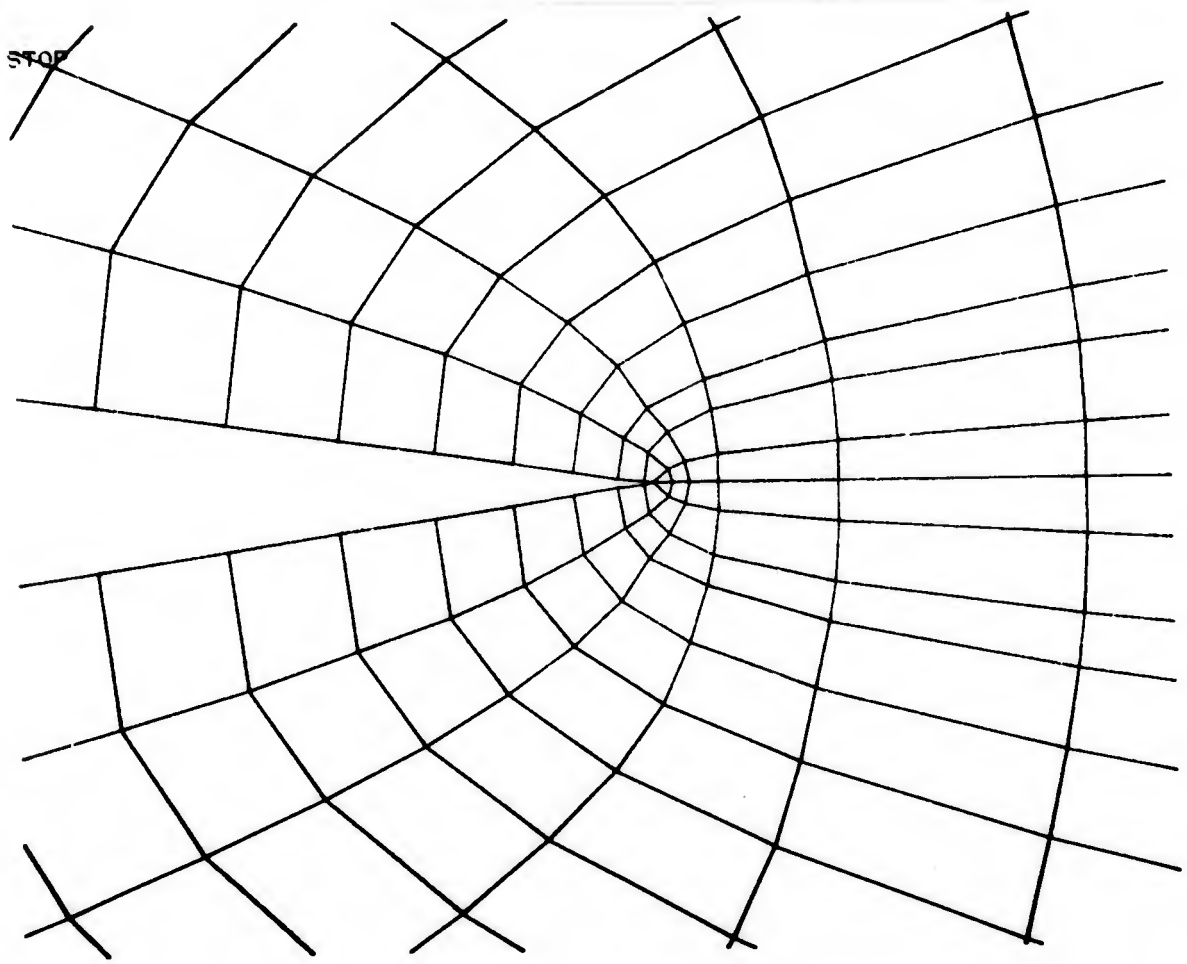
R.A.E.	AR 211		C.C.Lytton	01-3-16
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NACA 0012 GRID: $-0.05 < x < 0.05, -0.04 < y < 0.04$

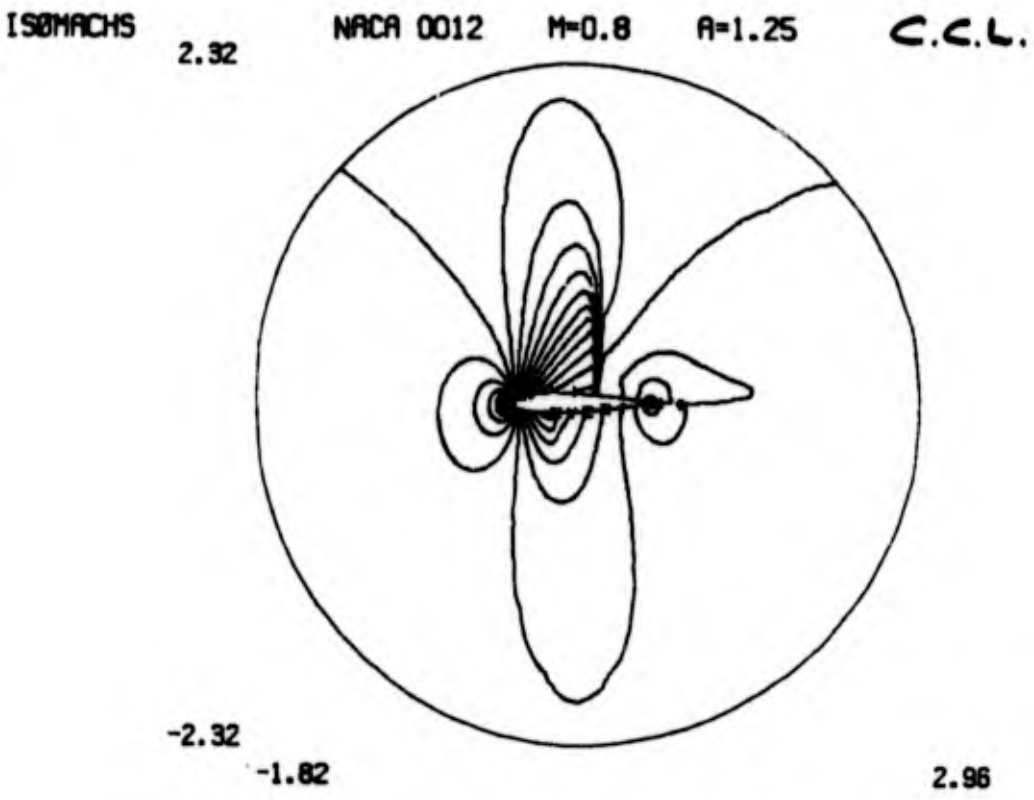


R.A.E.	AR 211		C.C.Lytton	01-3-17
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

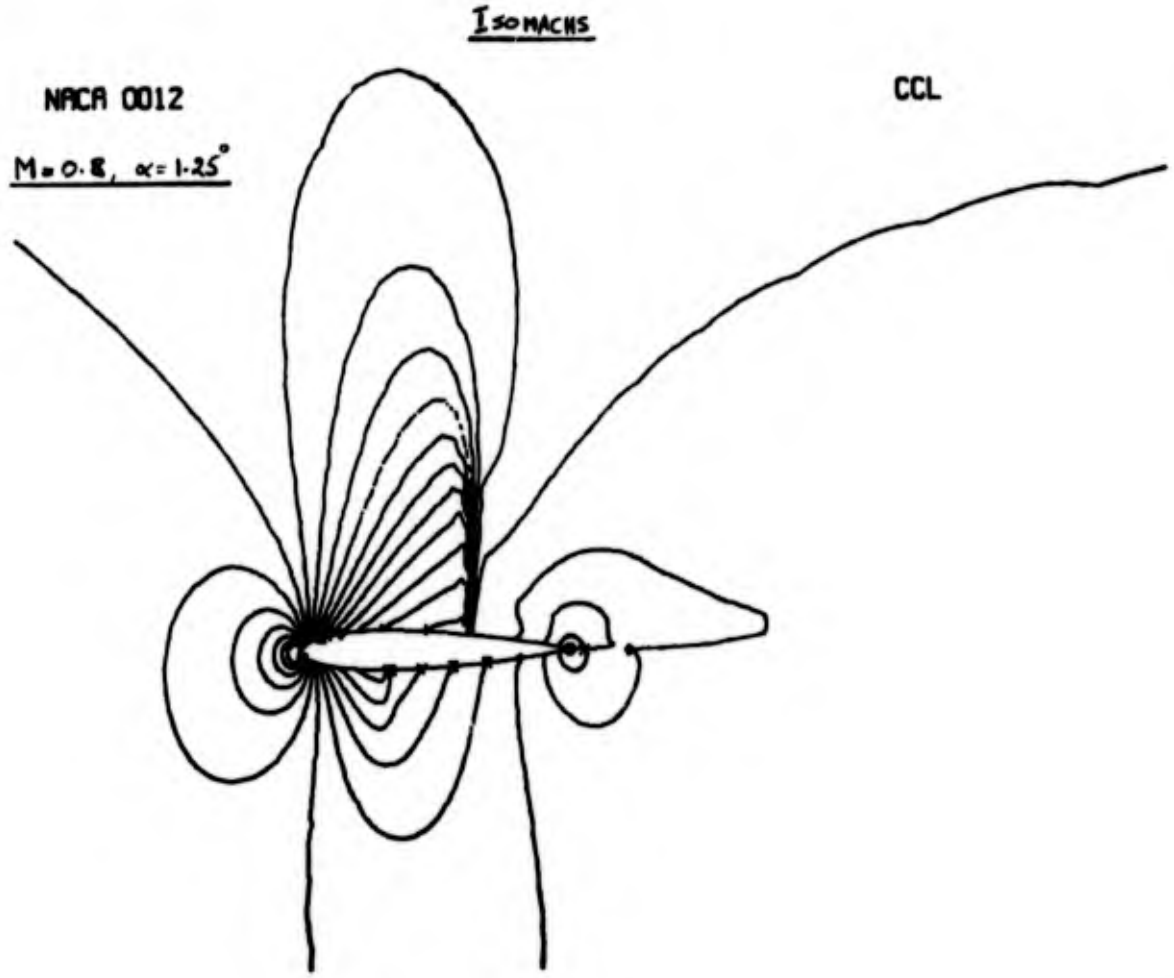
NACA 0012 GRID: $0.98 < x/c < 1.03, -0.02 < y < 0.02$



R.A.E.	AR 211		C.C.Lytton	01-3-18
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



R.A.E.	AR 211		C.C.Lytton	01-3-19
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 01

NACA 0012: MACH = 0.80, ALPHA = 1.25

Contributor No 5

T.H.Pulliam and J.T.Barton

(N.A.S.A. — Ames, U.S.A.)

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-1
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

TWO DIMENSIONAL EULER SOLUTIONS FOR AGARD TEST CASES

THOMAS H. PULLIAM‡ AND JOHN T. BARTON†

MS 202A-1, NASA Ames Research Center
Moffett Field, CA 94035

§1. Introduction. In compliance with the request of the AGARD Fluid Dynamics Panel a number of test cases are computed using a two–dimensional implicit Euler code. The code is based on one developed by Steger [1] and subsequently reported on in a number of specific showcase calculations, Steger and Bailey [2] and Steger et. al. [3] . The development of the algorithm and the results of numerical testing are given by [1] . The code has been improved as far as accuracy and convergence, and is coupled with an advanced graphics package. A general grid generation code for airfoils employing the analytical approach of Eiseman [4] is used for the geometry. Every attempt was made to comply with the requests of the Fluid Dynamics Panel, especially in the form of presentation of the final results.

A short outline of the code and numerics is presented below along with comments about the deficiencies and applicability of certain aspects of the numerical algorithm and code. Specific details are available in a recent paper by Pulliam, Jespersen and Childs [5] .

§2. Two–Dimensional Implicit Euler Code The two–dimensional Euler equations are written in generalized curvilinear coordinates and solved using an implicit approximate factorization algorithm. Details of the algorithm and code development are given by Steger[1] and Beam and Warming [6] . Here, we shall just outline some specific details. The equations are written in

---

‡Research Scientist, CFD Branch.
†Member, Professional Staff, Informatics General Corporation, Palo Alto, California. This work was supported in part by NASA Contract NAS2–9891.

generalized curvilinear coordinates

$$\partial_\tau \hat{Q} + \partial_\xi \hat{E} + \partial_\eta \hat{F} = 0 \tag{2.1a}$$

$$\hat{Q} = J^{-1}\begin{bmatrix}\rho\\ \rho u\\ \rho v\\ e\end{bmatrix}, \quad \hat{E} = J^{-1}\begin{bmatrix}\rho U\\ \rho u U + \xi_x p\\ \rho v U + \xi_y p\\ U(e+p) - \xi_t p\end{bmatrix}, \quad \hat{F} = J^{-1}\begin{bmatrix}\rho V\\ \rho u V + \eta_x p\\ \rho v V + \eta_y p\\ V(e+p) - \eta_t p\end{bmatrix} \tag{2.1b}$$

where the general transformations:

$$\begin{aligned} &\xi = \xi(x,y,t) && U = \xi_t + \xi_x u + \xi_y v\\ &\eta = \eta(x,y,t) && V = \eta_t + \eta_x u + \eta_y v\\ &\tau = t \end{aligned} \tag{2.2}$$

are used.

The equations are nondimensionalized, where density ρ is scaled by ρ_∞, the Cartesian velocities u and v by the free-stream speed of sound a_∞, and total energy e by $\rho_\infty {a_\infty}^2$. Pressure p is related to the other flow variables by the equation of state $p = (\gamma - 1)[e - \frac{1}{2}\rho(u^2 + v^2)]$. With this scaling, $p_\infty = \frac{1}{\gamma}$, $e_\infty = \frac{1}{\gamma(\gamma-1)} + \frac{1}{2}{M_\infty}^2$, and temperature scales to $T = \gamma p/\rho = a^2$.

The metric terms are related to derivatives of x, y, and t by

$$\begin{aligned} &\xi_x = J y_\eta, \quad \xi_y = -J x_\eta, \quad \xi_t = -x_\tau \xi_x - y_\tau \xi_y\\ &\eta_x = -J y_\xi, \quad \eta_y = J x_\xi, \quad \eta_t = -x_\tau \eta_x - y_\tau \eta_y\\ &J = 1/(x_\xi y_\eta - x_\eta y_\xi). \end{aligned} \tag{2.3}$$

With the use of these general transformations any two-dimensional geometry or grid system (the physical domain) can be mapped to a regular computational domain. The transformations are such that the spacing in the computational domain is unity and therefore uniform differencing formulas are used in the numerical algorithm irrespective of the spacings in the physical domain. Physical boundaries are mapped to constant ξ or η coordinate lines, making boundary condition application easier.

The numerical method is an implicit approximate factorization algorithm in delta form, see Beam and Warming[6] :

$$\begin{aligned} &(I + h\delta_\xi \hat{A}^n)(I + h\delta_\eta \hat{B}^n)\Delta\hat{Q}^n =\\ &\quad -\Delta t(\delta_\xi(\hat{A}\hat{Q})^n + \delta_\eta(\hat{B}\hat{Q})^n) \end{aligned} \tag{2.4}$$

where $\Delta\hat{Q}^n = \hat{Q}^{n+1} - \hat{Q}^n, h = \Delta t$ or $h = \Delta t/2$, and $\hat{A}$ and $\hat{B}$ are the Jacobians of the flux vectors (i.e., $\hat{A} = \partial\hat{E}/\partial\hat{Q}$). The Jacobian matrices are $\hat{A}$ or $\hat{B} =$

$$\begin{bmatrix} \kappa_t & \kappa_x & \kappa_y & 0 \\ -u\theta + \kappa_x\phi^2 & \kappa_t + \theta - (\gamma-2)\kappa_x u & \kappa_y u - (\gamma-1)\kappa_x v & (\gamma-1)\kappa_x \\ -v\theta + \kappa_y\phi^2 & \kappa_x v - (\gamma-1)\kappa_y u & \kappa_t + \theta - (\gamma-2)\kappa_y v & (\gamma-1)\kappa_y \\ \theta[2\phi^2 - \gamma(e/\rho)] & \kappa_x[\gamma(e/\rho) - \phi^2] - (\gamma-1)u\theta & \kappa_y[\gamma(e/\rho) - \phi^2] - (\gamma-1)v\theta & \gamma\theta + \kappa_t \end{bmatrix} \tag{2.5}$$

with $\theta = \kappa_x u + \kappa_y v$, $\phi^2 = \frac{1}{2}(\gamma-1)(u^2+v^2)$, and $\kappa = \xi$ or η for $\hat{A}$ or $\hat{B}$, respectively.

The numerical scheme can be first–order or second–order order accurate in time, depending upon whether ($h = \Delta t$) or ($h = \Delta t/2$) . Here we shall restrict ourselves to first–order accuracy and use the scheme to compute time–asymptotic steady states. Second–order central differences

$$\begin{aligned} q_{j,k} &:= q(j\Delta\xi, k\Delta\eta) \\ \delta_\xi q_{j,k} &= (q_{j+1,k} - q_{j-1,k})/(2\Delta\xi) \\ \delta_\eta q_{j,k} &= (q_{j,k+1} - q_{j,k-1})/(2\Delta\eta) \end{aligned} \tag{2.6}$$

are used throughout the solution domain except for a second–order upwind operator which is used in supersonic regions before shocks. Details of the upwind operator are given in the next section along with transition operators that blend the upwind with the central difference operators resulting in a conservative differencing scheme. The computational mesh spacing is chosen to be unity, i.e., $\Delta\xi = \Delta\eta = 1$.

A spatially variable time step that varies from point to point is employed, where Δt and h in Eq. (2.4) are replaced by

$$\sigma\left(\frac{1}{1+\sqrt{J}}\right) \tag{2.7}$$

and σ is then chosen to be $O(1)$. This particular form for the spatially variable time step was suggested by Srinivasan, Chyu, and Steger [7] .

For nonlinear flows, large gradients, such as shocks, introduce high–frequency oscillations that must be controlled by adding some form of filtering or smoothing term. Here, explicit fourth–order smoothing

$$-\epsilon_e \Delta t J^{-1}[(\nabla_\xi\Delta_\xi)^2 + (\nabla_\eta\Delta_\eta)^2]J\hat{Q}^n \tag{2.8a}$$

is added to the right–hand side of Eq. (2.4) and implicit second–order smoothing

$$-\epsilon_i \Delta t J^{-1} \nabla_\xi \Delta_\xi J, \quad -\epsilon_i \Delta t J^{-1} \nabla_\eta \Delta_\eta J \tag{2.8b}$$

is inserted into the respective implicit block operators. The difference operators are

$$\begin{aligned} \nabla_\xi q_{j,k} &= q_{j,k} - q_{j-1,k}, \quad \Delta_\xi q_{j,k} = q_{j+1,k} - q_{j,k} \\ \nabla_\eta q_{j,k} &= q_{j,k} - q_{j,k-1}, \quad \Delta_\eta q_{j,k} = q_{j,k+1} - q_{j,k} \end{aligned} \tag{2.9}$$

and are applied at all interior points. The parameter ϵ_e is chosen to be $O(1)$ and $\epsilon_i = 2\epsilon_e$. The smoothing terms scale with Δt, which is also replaced by Eq. (2.7) when the spatially variable time step is used.

The boundary conditions used are applied explicitly. Sketch 1 shows a sketch of the solution domain. At the in flow and far field outer boundary, free–stream values are held fixed. In the case of supersonic free–stream flow, all variables are extrapolated to the outflow boundaries. When the free–stream is subsonic, all variables but energy are extrapolated, and energy is set to preserve free–stream pressure. Averaging is used across the wake to ensure continuity. The Kutta condition at the trailing edge is automatically calculated; i.e., there is no special treatment of the trailing edge velocities or pressure. At the body, tangency is enforced by setting $V = 0$ and extrapolating U to the body. The Cartesian velocities are recovered by

$$\begin{pmatrix} u \\ v \end{pmatrix} = J^{-1} \begin{bmatrix} \eta_y & -\xi_y \\ -\eta_x & \xi_x \end{bmatrix} \cdot \begin{pmatrix} U - \xi_t \\ -\eta_t \end{pmatrix}. \tag{2.10}$$

The extrapolation of U requires that the mesh lines be clustered and near normal at the body surface.

The pressure on the body surface is obtained from the normal momentum equation

$$\begin{aligned} &\rho[\partial_\tau \eta_t + u\partial_\tau \eta_x + v\partial_\tau \eta_y] - \rho U(\eta_x u_\xi + \eta_y v_\xi) = \\ &(\eta_x \xi_x + \xi_y \eta_y) p_\xi + (\eta_x{}^2 + \eta_y{}^2) p_\eta = p_n \sqrt{\eta_x{}^2 + \eta_y{}^2} \end{aligned} \tag{2.11}$$

where n is the local normal to the body surface. Free–stream stagnation enthalpy h_0 is held constant along the body. Using the equation for enthalpy $h = (e + p)/\rho$ and the computed velocities and pressure, a value of density is obtained at the body.

§3. Upwind Differencing Scheme.

Central differencing is used throughout the solution domain, except in the region of supersonic flow before a shock. The use of upwinding for shocks is widespread in transonic potential calculations. Upwind differencing before shocks has a stabilizing effect and improves the accuracy of the calculations. The particular form of upwinding is taken from Warming and Beam [8] and was also employed in the original work of Steger[1] .

The central difference operator has the form

$$\delta_\xi^c = \frac{E^+ - E^-}{2\Delta\xi} \tag{3.1}$$

where E^+ and E^- represent shift operators (i.e., $E^+ u_j = u_{j+1}$ and $E^- u_j = u_{j-1}$). Here, we shall define everything in one dimension with $u_j = u(j\Delta\xi)$. In the supersonic region before a shock the second-order Padé operator

$$\delta_\xi^b = \frac{I - E^-}{\frac{1}{2}\Delta\xi(I + E^-)} \tag{3.2}$$

is used as the upwind operator.

A "C" mesh topology (see Section 4) is used where the ξ coordinate lines wrap around the airfoil from the lower surface trailing edge past the nose to the upper surface trailing edge. Therefore, on the upper surface an upwind difference is a backward difference operator; on the lower surface, forward differences have to be used. The forward difference operator has the form

$$\delta_\xi^f = \frac{E^+ - I}{\frac{1}{2}\Delta\xi(I + E^+)}. \tag{3.3}$$

As is well known from the work of Murman [9] , Warming and Beam [8] , and more recently, Hessenius and Pulliam [10] , the discontinuous switching from one operator to another can lead to local nonconservation. This particular example of switching from central differencing to one sided differencing does produce local nonconservation and therefore a transition operator is needed to smoothly join the two operators and maintain conservation. Warming and Beam [8] have developed and reported in detail a systematic way to form such a transition operator.

The method uses a combined operator which has a free parameter ϵ_j such that $\epsilon_j = 0$ produces the central operator and $\epsilon_j = 1$ gives the one-sided operator.

The new differencing scheme is

$$\tilde{\delta}_\xi = \frac{I - \tilde{\nabla}_\xi \epsilon_j}{\frac{1}{2}(2I - \epsilon_j I + E^{-}\epsilon_j)} \delta^c_\xi. \tag{3.4}$$

Warming and Beam [8] also show that a scheme obtained in the above manner is conservative. The resulting scheme at a transition point j (i.e., a point where $\epsilon_{j-1} \neq \epsilon_j$) is only first–order accurate. This occurs at only a few points in the flow field and does not seem to degrade the overall accuracy (as demonstrated in numerical experiments by the authors and Warming and Beam).

This new differencing depends on the two parameters $(\epsilon_{j-1}, \epsilon_j)$ and there are four possible cases :

$$(\epsilon_{j-1}, \epsilon_j) = \begin{bmatrix} (0,0) & \text{purely central differencing} \\ (1,1) & \text{purely upwind differencing} \\ (0,1) & \text{transition from central to upwind} \\ (1,0) & \text{transition from upwind to central} \end{bmatrix} \tag{3.5}$$

The parameter ϵ_j is chosen to be 0 in subsonic regions and 1 in supersonic regions. The eigenvalues of the Jacobian matrix $\hat{A}$ are $U, U, U \pm a\sqrt{\xi_x{}^2 + \xi_y{}^2}$, where $a = \sqrt{\gamma p/\rho}$. These are checked along each ξ coordinate line and ϵ_j is set to 1 when all the eigenvalues are positive. The upwind switches are post - processed to limit them to a few points near the shock.

Warming and Beam[8] discuss the necessity of turning off the added dissipation terms in the upwinded areas. The addition of the fourth–order smoothing has been found to be detrimental and not necessary due to the dissipative nature of the backward and forward difference operators. The fourth–order ξ terms of Eq. (2.8a) are modified to

$$((\nabla_\xi - \epsilon_j \nabla_\xi)\Delta_\xi \nabla_\xi \Delta_\xi) \tag{3.6}$$

where $\epsilon_j = 1$ turns off the smoothing and $\epsilon_j = 0$ produces the original term. By switching the ∇_ξ and ϵ_j in the first bracketed term we obtain the total operator with conservative transition

$$\begin{aligned} &[(\nabla_\xi - \nabla_\xi \epsilon_j)\Delta_\xi \nabla_\xi \Delta_\xi] = \\ &[(1 - \epsilon_j) - (1 - \epsilon_{j-1})E^{-1}] \cdot [E^{+2} - 3E + 3I - E^{-1}]. \end{aligned} \tag{3.7}$$

§4. Geometry and Grid Generation.

A specialized code which generates "C" grids around airfoil sections was developed. Details of the generation scheme are given below. The scheme is based on the algebraic grid generation work of Eiseman[4] . The airfoil coordinates are taken as input and used to define the airfoil surface. On the surface, grid points are distributed with clustering at the nose, trailing edge, and (optionally) at prescribed locations on the upper and lower surfaces. The locations of the upper and lower surface clusterings are chosen so as to resolve shocks. Coarse grid solutions can be used to determine these locations. The grid lines are clustered in the normal direction at the surface with a typical spacing of 0.005 chord normal to the airfoil surface. More details concerning the coordinates of the grid points in the wake and on the airfoil are given in Section 5.

The important constraints on the grids generated are that the lines come in normal to the surface (body) boundary, that minimum spacings are specified for clusterings and that the minimum spacing in the normal direction at the body is held constant. Other details of the grid generation can be found in Ref.[5] . The entire process is quite fast even for large grids. The present interactive program will generate a 161 by 33 grid around a NACA 0012 airfoil in about 7.5 seconds of CPU time on a VAX 11/780.

§5. Parameter Studies

In order to check the validity of the computations, the sensitivity of the solution to several parameters has been studied. The quantities which were felt to be possible significant sources of error were varied, and the effects on the solution observed. By far the greatest changes in the solution came from the placement of the outer boundaries. The other quantities which were perturbed were the grid spacing at the nose in the direction parallel to the body, the number of points in the direction perpendicular to the body, and the magnitude of the fourth order explicit and second order implicit smoothing. The base conditions from which all these calculations varied was the AGARD01 case, as described in this report, except the grid size was 249 by 41, and the outer boundaries were 12 chord lengths upstream of the body, and 24 chord lengths in all other directions.

The first change studied was the degree of clustering of the grid at the nose of the body. The spacing there, Δx_N was doubled to .004 and halved to .001. No appreciable effect on the coefficient of lift was seen. The computed values were respectively $c_L = .34980$ and $c_L = .34868$, as compared to $c_L = .348549$ (for $\Delta x_N = .002$). The flow expansion arising at the leading edge is a potential source of error because of the high gradients in the flow quantities

there. One may conclude that errors in the resolution of this region due to coarseness of grid were not consequential.

The implicit and explicit smoothing terms were simultaneously halved, with a resulting increase in c_L to .35104, a relatively small change. The smoothing terms are added to stabilize the algorithm, and dissipate oscillations arising from shocks. The solution is changed by these terms. One would expect that less smoothing would result in a shock location further aft, higher velocities, lower pressure in a larger supersonic region, and a stronger shock. All of these effects would contribute to higher lift. The small change in lift resulting from the halving of the smoothing shows that these effects are not important in this calculation.

The number of points in the direction normal to the airfoil was increased to 67 from 41, with no change in Δy_{min} at the body. There was a rise in lift to $c_L = .34891$, a small amount. The effect of this change was to change the factor by which the grid was exponentially stretched, and to reduce Δy_{max} at the outer boundary. Both of these are potential sources of error. The small magnitude of the change in lift is taken to indicate that these errors were not significant.

The distance to the outer boundary was halved to 6 chord lengths upstream, and 12 to the sides and downstream. The lift dropped to $c_L = .3324$. Doubling and redoubling the distances to the outer boundaries caused rises to $c_L = .3600$ and $c_L = .3661$, respectively. The difference between the high and low values of lift amounts to over 10%. This shows that the currently implemented far field Dirichlet boundary conditions in our code are very sensitive to boundary distance. This sensitivity is due to the assumption that the flow field is sufficiently close to uniform free stream at the far field boundary. We have rerun the AGARD01, AGARD02 and AGARD06 cases with boundaries at 96 chord lengths. Our approach to the difficulty, recalculation with the boundaries further removed, is not the best long term solution. One would wish for boundary conditions that are not sensitive to the distance to the boundary, and work is underway to that end.

§6. Results and Discussion

The cases considered here are the three airfoils from AGARD FDP WG 07, as suggested by Dr. Leonard Roberts who is our contact. Seven cases are considered, five for an NACA0012, one for the RAE2822, and one for the

NLR7301. They will be referred to as:

NAME	AIRFOIL	M_∞	α_∞
AGARD01	NACA0012	0.8	1.25
AGARD02	NACA0012	0.85	1.00
AGARD03	NACA0012	0.95	0.00
AGARD04	NACA0012	1.2	0.00
AGARD05	NACA0012	1.2	7.00
AGARD06	RAE 2822	0.75	3.00
AGARD07	NLR 7301	0.721	−0.194

Each case was initialized with a uniform free-stream flow at the prescribed Mach number and angle of attack. A slow start ramping of the boundary conditions over either 36 (or 100) time steps was employed for all the cases with peak residuals being reached at approximately 50 (or 150) time steps.

In the cases presented the grid size is either 249×41, 249×65, or 249×67, that is, 249 points in the ξ direction and either 41, 65, or 67 in the η direction. Specific details for each grid are given with the discussion of the results.

The residuals and ΔQ are defined relative to Eq. (2.4) and Eq.(2.8). The change in the flow variables, ΔQ is taken directly from Eq.(2.4), i.e.,$\Delta Q^n = Q^{n+1} - Q^n$. Note that the metric Jacobian has been taken out. For the residual we take the steady-state equations, the right hand side of Eq.(2.4) plus the explicit smoothing term, Eq.(2.8a). The time step is divided out and therefore the residual measures how well the solution satisfies the finite difference equations. Specifically, define

$$R^n = -(\delta_\xi(\hat{A}\hat{Q})^n + \delta_\eta(\hat{B}\hat{Q})^n) - \epsilon_e J^{-1}[(\nabla_\xi\Delta_\xi)^2 + (\nabla_\eta\Delta_\eta)^2]J\hat{Q}^n \quad . \quad (5.1)$$

The $L2$ norm and max norm are computed for each of the equations and flow variables separately in the usual way where

$$|R^n|_2 = \left\{\frac{1}{N}\sum_p (R_p^n)^2\right\}^{1/2} \quad (5.2a)$$

and

$$|R^n|_1 = MAX_p|R_p^n| \quad (5.2b)$$

with N the total number of points, p. The residuals are calculated before scaling by the spatially variable time step.

In all the graphics shown the scaling of the units relative to centimeters is as specified in AGARD FDP WG-07 except where otherwise noted on the figure. More information can be provided at the request of the panel.

§6a AGARD01 NACA0012 $M = 0.80 \quad \alpha = 1.25$

Grid

The grid for AGARD01 is presented in Figures 1a – 1e, with the full extent given in Fig. 1a and closeups in Figs. 1b–1e. There are 34 points in the wake from the trailing edge to the far field right boundary. A total of 181 points are distributed on the body (91 on the upper and 90 on the lower surface) with clustering at the leading edge (minimum $\Delta x = 0.002$) and clustering at the trailing edge (minimum $\Delta x = 0.004$). Clustering is also used for resolution of the shocks, where on the upper surface for $0.61 \leq x \leq 0.65 : \Delta x = 0.008$ and on the lower surface for $0.34 \leq x \leq 0.38 : \Delta x = 0.008$. The minimum spacing in the normal direction is $\Delta y = 0.005$ and exponential stretching is used to the outer boundary. There are 67 grid points in normal direction. The physical extent of the domain is $-48.0 \leq x \leq 96.0$ and $-96.0 \leq y \leq 96.0$.

Convergence Histories

A series of solutions were run to obtain the final result which is reported on here. Initially, coarse grid calculations were performed to determine the shock locations. Grids were then generated with some clustering in the shock regions. For cases in which the local shock clustering was extreme ($\Delta x \approx 0.001$) the residual history was oscillatory with very high frequency and large amplitude. The overall trend was convergent, but the convergence was slow. If the local clustering was not extreme ($\Delta x = 0.008$, for instance) a much cleaner convergence history was obtained, as shown in Figs. 1f – 1i. These plots show the residuals as defined in Eq.(5.2), where each curve corresponds to a separate flow variable or equation. The change in line type from solid to dashed indicates that a sequence of runs is shown. Calculations on this grid exhibited better overall convergence than the more highly clustered ones.

The source of the persistently large residuals on grids with extreme clustering was found to be the upwind switches toggling on and off along the shock line. Near the body, the grid cells were roughly square and the grid lines approximately normal to the body. In the region 10 to 20 grid points away from the body, where the shock was still reasonably strong, the aspect ratio of the grid was increased. This is because the Y-coordinates increase exponentially away from the body, whereas the X-coordinates change little. Since we employ a shock capturing technique, the shock is not exactly aligned with the grid, and the high aspect ratio exacerbates this discrepancy. The supersonic upwind scheme described in section 3 works well for moderately clustered grids, but can become nearly neutrally stable in the presence of extreme (e.g. $\Delta x = .001$) clustering at the shocks. Shock location can be determined to

within a fraction of the grid spacing by noting where, for example, the surface Mach number plot crosses 1.0. It is therefore not necessary to cluster grids more finely than we have in order to compute an accurate solution. The ability to cluster more finely would give greater flexibility to the user in grid selection, however, and would be desirable for that reason.

The residuals and ΔQ were decreased by 7 orders of magnitude in 2000 iterations. The solution was actually converged to plotting accuracy in about 400 iterations, as demonstrated by the convergence histories for C_L (coefficient of lift), C_D (coefficient of drag), and C_{pm} (coefficient of pitching moment about the quarter chord), in Figs. 1j – 1l. The flowfield was converged in about 400 iterations, as demonstrated by comparing contour plots at various stages during convergence.

Maximum residuals and ΔQ occur either at the top of the shock out in the field, or at the farfield downstream boundary. This is consistent throughout most the convergence history. The farfield errors could possibly be reduced with a better boundary condition treatment; we are currently investigating this. The large residuals at the upper portion of the shocks may be linked to the central differencing; again we are currently studying this issue. In general, the rest of the flowfield was fairly quiet and converged rapidly.

Surface Plots

Surface values are plotted versus x and y in Figs. 1m – 1v. These results are typical of what is usually obtained with this code for airfoils with shocks on the upper and lower surfaces. In this case, a strong shock occurs on the upper surface and a weak shock on the lower surface. In other calculations,(see for instance Ref.[5]), with a wide variety of grids and grid spacings the location of the shocks was consistent. The shock location is defined as the point where the shock crosses C_p^*.

The upwind operator eliminates pre–shock oscillations in this calculation. Post–shock oscillations are due to the central differencing in the subsonic regions. The surface plots show the actual distribution of points on the body which are then connected by lines. Note a slight error in stagnation pressure at the leading edge. This has been traced to the grid where the rapid change in curvature causes some error in the grid generator. But, as seen in the flowfield contours, good stagnation quantities are calculated at the nose. For all the cases presented here the condition of total stagnation enthalpy fixed at the body is equivalent to zero stagnation temperature at the body, as demonstrated in Figs. 1u and 1v.

Tabulated data for the surface values are presented in Table 1. The

converged values for lift, drag, and moment are

$$C_L = 0.3661, \quad C_D = 0.02288, \quad C_{pm} = -.04303,$$

with computed circulation $\Gamma = 0.17228$.

Flowfield Contours

Flowfield contours for this case are presented in Figs. 1w – 1ah. Mach contours in Fig.1w are smooth and exhibit a sharp captured shock. The discontinuity in Mach contours in the wake is due to the change in total quantities behind the shock, see Fig. 1ac. For instance, stagnation pressure jumps across the shock on the upper surface with the jump weakening with distance from the body. On the lower surface there is a very weak shock. This leads to a sharp gradient in total quantities along the wake cut roughly aligned with streamlines.

Figure 1y shows the relative thickness of upper surface shock. In Fig. 1z, a farfield view is shown, demonstrating how far away the farfield boundaries are from any large gradients in the solution.

Stagnation pressure and temperature are shown for the nose region in Figs. 1ae and 1ah. The stagnation temperature field is essentially constant, with variations only in the 3^{rd} decimal place, while for stagnation pressure all the variation is near the upper surface shock.

Please note that the contour values given at the left hand side of the figures are for the whole field including the flow domain not shown.

The scenario for the rest of the cases is very similar to that for AGARD01. The order of the figures is consistent and the comments made above can be applied in most instances. Wherever pertinent, additional details will be given below.

§6b AGARD02 NACA0012 $M = 0.85 \quad \alpha = 1.0$

Grid

The grid for AGARD02 is presented in Figures 2a – 2e, with the full extent given in Fig. 2a and closeups in Figs. 2b – 2e. There are 34 points in the wake from the trailing edge to the far field right boundary. A total of 181 points are distributed on the body (91 on the upper and 90 on the lower surface) with clustering at the leading edge (minimum $\Delta x = 0.002$) and clustering at the trailing edge (minimum $\Delta x = 0.004$). The minimum spacing in the normal direction is $dy = 0.005$ and exponential stretching is used to the

outer boundary. The physical extent of the domain is $-48.0 \leq x \leq 96.0$ and $-96.0 \leq y \leq 96.0$.

Convergence Histories

The residual and ΔQ histories are given in Figs. 2f – 2i. Again note the high frequency oscillation for the initial part of convergence and then the smooth convergence rates. The high frequency oscillation is due to a rapid one or two point motion of the shock system in the initial set up of the flow. This usually occurs out in the field about at the top of the shock. Maximum residuals occur in that location.

The residuals and ΔQ were decreased by over 5 orders of magnitude in 2000 iterations. The solution was actually converged to plotting accuracy in about 600 iterations, as demonstrated by the convergence histories for C_L, C_D,and C_{pm} in Figs. 2j – 2l.

Surface Plots

Surface values are plotted versus x and y in Figs. 2m – 2t. Note that all the shocks calculated are three point shocks, with very sharp profiles. The upwind operator eliminates pre–shock oscillations, except for the one point overshoot for the upper surface due to the transition operator. This overshoot is dependent on the switching point logic defined above and the location of a point near C_p^*, see Fig. 2o. When a grid point falls near C_p^* the switching point logic chooses the next point back as the transition point. Though one may try to fix this overshoot problem by various strategies involving the placement of the transition point, the most robust method found was to place it at the last supersonic point. These strategies are complicated by the curvature of the shock in computational space arising from the high aspect ratio of cells away from the body, as discussed in the previous section on AGARD01. The transition point cannot be forced to always lie in the middle of the shock because of possibility of unstable upwind differencing in subsonic regions. Post–shock oscillations are due to the central differencing in the subsonic regions. These comments apply to all the shocks obtained in this study. The surface plots show the actual distribution of points on the body which are then connected by lines.

Tabulated data for the surface values are presented in Table 2. The converged values for lift, drag, and moment are

$$C_L = 0.38895, \quad C_D = 0.05900, \quad C_{pm} = -0.13782,$$

with computed circulation $\Gamma = 0.20053$.

Flowfield Contours

Flowfield contours for this case are presented in Figs. 2u – 2ae. Mach contours in Fig.2u are smooth and exhibit sharp captured shocks. Figure 2w shows the relative thickness of upper surface shock. In Fig. 2x, a farfield view is shown, demonstrating how far away the farfield boundaries are from any large gradients in the solution.

Stagnation pressure and temperature are shown for the nose region in Figs. 2ab and 2ae. Again, good stagnation values are obtained at the nose. The stagnation temperature field is essentially constant, with variations only in the 3rd decimal place, while for stagnation pressure all the variation is near the upper surface shock.

§6c AGARD03 NACA0012 $M = 0.95 \quad \alpha = 0.0$

Grid

The grid for AGARD03 is presented in Figures 3a – 3f, with the full extent given in Fig. 3a and closeups in Figs. 3b – 3f. There are 65 points in the wake from the trailing edge to the far field right boundary. A total of 119 points are distributed on the body (60 on the upper and 59 on the lower surface) with clustering at the leading edge (minimum $\Delta x = 0.001$) and clustering at the trailing edge (minimum $\Delta x = 0.005$). The minimum spacing in the normal direction is $dy = 0.005$ and exponential stretching is used to the outer boundary. The physical extent of the domain is $-8.0 \leq x \leq 10.0$ and $-24.0 \leq y \leq 24.0$. A slight bit of clustering was added in the wake to resolve the expected shock system, here for $2.0 \leq x \leq 4.0 : \Delta x = 0.10$.

Convergence Histories

Convergence histories for this case are shown in Figs. 3g – 3j. Initially the solution appears to be converging, but then a state of neutral stability seems to occur. In fact, most of the field is fully converged, especially at the body surface, see Figs. 3k – 3m. Again, the maximum residuals and ΔQ occur either at the top of the shock out in the field or at the farfield downstream boundary. This is consistent throughout most the convergence history. The level of convergence shown in Figs. 3g – 3j is being controlled by the maximum values and is not really indicative of the overall convergence of the field.

It should be noted that this is a difficult case with a complicated flow and shock structure. As is seen from the surface plots and flowfield contours a "fishtail" shock system occurs and is extended far out into the field.

Surface Plots

Surface values are plotted versus x and y in Figs. 3n – 3aa. In this case an oblique supersonic to supersonic shock occurs at the trailing edge, and is then

terminated by a supersonic to subsonic normal shock downstream at about $x = 3.0$, see Fig. 3o. The upwind differencing is turned off in this case for the oblique shock and hence the central differencing causes oscillations in this region. See the discussion of AGARD04 for more information on this point.

Surface plots are given for the airfoil and downstream taken along the mean chord line. Wild oscillations occur for stagnation values, again due to the central differencing.

Tabulated data for the surface values are presented in Table 3. The converged values for lift, drag, and moment are

$$C_L = 0.236920 \times 10^{-4}, \quad C_D = 0.109066, \quad C_{pm} = -.650216 \times 10^{-5},$$

with computed circulation $\Gamma = 0.0$.

Flowfield Contours

Flowfield contours for this case are presented in Figs. 3ab – 3aj. Mach contours are shown in Fig. 3ab and exhibit the "fishtail" shock system. The view is expanded in Fig. 3ae showing that the outer boundary seems to be far enough out so as to not interfere with the shock system. A preliminary study of this flow showed a substantial variation in the secondary shock structure in response to a variation in outer boundary distance. In Figs. 3ak and 3al we compare the surface pressure for two outer boundary distances. In Fig. 3ak the outer boundary had a $y_{max} = 24.$, while in Fig. 3al the outer boundary was at $y_{max} = 12.$. The secondary shock moves about $\frac{1}{2}$ chord upstream for the closer boundary case. This is consistent with results reported by Holst[11] For the case presented here the outer boundary was placed at $y_{max} = 24$.

Stagnation pressure and stagnation temperature variations all occur at the trailing edge, Fig. 3ai and 3aj.

§6d AGARD04 NACA0012 $M = 1.2 \quad \alpha = 0.$

Grid

The grid for AGARD04 is presented in Figures 4a – 4e, with the full extent given in Fig. 4a and closeups in Figs. 4b – 4e. There are 34 points in the wake from the trailing edge to the far field right boundary. A total of 181 points are distributed on the body (91 on the upper and 90 on the lower surface) with clustering at the leading edge (minimum $\Delta x = 0.001$) and clustering at the trailing edge (minimum $\Delta x = 0.005$). The minimum spacing in the normal direction is $dy = 0.005$ and exponential stretching is used to the outer boundary. The physical extent of the domain is $-2.0 \leq x \leq 8.0$ and $-12.0 \leq y \leq 12.0$.

Convergence Histories

The residual and ΔQ histories are given in Figs. 4f – 4i. In this case, we converge about 10 orders of magnitude in 1600 iterations. Supersonic free–stream cases usually exhibit very good convergence due to the lack of upstream propagation of errors. Convergence histories for C_L, C_D,and C_{pm} are shown in Figs. 4j – 4l.

Surface Plots

Surface values are plotted versus x and y in Figs. 4m – 4u. In this case an oblique shock occurs at the trailing edge and as seen in the contours a bow shock forms in front of the airfoil. The oblique supersonic to supersonic shock at the trailing edge caused some trouble when the upwind operator was employed. In Fig. 4r, we have a solution without upwind differencing, and the central differences across the shock produce large oscillations. If the upwind operator is turned on, the pre–shock oscillations are eliminated, but since the flow past the trailing edge shock is supersonic the upwind differencing stays on and propagates oscillations far downstream. To eliminate this, the upwind operator was restricted to the region over the body surface only and central differences were used downstream of the trailing edge. This produces the essentially oscillation–free solution presented here, see for comparison Fig. 4q. This strategy was also used for AGARD05.

Tabulated data for the surface values are presented in Table 4. The converged values for lift, drag, and moment are

$$C_L = 0.00000, \quad C_D = 0.09586, \quad C_{pm} = 0.00000,$$

with computed circulation $\Gamma = 0.0000$.

Flowfield Contours

Flowfield contours for this case are presented in Figs. 4v – 4ab. Mach contours in Fig. 4v show the bow shock and trailing edge shock system. Figure 4w was added because the contour levels in Fig. 4v obscure the result. In Fig. 4y, a farfield view is shown, demonstrating how far away the farfield boundaries are from any large gradients in the solution.

Again, good stagnation values are obtained at the nose, see Fig. 4ab.

§6e AGARD05 NACA0012 $M = 1.2 \quad \alpha = 0$.

Grid

The grid for AGARD05 is the same as for AGARD04.

Convergence Histories

The residual and ΔQ histories are given in Figs. 5a – 5d. In this case, we converge about 10 orders of magnitude in 1600 iterations. Convergence

histories for C_L, C_D,and C_{pm} are shown in Figs. 5e – 5g. The jump in the residuals, see Fig. 5a, is due to a change in the boundary condition similar to what occurred in AGARD01. For AGARD05 the solution was sensitive to the stagnation enthalpy boundary condition at least in the initialization phase. The run was therefore started with the old density extrapolation boundary condition and then after 200 steps the new enthalpy condition was turned on for the remainder of the iterations. Convergence rates were not affected.

Surface Plots

Surface values are plotted versus x and y in Figs. 5h – 5q. This case also has an oblique shock at the trailing edge and, as seen in the contour plots, a bow shock in front of the airfoil. The same strategy for the upwind operators that was used for AGARD04 was used for this case.

Tabulated data for the surface values are presented in Table 5. The converged values for lift, drag, and moment are

$$C_L = 0.51965, \quad C_D = 0.15431, \quad C_{pm} = -0.11020,$$

with computed circulation $\Gamma = 0.2995$.

Flowfield Contours

Flowfield contours for this case are presented in Figs. 5r – 5w. Mach contours in Fig. 5r show the bow shock and trailing edge shock system. In Fig. 5u, a farfield view is shown, demonstrating how far away the farfield boundaries are from any large gradients in the solution. Again, good stagnation values are obtained, see Fig. 5w.

§6f AGARD06 RAE2822 $M = 0.75 \quad \alpha = 3.0$

Grid

The grid for AGARD06 is presented in Figures 6a – 6e, with the full extent given in Fig. 6a and closeups in Figs. 6b – 6e. It has 249 points in the direction parallel to the body, and 65 points normal to the body. There are 34 points in the wake from the trailing edge to the far field right boundary. A total of 181 points are distributed on the body (91 on the upper and 90 on the lower surface) with clustering at the leading edge (minimum $\Delta x = 0.001$) and clustering at the trailing edge (minimum $\Delta x = 0.01$). The minimum spacing in the normal direction is $dy = 0.005$ and exponential stretching is used to the outer boundary. The physical extent of the domain is $-98.0 \leq x \leq 98.0$ and $-98.0 \leq y \leq 98.0$.

Convergence Histories

The residual and ΔQ histories are given in Figs. 6f – 6i. There is a little bit of the high frequency oscillation for the initial part of convergence, then

the convergence rates becomes smooth. In this case the enthalpy boundary condition was used throughout the entire convergence history. Maximum residuals occur near the top of the shock.

The residuals and ΔQ were decreased by 9 orders of magnitude in 1600 iterations. The solution was actually converged to plotting accuracy in about 400 iterations, as demonstrated by the convergence histories for C_L, C_D,and C_{pm} in Figs. 6j – 6l.

Surface Plots

Surface values are plotted versus x and y in Figs. 6m – 6v. Nothing unusual occurs and the results are analogous to those of other calculations.

Tabulated data for the surface values are presented in Table 6. The converged values for lift, drag, and moment are

$$C_L = 1.04392, \quad C_D = 0.03873, \quad C_{pm} = -.16700,$$

with computed circulation $\Gamma = 0.48946$.

Flowfield Contours

Flowfield contours for this case are presented in Figs. 6w – 6ah. Mach contours in Fig. 6w are smooth and exhibit a sharp captured shock. Figure 6y shows the relative thickness of upper surface shock. In Fig. 6z, a farfield view is shown, demonstrating how far away the farfield boundaries are from any large gradients in the solution.

Stagnation pressure and temperature are shown for the nose region in Figs. 6ad and 6ag. Again, good stagnation values are obtained at the nose. The stagnation temperature field is essentially constant, with variations only in the 3^{rd} decimal place, while for stagnation pressure all the variation is near the upper surface shock. In Fig. 6ah, we see one problem with the stagnation enthalpy boundary condition in that the stagnation value jumps across the shock and is not consistent with the body condition. The error introduced is small and does not affect the overall solution.

§6g AGARD07 NLR7301 $M = 0.721 \quad \alpha = -0.194$

Grid

The grid for AGARD07 is presented in Figures 7a – 7e, with the full extent given in Fig. 7a and closeups in Figs. 7b – 7e. There are 34 points in the wake from the trailing edge to the far field right boundary. A total of 181 points are distributed on the body (91 on the upper and 90 on the lower surface) with clustering at the leading edge (minimum $\Delta x = 0.001$) and clustering at the trailing edge (minimum $\Delta x = 0.01$). The minimum spacing in the

normal direction is $dy = 0.005$ and exponential stretching is used to the outer boundary. The physical extent of the domain is $-8.0 \leq x \leq 12.0$ and $-12.0 \leq y \leq 12.0$.

Convergence Histories

The residual and ΔQ histories are given in Figs. 7f – 7i. The solution is converging and was terminated at 800 iterations because the desired result of shock free flow was not developing. The results are converged and demonstrate the same convergence characteristics as in the previous cases.

The residuals and ΔQ were decreased by 4 orders of magnitude in 800 iterations. The solution was actually converged to plotting accuracy in about 600 iterations, as demonstrated by the convergence histories for C_L, C_D,and C_{pm} in Figs. 7j – 7l.

Surface Plots

Surface values are plotted versus x and y in Figs. 7m – 7t. A weak shock forms on the upper surface. The NLR7301 airfoil is supposed to be shock–free at these design conditions. We did not obtain shock–free flow, as indicated by the surface plot. Previous studies of this case where the angle of attack was varied to match lift were also not able to produce shock free flow. The shock can be moved downstream to match lift but it requires an angle of attack of .55 degrees. Here we have restricted ourselves to just reporting on the requested conditions.

Tabulated data for the surface values are presented in Table 7. The converged values for lift, drag, and moment are

$$C_L = 0.44970, \quad C_D = 0.00168, \quad C_{pm} = -.11350$$

with computed circulation $\Gamma = 0.2230$.

Flowfield Contours

Flowfield contours for this case are presented in Figs. 7u – 7z. Mach contours in Fig. 7u exhibit the weak shock. In Fig. 7w, a farfield view is shown, demonstrating how far away the farfield boundaries are from any large gradients in the solution. The stagnation pressure field seems unusually jumpy, with the largest variations at the trailing edge.

§6. Acknowledgement

We would like to gratefully acknowledge the help of Pieter Buning who wrote the graphics package used here and Dennis Jespersen who wrote and modified the grid generator. Both Dennis and Pieter are employees of NASA Ames Research Center.

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-20
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

References

1. Steger, J. L. , Implicit Finite-Difference Simulation of Flow about Arbitrary Two-dimensional Geometries, J. Comp. Phys. 16, 679–686, 1978.
2. Steger, J. L. and Bailey, H. E., Calculation of Transonic Aileron Buzz, AIAA Journal, Vol. 18, No. 3, March 1980, pp.249 - 255.
3. Steger, J. L., Pulliam, T. H. , and Chima, R. V., An Implicit Finite Difference Code for Inviscid and Viscous Cascade Flow, AIAA paper 80-1497, Snowmass, Colo., 1980.
4. Eiseman, P. R., Geometric Methods in Computational Fluid Dynamics ICASE Report no. 80-11, April 18,1980.
5. Pulliam, T. H., Jespersen, D. C., and Childs, R. E., "An Enhanced Version of an Implicit Code for the Euler Equations", AIAA paper no. 83-0344, AIAA 21st Aerospace Sciences Meeting, Reno, Nevada, Jan. 1983.
6. Beam R., and Warming, R. F.," An Implicit Finite - Difference Algorithm for Hyperbolic Systems in Conservation - Law - Form," J. Comp. Physics, Vol. 22, Sept. 1976, pp 87 - 110.
7. Srinivasan, G. R. , Chyu, W. J. and Steger , J. L., "Computation of Simple Three–Dimensional Wing–Vortex Interaction in Transonic Flow," AIAA Paper 81–1206, AIAA 14th Fluid and Plasma Dynamics Conference, Palo Alto, June 1981.
8. Warming, R. F. and Beam R. M. , "Upwind Second – Order Difference Schemes and Applications in Aerodynamic Flows, " AIAA J. Vol. 14, No. 9 Sept. 1976, pp1241 - 1249.
9. Murman, E. M., "Analysis of Embedded Shock Waves Calculated by Relaxation Methods," AIAA J., Vol.12, No. 15, May 1974, pp.626-633
10. Hessenius, K. A. and Pulliam, T. H., "A Zonal Approach to Solution of the Euler Equations," AIAA Paper 82–0969, AIAA/AMSE Joint Fluids,

Plasma, Thermophysics, and Heat Transfer Conference, St. Louis, Missouri, June 7–11,1982

11. Numerical Methods for the Computation of Inviscid Transonic Flows with Shock Waves, Notes on Numerical Fluid Mechanics, Vol. 3, A. Rizzi and H. Viviand (Eds.), Friedr. Vieweg Sohn Verlagsgesellschaft mbH, Braunschweig ,1981.

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-22
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

```
$ SET NOVERIFY
%CX-S-INF_ON, Information broadcasts turned on
 Enter  GRID file name:
 Enter  Q file name:
          NACA0012        Mach = 0.800      Alpha = 1.250      Results on the airfoil surface

    N        X/C          Y/C        1-P/P1inf        Cp          Mach       1-P1/P1inf     1-T1/T1
    1      96.000000    0.000000     0.343979    -0.000001     0.800190    -0.000108    -0.000058
    2      74.287001    0.000000     0.343981    -0.000007     0.800191    -0.000106    -0.000056
    3      57.402550    0.000000     0.343986    -0.000026     0.800191    -0.000078    -0.000053
    4      44.454000    0.000000     0.343993    -0.000048     0.800189    -0.000166    -0.000058
    5      34.478630    0.000000     0.343999    -0.000069     0.800189    -0.000150    -0.000048
    6      26.792036    0.000000     0.344003    -0.000083     0.800198    -0.000159    -0.000
    7      20.869555    0.000000     0.344004    -0.000086     0.800219    -0.000179    -0.000048
    8      16.306313    0.000000     0.343998    -0.000067     0.800226    -0.000195    -0.000033
    9      12.790356    0.000000     0.343974    -0.000014     0.800148    -0.000153    -0.000023
   10      10.001329    0.000000     0.343919     0.000082     0.799892     0.000016    -0.000013
   11       7.994030    0.000000     0.343813     0.000563     0.799450     0.000297     0.000000
   12       6.385789    0.000000     0.343623     0.001289     0.799611     0.000440     0.000000
   13       5.146642    0.000000     0.343305     0.002290     0.798927     0.000039     0.000044
   14       4.191005    0.000000     0.342796     0.004022     0.799390    -0.001195     0.000000
   15       3.456250    0.000000     0.342015     0.006602     0.799969    -0.002962     0.000121
   16       2.889447    0.000000     0.340866     0.010610     0.799530    -0.004284     0.000153
   17       2.452727    0.000000     0.339227     0.016160     0.796874    -0.006125     0.000107
   18       2.116237    0.000000     0.337000     0.023715     0.791663    -0.002327     0.000068
   19       1.856973    0.000000     0.334121     0.033542     0.784614     0.000248     0.000013
   20       1.657212    0.000000     0.330510     0.045826     0.776678     0.002568     0.000117
   21       1.503296    0.000000     0.326173     0.060504     0.768243     0.004254     0.000101
   22       1.384785    0.000000     0.321150     0.077673     0.759218     0.005463     0.000089
   23       1.293332    0.000000     0.315499     0.096903     0.749520     0.006363     0.000072
   24       1.222929    0.000000     0.309289     0.118032     0.739193     0.007016     0.000072
   25       1.168603    0.000000     0.302609     0.140761     0.728202     0.007506     0.000054
   26       1.126088    0.000000     0.295582     0.164943     0.716816     0.007866     0.000057
   27       1.094684    0.000000     0.288009     0.190439     0.704814     0.008137     0.000071
   28       1.069872    0.000000     0.280161     0.217143     0.692273     0.008341     0.000045
   29       1.050754    0.000000     0.271897     0.245260     0.679118     0.008469     0.000039
   30       1.036024    0.000000     0.263207     0.274029     0.665259     0.008565     0.000036
   31       1.024674    0.000000     0.253924     0.303414     0.650434     0.008618     0.000034
   32       1.015929    0.000000     0.243657     0.341349     0.633892     0.008680     0.000016
   33       1.009192    0.000000     0.233216     0.376874     0.616760     0.008878     0.000042
   34       1.004000    0.000000     0.219770     0.422623     0.595103     0.008612    -0.000041
   35       1.000000    0.000000     0.172544     0.583312     0.508075    -0.039940     0.000000
   36       0.995951   -0.000578     0.201981     0.483151     0.608610    -0.024089     0.000000
   37       0.991713   -0.001180     0.231013     0.381648     0.631368    -0.008762     0.000000
   38       0.987276   -0.001807     0.241034     0.350273     0.647907    -0.006385     0.000000
   39       0.982625   -0.002460     0.250002     0.319555     0.663046    -0.003721     0.000000
   40       0.977749   -0.003141     0.256572     0.297405     0.676638    -0.001195     0.000000
   41       0.972631   -0.003851     0.263460     0.273967     0.685757    -0.000858     0.000000
   42       0.967257   -0.004592     0.268058     0.255601     0.697307    -0.011738     0.000000
   43       0.961611   -0.005366     0.274549     0.236238     0.703899    -0.000791     0.000000
   44       0.955673   -0.006173     0.279318     0.220000     0.713955    -0.012291     0.000000
   45       0.949426   -0.007017     0.284293     0.203002     0.719532    -0.010417     0.000000
   46       0.942849   -0.007898     0.288715     0.188035     0.728463    -0.012435     0.000000
   47       0.935922   -0.008818     0.293233     0.172663     0.733716    -0.010983     0.000000
   48       0.928623   -0.009780     0.297442     0.158341     0.741752    -0.012432     0.000000
   49       0.920929   -0.010785     0.301688     0.143923     0.746983    -0.011276     0.000000
```

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-23
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NACA##12 Mach = #.### Alpha = 1.25# Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-P1/P1inf	1-T1/Tinf
50	#.912817	-#.#11834	#.3#5757	#.13##52	#.754346	-#.#1238#	#.####
51	#.9#4262	-#.#1293#	#.3#9833	#.116181	#.759681	-#.#11562	#.######
52	#.895239	-#.#14#74	#.313836	#.1#2559	#.766543	-#.#12321	#.######
53	#.885725	-#.#15267	#.317825	#.###988	#.772#43	-#.#11781	#.######
54	#.875696	-#.#1651#	#.321797	#.#75474	#.778593	-#.#1229#	#.######
55	#.865138	-#.#178#4	#.325758	#.#61998	#.784258	-#.#11945	#.######
56	#.854##5	-#.#1915#	#.329742	#.#48439	#.79#6##	-#.#12258	#.######
57	#.842#6	-#.#2#546	#.333711	#.#34935	#.79#461	-#.#12#94	#.######
58	#.83##19	-#.#21992	#.337723	#.#21283	#.##2729	-#.#12278	#.######
59	#.817135	-#.#23485	#.341747	#.##7593	#.###739	-#.#12183	#.######
6#	#.8#3654	-#.#25#24	#.345822	-#.##6273	#.815#32	-#.#12294	#.######
61	#.789583	-#.#266#3	#.349915	-#.#2#2##	#.821215	-#.#12264	#.######
62	#.774937	-#.#28219	#.354#69	-#.#34334	#.827667	-#.#12328	#.######
63	#.759743	-#.#29864	#.358254	-#.#48573	#.83395#	-#.#12332	#.######
64	#.744#39	-#.#31532	#.362495	-#.#63##2	#.84#437	-#.#1237#	#.######
65	#.727876	-#.#33213	#.366703	-#.#77593	#.846975	-#.#1238#	#.######
66	#.711315	-#.#34899	#.371119	-#.#92347	#.853628	-#.#12429	#.######
67	#.694428	-#.#36578	#.375497	-#.1#7244	#.86#326	-#.#1245#	#.######
68	#.6773##	-#.#3824#	#.379924	-#.122#86	#.867115	-#.#12481	#.######
69	#.66##2#	-#.#39873	#.384377	-#.137458	#.873962	-#.#1252#	#.######
7#	#.642684	-#.#41467	#.388861	-#.152715	#.88#856	-#.#12548	#.######
71	#.625388	-#.#43#11	#.393361	-#.168#27	#.887792	-#.#1258.	#.######
72	#.6##229	-#.#44496	#.397867	-#.183359	#.894743	-#.#12612	#.######
73	#.591297	-#.#45914	#.4#2366	-#.198665	#.9#1693	-#.#12639	#.######
74	#.574676	-#.#47258	#.4#6837	-#.213######	#.9##633	-#.#1268#	#.######
75	#.558441	-#.#48523	#.41127#	-#.228963	#.915528	-#.#12734	#.######
76	#.542656	-#.#497#7	#.415653	-#.243876	#.922348	-#.#1276	#.######
77	#.527371	-#.#5###7	#.419966	-#.258551	#.929#74	-#.#128#2	#.######
78	#.512627	-#.#61823	#.4242##	-#.272958	#.935698	-#.#12833	#.######
79	#.498452	-#.#52756	#.428333	-#.287#2#	#.942184	-#.#12886	#.######
8#	#.484864	-#.#536#9	#.432361	-#.3##726	#.948513	-#.#12922	#.######
81	#.471878	-#.#54386	#.436267	-#.314#15	#.954665	-#.#12957	#.######
82	#.459471	-#.#55###8	#.44##39	-#.326852	#.96#63#	-#.#13##_	#.######
83	#.447668	-#.#55722	#.443661	-#.339173	#.966369	-#.#13#42	#.######
84	#.436424	-#.#56291	#.447115	-#.35#928	#.971844	-#.#13#67	#.######
85	#.425747	-#.#56##1	#.45#413	-#.362149	#.977#97	-#.#131#6	#.######
86	#.41561#	-#.#57255	#.45355#	-#.372823	#.982111	-#.#13152	#.######
87	#.4#5991	-#.#57658	#.456346	-#.382337	#.986692	-#.#13197	#.######
88	#.396865	-#.#58#15	#.459538	-#.389794	#.99#112	-#.#13232	#.######
89	#.388249	-#.#58329	#.46#5##	-#.396478	#.993245	-#.#13236	#.######
9#	#.38####	-#.#58646	#.463282	-#.4#5665	#.997633	-#.#1332#	#.######
91	#.372#41	-#.#58853	#.465349	-#.412969	1.##1196	-#.#1347#	#.######
92	#.364##1	-#.#59#79	#.46#671	-#.397#52	#.993567	-#.#13294	#.######
93	#.356##2	-#.#59283	#.445#56	-#.346644	#.969685	-#.#1287'	#.######
94	#.348##1	-#.#59463	#.449889	-#.36#366	#.974965	-#.#11595	#.######
95	#.34####	-#.#5962#	#.498521	-#.525839	1.#545#2	-#.#12729	#.######
96	#.331348	-#.#59761	#.531384	-#.637656	1.113##2	-#.#17096	#.######
97	#.32121#	-#.#59889	#.525#2#	-#.616##1	1.#98643	-#.#12444	#.######
98	#.3#9276	-#.#59984	#.528284	-#.6271#9	1.1#5515	-#.#14#99	#.######
99	#.295265	-#.#6##16	#.527#7#	-#.622979	1.1#5374	-#.#16536	#.######

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-24
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NACA##12 Mach = #.### Alpha = 1.25# Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-P1/P1inf	1-T1/T1inf
1##	#.270664	-#.#59936	#.522513	-#.6##471	1.#96938	-#.#1564.	#.######
1#1	#.259415	-#.#5967#	#.521196	-#.6#2989	1.#93921	-#.#14649	#.######
1#2	#.237466	-#.#59118	#.516697	-#.587681	1.#87987	-#.#16712	#.######
1#3	#.213236	-#.#58166	#.51#362	-#.566128	1.#76414	-#.#1556#	#.######
1#4	#.187655	-#.#56716	#.5#1569	-#.5362#9	1.#63#17	-#.#17##5	#.######
1#5	#.162#26	-#.#54731	#.498639	-#.499#2#	1.#448#7	-#.#1674#	#.######
1#6	#.137679	-#.#52256	#.477615	-#.454784	1.#24481	-#.#17722	#.######
1#7	#.115597	-#.#494#9	#.462734	-#.4#4#72	1.###753	-#.#17###	#.######
1#8	#.#96256	-#.#46334	#.446#81	-#.347818	#.975153	-#.#18597	# ######
1#9	#.#797##	-#.#43158	#.428237	-#.286692	#.947136	-#.#1878.	# ######
11#	#.#657#5	-#.#39976	#.4##949	-#.221#67	#.917381	-#.#18797	#.######
111	#.#53942	-#.#36846	#.388368	-#.151#37	#.885221	-#.#18187	#.######
112	#.#44#63	-#.#33797	#.366418	-#.#76324	#.85#595	-#.#16792	#.######
113	#.#36756	-#.#3#841	#.342845	#.###866	#.812356	-#.#14167	# ######
114	#.#28756	-#.#27976	#.317561	#.#89888	#.769997	-#.#1#177	#.######
115	#.#22848	-#.#25194	#.298#93	#.183349	#.721823	-#.##4331	#.######
116	#.#17#6#	-#.#22483	#.268556	#.283848	#.667536	#.##385.	# ######
117	#.#13658	-#.#1983#	#.228344	#.393458	#.6#5215	#.#11785	#.######
118	#.#1#142	-#.#17225	#.194145	#.5#9815	#.535#87	#.#2#169	#.######
119	#.##7236	-#.#14658	#.157438	#.634738	#.457872	#.#27164	#.######
12#	#.##4883	-#.#12126	#.12#155	#.761571	#.374578	#.#3#67.	#.######
121	#.##3#42	-#.##9636	#.##3246	#.887152	#.285129	#.#3###6	#.######
122	#.##1681	-#.##72#7	#.#51355	#.995665	#.19564#	#.#2#69.	#.######
123	#.###747	-#.##4834	#.#27#7#	1.#75#74	#.1#2527	#.#13788	#.######
124	#.###185	-#.##2422	#.#179#6	1.189476	#.#13#84	#.#2#363	#.######
125	#.######	#.######	#.#24847	1.#85859	#.##0987	#.#27745	#.######
126	#.###178	#.##2376	#.#4#844	1.##42#8	#.177318	#.#39593	#.######
127	#.###692	#.##4653	#.##5247	#.##8344	#.264694	#.#49129	# ######
128	#.##1498	#.##6811	#.127766	#.735674	#.353337	#.#5418.	#.######
129	#.##2599	#.###922	#.17#6#4	#.589914	#.437419	#.#54#53	#.######
13#	#.##4##4	#.#11#14	#.213115	#.445267	#.519661	#.#49198	#.######
131	#.##5698	#.#13#65	#.251895	#.313319	#.595417	#.#4#623	#.######
132	#.##767#	#.#15#73	#.287632	#.191722	#.666242	#.#3#219	# ######
133	#.###912	#.#17#38	#.318918	#.#8527#	#.728838	#.#191#7	#.######
134	#.#12422	#.#18962	#.347323	-#.#11381	#.785618	#.###751	#.######
135	#.#15199	#.#2#852	#.3722#6	-#.#96#45	#.834853	-#.###474	#.######
136	#.#18262	#.#22711	#.39474#	-#.172719	#.878672	-#.###837	#.######
137	#.#2159#	#.#24547	#.414673	-#.24#541	#.916574	-#.#14#72	# ######
138	#.#25229	#.#26363	#.432748	-#.3#2#43	#.95#127	-#.#18###8	#.######
139	#.#29188	#.#28166	#.448993	-#.367316	#.979562	-#.#21946	#.######
14#	#.#33494	#.#29957	#.463823	-#.4#7778	1.##5882	-#.#24289	#.######
141	#.#38164	#.#31742	#.477486	-#.453993	1.#29568	-#.#2588.	#.######
142	#.#43241	#.#33522	#.489968	-#.4967#9	1.#51167	-#.#26893	# ######
143	#.#48759	#.#353#1	#.5#1665	-#.536536	1.#71128	-#.#27488	#.######
144	#.#54762	#.#37###	#.512643	-#.573888	1.#89764	-#.#27758	#.######
145	#.#61298	#.#38858	#.523#12	-#.6##168	1.1#7334	-#.#27814	#.######
146	#.#68423	#.##8635	#.532888	-#.642745	1.124#94	-#.#2768.	#.######
147	#.#762##	#.#42418	#.54232#	-#.674868	1.14#181	-#.#27474	#.######
148	#.#84699	#.#44177	#.551391	-#.7#5732	1.155756	-#.#27161	# ######
149	#.#93997	#.#45933	#.56#161	-#.735572	1.17#921		

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-25
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NACA##12 Mach = #.### Alpha = 1.25# Results on the airfoil surface

N	X/C	Y/C	1-P/Pinf	Cp	Mach	1-Pi/Pinf	T /Tinf
15#	#.1#410#	#.#47668	#.568664	-#.7645#4	1.185701	-#.#26817	#.#####.
151	#.11534#	#.#49372	#.576935	-#.792646	1.2##398	-#.#2645#	#.######
152	#.127575	#.#51#32	#.584992	-#.82##6#	1.21402#	-#.#2689	#.######
153	#.14#983	#.#52634	#.592855	-#.846815	1.229#44	-#.#2568>	#.#### #
154	#.155663	#.#54144	#.6##51#	-#.872859	1.243#93	-#.#25322	#.#####?
155	#.1717#2	#.#55549	#.6#7959	-#.898#87	1.256948	-#.#24962	# .#####
156	#.189166	#.#56816	#.615155	-#.922694	1.27#5#5	-#.#246#6	#.######
157	#.2##892	#.#57913	#.622#97	-#.946313	1.283783	-#.#24297	#.#### #
158	#.228465	#.#58##9	#.628698	-#.968772	1.296552	-#.#23985	# .#####
159	#.25#21#	#.#59472	#.634929	-#.989973	1.3##786	-#.#237##	#.######
16#	#.273173	#.#59##8	#.64#729	-1.##97#6	1.32#3#1	-#.#23429	# ######
161	#.29712#	#.#6##17	#.646#11	-1.#27681	1.33#489	-#.#22586	#.#### ?
162	#.321738	#.#59883	#.65#847	-1.#44136	1.339867	-#.#21734	#.##^###
163	#.346657	#.#59491	#.655181	-1.#58881	1.3488##	-#.#21591	#.#####
164	#.37148#	#.#58869	#.65899#	-1.#7184#	1.356717	-#.#21457	# ######
165	#.395818	#.#58#54	#.662268	-1.#92996	1.363584	-#.#21339	#.######
166	#.419329	#.#57#92	#.665#4#	-1.#92427	1.369419	-#.#21223	#.######
167	#.441737	#.#56#26	#.667355	-1.1##3#4	1.374322	-#.#21127	#.######
168	#.462851	#.#54###	#.669278	-1.1#6845	1.378394	-#.#21#19	#.#### ??
169	#.482555	#.#5375#	#.67#67#	-1.112264	1.381###	-#.#2#957	#. #####
17#	#.5###1#	#.#526#4	#.672198	-1.11678#	1.38463#	-#.#2#87/	#.######
171	#.517628	#.#51483	#.673311	-1.12#569	1.387#2	-#.#2#798	#.######
172	#.533#63	#.#5#4#2	#.674251	-1.123769	1.389#21	-#.#2#745	#.######
173	#.547195	#.#49371	#.675#48	-1.126479	1.39#736	-#.#2#7#4	#.######
174	#.56#118	#.#48396	#.67573#	-1.128799	1.392196	-#.#2#65	#.#### ##
175	#.571931	#.#47475	#.676315	-1.13#792	1.393487	-#.#2#659	# #### ##
176	#.582733	#.#46612	#.676828	-1.132636	1.394594	-#.#2#629	#.######
177	#.59262#	#.#458#5	#.67727#	-1.134#39	1.395517	-#.#2#558	#.######
178	#.6#1682	#.#45#5#	#.67766#	-1.135365	1.396342	-#.#2#5##	#.######
179	#.61####	#.#44345	#.678#2#	-1.136593	1.397161	-#.#2#541	#.######
18#	#.618##2	#.#43656	#.67834#	-1.137681	1.397862	-#.#2#53#	# ######
181	#.626##3	#.#42957	#.678647	-1.138726	1.398539	-#.#2#531	#.#### .#
182	#.634##3	#.#42248	#.678718	-1.138966	1.399199	-#.#21254	#.######
183	#.642##2	#.#41529	#.663226	-1.##6254	1.354122	-#.##5141	#.######
184	#.65####	#.#4###8	#.35#941	-#.#23691	#.77#438	#.#38825	#.######
185	#.658352	#.#4#828	#.297882	#.156847	#.722868	#.##574?	# ######
186	#.667531	#.#39168	#.365718	-#.#73944	#.8#2##9	#.#3'19#	#.#### '#
187	#.677611	#.#3821#	#.32574#	#.#62#67	#.755458	#.#15714	# ?####
188	#.688663	#.#37142	#.3455#1	-#.##5182	#.779471	#.#22253	#.######
189	#.7##744	#.#35954	#.338635	#.#18182	#.771438	#.#19664	#.######
19#	#.713884	#.#3464#	#.341#38	#.#1###4	#.774397	#.#2#421	#.######
191	#.728#79	#.#33192	#.34#145	#.#13#45	#.773155	#.#2#27'	#.######
192	#.743274	#.#31612	#.339242	#.#16117	#.7717#1	#.#2#3#.	# .#### .'
193	#.75935#	#.#299#6	#.337789	#.#21#58	#.769351	#.#2#376	#.#### ##
194	#.776123	#.#28#89	#.335755	#.#2798#	#.766131	#.#2#4#5	#.######
195	#.793348	#.#26183	#.333191	#.#367#5	#.762#17	#.#2#491	#.######
196	#.81#735	#.#24219	#.33#137	#.#47#95	#.757224	#.#2#491	#.######
197	#.827977	#.#2223#	#.326625	#.#59#46	#.751566	#.#2#62.	#.####
198	#.844783	#.#2#252	#.322753	#.#72221	#.74555#	#.#2#56#	# ##'###
199	#.86#9#3	#.#18318	#.318537	#.#86566	#.7386#4	#.#2#816	# .####

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-26
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NACA##12 Mach = #.### Alpha = 1.25# Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-P1/P1inf	1-T1/T1 °
2##	#.#76149	#.#16454	#.314###	#.1#1714	#.731######	#.#2#5##	#.[illegible]
2#1	#.##9399	#.#14682	#.3##427	#.117562	#.723998	#.#21#74	#.#####3
2#2	#.##3593	#.#13#15	#.3#4###	#.133966	#.716995	#.#2#52#	#.######
2#3	#.915724	#.#11459	#.299698	#.15#694	#.7##185	#.#2144?	#.######
2#4	#.926022	#.#1#416	#.294583	#.160#69	#.7#1216	#.#2#452	#.######
2#5	#.936942	#.###603	#.289471	#.185465	#.691392	#.#21929	#.######
2#6	#.946156	#.##7456	#.284#37	#.2#3954	#.684487	#.#2#418	#.#### #
2#7	#.954537	#.##6327	#.278#74	#.222#99	#.673368	#.#22632	# .####.#
2##	#.962165	#.##529#	#.272713	#.242484	#.666#45	#.#2#697	#.######
2#9	#.969112	#.##4337	#.266959	#.262#63	#.653337	#.#23549	#.######
21#	#.975449	#.##3461	#.260#11	#.285#83	#.644129	#.#21868	#.######
211	#.981239	#.##2654	#.253378	#.3##271	#.629297	#.#2589?	#.######
212	#.986541	#.##191#	#.244675	#.337883	#.614##4	#.#2521.	#.####
213	#.991485	#.##1224	#.235758	#.360226	#.597##7	#.#27424	# .####.#
214	#.995078	#.###589	#.2#9###	#.457636	#.575#9#	#.#1#233	# .######
215	1.######	#.######	#.179#2	#.56#319	#.548773	-#.##7127	#.######
216	1.##4###	#.######	#.219778	#.422623	#.595183	#.###612	-#.#####1
217	1.##9192	#.######	#.233216	#.376#74	#.616768	#.###878	#.#####2
218	1.#15929	#.######	#.243657	#.341349	#.633892	#.###68#	#.#####6
219	1.#24674	#.######	#.253924	#.3#6414	#.65#434	#.###61#	# .###..
22#	1.#36#24	#.######	#.263#87	#.274#29	#.665259	#.###565	#.#####36
221	1.#58754	#.######	#.271#97	#.246268	#.679118	#.###469	# .#####39
222	1.#69#72	#.######	#.28#161	#.217143	#.692273	#.###341	#.#####45
223	1.#94684	#.######	#.28####	#.19#439	#.7##814	#.###13.	#.#####51
224	1.126###	#.######	#.295#82	#.164943	#.716#16	#.##7#66	#.#####57
225	1.16####	#.######	#.3#26##	#.14#761	#.720282	#.##7586	#.####.4
226	1.222928	#.######	#.3##289	#.11#832	#.739193	#.##7#16	#.#####72
227	1.293332	#.######	#.315499	#.#96#83	#.74952#	#.#86363	#.######
228	1.384785	#.######	#.321158	#.#77673	#.759218	#.##546.	#.#####89
229	1.483296	#.######	#.326173	#.#6#584	#.768243	#.###254	#.#####1
23#	1.657212	#.######	#.33#51#	#.#45#26	#.776678	#.##2568	#.#####17
231	1.856973	#.######	#.334121	#.#33542	#.784614	#.###248	#.#####38
232	2.116237	#.######	#.337###	#.#23715	#.791663	-#.##2327	#.####..
233	2.452727	#.######	#.339227	#.#16168	#.796#74	-#.###126	# .#####66
234	2.889447	#.######	#.34#06#	#.#1#61#	#.799536	-#.##428.	#.#####53
235	3.456258	#.######	#.342#15	#.##6682	#.799969	-#.##2962	#.#####21
236	4.191885	#.######	#.342796	#.###422	#.799398	-#.##1195	# .######
237	5.146642	#.######	#.343385	#.##229#	#.798927	#.#####39	#.#####44
238	6.385789	#.######	#.343623	#.##12#9	#.799#11	#.###44#	#.####..
239	7.994#38	#.######	#.343813	#.#####63	#.799458	#.#####293	# .#####8
24#	1#.#81329	#.######	#.343919	#.#####2	#.799892	#.####1.	-#.#####13
241	12.79#356	#.######	#.343974	#.#####4	#.8##148	-#.#####153	-#.#####23
242	16.386313	#.######	#.343998	-#.#####67	#.#####226	-#.#####195	-#.#####33
243	2#.869555	#.######?	#.344##4	-#.#####86	#.#####219	-#.#####179	-#.#####48
244	26.792#36	#.######	#.344##3	-#.#####83	#.#####198	-#.#####159	-#.#####45
245	34.478638	#.######	#.343999	-#.#####69	#.#####189	-#.#####156	-#.#####.
246	44.454###	#.######	#.343993	-#.#####48	#.#####189	-#.#####166	-#.#####8
247	57.482558	#.######	#.343986	-#.#####26	#.#####191	-#.#####.7	-#.#####53
248	74.287#81	#.######	#.343981	-#.#####7	#.#####191	-#.#####186	-#.#####56
249	96.######	#.######	#.343979	-#.######1	#.#####19#	-#.#####188	-#.#####58

FORTRAN STOP
Enter GRID file name:

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-27
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

GRID

AGARD1X - NACA0012 grid

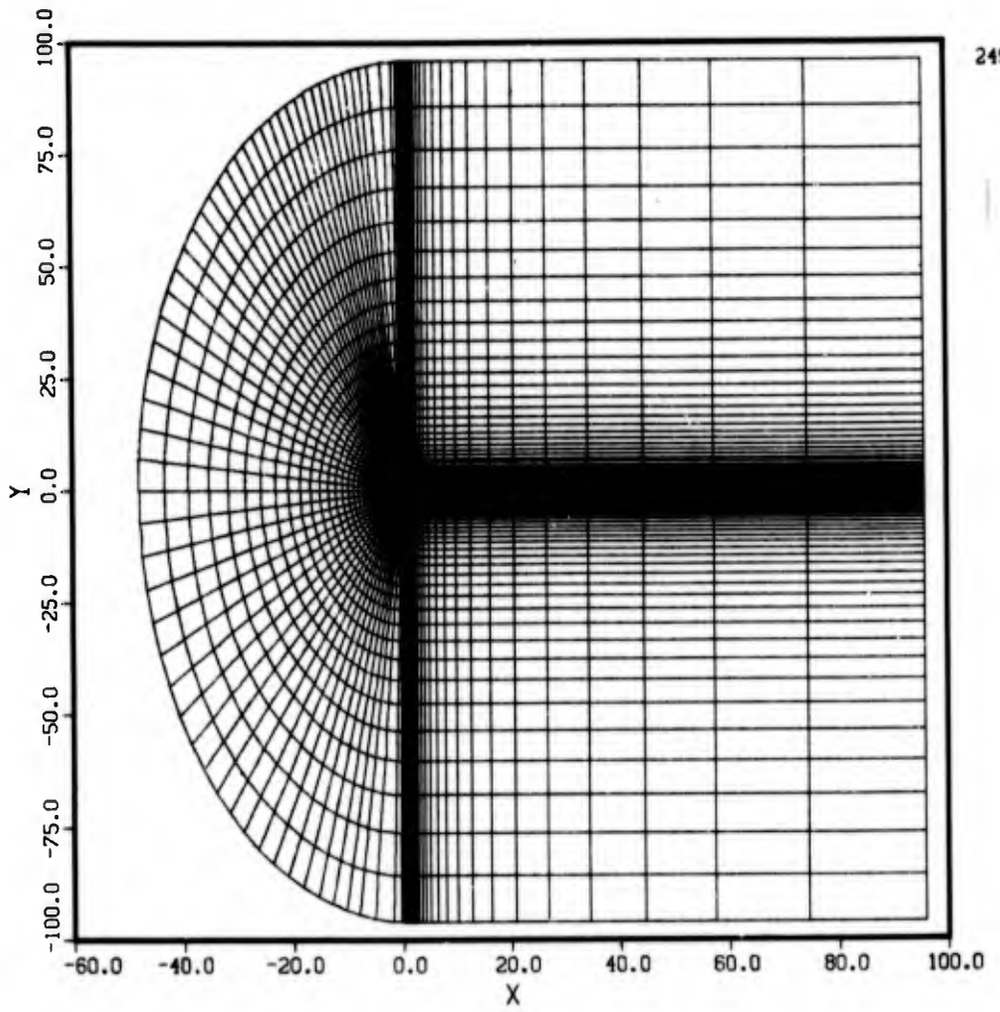


Figure 1a

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-28
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

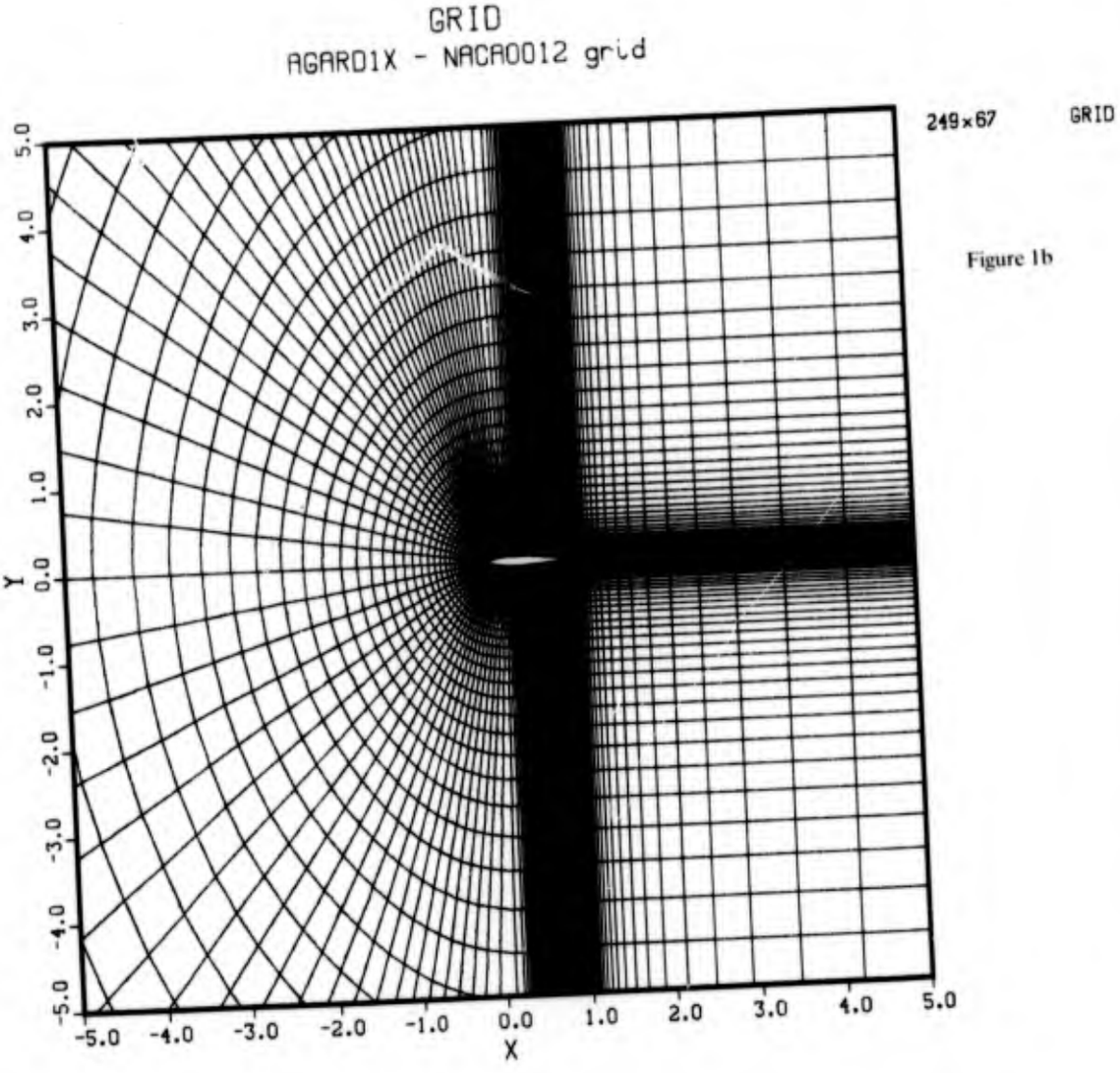


Figure 1b

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-29
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

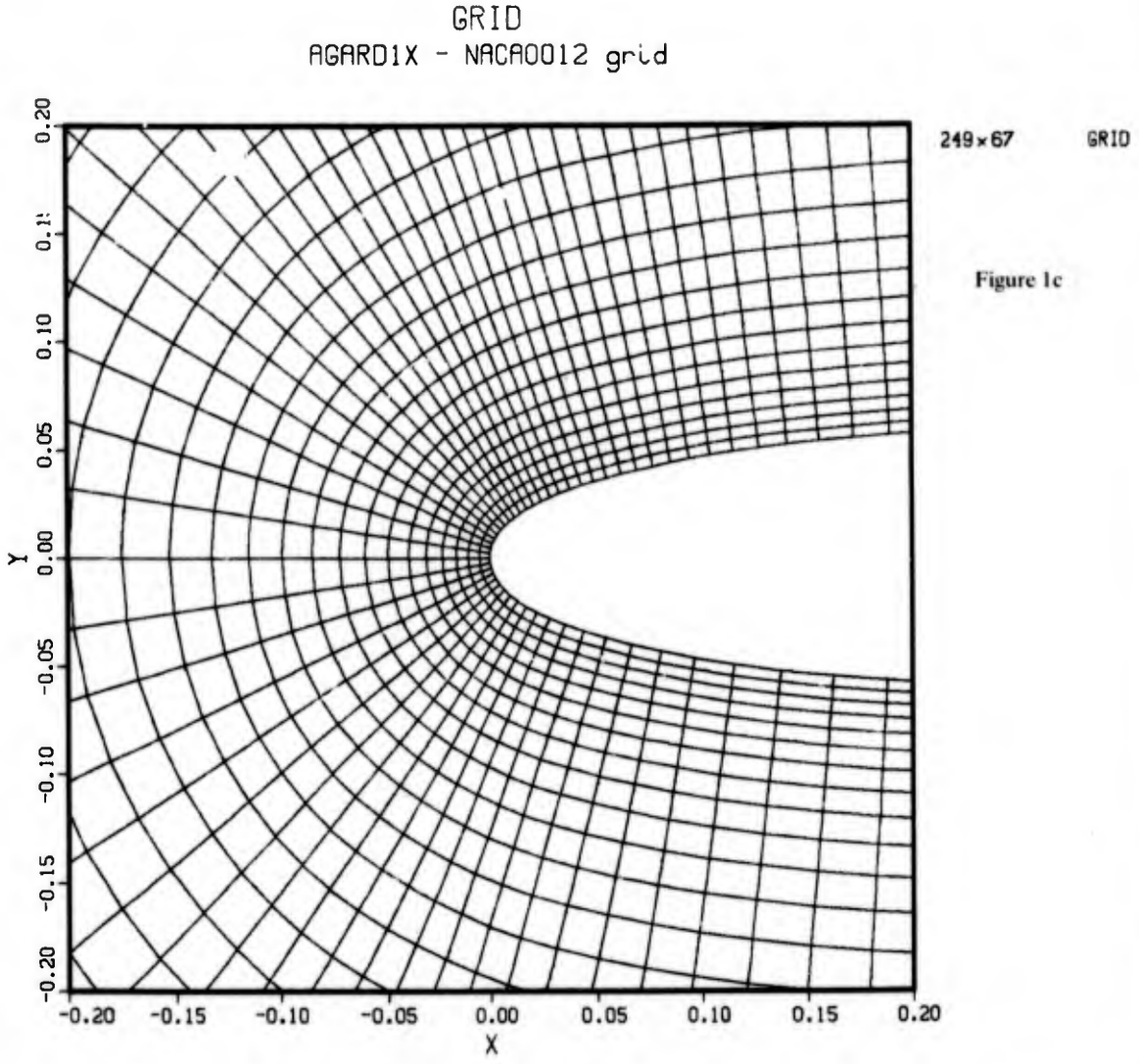


Figure 1c

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-30
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

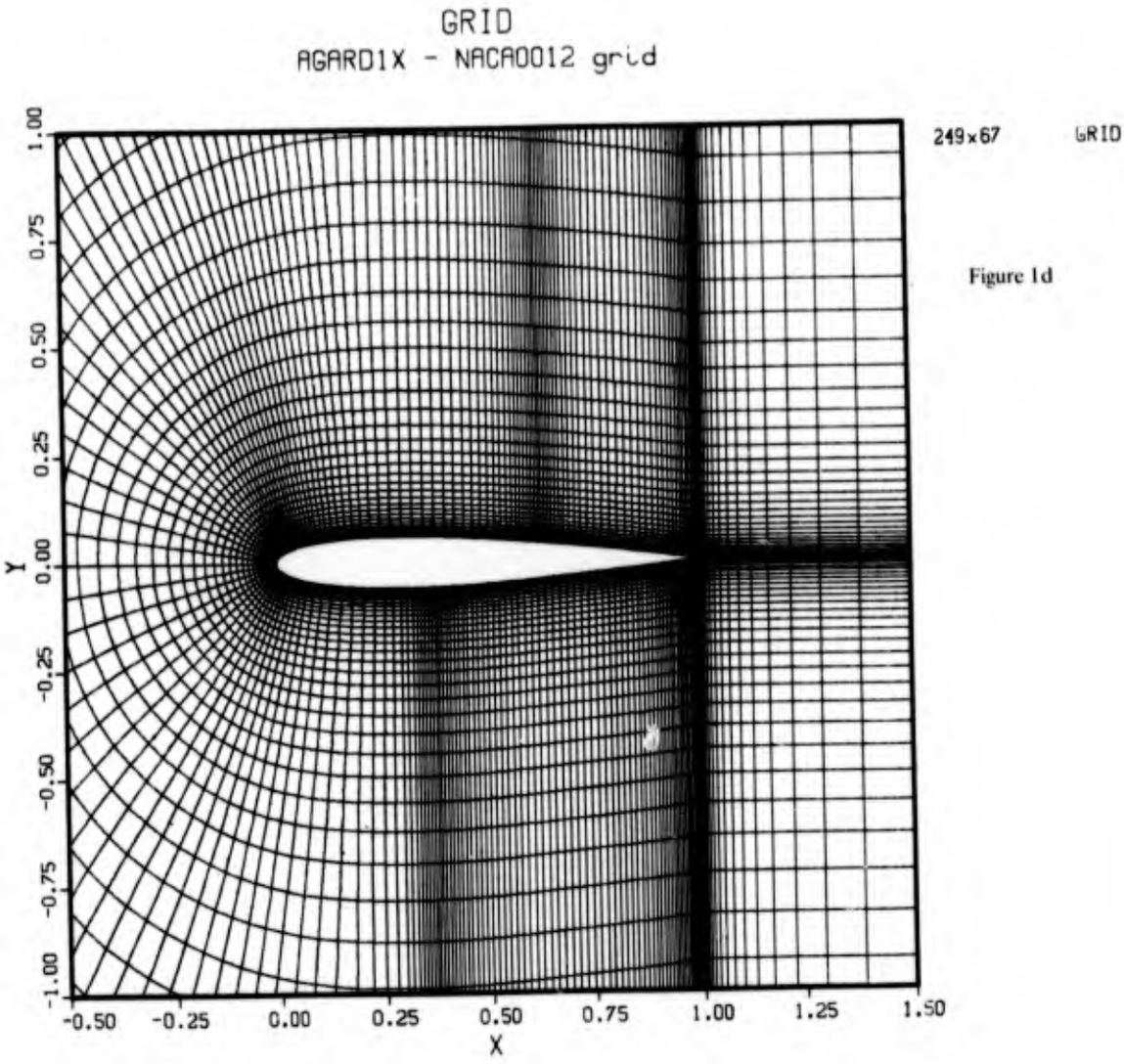


Figure 1d

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-31
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

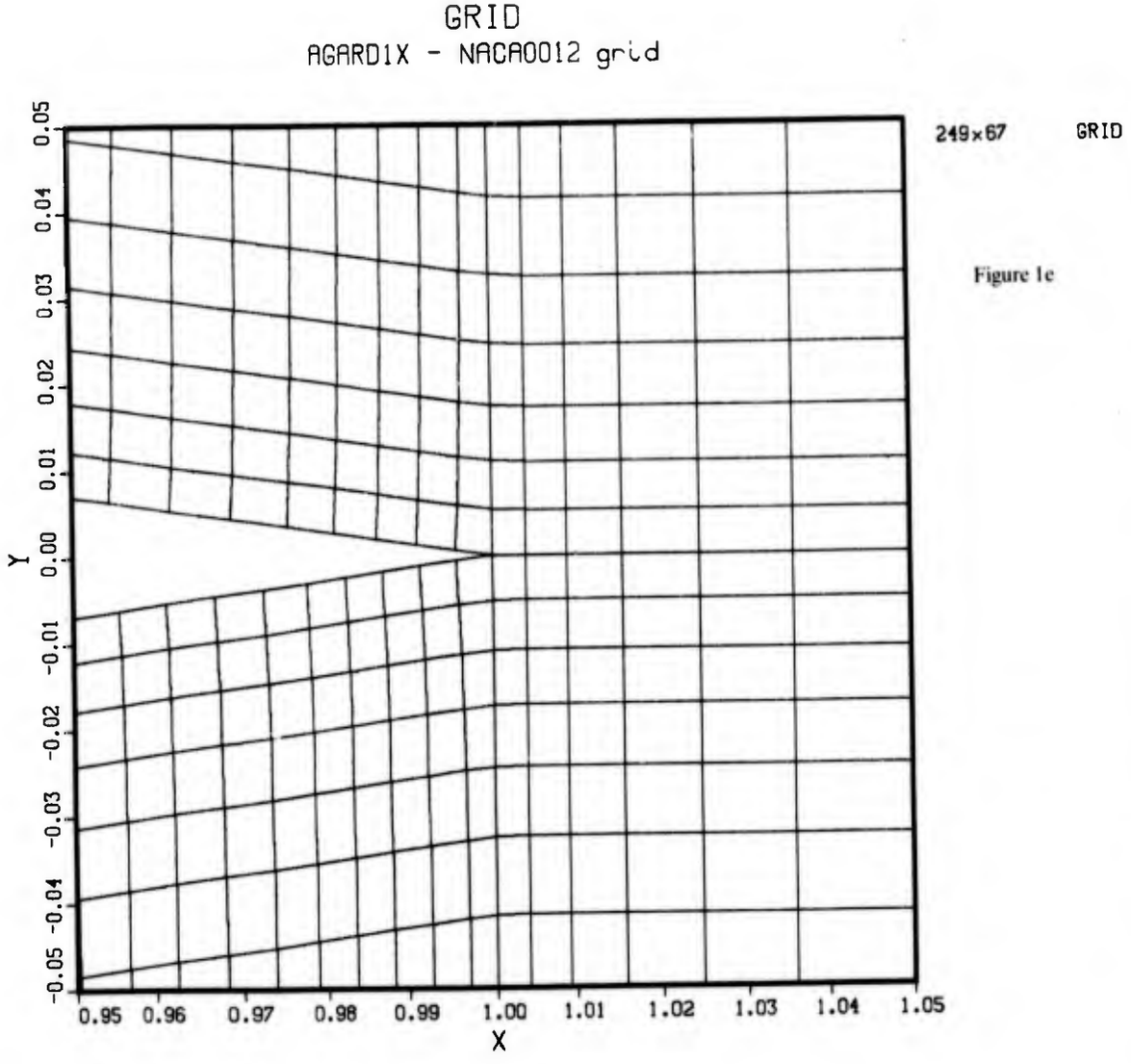


Figure 1e

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-32
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ARC2D - 249 x 67 grid, DT-3.
AGARD1X grid, clustering at shocks = .0_8
Upwinding, spatially variable time step
Mach number = .8, Alpha = 1.25

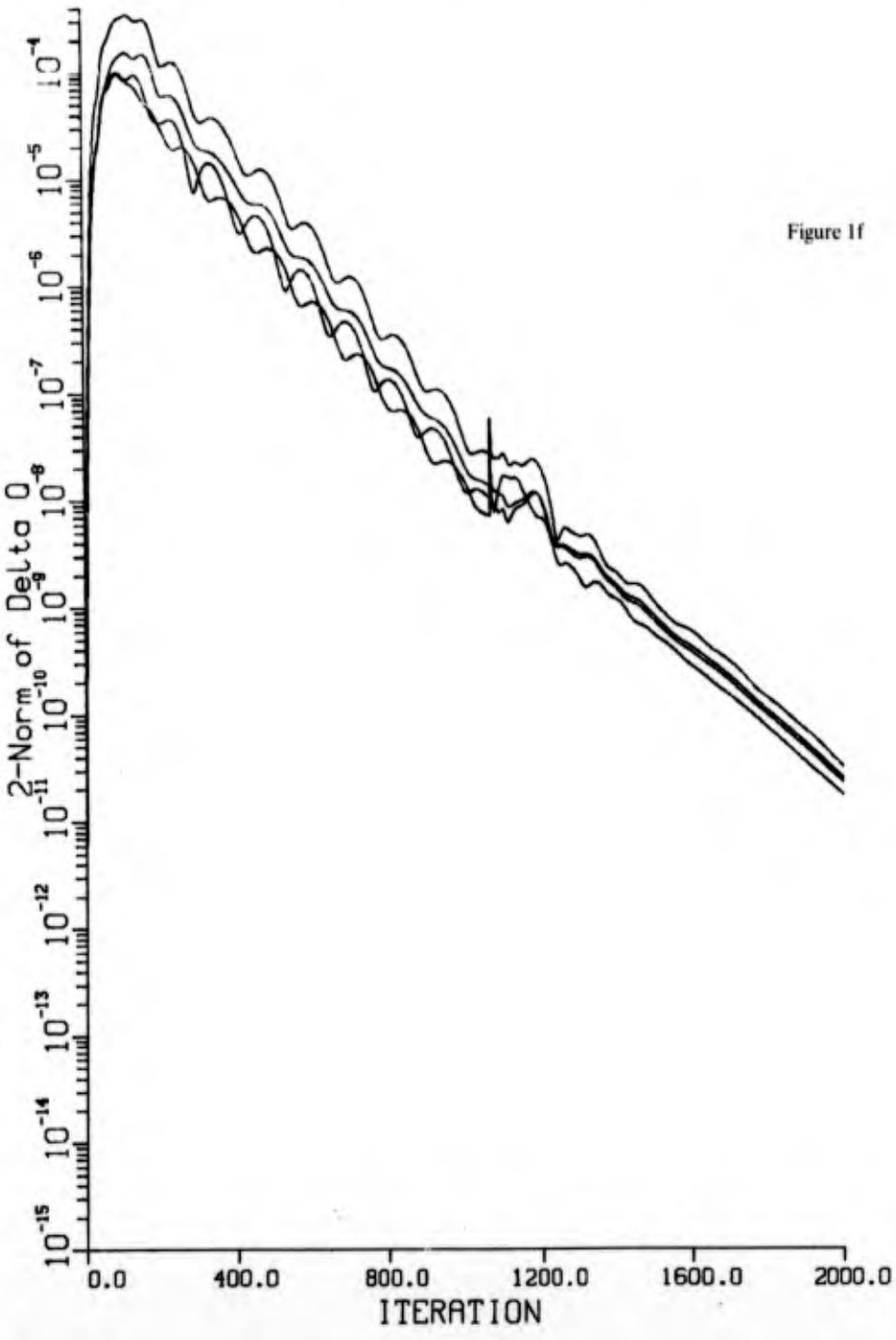


Figure 1f

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-33
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ARC2D - 249 x 67 grid, DT-3.
AGARD1X grid, clustering at shocks = .008
Upwinding, spatially variable time step
Mach number = .8, Alpha = 1.25

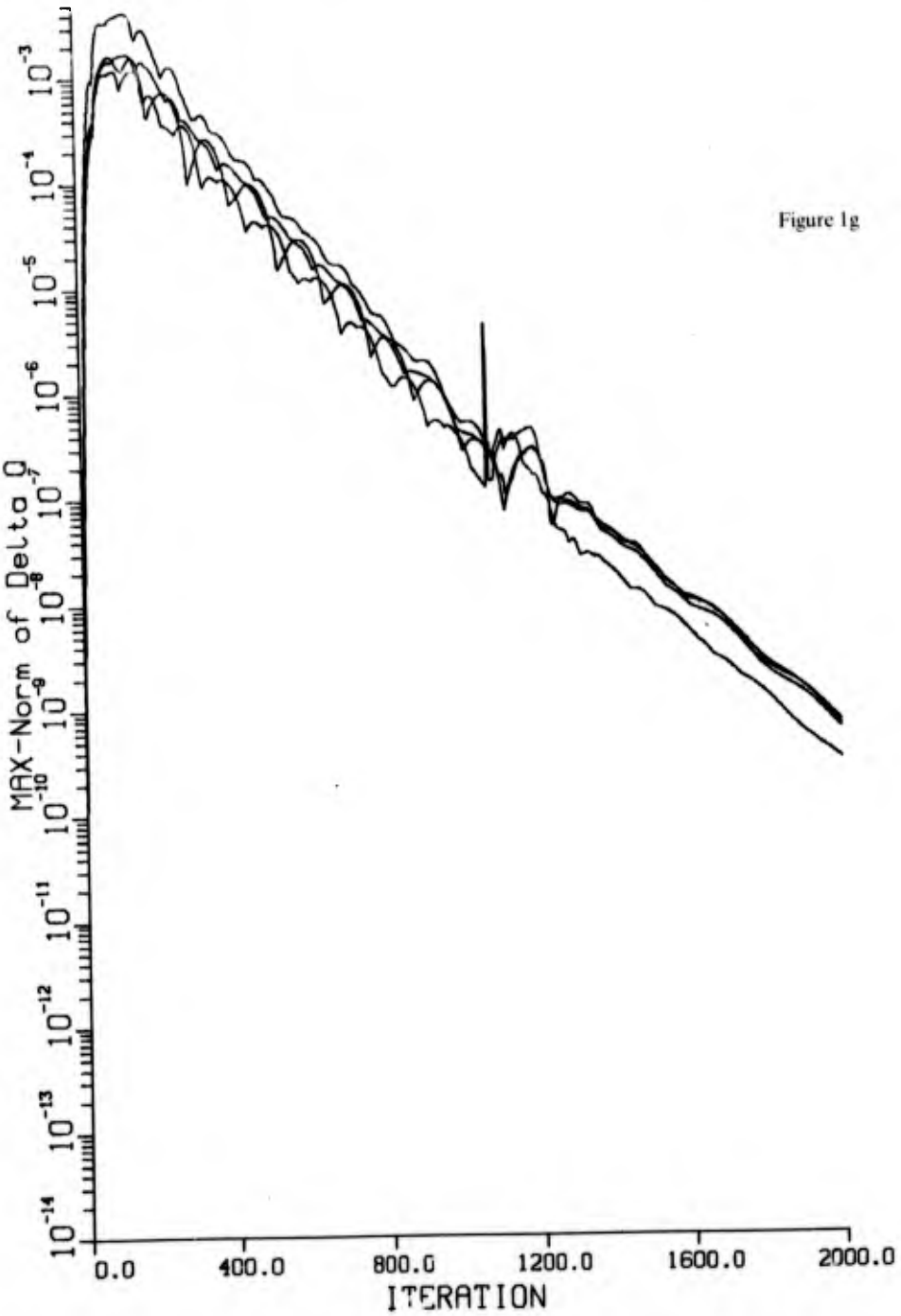


Figure 1g

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-34
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ARC2D - 249 x 67 grid, DT-3.
AGARD1X grid, clustering at shocks = .008
Upwinding, spatially variable time step
Mach number = .8, Alpha = 1.25

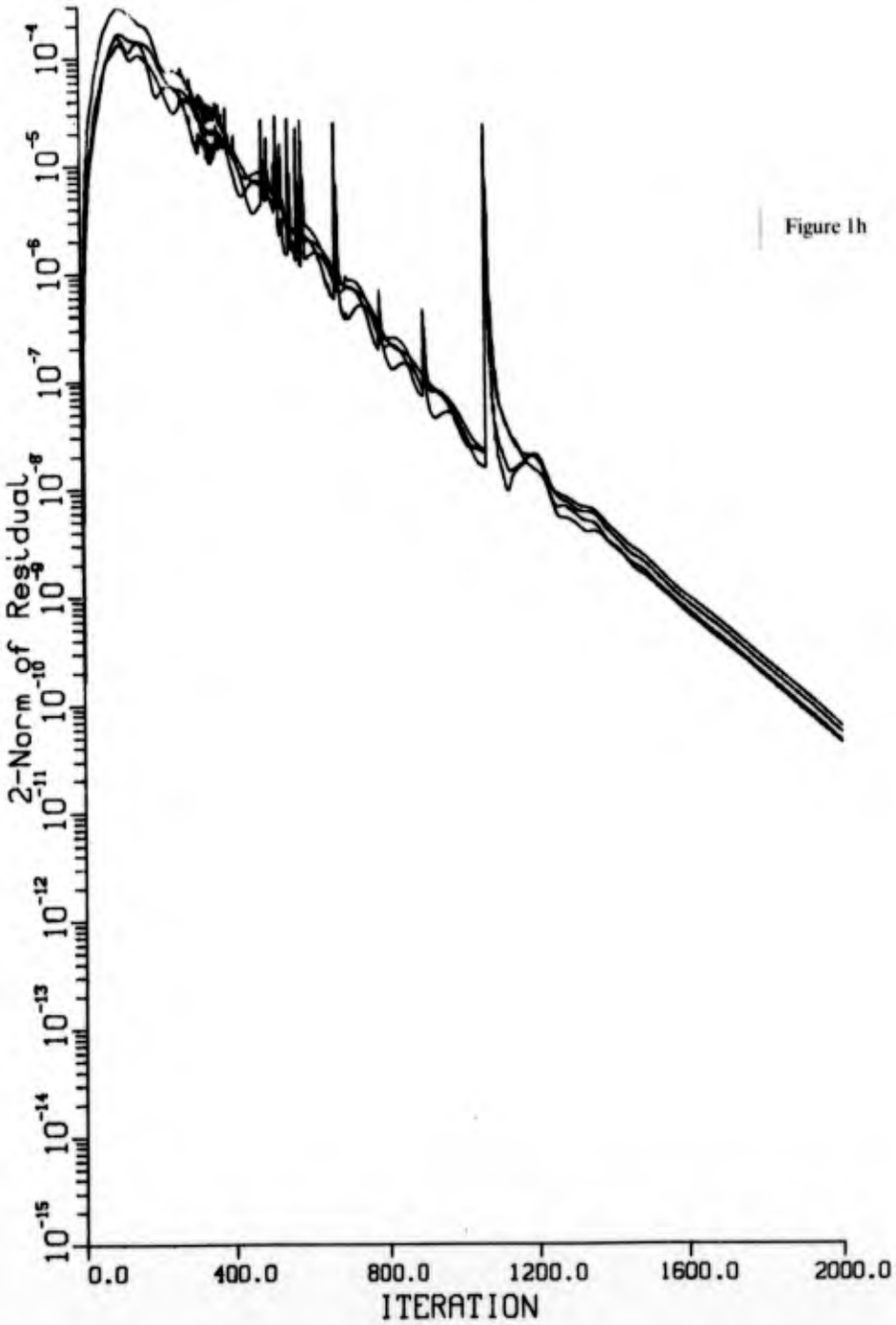


Figure 1h

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-35
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ARC2D - 249 x 67 grid, DT-3.
AGARD1X grid, clustering at shocks = .008
Upwinding, spatially variable time step
Mach number = .8, Alpha = 1.25

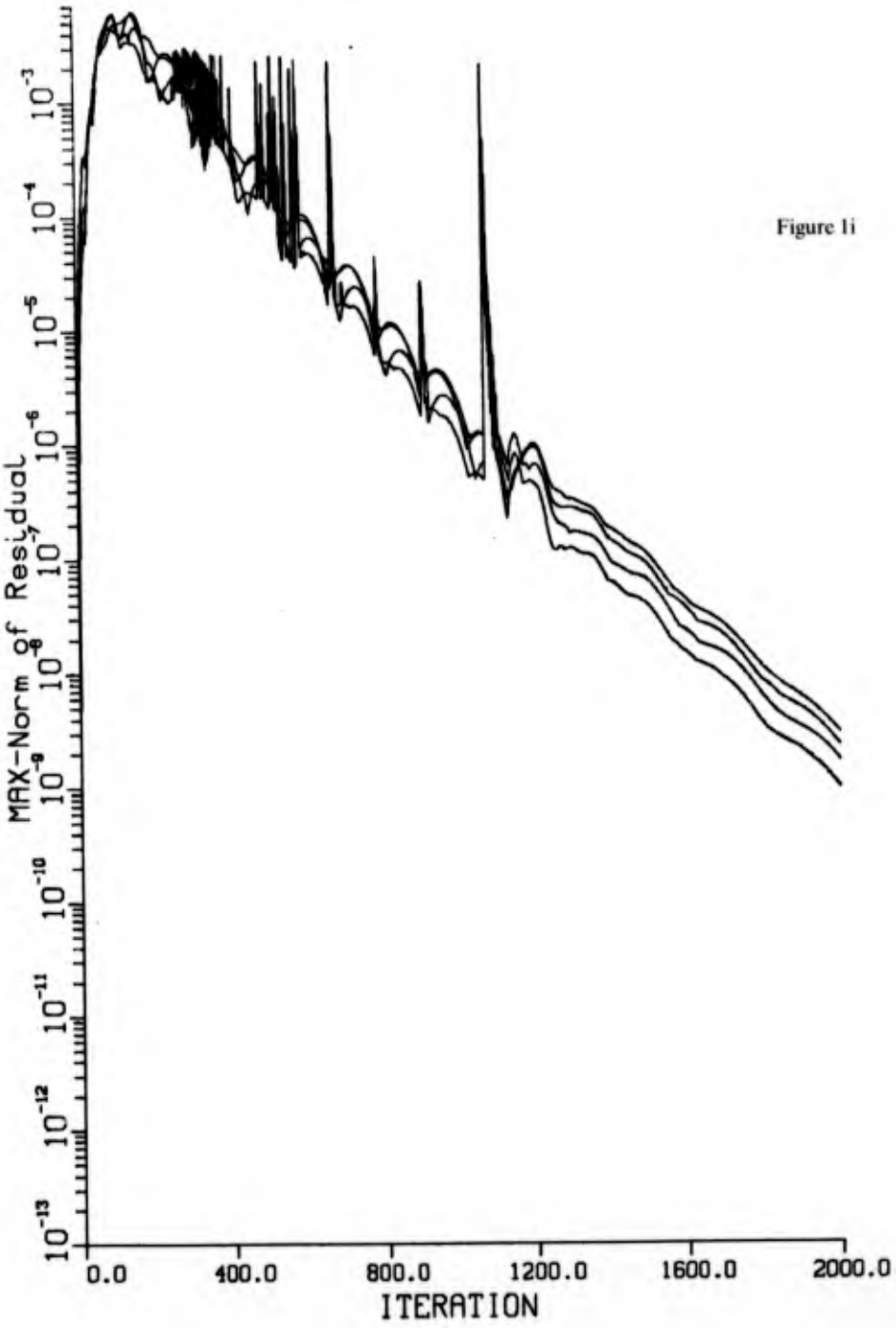


Figure 1i

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-36
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ARC2D - 249 x 67 grid, DT-3.
AGARD1X grid, clustering at shocks = .008
Upwinding, spatially variable time step
Mach number = .8, Alpha = 1.25

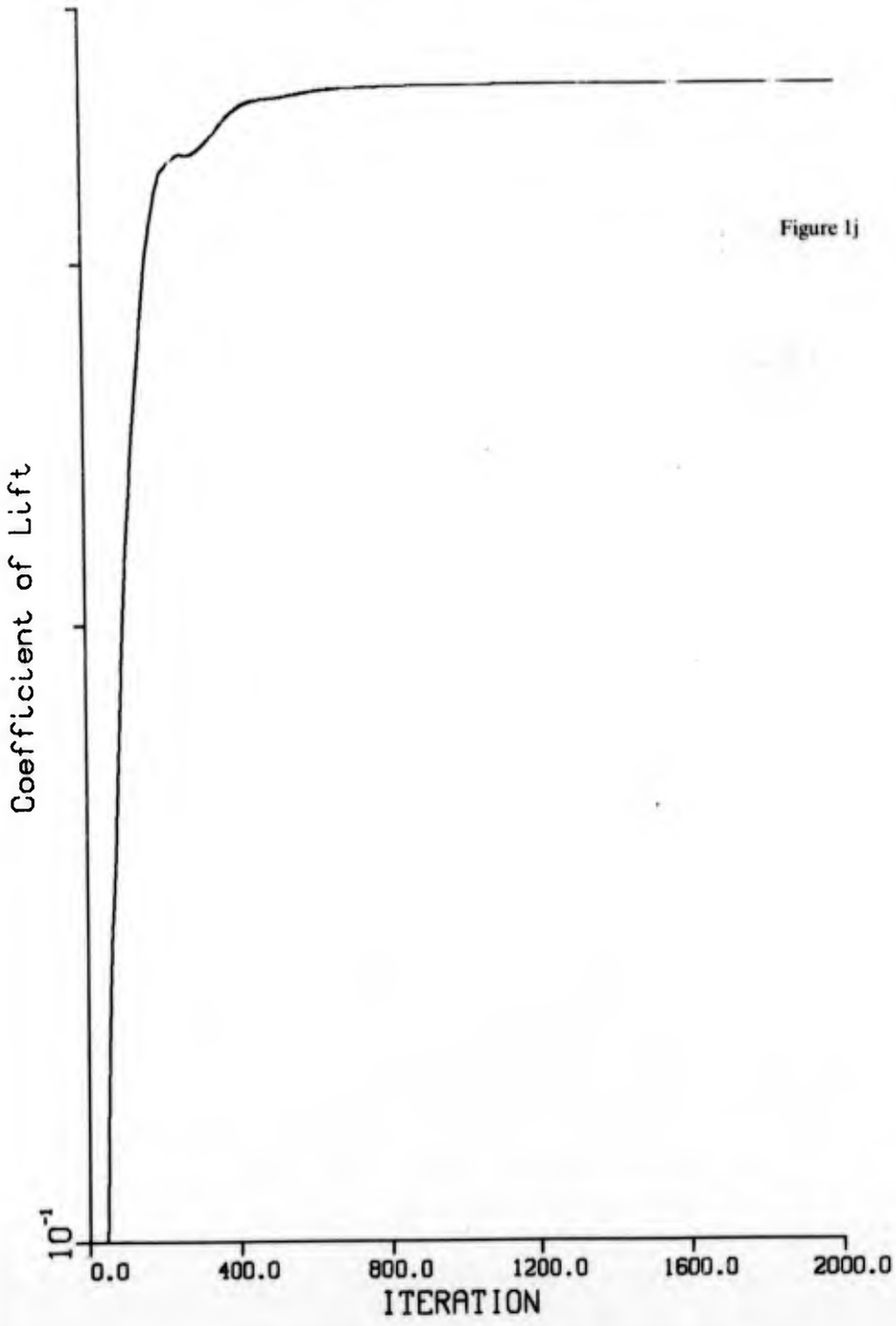


Figure 1j

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-37
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ARC2D - 249 x 67 grid, DT-3.
AGARD1X grid, clustering at shocks = .008
Upwinding, spatially variable time step
Mach number = .8, Alpha = 1.25

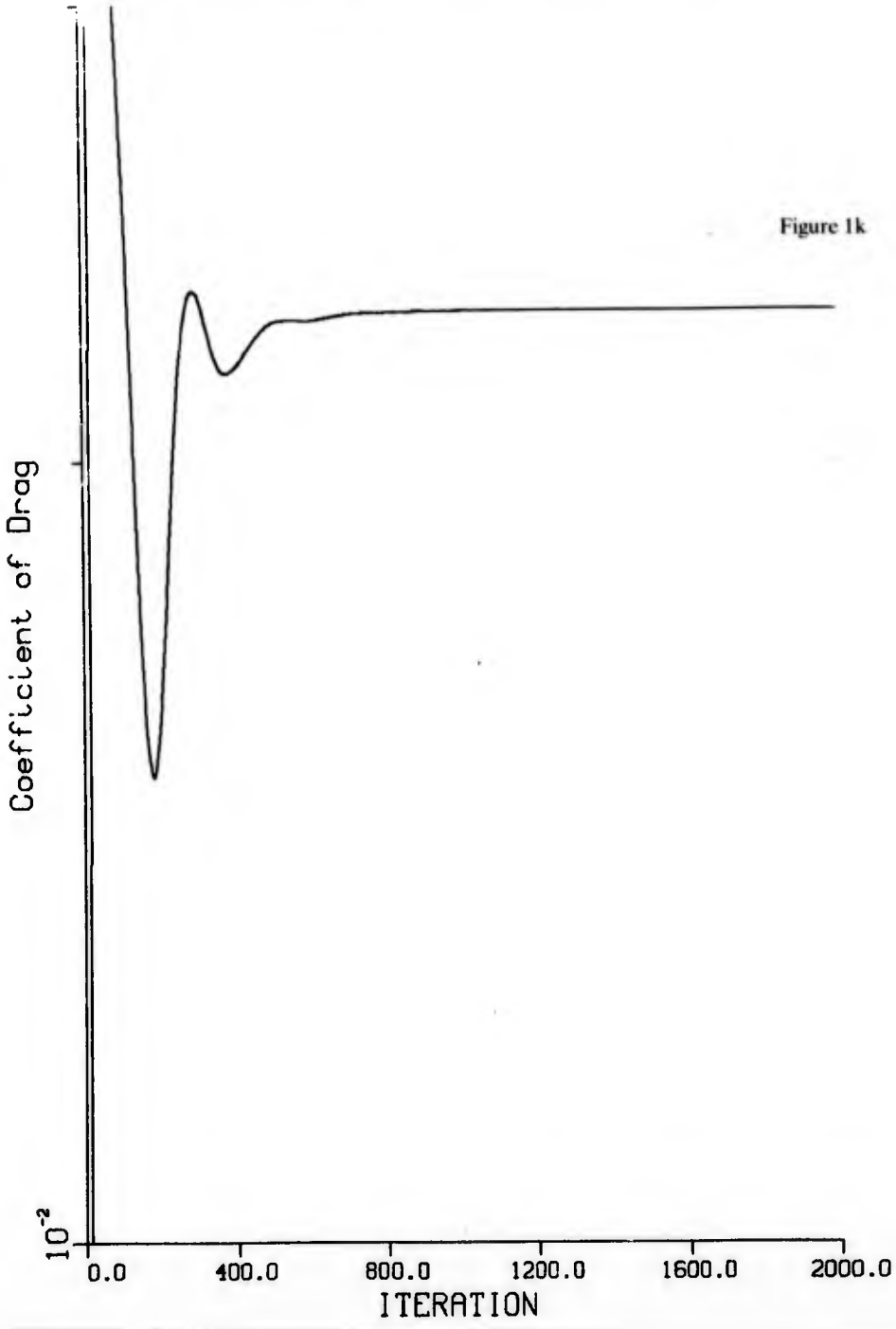
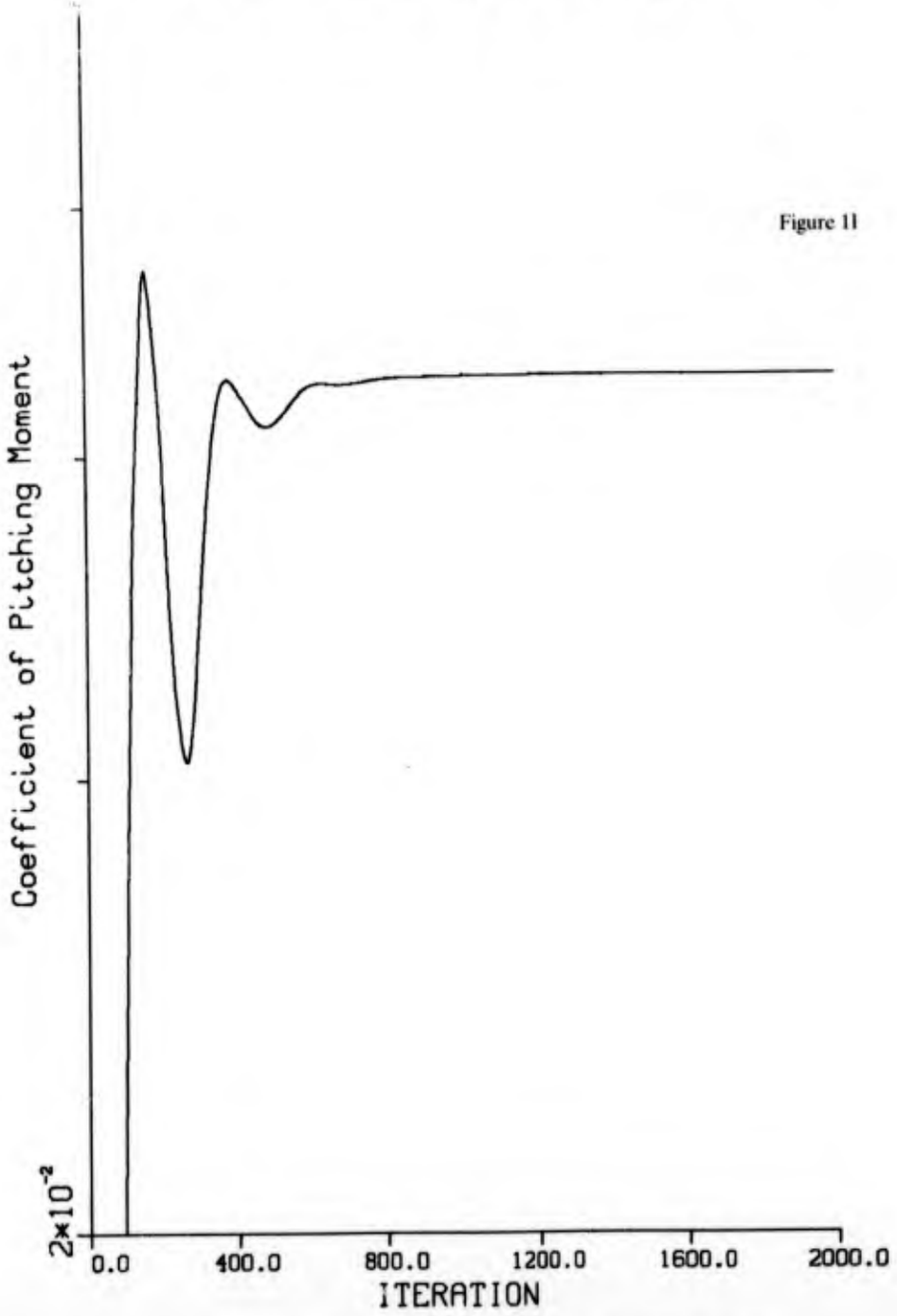


Figure 1k

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-38
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ARC2D - 249 x 67 grid, DT-3.
AGARD.X grid, clustering at shocks = .008
Upwinding, spatially variable time step
Mach number = .8, Alpha = 1.25

Figure 11



N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-39
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

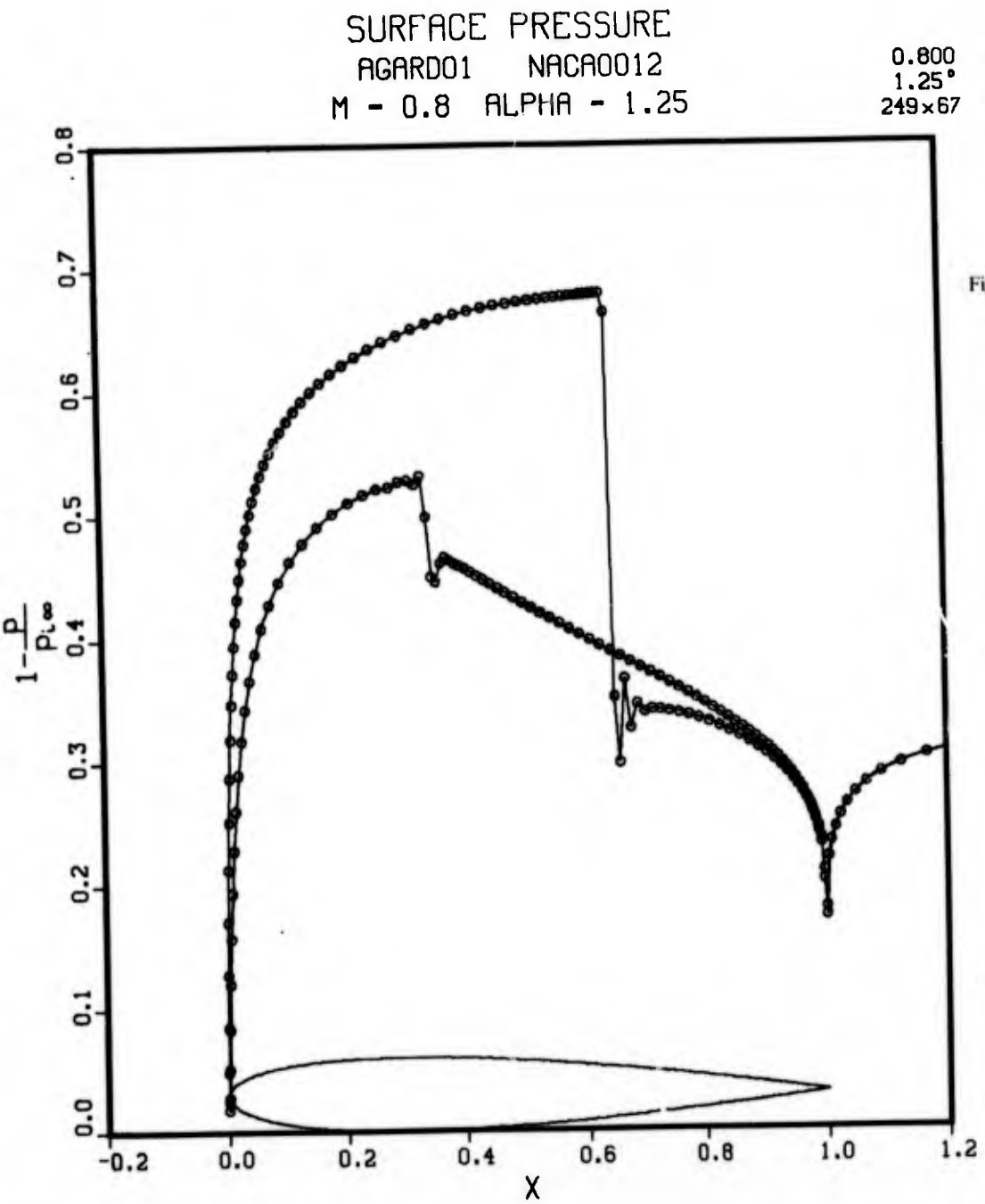


Figure 1m

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-40
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

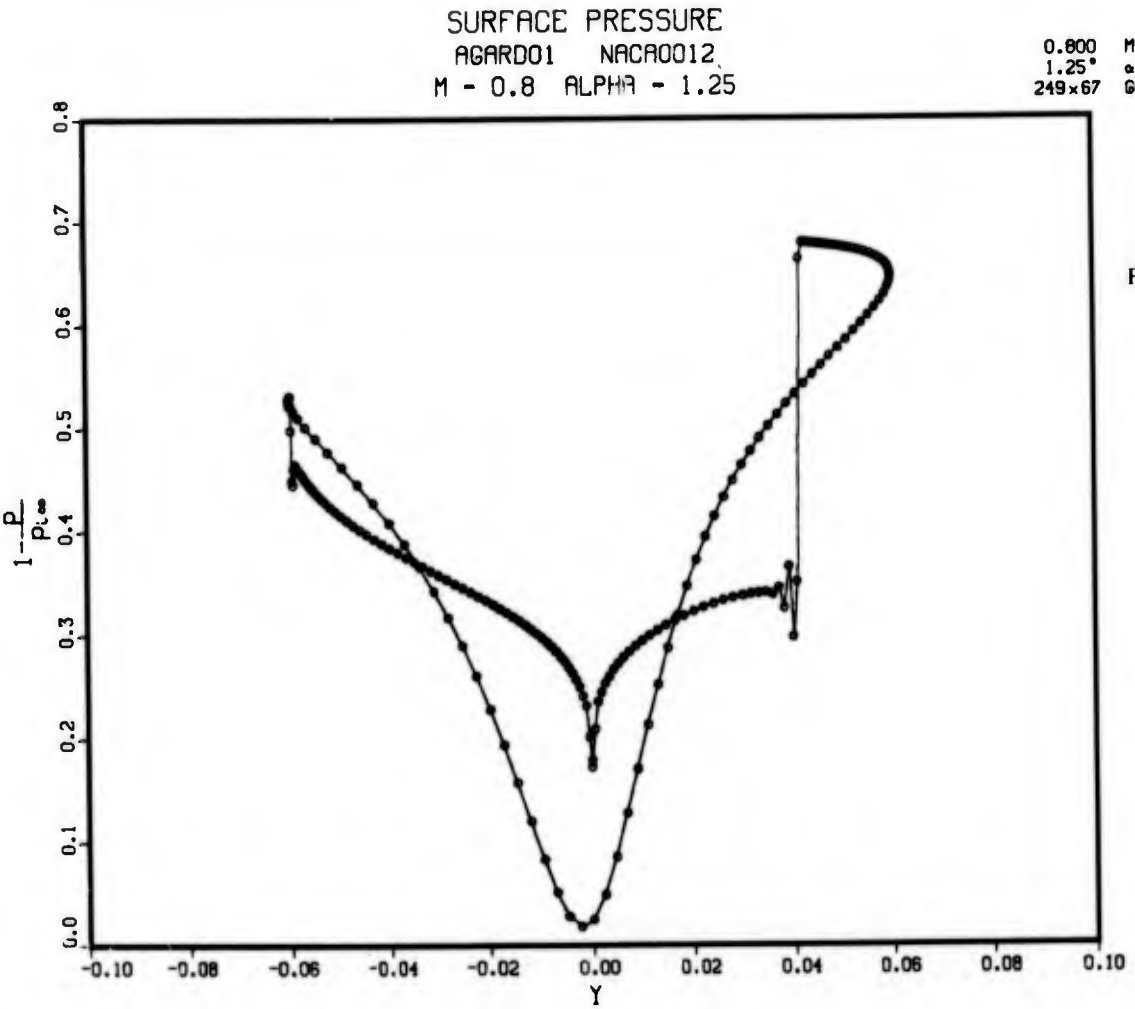


Figure 1n

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-41
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

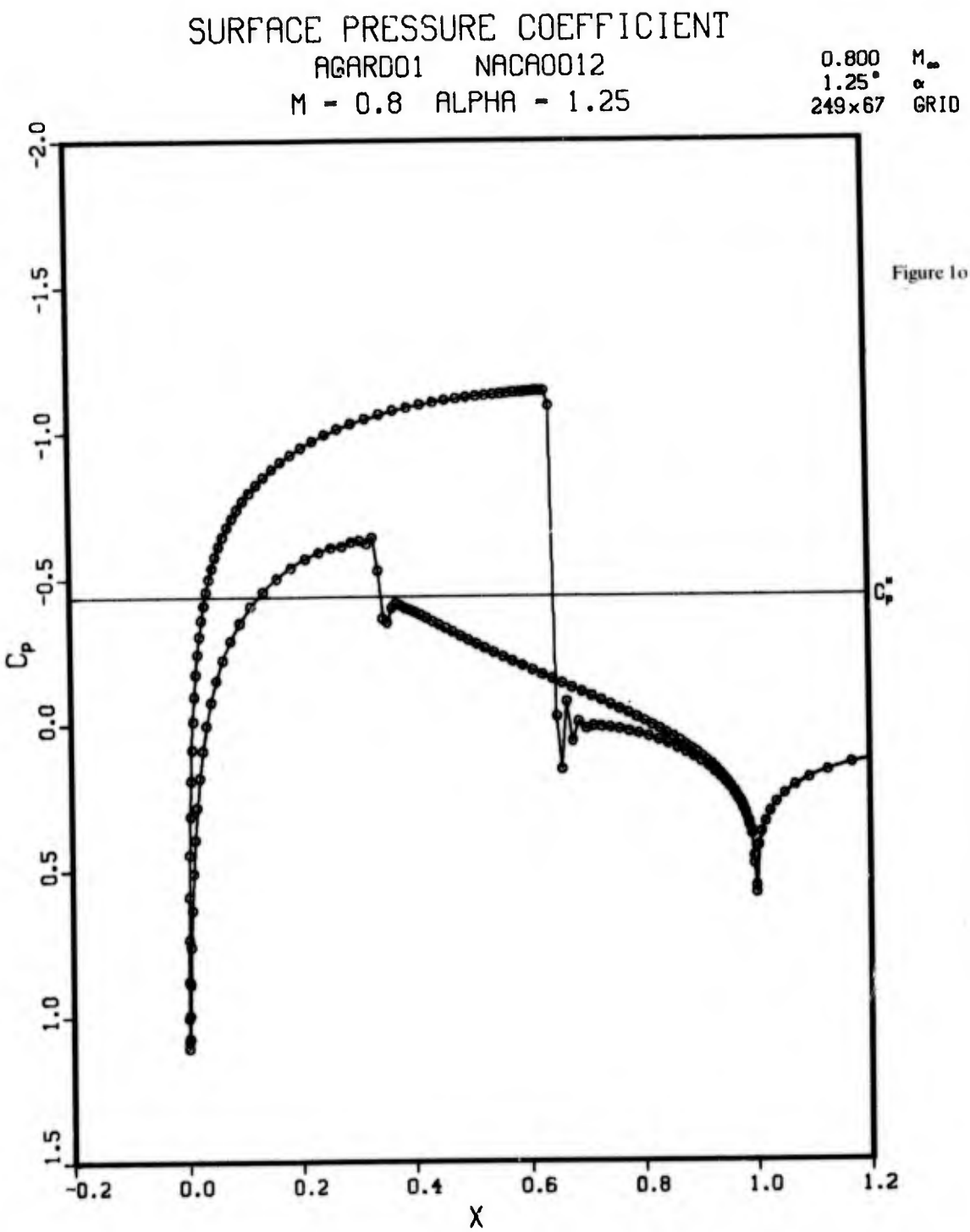


Figure 1o

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-42
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

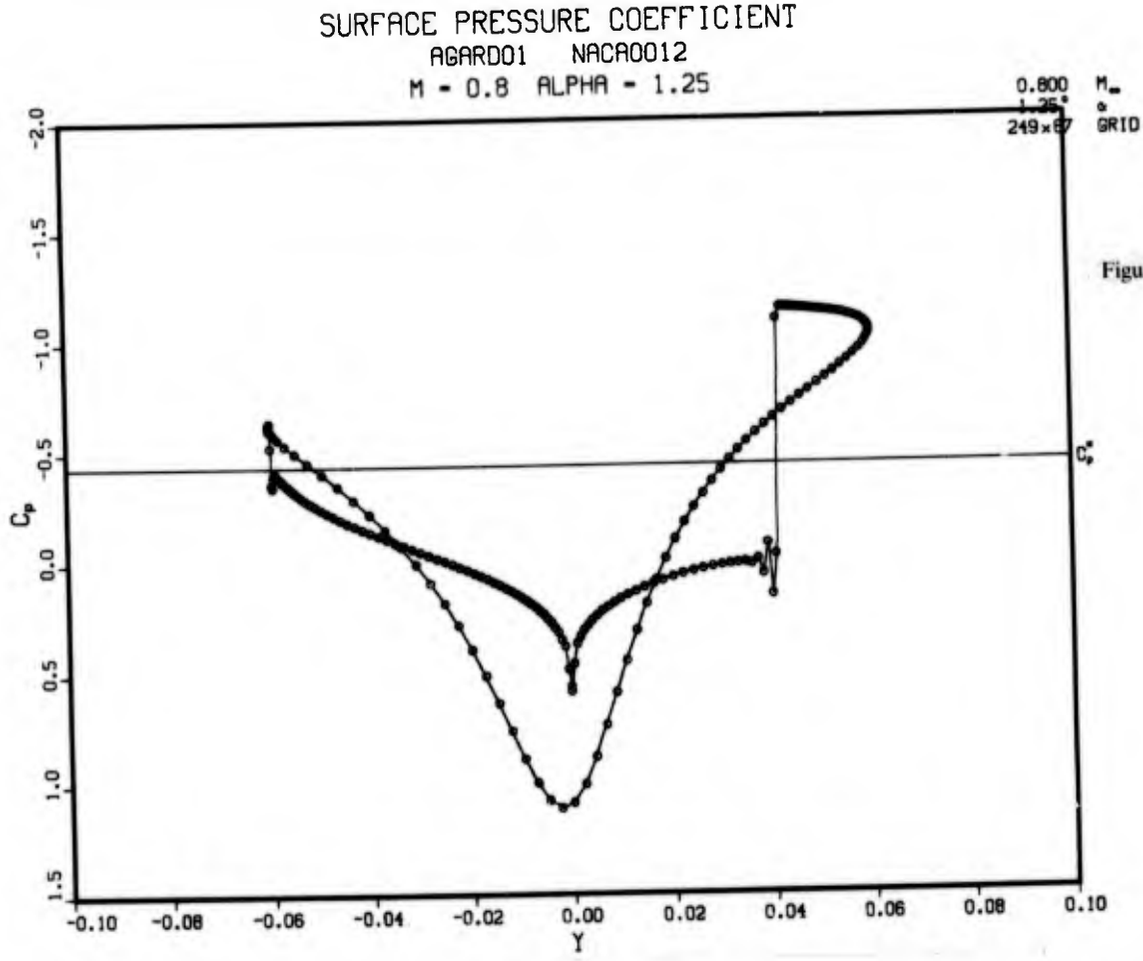


Figure 1p

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-43
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

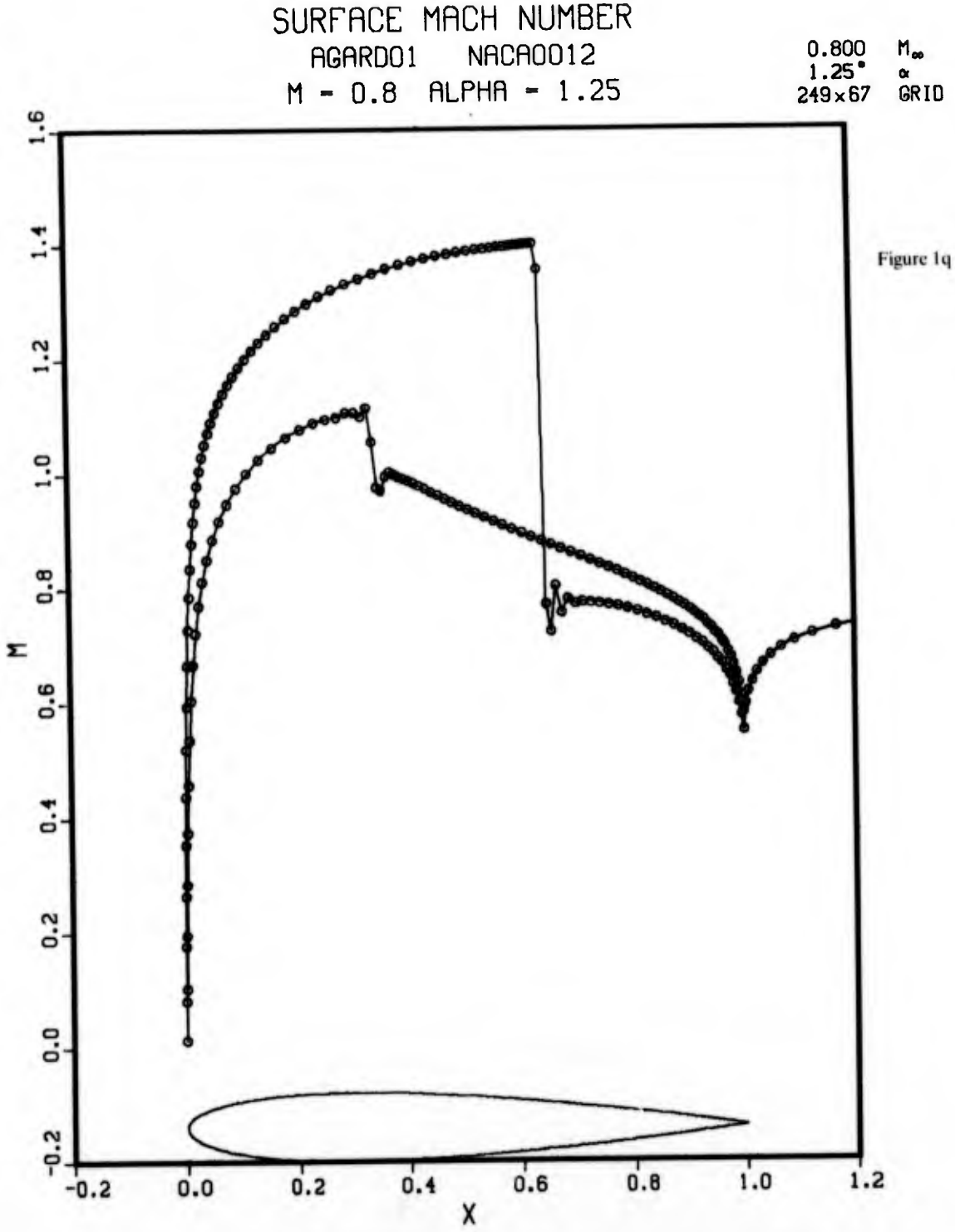


Figure 1q

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-44
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

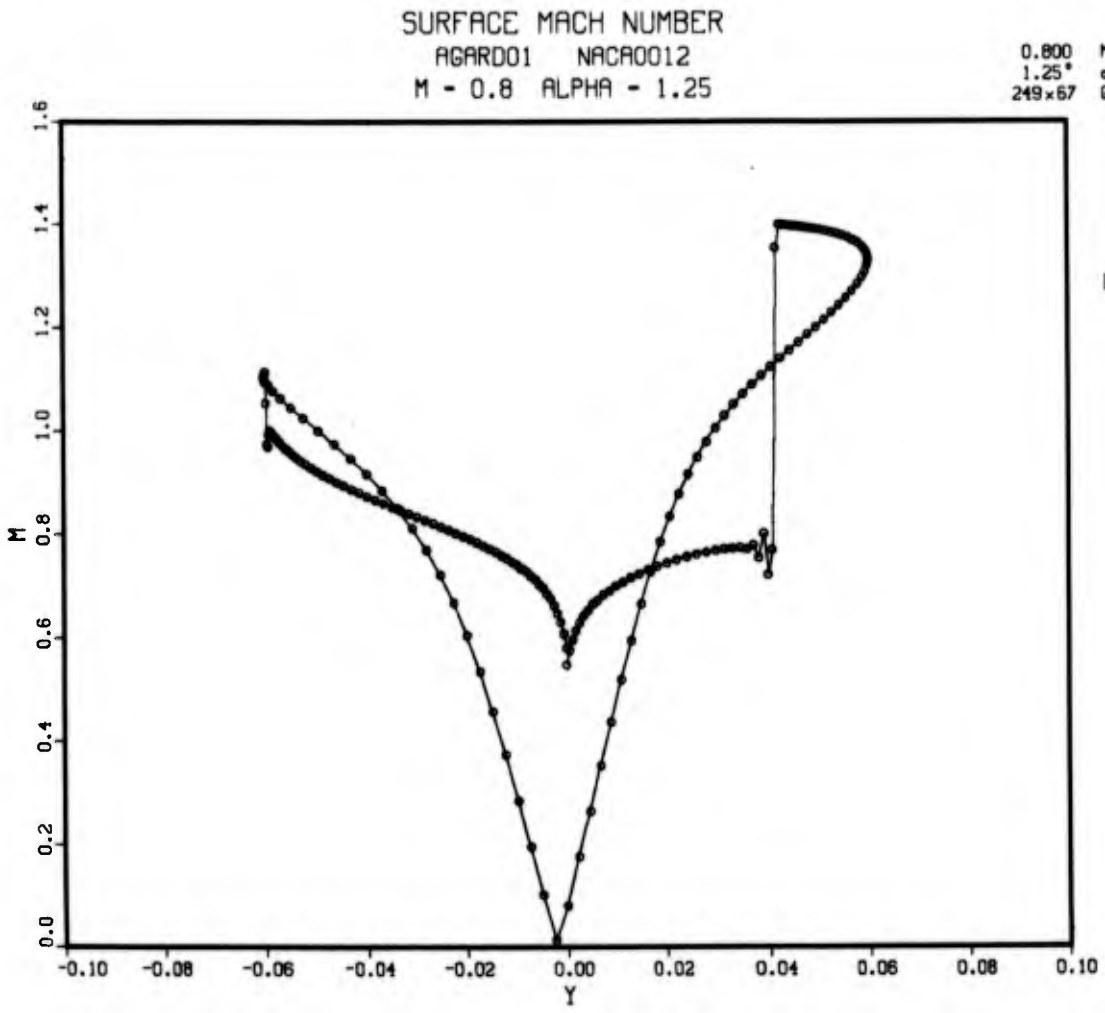


Figure 1r

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-45
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

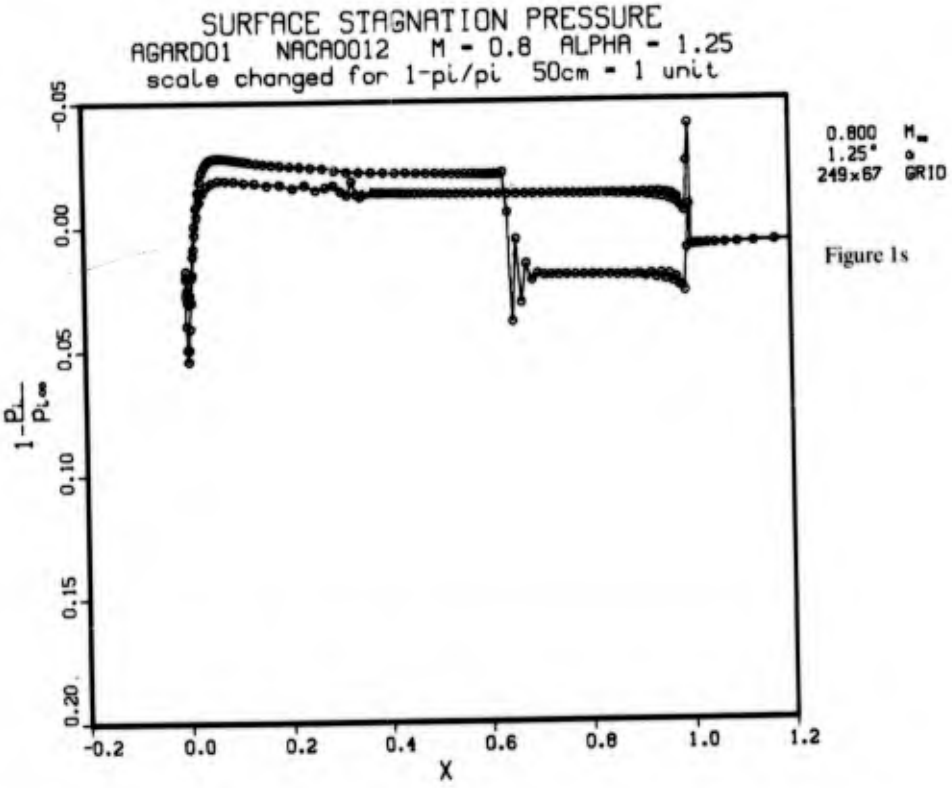


Figure 1s

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-46
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

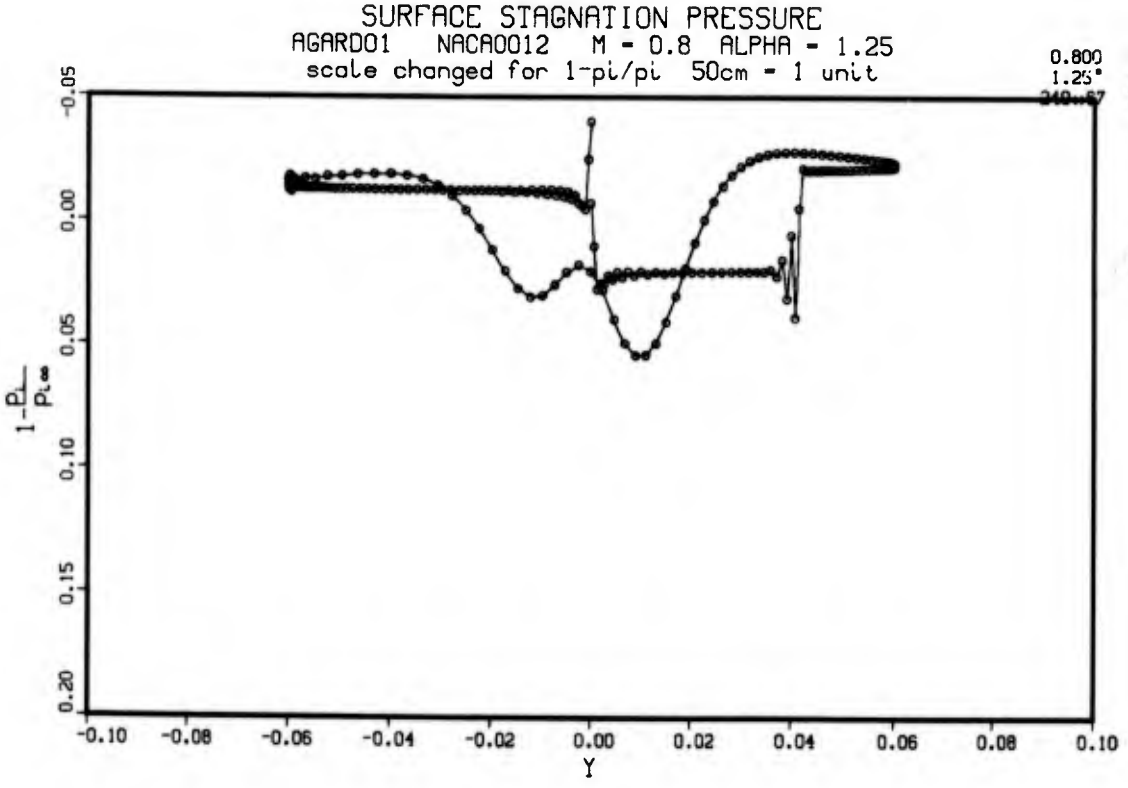


Figure 1t

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-47
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

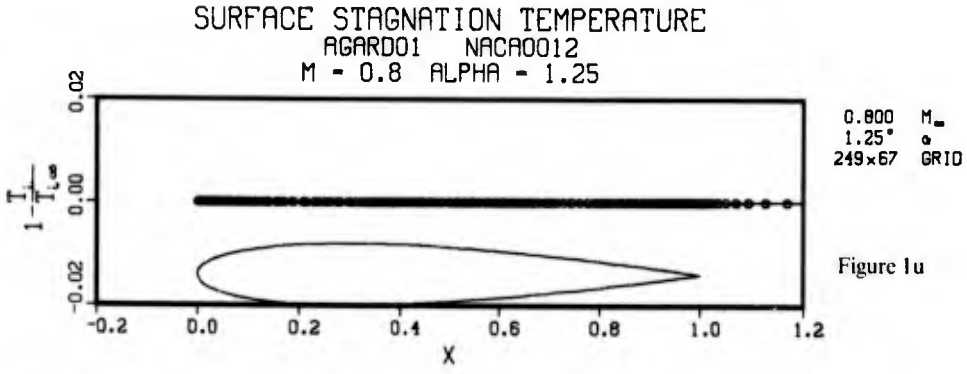


Figure 1u

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-48
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

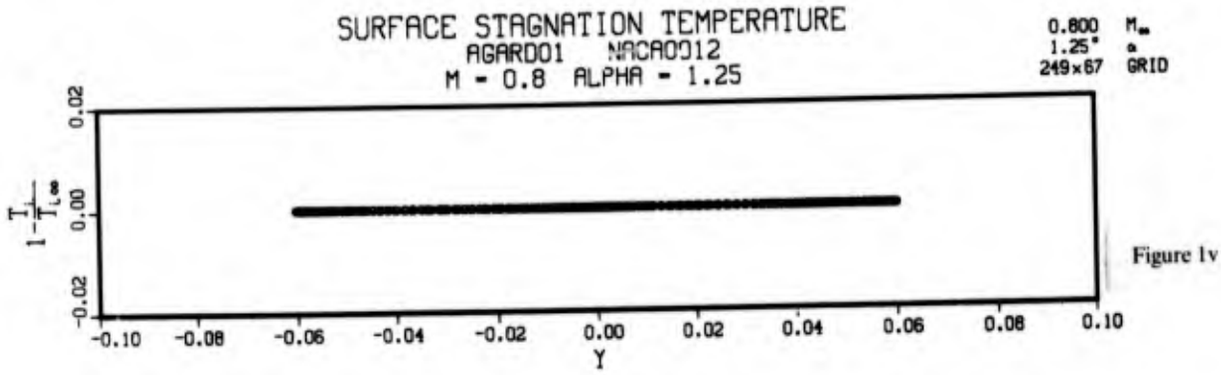


Figure 1v

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-49
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

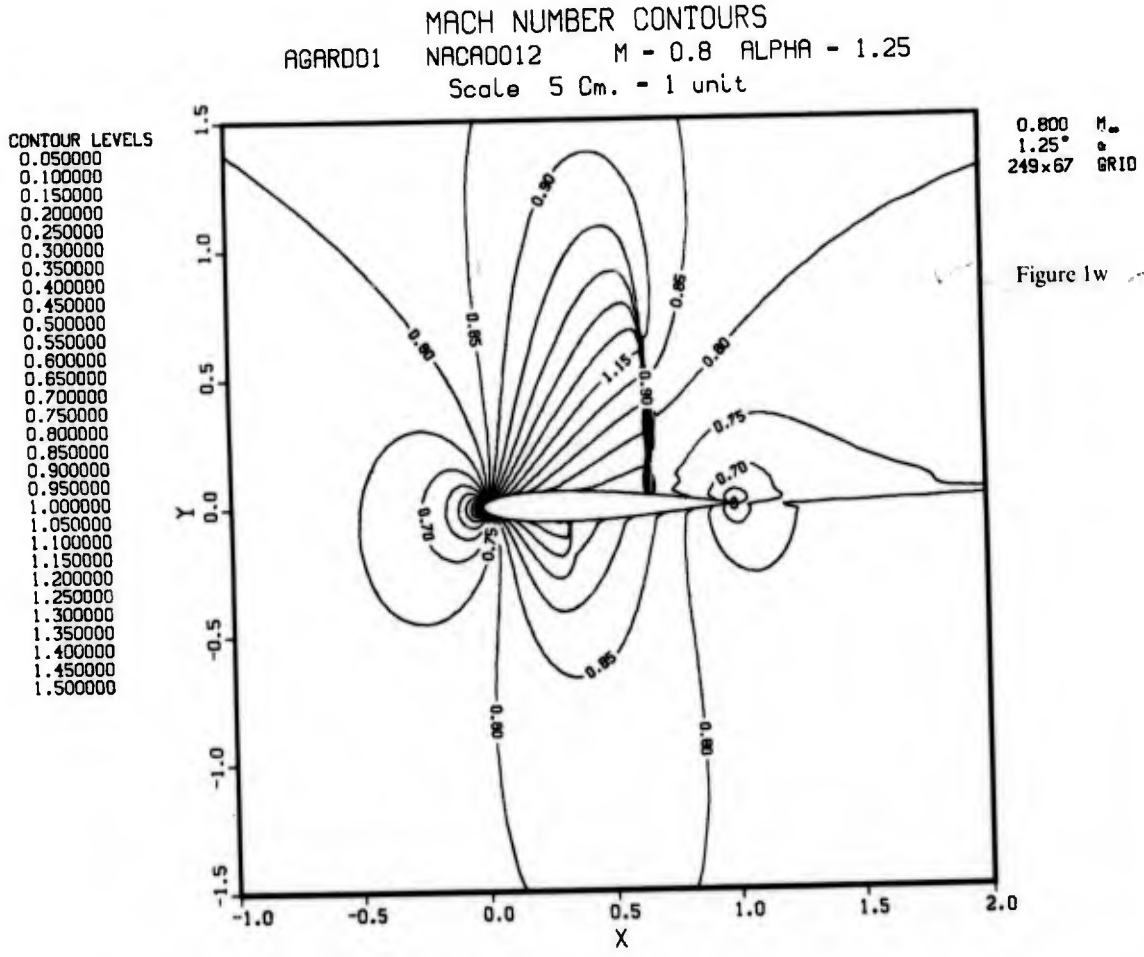


Figure 1w

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-50
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

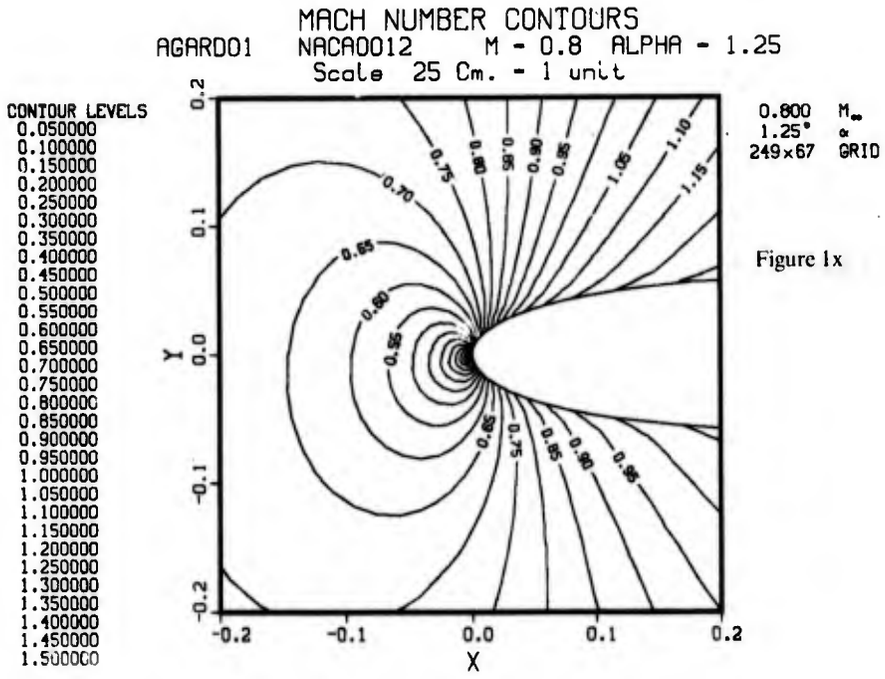


Figure 1x

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-51
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

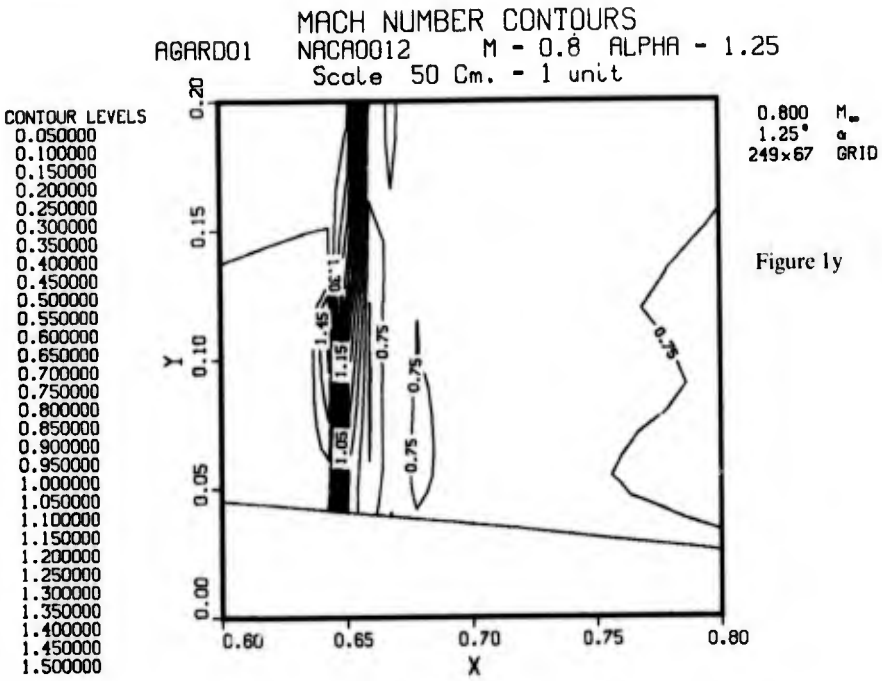


Figure 1y

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-52
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

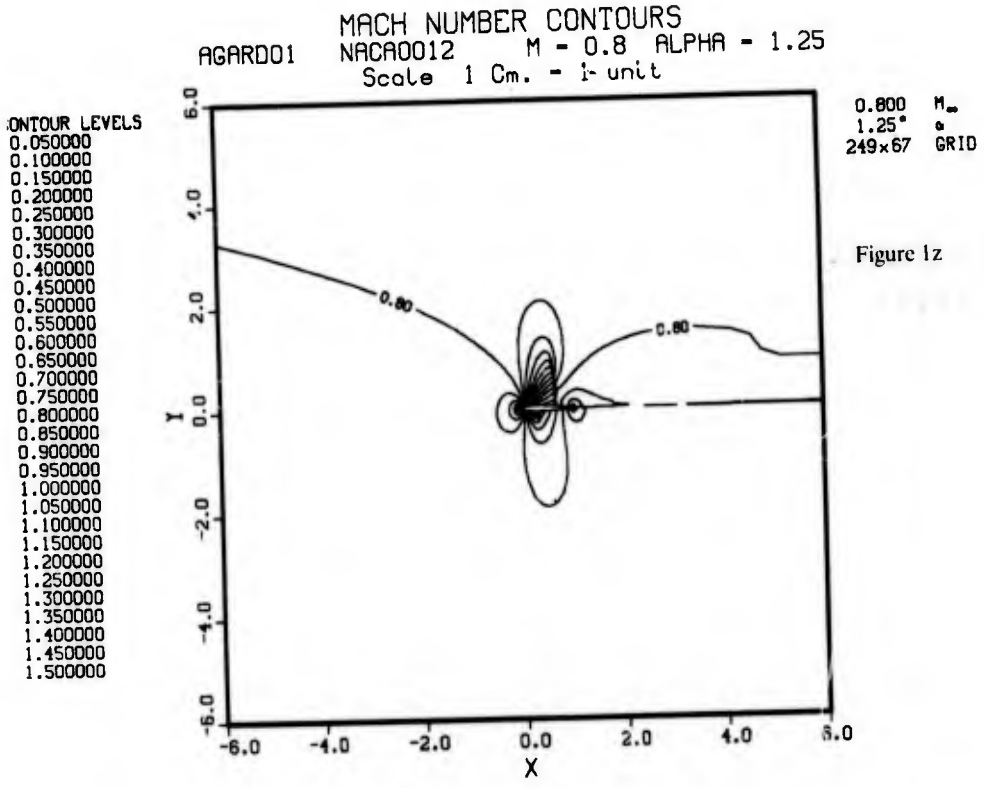


Figure 1z

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-53
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

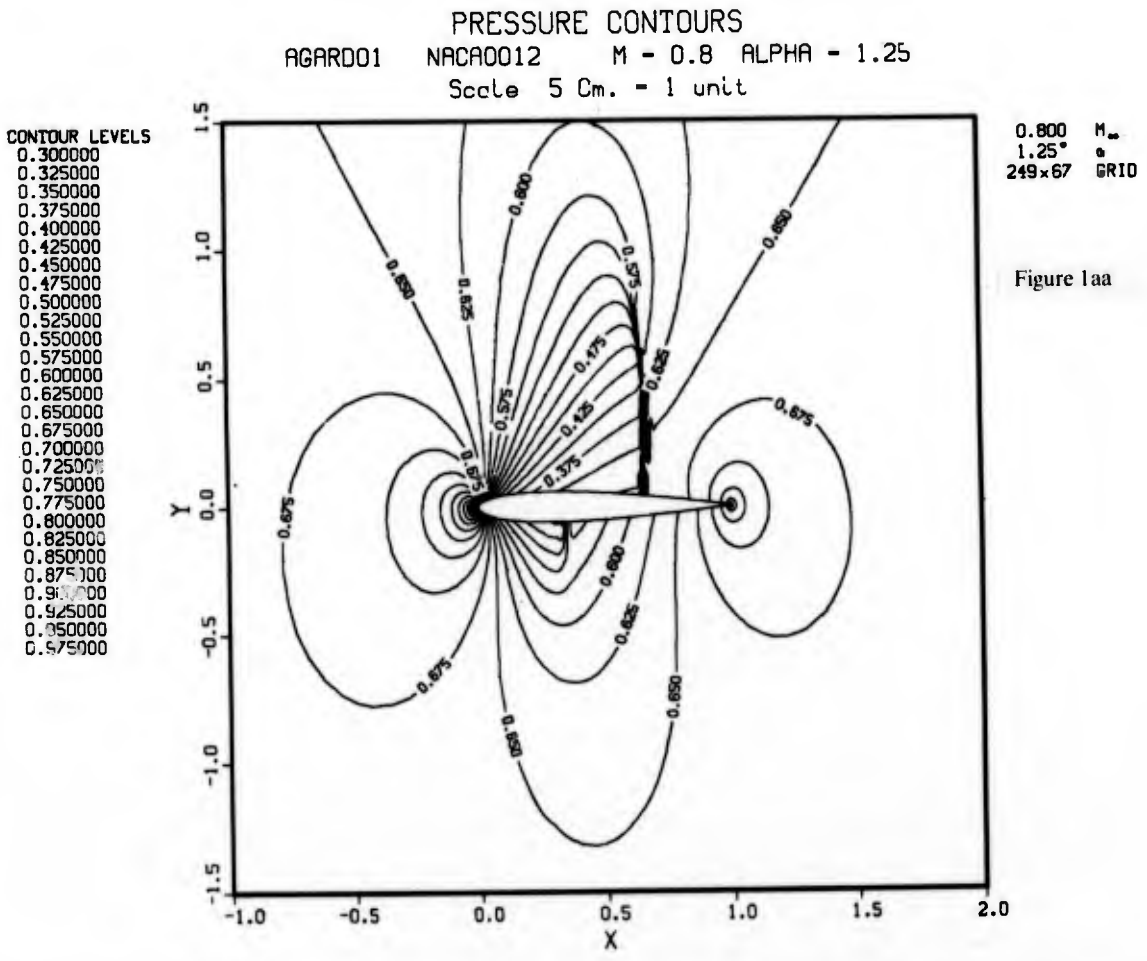


Figure 1aa

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-54
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

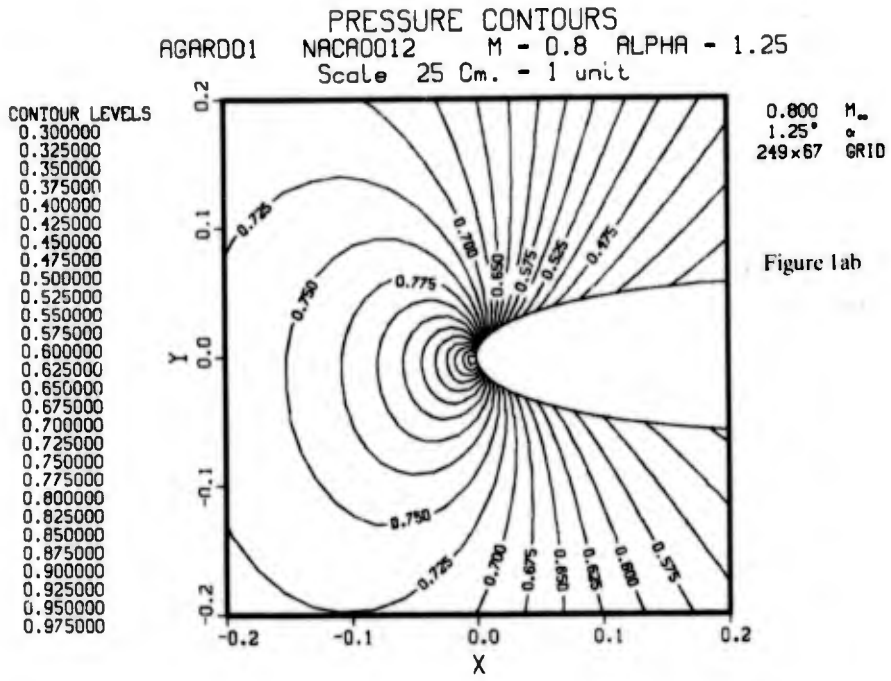


Figure 1ab

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-55
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

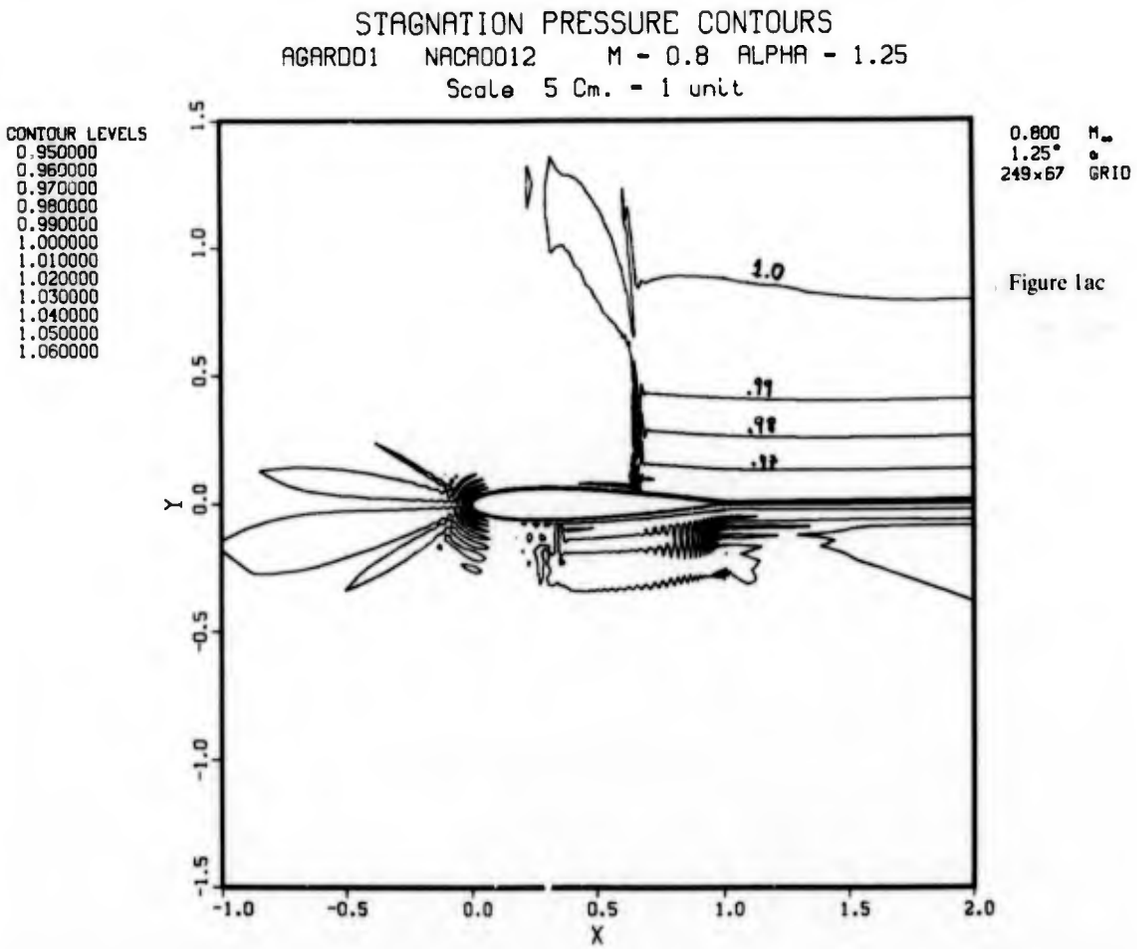


Figure 1ac

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-56
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

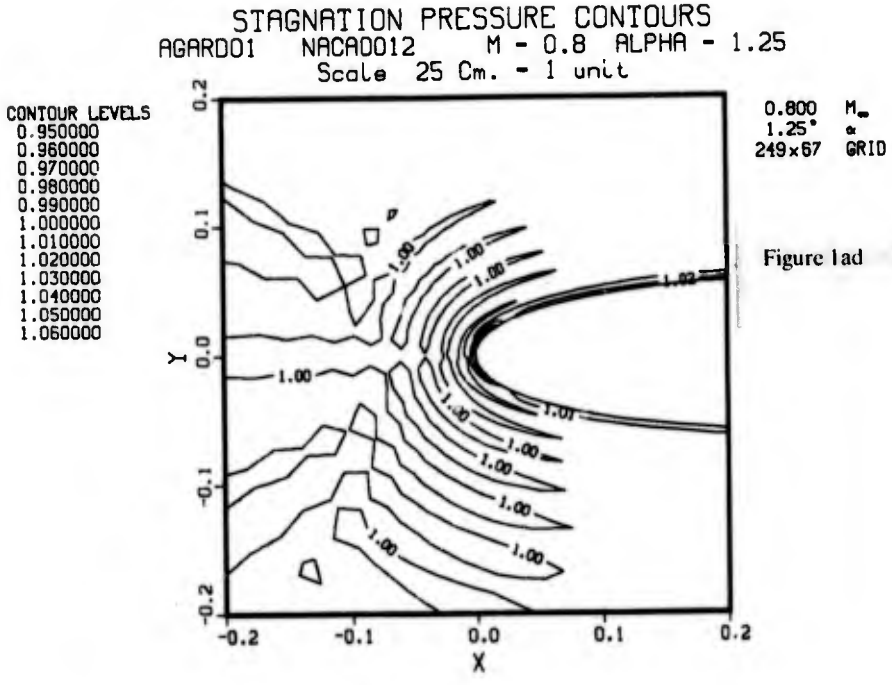


Figure 1ad

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-57
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

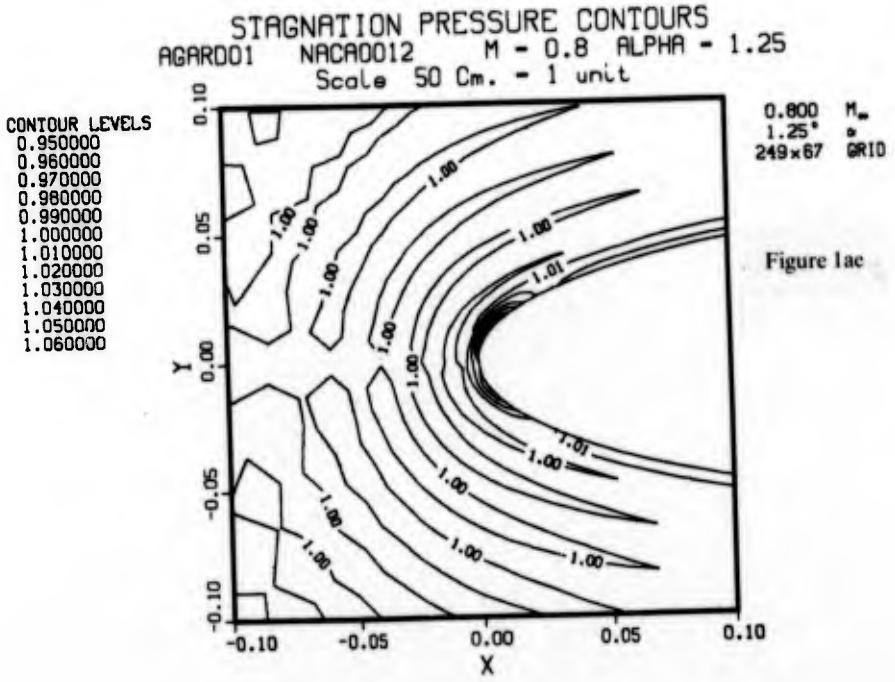


Figure 1ac

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-58
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

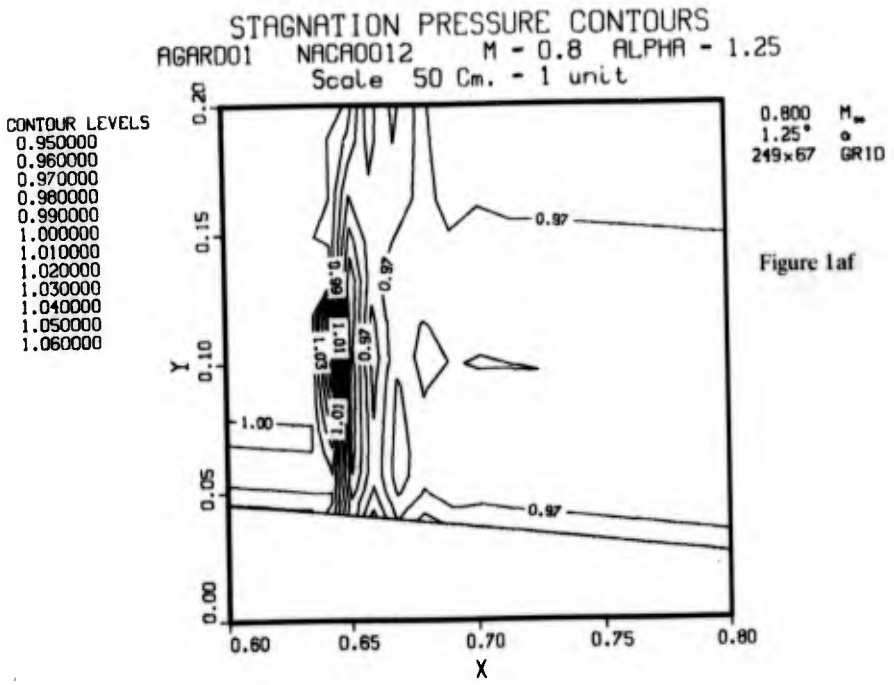


Figure 1af

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-59
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

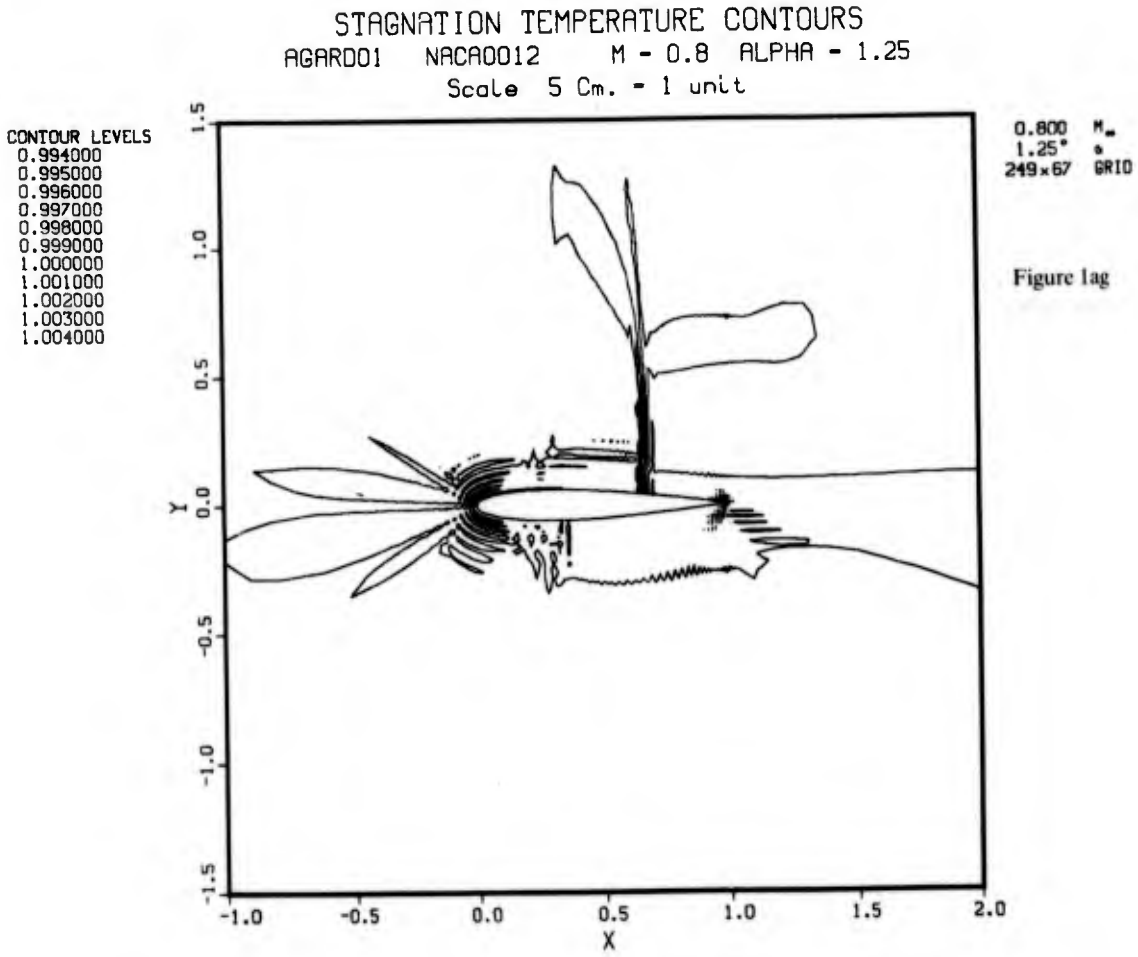


Figure 1ag

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-60
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

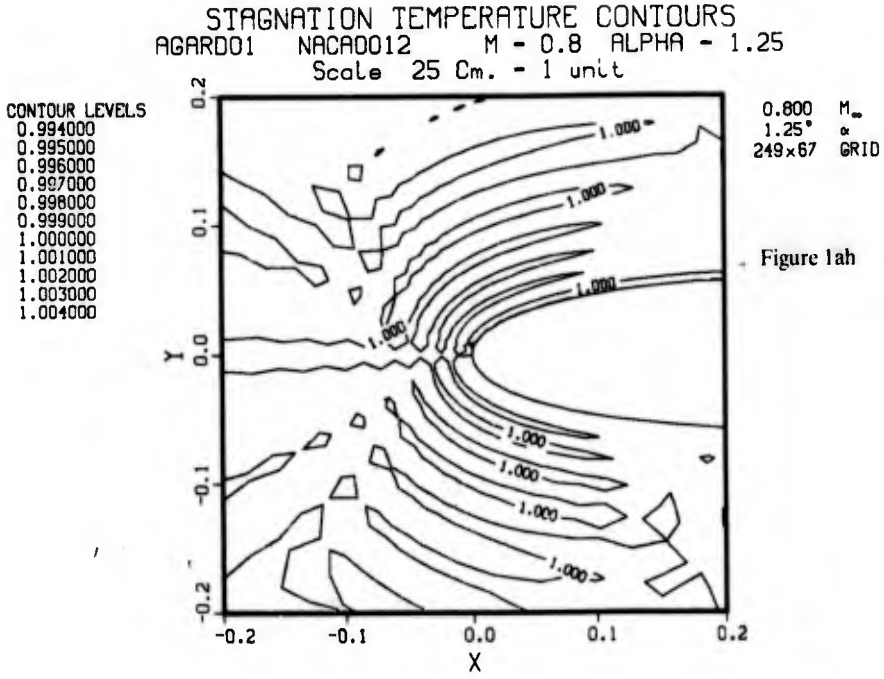


Figure 1ah

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	01-5-61
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

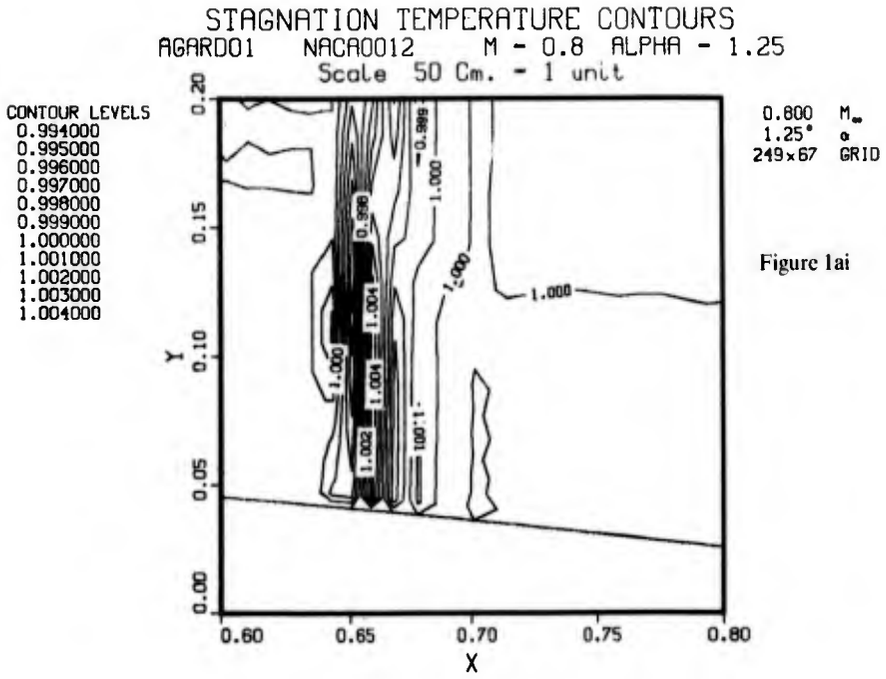


Figure 1ai

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 01

NACA 0012: MACH = 0.80, ALPHA = 1.25

Contributor No 6

M.D.Salas and J.C.South, Jr

(N.A.S.A. — Langley, U.S.A.)

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-2
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
1	.000115	.001330	.021888	1.095927	.159740	.004305
2	.000575	.003980	.059878	.966664	.285454	.005153
3	.001500	.006610	.110840	.793265	.399851	.007287
4	.002890	.009215	.168099	.598437	.510680	.006069
5	.004755	.011790	.224363	.406996	.606005	.005986
6	.007100	.014330	.273378	.240222	.684884	.005488
7	.009915	.016830	.317342	.090632	.752564	.006184
8	.013200	.019290	.354642	-.036285	.813304	.003091
9	.016960	.021710	.387141	-.146862	.862785	.003858
10	.021195	.024085	.414375	-.239527	.907762	.001133
11	.025895	.026405	.437401	-.317873	.942533	.002790
12	.031055	.028670	.456189	-.381800	.974795	.000184
13	.036675	.030880	.474352	-.443601	1.002446	.002140
14	.042750	.033030	.489201	-.494126	1.028857	-.000333
15	.049270	.035115	.502920	-.540807	1.049780	.001856
16	.056235	.037135	.514654	-.580732	1.071677	-.000798
17	.063640	.039085	.526534	-.621152	1.090080	.001409
18	.071470	.040960	.535436	-.651443	1.107393	-.001060
19	.079725	.042760	.545327	-.685097	1.122899	.001073
20	.088400	.044480	.554066	-.714831	1.140408	-.001603
21	.097480	.046115	.562567	-.743757	1.153668	.000788
22	.106960	.047665	.569601	-.767690	1.168569	-.002082
23	.116830	.049125	.577560	-.794771	1.181180	.000331
24	.127085	.050495	.583013	-.813326	1.193266	-.002350
25	.137720	.051775	.590040	-.837237	1.204554	-.000067
26	.148720	.052960	.595058	-.854311	1.215914	-.002641
27	.160080	.054050	.601420	-.875956	1.226278	-.000451
28	.171785	.055040	.606215	-.892273	1.237419	-.003091
29	.183825	.055935	.610934	-.908329	1.244453	-.000374
30	.196190	.056730	.616050	-.925735	1.256978	-.003851
31	.208870	.057420	.620886	-.942189	1.263869	-.000396
32	.221860	.058010	.624576	-.954744	1.274144	-.004432
33	.235140	.058500	.628898	-.969452	1.279685	-.000313
34	.248700	.058890	.632228	-.980781	1.289828	-.005027
35	.262530	.059180	.636263	-.994510	1.294382	-.000160
36	.276620	.059370	.639329	-1.004944	1.304683	-.005718
37	.290955	.059460	.643066	-1.017658	1.308114	.000033
38	.305520	.059455	.645141	-1.024721	1.316968	-.006253
39	.320305	.059355	.648848	-1.037333	1.319902	.000248
40	.335290	.059160	.650824	-1.044056	1.329172	-.006858
41	.350465	.058870	.654525	-1.056649	1.331639	.000428
42	.365820	.058490	.655597	-1.060297	1.339501	-.007325
43	.381335	.058030	.658080	-1.068744	1.338738	.000988
44	.396995	.057485	.659899	-1.074935	1.349319	-.008336
45	.412785	.056855	.662925	-1.085229	1.348669	.001533
46	.428690	.056150	.662471	-1.083686	1.355063	-.008710
47	.444695	.055370	.666670	-1.097973	1.356656	.001633
48	.460780	.054520	.665015	-1.092341	1.360604	-.008843
49	.476930	.053600	.669944	-1.109114	1.363796	.001581
50	.493130	.052615	.667739	-1.101610	1.366412	-.008758

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-3
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
51	.509365	.051575	.670995	-1.112690	1.366023	.001669
52	.525615	.050475	.670924	-1.112447	1.373687	-.009276
53	.541860	.049320	.672499	-1.117808	1.368651	.002587
54	.558085	.048115	.673321	-1.120603	1.379917	-.010687
55	.574270	.046865	.673933	-1.122686	1.370555	.004315
56	.590400	.045575	.673520	-1.121279	1.381327	-.012067
57	.606460	.044245	.677177	-1.133724	1.376923	.005417
58	.622430	.042880	.634312	-.987873	1.282223	.010897
59	.638285	.041485	.460412	-.396170	.932571	.054154
60	.654015	.040065	.329527	.049170	.746488	.029503
61	.669600	.038625	.343783	.000665	.764442	.033810
62	.685020	.037160	.342968	.003436	.763804	.033202
63	.700265	.035680	.344370	-.001333	.765547	.033651
64	.715310	.034190	.343726	.000858	.764568	.033610
65	.730140	.032685	.342814	.003960	.762929	.033784
66	.744740	.031175	.341258	.009255	.760448	.033790
67	.759090	.029665	.339886	.013925	.758109	.033933
68	.773175	.028155	.337924	.020599	.754936	.033980
69	.786975	.026650	.335650	.028337	.751218	.034069
70	.800475	.025155	.333446	.035838	.747693	.034080
71	.813665	.023670	.330860	.044636	.743418	.034220
72	.826525	.022200	.328137	.053901	.739108	.034189
73	.839040	.020745	.325302	.063547	.734435	.034322
74	.851195	.019310	.321611	.076105	.728578	.034286
75	.862975	.017905	.318819	.085605	.724044	.034347
76	.874365	.016525	.315453	.097058	.718560	.034431
77	.885350	.015175	.311296	.111202	.711918	.034411
78	.895915	.013865	.308108	.122049	.706802	.034409
79	.906050	.012590	.304200	.135349	.700306	.034591
80	.915740	.011355	.299832	.150210	.693445	.034439
81	.924970	.010165	.295693	.164295	.686593	.034584
82	.933735	.009025	.290871	.180701	.678867	.034518
83	.942015	.007940	.287091	.193561	.672635	.034602
84	.949795	.006905	.281712	.211863	.663770	.034695
85	.957065	.005930	.276281	.230342	.655150	.034491
86	.963815	.005020	.271409	.246921	.646871	.034729
87	.970035	.004175	.265602	.266680	.637410	.034650
88	.975710	.003395	.259819	.286355	.627717	.034751
89	.980825	.002685	.252043	.312815	.614781	.034745
90	.985370	.002055	.245447	.335258	.604042	.034503
91	.989335	.001505	.237648	.361794	.590046	.035118
92	.992700	.001035	.229290	.390232	.576571	.034538
93	.995450	.000645	.217768	.429435	.555056	.035675
94	.997570	.000345	.203840	.476826	.532096	.034564
95	.999035	.000140	.189539	.525486	.501564	.037617
96	.999800	.000030	.172579	.583194	.444107	.052600
97	.999800	-.000030	.155785	.640338	.466967	.019744
98	.999035	-.000140	.189139	.526849	.546148	.006831
99	.997570	-.000345	.199670	.491016	.574282	-.000835
100	.995450	-.000645	.217525	.430263	.598278	.003295

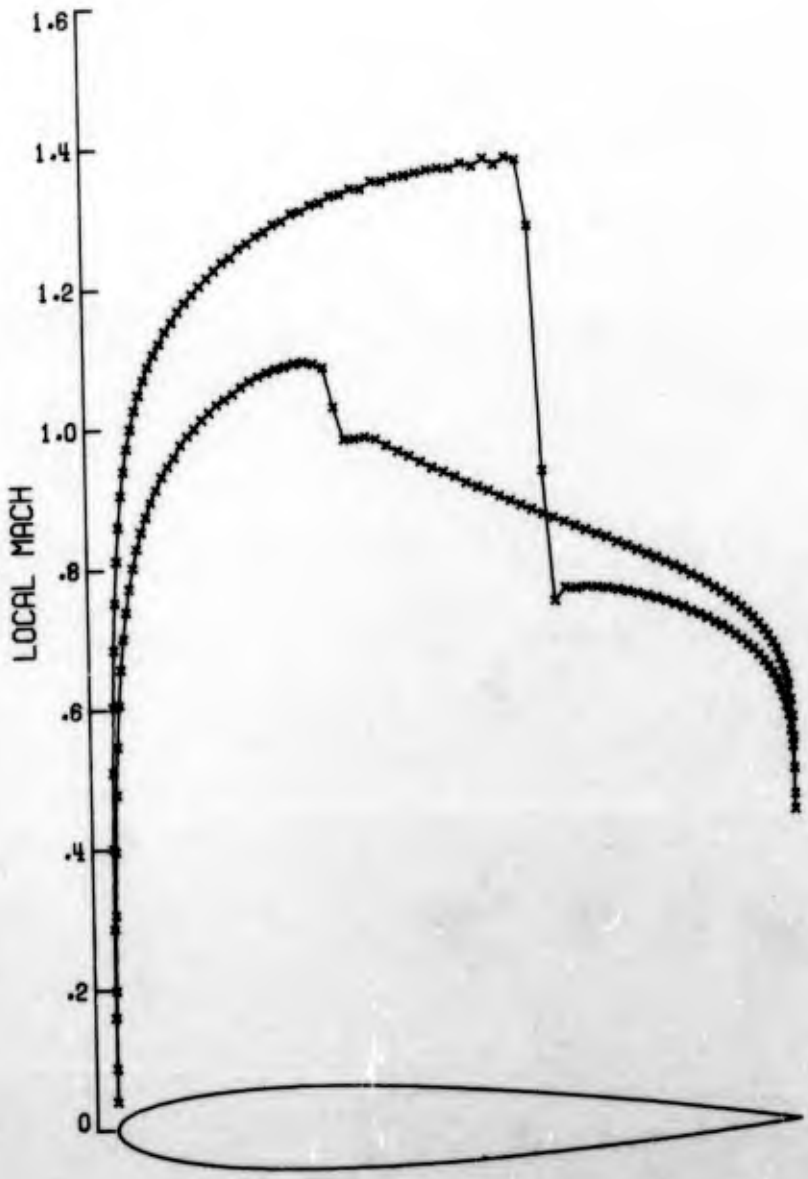
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-4
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
101	.992700	-.001035	.228413	.393217	.620797	-.000576
102	.989335	-.001505	.238458	.359038	.633511	.002178
103	.985370	-.002055	.245911	.333680	.648241	-.000198
104	.980825	-.002685	.253568	.307626	.658368	.001473
105	.975710	-.003395	.261541	.280496	.672226	.000356
106	.970035	-.004175	.268160	.257975	.681613	.001210
107	.963815	-.005020	.274081	.237829	.691660	.000508
108	.957065	-.005930	.279584	.219103	.699755	.000929
109	.949795	-.006905	.285359	.199456	.709078	.000613
110	.942015	-.007940	.291450	.178731	.718094	.000997
111	.933735	-.009025	.295500	.164949	.724874	.000528
112	.924970	-.010165	.300808	.146888	.732645	.000924
113	.915740	-.011355	.306068	.128991	.741041	.000663
114	.906050	-.012585	.309819	.116230	.746712	.000764
115	.895915	-.013860	.314790	.099315	.754404	.000729
116	.885350	-.015175	.319006	.084969	.760950	.000673
117	.874365	-.016525	.323696	.069013	.768029	.000800
118	.862975	-.017905	.327864	.054830	.774573	.000667
119	.851195	-.019310	.331357	.042945	.779924	.000683
120	.839040	-.020745	.336136	.026684	.787200	.000747
121	.826525	-.022200	.339970	.013639	.793196	.000641
122	.813665	-.023670	.343885	.000318	.799109	.000741
123	.800475	-.025155	.347777	-.012924	.805209	.000621
124	.786975	-.026650	.351460	-.025456	.810798	.000692
125	.773175	-.028155	.355493	-.039181	.817046	.000644
126	.759090	-.029665	.359418	-.052534	.823048	.000679
127	.744740	-.031175	.362995	-.064704	.828633	.000596
128	.730140	-.032685	.367535	-.080153	.835468	.000755
129	.715310	-.034185	.370776	-.091180	.840697	.000513
130	.700265	-.035675	.374776	-.104791	.846621	.000766
131	.685020	-.037155	.378411	-.117159	.852529	.000456
132	.669600	-.038620	.382852	-.132268	.859061	.000799
133	.654015	-.040065	.386636	-.145146	.865261	.000436
134	.638285	-.041485	.390645	-.158786	.871169	.000753
135	.622430	-.042880	.394795	-.172905	.877892	.000447
136	.606460	-.044245	.399162	-.187764	.884420	.000718
137	.590400	-.045575	.403403	-.202195	.891253	.000466
138	.574270	-.046865	.407517	-.216192	.897505	.000636
139	.558085	-.048115	.412632	-.233598	.905551	.000572
140	.541860	-.049315	.416228	-.245834	.911239	.000504
141	.525615	-.050465	.420382	-.259965	.917709	.000548
142	.509365	-.051570	.426152	-.279599	.926756	.000570
143	.493130	-.052615	.430575	-.294650	.933812	.000475
144	.476930	-.053595	.434684	-.308629	.940260	.000521
145	.460780	-.054515	.439940	-.326513	.948621	.000480
146	.444695	-.055370	.445386	-.345044	.957242	.000518
147	.428690	-.056150	.449625	-.359468	.964115	.000388
148	.412785	-.056855	.455037	-.377880	.972628	.000551
149	.396995	-.057485	.460594	-.396790	.981649	.000439
150	.381335	-.058030	.462436	-.403058	.984635	.000416

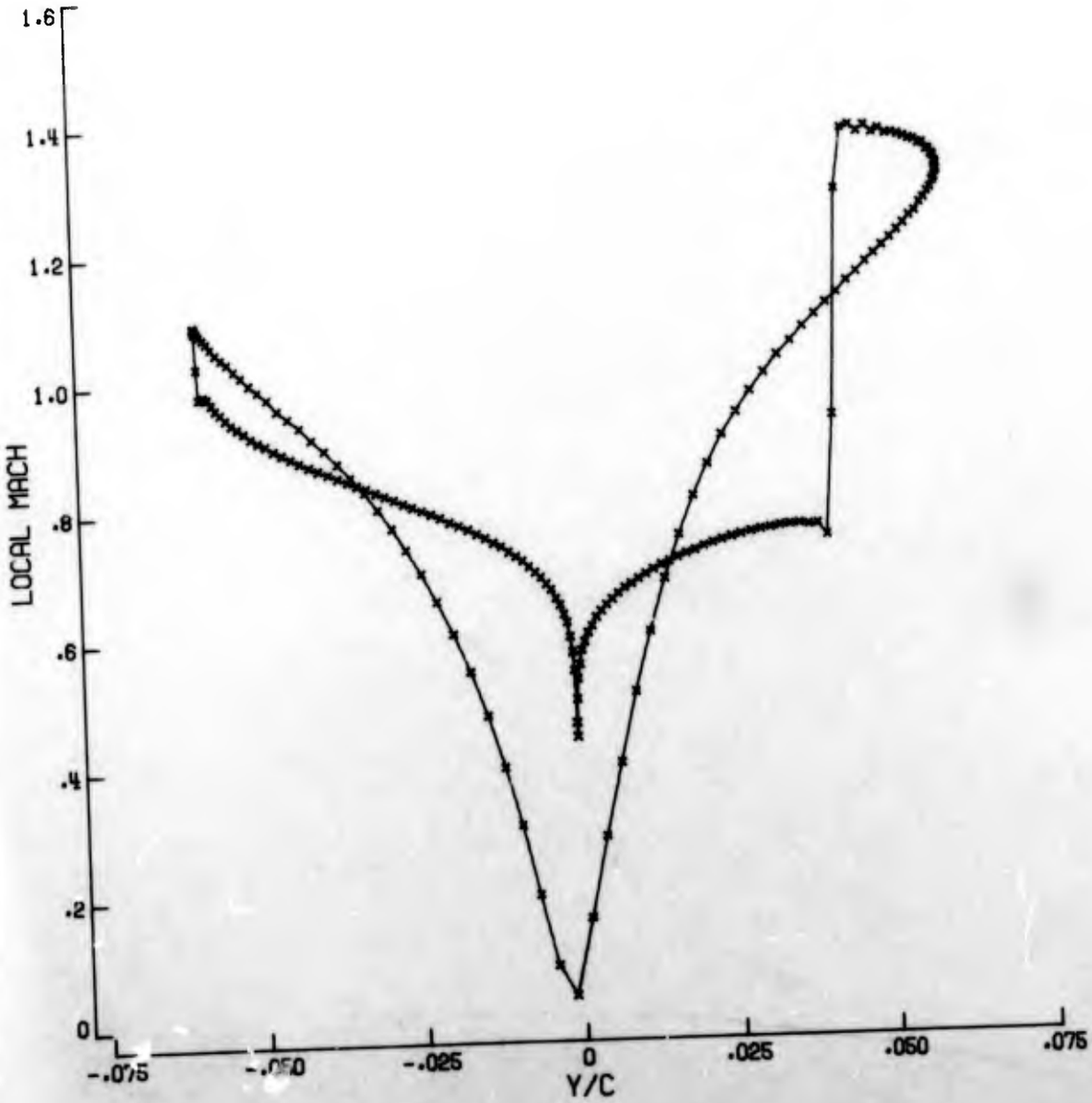
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-5
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
151	.365820	-.058490	.461291	-.399160	.982801	.000403
152	.350465	-.058865	.460638	-.396941	.981550	.000635
153	.335290	-.059155	.489863	-.496378	1.028399	.001506
154	.320305	-.059355	.522910	-.608824	1.085010	.000030
155	.305520	-.059455	.525976	-.619256	1.090146	.000153
156	.290955	-.059460	.527378	-.624024	1.092644	.000030
157	.276620	-.059370	.526521	-.621110	1.091016	.000229
158	.262530	-.059180	.524232	-.613322	1.087120	.000209
159	.248700	-.058890	.522333	-.606861	1.083642	.000502
160	.235140	-.058500	.519665	-.597783	1.079229	.000347
161	.221860	-.058010	.516616	-.587406	1.073783	.000681
162	.208870	-.057420	.512748	-.574247	1.067377	.000523
163	.196190	-.056730	.508218	-.558833	1.059453	.000889
164	.183825	-.055935	.502090	-.537980	1.049380	.000669
165	.171785	-.055040	.497726	-.523134	1.041611	.001276
166	.160080	-.054050	.493072	-.507298	1.034224	.000883
167	.148720	-.052960	.486550	-.485108	1.023082	.001343
168	.137720	-.051775	.480413	-.464226	1.013029	.001329
169	.127085	-.050495	.472847	-.438480	1.000622	.001412
170	.116830	-.049125	.466794	-.417887	.990477	.001796
171	.106960	-.047665	.458936	-.391149	.977987	.001583
172	.097480	-.046110	.448109	-.354311	.960420	.001836
173	.088400	-.044475	.438219	-.327464	.947534	.002200
174	.079725	-.042760	.431114	-.296483	.933251	.002043
175	.071470	-.040960	.419101	-.255608	.914087	.002315
176	.063640	-.039085	.408016	-.217890	.896490	.002573
177	.056235	-.037135	.394695	-.172567	.875868	.002433
178	.049270	-.035115	.380813	-.125333	.853784	.003016
179	.042750	-.033030	.365193	-.072185	.829916	.002740
180	.036675	-.030880	.348292	-.014676	.803199	.003409
181	.031055	-.028670	.328625	.052241	.773219	.003105
182	.025895	-.026405	.307616	.123723	.739825	.004025
183	.021195	-.024085	.283282	.206524	.702314	.003781
184	.016960	-.021710	.255490	.301085	.657635	.004664
185	.013200	-.019290	.223624	.409511	.606526	.004629
186	.009915	-.016830	.188910	.527628	.547327	.005705
187	.007100	-.014325	.149067	.663195	.478529	.004680
188	.004755	-.011785	.108724	.800464	.396917	.006501
189	.002890	-.009215	.067166	.941867	.304618	.005156
190	.001500	-.006610	.031770	1.062301	.196311	.005398
191	.000575	-.003975	.008413	1.141775	.085301	.003354
192	.000115	-.001325	.004616	1.154694	.040222	.003489

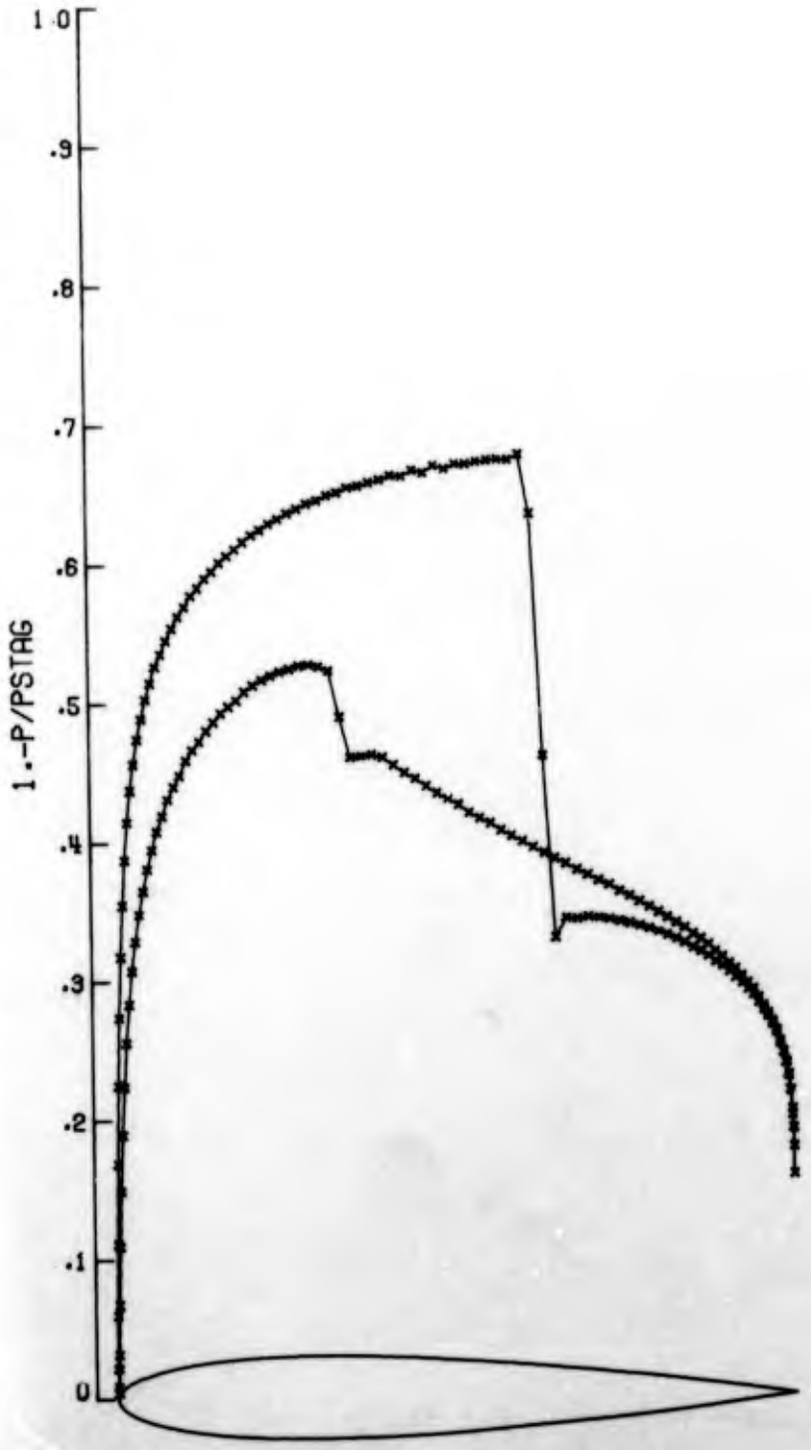
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-6
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



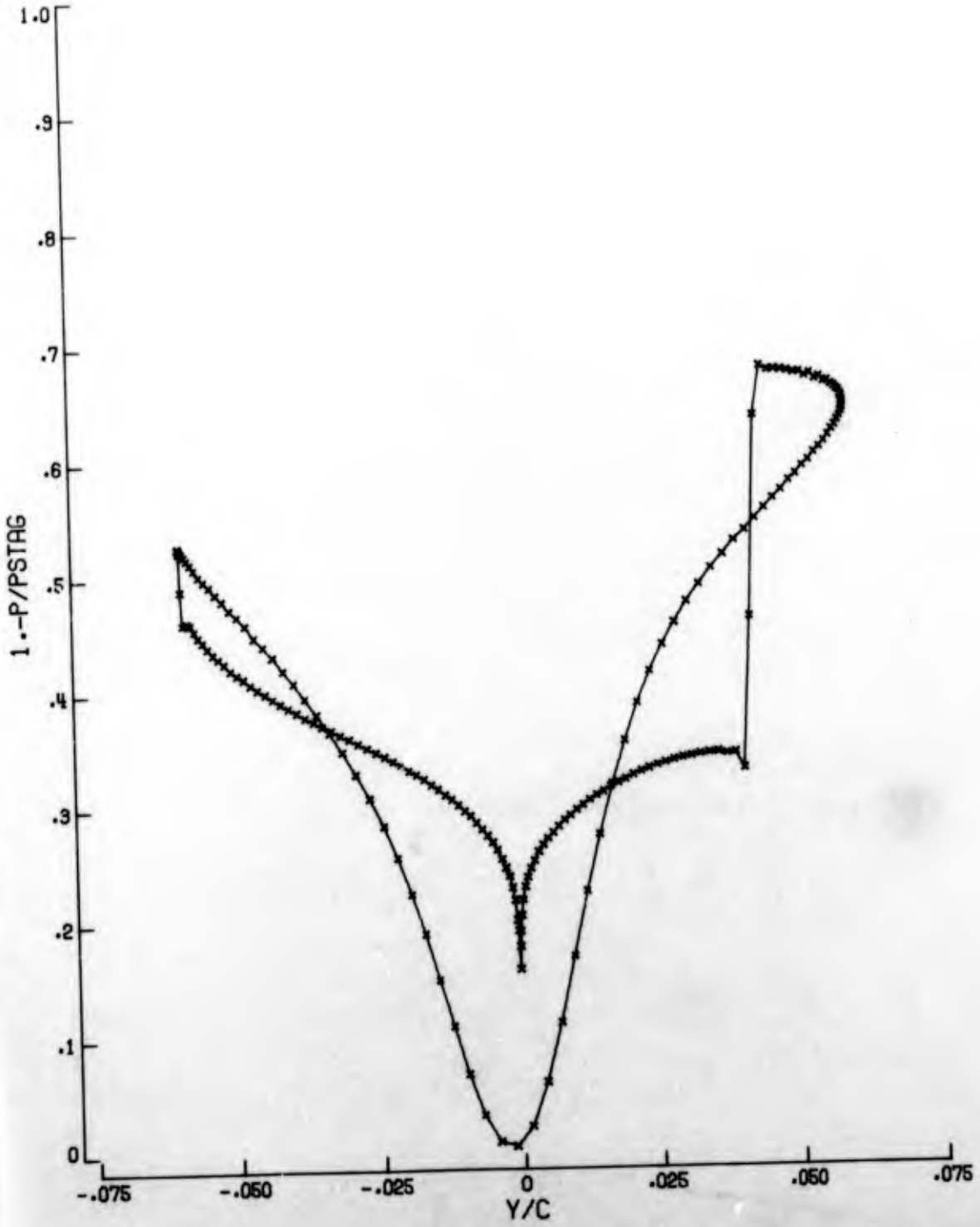
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	6-7
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



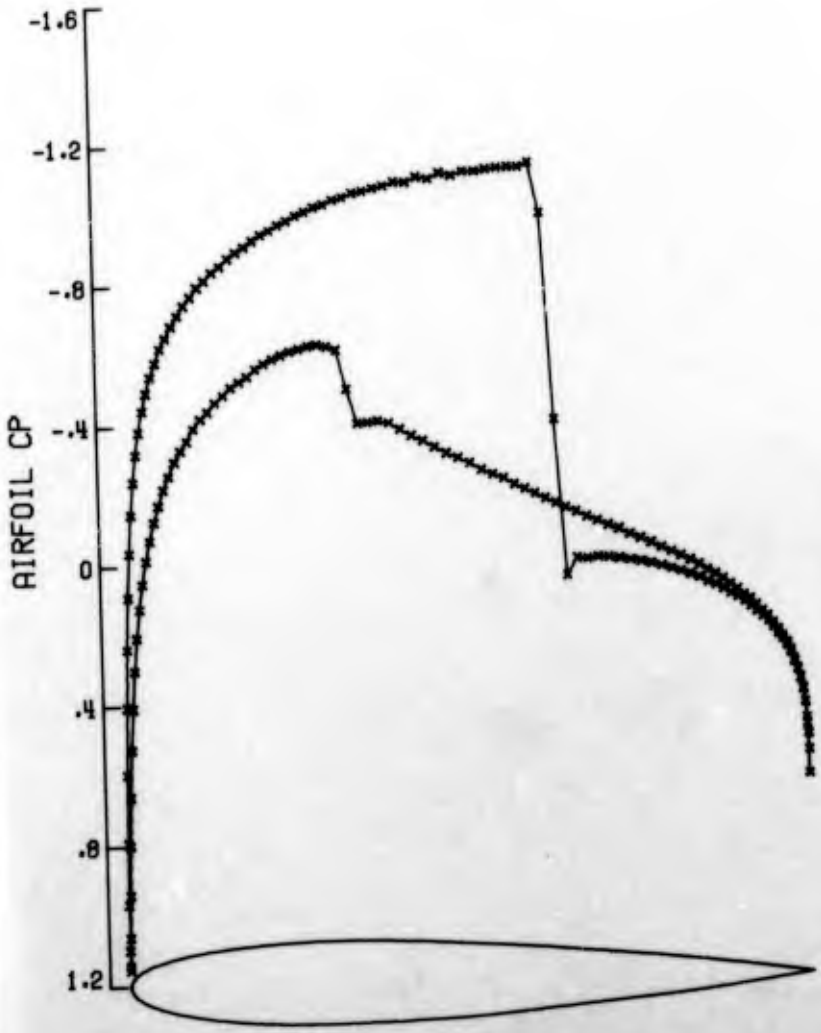
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-8
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



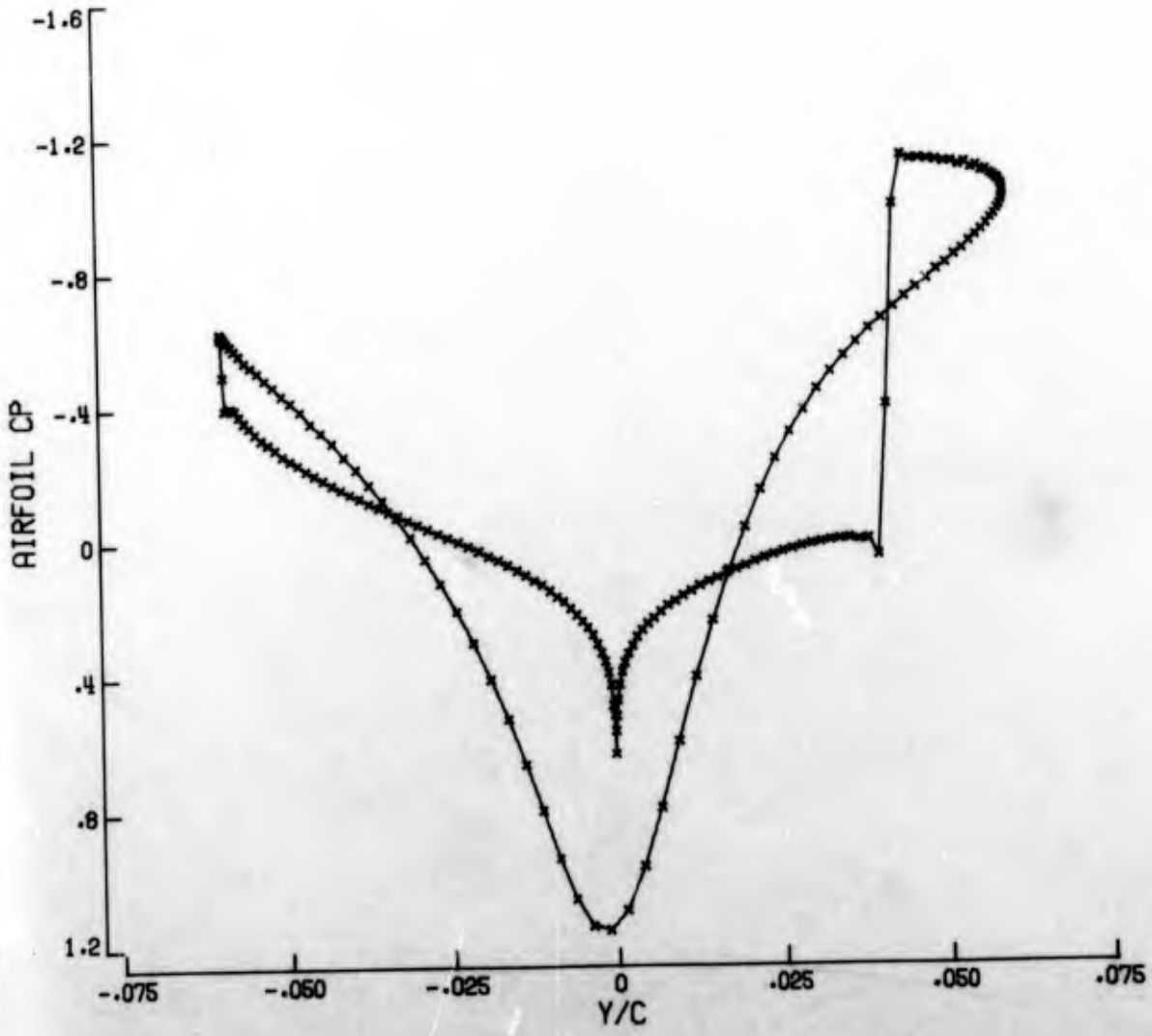
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-9
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



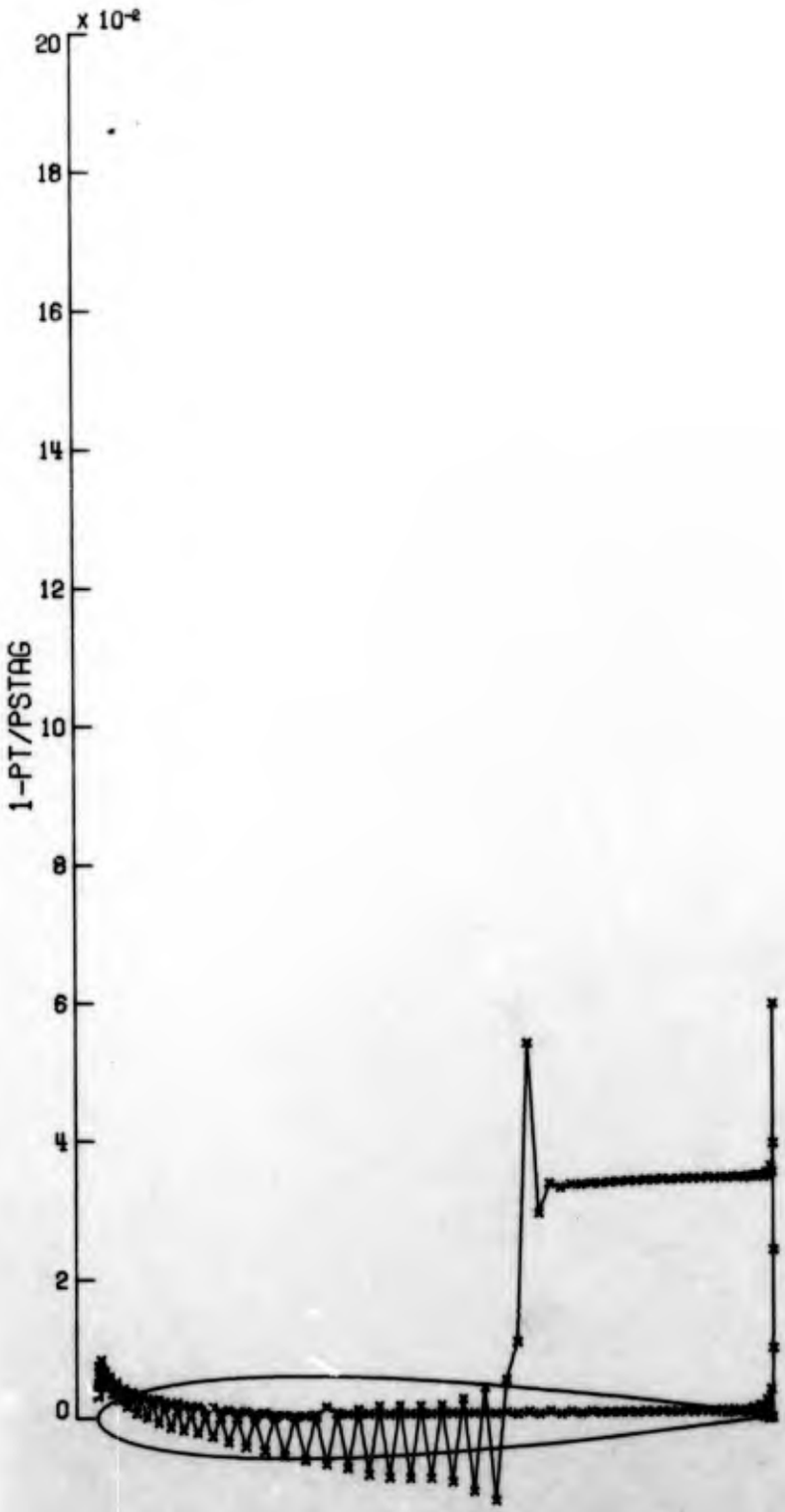
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-10
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



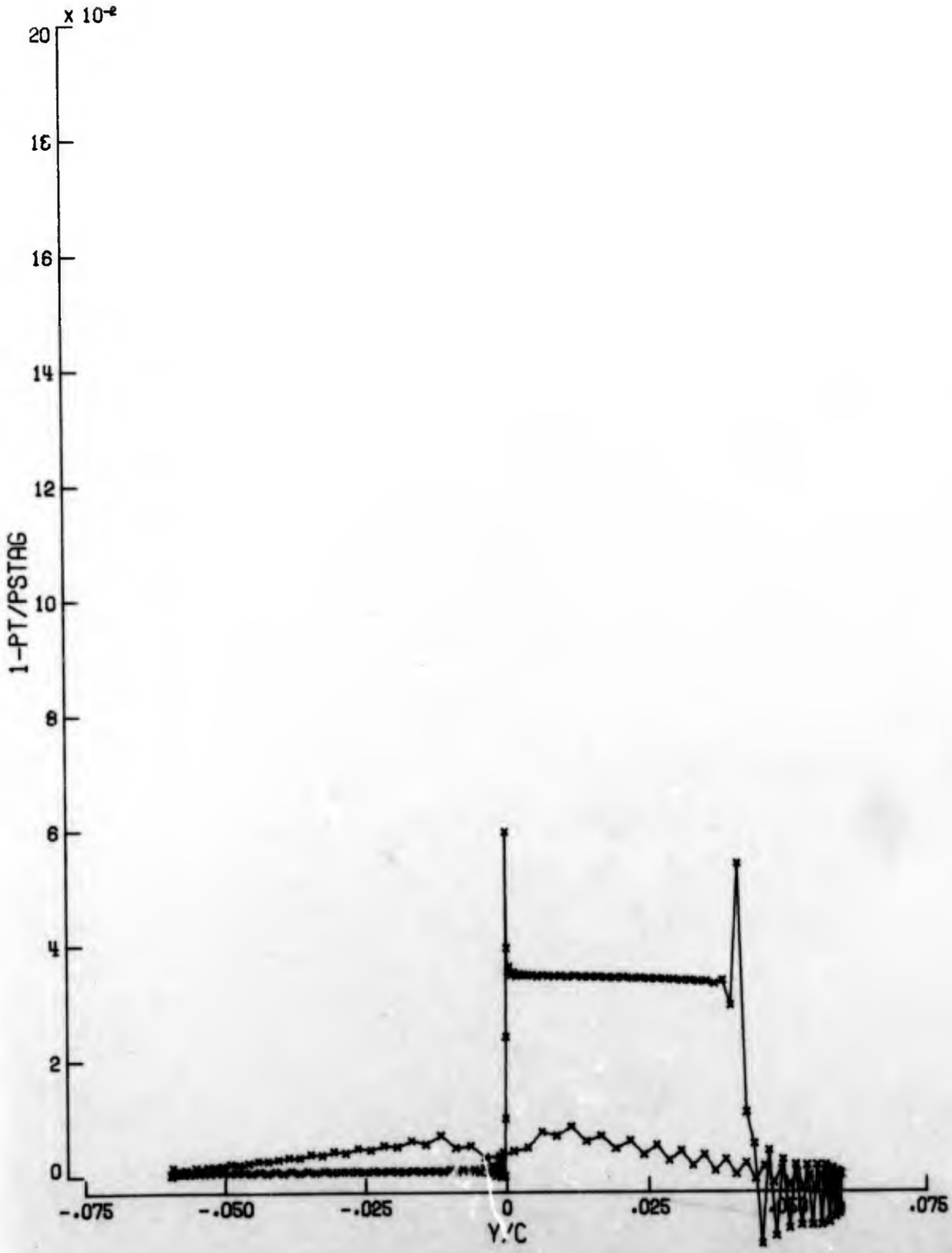
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-11
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



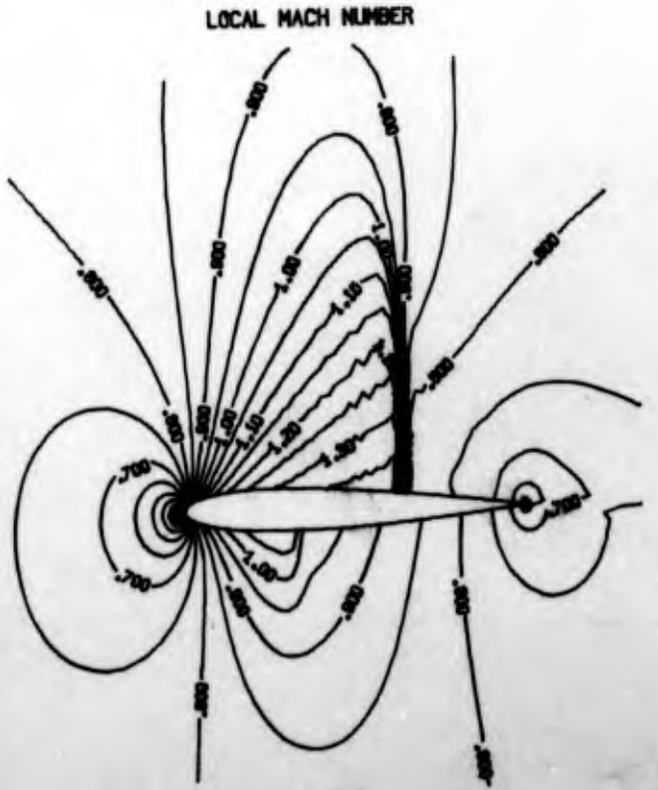
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-12
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



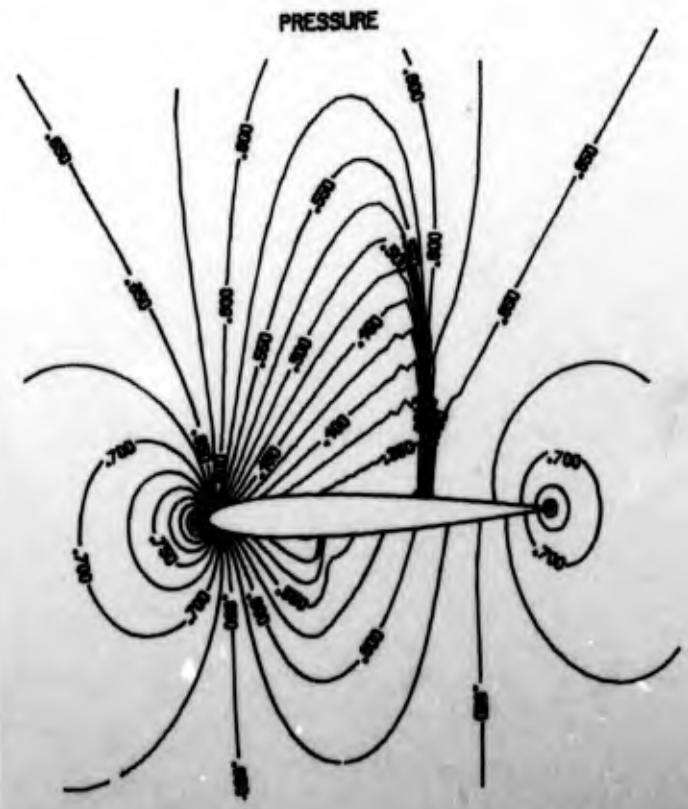
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-13
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-14
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

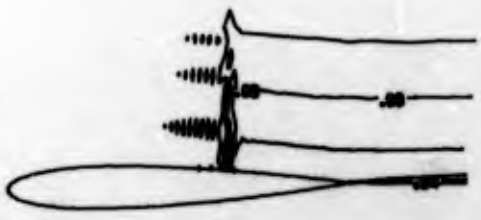


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-15
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-16
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

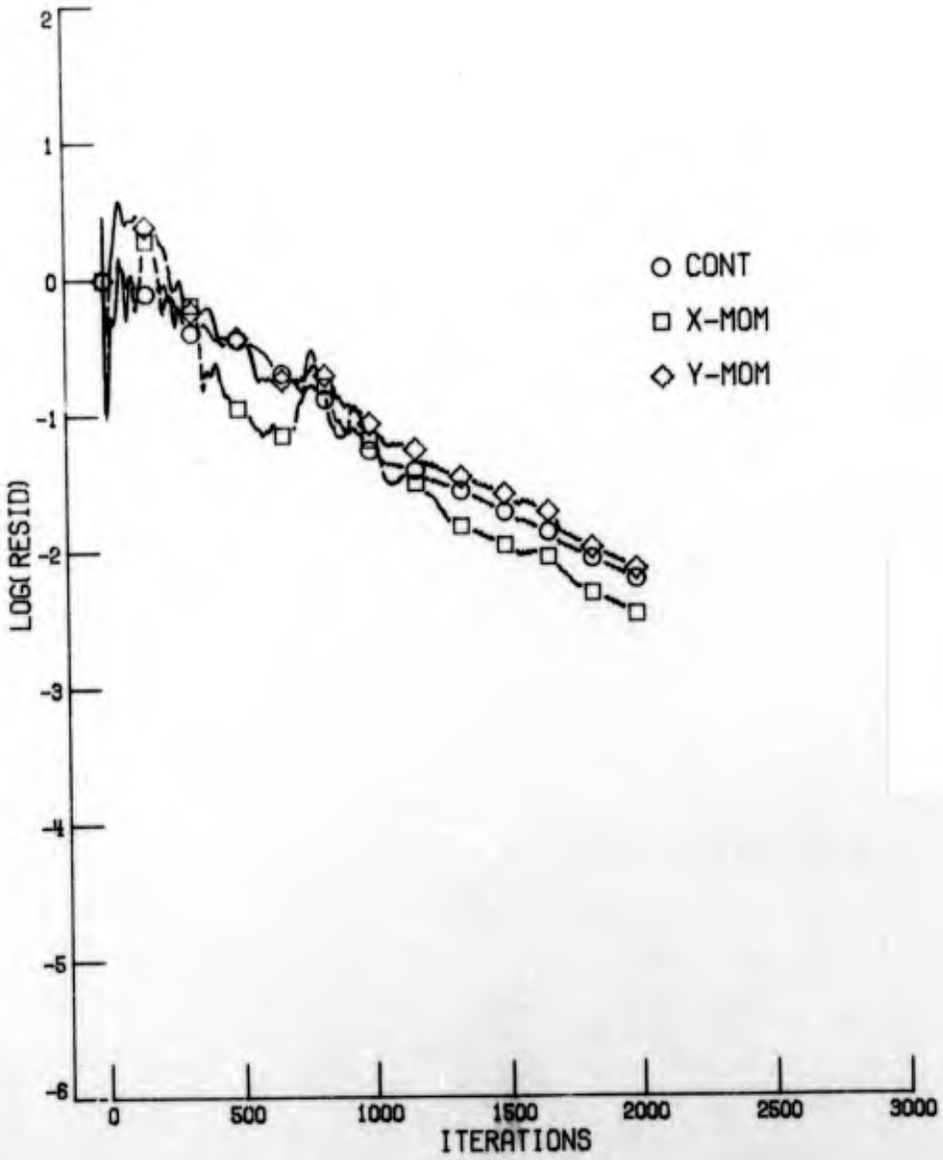
TOTAL PRESSURE



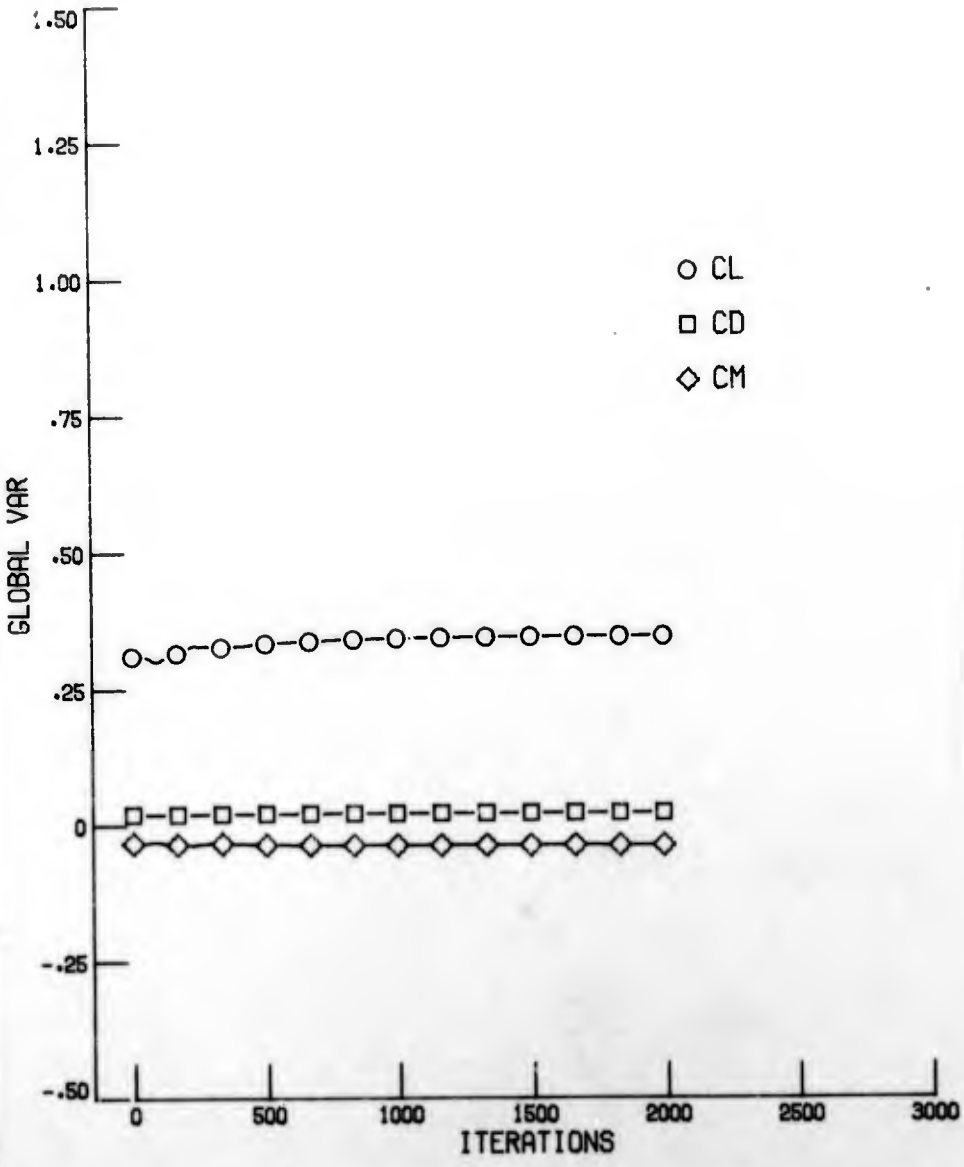
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-17
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ENTROPY

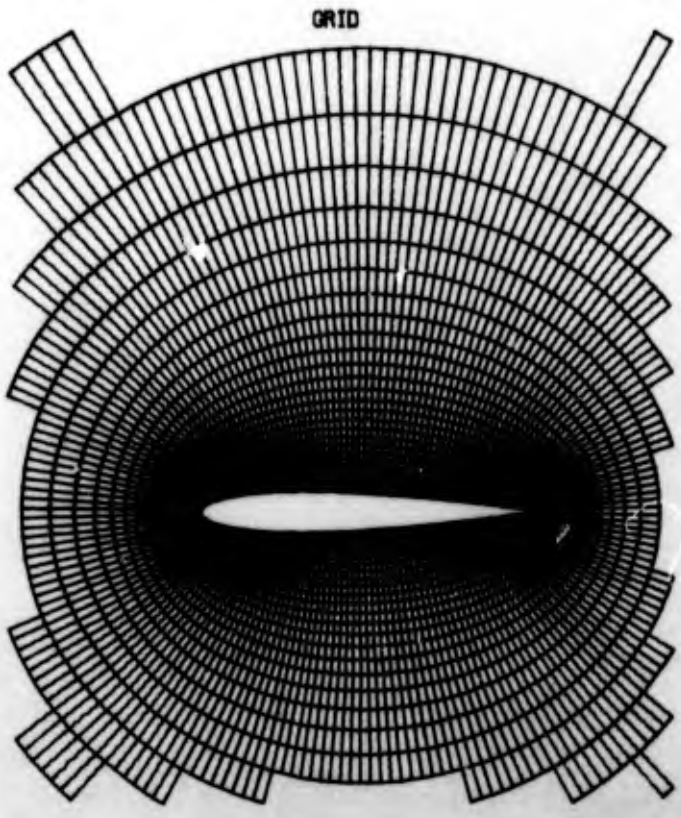
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-18
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



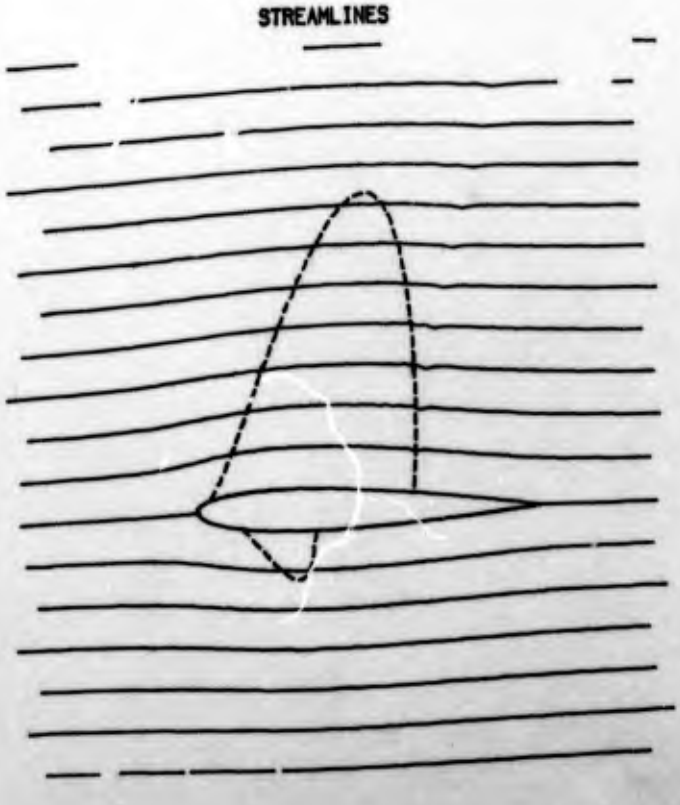
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-19
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



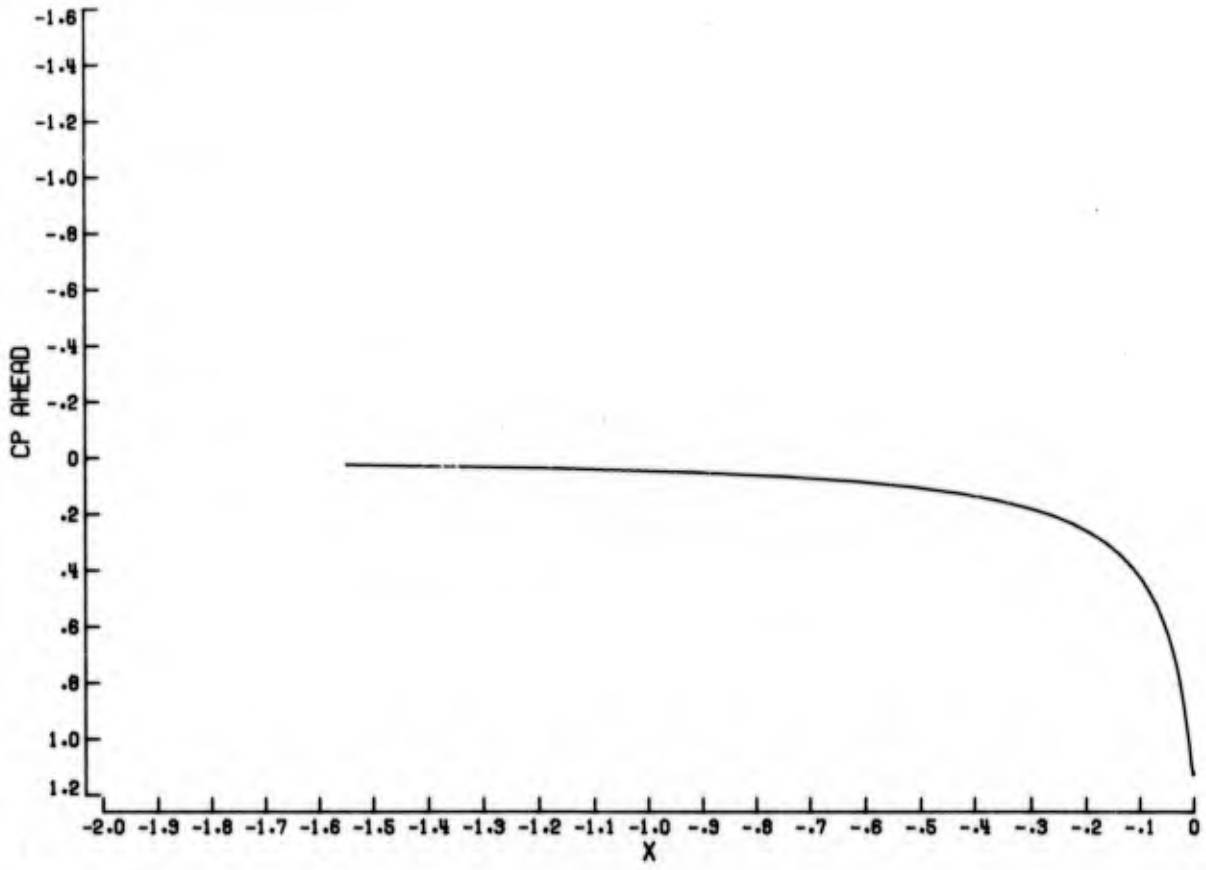
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-20
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



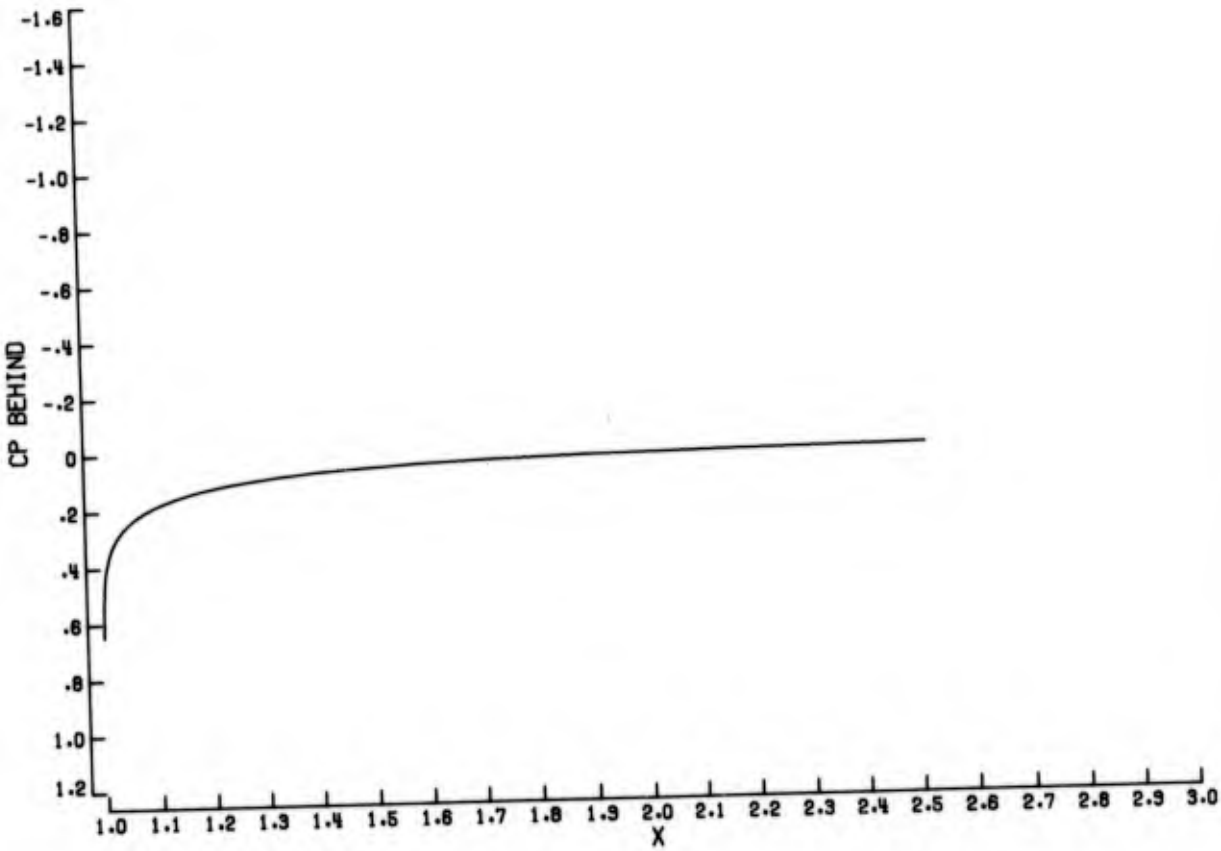
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-21
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-22
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	01-6-23
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 01

NACA 0012: MACH = 0.80, ALPHA = 1.25

Contributor No 8

A.Rizzi

(F.F.A., Sweden)

All the calculations have been carried out by A. Rizzi using mesh-generating and flow-solving software developed by Lars-Erik Eriksson and Arthur Rizzi at FFA.

The isoenergetic (T_i =constant) Euler equations are stepped forward in time by an explicit 3-stage Runge-Kutta type time-integration scheme using the local time step. All spatial derivatives are approximated by a centered finite-volume scheme. On solid walls a normal-momentum-equation technique determines the boundary pressure. At the farfield inflow/outflow boundary the First Approximation of Engquist's Nonreflecting Boundary Theory is implemented. Since this theory is only accurate for waves approaching the boundary at normal incidence, I correct the tangential velocity component by taking into account the strength of the vortex bound in the airfoil (2D airfoil cases only). The mesh used in 2D is an Eriksson O-type whose outer boundary is at 5 (10 for M_∞=0.95 case) chords from the the airfoil. In 3D it is an Eriksson O-O type with the outer boundary at 5 root chords away from the wing. Details of the method are presented in Refs. 1,2,3.

The rationale for our artificial viscosity model is given in Ref. 3 where we describe a combination of switched second-difference and nonswitched fourth-difference dissipation added to the convective terms at the same time level. An important property of this model is that it is negative definite at each and every cell in the mesh. In other words if you consider only the dissipative operator Du in the absence of the convective terms, you can establish that the time decay of the "energy"

$$\frac{d}{dt} u^2 = u^T \frac{d}{dt} u = u^T D u < 0$$

summed over all cells including those at the boundaries.

Another important feature of our integration scheme is that if a steady state is reached, we can show that the originalsteady total-difference operator must be equal to zero independent of the time step.[2]

In all of my calculations initial conditions are the uniform freestream. The solution in the ultimate fine mesh is approached by starting in a much coarser mesh and successively refining it to the fine mesh. Our method is a cell-centered one, and Mach number and 1-PI/PIINF are extrapolated from the middle of the adjacent cells to the airfoil surface.

REFERENCES:

1. Rizzi, A.W.: Damped Euler-Equation Method to Compute Transonic Flow Around Wing-Body Combinations, AIAA J., Vol. 20, No. 10, Oct. 1982.

2. Rizzi, A., and Eriksson, L.E.: Practical 3D Mesh Generation and Explicit Schemes to Solve the Euler Equations, in Advances in Computational Transonics, ed. W.G. Habashi, Pineridge Press, Swansea, 1983.

3. Eriksson, L.E., and Rizzi, A.: Analysis by Computer of the Convergence to Steady State of a Discrete Approximation to the Euler Equations, AIAA Paper No. 83-1951, presented at the 6th CFD Conf., Danvers, MA, 1983.

F.F.A.	AR 211		A.Rizzi	01-8-3
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

SOLUTION WITH LOWER TOTAL PRESSURE LOSS AT L.E.

I	X/C	Y/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.998314	-0.000163	0.200531	0.486086	0.560265	0.000524
2	0.994210	-0.000816	0.226996	0.398037	0.592897	0.000297
3	0.985354	-0.002052	0.246492	0.331703	0.640154	0.001184
4	0.972671	-0.003802	0.264293	0.271134	0.674296	0.000591
5	0.956583	-0.005985	0.279957	0.217836	0.700057	0.000542
6	0.937500	-0.008522	0.293224	0.172693	0.720903	0.000580
7	0.915823	-0.011335	0.305237	0.131819	0.739423	0.000731
8	0.891931	-0.014354	0.316151	0.094685	0.756363	0.000671
9	0.866187	-0.017512	0.326210	0.060459	0.771813	0.000734
10	0.838931	-0.020752	0.335549	0.028680	0.786215	0.000715
11	0.810477	-0.024023	0.344359	-0.001296	0.799747	0.000742
12	0.781120	-0.027285	0.352830	-0.030118	0.812771	0.000754
13	0.751125	-0.030499	0.361029	-0.058016	0.825381	0.000763
14	0.720735	-0.033631	0.369030	-0.085240	0.837695	0.000779
15	0.690171	-0.036654	0.376909	-0.112047	0.849833	0.000794
16	0.659627	-0.039542	0.384713	-0.138601	0.861889	0.000807
17	0.629275	-0.042276	0.392523	-0.165175	0.873965	0.000834
18	0.599267	-0.044837	0.400387	-0.191932	0.886155	0.000859
19	0.569732	-0.047211	0.408280	-0.218789	0.898427	0.000883
20	0.540782	-0.049386	0.416164	-0.245616	0.910731	0.000904
21	0.512511	-0.051354	0.424087	-0.272573	0.923142	0.000923
22	0.484994	-0.053108	0.432298	-0.300511	0.936032	0.000974
23	0.458294	-0.054646	0.440361	-0.329646	0.949531	0.001049
24	0.432457	-0.055965	0.448953	-0.357181	0.962399	0.001072
25	0.407518	-0.057066	0.455431	-0.379222	0.972813	0.000979
26	0.383502	-0.057952	0.460702	-0.397157	0.981286	0.000868
27	0.360423	-0.058629	0.468228	-0.422764	0.993175	0.001034
28	0.338284	-0.059101	0.482252	-0.470483	1.015586	0.001525
29	0.317085	-0.059373	0.501288	-0.535252	1.047228	0.001590
30	0.296816	-0.059466	0.516654	-0.587537	1.073658	0.001203
31	0.277463	-0.059374	0.523297	-0.610139	1.085265	0.000880
32	0.259007	-0.059114	0.522962	-0.609000	1.084552	0.000922
33	0.241424	-0.058694	0.519270	-0.596437	1.078003	0.001091
34	0.224690	-0.058124	0.514622	-0.580623	1.069936	0.001229
35	0.208777	-0.057415	0.509774	-0.564123	1.061645	0.001321
36	0.193656	-0.056576	0.504669	-0.546757	1.052986	0.001396
37	0.179295	-0.055615	0.499161	-0.528017	1.043698	0.001480
38	0.165666	-0.054542	0.493189	-0.507694	1.033677	0.001568
39	0.152737	-0.053364	0.486728	-0.485712	1.022899	0.001658
40	0.140478	-0.052089	0.479802	-0.462145	1.011410	0.001757
41	0.128861	-0.050722	0.472424	-0.437041	0.999246	0.001856
42	0.117858	-0.049271	0.464580	-0.410351	0.986387	0.001959

F.F.A.	AR 211		A.Rizzi	01-8-4
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

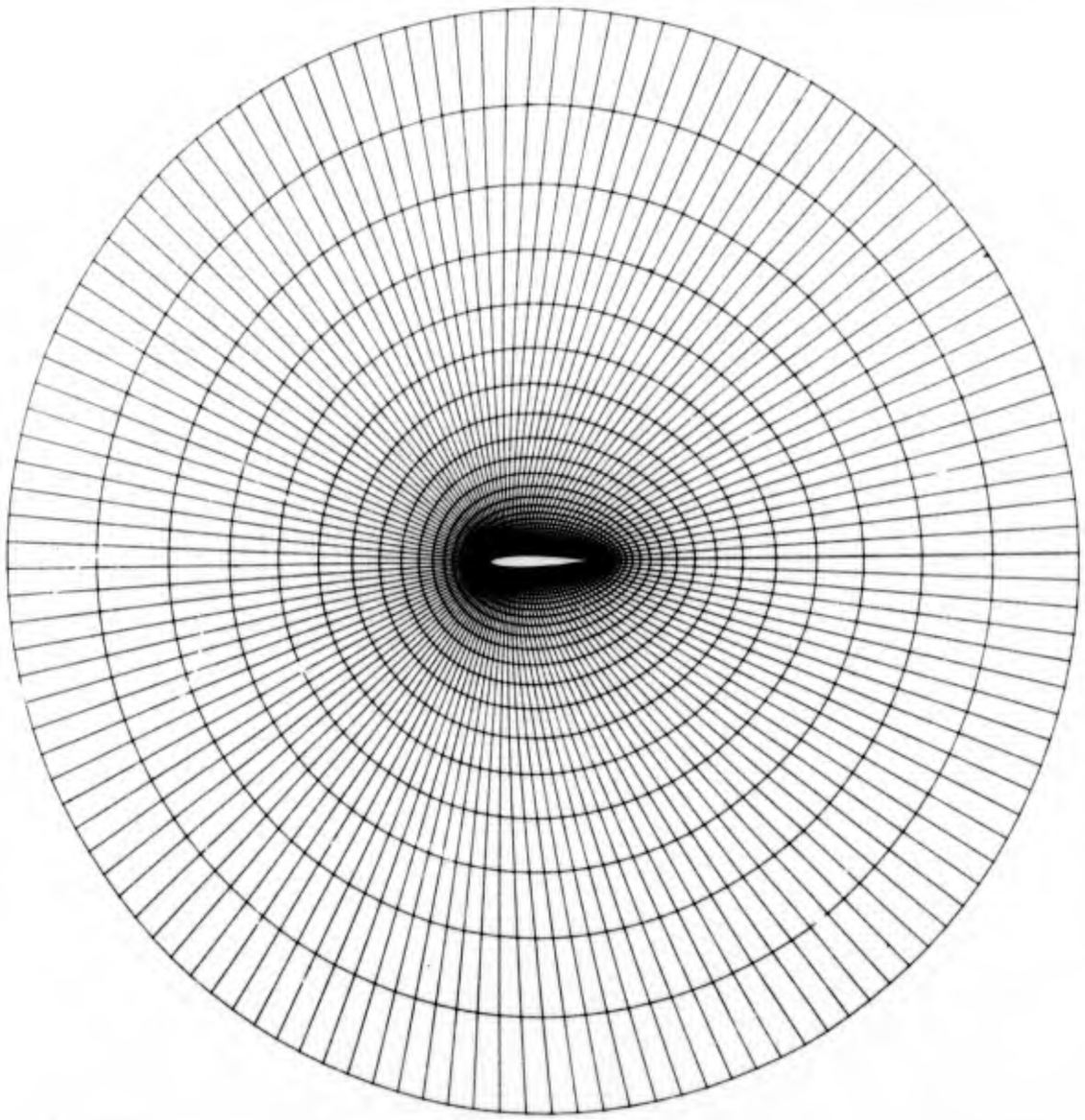
43	0.107442	-0.047741	0.456236	-0.351960	0.972789	0.002060
44	0.097589	-0.046134	0.447352	-0.351734	0.958393	0.002164
45	0.088277	-0.044457	0.437875	-0.319483	0.943120	0.002264
46	0.079484	-0.042711	0.427727	-0.284959	0.926848	0.002356
47	0.071193	-0.040900	0.416819	-0.247842	0.909444	0.002440
48	0.063388	-0.039026	0.405053	-0.207807	0.890767	0.002508
49	0.056055	-0.037090	0.392293	-0.164392	0.870602	0.002550
50	0.049182	-0.035094	0.378353	-0.116959	0.848673	0.002519
51	0.042762	-0.033040	0.363027	-0.064812	0.824657	0.002384
52	0.036788	-0.030928	0.346083	-0.007161	0.798167	0.002093
53	0.031256	-0.028760	0.327215	0.057027	0.768670	0.001593
54	0.026164	-0.026534	0.305525	0.130340	0.734669	0.000655
55	0.021511	-0.024253	0.281993	0.210892	0.697580	-0.000101
56	0.017301	-0.021916	0.255310	0.301700	0.654094	-0.000185
57	0.013535	-0.019525	0.224731	0.405744	0.603880	-0.001147
58	0.010220	-0.017083	0.190522	0.522141	0.544802	-0.001438
59	0.007361	-0.014589	0.152693	0.650341	0.476300	-0.002094
60	0.004963	-0.012043	0.112102	0.738970	0.395323	-0.001948
61	0.003035	-0.009443	0.071096	0.928530	0.300832	-0.001655
62	0.001582	-0.006790	0.034366	1.051770	0.191160	-0.000742
63	0.000609	-0.004092	0.010972	1.133071	0.071048	0.000110
64	0.000122	-0.001367	0.000620	1.147370	0.029048	0.000585
65	0.000122	0.001367	0.025345	1.084165	0.149317	0.000201
66	0.000609	0.004092	0.064963	0.949362	0.280521	-0.000623
67	0.001582	0.006790	0.118235	0.798104	0.402375	-0.001601
68	0.003035	0.009443	0.176263	0.670659	0.511257	-0.002051
69	0.004963	0.012043	0.231566	0.582489	0.605920	-0.002090
70	0.007361	0.014589	0.280742	0.215165	0.686467	-0.001241
71	0.010220	0.017083	0.322107	0.071015	0.755091	-0.000543
72	0.013535	0.019525	0.359245	-0.051946	0.812925	0.000482
73	0.017301	0.021916	0.389763	-0.155784	0.862163	0.000690
74	0.021511	0.024253	0.415523	-0.243435	0.903341	0.001471
75	0.026164	0.026534	0.438349	-0.322800	0.941365	0.002394
76	0.031256	0.028760	0.458762	-0.390554	0.973999	0.002760
77	0.036788	0.030928	0.475584	-0.448133	1.002019	0.002763
78	0.042762	0.033040	0.490555	-0.496726	1.026918	0.002680
79	0.049182	0.035094	0.503944	-0.544290	1.049641	0.002583
80	0.056055	0.037090	0.516032	-0.585421	1.070376	0.002463
81	0.063388	0.039026	0.527029	-0.622338	1.089420	0.002316
82	0.071193	0.040900	0.537146	-0.657263	1.107133	0.002165
83	0.079484	0.042711	0.546500	-0.689090	1.123704	0.002022
84	0.088277	0.044457	0.555193	-0.718667	1.139268	0.001870
85	0.097589	0.046134	0.563340	-0.746367	1.153996	0.001714
86	0.107442	0.047741	0.571028	-0.772546	1.168041	0.001559
87	0.117358	0.049271	0.578320	-0.797358	1.181503	0.001410
88	0.128361	0.050722	0.585260	-0.820973	1.194443	0.001270

F.F.A.	AR 211		A.Rizzi	01-8-5
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

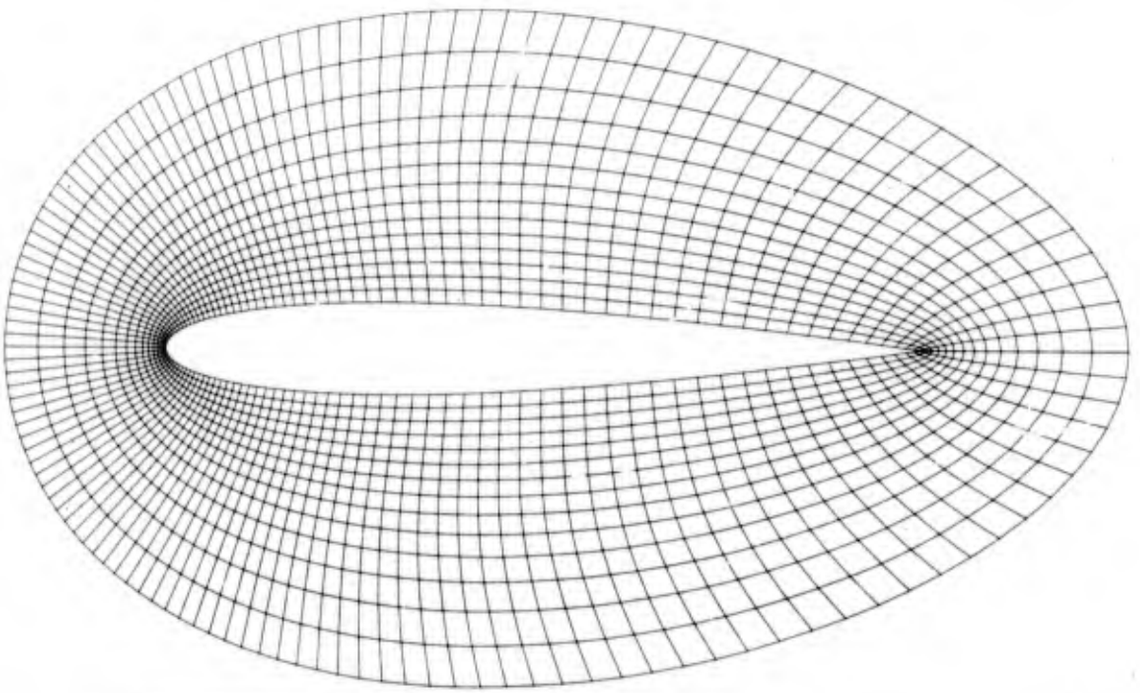
89	0.140478	0.052089	0.591859	-0.843523	1.206923	0.001133
90	0.152737	0.053364	0.598243	-0.865147	1.219004	0.001005
91	0.165065	0.054542	0.604341	-0.885395	1.230719	0.000886
92	0.179295	0.055615	0.610187	-0.905786	1.242051	0.000785
93	0.193656	0.056576	0.615801	-0.924867	1.253042	0.000678
94	0.208777	0.057415	0.621189	-0.943221	1.263690	0.000592
95	0.224690	0.058124	0.626335	-0.960732	1.273955	0.000506
96	0.241424	0.058694	0.631257	-0.977477	1.283851	0.000431
97	0.259007	0.059114	0.635949	-0.993443	1.293374	0.000359
98	0.277463	0.059374	0.640421	-1.008660	1.302528	0.000295
99	0.296816	0.059466	0.644667	-1.023107	1.311298	0.000236
100	0.317085	0.059378	0.648688	-1.036789	1.319692	0.000171
101	0.338284	0.059101	0.652402	-1.049425	1.327451	0.000163
102	0.360423	0.058629	0.655863	-1.061202	1.334783	0.000066
103	0.383502	0.057952	0.659084	-1.072161	1.341568	0.000113
104	0.407518	0.057066	0.662130	-1.082525	1.348251	-0.000109
105	0.432457	0.055965	0.664611	-1.090966	1.353308	0.000264
106	0.458294	0.054646	0.667123	-1.099514	1.359049	-0.000324
107	0.484994	0.053108	0.669750	-1.108451	1.364731	-0.000168
108	0.512511	0.051354	0.669349	-1.107089	1.362695	0.001433
109	0.540782	0.049386	0.674360	-1.125839	1.377001	-0.002034
110	0.569732	0.047211	0.684338	-1.159790	1.405423	-0.010052
111	0.599267	0.044837	0.640333	-1.010059	1.287676	0.023153
112	0.629275	0.042276	0.495993	-0.517236	0.985943	0.061766
113	0.659627	0.039542	0.370934	-0.091717	0.799684	0.040511
114	0.690171	0.036654	0.340847	0.010656	0.761704	0.031576
115	0.720735	0.033631	0.346001	-0.006886	0.767847	0.033794
116	0.751125	0.030499	0.346382	-0.006177	0.767288	0.034904
117	0.781120	0.027285	0.340389	0.012214	0.758140	0.034320
118	0.810477	0.024023	0.334006	0.033932	0.748047	0.034450
119	0.838931	0.020752	0.327322	0.056676	0.737364	0.034460
120	0.866187	0.017512	0.319581	0.083013	0.724813	0.034591
121	0.891931	0.014354	0.310690	0.113265	0.710742	0.034395
122	0.915823	0.011335	0.300930	0.146475	0.694654	0.034671
123	0.937500	0.008522	0.289773	0.184437	0.677081	0.034160
124	0.956583	0.005985	0.277656	0.225664	0.656200	0.034832
125	0.972671	0.003802	0.262574	0.276981	0.631830	0.033437
126	0.985354	0.002052	0.246648	0.331170	0.595348	0.036931
127	0.994210	0.000816	0.225658	0.402592	0.547787	0.041100
128	0.998814	0.000168	0.216171	0.434670	0.534459	0.035718

F.F.A.	AR 211		A.Rizzi	01-8-6
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

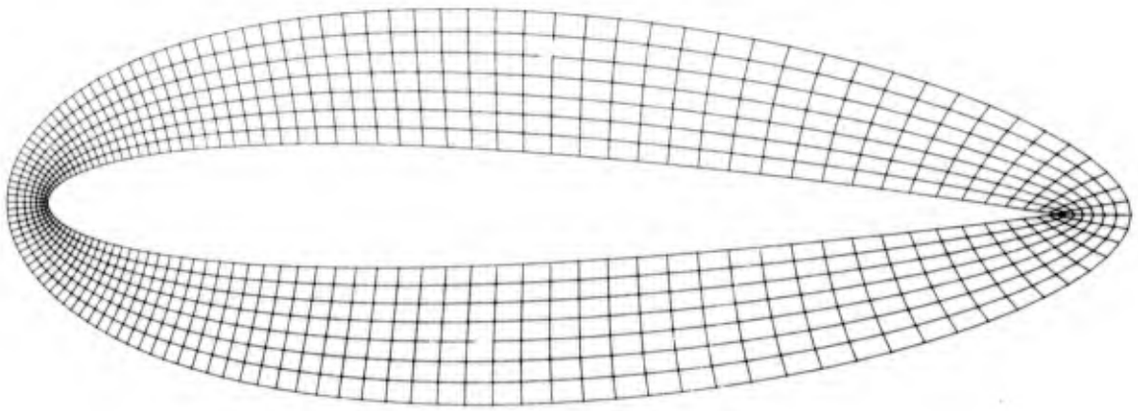
STANDARD NACA 0012 MESH
0-type
129 × 29 points
128 × 28 cells
outer boundary
5 chords



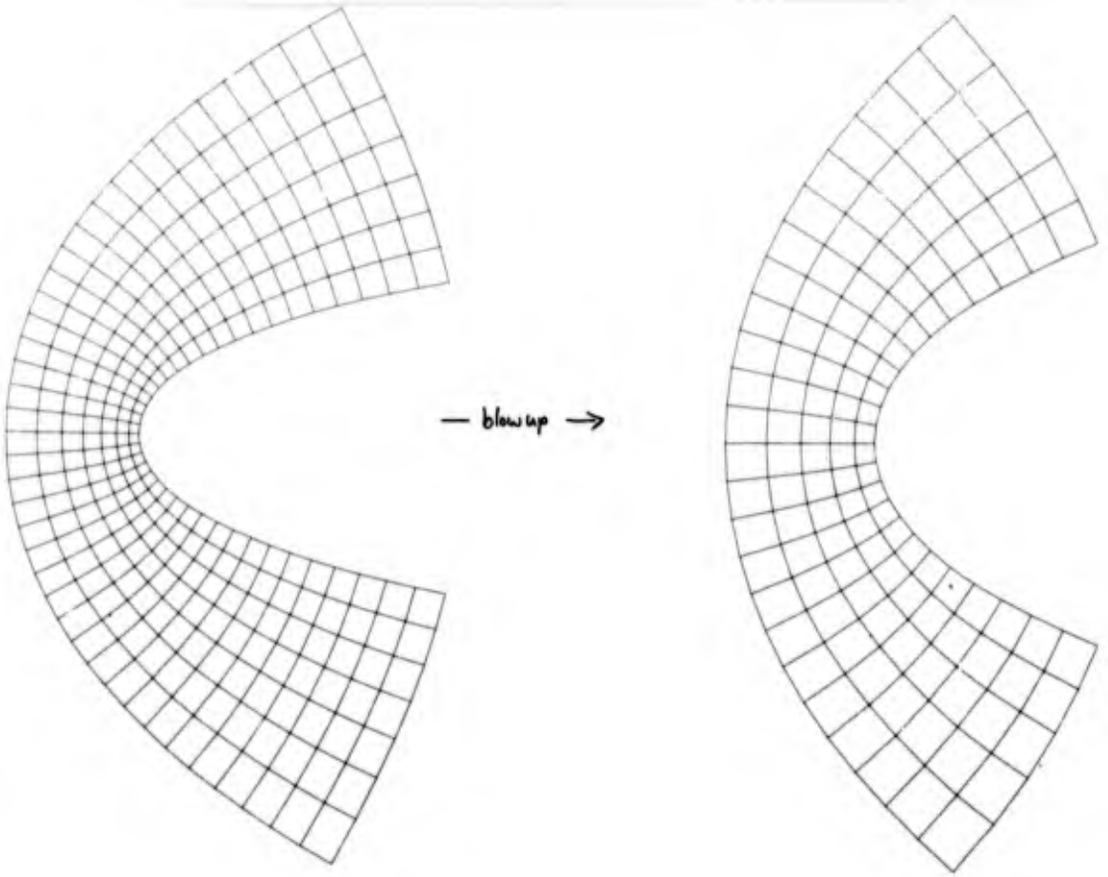
F.F.A.	AR 211		A.Rizzi	01-8-7
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



F.F.A.	AR 211		A.Rizzi	01-8-8
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

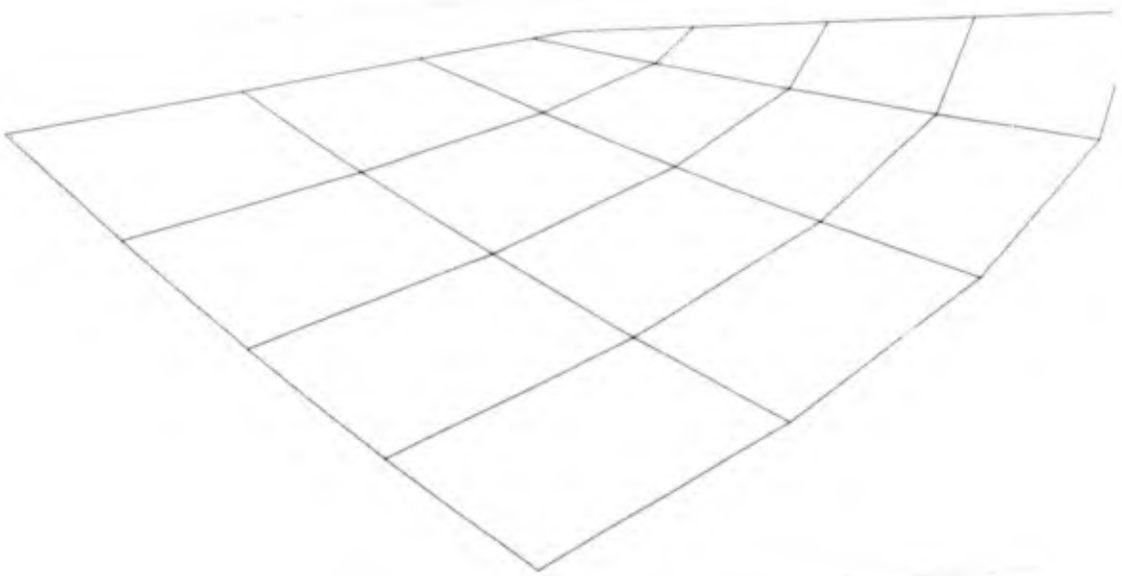


F.F.A.	AR 211		A.Rizzi	01-8-9
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



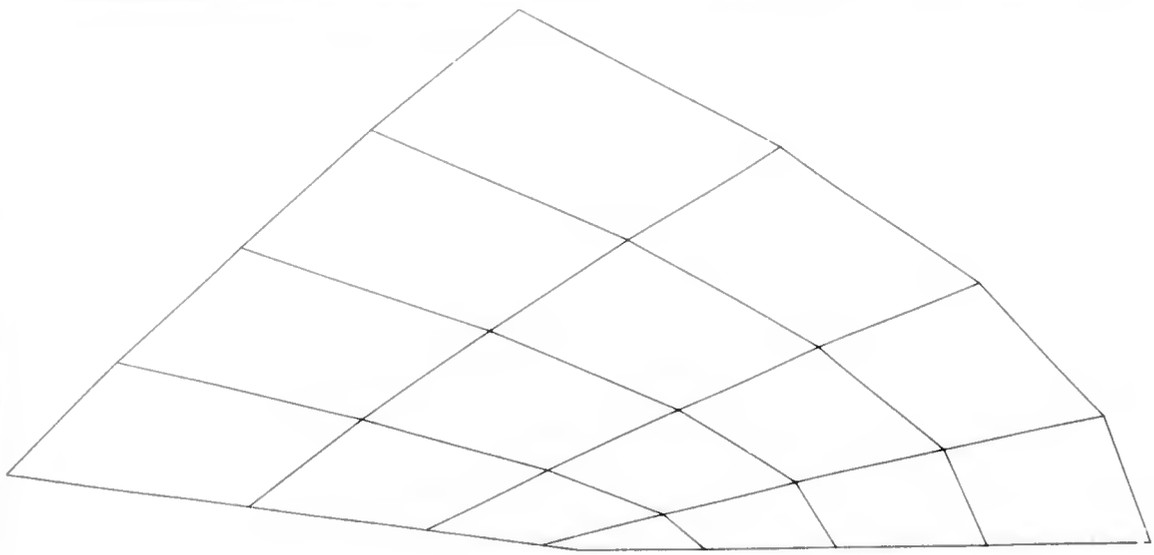
F.F.A.	AR 211		A.Rizzi	01-8-10
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

LOWER TRAILING EDGE



F.F.A.	AR 211		A.Rizzi	01-8-11
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

UPPER TRAILING EDGE

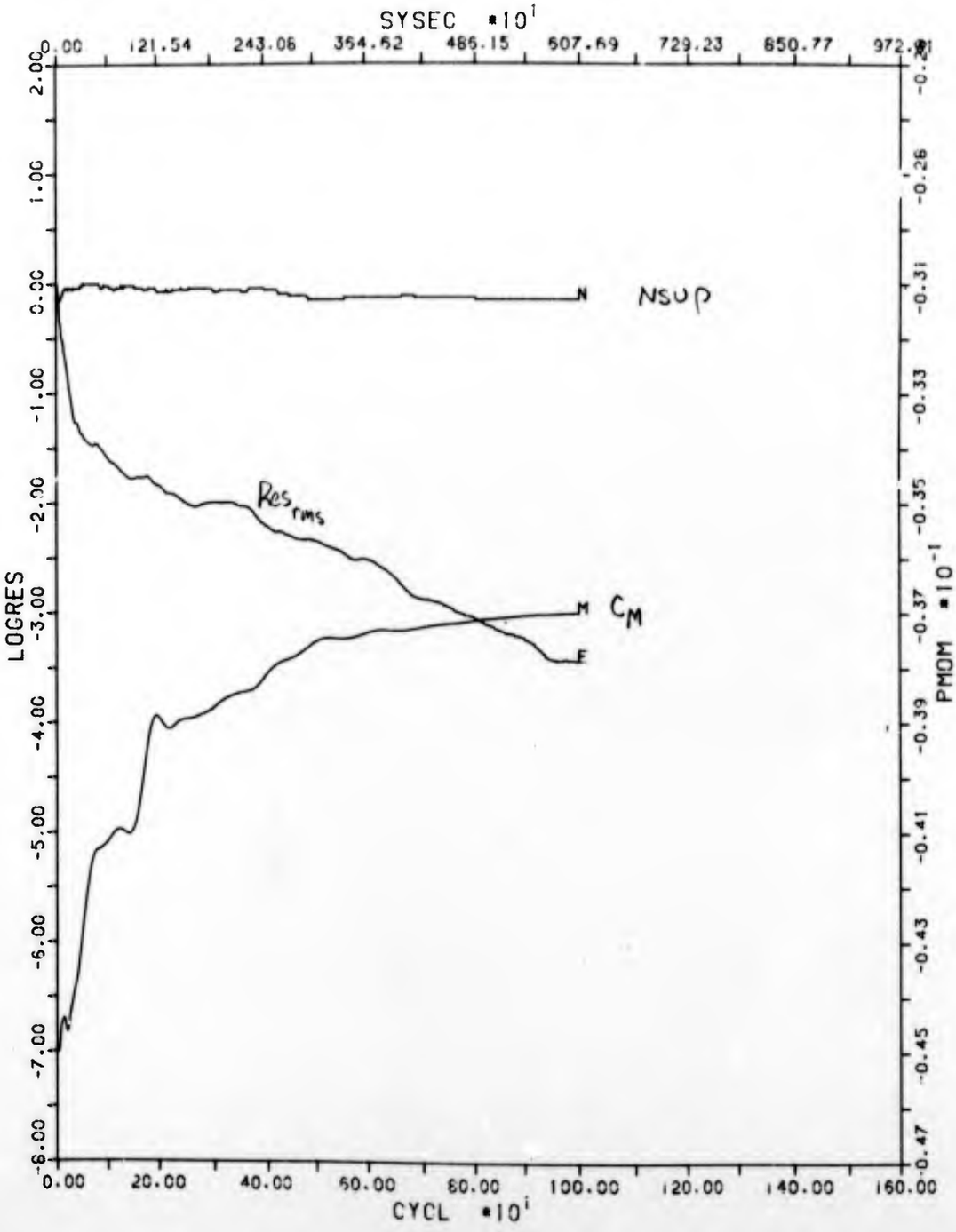


SOLUTION WITH LOWER TOTAL PRESSURE LOSS AT LEADING EDGE STANDARD MESH

28/6 INVOR UNORO MESH .80 1.25 NO1 CON SWT .05 .01

C_M PITCH	-0.037	Γ CCIRC	0.161		
MACH	0.800	ALPHA	1.250		
RATE	0.992	start RESAS$_{rms}$	0.193E-02		
NSUP	428	C_L LIFT	0.350E+00		
CYCL	1000	SYSEC	0.608E+04		

	CELLS	128X28
end	RESAE	0.710E-06
C_D	DRAG	0.221E-01
	RESMX$_{max}$	0.775E-05

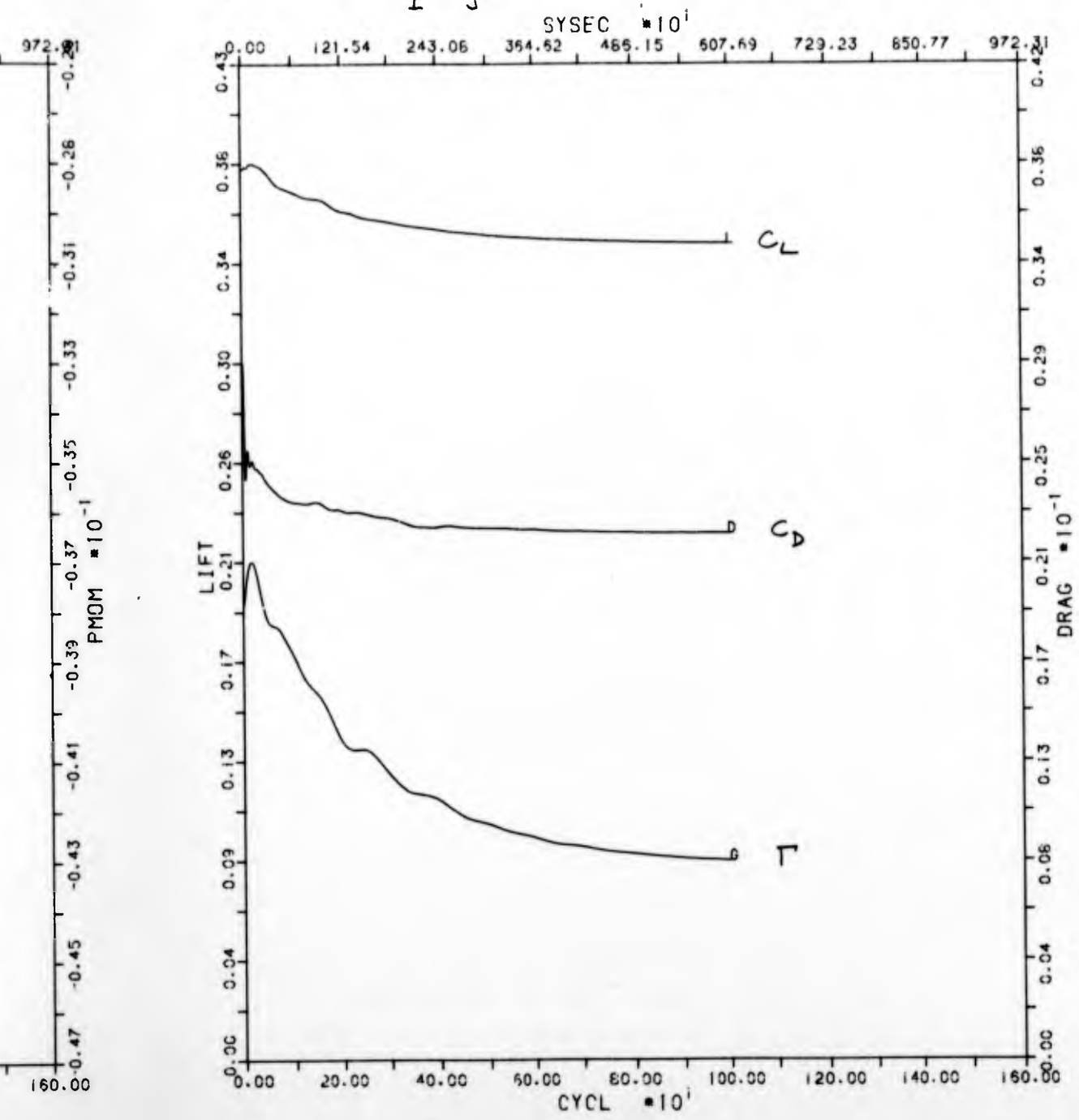


F.F.A.	AR 211		A.Rizzi	01-6-12
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

ANDARD MESH

1 CON SWT .05 .01

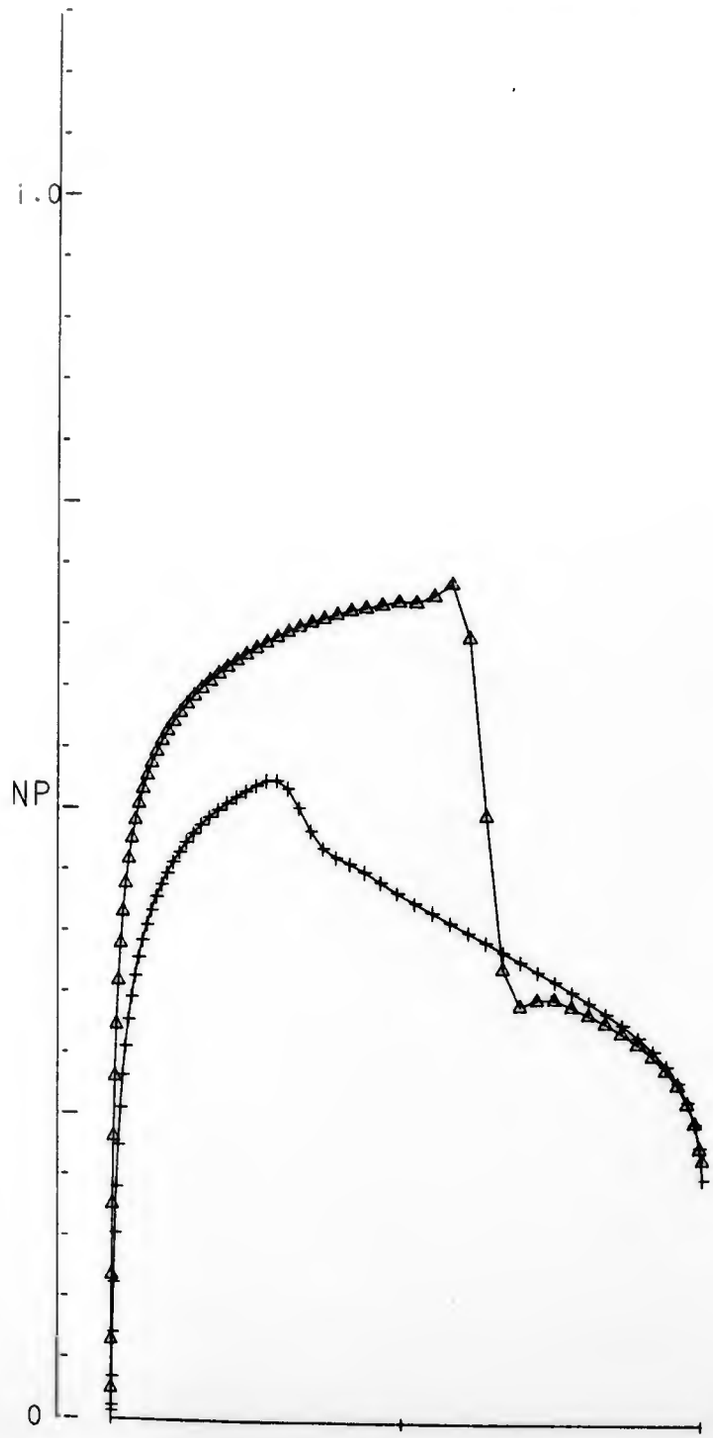
CELLS 128X28
end RESAE 0.710E-06
C_D DRAG 0.221E-01
$RESMX_{max}$ 0.775E-05 111 1
I J



F.F.A.

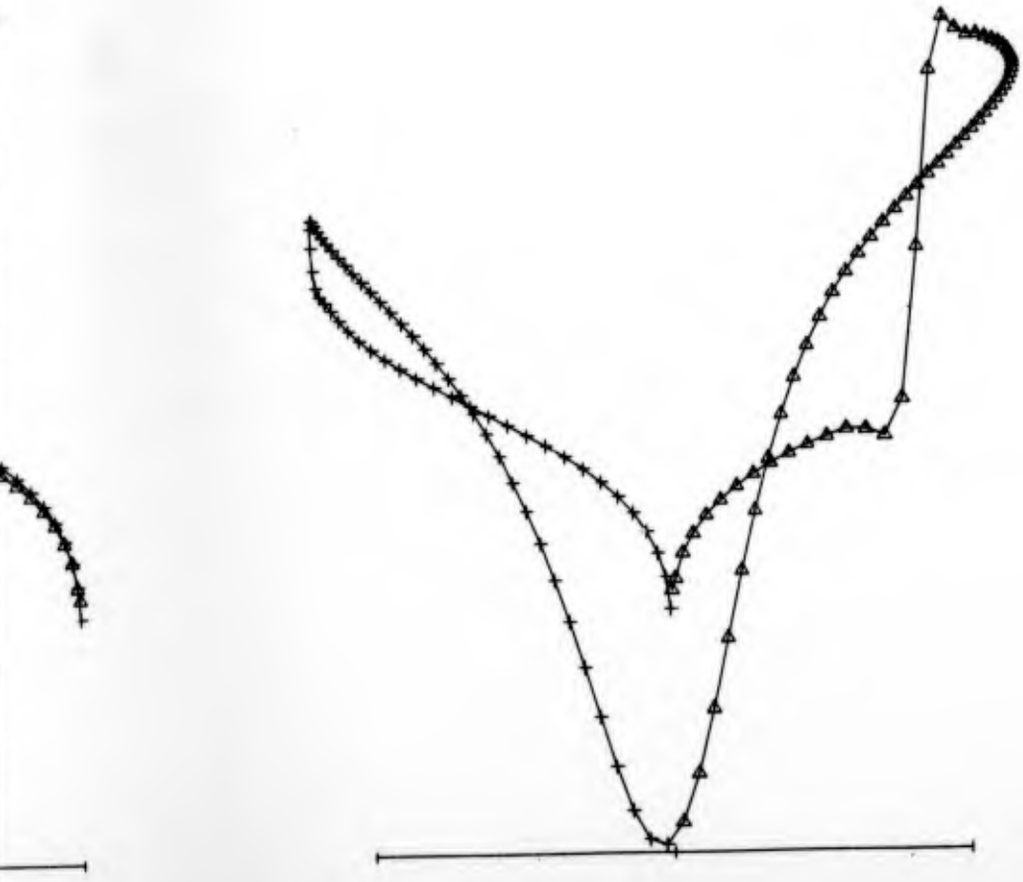
28/6 INVOR UNORO MESH .80 1.25 [illegible]i ON SWT .05 .01

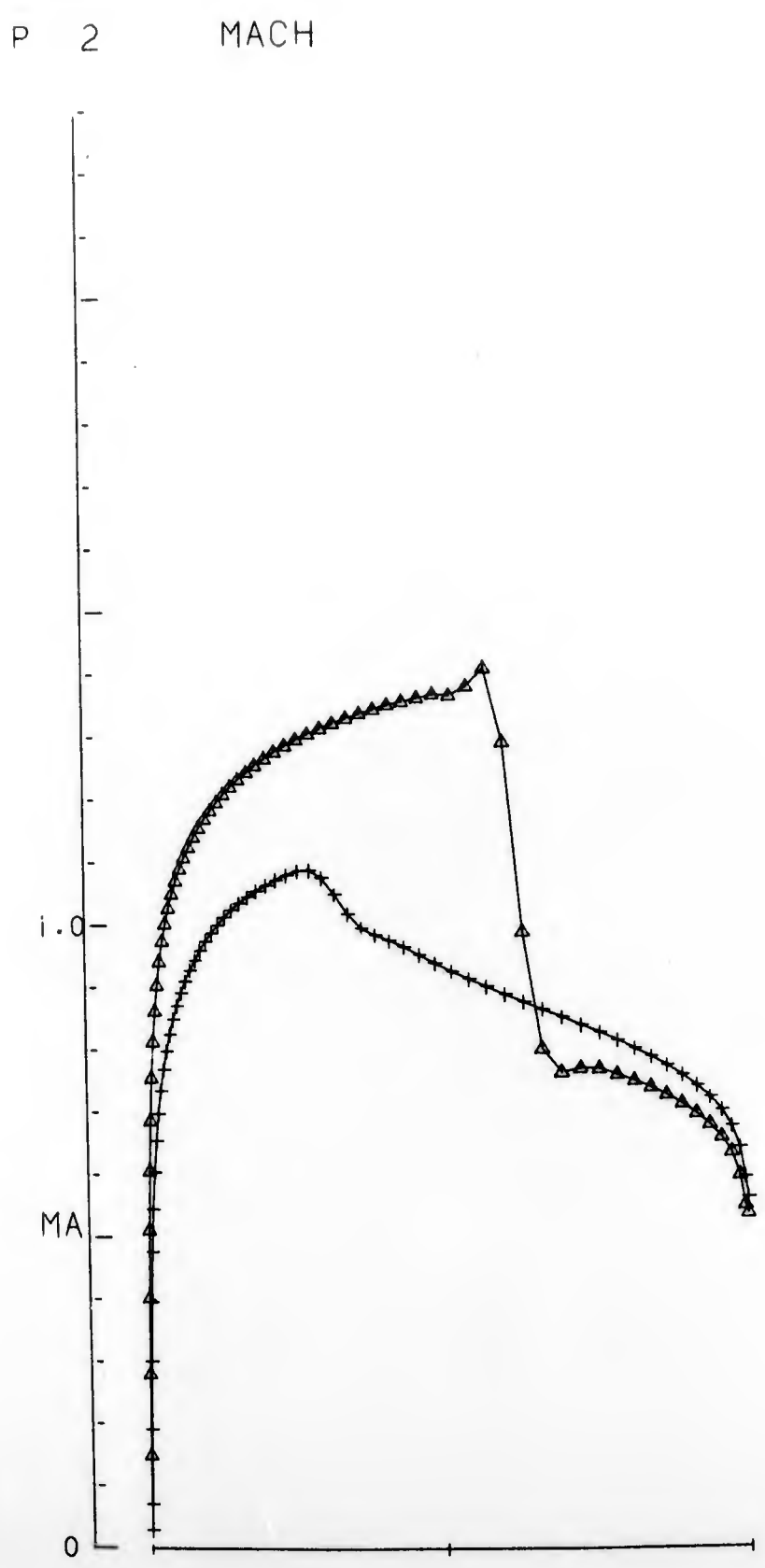
P 1 PRES 1-P/PIINF



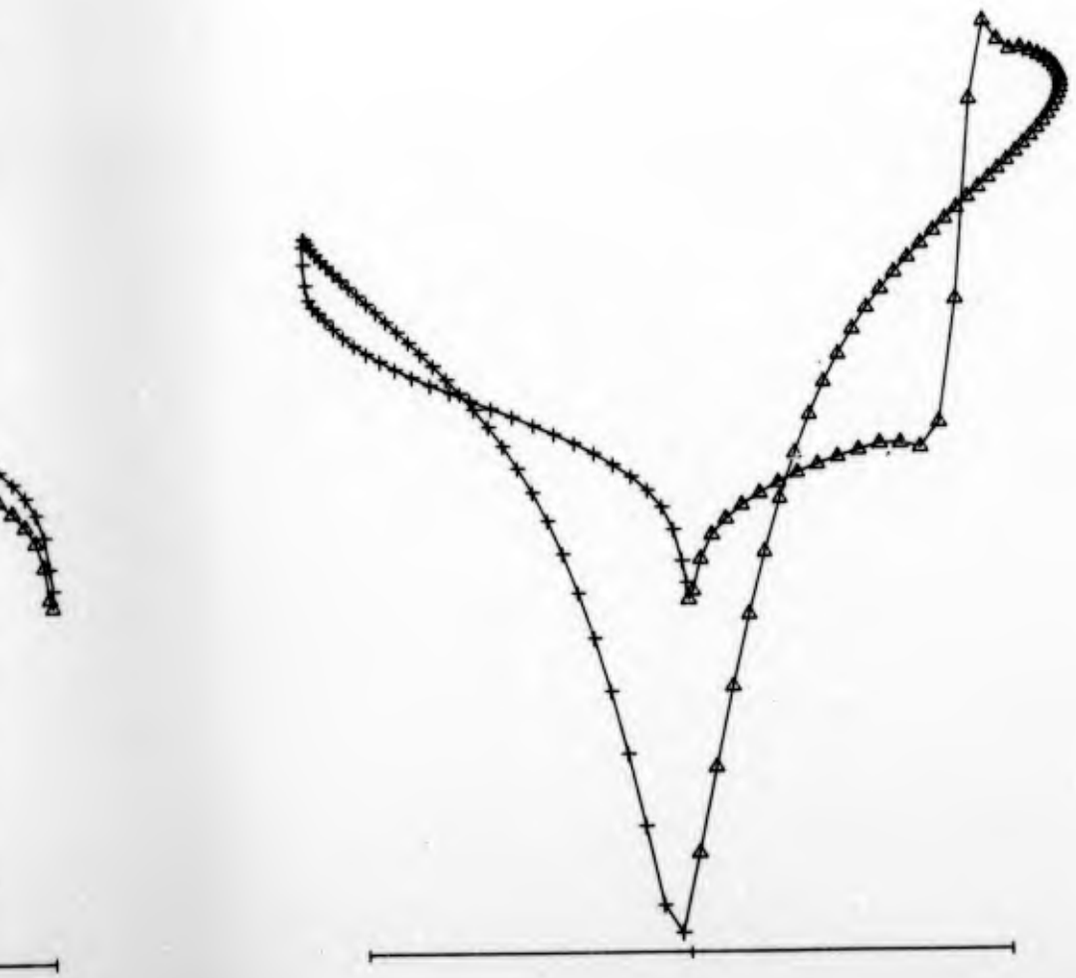
F.F.A.	AR 211		A.Rizzi	01-8-13
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

25 NOI CON SWT .05 .01



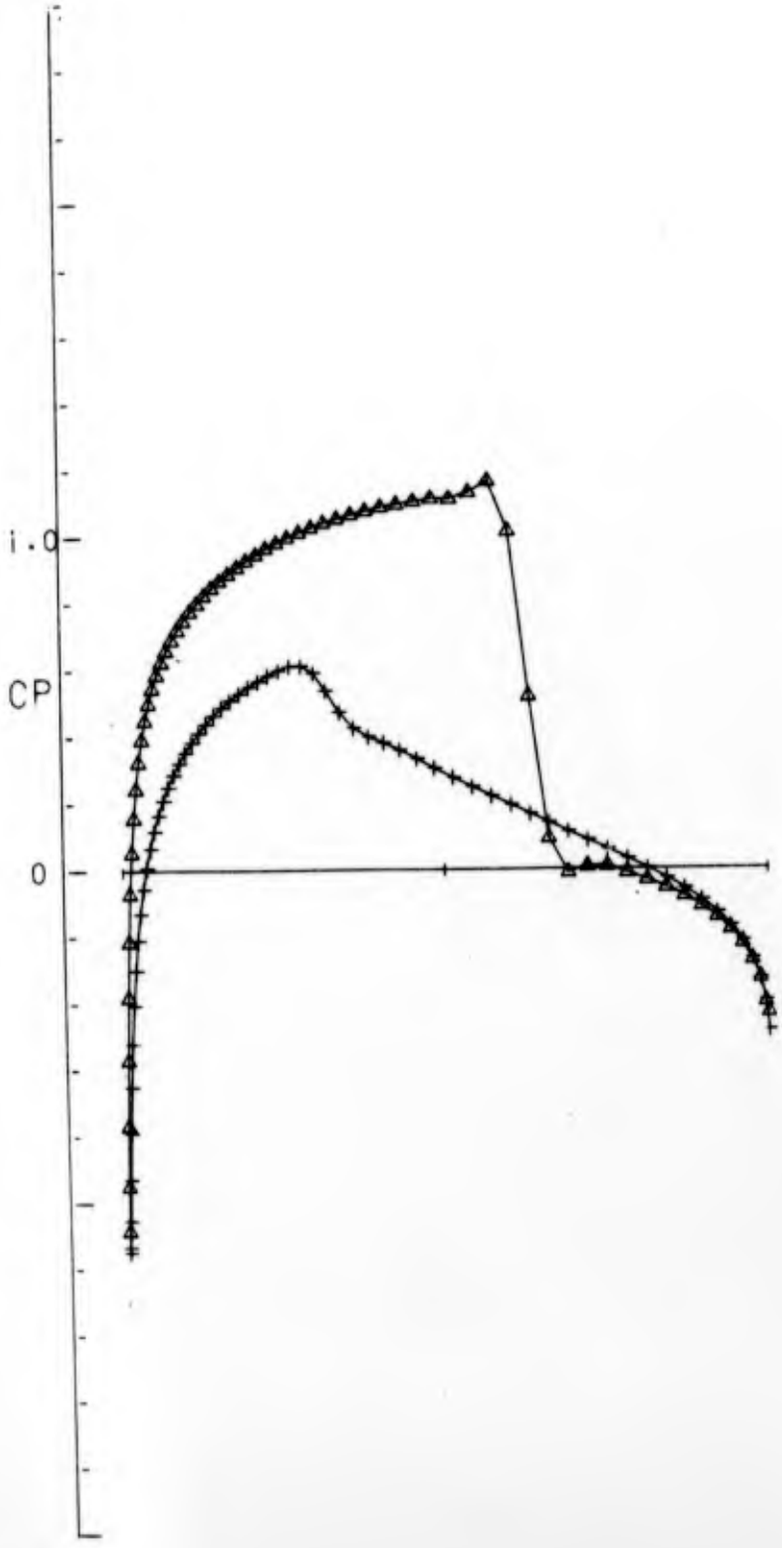

P 2
MACH
i.0
MA
0

F.F.A.	AR 211		A.Rizzi	01-8-14
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

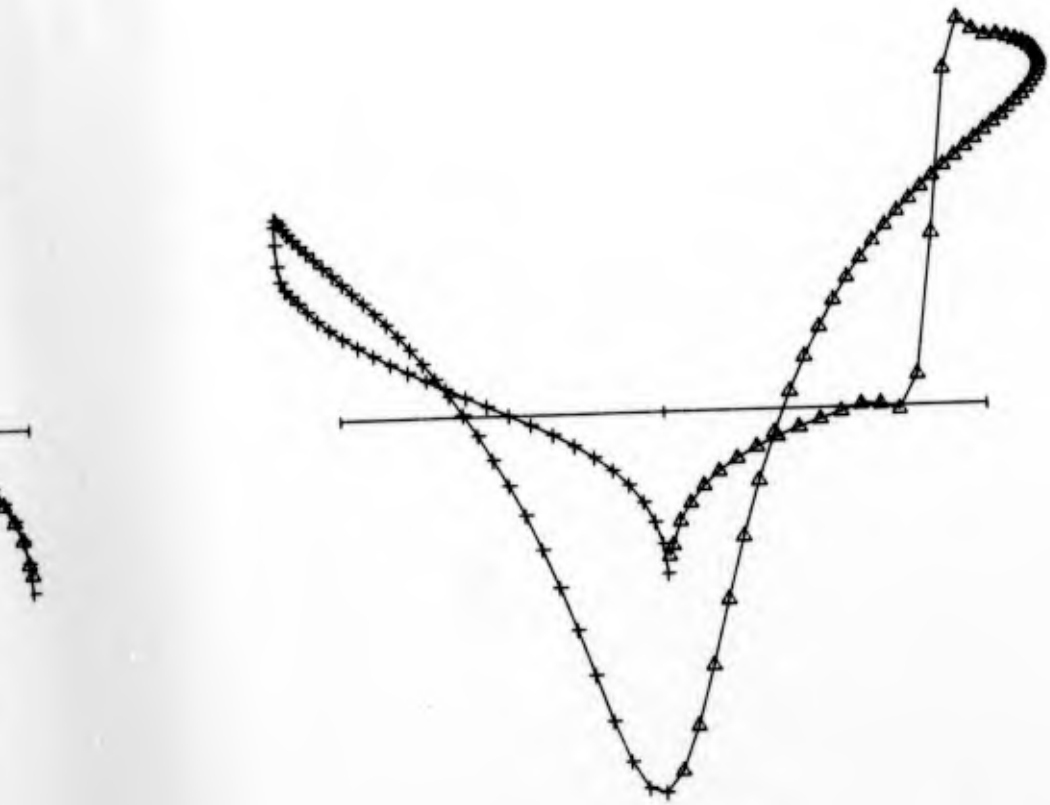


F.F.A.

P 3 COEP



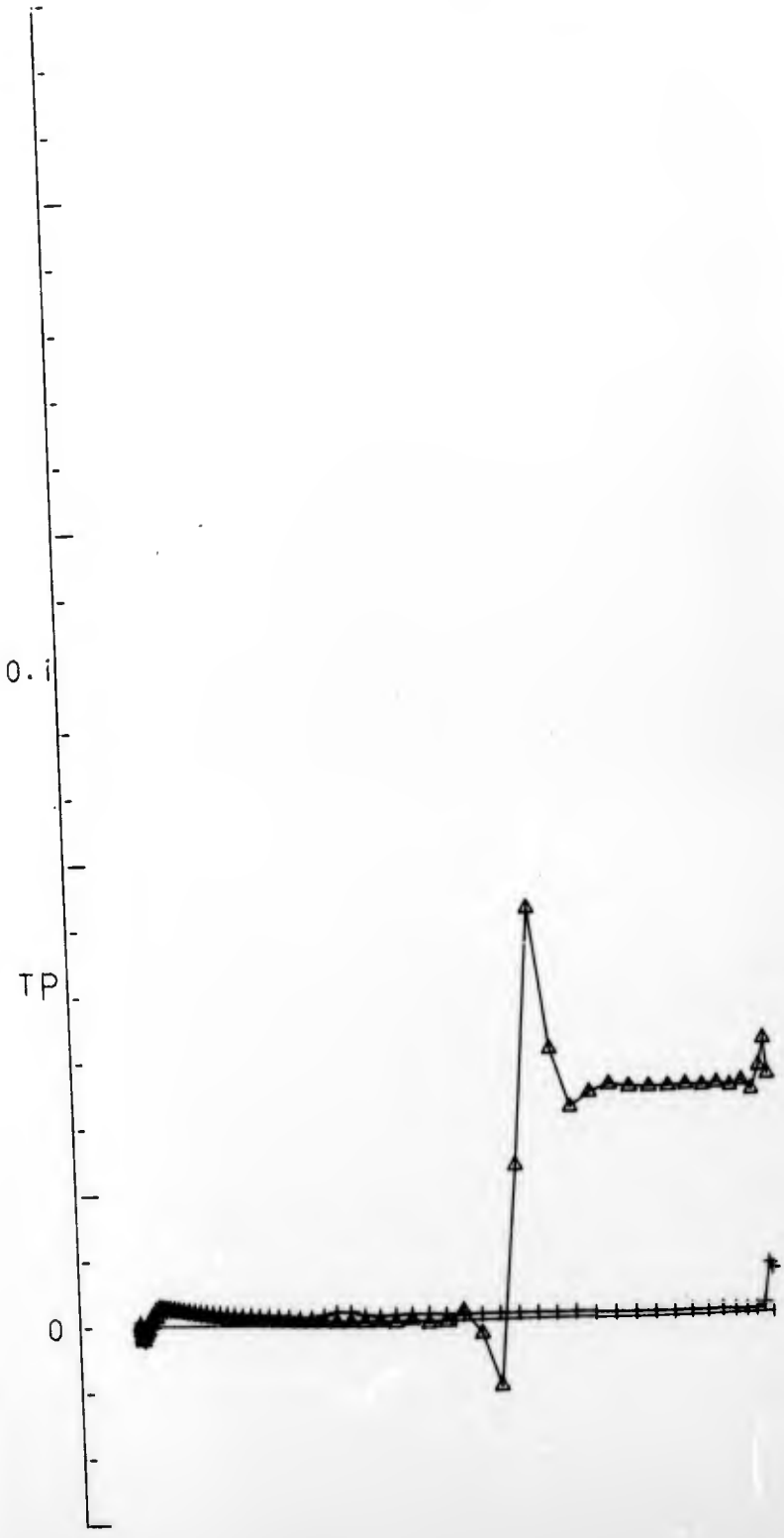
F.F.A.	AR 211		A.Rizzi	01-8-15
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

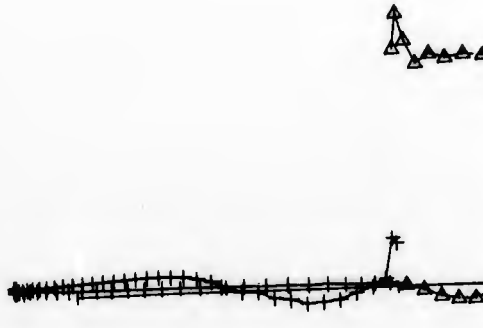


F.F.A.	AR
	NA

28/6 INVOR UNORO MESH .80 1.25 1 CON SWT .05 .01

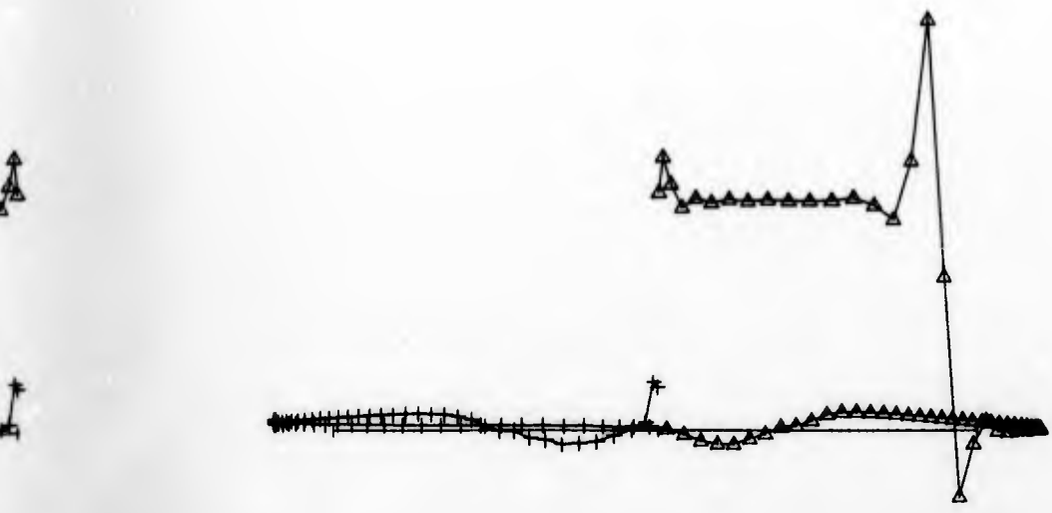
P 1 TOTP 1-PI/PINF





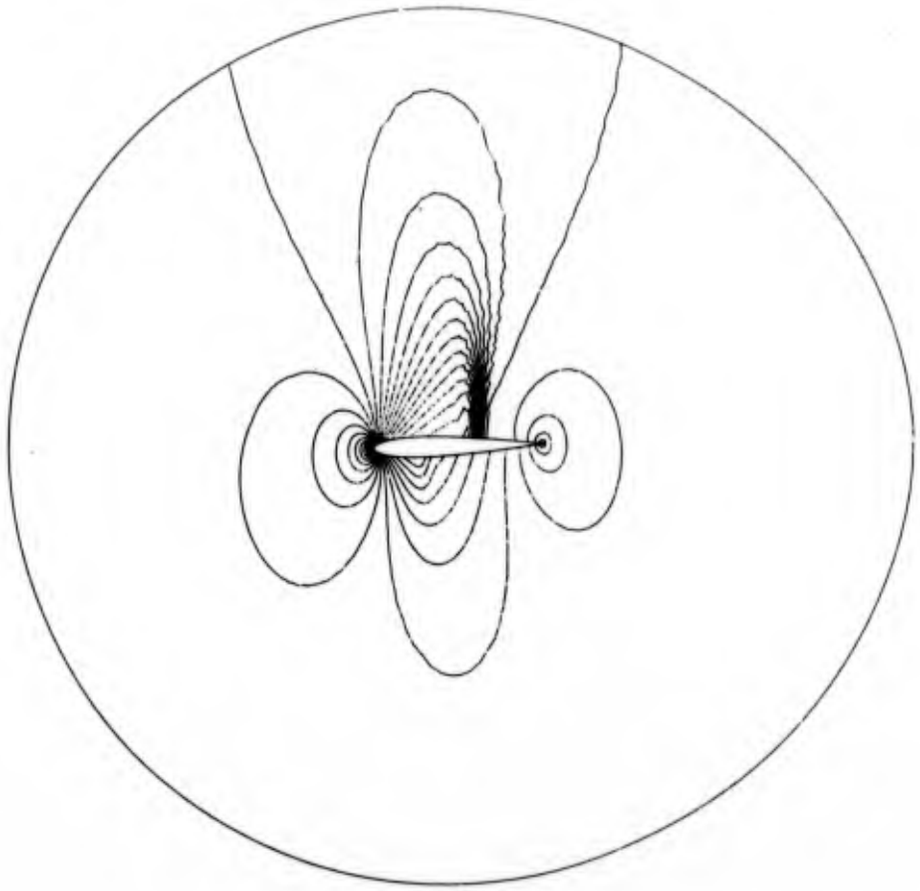
F.F.A.	AR 211		A.Rizzi	01-8-16
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NO CON SWT .05 .01



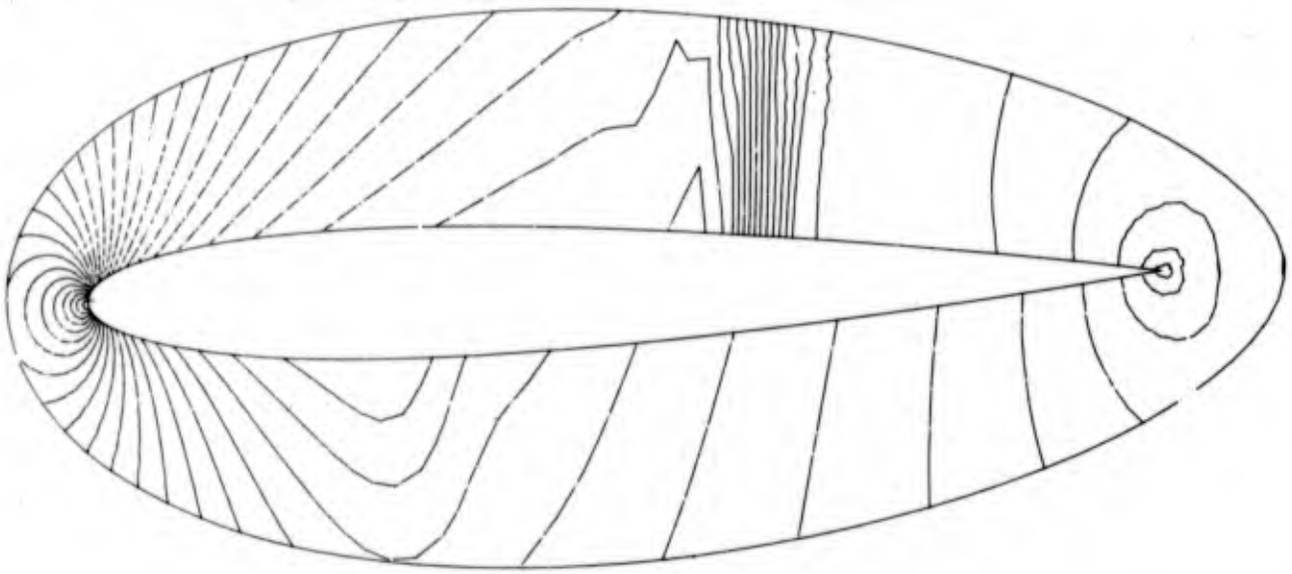
F.F.A.	AR 211		A.Rizzi	01-8-17
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

P 4 PRES 1-P/PIINF INC = .025 min = .025 max = .675



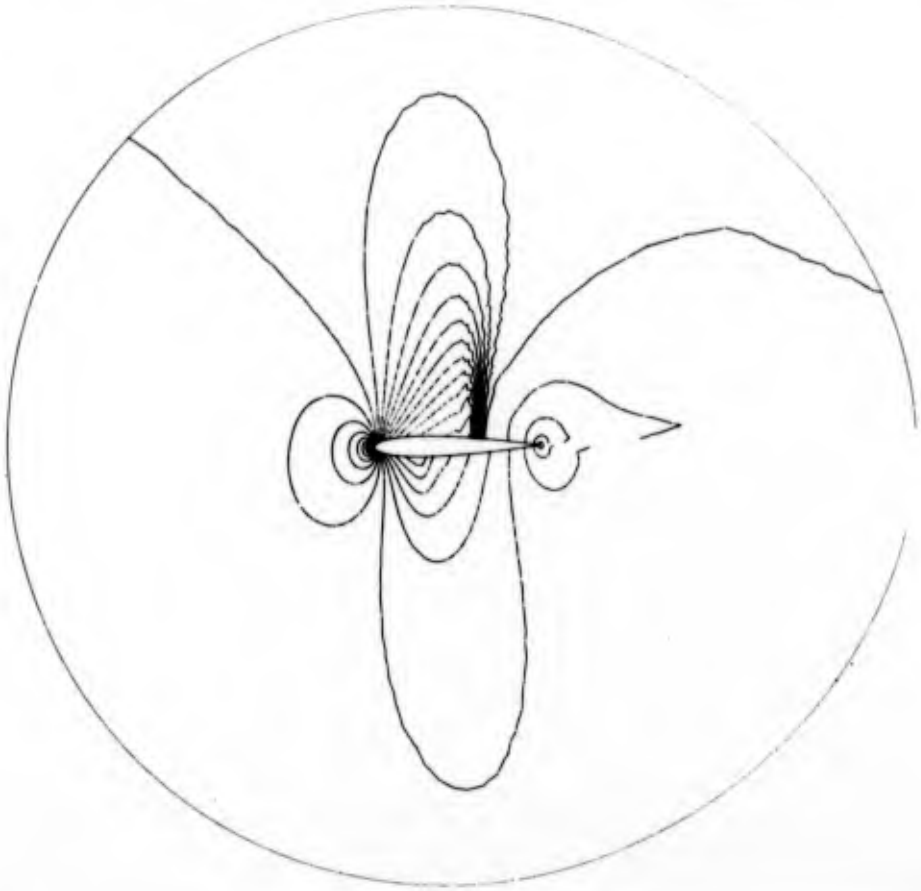
F.F.A.	AR 211		A.Rizzi	01-8-18
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

P 5 PRES 1-P/PIINF INC = .025 min = .025 max = .675



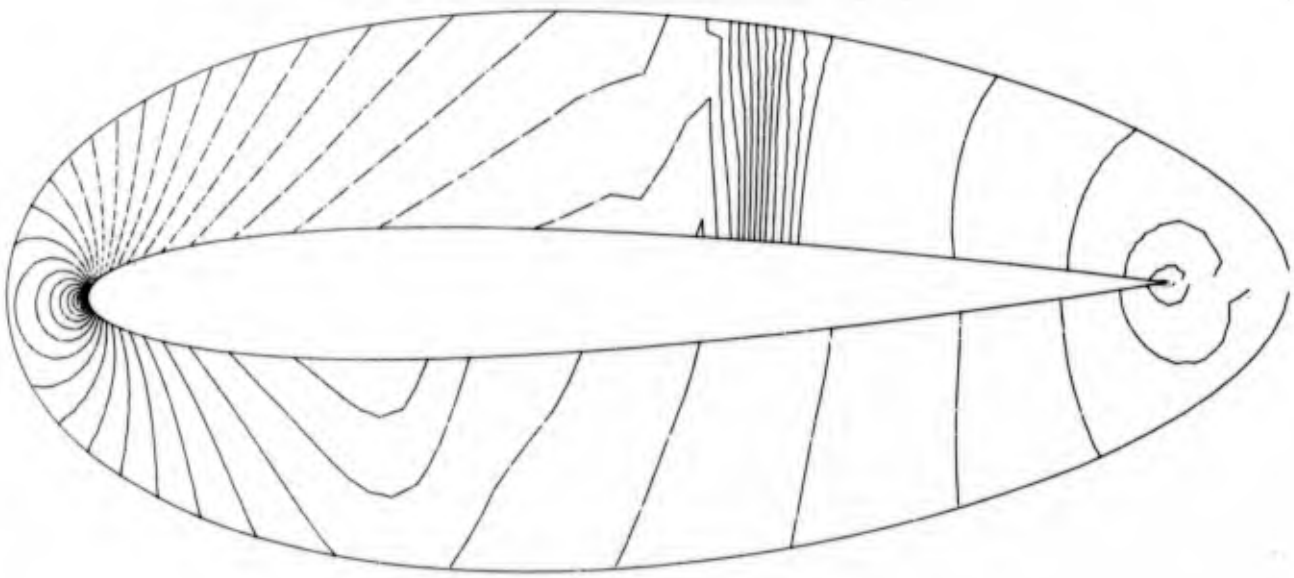
F.F.A.	AR 211		A.Rizzi	01-8-19
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

P 6 MACH INC = .05 min = .05 max = 1.40



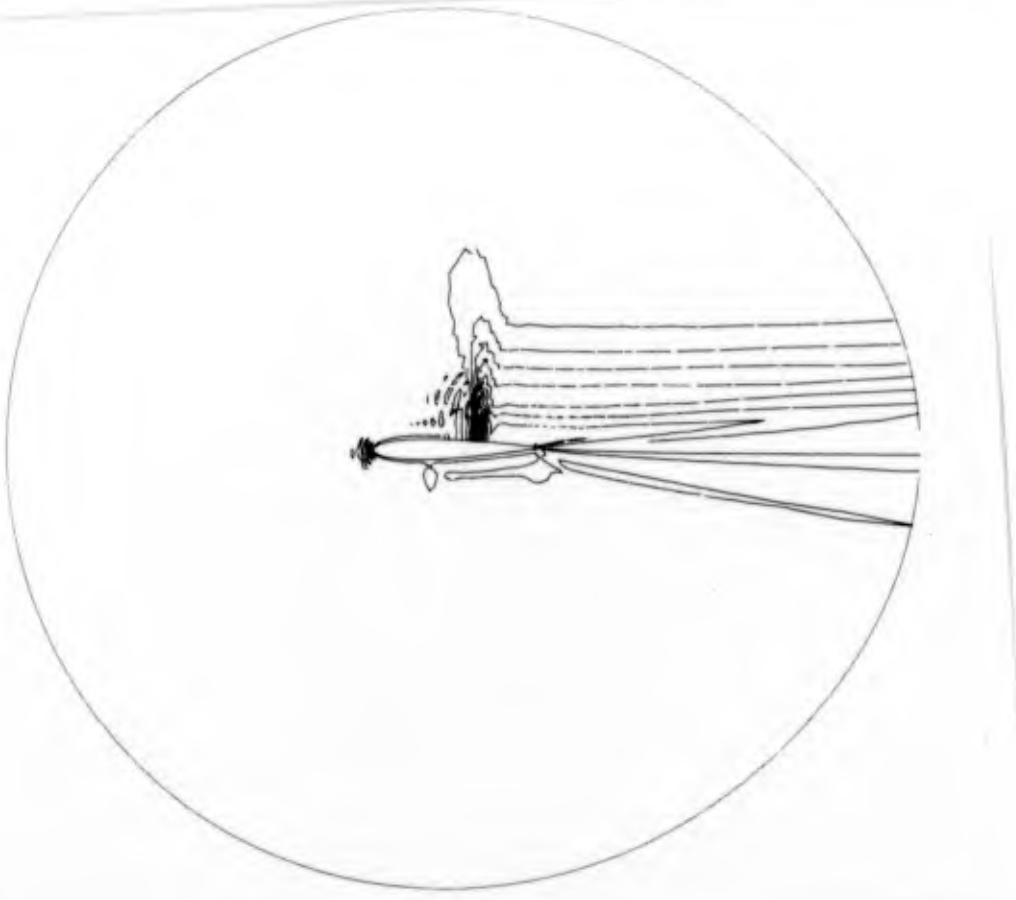
F.F.A.	AR 211		A.Rizzi	01-8-20
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

P 7 MACH INC = .05 min = .05 max = 1.40



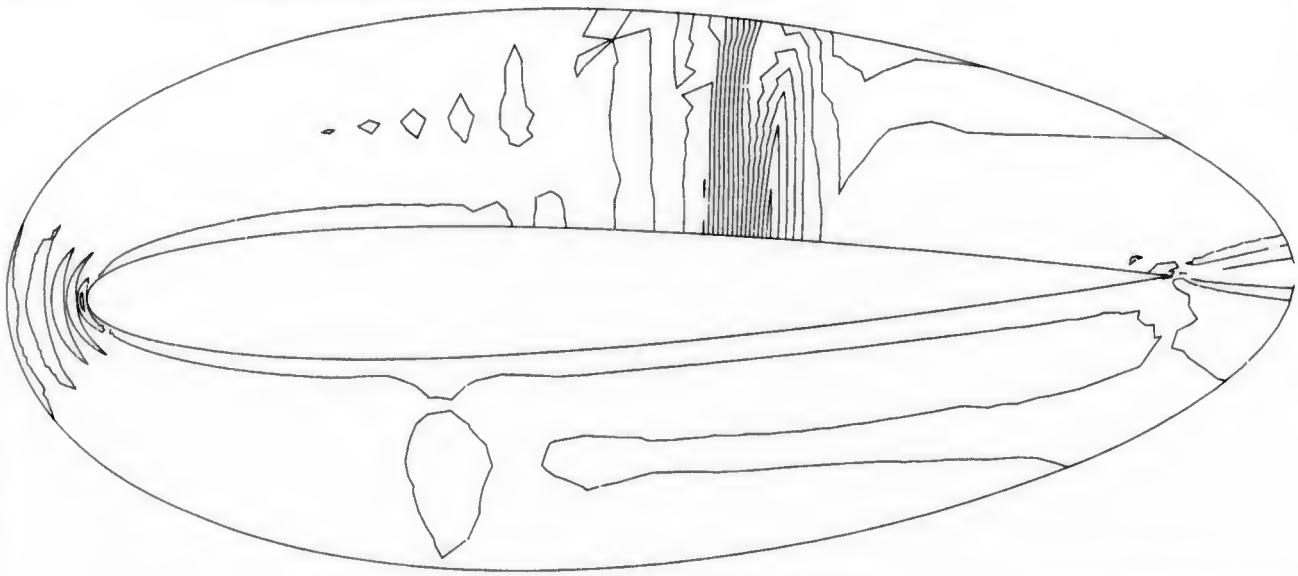
F.F.A.	AR 211		A.Rizzi	01-8-21
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

P 2 TOTP 1-PI/PIINF INC = .005 min = −.01 max = .06



F.F.A.	AR 211		A.Rizzi	01-8-22
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

P 8 TOTP 1-PI/PIINF INC = .005 min = -.01 max = .06



AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 01

NACA 0012: MACH = 0.80, ALPHA = 1.25

Contributor No 9

W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

		01-9-1	01-9-2	01-9-3	01-9-4	01-9-5	01-9-6	01-9-7	01-9-8	01-9-9	01-9-10	01-9-11	01-9-12	FICHE Nº 3
01-9-13	01-9-14	01-9-15	01-9-16	01-9-17	01-9-18	01-9-19	01-9-20	01-9-21	01-9-22	01-9-23	01-9-24	01-9-25	TEST CASE 02 CONTRIBUTOR 1	
02-1-1	02-1-2	02-1-3	02-1-4	02-1-5	02-1-6	02-1-7	02-1-8	02-1-9	02-1-10	02-1-11	02-1-12	02-1-13	02-1-14	
02-1-15	02-1-16	02-1-17	02-1-18	02-1-19	02-1-20	02-1-21	02-1-22	02-1-23	02-1-24	02-1-25	02-1-26	TEST CASE 02 CONTRIBUTOR 2	02-2-1	
02-2-2	02-2-3	02-2-4	02-2-5	02-2-6	02-2-7	02-2-8	02-2-9	02-2-10	02-2-11	02-2-12	02-2-13	02-2-14	02-2-15	
02-2-16	02-2-17	02-2-18	02-2-19	02-2-20	02-2-21	TEST CASE 02 CONTRIBUTOR 3	02-3-1	02-3-2	02-3-3	02-3-4	02-3-5	02-3-6	02-3-7	
02-3-8	02-3-9	02-3-10	02-3-11	02-3-12	02-3-13	02-3-14	TEST CASE 02 CONTRIBUTOR 5	02-5-1	02-5-2	02-5-3	02-5-4	02-5-5	CONTINUED	

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-1
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

N	X/C(%)	Z/C(%)	1-P/PIINF	CP	MACH	1-PI/PIINF
2	99.992828	-Ø.ØØ1ØØØ	Ø.139562	Ø.695531	Ø.468564	-Ø.ØØØØ93
3	99.965897	-Ø.ØØ4846	Ø.17Ø725	Ø.589496	Ø.522552	Ø.ØØ1101
4	99.914658	-Ø.Ø12110	Ø.184682	Ø.542ØØ9	Ø.548702	-Ø.ØØØ47Ø
5	99.840439	-Ø.Ø22620	Ø.196671	Ø.5Ø1216	Ø.567548	Ø.ØØØ48Ø
6	99.744ØØ3	-Ø.Ø36276	Ø.2Ø5956	Ø.469621	Ø.583620	-Ø.ØØØØ39
7	99.625946	-Ø.Ø52983	Ø.214201	Ø.441568	Ø.596761	Ø.ØØØ247
8	99.486725	-Ø.Ø72632	Ø.221169	Ø.417858	Ø.608279	Ø.ØØØØ96
9	99.326721	-Ø.Ø95145	Ø.227405	Ø.396641	Ø.618255	Ø.ØØØ168
1Ø	99.146286	-Ø.12Ø481	Ø.233107	Ø.377240	Ø.627432	Ø.ØØØ151
11	98.945786	-Ø.148593	Ø.238500	Ø.358888	Ø.636ØØØ	Ø.ØØØ192
12	98.725494	-Ø.179389	Ø.243378	Ø.342293	Ø.643829	Ø.ØØØ133
13	98.485703	-Ø.212798	Ø.247929	Ø.326808	Ø.651014	Ø.ØØØ157
14	98.226700	-Ø.248813	Ø.252471	Ø.311351	Ø.658128	Ø.ØØØ211
15	97.948761	-Ø.287339	Ø.256673	Ø.297Ø55	Ø.664834	Ø.ØØØ139
16	97.652130	-Ø.328249	Ø.26Ø5Ø5	Ø.284Ø18	Ø.67Ø849	Ø.ØØØ144
17	97.337Ø82	-Ø.371551	Ø.264340	Ø.27Ø967	Ø.676801	Ø.ØØØ194
18	97.ØØ3891	-Ø.417216	Ø.268090	Ø.258210	Ø.682709	Ø.ØØØ158
19	96.652786	-Ø.465119	Ø.271631	Ø.246159	Ø.688243	Ø.ØØØ155
2Ø	96.284Ø27	-Ø.515193	Ø.275Ø56	Ø.234508	Ø.693565	Ø.ØØØ168
21	95.897858	-Ø.567390	Ø.278398	Ø.223136	Ø.698767	Ø.ØØØ167
22	95.494553	-Ø.621635	Ø.281625	Ø.212154	Ø.7Ø3786	Ø.ØØØ165
23	95.Ø74341	-Ø.677854	Ø.284713	Ø.2Ø1647	Ø.7Ø8587	Ø.ØØØ156
24	94.637466	-Ø.735998	Ø.287720	Ø.191416	Ø.713243	Ø.ØØØ158
25	94.184219	-Ø.796Ø38	Ø.290743	Ø.181132	Ø.717907	Ø.ØØØ171
26	93.714828	-Ø.857Ø3	Ø.293734	Ø.17Ø955	Ø.722542	Ø.ØØØ164
27	93.229553	-Ø.921482	Ø.296625	Ø.161116	Ø.727Ø11	Ø.ØØØ165
28	92.728638	-Ø.986685	Ø.299384	Ø.151730	Ø.731280	Ø.ØØØ154
29	92.212341	-1.Ø53459	Ø.3Ø2Ø68	Ø.142596	Ø.735413	Ø.ØØØ163
3Ø	91.680923	-1.121780	Ø.3Ø4747	Ø.133483	Ø.739534	Ø.ØØØ17Ø
31	91.134644	-1.191594	Ø.3Ø7399	Ø.124459	Ø.743625	Ø.ØØØ166
32	9Ø.573761	-1.262822	Ø.31ØØ28	Ø.115514	Ø.747665	Ø.ØØØ172
33	89.998535	-1.335393	Ø.312650	Ø.1Ø6590	Ø.751691	Ø.ØØØ182
34	89.4Ø9225	-1.4Ø9214	Ø.315172	Ø.Ø98ØØ9	Ø.755586	Ø.ØØØ168
35	88.8Ø6Ø91	-1.484191	Ø.317565	Ø.Ø89869	Ø.759273	Ø.ØØØ161
36	88.189407	-1.56Ø317	Ø.32ØØØ5	Ø.Ø81567	Ø.762988	Ø.ØØØ195
37	87.559418	-1.637572	Ø.322493	Ø.Ø73101	Ø.766815	Ø.ØØØ191
38	86.916428	-1.715837	Ø.324898	Ø.Ø64916	Ø.77Ø524	Ø.ØØØ178
39	86.26Ø666	-1.795Ø19	Ø.327241	Ø.Ø56944	Ø.774110	Ø.ØØØ193
4Ø	85.592407	-1.875Ø83	Ø.329576	Ø.Ø48999	Ø.777688	Ø.ØØØ199
41	84.911942	-1.955977	Ø.3319Ø7	Ø.Ø41Ø7Ø	Ø.781262	Ø.ØØØ2Ø5
42	84.219528	-2.Ø37631	Ø.334211	Ø.Ø33230	Ø.784793	Ø.ØØØ211
43	83.515427	-2.119970	Ø.336469	Ø.Ø25545	Ø.788261	Ø.ØØØ21Ø
44	82.799927	-2.2Ø2941	Ø.338705	Ø.Ø17939	Ø.791682	Ø.ØØØ22Ø
45	82.Ø73288	-2.286501	Ø.340946	Ø.Ø1Ø314	Ø.795116	Ø.ØØØ229
46	81.335815	-2.37Ø6ØØ	Ø.343208	Ø.ØØ2618	Ø.798578	Ø.ØØØ24Ø
47	8Ø.587753	-2.455165	Ø.345466	-Ø.ØØ5Ø65	Ø.8Ø2Ø41	Ø.ØØØ243
48	79.829376	-2.54Ø112	Ø.347684	-Ø.Ø12613	Ø.8Ø5444	Ø.ØØØ247
49	79.Ø6Ø974	-2.625375	Ø.349875	-Ø.Ø2Ø868	Ø.8Ø88ØØ	Ø.ØØØ257
5Ø	78.282837	-2.71Ø91Ø	Ø.352Ø74	-Ø.Ø27551	Ø.812166	Ø.ØØØ27Ø
51	77.495209	-2.796670	Ø.354306	-Ø.Ø35143	Ø.815579	Ø.ØØØ287
52	76.698410	-2.882581	Ø.356515	-Ø.Ø42661	Ø.818974	Ø.ØØØ286
53	75.892685	-2.968552	Ø.358652	-Ø.Ø49931	Ø.822261	Ø.ØØØ283
54	75.Ø78339	-3.Ø54547	Ø.36Ø812	-Ø.Ø57282	Ø.825556	Ø.ØØØ312
55	74.255630	-3.14Ø56Ø	Ø.363Ø42	-Ø.Ø64868	Ø.828975	Ø.ØØØ325
56	73.424866	-3.226509	Ø.365264	-Ø.Ø72430	Ø.832397	Ø.ØØØ32Ø
57	72.586319	-3.312301	Ø.367484	-Ø.Ø79984	Ø.835798	Ø.ØØØ338
58	71.74Ø265	-3.397891	Ø.369738	-Ø.Ø87654	Ø.839253	Ø.ØØØ357
59	7Ø.887ØØ9	-3.483205	Ø.371953	-Ø.Ø95189	Ø.842672	Ø.ØØØ35Ø
6Ø	7Ø.Ø26794	-3.568157	Ø.374129	-Ø.1Ø2594	Ø.846Ø2Ø	Ø.ØØØ357
61	69.159943	-3.652738	Ø.376411	-Ø.11Ø356	Ø.849503	Ø.ØØØ395
62	68.286728	-3.736912	Ø.378755	-Ø.118333	Ø.853120	Ø.ØØØ395
63	67.4Ø744Ø	-3.82Ø54Ø	Ø.381Ø11	-Ø.126Ø1Ø	Ø.856615	Ø.ØØØ385
64	66.522354	-3.9Ø3537	Ø.383223	-Ø.133537	Ø.86ØØ16	Ø.ØØØ4Ø2
65	65.631760	-3.985905	Ø.385506	-Ø.141303	Ø.863532	Ø.ØØØ417
66	64.735947	-4.Ø67623	Ø.387906	-Ø.149471	Ø.867227	Ø.ØØØ439
67	63.835220	-4.148601	Ø.39Ø338	-Ø.157744	Ø.87Ø992	Ø.ØØØ438
68	62.929840	-4.228698	Ø.392676	-Ø.165701	Ø.874628	Ø.ØØØ425
69	62.Ø2Ø111	-4.3Ø7839	Ø.394998	-Ø.173602	Ø.878210	Ø.ØØØ445
7Ø	61.1Ø63Ø8	-4.386Ø3Ø	Ø.397404	-Ø.181788	Ø.881932	Ø.ØØØ459
71	6Ø.188751	-4.463216	Ø.399866	-Ø.19Ø165	Ø.885757	Ø.ØØØ46Ø
72	59.267700	-4.539302	Ø.4Ø2356	-Ø.198636	Ø.889622	Ø.ØØØ467
73	58.343460	-4.614206	Ø.4Ø4866	-Ø.2Ø7176	Ø.893523	Ø.ØØØ474
74	57.416321	-4.687847	Ø.4Ø7359	-Ø.215659	Ø.897414	Ø.ØØØ47Ø
75	56.486572	-4.76Ø14Ø	Ø.4Ø9845	-Ø.224119	Ø.9Ø1291	Ø.ØØØ474
76	55.554504	-4.831Ø51	Ø.412427	-Ø.232902	Ø.9Ø5299	Ø.ØØØ498
77	54.62Ø422	-4.9ØØ533	Ø.415Ø72	-Ø.241905	Ø.9Ø9439	Ø.ØØØ497
78	53.684616	-4.968453	Ø.417641	-Ø.25Ø644	Ø.913482	Ø.ØØØ474
79	52.747375	-5.Ø34718	Ø.42Ø2Ø1	-Ø.259357	Ø.917480	Ø.ØØØ492
8Ø	51.8Ø8990	-5.Ø99324	Ø.422880	-Ø.268472	Ø.921672	Ø.ØØØ5Ø6

0767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-2
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

81	50.869781	-5.162216	0.425628	-0.277821	0.926000	0.000497
82	49.930008	-5.223271	0.428392	-0.287224	0.930350	0.000500
83	48.990005	-5.282402	0.431180	-0.296710	0.934741	0.000504
84	48.050049	-5.339531	0.433976	-0.306226	0.939162	0.000498
85	47.110458	-5.394568	0.436774	-0.315745	0.943590	0.000497
86	46.171509	-5.447458	0.439626	-0.325448	0.948094	0.000514
87	45.233521	-5.498161	0.442507	-0.335254	0.952672	0.000513
88	44.296783	-5.546580	0.445314	-0.344804	0.957156	0.000490
89	43.361603	-5.592612	0.448107	-0.354306	0.961609	0.000486
90	42.428284	-5.636191	0.451117	-0.364549	0.966404	0.000498
91	41.497131	-5.677249	0.454527	-0.376149	0.971833	0.000527
92	40.568451	-5.715693	0.458256	-0.388837	0.977776	0.000571
93	39.642548	-5.751444	0.461847	-0.401058	0.983529	0.000599
94	38.719727	-5.784445	0.464523	-0.410164	0.987860	0.000582
95	37.800293	-5.814661	0.465454	-0.413330	0.989443	0.000487
96	36.884567	-5.842010	0.464345	-0.409558	0.987811	0.000305
97	35.972839	-5.866369	0.462312	-0.402639	0.984664	0.000155
98	35.065430	-5.887674	0.462330	-0.402701	0.984613	0.000247
99	34.162659	-5.905882	0.468363	-0.423230	0.993986	0.000673
100	33.264816	-5.920918	0.482327	-0.470741	1.016296	0.001173
101	32.372223	-5.932717	0.500619	-0.532980	1.046573	0.001099
102	31.485199	-5.941235	0.515879	-0.584903	1.072679	0.000509
103	30.604050	-5.946396	0.523641	-0.611312	1.086249	0.000039
104	29.729080	-5.948131	0.525254	-0.616803	1.089040	-0.000003
105	28.860626	-5.946407	0.524251	-0.613389	1.087199	0.000152
106	27.998978	-5.941193	0.522803	-0.608461	1.084632	0.000269
107	27.144455	-5.932426	0.521576	-0.604287	1.082506	0.000313
108	26.297394	-5.920048	0.520547	-0.600786	1.080756	0.000313
109	25.458069	-5.904007	0.519498	-0.597218	1.078983	0.000301
110	24.626831	-5.884267	0.518259	-0.593002	1.076888	0.000294
111	23.803986	-5.860794	0.516763	-0.587911	1.074353	0.000290
112	22.989822	-5.833555	0.515000	-0.581912	1.071373	0.000288
113	22.184692	-5.802505	0.512987	-0.575064	1.067979	0.000283
114	21.388901	-5.767619	0.510799	-0.567617	1.064282	0.000294
115	20.602753	-5.728903	0.508497	-0.559785	1.060405	0.000307
116	19.826538	-5.686358	0.506062	-0.551501	1.056320	0.000309
117	19.060608	-5.639968	0.503425	-0.542526	1.051909	0.000308
118	18.305237	-5.589691	0.500519	-0.532639	1.047071	0.000300
119	17.560776	-5.535499	0.497359	-0.521890	1.041817	0.000302
120	16.827515	-5.477386	0.494015	-0.510511	1.036269	0.000307
121	16.105759	-5.415383	0.490568	-0.498781	1.030538	0.000326
122	15.395823	-5.349519	0.487015	-0.486693	1.024704	0.000329
123	14.697994	-5.279799	0.483288	-0.474010	1.018585	0.000330
124	14.012589	-5.206223	0.479335	-0.460561	1.012116	0.000333
125	13.339911	-5.128796	0.475135	-0.446271	1.005268	0.000334
126	12.680262	-5.047531	0.470694	-0.431161	0.998055	0.000335
127	12.033938	-4.962469	0.466088	-0.415488	0.990581	0.000357
128	11.401228	-4.873669	0.461348	-0.399359	0.982917	0.000377
129	10.782431	-4.781145	0.456308	-0.382212	0.974845	0.000350
130	10.177848	-4.684890	0.450949	-0.363978	0.966255	0.000361
131	9.587761	-4.584977	0.445433	-0.345209	0.957417	0.000409
132	9.012450	-4.481469	0.439666	-0.325586	0.948265	0.000393
133	8.452214	-4.374364	0.433498	-0.304599	0.938505	0.000389
134	7.907336	-4.263697	0.426986	-0.282439	0.928207	0.000420
135	7.378089	-4.149546	0.420162	-0.259222	0.917470	0.000434
136	6.864746	-4.031963	0.412967	-0.234742	0.906193	0.000447
137	6.367586	-3.910989	0.405314	-0.208703	0.894251	0.000445
138	5.886880	-3.786671	0.397228	-0.181188	0.881652	0.000467
139	5.422886	-3.659085	0.388764	-0.152389	0.868479	0.000518
140	4.975878	-3.528265	0.379663	-0.121423	0.854434	0.000489
141	4.546138	-3.394206	0.369772	-0.087770	0.839179	0.000487
142	4.133910	-3.257002	0.359356	-0.052329	0.823060	0.000573
143	3.739435	-3.116738	0.348254	-0.014552	0.806002	0.000562
144	3.363000	-2.973392	0.336121	0.026731	0.787387	0.000543
145	3.004865	-2.826992	0.323025	0.071289	0.767208	0.000601
146	2.665271	-2.677608	0.308890	0.119386	0.745450	0.000609
147	2.344483	-2.525252	0.293457	0.171896	0.721644	0.000595
148	2.042769	-2.369932	0.276618	0.229191	0.695501	0.000610
149	1.760388	-2.211676	0.258269	0.291626	0.666797	0.000607
150	1.497621	-2.050480	0.238238	0.359780	0.635077	0.000608
151	1.254779	-1.886312	0.216270	0.434529	0.599726	0.000565
152	1.032200	-1.719143	0.192264	0.516208	0.560107	0.000534
153	0.830213	-1.548982	0.166374	0.604302	0.515784	0.000533
154	0.649191	-1.375844	0.138776	0.698205	0.466107	0.000536
155	0.489575	-1.199747	0.109835	0.796676	0.410232	0.000486
156	0.351844	-1.020777	0.080553	0.896312	0.347779	0.000326
157	0.236489	-0.839120	0.052622	0.991347	0.278390	0.000223
158	0.143964	-0.655104	0.028329	1.074005	0.202415	0.000176
159	0.074616	-0.469198	0.010425	1.134924	0.121172	0.000218
160	0.028571	-0.281985	0.001545	1.165139	0.042215	0.000302

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-3
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

161	Ø.ØØ5686	-Ø.Ø94Ø65	Ø.ØØ3446	1.158669	Ø.Ø67258	Ø.ØØØ289
162	Ø.ØØ5686	Ø.Ø94Ø65	Ø.Ø166Ø7	1.113887	Ø.154537	Ø.ØØ0Ø71
163	Ø.Ø28571	Ø.281985	Ø.Ø4Ø515	1.Ø32542	Ø.244415	-Ø.ØØØ21Ø
164	Ø.Ø74616	Ø.469198	Ø.Ø73246	Ø.921173	Ø.332349	-Ø.ØØØ4Ø9
165	Ø.143964	Ø.655104	Ø.111Ø8Ø	Ø.789964	Ø.415830	-Ø.ØØØ423
166	Ø.236489	Ø.839120	Ø.152893	Ø.650172	Ø.493ØØ6	-Ø.ØØØ2Ø3
167	Ø.351844	1.Ø20777	Ø.193649	Ø.511497	Ø.563285	-Ø.ØØØ102
168	Ø.489575	1.199747	Ø.232Ø99	Ø.38Ø669	Ø.626Ø69	-Ø.ØØØØ54
169	Ø.649191	1.375844	Ø.267510	Ø.26Ø183	Ø.681891	Ø.ØØØØ81
17Ø	Ø.83Ø213	1.548982	Ø.299502	Ø.151328	Ø.731364	Ø.ØØØ245
171	1.Ø322ØØ	1.719143	Ø.328Ø97	Ø.Ø54Ø32	Ø.775280	Ø.ØØØ333
172	1.254779	1.886312	Ø.353571	-Ø.Ø32644	Ø.814318	Ø.ØØØ419
173	1.497621	2.Ø5Ø48Ø	Ø.376Ø77	-Ø.1Ø9223	Ø.848882	Ø.ØØØ5Ø6
174	1.76Ø388	2.211676	Ø.395965	-Ø.176890	Ø.879632	Ø.ØØØ529
175	2.Ø42769	2.369932	Ø.413746	-Ø.237392	Ø.9Ø7323	Ø.ØØØ541
176	2.344483	2.525252	Ø.429758	-Ø.291874	Ø.932480	Ø.ØØØ527
177	2.665271	2.677Ø8	Ø.444164	-Ø.34Ø89Ø	Ø.955276	Ø.ØØØ546
178	3.ØØ4866	2.826992	Ø.457111	-Ø.384942	Ø.975965	Ø.ØØØ539
179	3.363ØØØ	2.973392	Ø.46895Ø	-Ø.425225	Ø.995121	Ø.ØØØ459
18Ø	3.739435	3.116738	Ø.479797	-Ø.462134	1.Ø12745	Ø.ØØØ481
181	4.133910	3.257ØØ2	Ø.489545	-Ø.495ØØØ	1.Ø28711	Ø.ØØØ514
182	4.546138	3.394Ø06	Ø.498599	-Ø.526105	1.Ø43787	Ø.ØØØ4Ø7
183	4.975878	3.528265	Ø.5Ø7231	-Ø.555477	1.Ø58214	Ø.ØØØ386
184	5.422886	3.659Ø85	Ø.515147	-Ø.582411	1.Ø71499	Ø.ØØØ438
185	5.886880	3.786671	Ø.522406	-Ø.6Ø7112	1.Ø83856	Ø.ØØØ393
186	6.367586	3.91Ø989	Ø.529282	-Ø.63Ø5Ø7	1.Ø95642	Ø.ØØØ365
187	**6.864746**	**4.Ø31963**	**Ø.535782**	**-Ø.652623**	**1.1Ø6848**	**Ø.ØØØ365**
188	7.378Ø89	4.149546	Ø.541888	-Ø.673399	1.117460	Ø.ØØØ36Ø
189	7.9Ø7336	4.263697	Ø.547684	-Ø.693122	1.127612	Ø.ØØØ35Ø
19Ø	**8.452214**	**4.374364**	**Ø.553260**	**-Ø.712Ø93**	**1.137471**	**Ø.ØØØ313**
191	9.Ø12450	4.481469	Ø.558589	-Ø.73Ø224	1.146931	Ø.ØØØ316
192	9.587761	4.584977	Ø.563570	-Ø.747175	1.155815	Ø.ØØØ345
193	**1Ø.177848**	**4.684890**	**Ø.568325**	**-Ø.763354**	**1.164Ø09**	**Ø.ØØØ3Ø5**
194	1Ø.782431	4.781145	Ø.572984	-Ø.779206	1.172873	Ø.ØØØ278
195	11.4Ø1228	4.873669	Ø.577405	-Ø.794249	1.18Ø911	Ø.ØØØ314
196	**12.Ø33938**	**4.962469**	**Ø.581566**	**-Ø.8Ø8405**	**1.188558**	**Ø.ØØØ3Ø7**
197	12.68Ø262	5.Ø47531	Ø.585613	-Ø.822174	1.196Ø52	Ø.ØØØ284
198	13.339911	5.128796	Ø.589556	-Ø.835591	1.2Ø3383	Ø.ØØØ284
199	**14.Ø12589**	**5.2Ø6223**	**Ø.593350**	**-Ø.848502**	**1.21Ø481**	**Ø.ØØØ285**
2ØØ	14.697994	5.279799	Ø.596988	-Ø.86Ø879	1.217330	Ø.ØØØ281
2Ø1	15.395823	**5.349519**	**Ø.6ØØ465**	**-Ø.872711**	**1.223909**	**Ø.ØØØ283**
2Ø2	**16.1Ø5759**	**5.415383**	**Ø.6Ø3796**	**-Ø.884Ø44**	**1.23Ø249**	**Ø.ØØØ284**
2Ø3	16.827515	5.477386	Ø.6Ø7Ø38	-Ø.895Ø74	1.236465	Ø.ØØØ272
2Ø4	17.56Ø776	**5.535499**	**Ø.61Ø221**	**-Ø.9Ø59Ø7**	**1.242596**	**Ø.ØØØ266**
2Ø5	18.3Ø5237	5.589691	Ø.613314	-Ø.916428	1.248583	Ø.ØØØ263
2Ø6	19.Ø6Ø6Ø8	5.639968	Ø.616275	-Ø.926505	1.254340	Ø.ØØØ27Ø
2Ø7	**19.826538**	**5.686358**	**Ø.619084**	**-Ø.936Ø61**	**1.259831**	**Ø.ØØØ273**
2Ø8	2Ø.6Ø2753	5.728903	Ø.621770	-Ø.945203	1.265113	Ø.ØØØ273
2Ø9	21.388901	5.767619	Ø.624383	-Ø.954Ø91	1.27Ø279	Ø.ØØØ267
21Ø	**22.184692**	**5.8Ø25Ø5**	**Ø.626953**	**-Ø.962835**	**1.275386**	**Ø.ØØØ258**
211	22.989822	5.833555	Ø.629452	-Ø.971338	1.28Ø364	Ø.ØØØ266
212	23.8Ø3986	5.86Ø794	Ø.631844	-Ø.979478	1.285154	Ø.ØØØ271
213	**24.626831**	**5.884267**	**Ø.634141**	**-Ø.987295**	**1.289779**	**Ø.ØØØ27Ø**
214	25.458Ø69	5.9Ø4ØØ7	Ø.636362	-Ø.994850	1.294271	Ø.ØØØ266
215	26.297394	5.92ØØ48	Ø.638512	-1.ØØ2168	1.298638	Ø.ØØØ265
216	**27.144455**	**5.932426**	**Ø.64Ø584**	**-1.ØØ9216**	**1.3Ø2862**	**Ø.ØØØ267**
217	27.998978	5.941193	Ø.642562	-1.Ø15945	1.3Ø6911	Ø.ØØØ266
218	28.86Ø626	5.946407	Ø.644446	-1.Ø22358	1.31Ø779	Ø.ØØØ276
219	**29.729Ø8Ø**	**5.948131**	**Ø.646268**	**-1.Ø28555**	**1.314540**	**Ø.ØØØ27Ø**
22Ø	3Ø.6Ø4Ø5Ø	5.946396	Ø.648Ø57	-1.Ø34643	1.318254	Ø.ØØØ257
221	31.485199	5.941235	Ø.649780	-1.Ø4Ø5Ø4	1.321824	Ø.ØØØ272
222	**32.372223**	**5.932717**	**Ø.651408**	**-1.Ø46Ø46**	**1.325216**	**Ø.ØØØ277**
223	33.264816	5.92Ø918	Ø.652981	-1.Ø51398	1.328516	Ø.ØØØ267
224	34.162659	5.9Ø5882	Ø.654502	-1.Ø56574	1.331707	Ø.ØØØ272
225	**35.Ø65430**	**5.887674**	**Ø.655947**	**-1.Ø61488**	**1.334741**	**Ø.ØØØ282**
226	35.972839	5.866369	Ø.657348	-1.Ø66257	1.337710	Ø.ØØØ27Ø
227	36.884567	5.842Ø1Ø	Ø.658719	-1.Ø7Ø923	1.34Ø623	Ø.ØØØ262
228	**37.8ØØ293**	**5.814661**	**Ø.659991**	**-1.Ø75251**	**1.343308**	**Ø.ØØØ288**
229	38.719727	5.784445	Ø.661162	-1.Ø79234	1.345803	Ø.ØØØ287
23Ø	39.642548	5.751444	Ø.662307	-1.Ø83131	1.348258	Ø.ØØØ277
231	**4Ø.568451**	**5.715693**	**Ø.663438**	**-1.Ø86977**	**1.35Ø678**	**Ø.ØØØ277**
232	41.497131	5.677249	Ø.664523	-1.Ø9Ø669	1.353ØØ6	Ø.ØØØ279
233	42.428284	5.636191	Ø.665539	-1.Ø94128	1.355186	Ø.ØØØ292
234	43.361603	5.592612	Ø.666500	-1.Ø97396	1.357259	Ø.ØØØ290
235	44.296783	5.546580	Ø.667434	-1.1ØØ574	1.359287	Ø.ØØØ277
236	45.233521	5.498161	Ø.668313	-1.1Ø3565	1.361181	Ø.ØØØ292
237	46.171509	5.447458	Ø.669110	-1.1Ø6277	1.362903	Ø.ØØØ3Ø1
238	47.11Ø458	5.394568	Ø.669882	-1.1Ø89Ø2	1.364590	Ø.ØØØ289
239	48.Ø5ØØ49	5.339531	Ø.67Ø652	-1.111524	1.366270	Ø.ØØØ286
24Ø	48.99ØØØ5	5.282402	Ø.671383	-1.114Ø10	1.367853	Ø.ØØØ3Ø1

167

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-4
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

241	49.930008	5.223271	0.672070	-1.116347	1.369360	0.000293
242	50.869781	5.162216	0.672719	-1.118555	1.370779	0.000296
243	51.808990	5.099324	0.673285	-1.120483	1.372018	0.000300
244	52.747375	5.034718	0.673799	-1.122232	1.373121	0.000335
245	53.684616	4.968453	0.674350	-1.124106	1.374393	0.000248
246	54.620422	4.900533	0.674917	-1.126035	1.375566	0.000351
247	55.554504	4.831051	0.675363	-1.127554	1.376635	0.000233
248	56.486572	4.760140	0.675804	-1.129052	1.377439	0.000466
249	57.416321	4.687847	0.676196	-1.130385	1.378608	0.000043
250	58.343460	4.614206	0.676667	-1.131991	1.379128	0.000771
251	59.267700	4.539302	0.676991	-1.133094	1.380708	-0.000434
252	60.188751	4.463216	0.677606	-1.135186	1.380813	0.001323
253	61.106308	4.386030	0.677323	-1.134221	1.381716	-0.000819
254	62.020111	4.307839	0.675286	-1.127292	1.373565	0.004274
255	62.929840	4.228698	0.650653	-1.043476	1.310627	0.017929
256	63.835220	4.148601	0.552235	-0.708605	1.090365	0.055285
257	64.735947	4.067623	0.421976	-0.265395	0.865887	0.057409
258	65.631760	3.985905	0.337689	0.021396	0.750665	0.037535
259	66.522354	3.903537	0.337836	0.020896	0.751790	0.036727
260	67.407440	3.820540	0.339457	0.015378	0.754115	0.036969
261	68.286728	3.736912	0.340692	0.011176	0.755851	0.037184
262	69.159943	3.652738	0.340910	0.010437	0.756222	0.037161
263	70.026794	3.568157	0.340878	0.010544	0.756249	0.037093
264	70.887009	3.483205	0.340841	0.010671	0.756197	0.037083
265	71.740265	3.397891	0.340614	0.011442	0.755823	0.037096
266	72.586319	3.312301	0.340187	0.012896	0.755157	0.037081
267	73.424866	3.226509	0.339645	0.014739	0.754309	0.037067
268	74.255630	3.140560	0.338974	0.017021	0.753233	0.037071
269	75.078339	3.054547	0.338181	0.019721	0.751975	0.037062
270	75.892685	2.968552	0.337340	0.022582	0.750651	0.037044
271	76.698410	2.882581	0.336419	0.025717	0.749172	0.037049
272	77.495209	2.796670	0.335347	0.029364	0.747457	0.037050
273	78.282837	2.710910	0.334181	0.033332	0.745602	0.037042
274	79.060974	2.625375	0.332967	0.037462	0.743662	0.037041
275	79.829376	2.540112	0.331686	0.041819	0.741617	0.037039
276	80.587753	2.455165	0.330319	0.046472	0.739424	0.037042
277	81.335815	2.370600	0.328859	0.051439	0.737086	0.037045
278	82.073288	2.286501	0.327342	0.056601	0.734662	0.037039
279	82.799927	2.202941	0.325791	0.061880	0.732175	0.037041
280	83.515427	2.119970	0.324194	0.067313	0.729618	0.037040
281	84.219528	2.037631	0.322533	0.072962	0.726949	0.037048
282	84.911942	1.955977	0.320794	0.078880	0.724157	0.037047
283	85.592407	1.875083	0.318996	0.084998	0.721270	0.037048
284	86.260666	1.795019	0.317159	0.091250	0.718317	0.037051
285	86.916428	1.715837	0.315281	0.097641	0.715302	0.037047
286	87.559418	1.637572	0.313319	0.104317	0.712128	0.037066
287	88.189407	1.560317	0.311258	0.111327	0.708806	0.037069
288	88.806091	1.484191	0.309213	0.118288	0.705537	0.037047
289	89.409225	1.409214	0.307180	0.125204	0.702244	0.037060
290	89.998535	1.335393	0.305010	0.132588	0.698723	0.037077
291	90.573761	1.262822	0.302737	0.140322	0.695054	0.037074
292	91.134644	1.191594	0.300439	0.148139	0.691341	0.037074
293	91.680923	1.121780	0.298099	0.156102	0.687540	0.037083
294	92.212341	1.053459	0.295714	0.164215	0.683678	0.037082
295	92.728638	0.986685	0.293307	0.172406	0.679770	0.037081
296	93.229553	0.921482	0.290818	0.180875	0.675711	0.037093
297	93.714828	0.857903	0.288199	0.189785	0.671443	0.037094
298	94.184219	0.796038	0.285482	0.199033	0.667000	0.037106
299	94.637466	0.735998	0.282720	0.208429	0.662499	0.037098
300	95.074341	0.677854	0.279952	0.217847	0.657970	0.037096
301	95.494553	0.621635	0.277096	0.227564	0.653275	0.037105
302	95.897858	0.567390	0.274106	0.237740	0.648356	0.037109
303	96.284027	0.515193	0.271003	0.248298	0.643234	0.037116
304	96.652786	0.465119	0.267811	0.259159	0.637978	0.037104
305	97.003891	0.417216	0.264499	0.270426	0.632482	0.037113
306	97.337082	0.371551	0.260992	0.282360	0.626617	0.037145
307	97.652130	0.328249	0.257388	0.294624	0.620670	0.037100
308	97.948761	0.287339	0.253764	0.306953	0.614605	0.037104
309	98.226700	0.248813	0.249797	0.320452	0.607863	0.037166
310	98.485703	0.212798	0.245514	0.335025	0.600706	0.037118
311	98.725494	0.179389	0.241196	0.349718	0.593410	0.037108
312	98.945786	0.148593	0.236555	0.365509	0.585437	0.037156
313	99.146286	0.120481	0.231437	0.382922	0.576707	0.037130
314	99.326721	0.095145	0.226008	0.401395	0.567327	0.037142
315	99.486725	0.072632	0.220069	0.421603	0.557057	0.037100
316	99.625946	0.052983	0.213425	0.444208	0.545258	0.037198
317	99.744003	0.036276	0.205659	0.470632	0.531722	0.037024
318	99.840439	0.022620	0.196846	0.500617	0.515338	0.037363
319	99.914658	0.012110	0.185730	0.538441	0.495956	0.036698
320	99.965897	0.004846	0.172812	0.582397	0.469664	0.037890
321	99.992828	0.001020	0.148697	0.664449	0.422318	0.037591

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-5
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

NACA 0012 M=0.80, ALPHA=1.25
RESULTS AT FAR-FIELD BOUNDARY

I	X/C(%)	Z/C(%)	RHO	U	V	P
2	1858.61133	-17.744659	1.001072	0.950049	0.019267	1.000074
3	1857.91431	-53.227142	0.999761	0.946073	0.019045	0.999842
4	1856.52051	-88.689102	0.999713	0.945180	0.019286	1.000034
5	1854.43018	-124.116882	0.999770	0.945761	0.019142	0.999936
6	1851.64453	-159.496811	0.999938	0.946026	0.019189	1.000031
7	1848.16479	-194.815277	0.999865	0.945917	0.019131	0.999988
8	1843.99170	-230.058624	0.999894	0.945837	0.019174	1.000037
9	1839.12720	-265.213135	0.999873	0.945821	0.019143	1.000022
10	1833.57324	-300.265625	0.999898	0.945804	0.019159	1.000051
11	1827.33203	-335.202393	0.999886	0.945774	0.019144	1.000048
12	1820.40576	-370.010010	0.999899	0.945748	0.019153	1.000067
13	1812.79712	-404.674805	0.999895	0.945721	0.019146	1.000071
14	1804.50928	-439.183838	0.999903	0.945695	0.019150	1.000086
15	1795.54541	-473.523682	0.999903	0.945668	0.019146	1.000093
16	1785.90869	-507.680908	0.999909	0.945641	0.019148	1.000107
17	1775.60303	-541.642334	0.999911	0.945612	0.019147	1.000116
18	1764.63257	-575.395264	0.999917	0.945583	0.019148	1.000130
19	1753.00122	-608.926514	0.999920	0.945553	0.019147	1.000141
20	1740.71387	-642.222900	0.999926	0.945523	0.019148	1.000154
21	1727.77466	-675.271973	0.999931	0.945492	0.019147	1.000168
22	1714.18921	-708.061035	0.999937	0.945461	0.019148	1.000183
23	1699.96240	-740.576904	0.999943	0.945428	0.019148	1.000198
24	1685.09985	-772.807617	0.999950	0.945395	0.019149	1.000215
25	1669.60718	-804.740723	0.999958	0.945361	0.019150	1.000231
26	1653.49072	-836.363770	0.999966	0.945326	0.019151	1.000249
27	1636.75610	-867.664551	0.999975	0.945291	0.019152	1.000267
28	1619.41016	-898.630859	0.999985	0.945254	0.019154	1.000287
29	1601.45972	-929.251221	0.999995	0.945217	0.019155	1.000307
30	1582.91113	-959.513672	1.000006	0.945181	0.019157	1.000328
31	1563.77222	-989.406494	1.000018	0.945142	0.019159	1.000351
32	1544.04980	-1018.91797	1.000031	0.945103	0.019162	1.000374
33	1523.75195	-1048.03735	1.000045	0.945064	0.019165	1.000399
34	1502.88623	-1076.75269	1.000059	0.945024	0.019168	1.000423
35	1481.46045	-1105.05347	1.000074	0.944983	0.019171	1.000450
36	1459.48340	-1132.92871	1.000092	0.944941	0.019175	1.000478
37	1436.96313	-1160.36768	1.000109	0.944898	0.019179	1.000506
38	1413.90845	-1187.35962	1.000127	0.944856	0.019184	1.000537
39	1390.32837	-1213.89429	1.000146	0.944812	0.019189	1.000567
40	1366.23169	-1239.96143	1.000167	0.944767	0.019195	1.000600
41	1341.62793	-1265.55127	1.000188	0.944723	0.019201	1.000633
42	1316.52637	-1290.65356	1.000210	0.944677	0.019208	1.000668
43	1290.93701	-1315.25903	1.000234	0.944631	0.019216	1.000704
44	1264.86914	-1339.35791	1.000257	0.944585	0.019224	1.000740
45	1238.33325	-1362.94116	1.000282	0.944538	0.019233	1.000778
46	1211.33960	-1385.99951	1.000309	0.944490	0.019243	1.000817
47	1183.89819	-1408.52441	1.000336	0.944442	0.019254	1.000856
48	1156.01978	-1430.50684	1.000363	0.944394	0.019266	1.000897
49	1127.71509	-1451.93848	1.000392	0.944345	0.019278	1.000939
50	1098.99512	-1472.81104	1.000422	0.944297	0.019292	1.000982
51	1069.87085	-1493.11670	1.000452	0.944248	0.019307	1.001026
52	1040.35327	-1512.84741	1.000484	0.944198	0.019324	1.001070
53	1010.45386	-1531.99585	1.000515	0.944150	0.019341	1.001115
54	980.184326	-1550.55444	1.000547	0.944101	0.019360	1.001161
55	949.556152	-1568.51587	1.000581	0.944052	0.019380	1.001206
56	918.581055	-1585.87378	1.000614	0.944004	0.019402	1.001252
57	887.270996	-1602.62109	1.000648	0.943957	0.019425	1.001299
58	855.637939	-1618.75122	1.000681	0.943910	0.019450	1.001345
59	823.694092	-1634.25830	1.000715	0.943864	0.019477	1.001391
60	791.451904	-1649.13647	1.000750	0.943820	0.019505	1.001437
61	758.923340	-1663.37964	1.000783	0.943777	0.019535	1.001482
62	726.121338	-1676.98242	1.000817	0.943735	0.019567	1.001528
63	693.058350	-1689.93945	1.000851	0.943695	0.019600	1.001572
64	659.747070	-1702.24609	1.000884	0.943657	0.019636	1.001616
65	626.200195	-1713.89746	1.000916	0.943621	0.019672	1.001657
66	592.430908	-1724.88916	1.000950	0.943586	0.019711	1.001699
67	558.451904	-1735.21655	1.000981	0.943555	0.019751	1.001740
68	524.276367	-1744.87622	1.001013	0.943526	0.019793	1.001780
69	489.917236	-1753.86377	1.001044	0.943499	0.019836	1.001818
70	455.387939	-1762.17651	1.001075	0.943475	0.019880	1.001855
71	420.701904	-1769.81055	1.001105	0.943453	0.019926	1.001890
72	385.872070	-1776.76318	1.001136	0.943434	0.019973	1.001925
73	350.911865	-1783.03198	1.001165	0.943419	0.020021	1.001959
74	315.834961	-1788.61426	1.001195	0.943407	0.020070	1.001992
75	280.654541	-1793.50757	1.001225	0.943398	0.020120	1.002025
76	245.384491	-1797.71045	1.001255	0.943391	0.020170	1.002056
77	210.038055	-1801.22119	1.001286	0.943388	0.020221	1.002087
78	174.628922	-1804.03833	1.001317	0.943389	0.020273	1.002118
79	139.170700	-1806.16089	1.001356	0.943387	0.020325	1.002157
80	103.677017	-1807.58765	1.001395	0.943390	0.020378	1.002195

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-6
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

81	68.161499	-1808.31836	1.001386	0.943453	0.020432	1.002169
82	32.637817	-1808.35278	1.001343	0.943468	0.020470	1.002123
83	-2.880385	-1807.69067	1.001339	0.943498	0.020517	1.002110
84	-38.379456	-1806.33203	1.001322	0.943506	0.020558	1.002090
85	-73.845734	-1804.27783	1.001318	0.943525	0.020602	1.002081
86	-109.265610	-1801.52856	1.001307	0.943536	0.020645	1.002068
87	-144.625443	-1798.08545	1.001303	0.943552	0.020688	1.002059
88	-179.911652	-1793.94946	1.001295	0.943564	0.020731	1.002048
89	-215.110641	-1789.12231	1.001289	0.943580	0.020773	1.002037
90	-250.208893	-1783.60596	1.001283	0.943595	0.020816	1.002026
91	-285.192871	-1777.40210	1.001276	0.943613	0.020858	1.002014
92	-320.049072	-1770.51343	1.001268	0.943630	0.020901	1.002002
93	-354.764160	-1762.94238	1.001261	0.943650	0.020942	1.001988
94	-389.324951	-1754.69189	1.001252	0.943670	0.020984	1.001975
95	-423.717773	-1745.76514	1.001244	0.943692	0.021025	1.001960
96	-457.929687	-1736.16553	1.001234	0.943715	0.021066	1.001945
97	-491.947510	-1725.89648	1.001225	0.943738	0.021106	1.001927
98	-525.757812	-1714.96191	1.001214	0.943763	0.021145	1.001910
99	-559.347900	-1703.36621	1.001203	0.943790	0.021184	1.001891
100	-592.704834	-1691.11377	1.001190	0.943817	0.021223	1.001872
101	-625.815430	-1678.20923	1.001178	0.943846	0.021260	1.001852
102	-658.667480	-1664.65723	1.001165	0.943875	0.021297	1.001831
103	-691.247803	-1650.46313	1.001151	0.943906	0.021333	1.001809
104	-723.543945	-1635.63257	1.001138	0.943936	0.021368	1.001786
105	-755.543701	-1620.17090	1.001122	0.943969	0.021403	1.001762
106	-787.234375	-1604.08423	1.001107	0.944002	0.021436	1.001739
107	-818.604248	-1587.37842	1.001092	0.944035	0.021469	1.001714
108	-849.640625	-1570.06030	1.001076	0.944070	0.021501	1.001688
109	-880.332031	-1552.13599	1.001060	0.944104	0.021532	1.001662
110	-910.666504	-1533.61255	1.001042	0.944140	0.021562	1.001636
111	-940.632080	-1514.49731	1.001025	0.944176	0.021592	1.001609
112	-970.217285	-1494.79712	1.001008	0.944212	0.021620	1.001581
113	-999.410889	-1474.52002	1.000991	0.944248	0.021647	1.001554
114	-1028.20142	-1453.67334	1.000973	0.944285	0.021674	1.001526
115	-1056.57764	-1432.26514	1.000955	0.944322	0.021700	1.001498
116	-1084.52905	-1410.30371	1.000937	0.944359	0.021725	1.001470
117	-1112.04443	-1387.79785	1.000918	0.944397	0.021750	1.001441
118	-1139.11328	-1364.75537	1.000900	0.944434	0.021773	1.001412
119	-1165.72534	-1341.18579	1.000882	0.944471	0.021796	1.001384
120	-1191.86987	-1317.09790	1.000864	0.944508	0.021818	1.001355
121	-1217.53711	-1292.50098	1.000846	0.944545	0.021839	1.001327
122	-1242.71680	-1267.40430	1.000827	0.944583	0.021860	1.001298
123	-1267.39966	-1241.81763	1.000809	0.944620	0.021880	1.001270
124	-1291.57593	-1215.75098	1.000791	0.944657	0.021899	1.001242
125	-1315.23608	-1189.21387	1.000772	0.944694	0.021918	1.001213
126	-1338.37109	-1162.21704	1.000754	0.944731	0.021936	1.001185
127	-1360.97217	-1134.77051	1.000736	0.944768	0.021954	1.001157
128	-1383.03027	-1106.88501	1.000718	0.944805	0.021971	1.001129
129	-1404.53711	-1078.57129	1.000700	0.944841	0.021988	1.001101
130	-1425.48413	-1049.84009	1.000683	0.944877	0.022004	1.001074
131	-1445.86328	-1020.70239	1.000665	0.944914	0.022020	1.001046
132	-1465.66675	-991.169678	1.000648	0.944949	0.022035	1.001019
133	-1484.88672	-961.252930	1.000630	0.944984	0.022050	1.000992
134	-1503.51587	-930.964111	1.000613	0.945020	0.022064	1.000965
135	-1521.54687	-900.314453	1.000596	0.945055	0.022078	1.000937
136	-1538.97290	-869.316162	1.000579	0.945090	0.022092	1.000912
137	-1555.78711	-837.980713	1.000562	0.945126	0.022105	1.000885
138	-1571.98291	-806.320557	1.000546	0.945160	0.022118	1.000858
139	-1587.55420	-774.347656	1.000528	0.945195	0.022131	1.000833
140	-1602.49463	-742.074463	1.000512	0.945229	0.022144	1.000807
141	-1616.79858	-709.513184	1.000495	0.945264	0.022156	1.000781
142	-1630.46045	-676.676514	1.000479	0.945298	0.022167	1.000755
143	-1643.47510	-643.577393	1.000463	0.945332	0.022179	1.000730
144	-1655.83716	-610.228027	1.000446	0.945366	0.022190	1.000704
145	-1667.54175	-576.641357	1.000430	0.945400	0.022201	1.000679
146	-1678.[illegible]472	-542.830811	1.000414	0.945434	0.022212	1.000653
147	-1688.9[illegible]43	-508.808838	1.000399	0.945467	0.022223	1.000628
148	-1698.66748	-474.588623	1.000382	0.945501	0.022233	1.000603
149	-1707.69946	-440.183838	1.000366	0.945535	0.022243	1.000578
150	-1716.05347	-405.606934	1.000351	0.945568	0.022253	1.000553
151	-1723.72607	-370.872070	1.000335	0.945602	0.022263	1.000528
152	-1730.71387	-335.991943	1.000319	0.945635	0.022273	1.000504
153	-1737.01343	-300.980225	1.000303	0.945669	0.022282	1.000479
154	-1742.62231	-265.850586	1.000288	0.945702	0.022291	1.000454
155	-1747.53711	-230.616425	1.000273	0.945735	0.022301	1.000429
156	-1751.75513	-195.291397	1.000257	0.945769	0.022309	1.000404
157	-1755.27344	-159.889282	1.000241	0.945803	0.022318	1.000380
158	-1758.09009	-124.423950	1.000225	0.945837	0.022327	1.000355
159	-1760.20288	-88.909393	1.000210	0.945870	0.022335	1.000330
160	-1761.61133	-53.359665	1.000194	0.945903	0.022344	1.000305

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-7
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

161-1762.31494	-17.788895	1.000177	0.945936	0.022352	1.000280
162-1762.31494	17.788895	1.000161	0.945967	0.022360	1.000255
163-1761.61133	53.359665	1.000144	0.945999	0.022369	1.000230
164-1760.20288	88.909393	1.000128	0.946030	0.022377	1.000204
165-1758.09009	124.423950	1.000111	0.946063	0.022386	1.000178
166-1755.27344	159.889282	1.000093	0.946095	0.022395	1.000153
167-1751.75513	195.291397	1.000075	0.946128	0.022404	1.000126
168-1747.53711	230.616425	1.000058	0.946161	0.022413	1.000099
169-1742.62231	265.850586	1.000040	0.946195	0.022422	1.000072
170-1737.01343	300.980225	1.000022	0.946229	0.022431	1.000045
171-1730.71387	335.991943	1.000004	0.946264	0.022441	1.000016
172-1723.72607	370.872070	0.999985	0.946298	0.022450	0.999988
173-1716.05347	405.606934	0.999966	0.946334	0.022460	0.999959
174-1707.69946	440.183838	0.999946	0.946371	0.022470	0.999930
175-1698.66748	474.588623	0.999926	0.946408	0.022479	0.999900
176-1688.96143	508.808838	0.999906	0.946447	0.022489	0.999869
177-1678.58472	542.830811	0.999885	0.946485	0.022499	0.999837
178-1667.54175	576.641357	0.999863	0.946524	0.022509	0.999805
179-1655.83716	610.228027	0.999841	0.946565	0.022519	0.999772
180-1643.47510	643.577393	0.999819	0.946606	0.022529	0.999739
181-1630.46045	676.676514	0.999796	0.946648	0.022539	0.999704
182-1616.79858	709.513184	0.999772	0.946691	0.022550	0.999668
183-1602.49463	742.074463	0.999747	0.946736	0.022560	0.999632
184-1587.55420	774.347656	0.999722	0.946781	0.022570	0.999595
185-1571.98291	806.320557	0.999696	0.946827	0.022580	0.999556
186-1555.78711	837.980713	0.999670	0.946874	0.022590	0.999516
187-1538.97290	869.316162	0.999642	0.946923	0.022600	0.999476
188-1521.54687	900.314453	0.999614	0.946974	0.022610	0.999434
189-1503.51587	930.964111	0.999585	0.947025	0.022620	0.999391
190-1484.88672	961.252930	0.999554	0.947078	0.022630	0.999346
191-1465.66675	991.169678	0.999523	0.947132	0.022640	0.999300
192-1445.86328	1020.70239	0.999491	0.947189	0.022649	0.999252
193-1425.48413	1049.84009	0.999457	0.947246	0.022658	0.999204
194-1404.53711	1078.57129	0.999423	0.947305	0.022667	0.999153
195-1383.03027	1106.88501	0.999387	0.947366	0.022676	0.999101
196-1360.97217	1134.77051	0.999350	0.947429	0.022685	0.999047
197-1338.37109	1162.21704	0.999312	0.947494	0.022693	0.998991
198-1315.23608	1189.21387	0.999273	0.947562	0.022700	0.998933
199-1291.57593	1215.75098	0.999232	0.947631	0.022707	0.998873
200-1267.39966	1241.81763	0.999189	0.947701	0.022714	0.998812
201-1242.71680	1267.40430	0.999145	0.947775	0.022719	0.998748
202-1217.53711	1292.50098	0.999100	0.947851	0.022725	0.998682
203-1191.86987	1317.09790	0.999053	0.947929	0.022729	0.998614
204-1165.72534	1341.18579	0.999005	0.948009	0.022732	0.998544
205-1139.11328	1364.75537	0.998955	0.948092	0.022734	0.998471
206-1112.04443	1387.79785	0.998903	0.948177	0.022736	0.998397
207-1084.52905	1410.30371	0.998850	0.948265	0.022735	0.998320
208-1056.57764	1432.26514	0.998795	0.948355	0.022734	0.998240
209-1028.20142	1453.67334	0.998738	0.948448	0.022731	0.998159
210 -999.410889	1474.52002	0.998680	0.948543	0.022726	0.998075
211 -970.217285	1494.79712	0.998621	0.948641	0.022719	0.997989
212 -940.632080	1514.49731	0.998560	0.948740	0.022710	0.997901
213 -910.666504	1533.61255	0.998497	0.948843	0.022699	0.997811
214 -880.332031	1552.13599	0.998433	0.948947	0.022685	0.997719
215 -849.640625	1570.06030	0.998368	0.949052	0.022669	0.997626
216 -818.604248	1587.37842	0.998302	0.949161	0.022650	0.997531
217 -787.234375	1604.08423	0.998235	0.949270	0.022629	0.997434
218 -755.543701	1620.17090	0.998168	0.949380	0.022603	0.997337
219 -723.543945	1635.63257	0.998100	0.949492	0.022575	0.997239
220 -691.247803	1650.46313	0.998032	0.949604	0.022543	0.997141
221 -658.667480	1664.65723	0.997964	0.949716	0.022507	0.997043
222 -625.815430	1678.20923	0.997896	0.949827	0.022467	0.996946
223 -592.704834	1691.11377	0.997830	0.949937	0.022423	0.996849
224 -559.347900	1703.36621	0.997764	0.950046	0.022375	0.996755
225 -525.757812	1714.96191	0.997701	0.950153	0.022323	0.996663
226 -491.947510	1725.89648	0.997639	0.950257	0.022267	0.996573
227 -457.929687	1736.16553	0.997580	0.950358	0.022206	0.996488
228 -423.717773	1745.76514	0.997524	0.950454	0.022141	0.996406
229 -389.324951	1754.69189	0.997472	0.950547	0.022072	0.996329
230 -354.764160	1762.94238	0.997422	0.950632	0.021999	0.996257
231 -320.049072	1770.51343	0.997378	0.950715	0.021923	0.996191
232 -285.192871	1777.40210	0.997336	0.950788	0.021843	0.996129
233 -250.208893	1783.60596	0.997301	0.950859	0.021760	0.996076
234 -215.110641	1789.12231	0.997265	0.950919	0.021674	0.996024
235 -179.911652	1793.94946	0.997239	0.950981	0.021587	0.995982
236 -144.625443	1798.08545	0.997204	0.951029	0.021498	0.995934
237 -109.265610	1801.52856	0.997185	0.951092	0.021407	0.995899
238 -73.845734	1804.27783	0.997134	0.951136	0.021316	0.995837
239 -38.379456	1806.33203	0.997106	0.951232	0.021223	0.995783
240 -2.880385	1807.69067	0.996980	0.951315	0.021135	0.995635

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-8
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

241	32.637817	1808.35278	0.996899	0.951524	0.021035	0.995498
242	68.161499	1808.31836	0.997051	0.951456	0.020934	0.995669
243	103.677017	1807.58765	0.997213	0.951364	0.020838	0.995856
244	139.170700	1806.16089	0.997347	0.951293	0.020744	0.996010
245	174.628922	1804.03833	0.997480	0.951212	0.020654	0.996165
246	210.038055	1801.22119	0.997616	0.951120	0.020567	0.996327
247	245.384491	1797.71045	0.997752	0.951021	0.020484	0.996489
248	280.654541	1793.50757	0.997885	0.950917	0.020405	0.996651
249	315.834961	1788.61426	0.998017	0.950808	0.020330	0.996813
250	350.911865	1783.03198	0.998147	0.950696	0.020259	0.996973
251	385.872070	1776.76318	0.998273	0.950581	0.020191	0.997131
252	420.701904	1769.81055	0.998397	0.950465	0.020128	0.997287
253	455.387939	1762.17651	0.998517	0.950347	0.020068	0.997439
254	489.917236	1753.86377	0.998634	0.950230	0.020011	0.997587
255	524.276367	1744.87622	0.998746	0.950114	0.019958	0.997731
256	558.451904	1735.21655	0.998854	0.949999	0.019908	0.997871
257	592.430908	1724.88916	0.998957	0.949884	0.019861	0.998005
258	626.200195	1713.89746	0.999056	0.949772	0.019816	0.998134
259	659.747070	1702.24609	0.999150	0.949663	0.019774	0.998258
260	693.058350	1689.93945	0.999239	0.949555	0.019733	0.998376
261	726.121338	1676.98242	0.999323	0.949451	0.019695	0.998489
262	758.923340	1663.37964	0.999402	0.949349	0.019659	0.998596
263	791.451904	1649.13647	0.999476	0.949250	0.019624	0.998697
264	823.694092	1634.25830	0.999546	0.949154	0.019590	0.998793
265	855.637939	1618.75122	0.999611	0.949059	0.019558	0.998884
266	887.270996	1602.62109	0.999672	0.948969	0.019527	0.998969
267	918.581055	1585.87378	0.999728	0.948881	0.019497	0.999049
268	949.556152	1568.51587	0.999780	0.948795	0.019468	0.999125
269	980.184326	1550.55444	0.999828	0.948712	0.019440	0.999195
270	1010.45386	1531.99585	0.999872	0.948632	0.019412	0.999261
271	1040.35327	1512.84741	0.999913	0.948553	0.019385	0.999323
272	1069.87085	1493.11670	0.999949	0.948477	0.019359	0.999380
273	1098.99512	1472.81104	0.999983	0.948403	0.019333	0.999434
274	1127.71509	1451.93848	1.000012	0.948331	0.019308	0.999483
275	1156.01978	1430.50684	1.000039	0.948261	0.019284	0.999530
276	1183.89819	1408.52441	1.000063	0.948193	0.019260	0.999572
277	1211.33960	1385.99951	1.000085	0.948125	0.019236	0.999612
278	1238.33325	1362.94116	1.000103	0.948060	0.019213	0.999649
279	1264.86914	1339.35791	1.000119	0.947996	0.019191	0.999682
280	1290.93701	1315.25903	1.000134	0.947933	0.019169	0.999713
281	1316.52637	1290.65356	1.000145	0.947871	0.019147	0.999742
282	1341.62793	1265.55127	1.000155	0.947810	0.019126	0.999768
283	1366.23169	1239.96143	1.000163	0.947751	0.019106	0.999793
284	1390.32837	1213.89429	1.000169	0.947692	0.019086	0.999815
285	1413.90845	1187.35962	1.000174	0.947634	0.019067	0.999835
286	1436.96313	1160.36768	1.000176	0.947577	0.019048	0.999853
287	1459.48340	1132.92871	1.000178	0.947520	0.019030	0.999870
288	1481.46045	1105.05347	1.000178	0.947465	0.019013	0.999885
289	1502.88623	1076.75269	1.000176	0.947410	0.018996	0.999899
290	1523.75195	1048.03735	1.000175	0.947356	0.018980	0.999911
291	1544.04980	1018.91797	1.000171	0.947302	0.018965	0.999922
292	1563.77222	989.406494	1.000167	0.947249	0.018950	0.999932
293	1582.91113	959.513672	1.000161	0.947197	0.018936	0.999941
294	1601.45972	929.251221	1.000155	0.947144	0.018923	0.999949
295	1619.41016	898.630859	1.000148	0.947094	0.018911	0.999956
296	1636.75610	867.664551	1.000140	0.947043	0.018899	0.999962
297	1653.49072	836.363770	1.000133	0.946992	0.018888	0.999968
298	1669.60718	804.740723	1.000124	0.946943	0.018877	0.999973
299	1685.09985	772.807617	1.000114	0.946894	0.018868	0.999976
300	1699.96240	740.576904	1.000105	0.946846	0.018859	0.999980
301	1714.18921	708.061035	1.000094	0.946799	0.018851	0.999983
302	1727.77466	675.271973	1.000085	0.946752	0.018843	0.999985
303	1740.71387	642.222900	1.000073	0.946706	0.018837	0.999987
304	1753.00122	608.926514	1.000064	0.946661	0.018830	0.999988
305	1764.63257	575.395264	1.000051	0.946618	0.018826	0.999988
306	1775.60303	541.642334	1.000042	0.946575	0.018819	0.999990
307	1785.90869	507.680908	1.000029	0.946534	0.018817	0.999988
308	1795.54541	473.523682	1.000020	0.946495	0.018810	0.999990
309	1804.50928	439.183838	1.000005	0.946457	0.018810	0.999985
310	1812.79712	404.674805	0.999999	0.946423	0.018801	0.999988
311	1820.40576	370.010010	0.999982	0.946397	0.018805	0.999977
312	1827.33203	335.202393	0.999984	0.946383	0.018792	0.999984
313	1833.57324	300.265625	0.999958	0.946362	0.018800	0.999963
314	1839.12720	265.213135	0.999969	0.946353	0.018772	0.999976
315	1843.99170	230.058624	0.999958	0.946461	0.018810	0.999936
316	1848.16479	194.815277	1.000015	0.946561	0.018759	0.999968
317	1851.64453	159.496811	0.999702	0.945700	0.018722	0.999887
318	1854.43018	124.116882	0.998995	0.942841	0.018463	0.999952
319	1856.52051	88.689102	0.997779	0.938888	0.018582	0.999793
320	1857.91431	53.227142	0.997388	0.936707	0.018654	0.999984
321	1858.61133	17.744659	0.997387	0.937568	0.019286	0.999749
322	1593.30371	266.995117	1.001072	0.950049	0.019267	1.000074

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-9
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

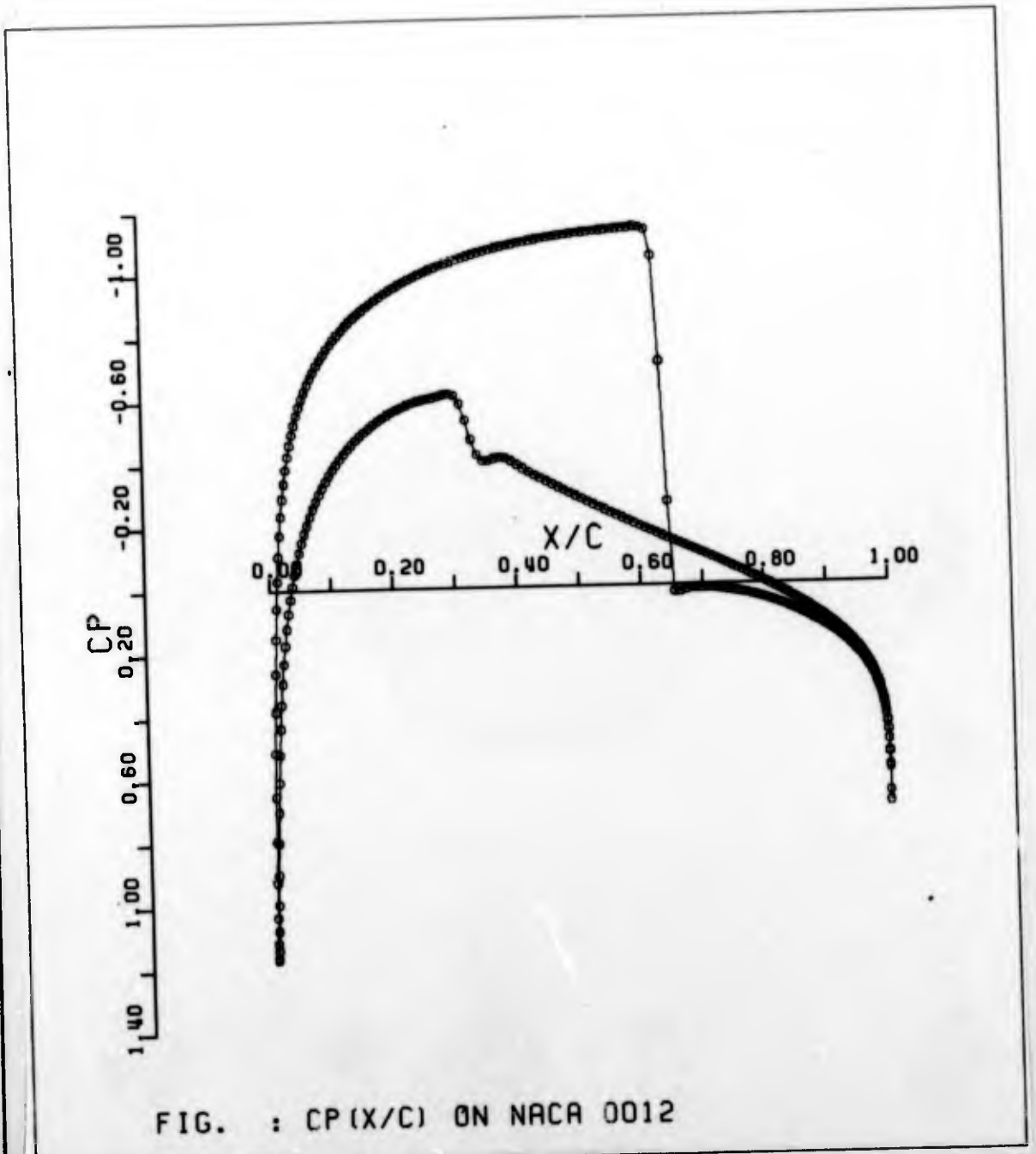


FIG. : CP(X/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-10
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

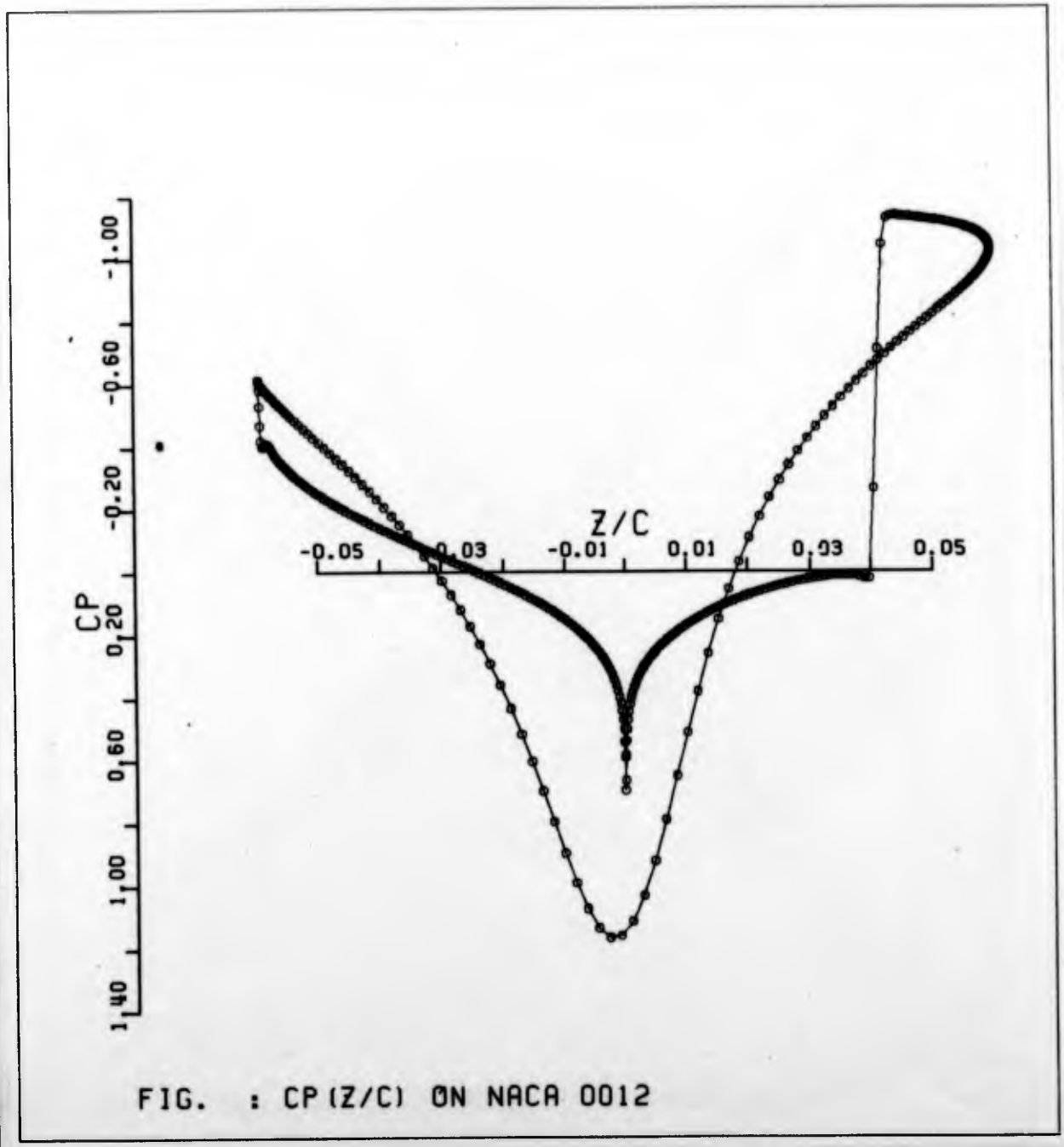


FIG. : CP(Z/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-11
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

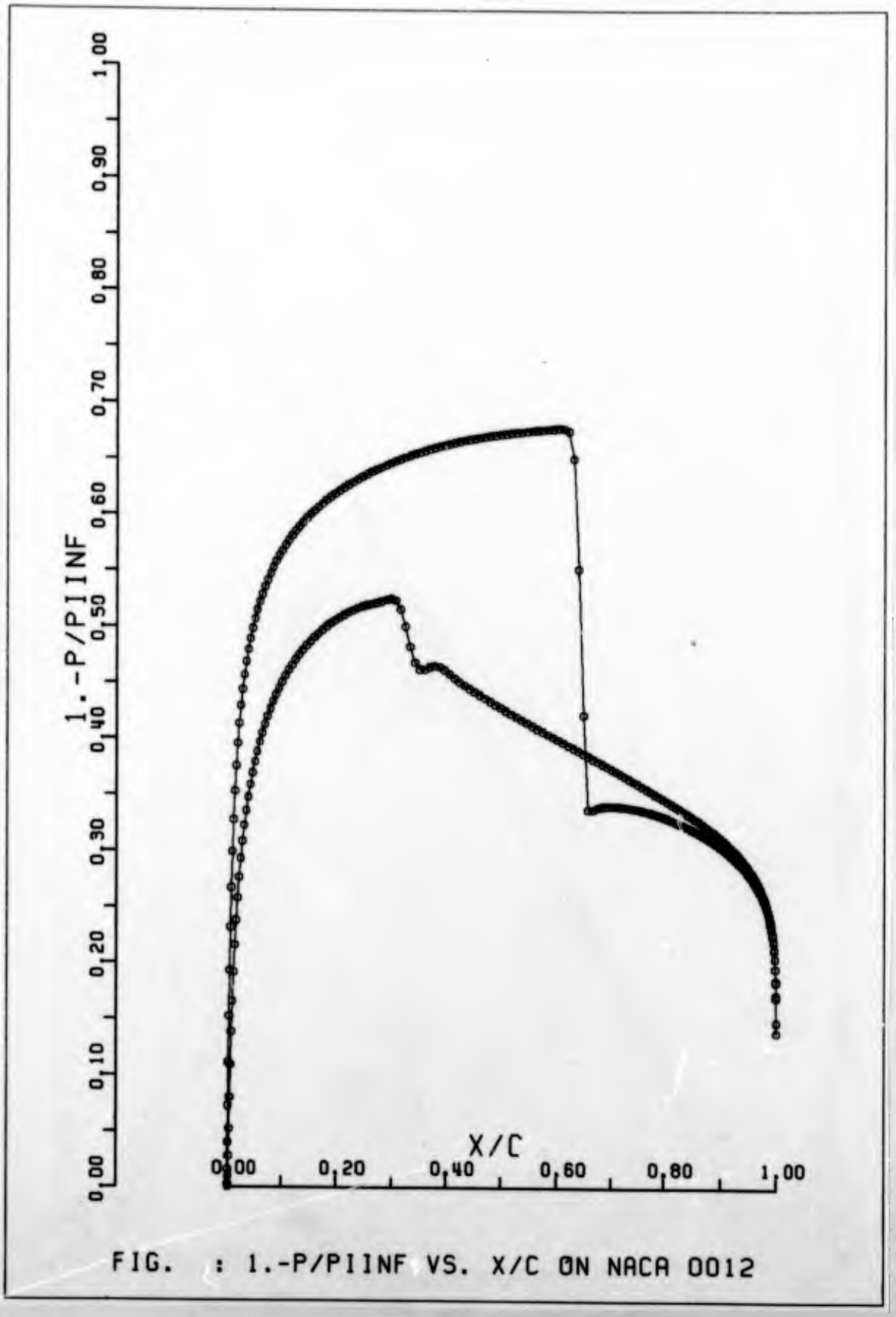


FIG. : 1.-P/PIINF VS. X/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-12
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

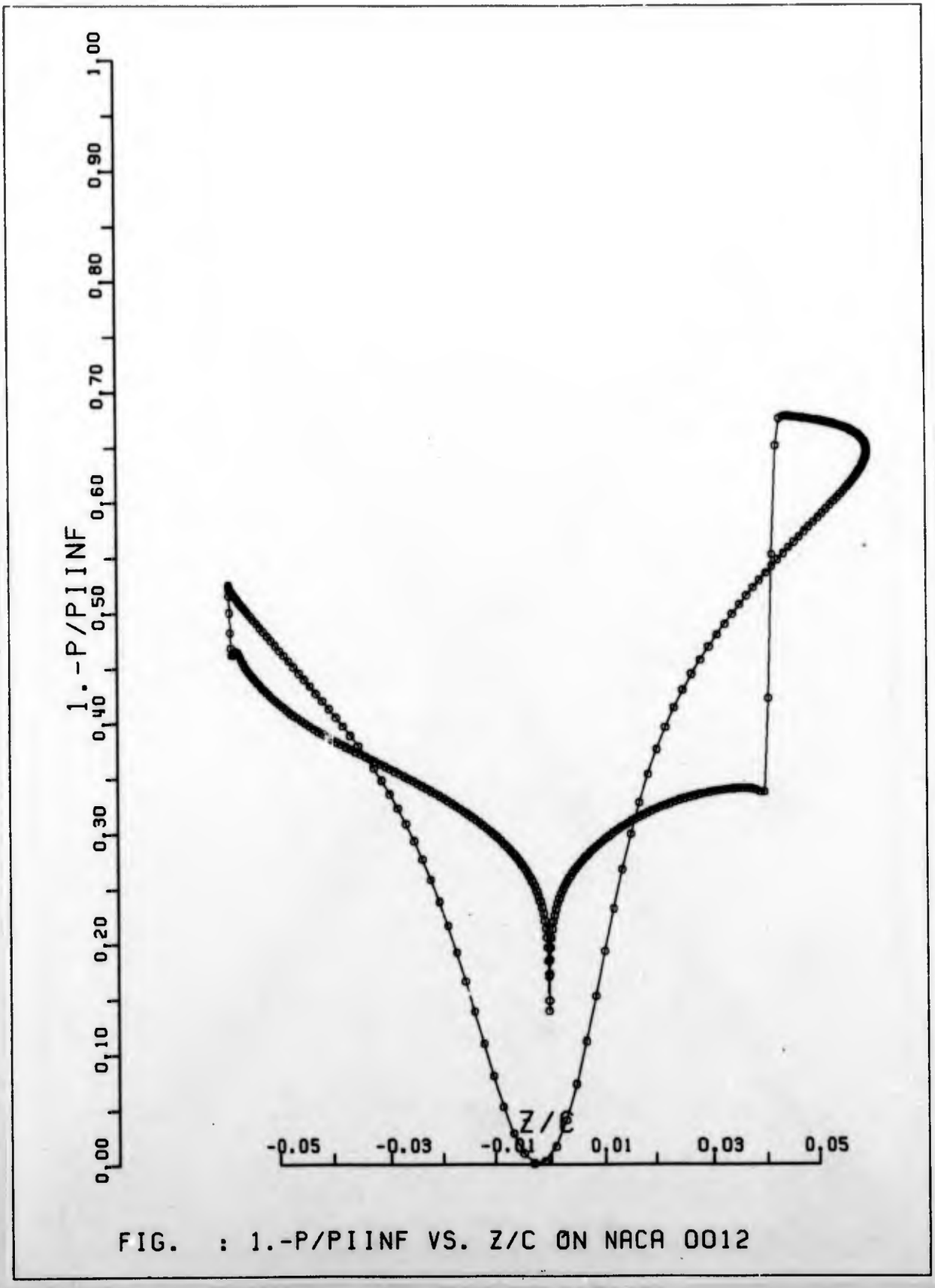


FIG. : 1.-P/PIINF VS. Z/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-13
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

3

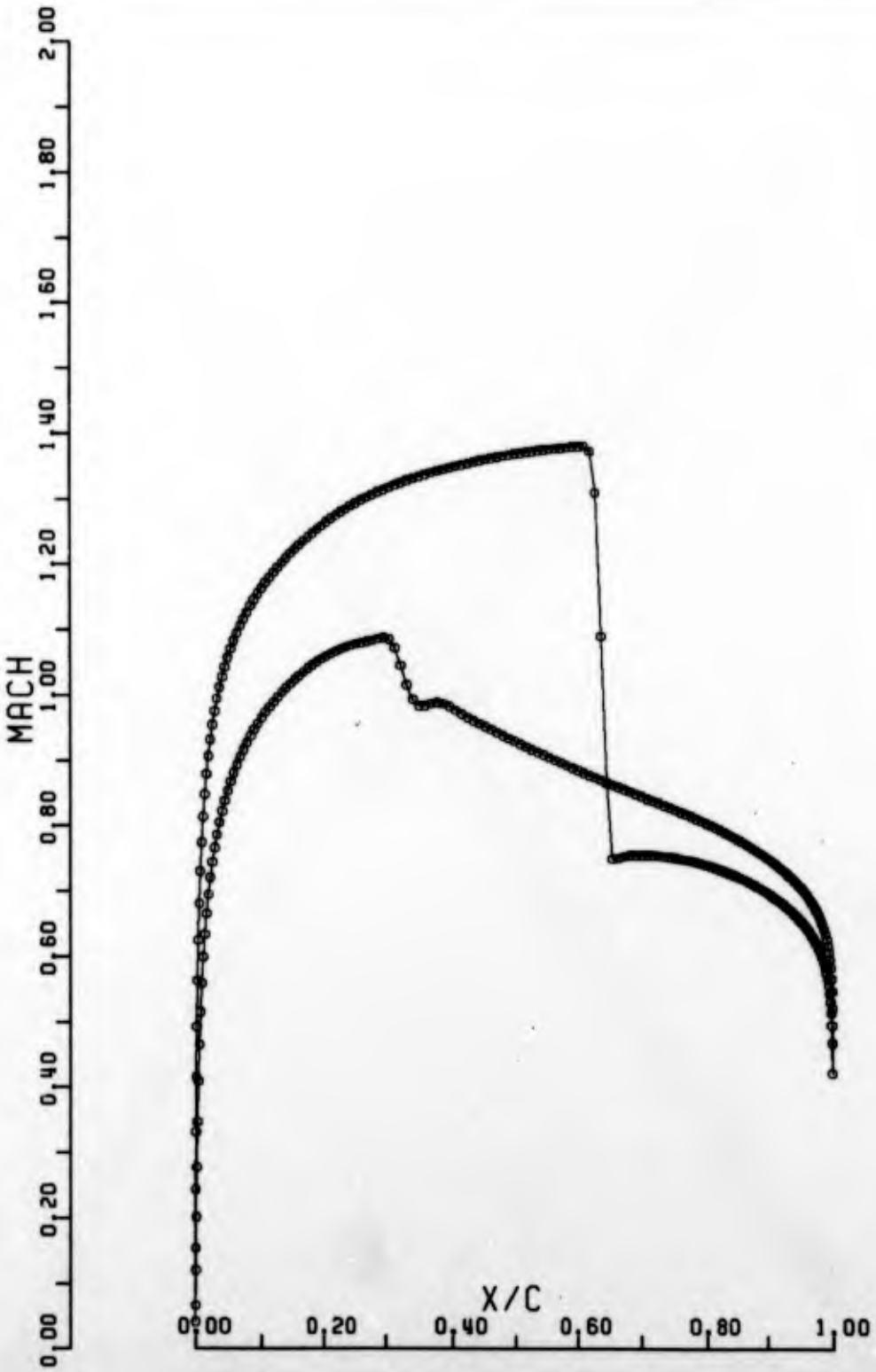


FIG. : MACH(X/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-14
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

14

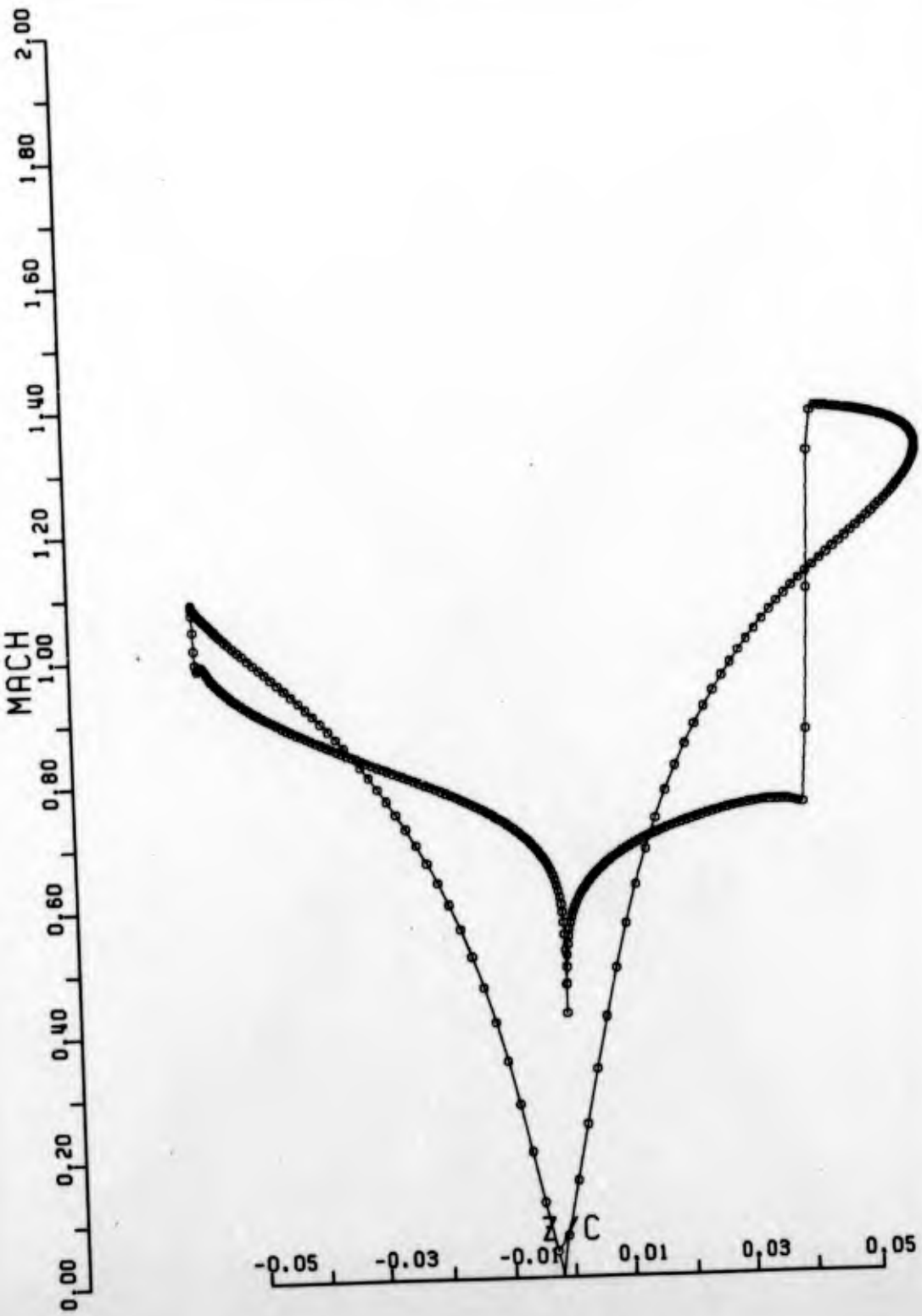


FIG. : MACH (Z/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-15
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

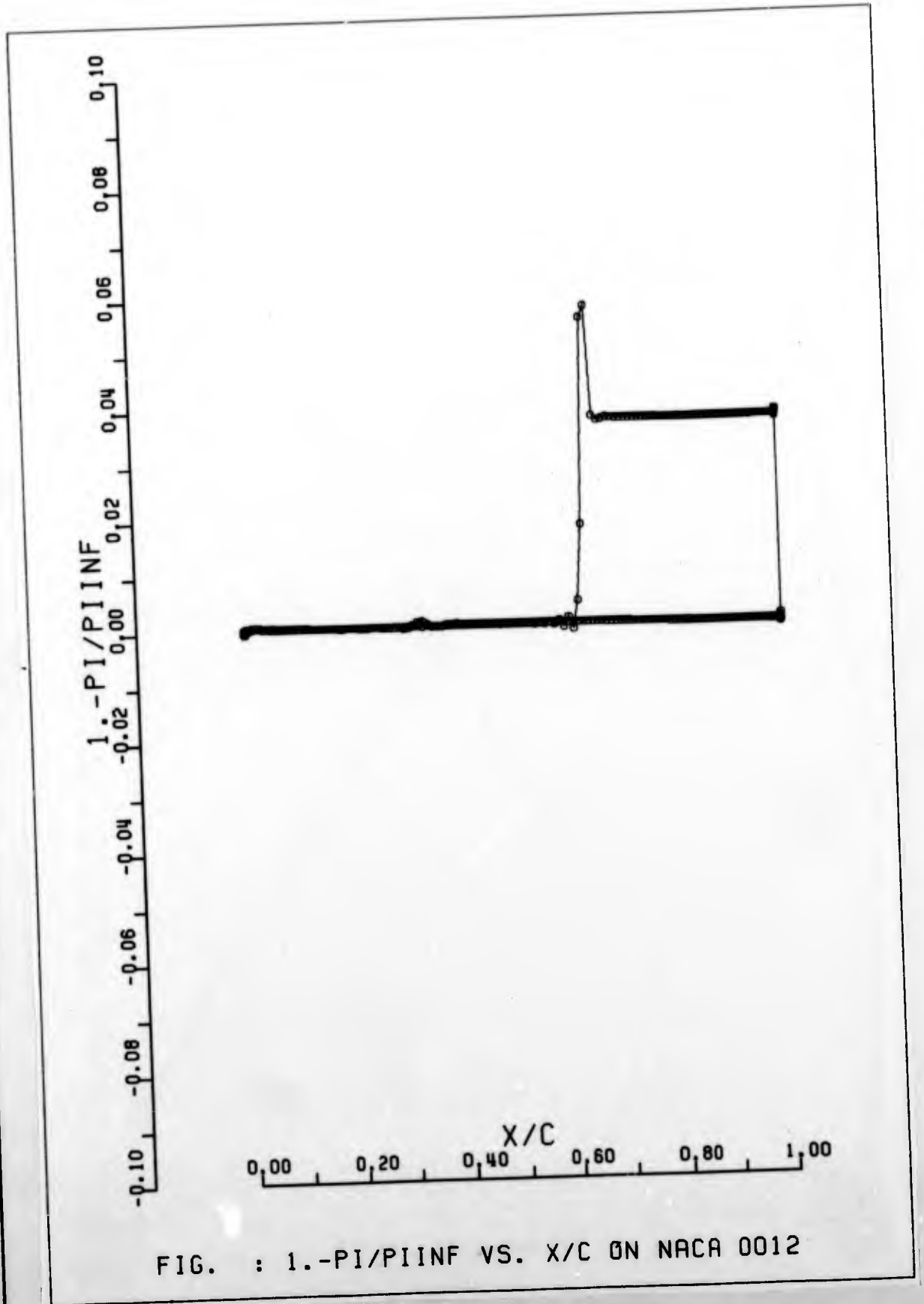


FIG. : 1.-PI/PIINF VS. X/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-16
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

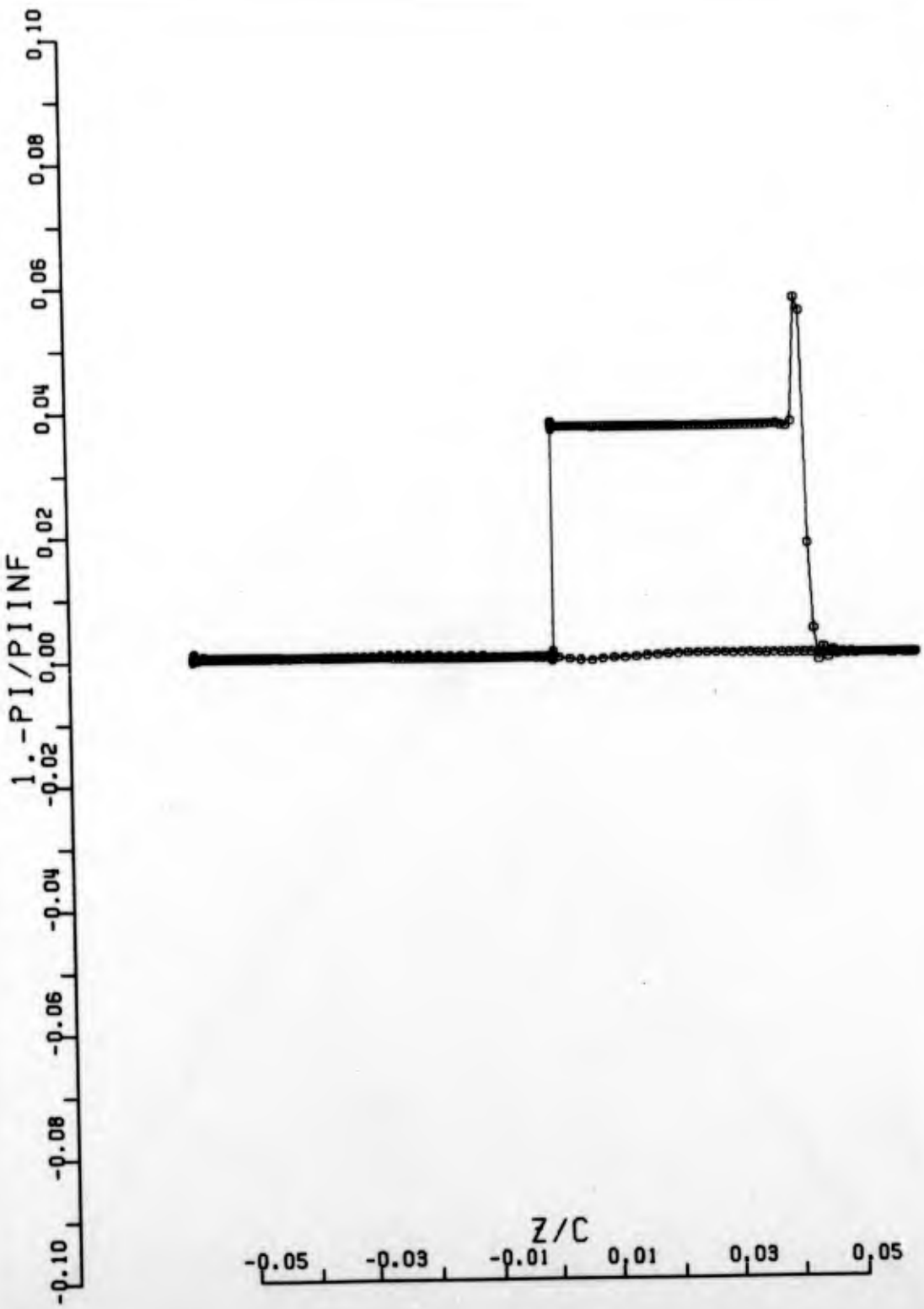
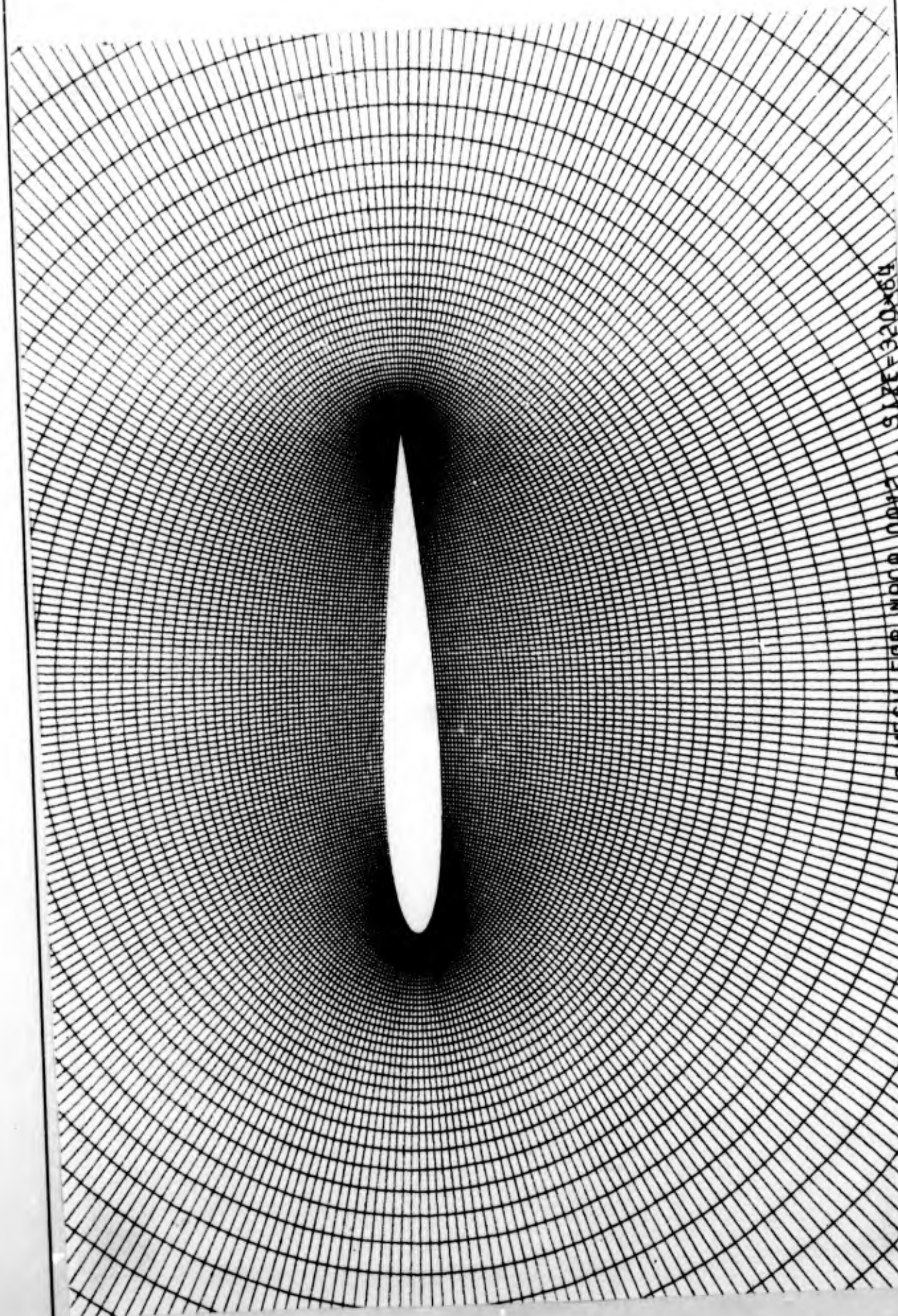
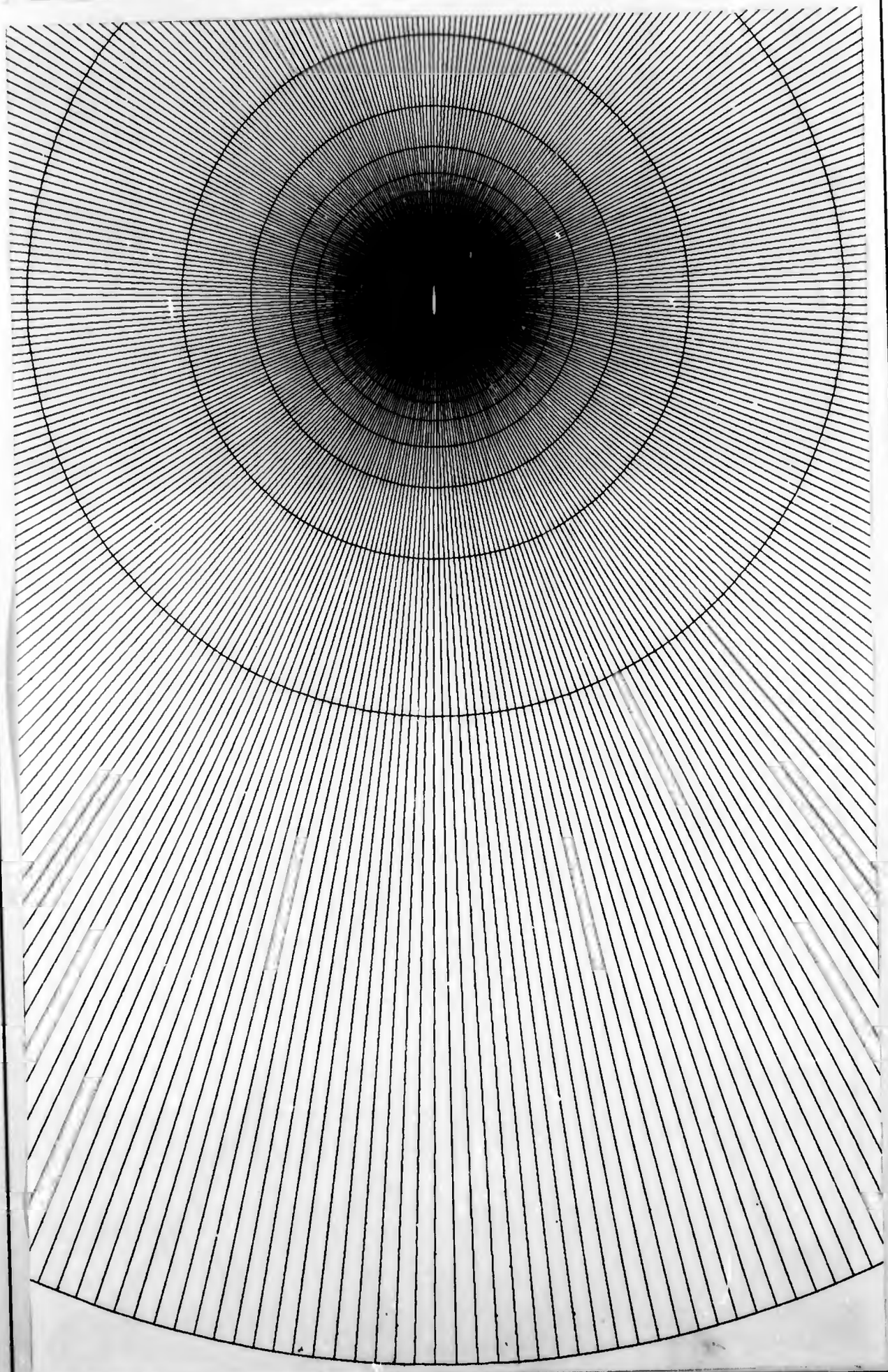


FIG. : 1.-PI/PIINF VS. Z/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-17
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-18
	NACA 0012: MACH = 0.80, ALPHA = 1.25			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-19
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

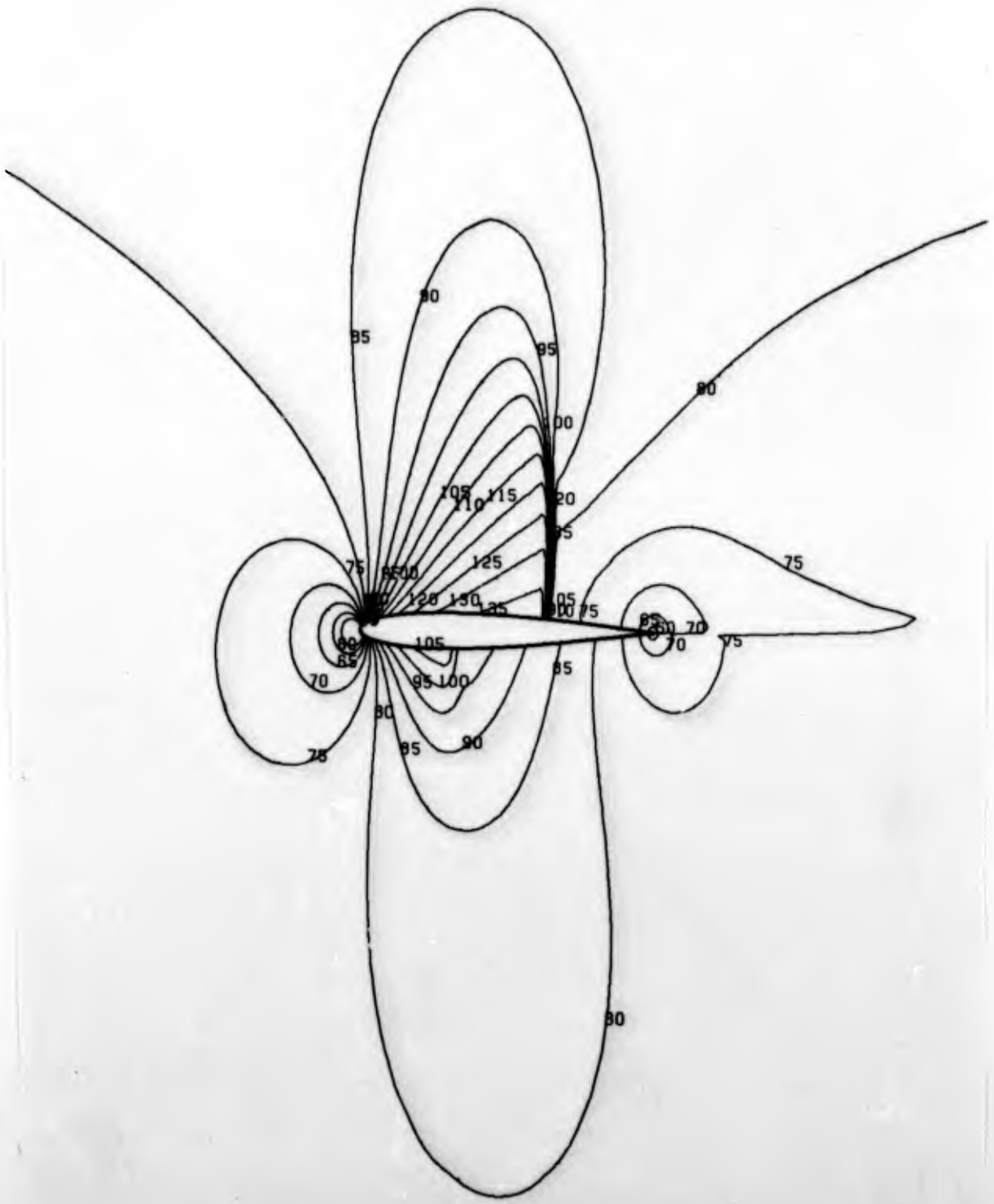


FIG. : ISO-MACH (DELTA = 0.050)

××× VALUES OF CURVE PARAMETER = 100×MACH ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-20
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

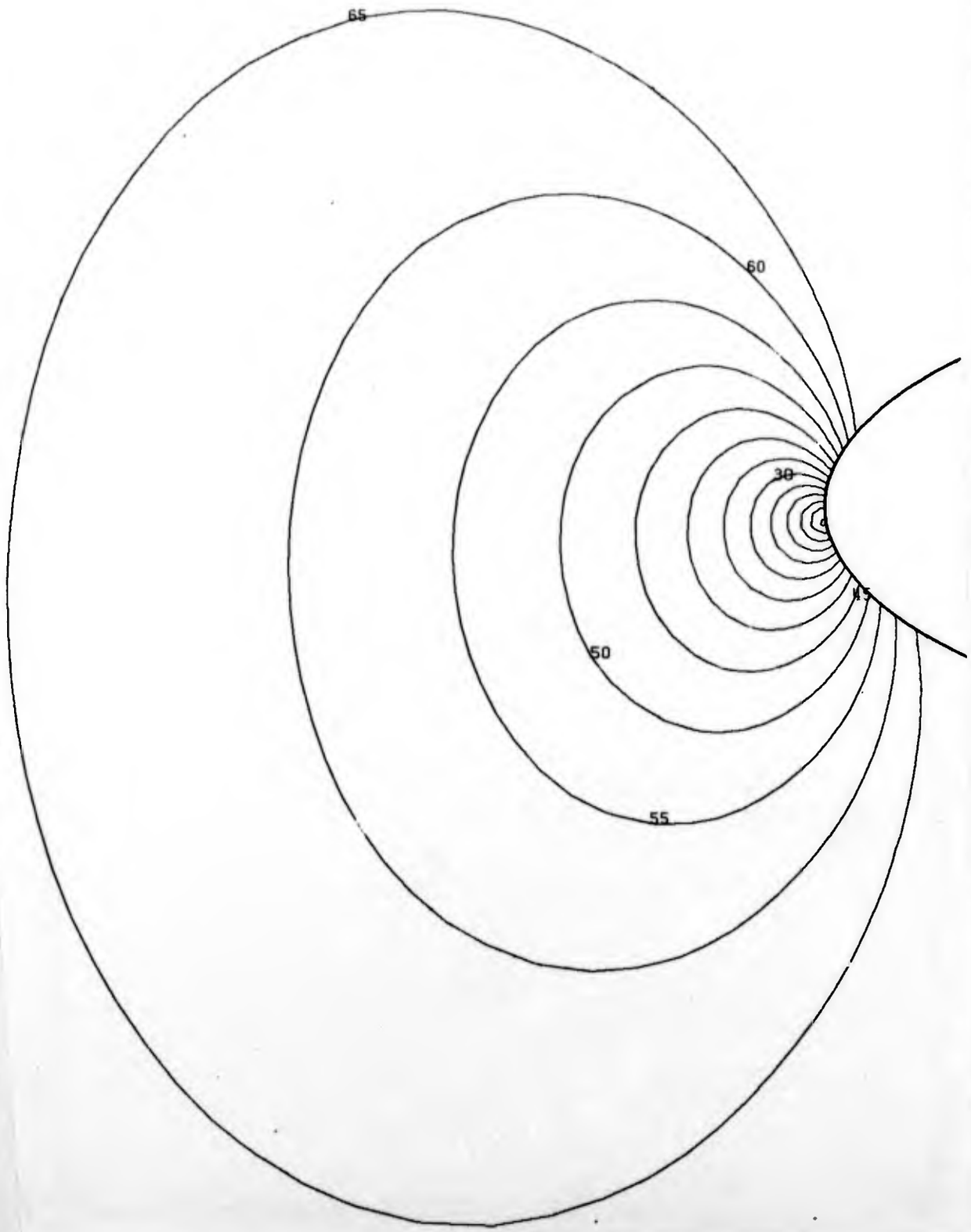


FIG. : ISO-MACH (DELTA = 0.050)

××× VALUES OF CURVE PARAMETER = 100×MACH ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-21
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

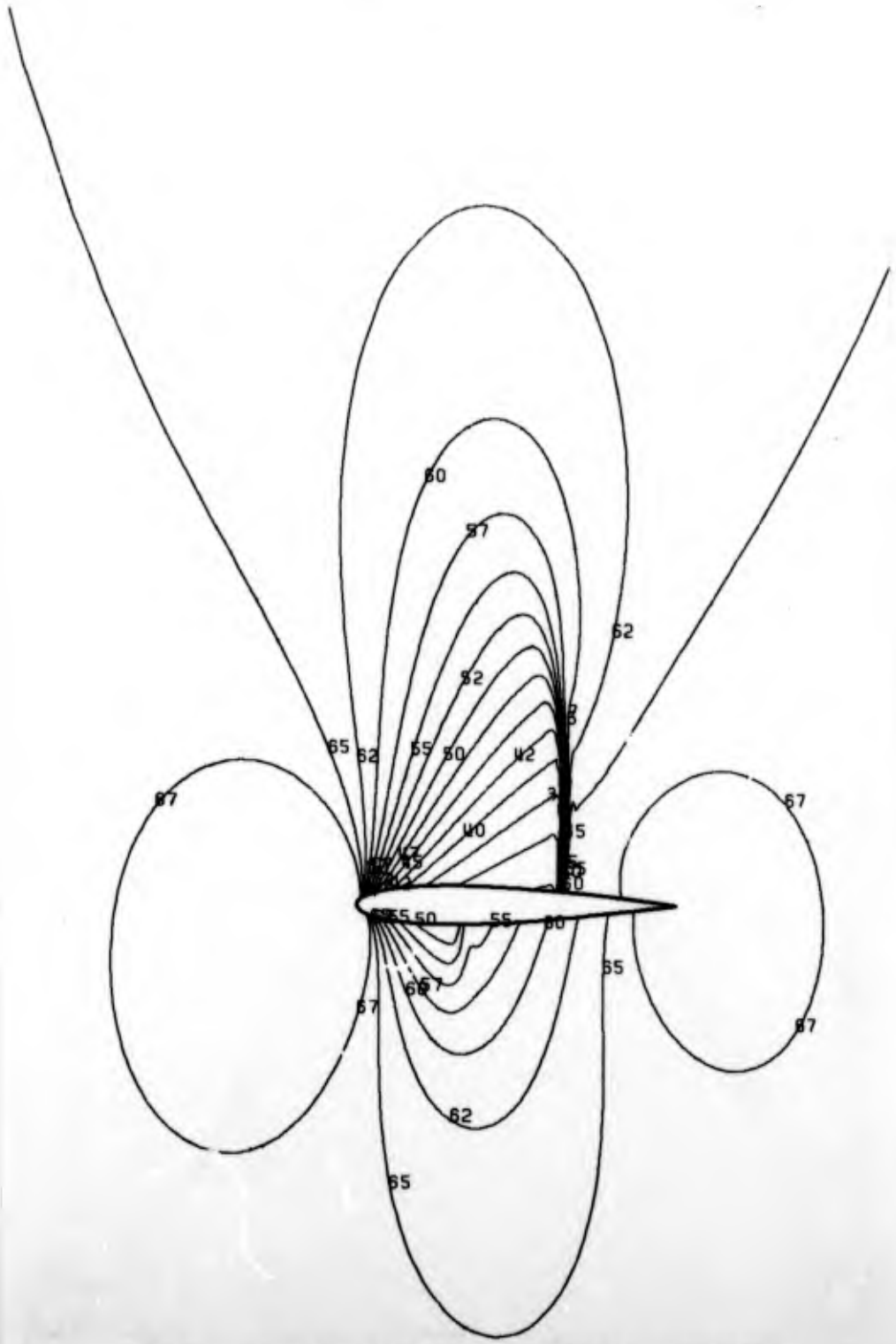


FIG. : ISO-P/PIINF (DELTA = 0.025)

××× VALUES OF CURVE PARAMETER = 100×P/PIINF ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-22
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

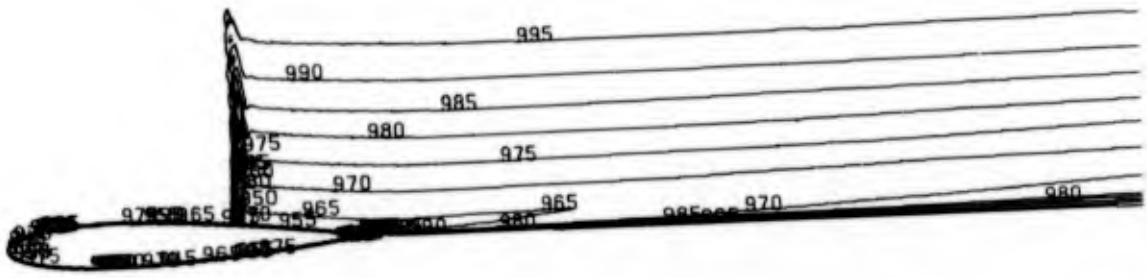


FIG. : ISO-PI/PIINF (DELTA = 0.005)

**** VALUES OF CURVE PARAMETER = 1000*PI/PIINF ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-23
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

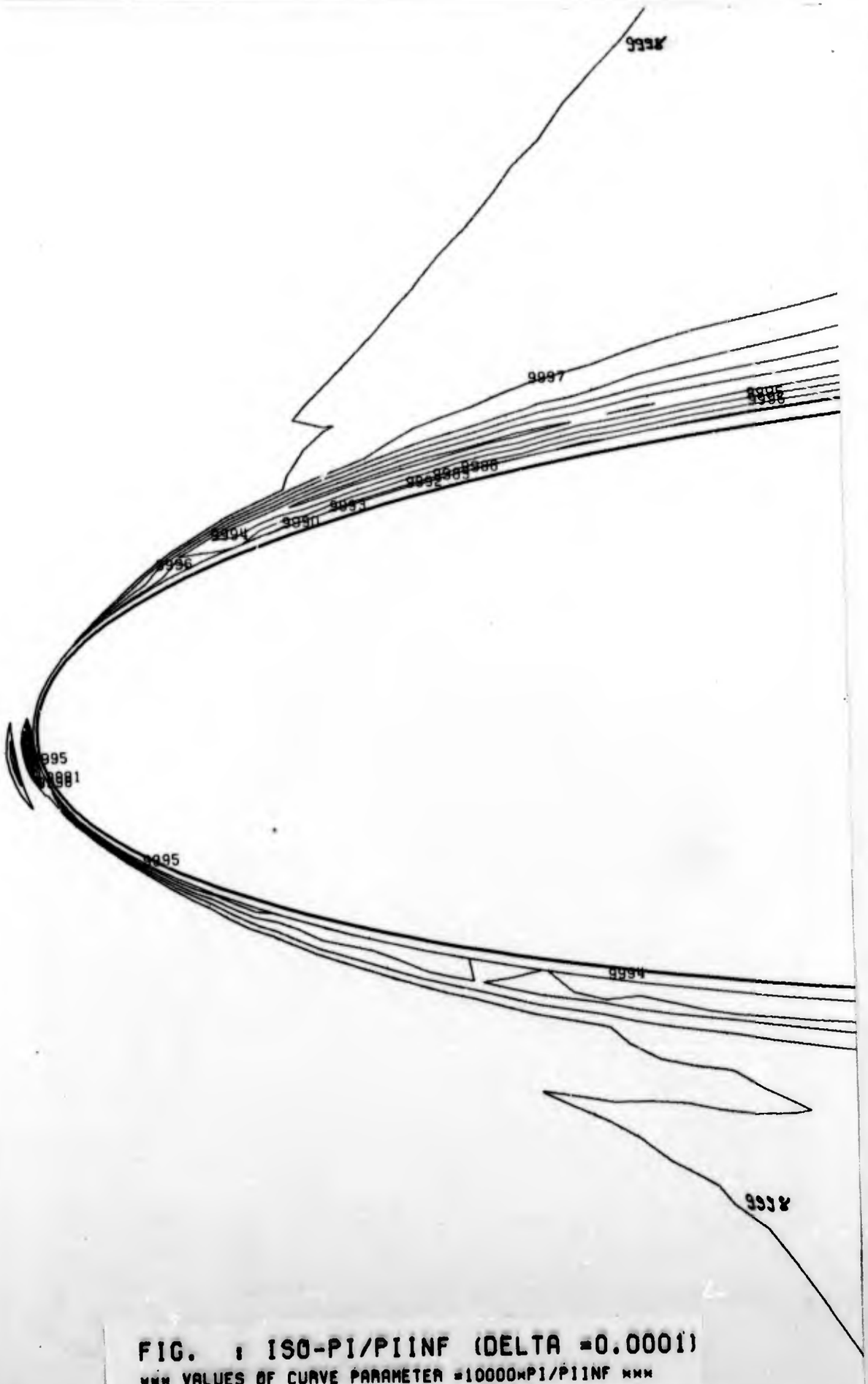


FIG. : ISO-PI/PIINF (DELTA =0.0001)

*** VALUES OF CURVE PARAMETER =10000*PI/PIINF ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-24
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

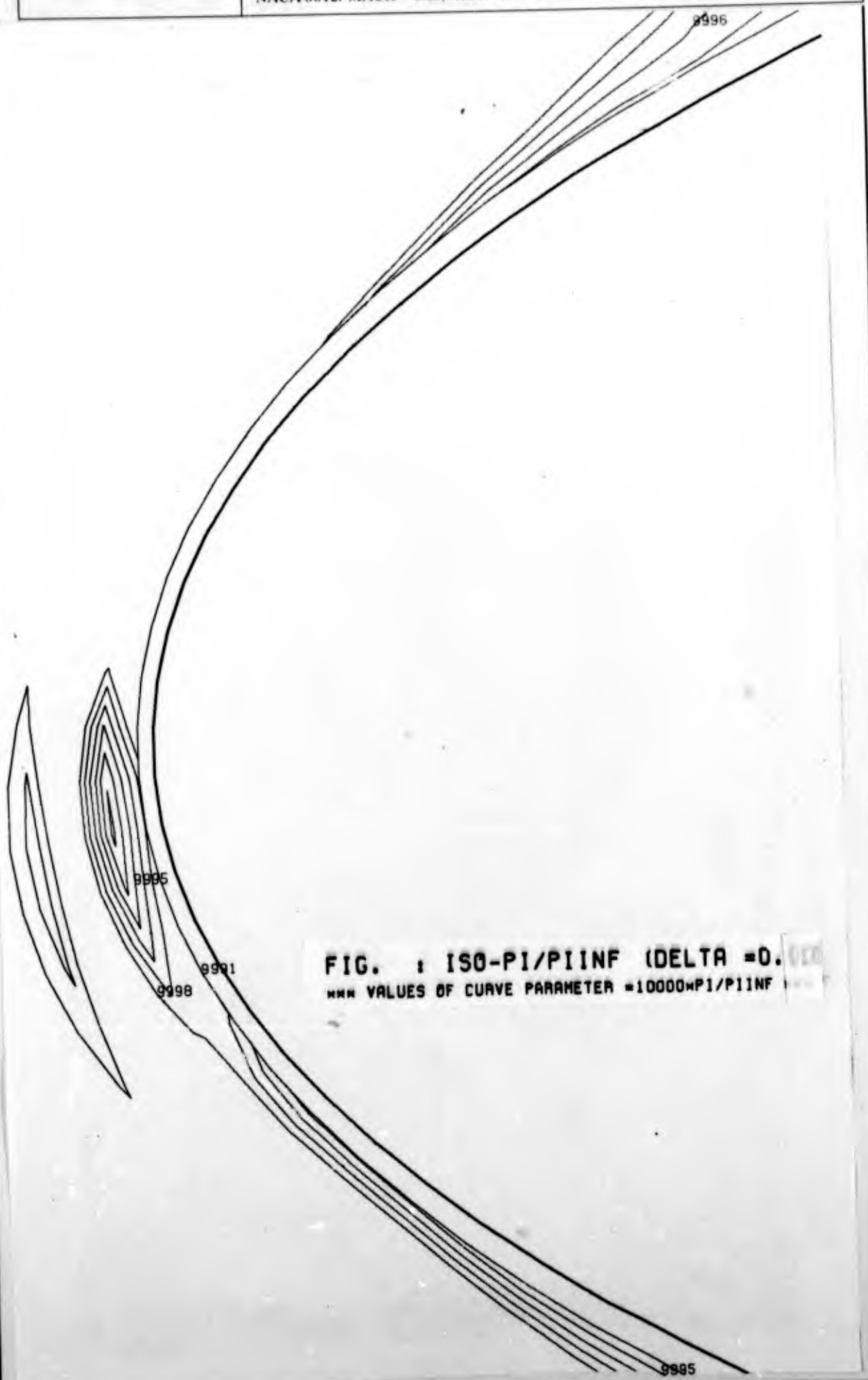


FIG. : ISO-PI/PIINF (DELTA =0.

*** VALUES OF CURVE PARAMETER =10000*PI/PIINF

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	01-9-25
	NACA 0012: MACH = 0.80, ALPHA = 1.25			

MESH	C_L	C_D	C_M	$(\Delta S/\Delta t)_{local}$ n=1	$(\Delta S/\Delta t)_{local}$ n = CYCLE	CYCLE
80 x 16	0.3150	0.0223	- 0.0307	0.22	$0.30 \cdot 10^{-5}$	200
160 x 32	0.3656	0.0235	- 0.0400	0.19	$0.33 \cdot 10^{-4}$	750
320 x 64	0.3632	0.0230	- 0.0397	0.33	$0.27 \cdot 10^{-3}$	750

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 02

NACA 0012: MACH = 0.85, ALPHA = 1

Contributor No 1

J.P.Veuillot and A.M.Vuillot

(O.N.E.R.A., France)

COMMENTS ON CALCULATION FOR TEST CASE 02

* The computational domain is inscribed in the rectangle

  $-9.91 \leq x/c \leq 10.52$, $-13.87 \leq z/c \leq 13.87$

* Number of mesh points : 193 x 29 = 5 597 (147 mesh points on the profile)

* Artificial viscosity ;

  D_1 term : $Q_{1i} = Q_{1j} = 0.1\ 10^{-2}$

  D_2 term : $Q_{2i} = 1.6$, $Q_{2j}' = 0.8$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-2
	NACA 0012: MACH = 0.85, ALPHA = 1			

WALL VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	.008750	1.166160	.077313	.004596
2	.000125	.001971	.025109	1.114284	.172851	.004567
3	.000513	.003978	.055856	1.016778	.270875	.006468
4	.001199	.006050	.095464	.891176	.367684	.006932
5	.002235	.008213	.141974	.743684	.462386	.006550
6	.003686	.010485	.191362	.587065	.552217	.005187
7	.005631	.012876	.240726	.430523	.635474	.003544
8	.008159	.015389	.287203	.283138	.710251	.002136
9	.011365	.018020	.329338	.149522	.775950	.001527
10	.015341	.020757	.367044	.029949	.833895	.001591
11	.020177	.023581	.400258	-.075378	.884801	.002133
12	.025946	.026465	.429323	-.167547	.929767	.002770
13	.032704	.029378	.454758	-.248206	.969687	.003398
14	.040482	.032285	.477106	-.319076	1.005386	.003949
15	.049286	.035150	.496869	-.381747	1.037593	.004369
16	.059097	.037938	.514459	-.437528	1.066794	.004738
17	.069878	.040617	.530130	-.487226	1.093330	.005012
18	.081572	.043161	.544248	-.531994	1.117685	.005227
19	.094113	.045546	.557020	-.572497	1.140111	.005406
20	.107430	.047757	.568583	-.609165	1.160775	.005539
21	.121447	.049781	.579148	-.642670	1.179961	.005657
22	.136091	.051611	.588867	-.673489	1.197901	.005741
23	.151293	.053242	.597849	-.701973	1.214720	.005829
24	.166989	.054673	.606083	-.728083	1.230360	.005907
25	.183118	.055907	.613657	-.752103	1.244945	.005976
26	.199629	.056947	.620613	-.774161	1.258509	.006047
27	.216473	.057800	.627060	-.794606	1.271252	.006091
28	.233610	.058470	.633077	-.813687	1.283269	.006154
29	.251004	.058964	.638559	-.831071	1.294338	.006214
30	.268623	.059292	.643627	-.847143	1.304685	.006263
31	.286440	.059459	.648342	-.862093	1.314400	.006319
32	.304432	.059474	.652677	-.875841	1.323420	.006367
33	.322578	.059344	.656707	-.888622	1.331878	.006414
34	.340862	.059076	.660417	-.900387	1.339726	.006464
35	.359268	.058678	.663819	-.911173	1.346976	.006511
36	.377784	.058157	.666970	-.921166	1.353742	.006556
37	.396398	.057519	.669901	-.930461	1.360078	.006598
38	.415100	.056770	.672613	-.939063	1.365977	.006642
39	.433879	.055916	.675086	-.946905	1.371385	.006687
40	.452725	.054964	.677374	-.954160	1.376418	.006725
41	.471630	.053918	.679520	-.960966	1.381163	.006763
42	.490588	.052783	.681468	-.967144	1.385488	.006802
43	.509595	.051565	.683243	-.972770	1.389438	.006847
44	.528646	.050268	.684942	-.978160	1.393255	.006868
45	.547738	.048894	.686499	-.983098	1.396739	.006923
46	.566866	.047449	.687950	-.987697	1.400035	.006923
47	.586027	.045935	.689269	-.991882	1.402970	.007025
48	.605217	.044356	.690591	-.996074	1.406059	.006932
49	.624424	.042714	.691738	-.999712	1.408518	.007175
50	.643637	.041014	.692890	-1.003362	1.411398	.006851
51	.662842	.039258	.694048	-1.007037	1.413635	.007466
52	.682022	.037451	.694791	-1.009391	1.416021	.006527
53	.701156	.035596	.696107	-1.013567	1.417851	.008247
54	.720218	.033696	.697542	-1.018115	1.423436	.005085
55	.739174	.031758	.695697	-1.012266	1.414675	.011363
56	.757981	.029787	.705889	-1.044586	1.450256	-.005111
57	.776587	.027790	.674194	-.944074	1.338459	.048435
58	.794931	.025776	.584820	-.660656	1.102990	.110239
59	.812940	.023754	.453073	-.242864	.875765	.098741
60	.830534	.021737	.346700	.094465	.740595	.059568
61	.847626	.019737	.327303	.155975	.717121	.052388
62	.864124	.017768	.337573	.123408	.727251	.058160
63	.879937	.015844	.324894	.163614	.710309	.054851
64	.894980	.013982	.324405	.165163	.707509	.056552
65	.909179	.012192	.317136	.188215	.696570	.055688
66	.922481	.010489	.312847	.201816	.688890	.056193
67	.934854	.008880	.306469	.222044	.678593	.055979
68	.946300	.007371	.300544	.240830	.668470	.056212
69	.956854	.005960	.293536	.263054	.656839	.056164
70	.966589	.004643	.286115	.286590	.643844	.056596
71	.975614	.003407	.277148	.315025	.628466	.056774
72	.984074	.002237	.267404	.345925	.609206	.058761
73	.992138	.001110	.248355	.406332	.573039	.060928
74	1.000000	0.000000	.216707	.506693	.534523	.048536

SLIP LINE VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
75	1.007858	.000092	.235697	.446472	.565984	.050144
76	1.015929	.000181	.267337	.346137	.608762	.059006
77	1.024629	.000273	.271826	.331900	.620122	.056237
78	1.034941	.000378	.283620	.294500	.638907	.057169
79	1.048516	.000508	.290045	.274125	.650968	.056185
80	1.067378	.000679	.299668	.243609	.666535	.056597
81	1.093842	.000904	.307777	.217894	.680400	.056277
82	1.130801	.001201	.316848	.189128	.695216	.056426
83	1.182032	.001594	.325536	.161577	.709460	.056474
84	1.252417	.002122	.334081	.134481	.723247	.056671
85	1.348216	.002854	.342193	.108757	.736117	.057025
86	1.477385	.003903	.349642	.085132	.747670	.057572
87	1.649975	.005439	.356208	.064313	.757546	.058324
88	1.878609	.007691	.361682	.046952	.765591	.059128
89	2.179039	.010940	.366061	.033068	.771972	.059825
90	2.570797	.015555	.369508	.022136	.776898	.060468
91	3.077953	.021998	.372064	.014029	.780496	.060999
92	3.730060	.030832	.373826	.008443	.782957	.061383
93	4.563334	.042746	.374957	.004856	.784525	.061641
94	5.622126	.058542	.375634	.002710	.785467	.061793
95	6.959964	.079136	.376031	.001448	.786088	.061820
96	8.605685	.105070	.376323	.000524	.786559	.061825
97	10.515943	.135425	.376488	.000000	.786966	.061700

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-4
	NACA 0012: MACH = 0.85, ALPHA = 1			

WALL VALUES - LOWER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	.008750	1.166160	.077313	.004596
2	.000125	-.001971	.003482	1.182865	.017364	.003272
3	.000513	-.003978	.014783	1.147028	.113936	.005801
4	.001199	-.006050	.037725	1.074275	.210267	.007613
5	.002235	-.008213	.070128	.971520	.304406	.008402
6	.003686	-.010485	.108744	.849061	.394140	.008004
7	.005631	-.012876	.150491	.716675	.477706	.006869
8	.008159	-.015389	.192409	.583745	.553533	.005521
9	.011365	-.018020	.232533	.456506	.621258	.004398
10	.015341	-.020757	.269761	.338449	.681073	.003864
11	.020177	-.023581	.303767	.230610	.734056	.003850
12	.025946	-.026465	.334394	.133489	.781122	.004059
13	.032704	-.029378	.361846	.046431	.823119	.004395
14	.040482	-.032285	.386422	-.031501	.860815	.004751
15	.049286	-.035150	.408460	-.101387	.894874	.005060
16	.059097	-.037938	.428270	-.164210	.925770	.005346
17	.069878	-.040617	.446061	-.220626	.953817	.005594
18	.081572	-.043160	.462082	-.271434	.979394	.005781
19	.094113	-.045546	.476676	-.317714	1.002986	.005925
20	.107430	-.047757	.489988	-.359927	1.024747	.006069
21	.121447	-.049781	.502120	-.398398	1.044842	.006167
22	.136091	-.051611	.513279	-.433787	1.063534	.006265
23	.151294	-.053241	.523448	-.466035	1.080756	.006361
24	.166989	-.054673	.532752	-.495540	1.096713	.006416
25	.183118	-.055907	.541338	-.522766	1.111570	.006498
26	.199629	-.056947	.549149	-.547538	1.125244	.006550
27	.216473	-.057800	.556382	-.570475	1.138024	.006603
28	.233611	-.058469	.563019	-.591522	1.149857	.006657
29	.251004	-.058964	.569046	-.610634	1.160697	.006706
30	.268623	-.059291	.574576	-.628171	1.170729	.006748
31	.286440	-.059459	.579675	-.644339	1.180048	.006789
32	.304432	-.059473	.584305	-.659022	1.188567	.006836
33	.322578	-.059344	.588534	-.672432	1.196412	.006863
34	.340862	-.059076	.592430	-.684788	1.203671	.006908
35	.359268	-.058678	.595937	-.695909	1.210260	.006929
36	.377784	-.058156	.599095	-.705925	1.216197	.006986
37	.396398	-.057518	.601937	-.714937	1.221612	.006976
38	.415100	-.056769	.604490	-.723034	1.226412	.007080
39	.433879	-.055916	.606818	-.730414	1.230963	.006970
40	.452725	-.054963	.608822	-.736769	1.234619	.007239
41	.471630	-.053918	.610565	-.742297	1.238274	.006861
42	.490588	-.052783	.612314	-.747843	1.241146	.007546
43	.509595	-.051565	.613396	-.751274	1.244096	.006428
44	.528646	-.050267	.613897	-.752864	1.243299	.008766
45	.547738	-.048894	.620734	-.774546	1.261489	.002393
46	.566866	-.047448	.603283	-.719204	1.216016	.017591
47	.586027	-.045934	.544981	-.534318	1.087484	.043380
48	.605217	-.044355	.459911	-.264547	.943355	.041807
49	.624424	-.042714	.387610	-.035268	.845740	.022170
50	.643637	-.041013	.369840	.021084	.824528	.015458
51	.662842	-.039258	.384992	-.026968	.844280	.019474
52	.682022	-.037451	.380269	-.011991	.838074	.018249
53	.701156	-.035595	.380791	-.013644	.838451	.018695
54	.720218	-.033696	.378290	-.005715	.834665	.018557
55	.739174	-.031757	.375906	.001845	.830845	.018640
56	.757981	-.029786	.372684	.012065	.825786	.018647
57	.776587	-.027789	.369073	.023516	.820097	.018679
58	.794931	-.025775	.365022	.036362	.813731	.018702
59	.812940	-.023754	.360620	.050322	.806819	.018723
60	.830534	-.021737	.355872	.065378	.799360	.018753
61	.847626	-.019736	.350764	.081577	.791346	.018775
62	.864124	-.017767	.345391	.098616	.782920	.018795
63	.879937	-.015844	.339770	.116439	.774094	.018824
64	.894980	-.013981	.333849	.135217	.764795	.018851
65	.909179	-.012192	.327628	.154945	.755018	.018880
66	.922481	-.010488	.321091	.175675	.744731	.018912
67	.934854	-.008880	.314270	.197306	.733991	.018935
68	.946300	-.007370	.307038	.220238	.722494	.019040
69	.956854	-.005969	.299175	.245172	.710089	.019040
70	.966589	-.004642	.290744	.271909	.696323	.019406
71	.975614	-.003407	.280879	.303192	.680413	.019595
72	.984074	-.002236	.269979	.337759	.660833	.021379
73	.992138	-.001109	.249361	.403143	.624672	.023533
74	1.000000	.000001	.216233	.508195	.585092	.011788

SLIP LINE VALUES - LOWER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
75	1.007858	.000093	.235697	.446472	.614898	.013559
76	1.015929	.000182	.267337	.346137	.656193	.021696
77	1.024629	.000274	.271826	.331900	.666542	.019086
78	1.034941	.000379	.283620	.294500	.684435	.019893
79	1.048516	.000509	.290045	.274125	.695713	.018972
80	1.067378	.000680	.299668	.243609	.710513	.019354
81	1.093842	.000905	.307777	.217894	.723655	.019043
82	1.130801	.001202	.316848	.189128	.737783	.019174
83	1.182032	.001595	.325536	.161577	.751399	.019196
84	1.252417	.002123	.334081	.134481	.764634	.019345
85	1.348216	.002855	.342193	.108757	.777047	.019622
86	1.477385	.003904	.349642	.085132	.788253	.020065
87	1.649975	.005440	.356208	.064313	.797886	.020697
88	1.878609	.007692	.361682	.046952	.805771	.021380
89	2.179039	.010942	.366061	.033068	.812046	.021965
90	2.570797	.015557	.369508	.022136	.816912	.022507
91	3.077953	.022000	.372064	.014029	.820491	.022943
92	3.730060	.030835	.373826	.008443	.822975	.023228
93	4.563334	.042749	.374957	.004856	.824605	.023377
94	5.622126	.058546	.375634	.002710	.825632	.023416
95	6.959964	.079141	.376031	.001448	.826341	.023333
96	8.605685	.105076	.376323	.000524	.826927	.023206
97	10.515943	.135432	.376488	.000000	.827135	.023259

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-6
	NACA 0012: MACH = 0.85, ALPHA = 1			

UPPER SURFACE

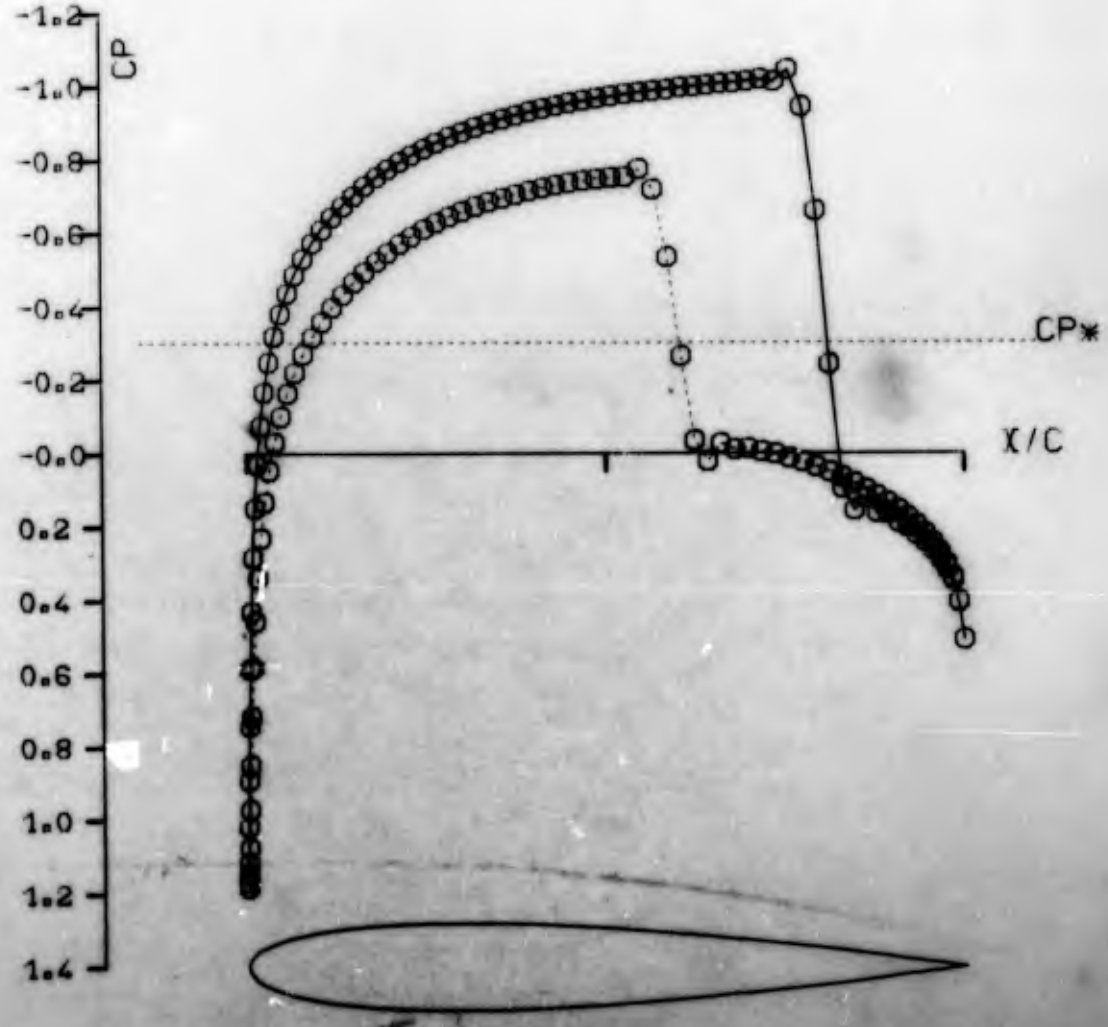
LOWER SURFACE

CL= 0.3405

CD= 0.0464

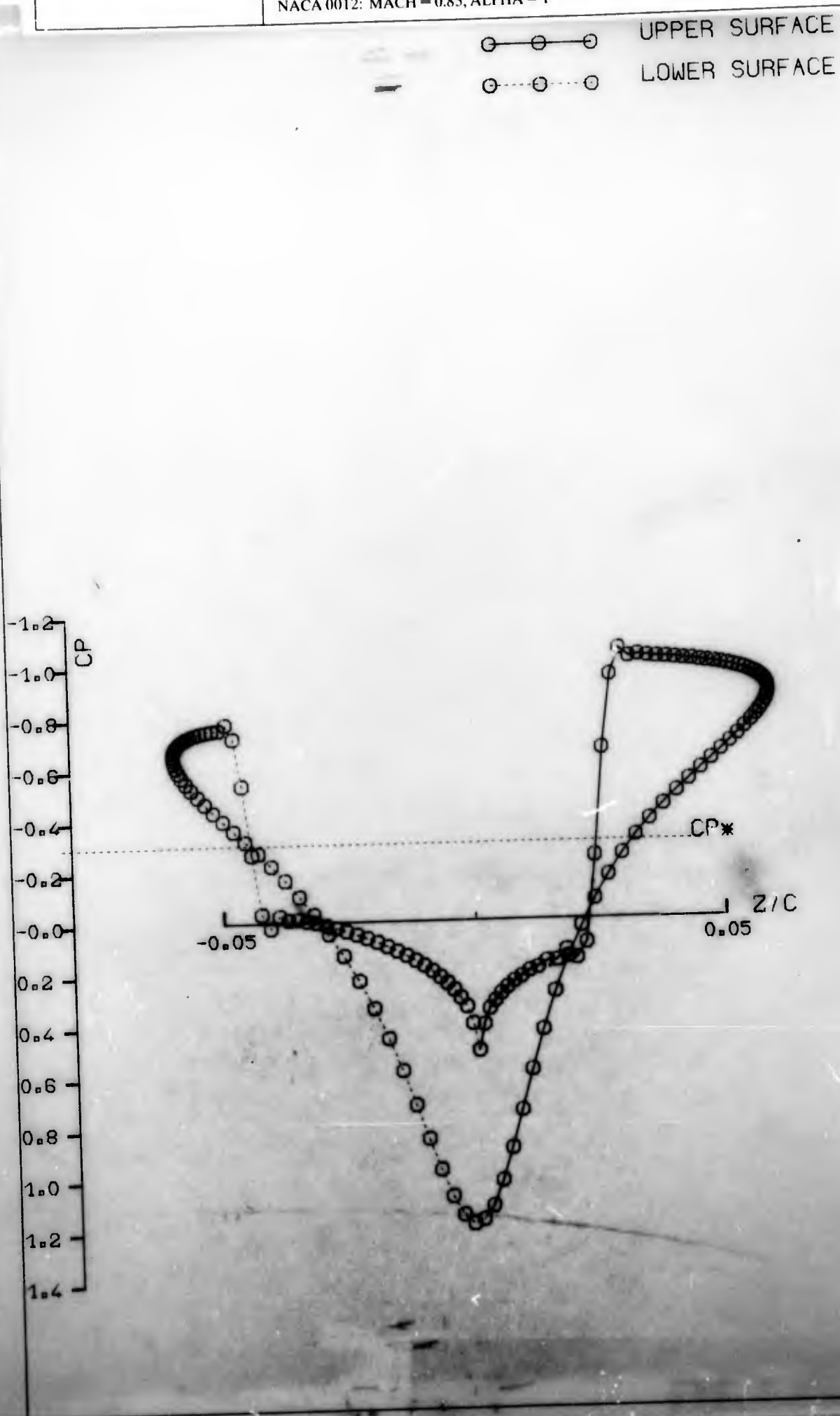
CM= -0.0951

Γ = 0.1699



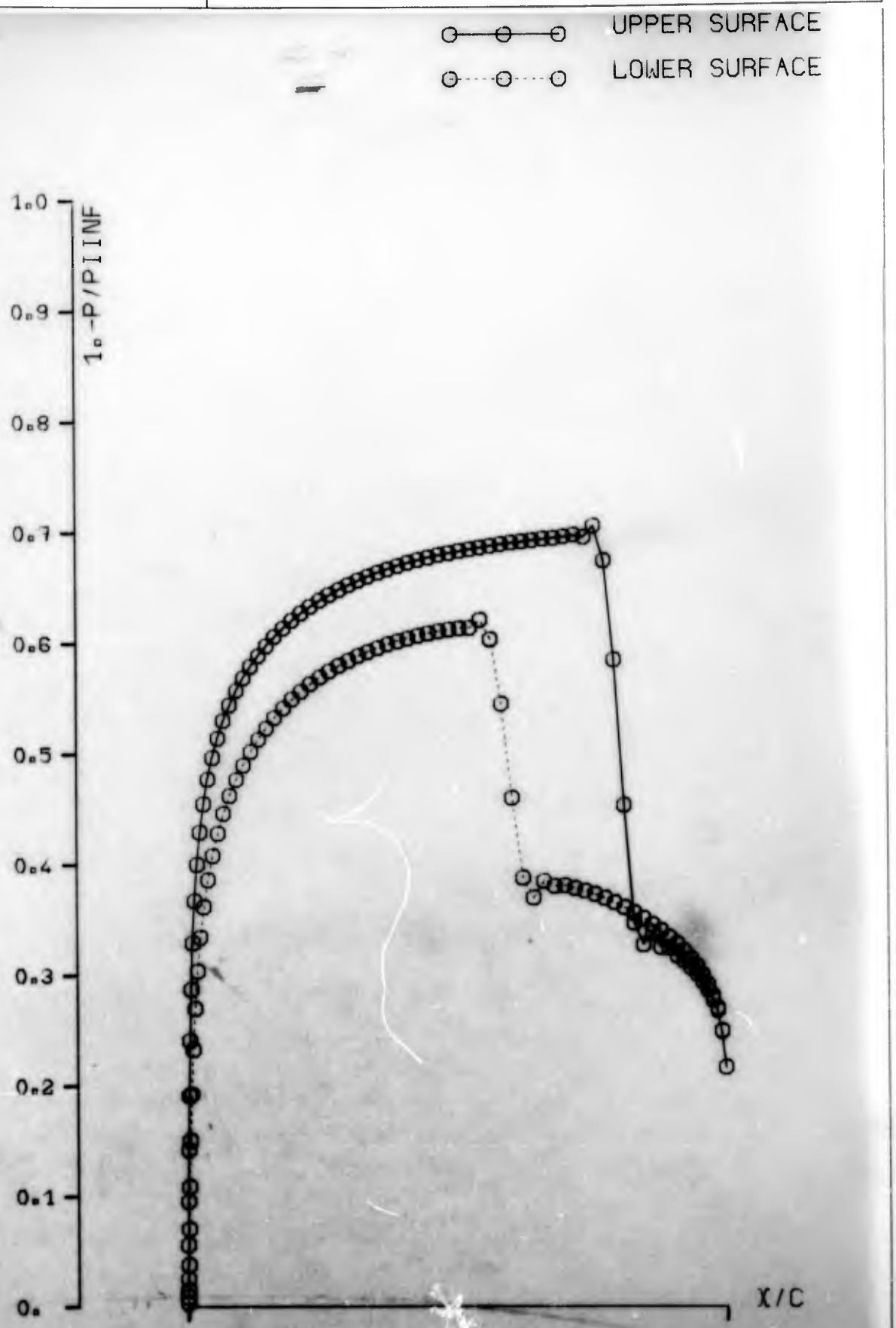
VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-7
	NACA 0012: MACH = 0.85, ALPHA = 1			



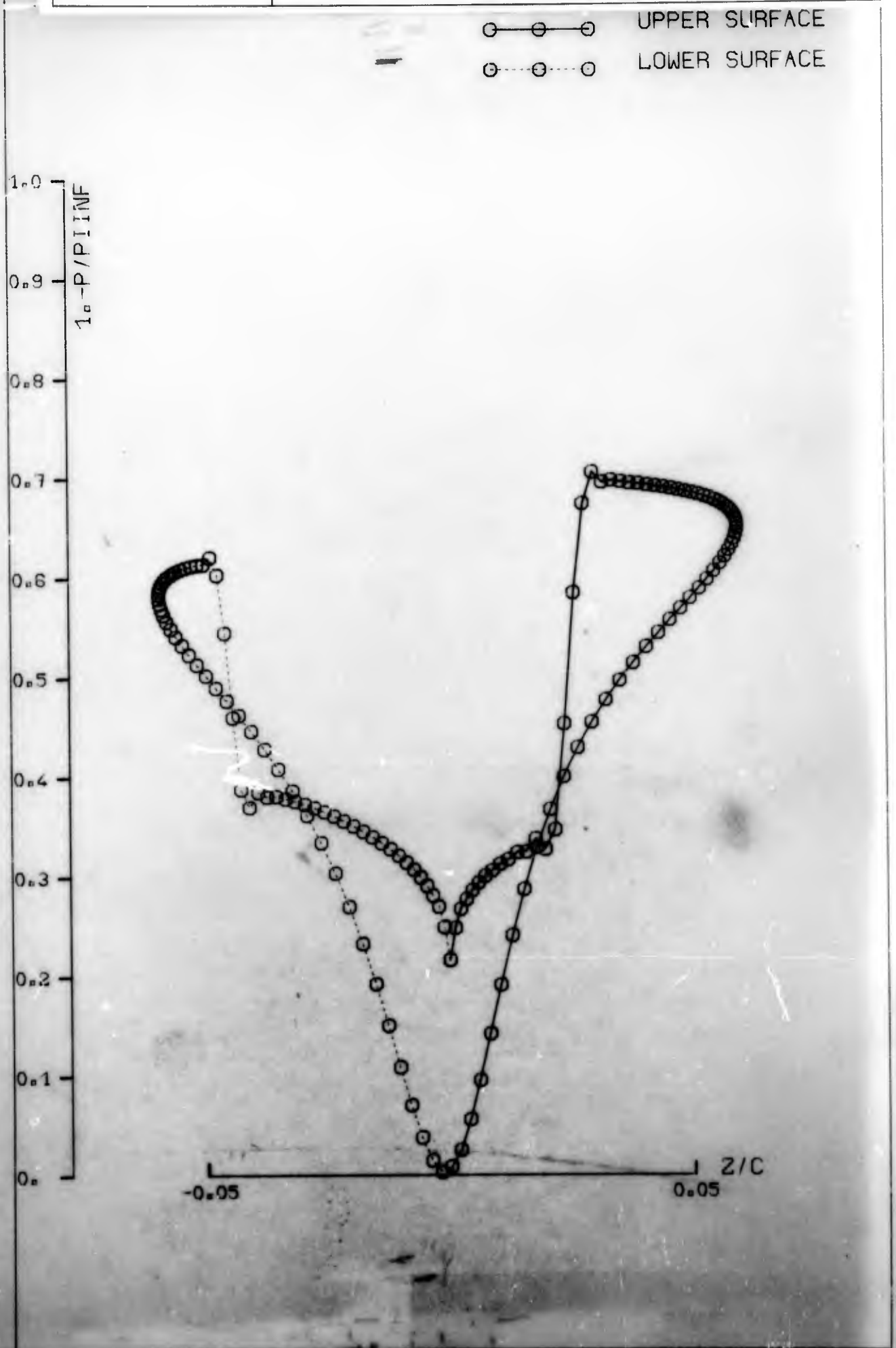
EUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-8
	NACA 0012: MACH = 0.85, ALPHA = 1			



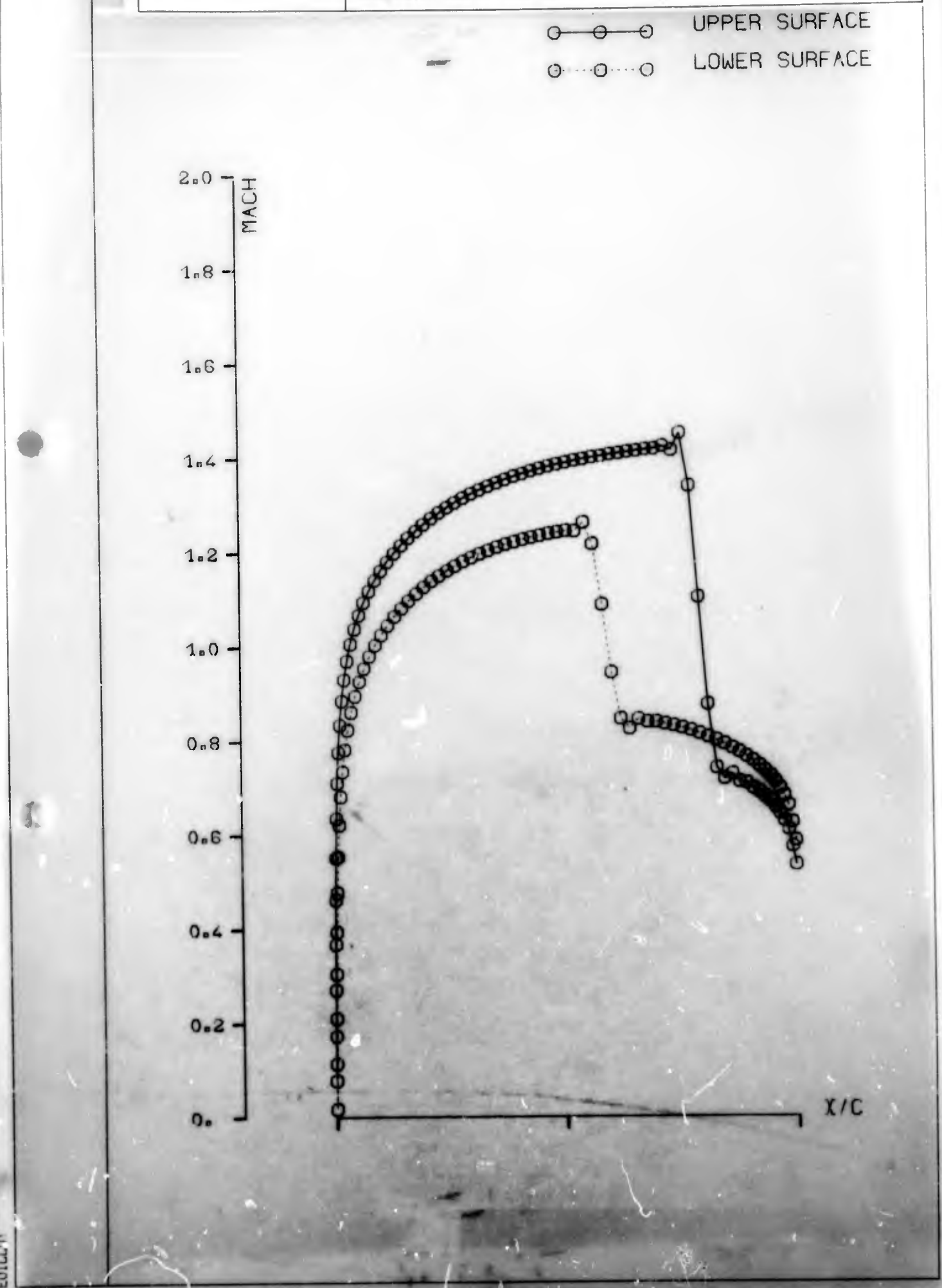
VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-9
	NACA 0012: MACH = 0.85, ALPHA = 1			



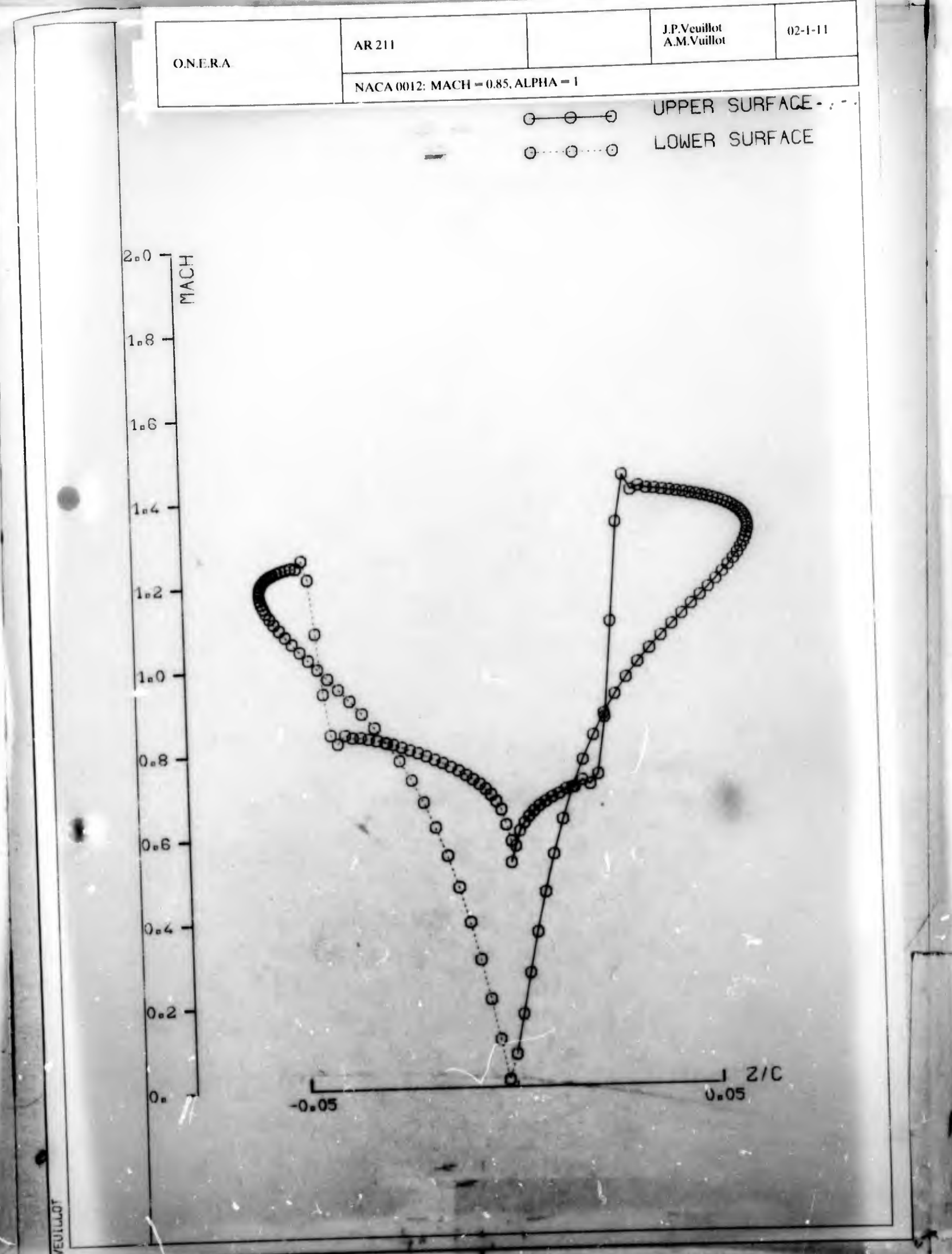
VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-10
	NACA 0012: MACH = 0.85, ALPHA = 1			



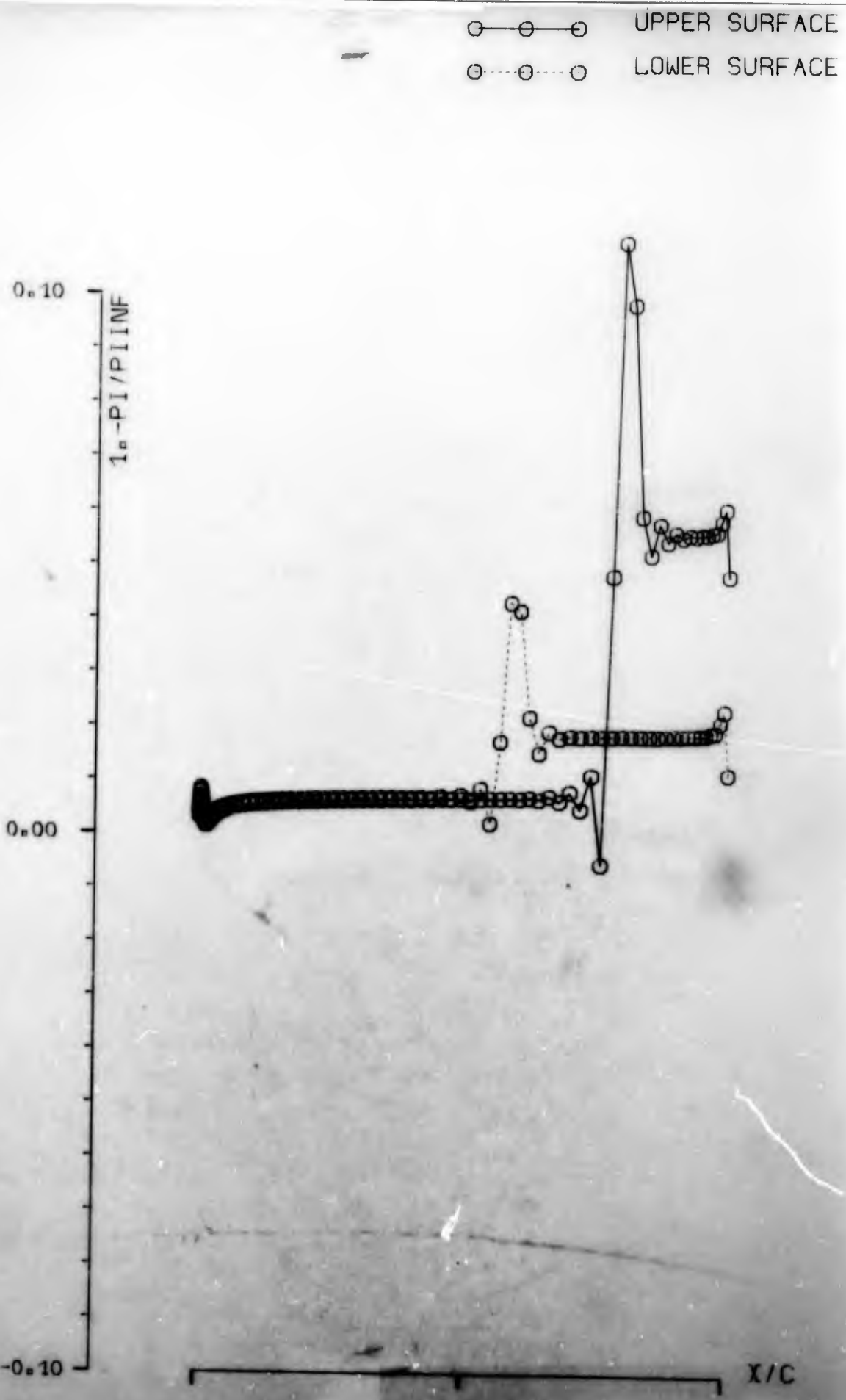
VEUILLOT

O.N.E.R.A	AR 211		J.P.Veuillot A.M.Vuillot	02-1-11
	NACA 0012: MACH = 0.85, ALPHA = 1			



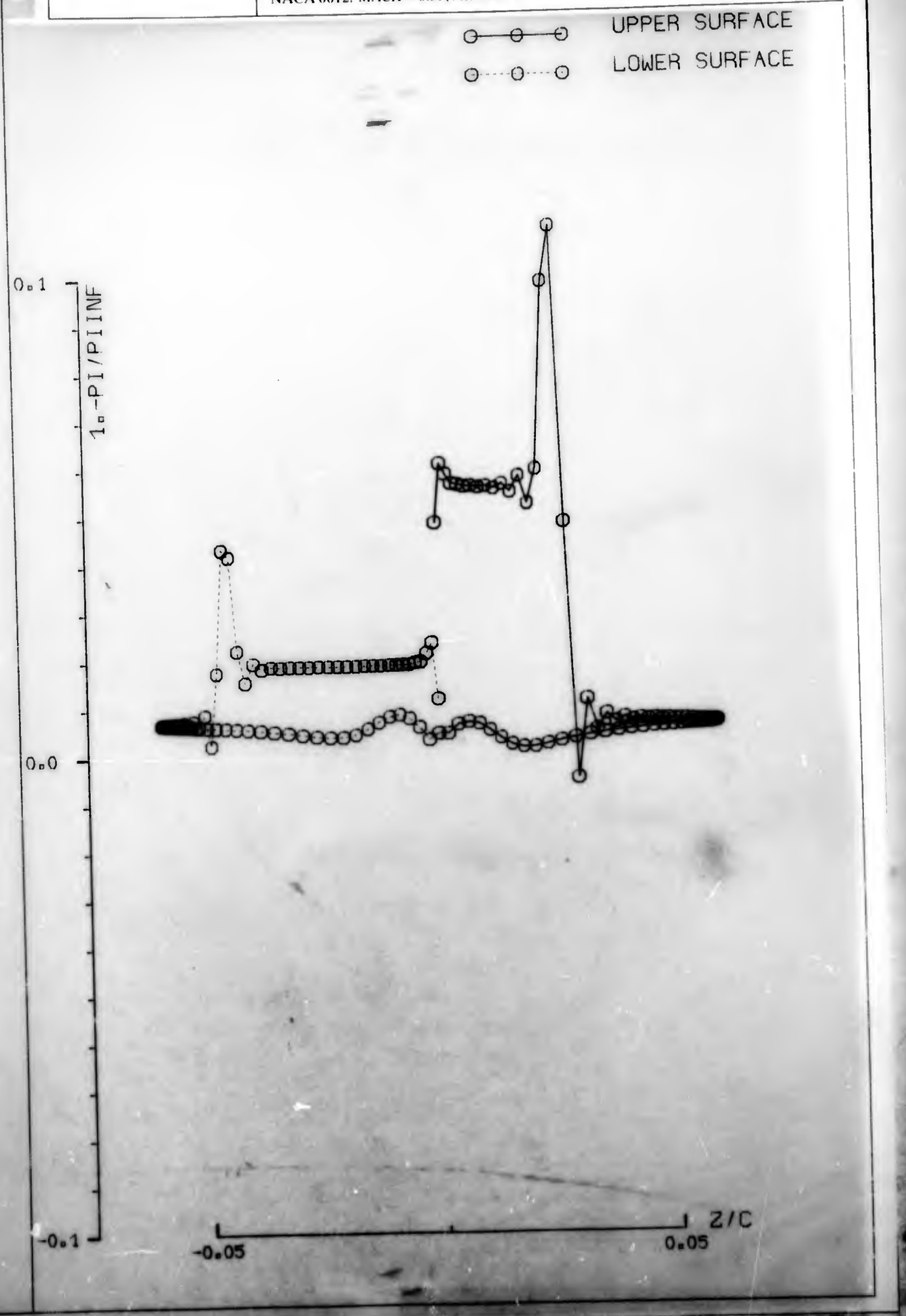
VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-12
	NACA 0012: MACH = 0.85, ALPHA = 1			

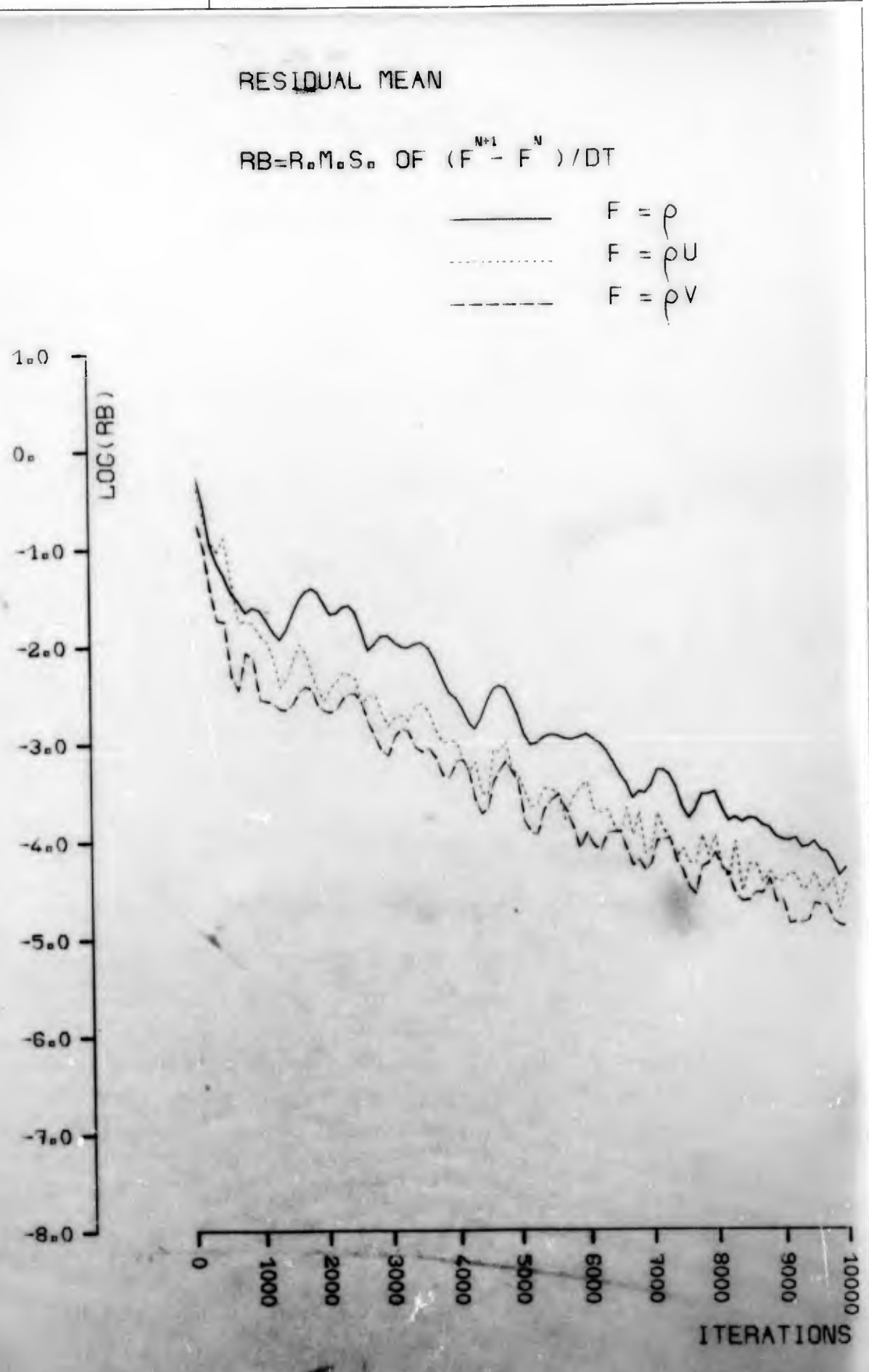


VEUILLOT

O.N.E.R.A.	AR 211		A.M.Vuillot	62-4-15
	NACA 0012: MACH = 0.85, ALPHA = 1			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-14
	NACA 0012: MACH = 0.85, ALPHA = 1			



VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-15
	NACA 0012: MACH = 0.85, ALPHA = 1			

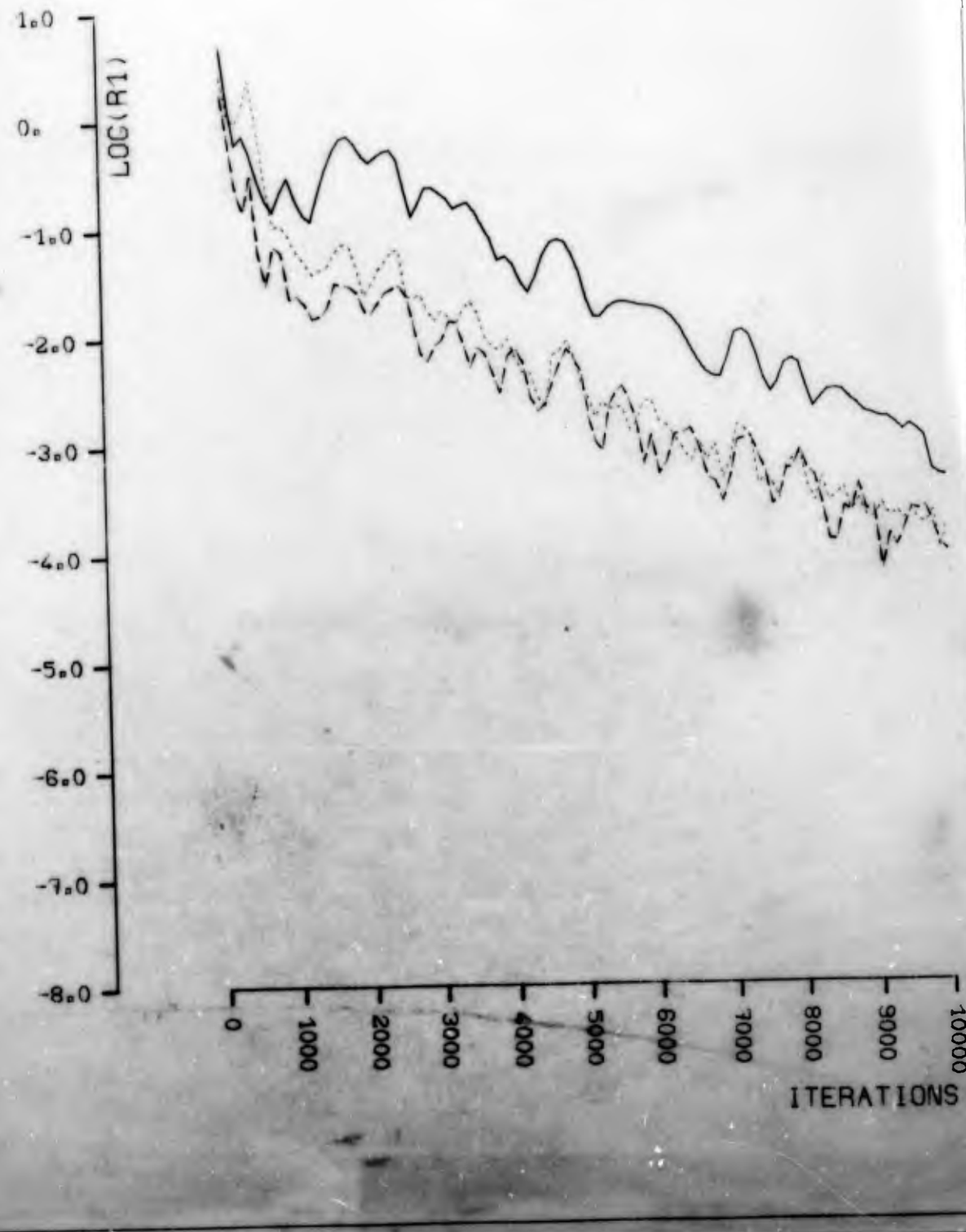
RESIDUAL MAXIMUM

R1=MAX OF $(F^{N+1} - F^{N})/DT$

——— $F = \rho$

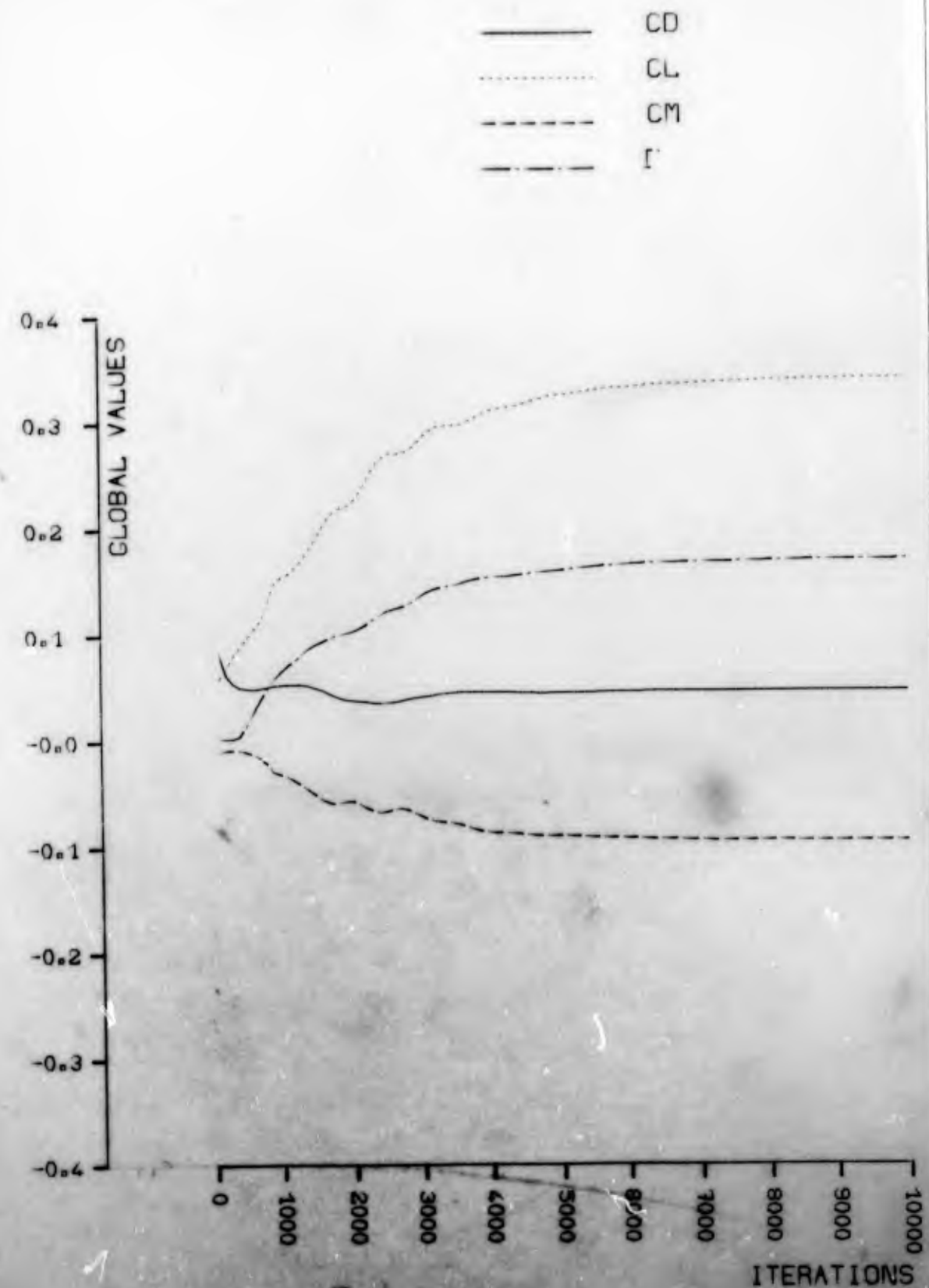
..... $F = \rho U$

– – – – – $F = \rho V$



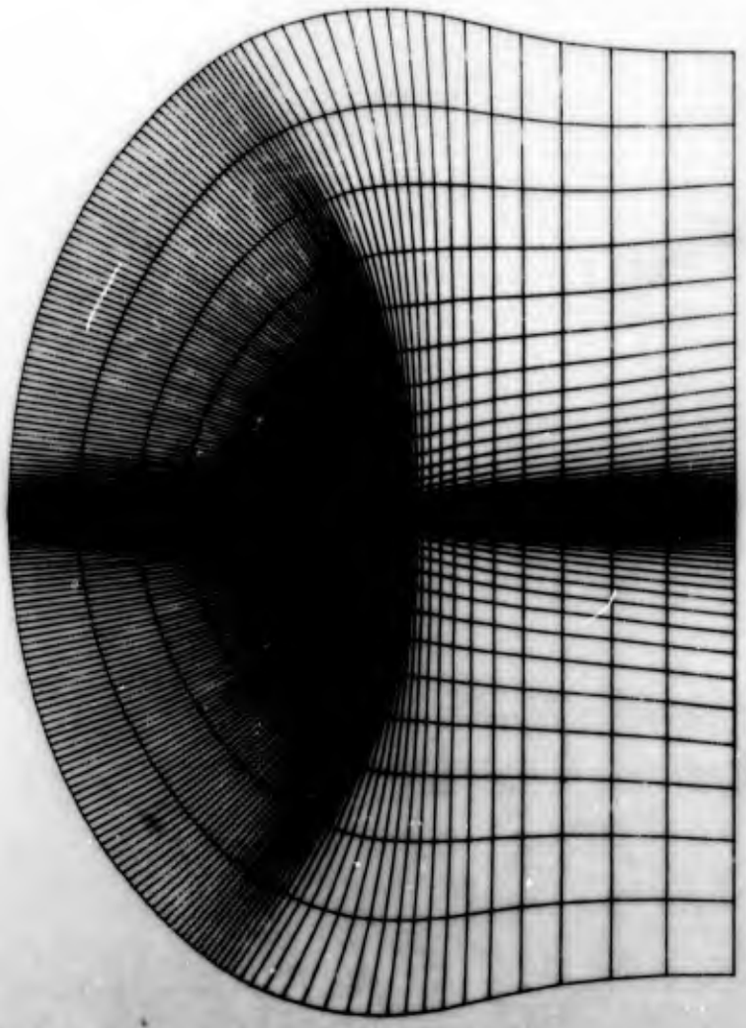
VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-16
	NACA 0012: MACH = 0.85, ALPHA = 1			



VEUILLOT

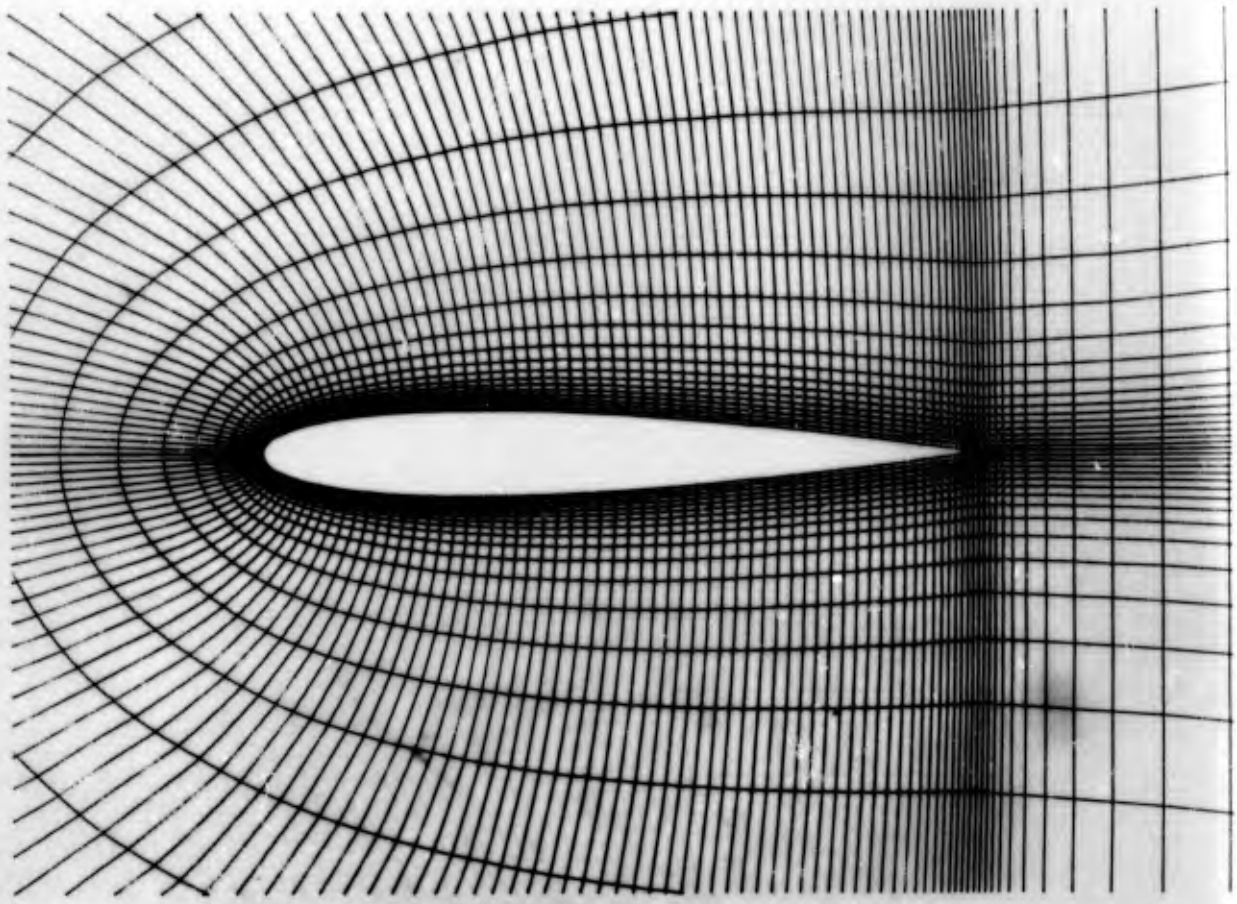
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-17
	NACA 0012: MACH = 0.85, ALPHA = 1			



193X29 MESH (1 CHORD = .5 CM)

VEUILLOT

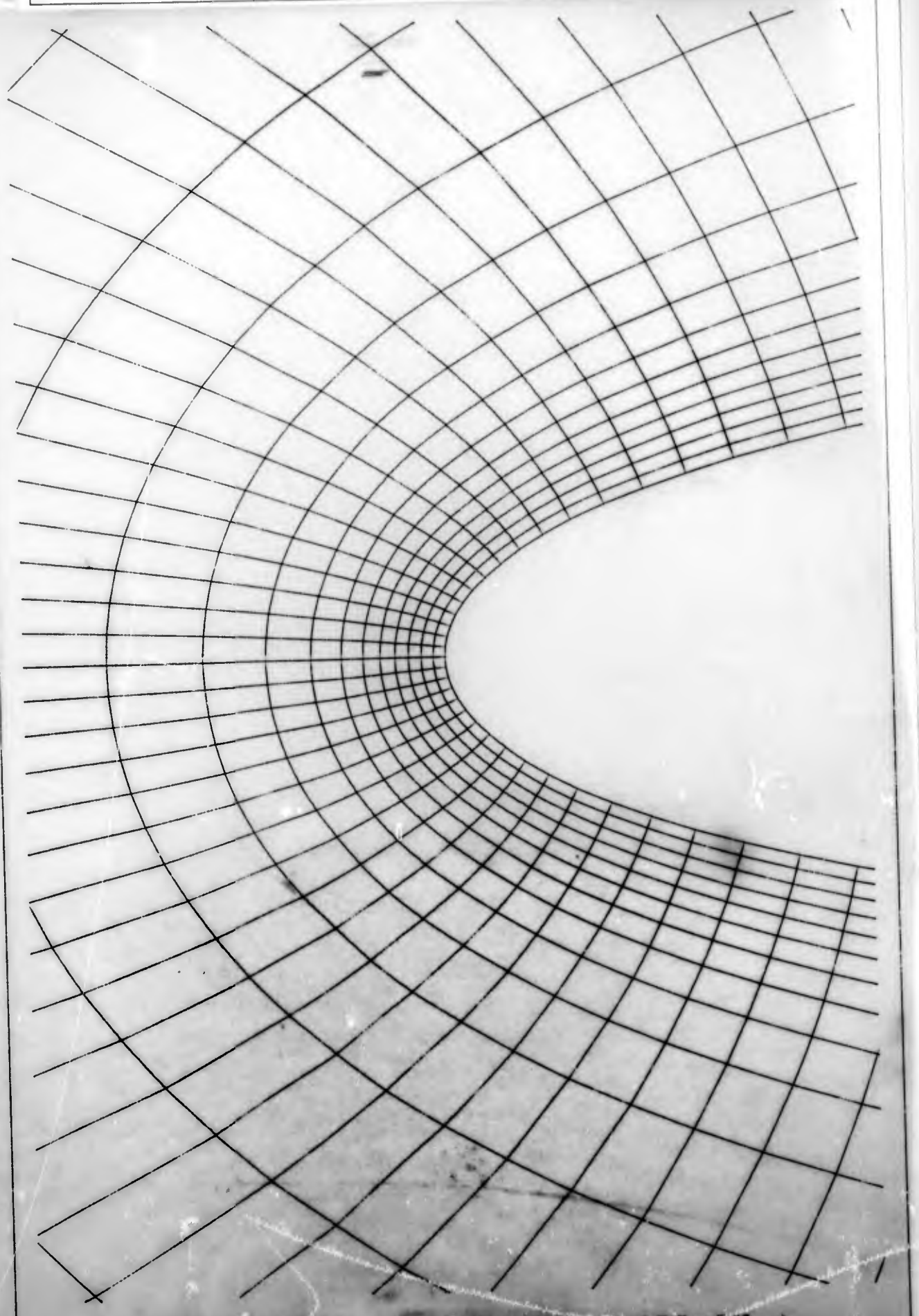
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-18
	NACA 0012: MACH = 0.85, ALPHA = 1			



193X29 MESH (1 CHORD = 10 CM)

VEUILLOT

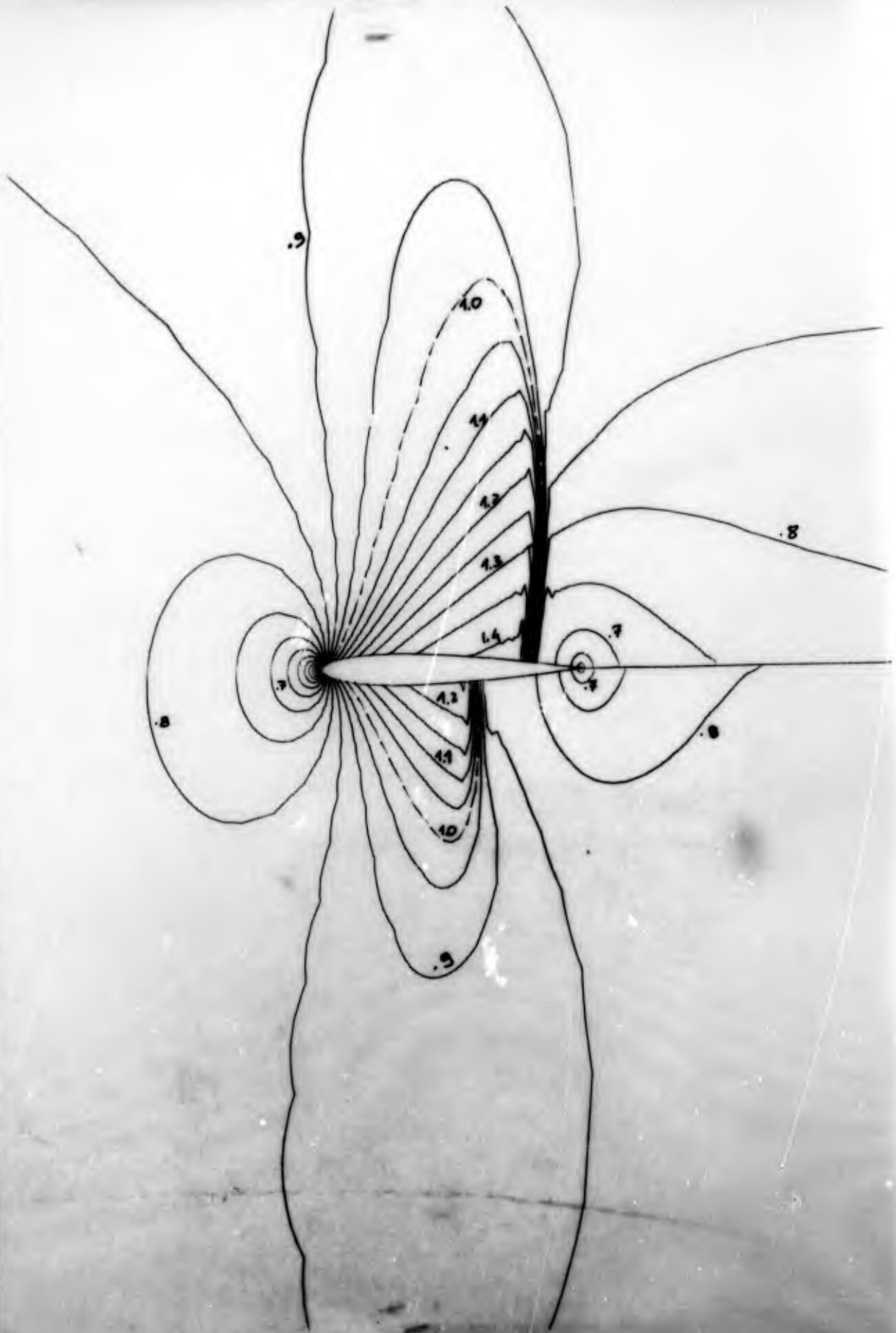
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-19
	NACA 0012: MACH = 0.85, ALPHA = 1			



193X29 MESH (1 CHORD = 100 CM)

VEUILLOT

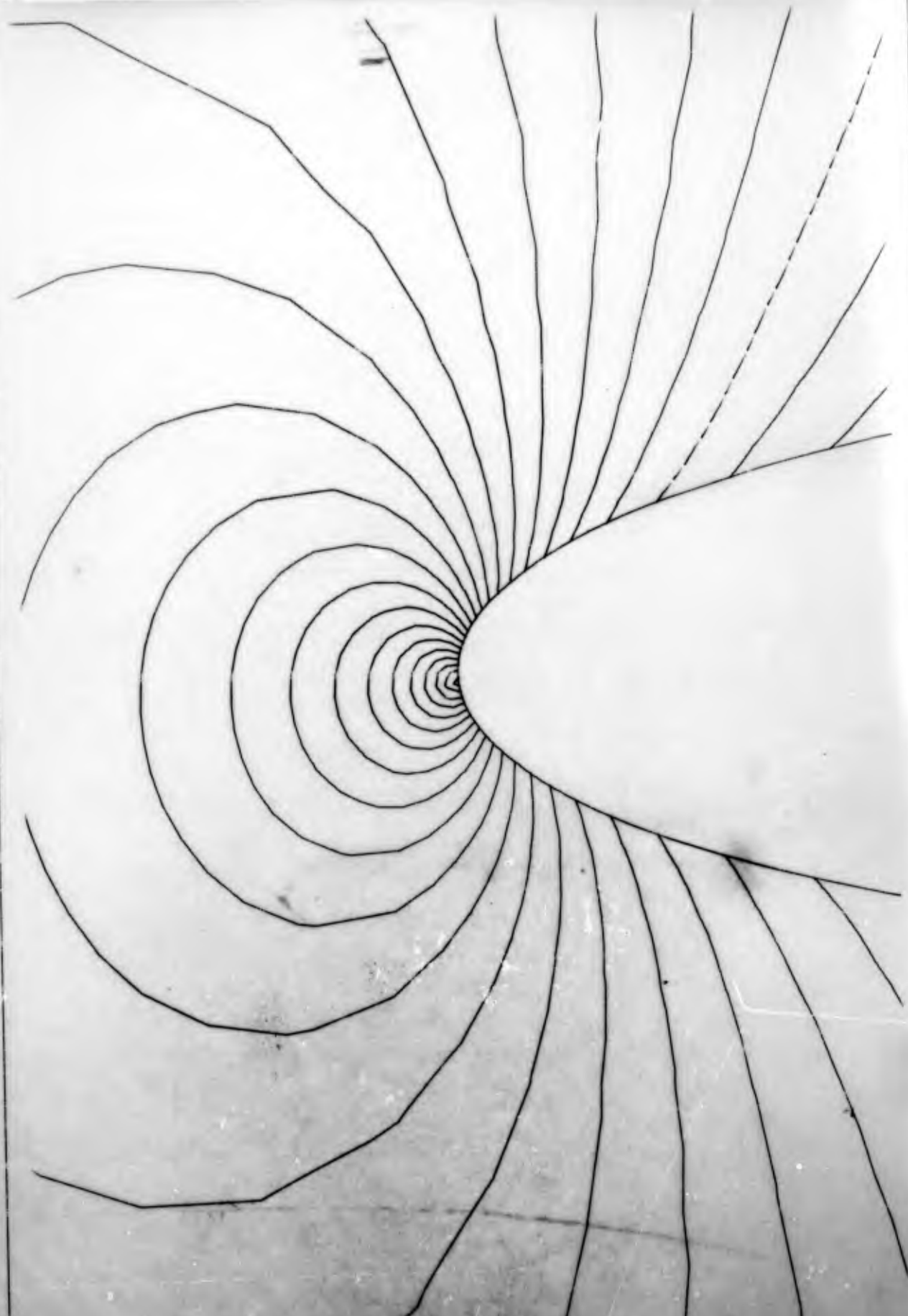
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-20
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-MACH LINES

VEUILLOT

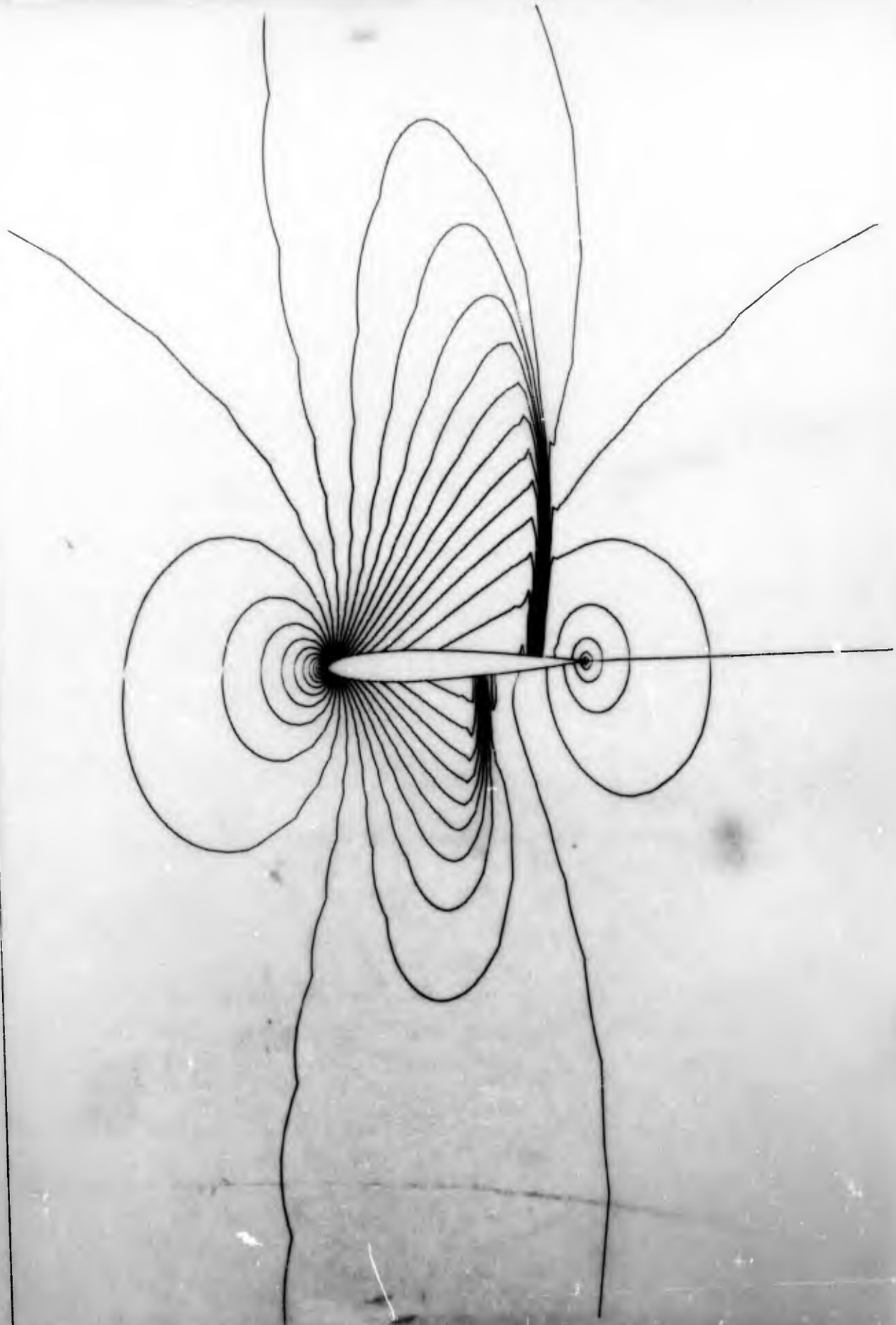
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-21
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-MACH LINES (1 CHORD = 100 CM)

VEUILLOT

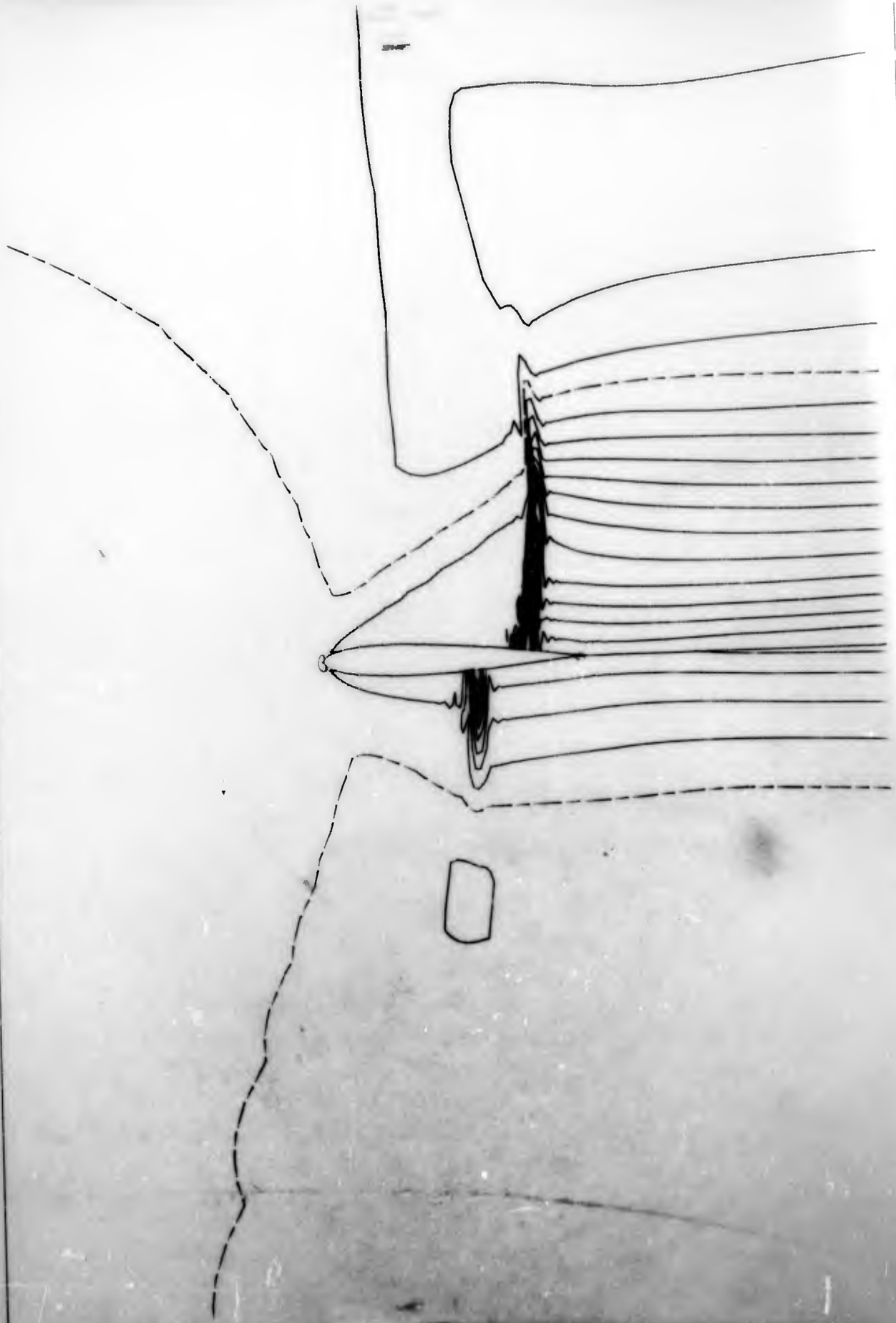
O.N.E.R.A.	AR 211		J P.Veuillot A.M.Vuillot	02-1-22
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-P/PIINF LINES

VUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-23
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-PI/PIINF LINES

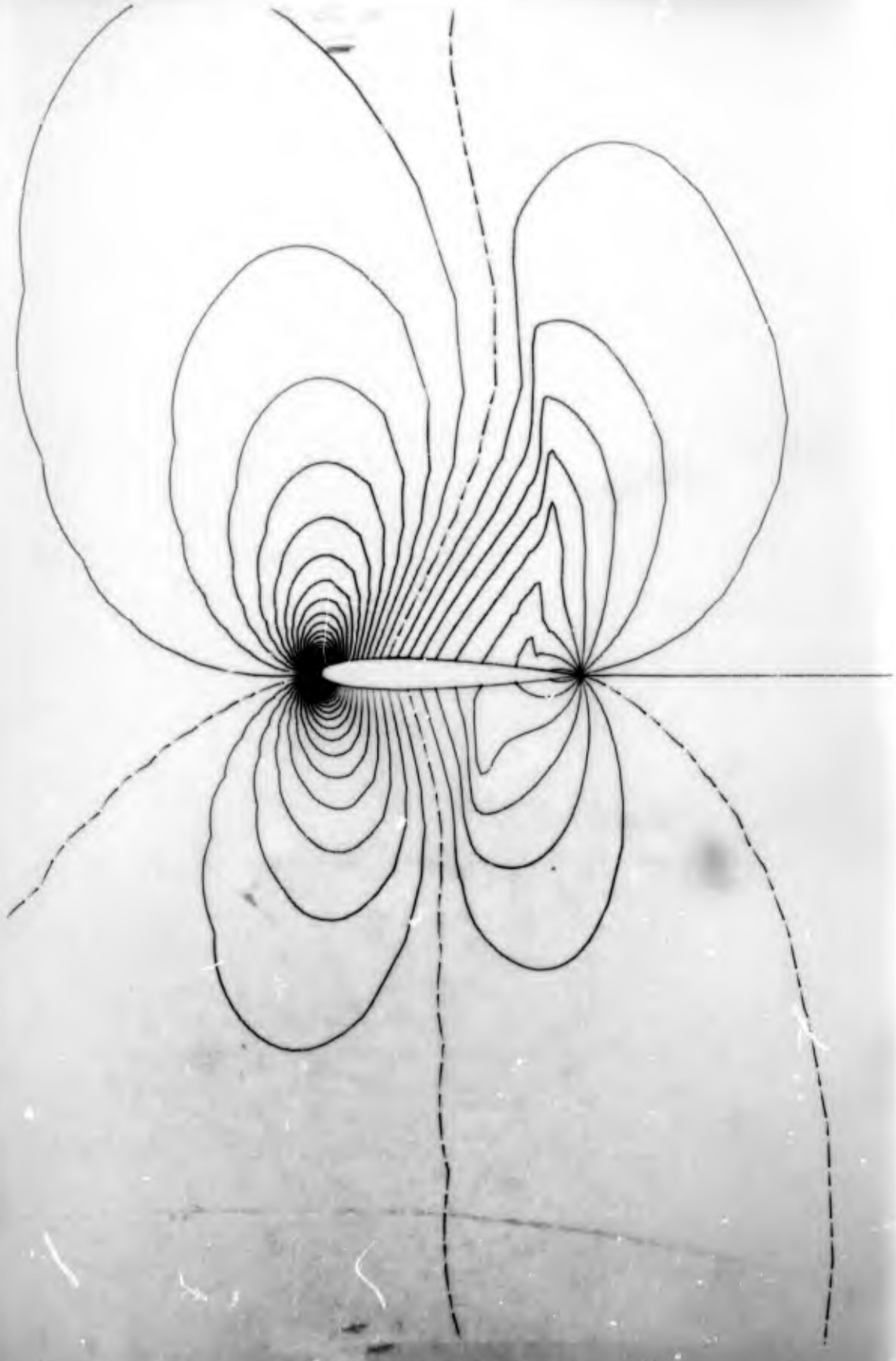
VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-24
	NACA 0012: MACH = 0.85, ALPHA = 1			

ISO-PI/PIINF LINES (1 CHORD = 100 CM)

VEUILLOT

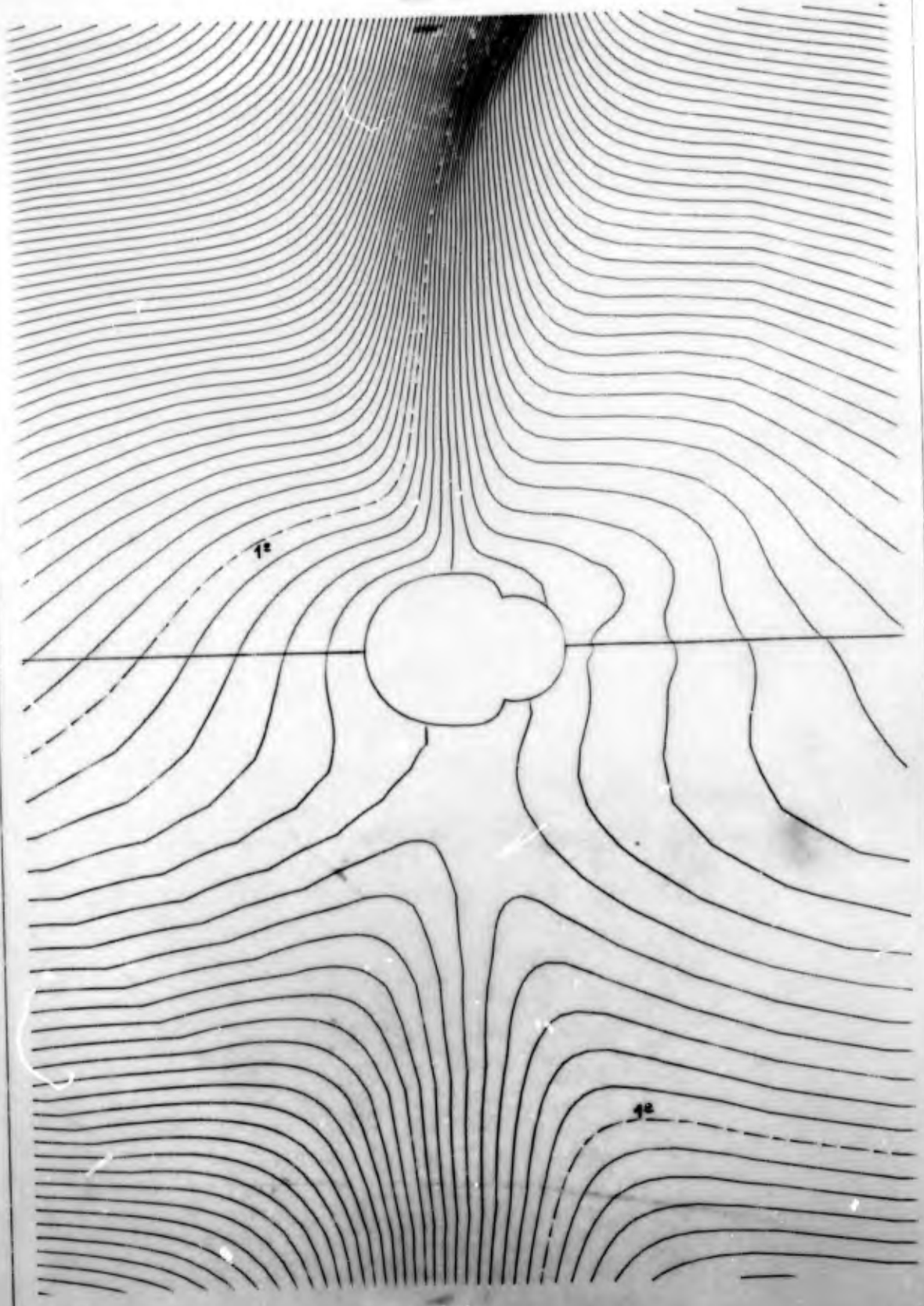
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-25
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-TETA LINES

VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	02-1-26
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-TETA LINES

VEUILLOT

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 02

NACA 0012: MACH = 0.85, ALPHA = 1

Contributor No 2

J.Sidès

(O.N.E.R.A., France)

COMMENTS ON CALCULATION FOR TEST CASE 02

C-Mesh

The mesh is constructed algebrically from the data of points on the airfoil surface , on a cut-line and on an arbitrary external boundary. One family of mesh-lines is composed of parabolas starting from the airfoil surface and from the cut-line. The second family of lines is obtained by the application of a stretching function between the airfoil surface and the external boundary along each parabola.

The total number of cells is : 188 x 24.

There are 146 points on the airfoil surface:

73 on the lower surface,

73 on the upper surface.

In a parallel direction to the x-axis:

the distance between the leading edge and the external boundary is: 4 C (where C is the chord length),

the distance between the trailing edge and the external boundary is 6 C.

In a paralel direction to the z-axis:

the distance between the airfoil surface and the external boundary is : about 6 C.

Convergence

The numerical results are reported after 3000 time steps of the implicit method but no doubt that about 1500 steps would be sufficient to reach the converged solution.

40-911-120

O.N.E.R.A.	AR 211		J.Sidès	02-2-4
	NACA 0012: MACH = 0.85, ALPHA = 1			

UPPER SURFACE

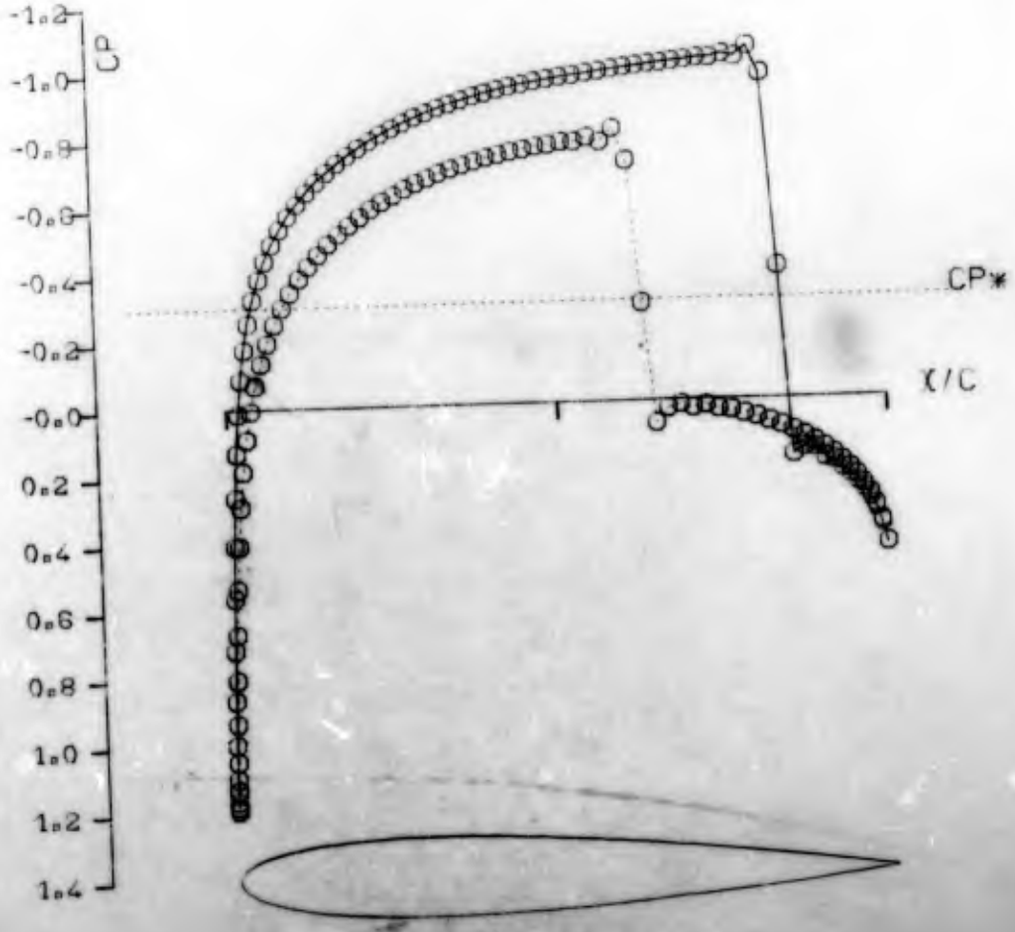
LOWER SURFACE

CL= 0.3436

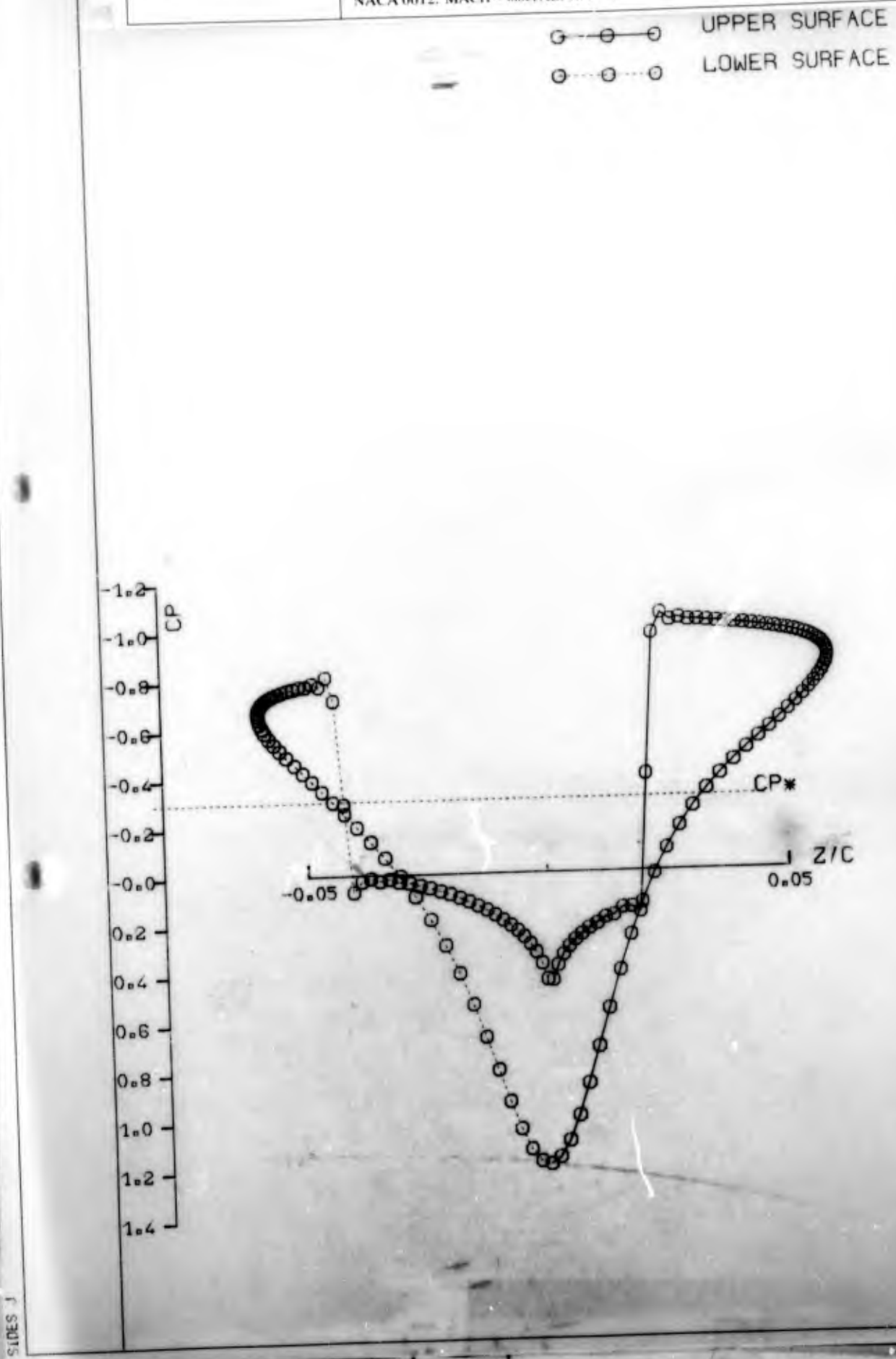
CD= 0.0541

CM= -0.1093

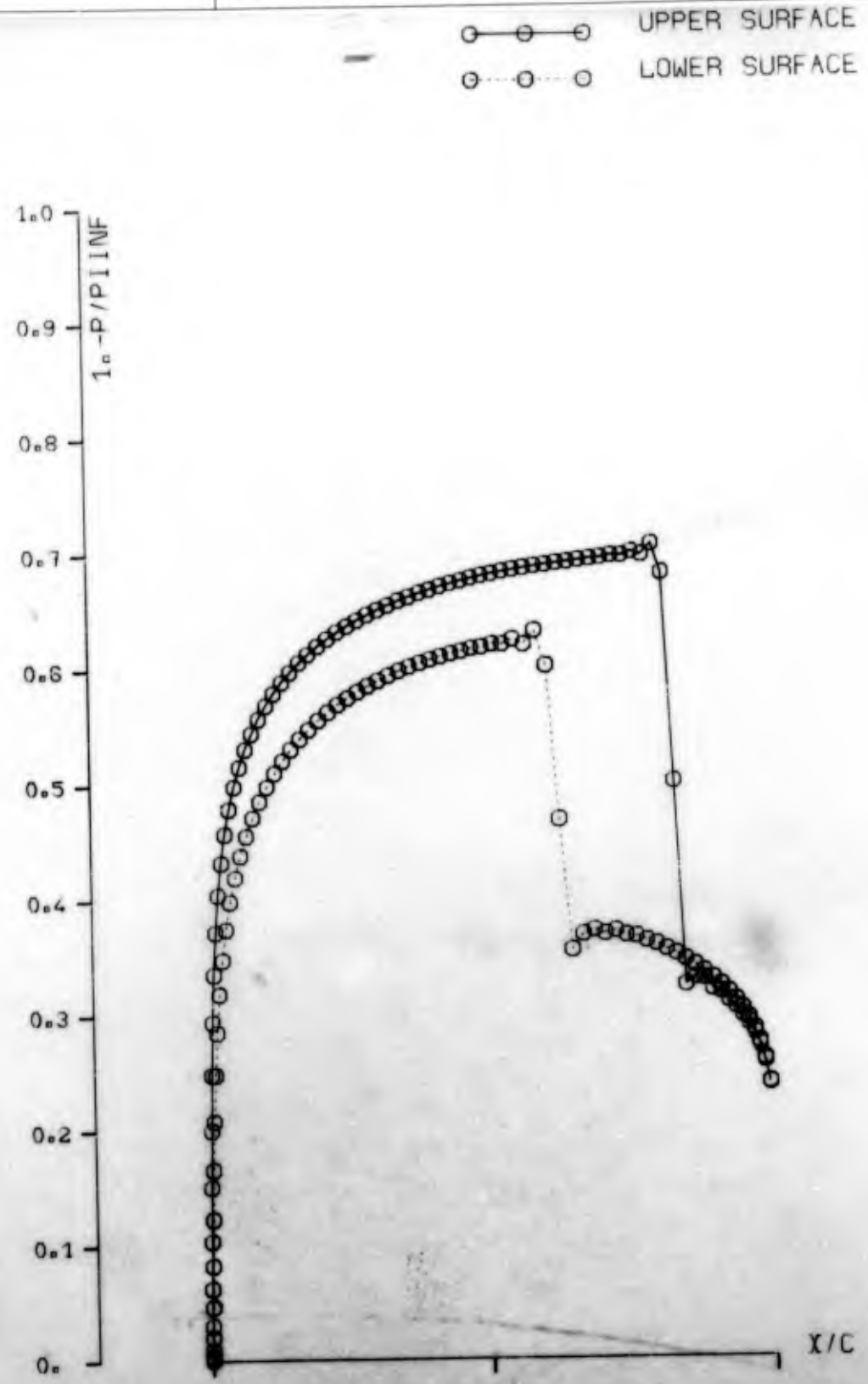
Γ = 0.1733



O.N.E.R.A.	AR 211		J.Sidès	02-2-5
	NACA 0012: MACH = 0.85, ALPHA = 1			

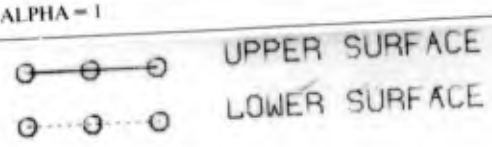


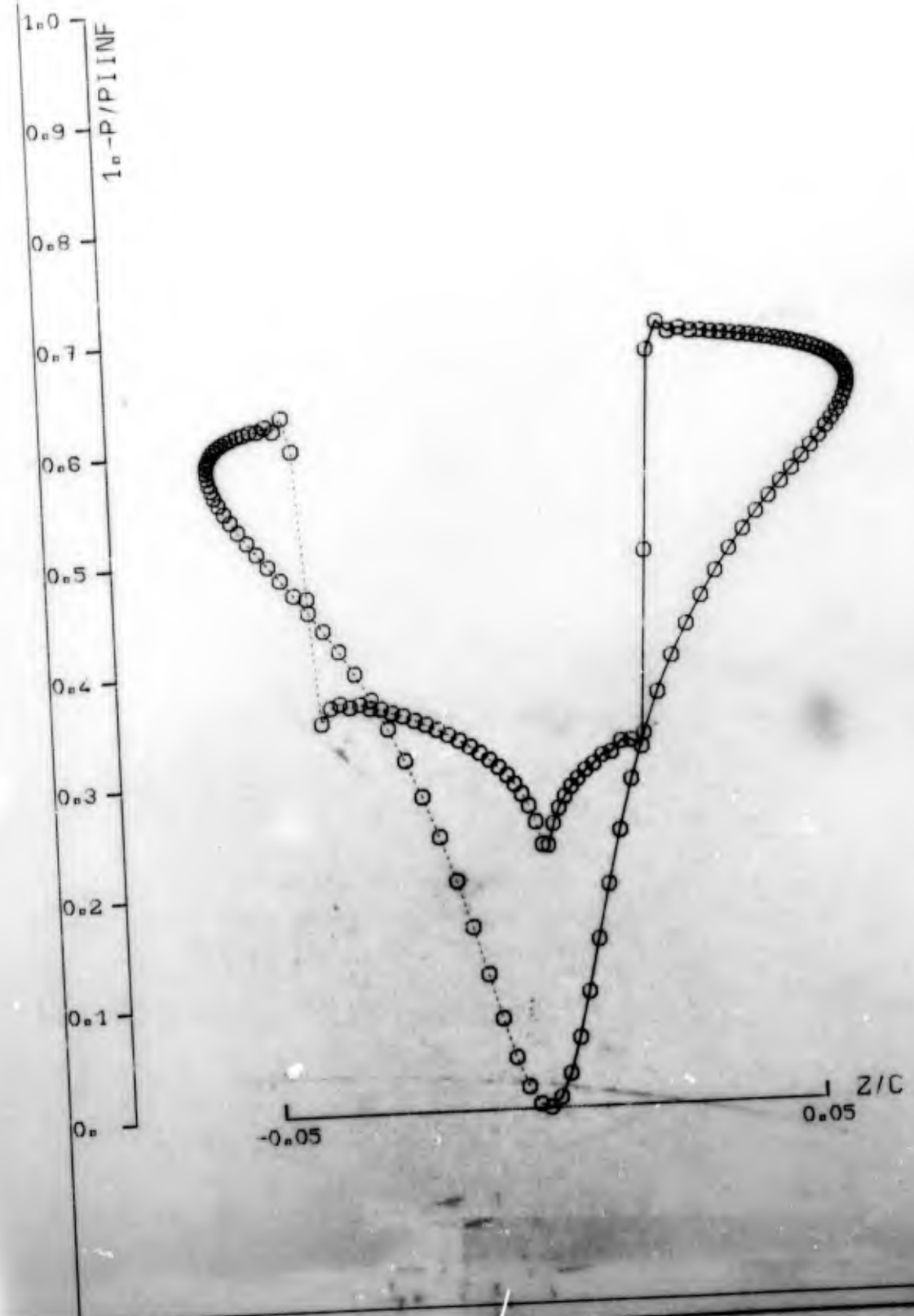
O.N.E.R.A.	AR 211		J.Sidès	02-2-6
	NACA 0012: MACH = 0.85, ALPHA = 1			



SIDES J

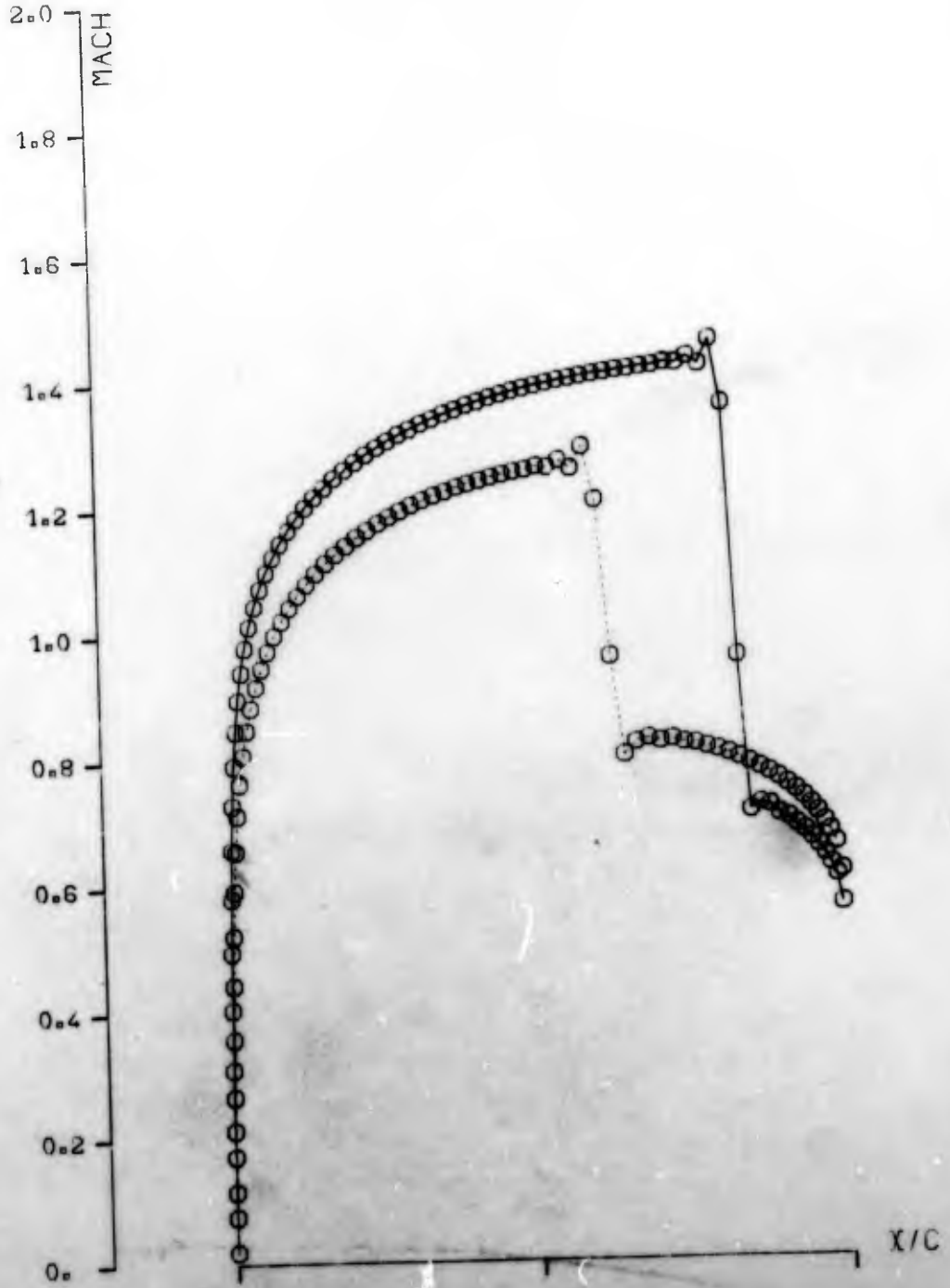
O.N.E.R.A.	AR 211		J.Sides	02-2-7
	NACA 0012: MACH = 0.85, ALPHA = 1			





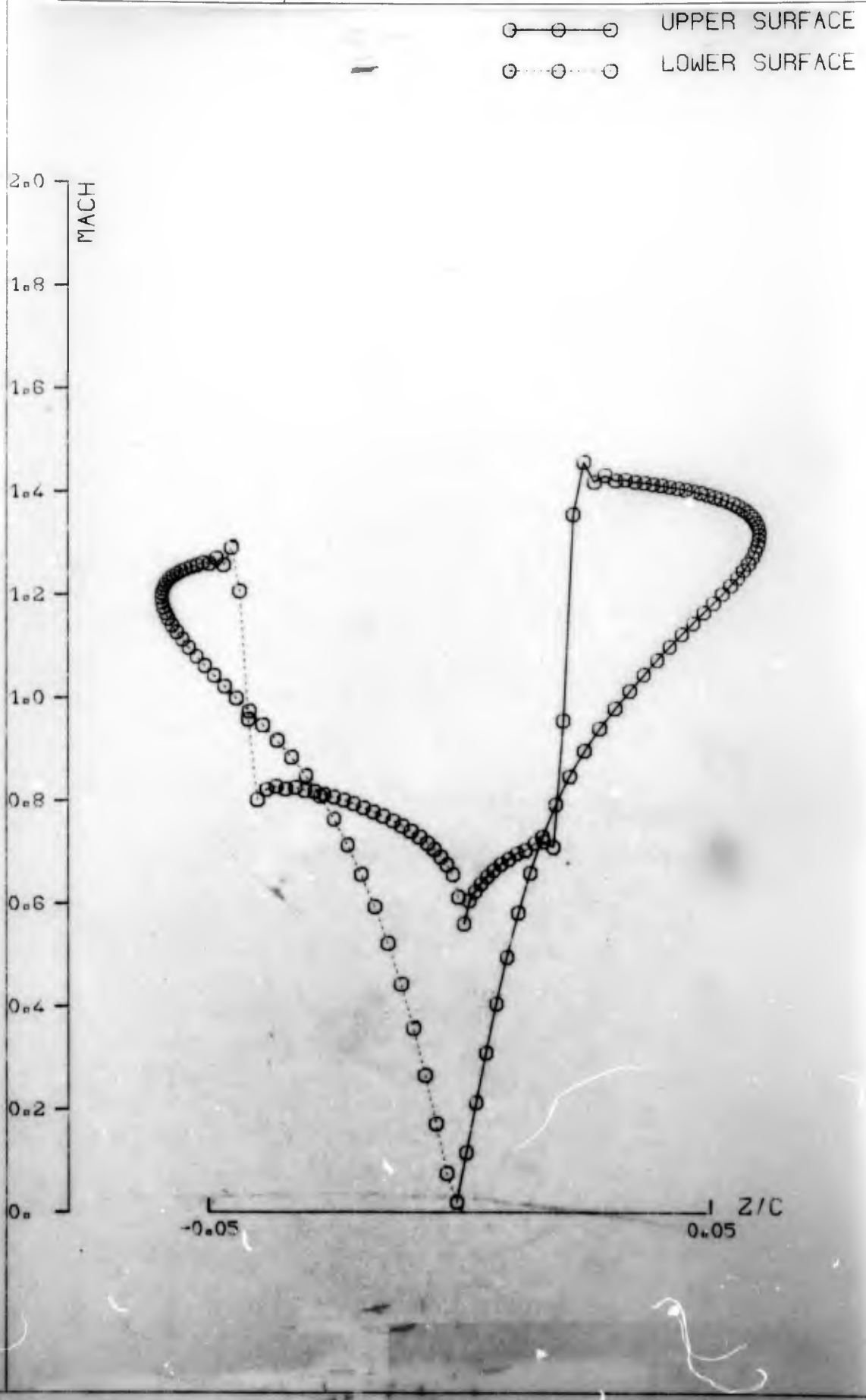
SIDES J

O.N.E.R.A.	AR 211		J.Sidès	02-2-8
	NACA 0012: MACH = 0.85, ALPHA = 1			

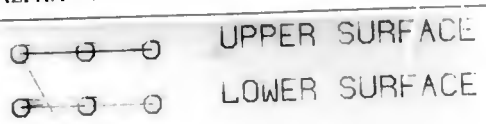


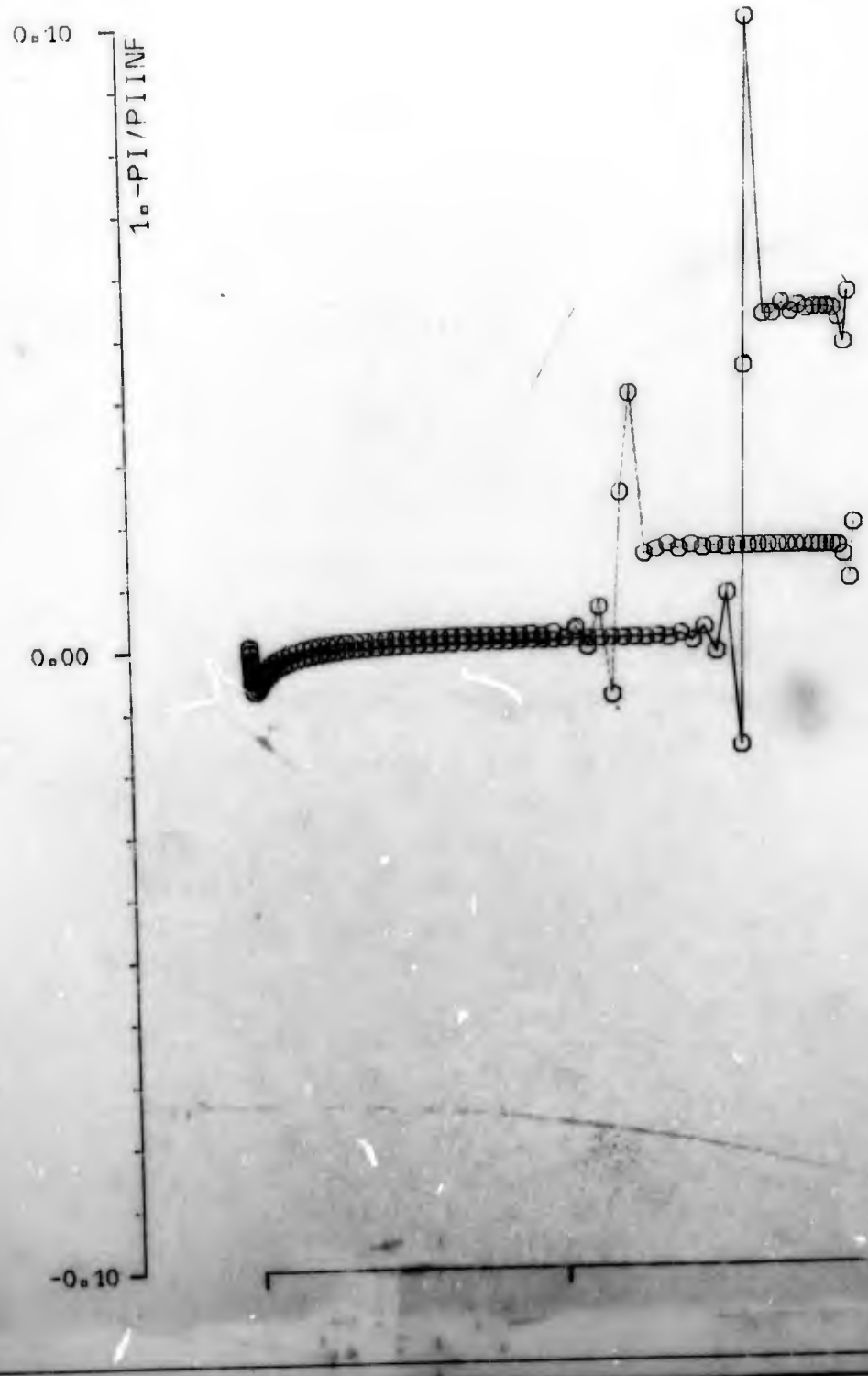
SIDES

O.N.E.R.A.	AR 211		J.Sides	02-2-9
	NACA 0012: MACH = 0.85, ALPHA = 1			

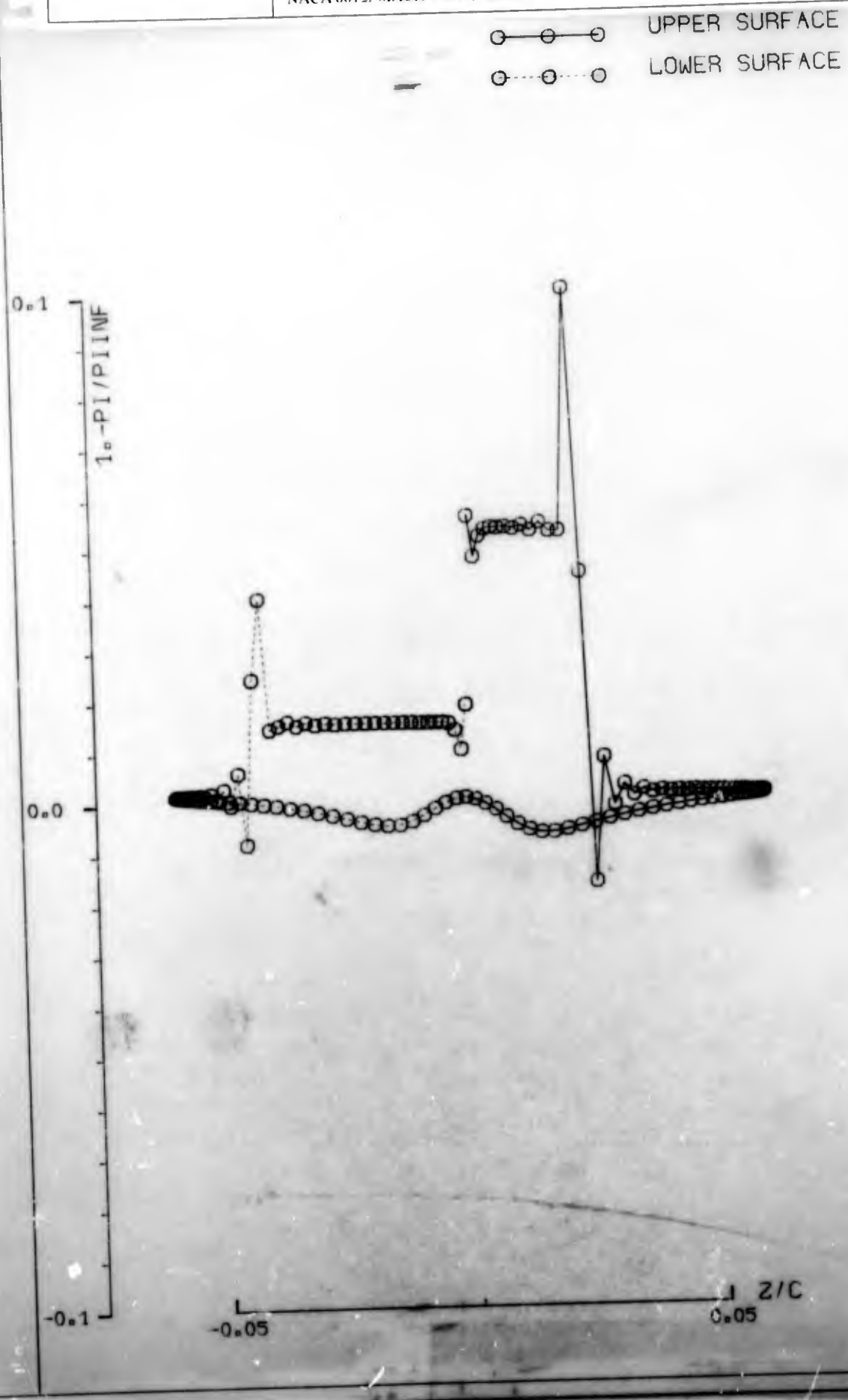


O.N.E.R.A.	AR 211		J.Sidès	02-2-10
	NACA 0012: MACH = 0.85, ALPHA = 1			





O.N.E.R.A.	AR 211		J.Sidès	02-2-11
	NACA 0012: MACH = 0.85, ALPHA = 1			



O.N.E.R.A.	AR 211		J.Sidès	02-2-12
	NACA 0012: MACH = 0.85, ALPHA = 1			

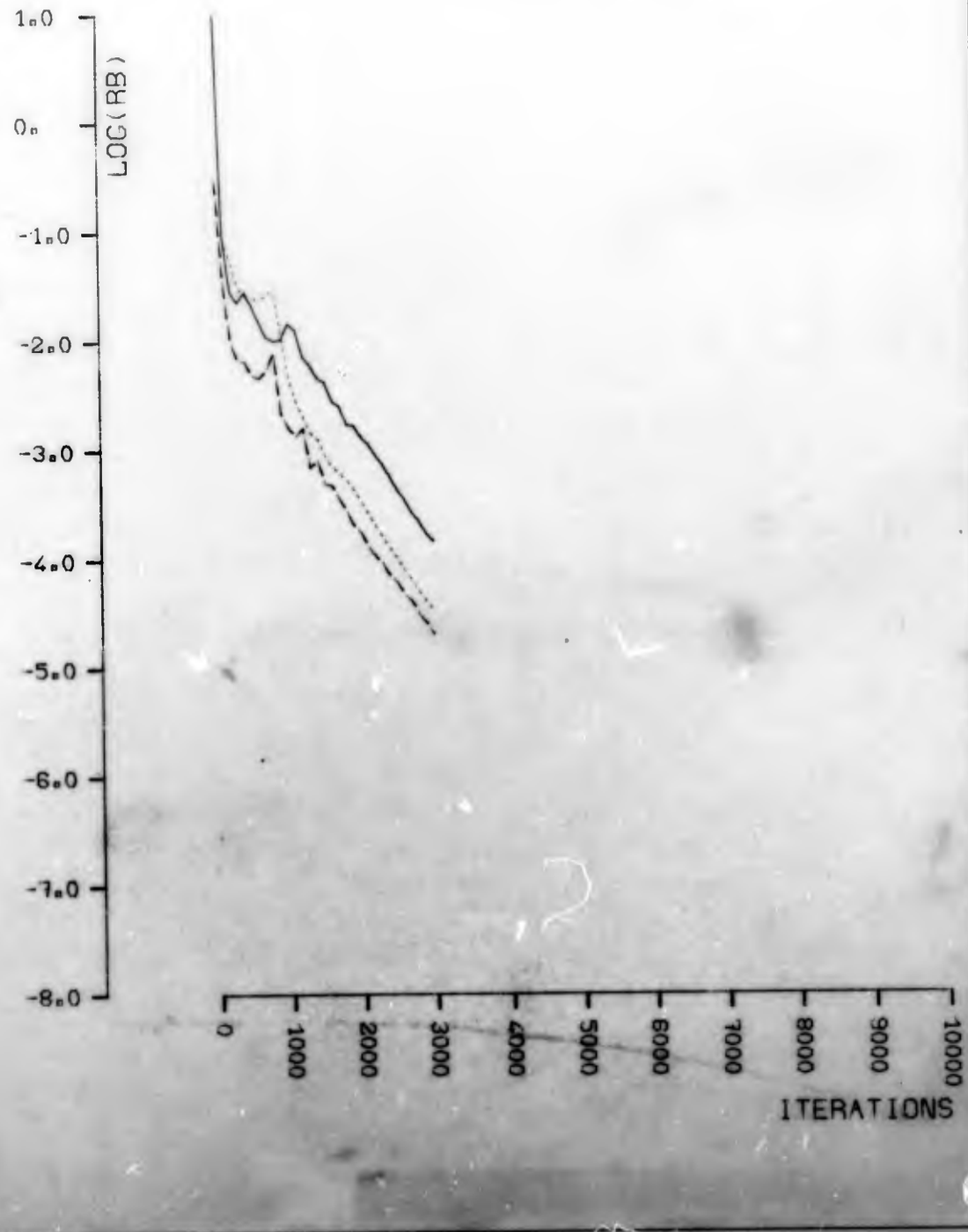
RESIDUAL MEAN

RB=R.M.S. OF $(F^{N+1} - F^{N})/DT$

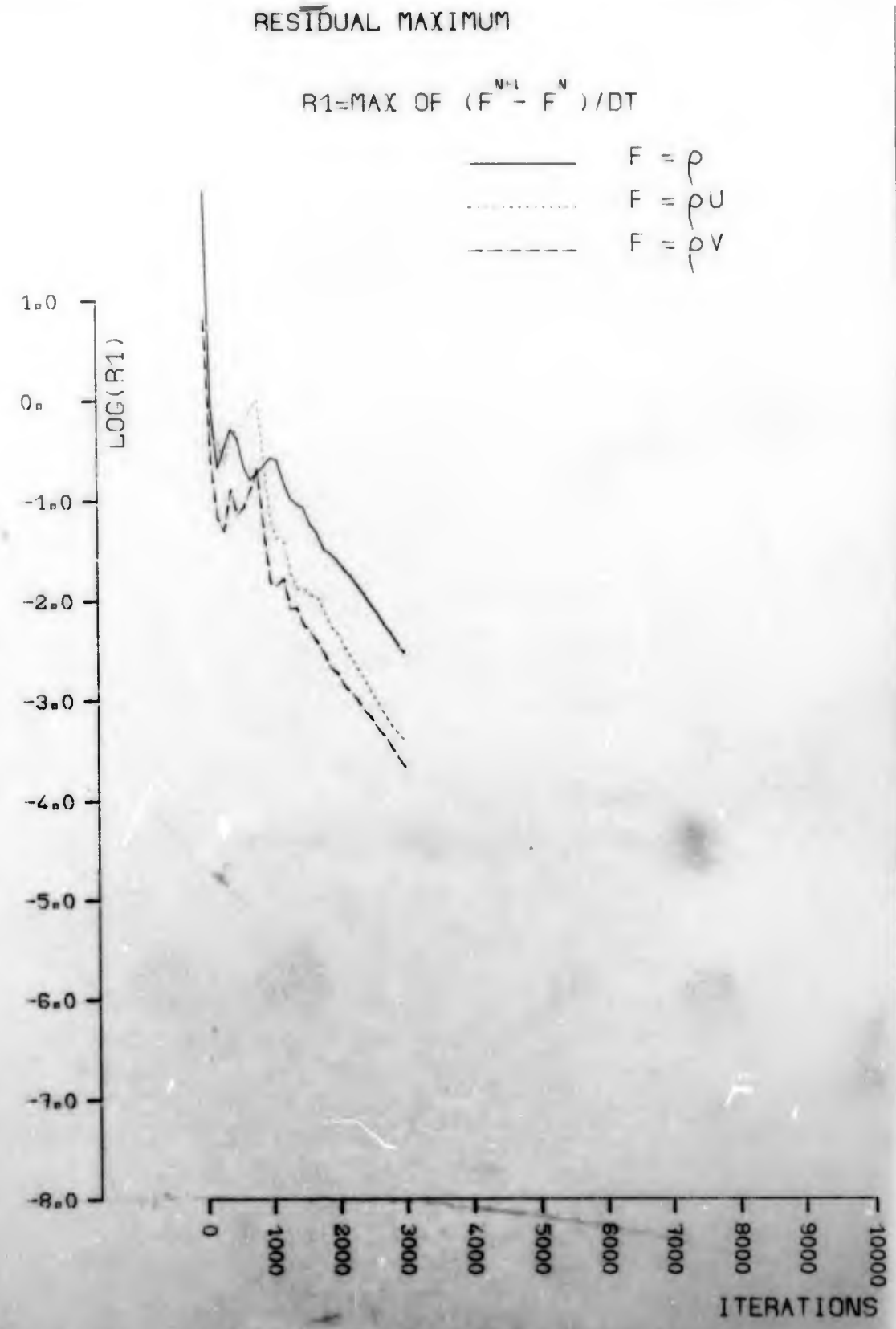
——— $F = \rho$

..... $F = \rho U$

– – – – – $F = \rho V$

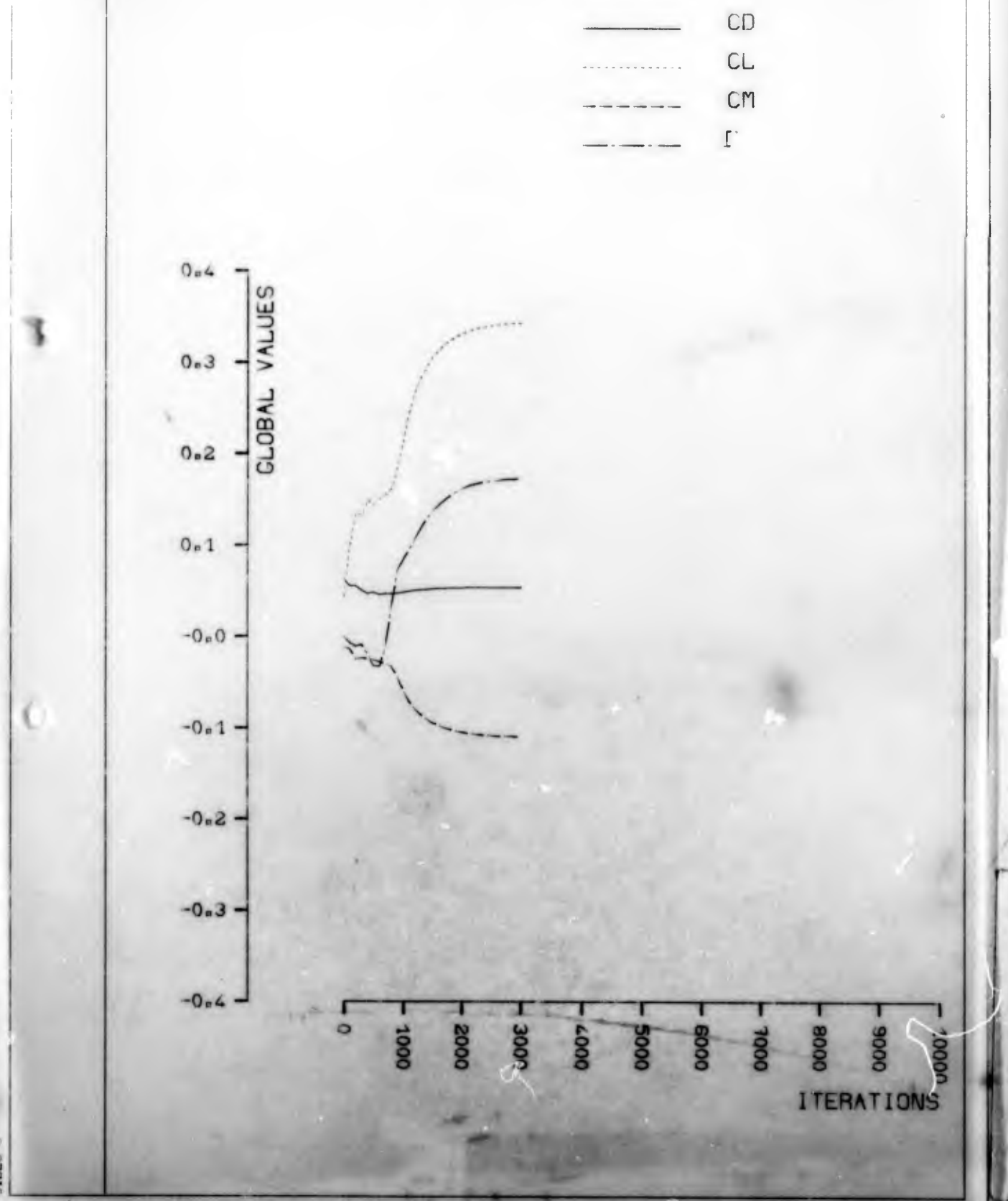


O.N.E.R.A.	AR 211		J.Sidès	02-2-13
	NACA 0012: MACH = 0.85, ALPHA = 1			



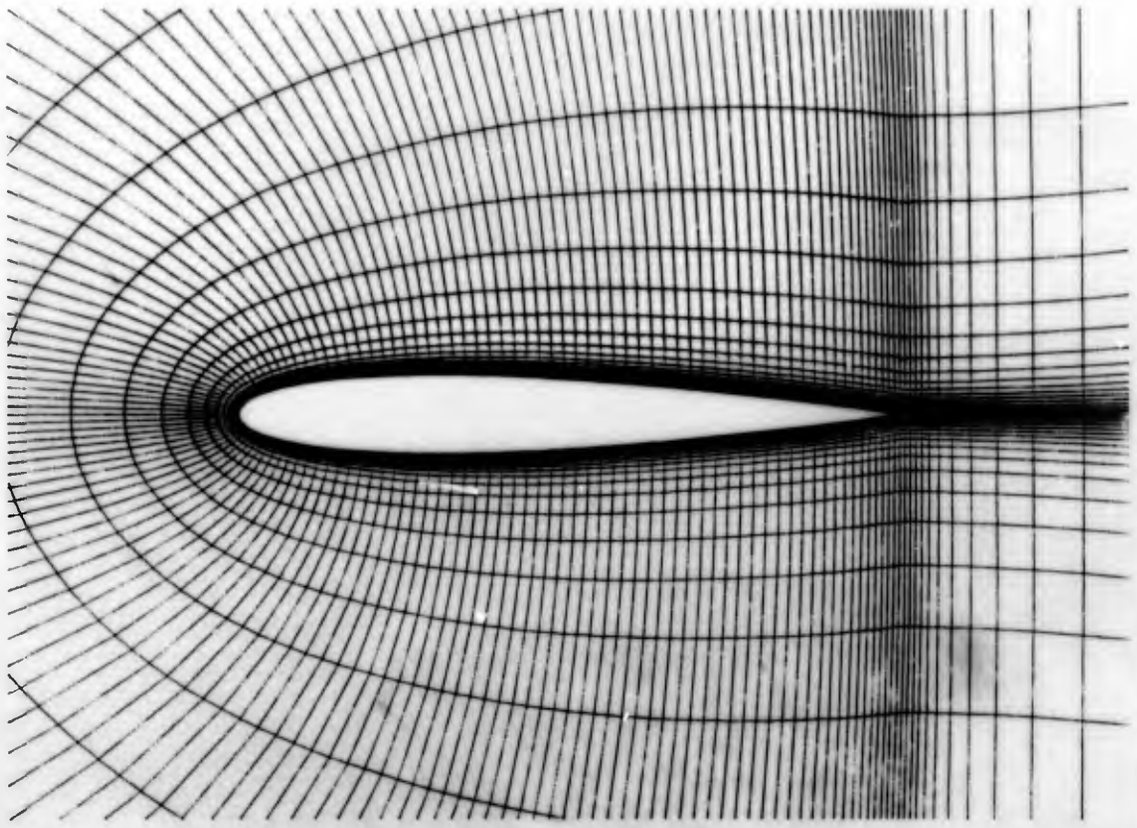
SIDES J

O.N.E.R.A.	AR 211		J.Sidès	02-2-14
	NACA 0012: MACH = 0.85, ALPHA = 1			



SIDES J

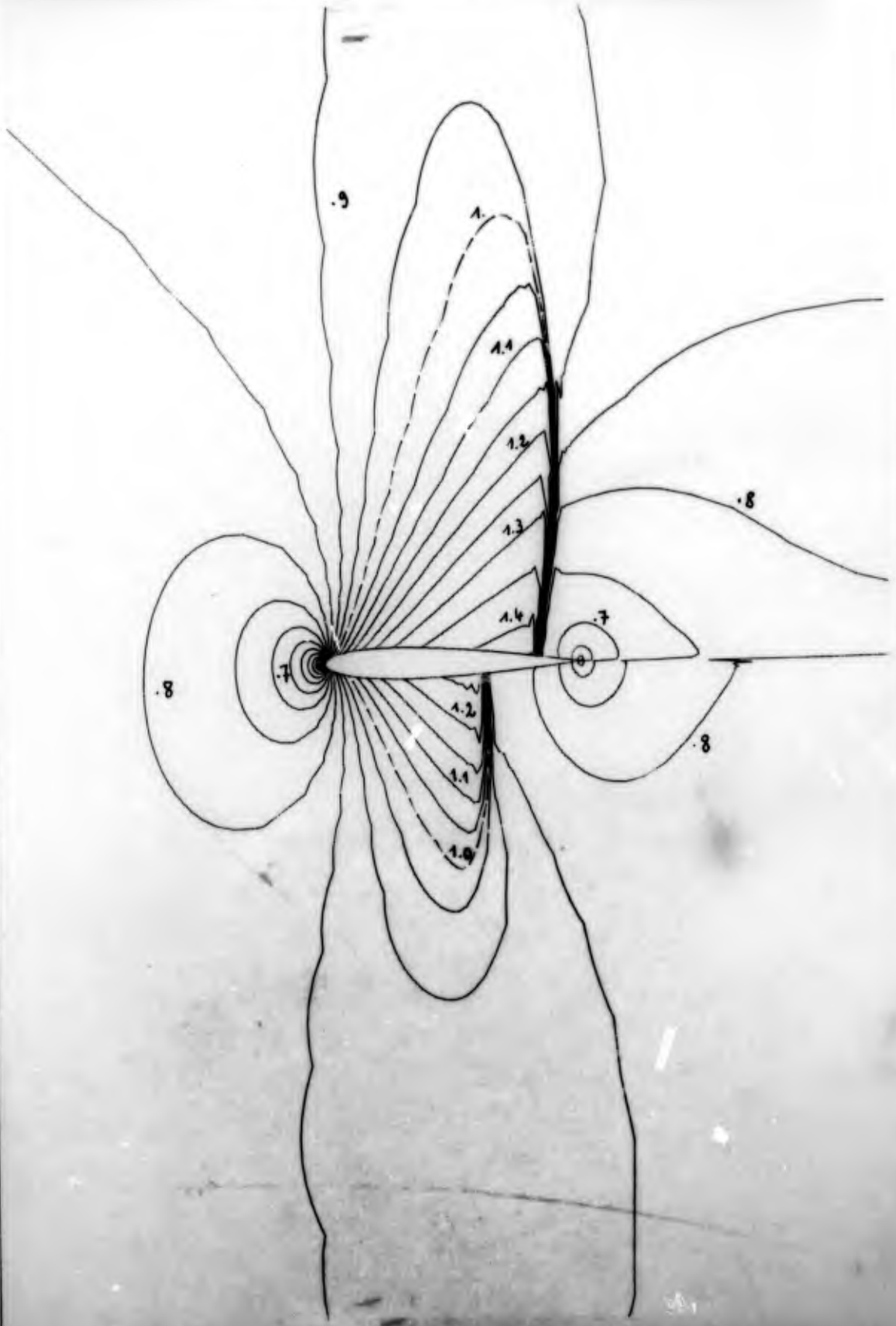
O.N.E.R.A.	AR 211		J.Sidès	02-2-15
	NACA 0012: MACH = 0.85, ALPHA = 1			



189X25 MESH (PARTIAL VIEW)

AR-SIDES

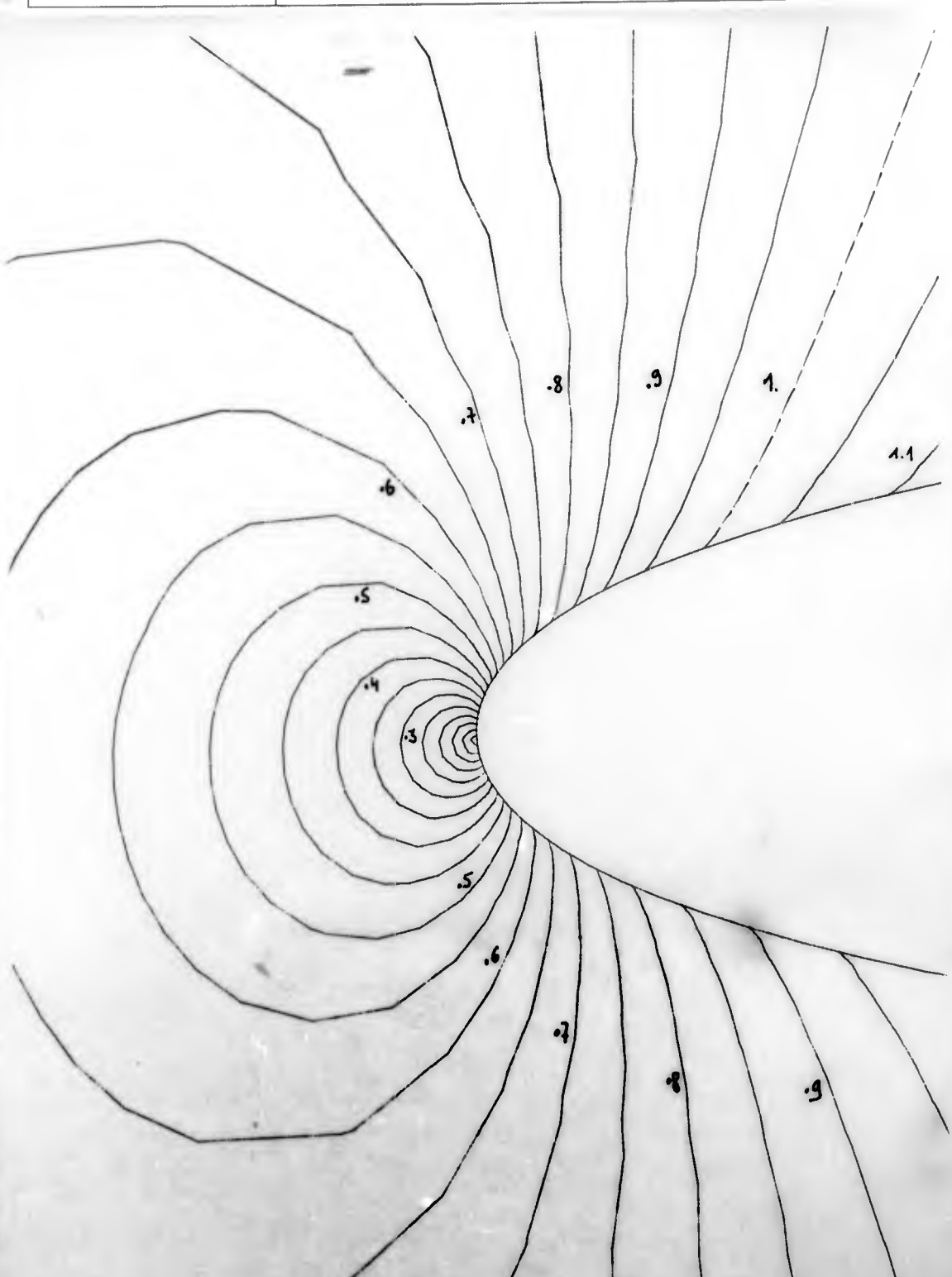
O.N.E.R.A.	AR 211		J.Sidès	02-2-16
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-MACH LINES DM=0.050 CHORD = 5 CM

AB-SIDES

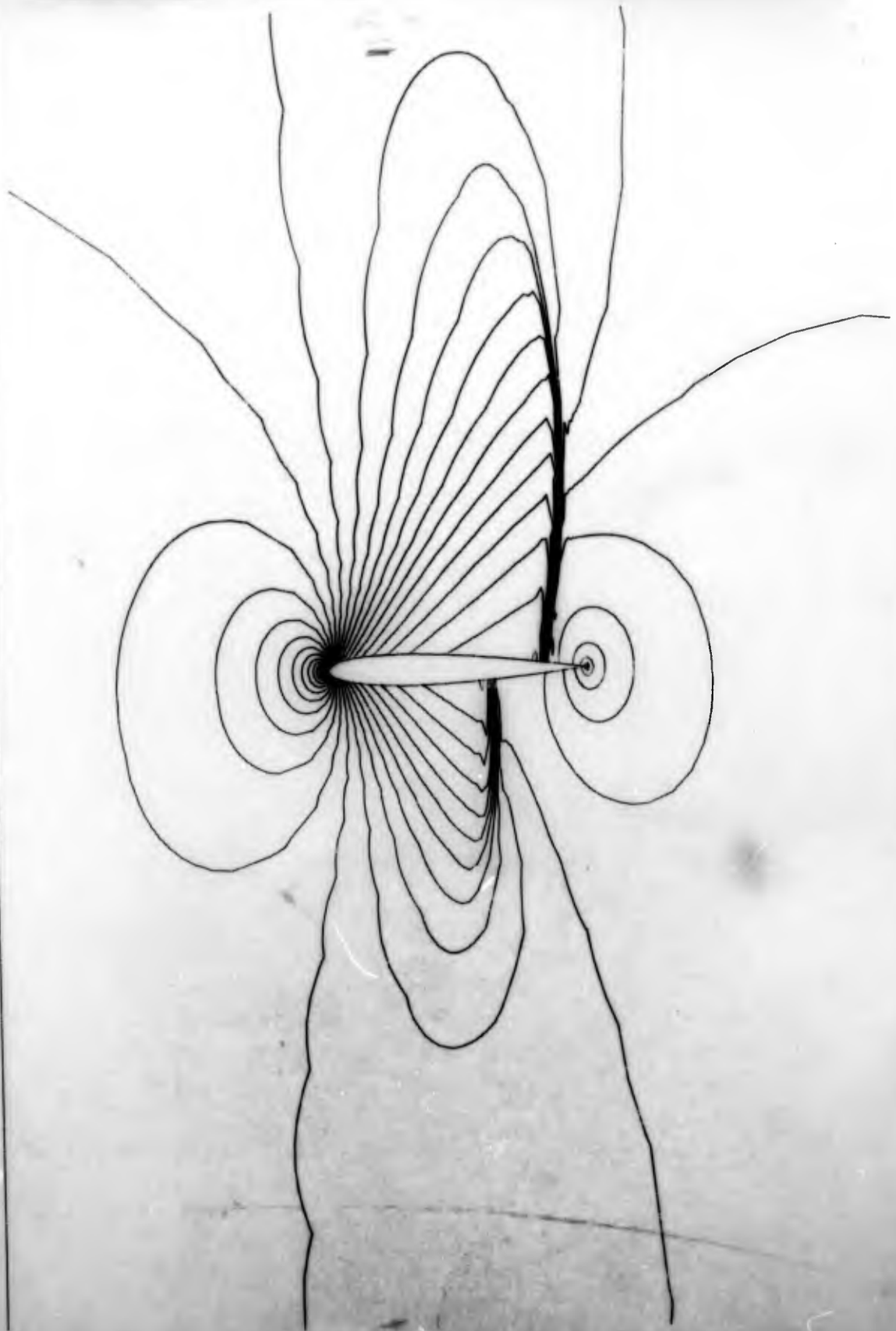
O.N.E.R.A.	AR 211		J.Sidès	02-2-17
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-MACH LINES DM=0.050 CHORD=100 CM

AB-SIDES

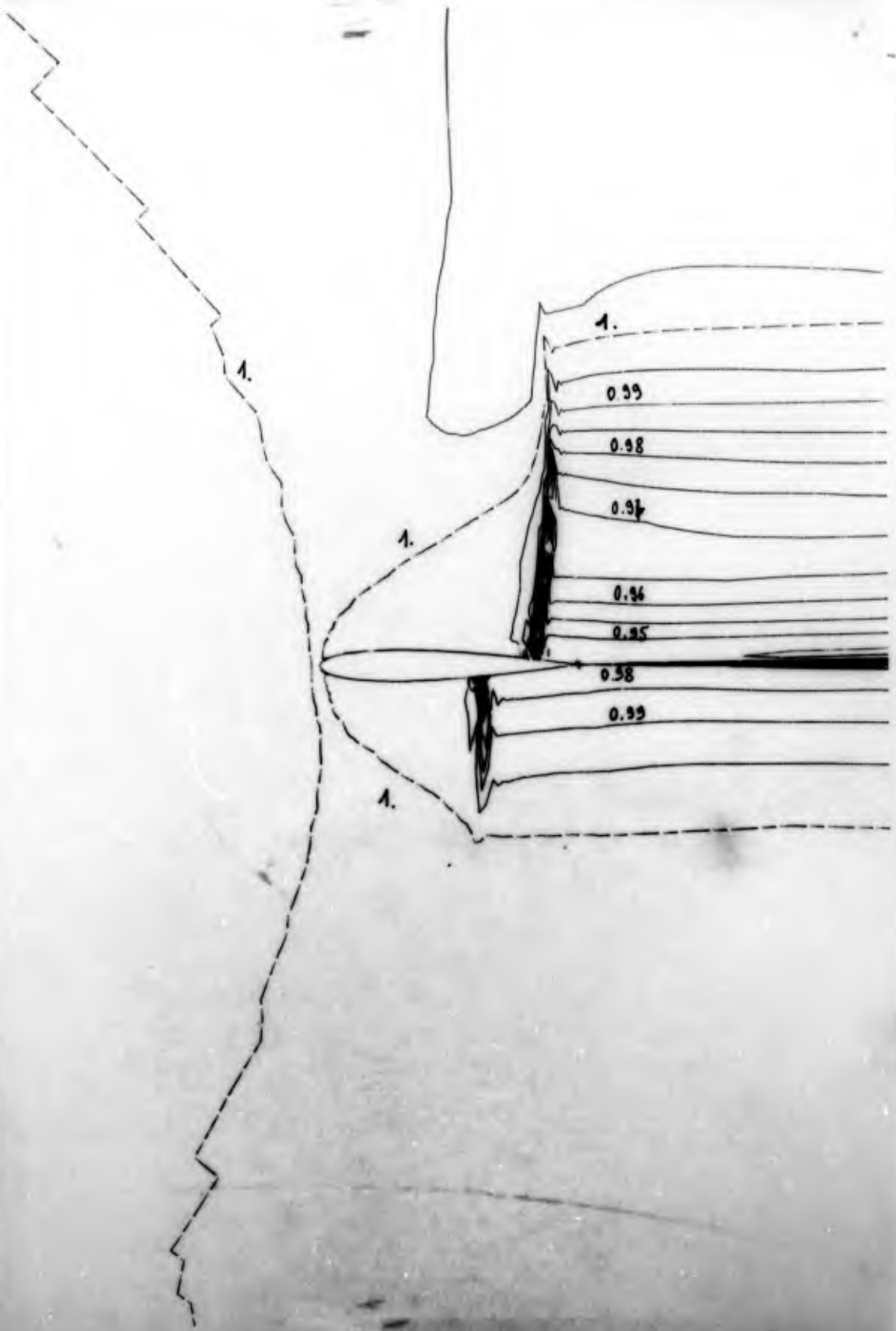
O.N.E.R.A.	AR 211		J.Sidès	02-2-18
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-P/PIINF DP=0.025 CHORD= 5 CM

AB-SIDES

O.N.E.R.A.	AR 211		J.Sidès	02-2-19
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-PI/PIINF DPI=0.005 CHORD= 5 CM

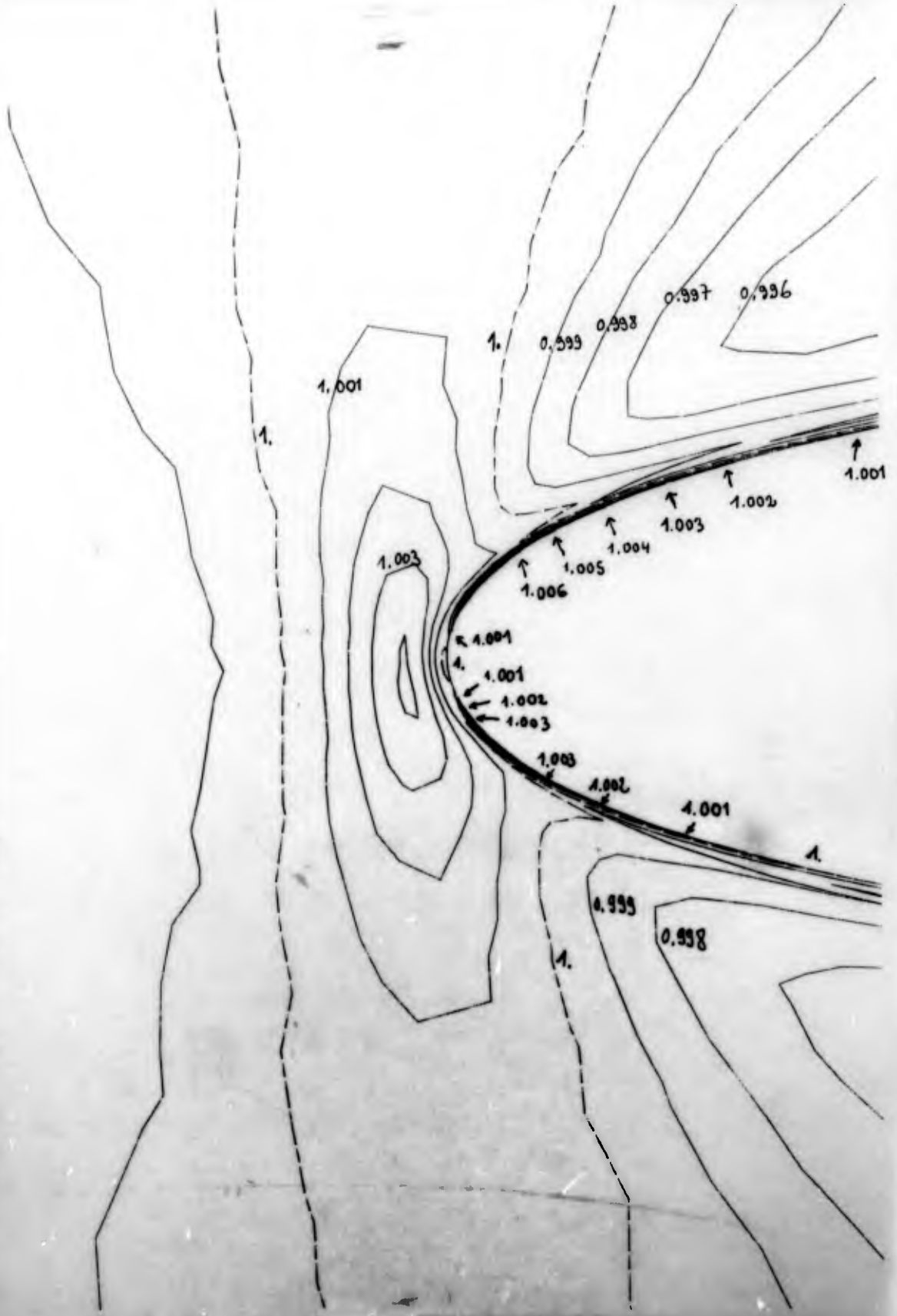
AB-SIDES

O.N.E.R.A.	AR 211		J.Sides	02-2-20
	NACA 0012: MACH = 0.85, ALPHA = 1			

ISO-PI/PIINF DPI=0.005 CHORD= 100CM

AD-SIDES

O.N.E.R.A.	AR 211		J.Sidès	02-2-21
	NACA 0012: MACH = 0.85, ALPHA = 1			



ISO-PI/PIINF DPI=0.001 CHORD= 100CM

49-SIDES

O.N.E.R.A.	AR 211		J.Sidès	02-2-2
	NACA 0012: MACH = 0.85, ALPHA = 1			

LOWER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.996075	-.000554	.238703	.436941	.613239	.018740
2	988118	-.001671	.259187	.371982	657241	.00[illegible]830
3	.979851	-.002821	.273851	.325479	.676058	.013755
4	.971086	-.004027	.284810	.290728	.691851	.015113
5	.961660	-.005309	.293960	.261710	.706041	.015337
6	.951446	-.006682	.302088	.235934	.718807	.015357
7	.940353	-.008154	.309539	.212306	.730482	.015372
8	.928329	-.009728	.316503	.190223	.741362	.015394
9	.915361	-.011400	.323050	.169460	.751582	.015410
10	.901469	-.013163	.329247	.149809	.761245	.015424
11	.886701	-.015006	.335085	.131295	.770351	.015428
12	.871129	-.016915	.340623	.113735	.778978	.015437
13	.854837	-.018876	.345755	.097461	.786987	.015430
14	.837919	-.020872	.350655	.081921	.794605	.015452
15	.820468	-.022891	.354914	.068416	.801280	.015418
16	.802577	-.024917	.359221	.054757	.807934	.015480
17	.784331	-.026939	.362253	.045141	.812775	.015371
18	.765805	-.028946	.366181	.032686	.818719	.015554
19	.747065	-.030930	.367151	.029608	.820519	.015271
20	.728166	-.032883	.371246	.016624	.826439	.015744
21	.709153	-.034798	.368829	.024288	.823320	.015088
22	.690062	-.036671	.372348	.013130	.828004	.015901
23	.670922	-.038497	.368623	.024943	.822942	.015144
24	.651754	-.040271	.355165	.067620	.802618	.014490
25	.632575	-.041992	.468257	-.291015	.958577	.040285
26	.613400	-.043656	.601857	-.714683	1.207990	.024384
27	.594238	-.045259	.632361	-.811416	1.292360	-.008118
28	.575101	-.046798	.620414	-.773531	1.258184	.005958
29	.555995	-.048270	.624813	-.787480	1.271613	-.000384
30	.536923	-.049672	.620566	-.774013	1.260849	.002806
31	.517891	-.051000	.620826	-.774838	1.262657	.001072
32	.498901	-.052250	.618332	-.766928	1.257027	.002051
33	.479957	-.053419	.617035	-.762973	1.254991	.001511
34	.461065	-.054502	.614835	-.755839	1.250379	.001809
35	.442229	-.055494	.612818	-.749443	1.246590	.001635
36	.423458	-.056389	.610319	-.741516	1.241689	.001719
37	.404760	-.057183	.607708	-.733238	1.236704	.001658
38	.386145	-.057870	.604756	-.723877	1.231033	.001671
39	.367623	-.058443	.601558	-.713734	1.224954	.001641
40	.349204	-.058896	.598033	-.702555	1.218275	.001629
41	.330901	-.059222	.594190	-.690370	1.211052	.001600
42	.312727	-.059414	.589960	-.676956	1.203145	.001578
43	.294698	-.059466	.585378	-.662425	1.194648	.001542
44	.276834	-.059369	.580379	-.646572	1.185444	.001506
45	.259155	-.059116	.574948	-.629351	1.175530	.001461
46	.241688	-.058699	.569043	-.610623	1.164841	.001410
47	.224461	-.058112	.562601	-.590196	1.153289	.001349
48	.207508	-.057346	.555562	-.567873	1.140786	.001279
49	.190867	-.056395	.547989	-.543858	1.127471	.001199
50	.174584	-.055254	.539717	-.517626	1.113085	.001099
51	.158708	-.053917	.530645	-.488859	1.097479	.000990
52	.143294	-.052383	.5209[illegible]	-.457995	1.080931	.000861
53	.128406	-.050651	.510106	-.423724	1.062782	.000[illegible]98
54	.114109	-.048722	.498476	-.386843	1.043477	.000532
55	.100476	-.046603	.485582	-.345957	1.022370	.000303
56	.087579	-.044303	.471573	-.301530	.999703	.000072
57	.075493	-.041838	.455993	-.252122	.974861	-.000252
58	.064285	-.039227	.438893	-.197897	.947901	-.000577
59	.054018	-.036494	.419821	-.137414	.918255	-.001020
60	.044737	-.033670	.398613	-.070163	.885621	-.001482
61	.036471	-.030786	.374906	.005017	.849537	-.002055
62	.029225	-.027879	.348310	.089359	.809322	-.002677
63	.022982	-.024983	.318524	.183813	.764406	-.003345
64	.017696	-.022133	.285270	.289270	.714047	-.004014
65	.013305	-.019356	.248532	.405770	.657560	-.004575
66	.009726	-.016675	.208491	.532748	.594048	-.004896
67	.006870	-.014107	.166202	.666853	.523062	-.004706
68	.004641	-.011659	.123289	.802939	.444436	-.004036
69	.002949	-.009332	.082509	.932258	.358825	-.002880
70	.001711	-.007118	.047090	1.044576	.267674	-.001564
71	.000853	-.005004	.020229	1.129757	.172870	-.000420
72	.000318	-.002969	.004392	1.179978	.076420	.000316
73	.000062	-.000984	.000843	1.191233	.020178	.000559

O.N.E.R.A.	AR 211		J.Sidès	02-2-3
	NACA 0012: MACH = 0.85, ALPHA = 1			

UPPER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
74	.000062	.000984	.009595	1.163481	.116570	.000142
75	.000318	.002969	.030566	1.096979	.213484	-.000716
76	.000853	.005004	.062754	.994906	.310327	-.001964
77	.001711	.007118	.103967	.864212	.405468	-.003460
78	.002949	.009332	.151019	.715000	.496793	-.004927
79	.004641	.011659	.200396	.558418	.582364	-.006079
80	.006870	.014107	.248987	.404329	.660675	-.006626
81	.009726	.016675	.294396	.260327	.730924	-.006634
82	.013305	.019356	.335703	.129338	.793559	-.006180
83	.017696	.022133	.372330	.013188	.848927	-.005548
84	.022982	.024983	.404596	-.089135	.898013	-.004843
85	.029225	.027879	.432846	-.178719	.941530	-.004155
86	.036471	.030786	.457614	-.257263	.980296	-.003519
87	.044737	.033670	.479353	-.326200	1.014913	-.002933
88	.054018	.036494	.498576	-.387161	1.046130	-.002456
89	.064285	.039227	.515746	-.441612	1.074508	-.002004
90	.075493	.041838	.531012	-.490022	1.100241	-.001652
91	.087579	.044304	.544909	-.534090	1.124075	-.001323
92	.100476	.046603	.557356	-.573561	1.145814	-.001057
93	.114109	.048722	.568820	-.609918	1.166176	-.000818
94	.128406	.050651	.579150	-.642674	1.184823	-.000613
95	.143294	.052383	.588762	-.673156	1.202455	-.000438
96	.158708	.053917	.597457	-.700730	1.218637	-.000276
97	.174584	.055254	.605558	-.726419	1.233939	-.000142
98	.190867	.056395	.612983	-.749966	1.248154	-.000020
99	.207508	.057346	.619810	-.771616	1.261392	.000091
100	.224461	.058112	.626178	-.791809	1.273900	.000184
101	.241688	.058699	.632038	-.810391	1.285542	.000271
102	.259155	.059116	.637443	-.827531	1.296402	.000348
103	.276834	.059369	.642443	-.843388	1.306554	.000418
104	.294698	.059466	.647076	-.858081	1.316058	.000478
105	.312727	.059415	.651360	-.871666	1.324924	.000538
106	.330901	.059222	.655344	-.884299	1.333248	.000586
107	.349204	.058896	.659010	-.895923	1.340968	.000634
108	.367623	.058443	.662401	-.906670	1.348167	.000676
109	.386145	.057870	.665541	-.916634	1.354881	.000715
110	.404760	.057184	.668445	-.925844	1.361134	.000751
111	.423458	.056390	.671134	-.934371	1.366962	.000783
112	.442229	.055494	.673622	-.942261	1.372385	.000815
113	.461069	.054502	.675927	-.949572	1.377441	.000842
114	.479957	.053419	.678062	-.956341	1.382145	.000869
115	.498901	.052251	.680045	-.962629	1.386538	.000892
116	.517891	.051000	.681884	-.968463	1.390631	.000917
117	.536923	.049672	.683600	-.973905	1.394468	.000935
118	.555995	.048270	.685198	-.978972	1.398049	.000962
119	.575101	.046798	.686703	-.983742	1.401446	.000970
120	.594238	.045259	.688101	-.988175	1.404591	.001009
121	.613400	.043656	.689450	-.992455	1.407676	.000994
122	.632575	.041993	.690681	-.996357	1.410432	.001072
123	.651754	.040272	.691949	-1.000381	1.413403	.000984
124	.670922	.038497	.693010	-1.003745	1.415697	.001190
125	.690062	.036671	.694316	-1.007885	1.418936	.000867
126	.709153	.034799	.695078	-1.010301	1.420249	.001501
127	.728166	.032884	.696774	-1.015679	1.424969	.000387
128	.747065	.030931	.696712	-1.015483	1.423329	.002506
129	.765805	.028947	.699822	-1.025348	1.433385	-.001463
130	.784331	.026940	.697233	-1.017136	1.420672	.007964
131	.802577	.024917	.706344	-1.046028	1.459276	-.016595
132	.820468	.022891	.681126	-.966059	1.357002	.044473
133	.837919	.020873	.500238	-.392431	.956294	.100335
134	.854837	.018876	.323666	.167508	.710909	.052618
135	.871129	.016916	.329948	.147587	.721167	.052623
136	.886701	.015007	.329260	.149767	.718087	.054314
137	.901469	.013164	.319855	.179593	.704436	.052817
138	.915361	.011401	.317263	.187814	.698993	.053824
139	.928329	.009729	.309709	.211769	.687212	.053281
140	.940353	.008155	.304216	.229186	.677780	.053583
141	.951446	.006683	.296984	.252120	.665947	.053458
142	.961660	.005310	.289670	.275316	.653672	.053534
143	.971086	.004027	.281100	.302493	.639625	.053290
144	.979851	.002821	.270893	.334860	.624229	.051884
145	.988118	.001672	.257073	.378685	.606091	.047840
146	.996075	.000554	.237803	.439794	.561524	.055891

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 02

NACA 0012: MACH = 0.85, ALPHA = 1

Contributor No 3

C.C.Lytton

(R.A.E., G.B.)

R.A.E.	AR 211		C.C.Lytton	02-3-1
	NACA 0012: MACH = 0.85, ALPHA = 1			

NACA0012 MACH 0.850 ALPHA 1.000 BY FORMULA 0<X<1:

VERSION 87: KEEPS WALL CELLS ROUGHLY SAME ASPECT RATIO

AFTER K=1, CELL DEPTHS INCREASE IN GEOMETRIC PROGRESSION

TOTAL CELL DEPTH =16.0*CHORD

JL	KL	NEND	NPRNT
160	24	0	0

CP*	P(CR)	CPS	P(ST)
-0.3020	0.8376	1.1939	1.5856

J	X/C	Z/C	1-P/H	CP	M	1-PI/H
2	1.000	-0.0000	0.1863	0.6031	0.5331	0.0126
3	0.999	-0.0001	0.2061	0.5404	0.5677	0.0120
4	0.997	-0.0004	0.2240	0.4835	0.5988	0.0112
5	0.995	-0.0007	0.2381	0.4389	0.6218	0.0112
6	0.992	-0.0011	0.2499	0.4016	0.6413	0.0108
7	0.988	-0.0017	0.2600	0.3694	0.6576	0.0107
8	0.983	-0.0024	0.2690	0.3407	0.6719	0.0108
9	0.978	-0.0031	0.2774	0.3143	0.6850	0.0108
10	0.972	-0.0040	0.2851	0.2897	0.6971	0.0109
11	0.965	-0.0049	0.2924	0.2668	0.7084	0.0110
12	0.957	-0.0060	0.2991	0.2454	0.7190	0.0110
13	0.948	-0.0071	0.3054	0.2255	0.7288	0.0110
14	0.939	-0.0083	0.3113	0.2068	0.7380	0.0110
15	0.930	-0.0096	0.3169	0.1889	0.7467	0.0110
16	0.919	-0.0109	0.3223	0.1718	0.7551	0.0110
17	0.908	-0.0124	0.3275	0.1554	0.7632	0.0110
18	0.896	-0.0138	0.3324	0.1397	0.7709	0.0110
19	0.884	-0.0154	0.3372	0.1246	0.7783	0.0109
20	0.871	-0.0170	0.3417	0.1102	0.7855	0.0109
21	0.857	-0.0186	0.3461	0.0963	0.7923	0.0108
22	0.843	-0.0203	0.3503	0.0830	0.7989	0.0107
23	0.828	-0.0220	0.3543	0.0704	0.8051	0.0107
24	0.813	-0.0238	0.3580	0.0587	0.8109	0.0106
25	0.797	-0.0255	0.3614	0.0478	0.8163	0.0106
26	0.781	-0.0273	0.3646	0.0376	0.8213	0.0105
27	0.764	-0.0291	0.3675	0.0285	0.8259	0.0104
28	0.747	-0.0309	0.3700	0.0207	0.8298	0.0104
29	0.730	-0.0327	0.3719	0.0145	0.8329	0.0103
30	0.712	-0.0345	0.3733	0.0102	0.8350	0.0103
31	0.694	-0.0363	0.3742	0.0073	0.8363	0.0104
32	0.675	-0.0381	0.3737	0.0087	0.8358	0.0103
33	0.656	-0.0399	0.3723	0.0132	0.8333	0.0105
34	0.637	-0.0416	0.3670	0.0301	0.8249	0.0106
35	0.618	-0.0433	0.5644	-0.5958	1.1551	0.0031
36	0.599	-0.0449	0.6246	-0.7867	1.2721	-0.0017
37	0.579	-0.0465	0.6222	-0.7793	1.2675	-0.0018
38	0.559	-0.0480	0.6214	-0.7768	1.2659	-0.0017
39	0.540	-0.0495	0.6201	-0.7724	1.2632	-0.0017
40	0.520	-0.0509	0.6185	-0.7676	1.2602	-0.0017
41	0.500	-0.0522	0.6168	-0.7621	1.2569	-0.0018
42	0.480	-0.0534	0.6149	-0.7561	1.2532	-0.0018
43	0.460	-0.0545	0.6128	-0.7493	1.2491	-0.0019
44	0.441	-0.0556	0.6104	-0.7419	1.2446	-0.0019
45	0.421	-0.0565	0.6078	-0.7336	1.2397	-0.0020

R.A.E.	AR 211		C.C.Lytton	02-3-2
	NACA 0012: MACH = 0.85, ALPHA = 1			

46	0.401	-0.0573	0.6050	-0.7247	1.2344	-0.0022
47	0.382	-0.0580	0.6019	-0.7147	1.2285	-0.0023
48	0.363	-0.0586	0.5984	-0.7038	1.2221	-0.0024
49	0.344	-0.0590	0.5947	-0.6920	1.2151	-0.0025
50	0.325	-0.0593	0.5906	-0.6790	1.2075	-0.0026
51	0.306	-0.0594	0.5861	-0.6648	1.1993	-0.0026
52	0.288	-0.0594	0.5816	-0.6505	1.1912	-0.0030
53	0.270	-0.0593	0.5766	-0.6347	1.1820	-0.0029
54	0.253	-0.0590	0.5710	-0.6170	1.1719	-0.0030
55	0.236	-0.0585	0.5651	-0.5982	1.1614	-0.0033
56	0.219	-0.0579	0.5590	-0.5787	1.1503	-0.0031
57	0.203	-0.0571	0.5518	-0.5561	1.1380	-0.0035
58	0.187	-0.0562	0.5453	-0.5353	1.1267	-0.0038
59	0.172	-0.0551	0.5374	-0.5103	1.1130	-0.0038
60	0.157	-0.0538	0.5284	-0.4818	1.0977	-0.0041
61	0.143	-0.0524	0.5203	-0.4560	1.0842	-0.0045
62	0.129	-0.0508	0.5098	-0.4227	1.0665	-0.0045
63	0.116	-0.0491	0.5002	-0.3922	1.0506	-0.0047
64	0.104	-0.0472	0.4889	-0.3564	1.0324	-0.0052
65	0.092	-0.0452	0.4771	-0.3191	1.0131	-0.0051
66	0.081	-0.0430	0.4637	-0.2765	0.9919	-0.0057
67	0.070	-0.0407	0.4501	-0.2334	0.9701	-0.0057
68	0.061	-0.0383	0.4340	-0.1825	0.9449	-0.0058
69	0.052	-0.0358	0.4162	-0.1259	0.9170	-0.0059
70	0.043	-0.0331	0.3966	-0.0639	0.8866	-0.0058
71	0.035	-0.0304	0.3741	0.0077	0.8516	-0.0055
72	0.028	-0.0275	0.3491	0.0867	0.8129	-0.0050
73	0.022	-0.0246	0.3203	0.1782	0.7686	-0.0048
74	0.017	-0.0216	0.2854	0.2890	0.7143	-0.0041
75	0.012	-0.0184	0.2448	0.4178	0.6497	-0.0029
76	0.008	-0.0153	0.1945	0.5772	0.5692	-0.0035
77	0.005	-0.0120	0.1378	0.7569	0.4717	-0.0042
78	0.003	-0.0086	0.0764	0.9517	0.3482	-0.0044
79	0.001	-0.0052	0.0173	1.1390	0.1968	-0.0096
80	0.000	-0.0018	-0.0049	1.2094	0.0715	-0.0085
81	0.000	0.0018	0.0056	1.1762	0.1559	-0.0114
82	0.001	0.0052	0.0635	0.9926	0.3171	-0.0041
83	0.003	0.0086	0.1422	0.7430	0.4732	0.0001
84	0.005	0.0120	0.2127	0.5195	0.5939	0.0005
85	0.008	0.0153	0.2766	0.3167	0.6950	0.0010
86	0.012	0.0184	0.3290	0.1506	0.7769	0.0001
87	0.017	0.0216	0.3713	0.0163	0.8427	-0.0007
88	0.022	0.0246	0.4052	-0.0909	0.8956	-0.0012
89	0.028	0.0275	0.4332	-0.1797	0.9403	-0.0022
90	0.035	0.0304	0.4565	-0.2537	0.9787	-0.0038
91	0.043	0.0331	0.4766	-0.3174	1.0096	-0.0020
92	0.052	0.0358	0.4965	-0.3806	1.0437	-0.0037
93	0.061	0.0383	0.5101	-0.4238	1.0652	-0.0022
94	0.070	0.0407	0.5251	-0.4713	1.0908	-0.0025
95	0.081	0.0430	0.5386	-0.5142	1.1141	-0.0025
96	0.092	0.0452	0.5495	-0.5488	1.1328	-0.0021
97	0.104	0.0472	0.5605	-0.5836	1.1518	-0.0014
98	0.116	0.0491	0.5708	-0.6160	1.1699	-0.0011
99	0.129	0.0508	0.5790	-0.6422	1.1848	-0.0010
100	0.143	0.0524	0.5879	-0.6703	1.2004	0.0001
101	0.157	0.0538	0.5961	-0.6965	1.2158	0.0001
102	0.172	0.0551	0.6033	-0.7194	1.2294	0.0003
103	0.187	0.0562	0.6103	-0.7413	1.2423	0.0008
104	0.203	0.0571	0.6167	-0.7617	1.2546	0.0011
105	0.219	0.0579	0.6226	-0.7804	1.2660	0.0012

R.A.E.	AR 211		C.C.Lytton	02-3-3
	NACA 0012: MACH = 0.85, ALPHA = 1			

106	0.236	0.0585	0.6282	-0.7982	1.2769	0.0015
107	0.253	0.0590	0.6336	-0.8152	1.2876	0.0017
108	0.270	0.0593	0.6385	-0.8310	1.2976	0.0017
109	0.288	0.0594	0.6432	-0.8457	1.3070	0.0018
110	0.306	0.0594	0.6475	-0.8595	1.3158	0.0020
111	0.325	0.0593	0.6517	-0.8726	1.3246	0.0018
112	0.344	0.0590	0.6555	-0.8847	1.3328	0.0016
113	0.363	0.0586	0.6590	-0.8959	1.3403	0.0016
114	0.382	0.0580	0.6622	-0.9061	1.3471	0.0016
115	0.401	0.0573	0.6652	-0.9156	1.3533	0.0018
116	0.421	0.0565	0.6680	-0.9245	1.3593	0.0021
117	0.441	0.0556	0.6707	-0.9329	1.3649	0.0022
118	0.460	0.0545	0.6731	-0.9407	1.3703	0.0023
119	0.480	0.0534	0.6754	-0.9480	1.3753	0.0024
120	0.500	0.0522	0.6776	-0.9548	1.3800	0.0024
121	0.520	0.0509	0.6795	-0.9610	1.3843	0.0025
122	0.540	0.0495	0.6814	-0.9668	1.3884	0.0025
123	0.559	0.0480	0.6831	-0.9722	1.3922	0.0024
124	0.579	0.0465	0.6847	-0.9772	1.3958	0.0024
125	0.599	0.0449	0.6861	-0.9820	1.3992	0.0024
126	0.618	0.0433	0.6876	-0.9865	1.4023	0.0025
127	0.637	0.0416	0.6889	-0.9907	1.4053	0.0026
128	0.656	0.0399	0.6902	-0.9947	1.4081	0.0027
129	0.675	0.0381	0.6914	-0.9986	1.4109	0.0027
130	0.694	0.0363	0.6926	-1.0024	1.4136	0.0028
131	0.712	0.0345	0.6937	-1.0060	1.4162	0.0029
132	0.730	0.0327	0.6949	-1.0096	1.4187	0.0029
133	0.747	0.0309	0.6959	-1.0130	1.4212	0.0029
134	0.764	0.0291	0.6970	-1.0164	1.4237	0.0029
135	0.781	0.0273	0.6980	-1.0195	1.4260	0.0029
136	0.797	0.0255	0.6989	-1.0224	1.4282	0.0029
137	0.813	0.0238	0.6998	-1.0253	1.4298	0.0037
138	0.828	0.0220	0.7021	-1.0326	1.4366	0.0016
139	0.843	0.0203	0.6894	-0.9922	1.4864	-0.1182
140	0.857	0.0186	0.3619	0.0463	0.8002	0.0271
141	0.871	0.0170	0.3372	0.1245	0.7632	0.0253
142	0.884	0.0154	0.3353	0.1306	0.7615	0.0241
143	0.896	0.0138	0.3315	0.1426	0.7558	0.0239
144	0.908	0.0124	0.3270	0.1570	0.7484	0.0241
145	0.919	0.0109	0.3219	0.1730	0.7402	0.0243
146	0.930	0.0096	0.3166	0.1900	0.7314	0.0245
147	0.939	0.0083	0.3109	0.2080	0.7222	0.0247
148	0.948	0.0071	0.3050	0.2267	0.7126	0.0250
149	0.957	0.0060	0.2988	0.2462	0.7026	0.0252
150	0.965	0.0049	0.2923	0.2669	0.6919	0.0254
151	0.972	0.0040	0.2853	0.2891	0.6804	0.0257
152	0.978	0.0031	0.2776	0.3134	0.6678	0.0259
153	0.983	0.0024	0.2693	0.3400	0.6540	0.0261
154	0.988	0.0017	0.2601	0.3692	0.6389	0.0262
155	0.992	0.0011	0.2499	0.4016	0.6217	0.0265
156	0.995	0.0007	0.2380	0.4393	0.6015	0.0269
157	0.997	0.0004	0.2237	0.4844	0.5778	0.0267
158	0.999	0.0001	0.2053	0.5427	0.5455	0.0272
159	1.000	0.0000	0.1862	0.6034	0.5104	0.0279

k.A.E.	AR 211		C.C.Lytton	02-3-4
	NACA 0012: MACH = 0.85, ALPHA = 1			

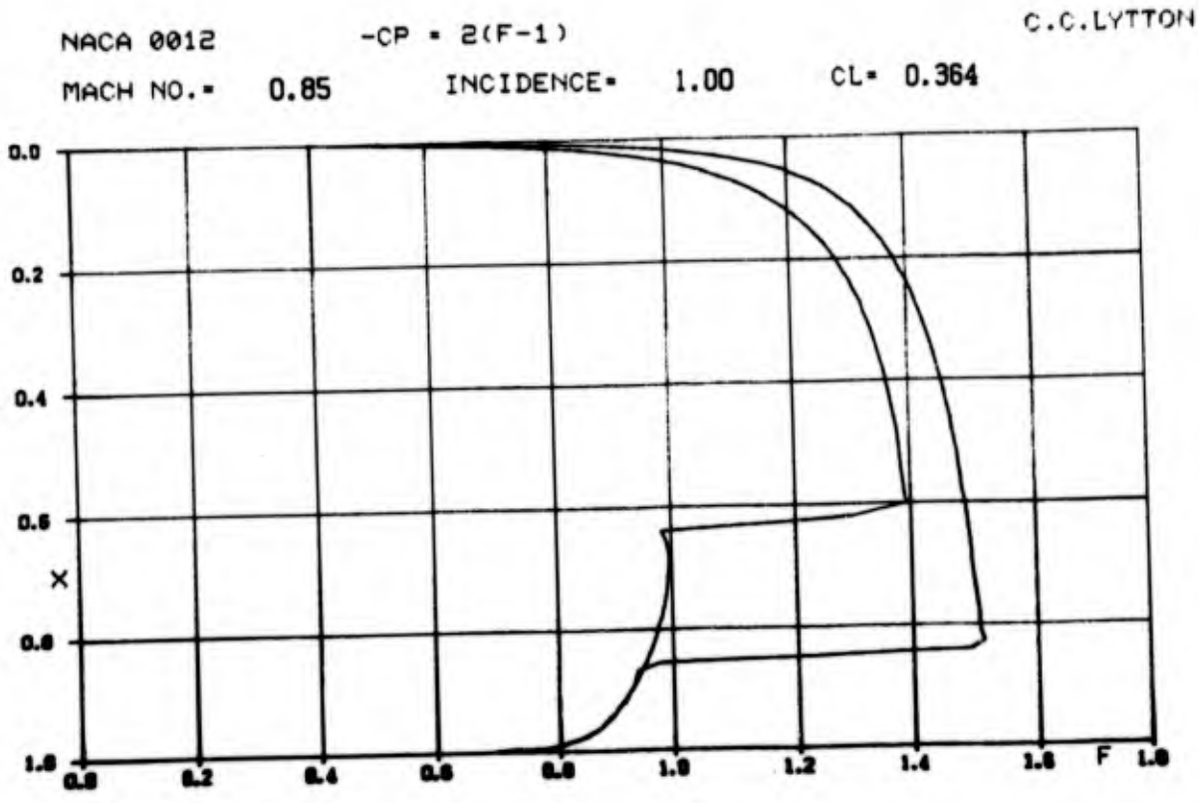
CL= 0.36371 CD= 0.05559 CM= -0.12092

GAMMA AROUND PROFILE = 0.18696

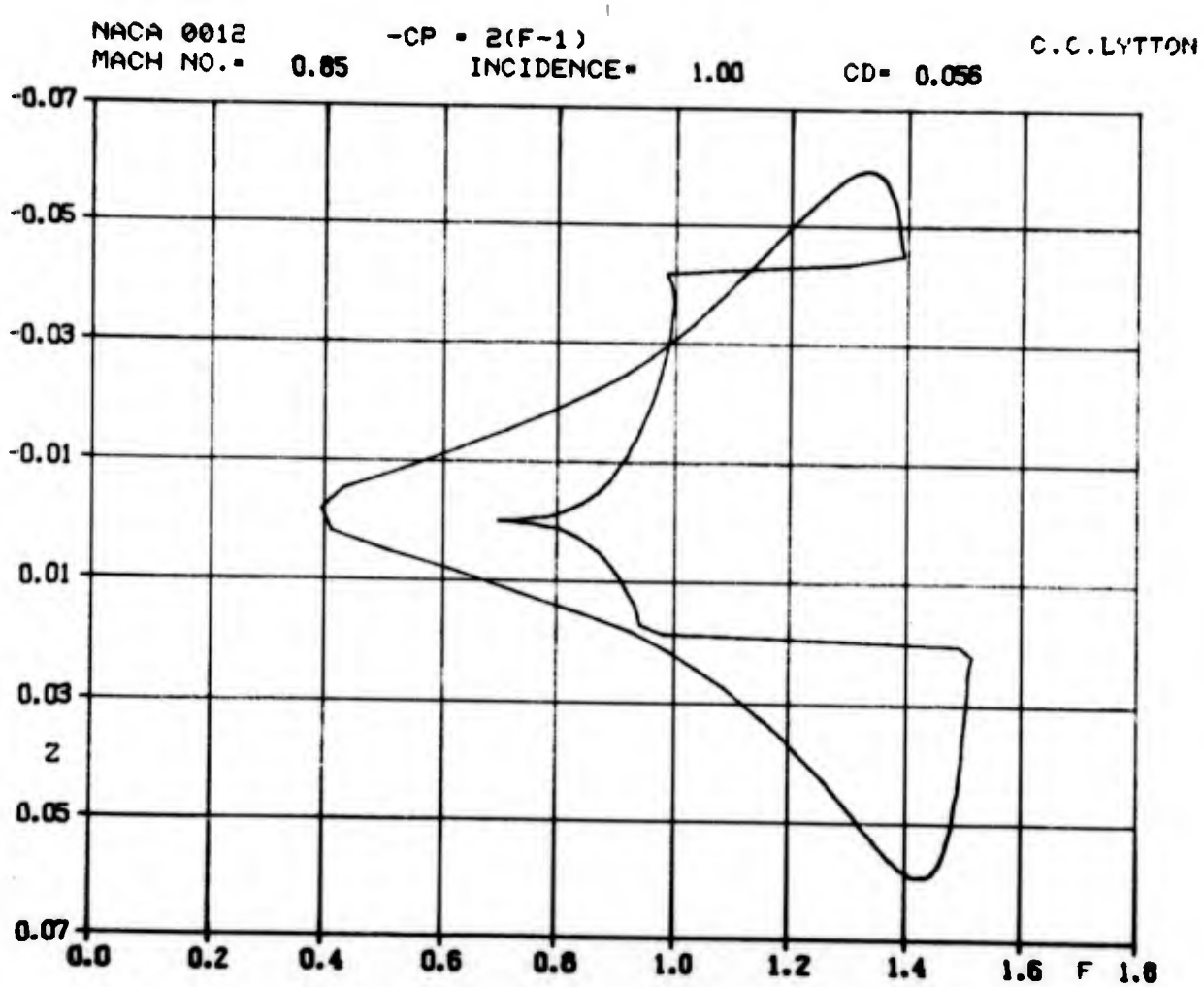
K	GAMMA
1	0.18737
2	0.18919
3	0.18518
4	0.18629
5	0.18360
6	0.18179
7	0.18084
8	0.17853
9	0.17571
10	0.17226
11	0.16930
12	0.16974
13	0.17378
14	0.17664
15	0.17863
16	0.18002
17	0.18044
18	0.18081
19	0.18169
20	0.18284
21	0.18357
22	0.18421
23	0.18687

CD (SHOCK INTEGRAL - Mk.2) = 0.05252

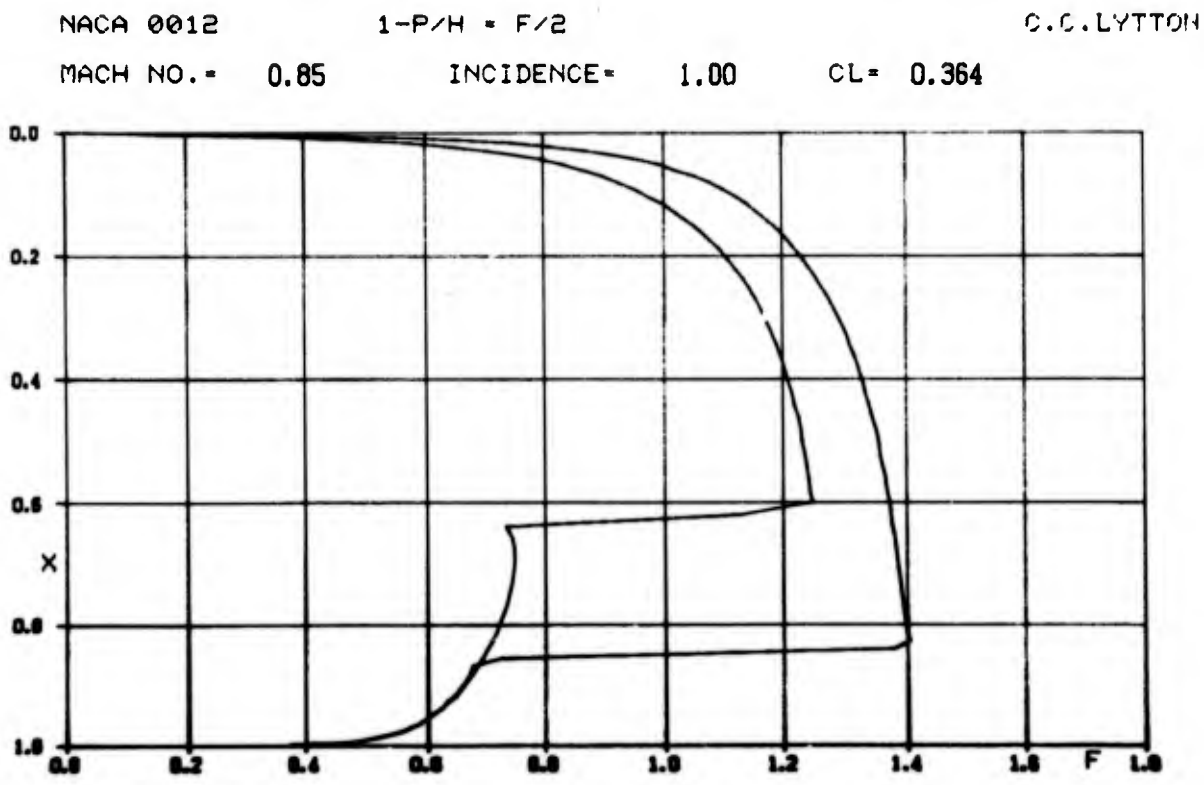
R.A.E.	AR 211		C.C.Lytton	02-3-5
	NACA 0012: MACH = 0.85, ALPHA = 1			



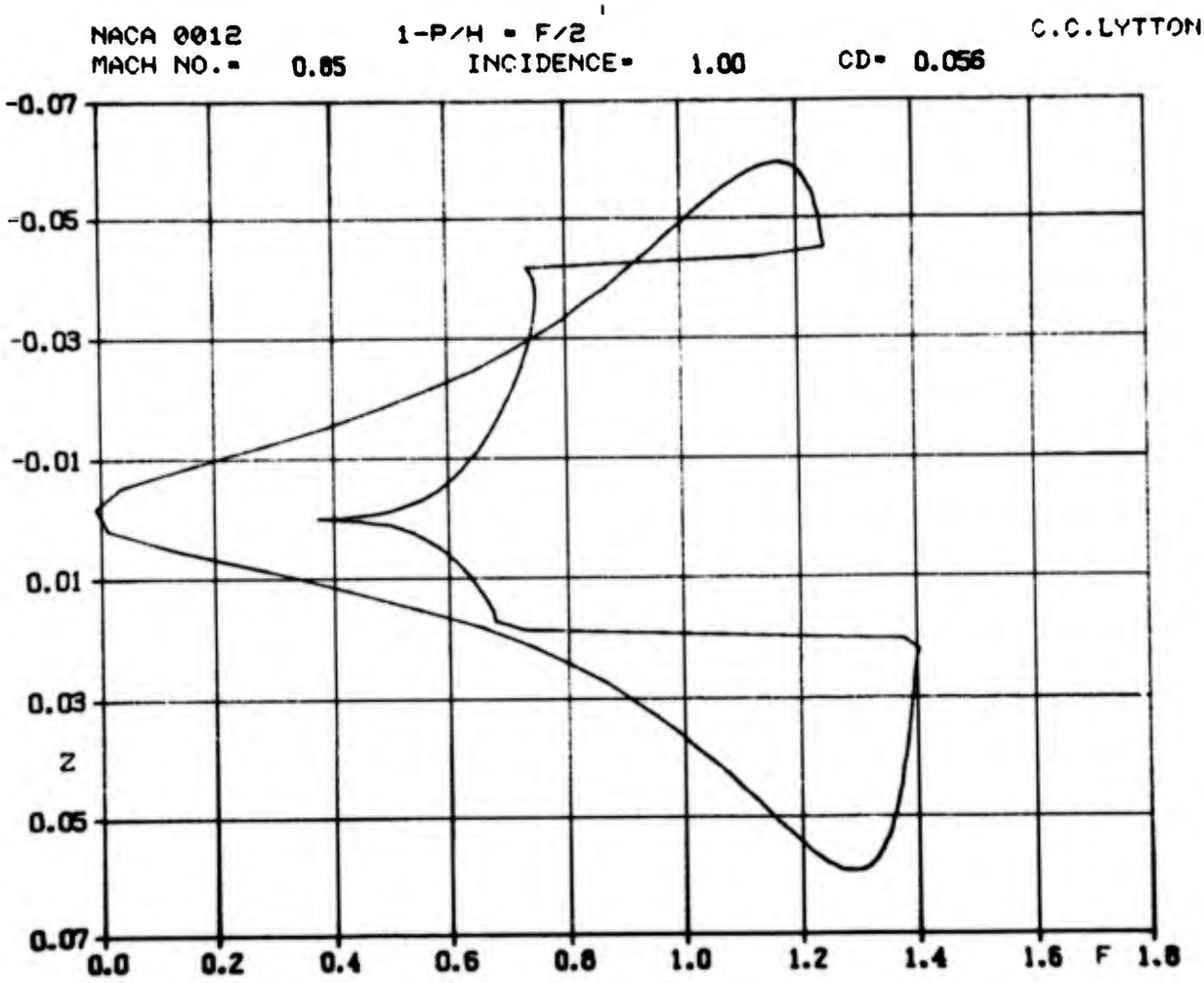
R.A.E.	AR 211		C.C.Lytton	02-3-6
	NACA 0012: MACH = 0.85, ALPHA = 1			



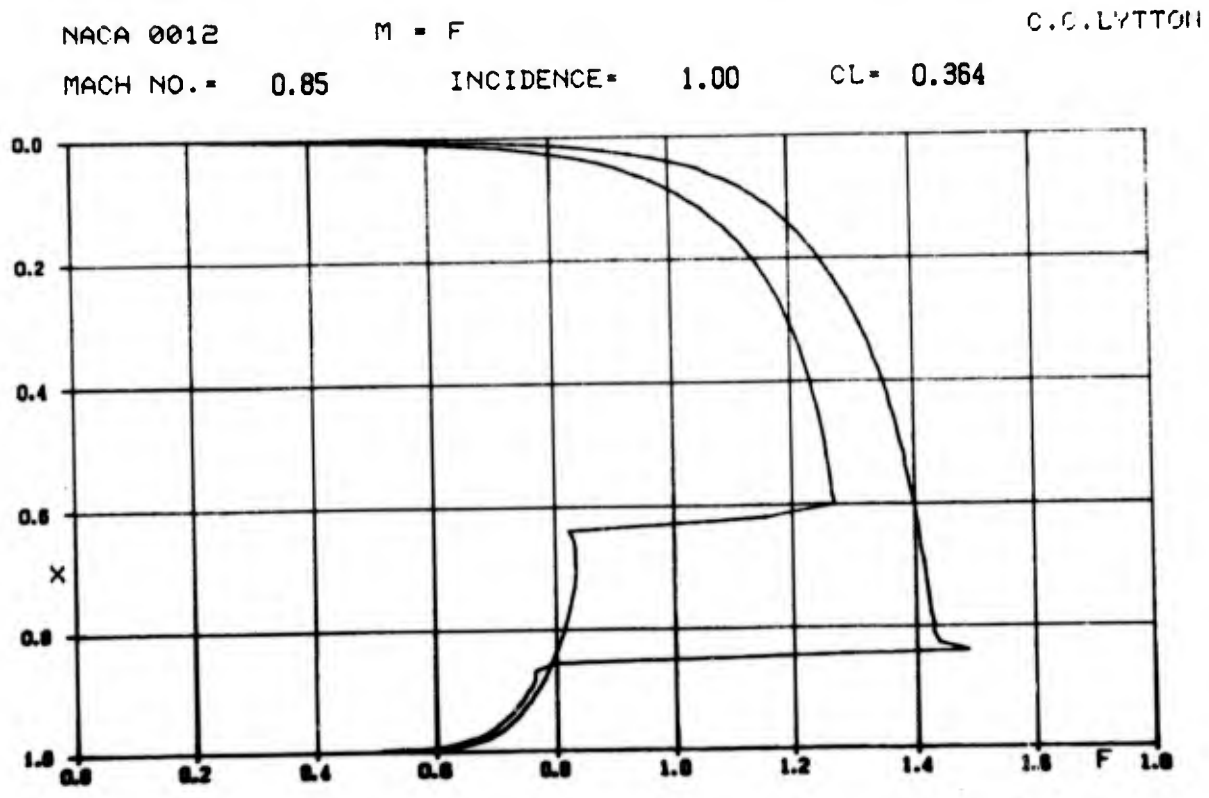
R.A.E.	AR 211		C.C.Lytton	02-3-7
	NACA 0012: MACH = 0.85, ALPHA = 1			



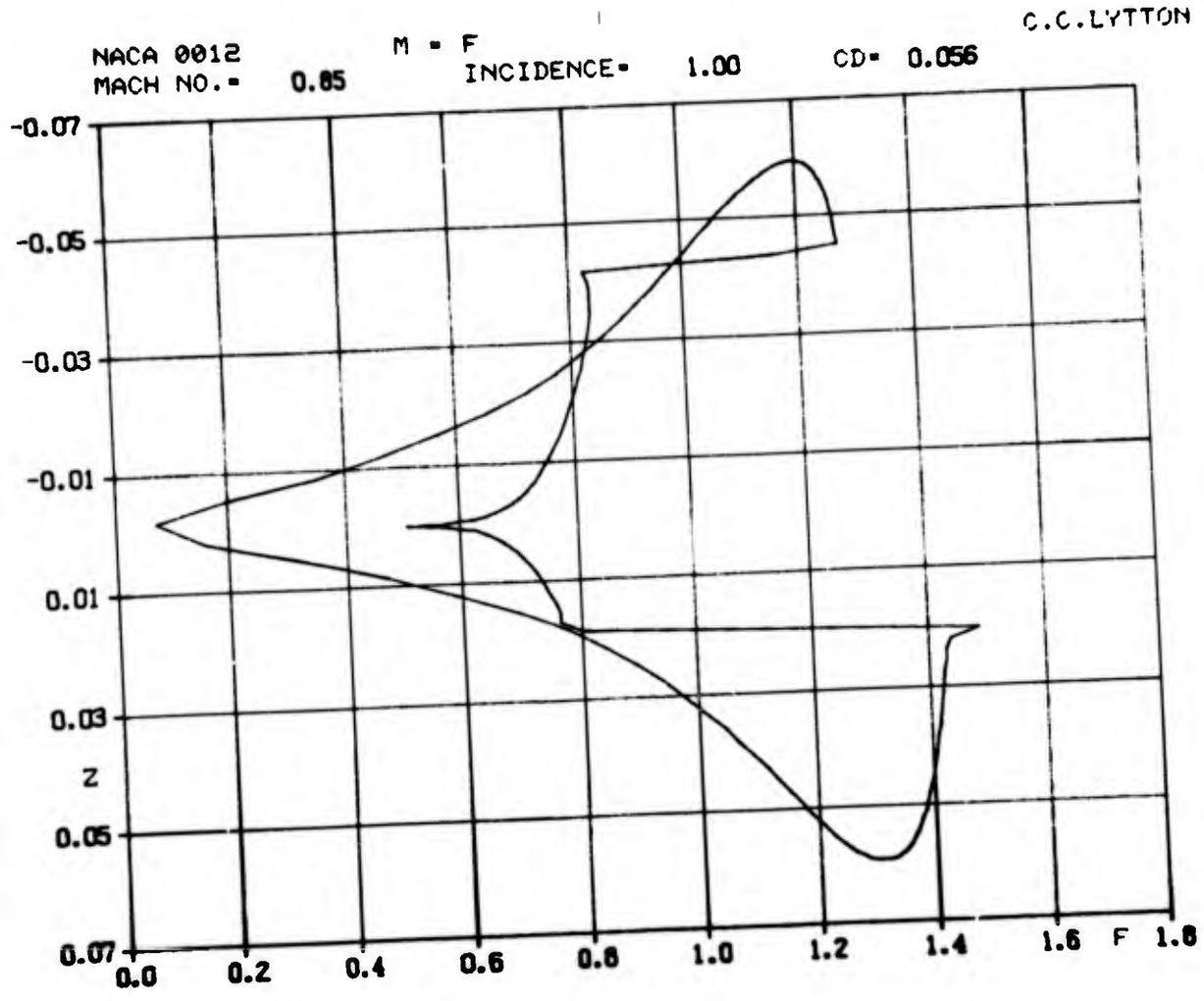
R.A.E.	AR 211		C.C.Lytton	02-3-8
	NACA 0012: MACH = 0.85, ALPHA = 1			



R.A.E.	AR 211		C.C.Lytton	02-3-9
	NACA 0012: MACH = 0.85, ALPHA = 1			



R.A.E.	AR 211		C.C.Lytton	02-3-10
	NACA 0012: MACH = 0.85, ALPHA = 1			

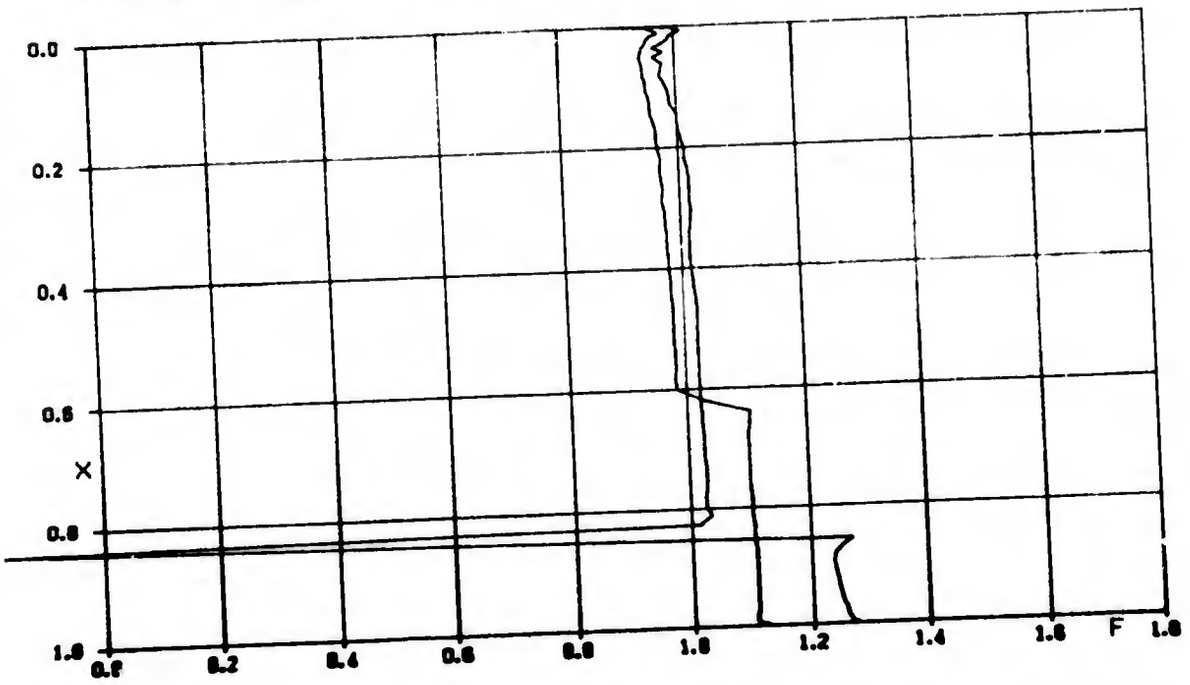


R.A.E.	AR 211		C.C.Lytton	02-3-11
	NACA 0012: MACH = 0.85, ALPHA = 1			

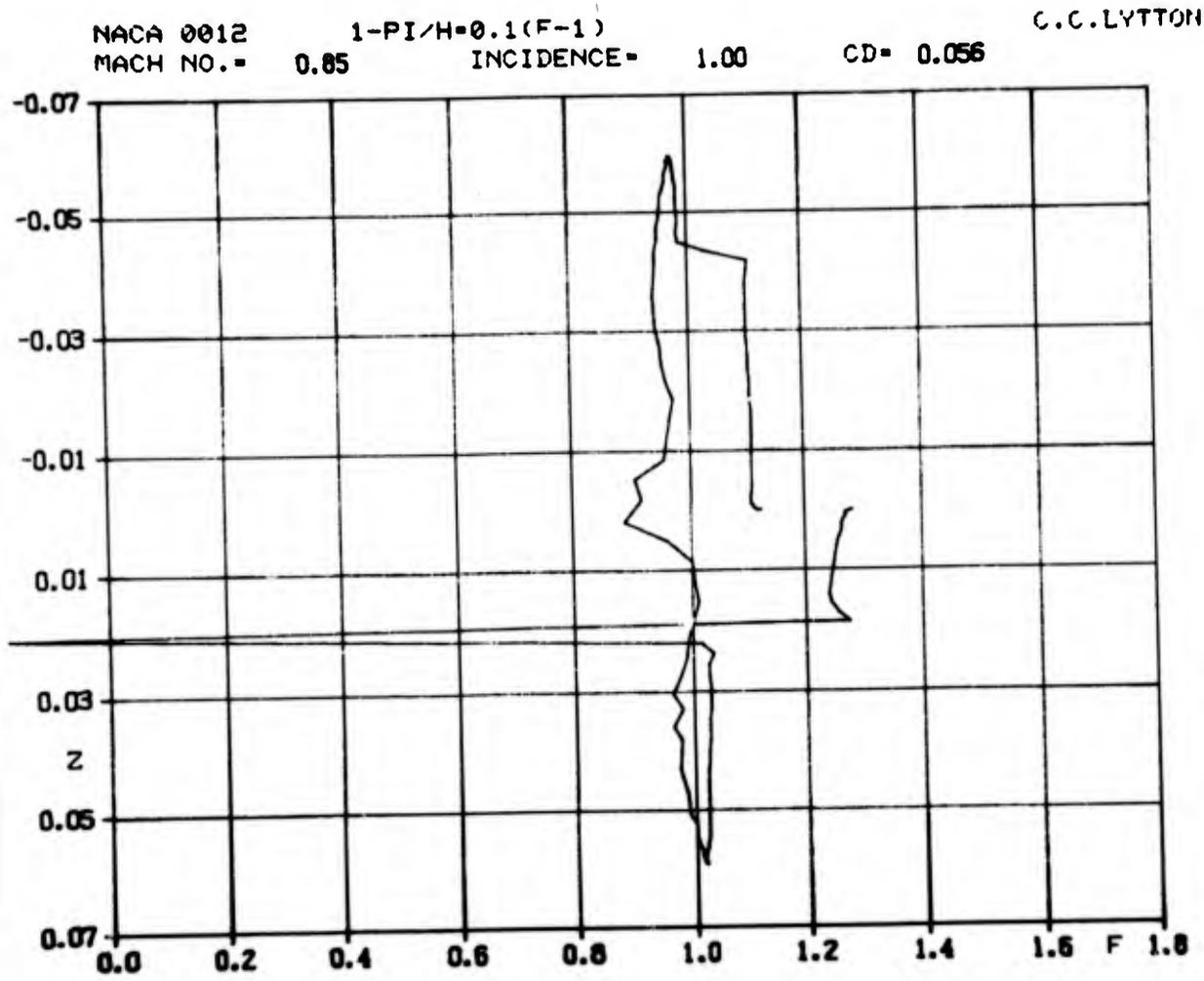
C.C.LYTTON

NACA 0012 1-PI/H=0.1(F-1)

MACH NO.= 0.85 INCIDENCE= 1.00 CL= 0.364

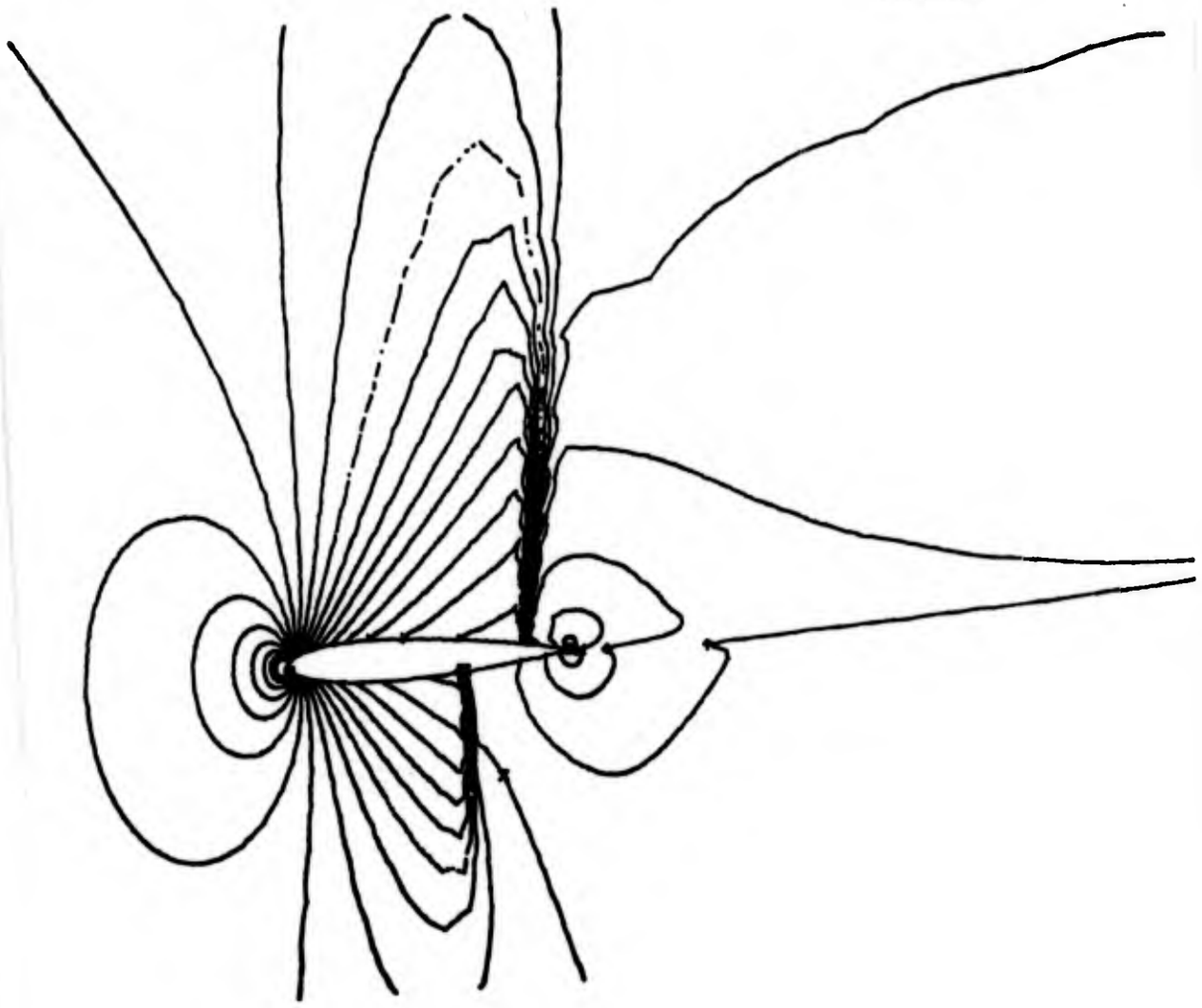


R.A.E.	AR 211		C.C.Lytton	02-3-12
	NACA 0012: MACH = 0.85, ALPHA = 1			



R.A.E.	AR 211		C.C.Lytton	02-3-13
	NACA 0012: MACH = 0.85, ALPHA = 1			

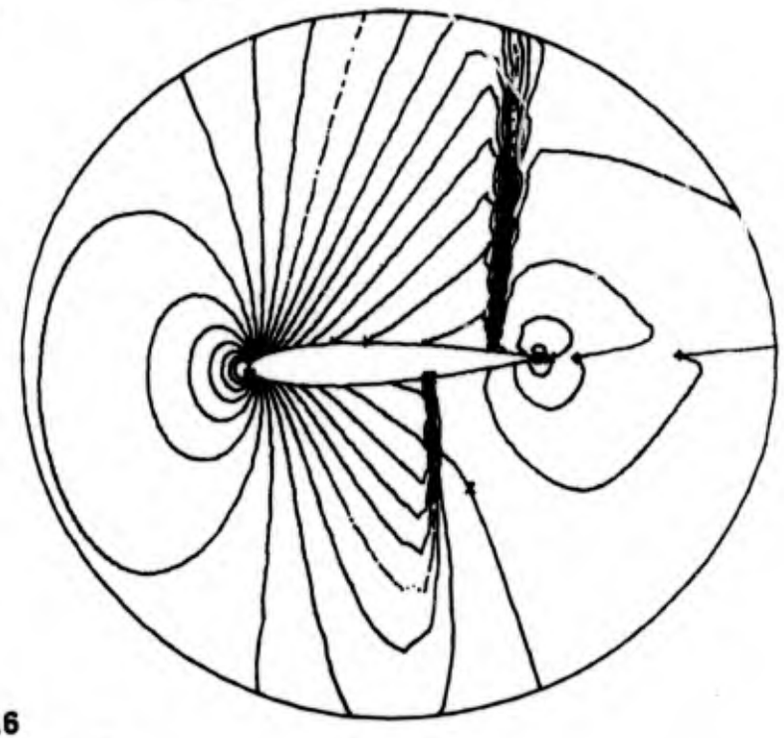
ISOMACHS



R.A.E.	AR 211		C.C.Lytton	02-3-14
	NACA 0012: MACH = 0.85, ALPHA = 1			

NACA 0012 M=0.85 A=1.0 CCL .... ISOMACHS

1.16



-1.16 1.84

-0.78

0.50 ■	0.55 ●	0.60 ▲	0.65 ✦	0.70 ×	0.75 ◆	0.80 ✦	0.85 ×
0.90 z	0.95 Y	1.00 x	1.05 ■	1.10 x	1.15 !	1.20 ✦	1.25 -
1.30 :	1.35 !	1.40 :	1.45 -	1.50 •	1.55 ▲	1.60 •	1.65 •
1.70 •	1.75 •	1.80 •					

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 02

NACA 0012: MACH = 0.85, ALPHA = 1

Contributor No 5

T.H.Pulliam and J.T.Barton

(N.A.S.A. — Ames, U.S.A.)

§6b AGARD02 NACA0012 $M = 0.85 \quad \alpha = 1.0$

Grid

The grid for AGARD02 is presented in Figures 2a – 2e, with the full extent given in Fig. 2a and closeups in Figs. 2b – 2e. There are 34 points in the wake from the trailing edge to the far field right boundary. A total of 181 points are distributed on the body (91 on the upper and 90 on the lower surface) with clustering at the leading edge (minimum $\Delta x = 0.002$) and clustering at the trailing edge (minimum $\Delta x = 0.004$). The minimum spacing in the normal direction is $dy = 0.005$ and exponential stretching is used to the outer boundary. The physical extent of the domain is $-48.0 \leq x \leq 96.0$ and $-96.0 \leq y \leq 96.0$.

Convergence Histories

The residual and ΔQ histories are given in Figs. 2f – 2i. Again note the high frequency oscillation for the initial part of convergence and then the smooth convergence rates. The high frequency oscillation is due to a rapid one or two point motion of the shock system in the initial set up of the flow. This usually occurs out in the field about at the top of the shock. Maximum residuals occur in that location.

The residuals and ΔQ were decreased by over 5 orders of magnitude in 2000 iterations. The solution was actually converged to plotting accuracy in about 600 iterations, as demonstrated by the convergence histories for C_L, C_D,and C_{pm} in Figs. 2j – 2l.

Surface Plots

Surface values are plotted versus x and y in Figs. 2m – 2t. Note that all the shocks calculated are three point shocks, with very sharp profiles. The upwind operator eliminates pre–shock oscillations, except for the one point overshoot for the upper surface due to the transition operator. This overshoot is dependent on the switching point logic defined above and the location of a point near C_p^*, see Fig. 2o. When a grid point falls near C_p^* the switching point logic chooses the next point back as the transition point. Though one may try to fix this overshoot problem by various strategies involving the placement of the transition point, the most robust method found was to place it at the last supersonic point. These strategies are complicated by the curvature of the shock in computational space arising from the high aspect ratio of cells away from the body, as discussed in the previous section on AGARD01. The transition point cannot be forced to always lie in the middle of the shock because of possibility of unstable upwind differencing in subsonic regions. Post–shock oscillations are due to the central differencing in the subsonic regions. These comments apply to all the shocks obtained in this study. The surface plots show the actual distribution of points on the body which are then connected by lines.

Tabulated data for the surface values are presented in Table 2. The converged values for lift, drag, and moment are

$$C_L = 0.38895, \quad C_D = 0.05900, \quad C_{pm} = -0.13782,$$

with computed circulation $\Gamma = 0.20053$.

Flowfield Contours

Flowfield contours for this case are presented in Figs. 2u – 2ae. Mach contours in Fig.2u are smooth and exhibit sharp captured shocks. Figure 2w shows the relative thickness of upper surface shock. In Fig. 2x, a farfield view is shown, demonstrating how far away the farfield boundaries are from any large gradients in the solution.

Stagnation pressure and temperature are shown for the nose region in Figs. 2ab and 2ae. Again, good stagnation values are obtained at the nose. The stagnation temperature field is essentially constant, with variations only in the 3rd decimal place, while for stagnation pressure all the variation is near the upper surface shock.

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-3
	NACA 0012: MACH = 0.85, ALPHA = 1			

Enter Q file name: NACA##12 Mach = #.85# Alpha = 1.### Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-P1/P1inf	1-T1/T1-f
1	96.######	#.######	#.376489	-#.#####1	#.85#135	-#.###14#	-#.###232
2	74.2#7##1	#.######	#.37652#	-#.###1##	#.85#157	-#.###112	-#.###189
3	57.4#255#	#.######	#.376558	-#.###221	#.85##62	#.#####48	-#.###147
4	44.454###	#.######	#.376599	-#.###35#	#.849603	#.0#85#7	-#.###114
5	34.478638	#.######	#.376641	-#.###485	#.84891#	#.##1377	-#.[illegible]
6	26.792#36	#.######	#.376686	-#.###626	#.847689	#.##2713	-#.######
7	2#.869555	#.######	#.376733	-#.###777	#.846#25	#.##4589	-#.###966
8	16.3#6313	#.######	#.37678#	-#.###925	#.843975	#.##6693	-#.###859
9	12.79#356	#.#####6	#.376869	-#.##1#16	#.841684	#.##8988	-#.###951
1#	1#.##1329	#.######	#.376797	-#.###979	#.83941#	#.#11398	-#.[illegible]
11	7.994#38	#.######	#.37671#	-#.###7#5	#.83753#	#.#13169	#.######
12	6.3#5789	#.######	#.376497	-#.###827	#.8364#2	#.#13969	#.######
13	5.146642	#.######	#.376#82	#.##1289	#.836#64	#.#13655	#.######
14	4.191#85	#.######	#.375361	#.##3574	#.835952	#.#12638	#.######
15	3.456258	#.######	#.374199	#.##7261	#.83494#	#.#11819	#.######
16	2.#89447	#.######	#.372433	#.#12861	#.831#84	#.#1218#	#.######
17	2.452727	#.######	#.369#85	#.#2#877	#.826425	#.#13658	#.######
18	2.116237	#.######	#.366493	#.#31695	#.818959	#.#15#81	#.######
19	1.856973	#.######	#.362148	#.#45476	#.81#252	#.#17699	#.######
2#	1.657212	#.######	#.356#86	#.#62#98	#.###7#5	#.#19#28	#.######
21	1.5#3296	#.######	#.35#892	#.##1171	#.79#357	#.#19923	#.######
22	1.384785	#.######	#.344274	#.1#2156	#.779259	#.#20623	#.######
23	1.293332	#.######	#.337286	#.124569	#.767587	#.#21176	#.######
24	1.222929	#.######	#.329887	#.148#33	#.7555#7	#.#216#6	#.######
25	1.168603	#.######	#.322166	#.172265	#.743#62	#.#21961	#.######
26	1.126#88	#.######	#.314298	#.197215	#.73#394	#.#22238	-#.######
27	1.#94584	#.######	#.3062#1	#.222893	#.717361	#.#22447	-#.######
28	1.#69872	#.######	#.297857	#.249361	#.7#3939	#.#22619	-#.######
29	1.#5#754	#.######	#.289165	#.276917	#.689994	#.#22715	-#.######
3#	1.#36#24	#.######	#.28#116	#.3#5614	#.675434	#.#22792	-#.######
31	1.#24674	#.######	#.27#482	#.336163	#.659923	#.#22811	-#.######
32	1.#15929	#.######	#.259957	#.369548	#.642796	#.#22881	-#.######
33	1.##9192	#.######	#.249221	#.4#3587	#.625#48	#.#23#53	-#.######
34	1.######	#.######	#.235541	#.446967	#.6#2775	#.#22#3	-#.######
35	1.######	#.######	#.188256	#.596915	#.58787#	-#.#25673	#.######
36	#.995928	-#.###581	#.218193	#.5#198#	#.616213	-#.#18#96	#.######
37	#.991619	-#.##1193	#.248151	#.486978	#.639848	#.##9718	#.######
38	#.987#54	-#.##1838	#.267622	#.376945	#.657#64	#.##7993	#.######
39	#.982211	-#.##2618	#.266913	#.347483	#.672778	#.##7154	#.######
4#	#.977#68	-#.##3236	#.273786	#.325948	#.686968	#.##4119	#.######
41	#.971688	-#.##3994	#.28#875	#.3#3285	#.696619	#.##55#1	#.######
42	#.965779	-#.##4795	#.286573	#.286135	#.7##752	#.##2685	#.######
43	#.959576	-#.##5643	#.292545	#.266199	#.715897	#.##4534	#.######
44	#.952956	-#.##6541	#.297667	#.249957	#.726525	#.##2#88	#.######
45	#.945#86	-#.##7492	#.3#2941	#.233231	#.732789	#.##3912	#.######
46	#.938326	-#.##8#8#	#.3#7726	#.218#57	#.74218#	#.##1987	#.######
47	#.93#236	-#.##9568	#.312576	#.2#2676	#.748168	#.##3397	#.######
48	#.921673	-#.#1#7#1	#.317168	#.188115	#.756697	#.##2#26	#.######
49	#.912298	-#.#11#82	#.321749	#.173586	#.762711	#.##3#22	#.######

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-4
	NACA 0012: MACH = 0.85, ALPHA = 1			

NACA##12 Mach = #.85# Alpha = 1.### Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-Pt/P1inf	1-T1/T1inf
5#	#.9#2341	-#.#13174	#.326199	#.159475	#.77#564	#.##2#6.	#.######
51	#.891677	-#.#14522	#.33#61#	#.145488	#.776663	#.##2732	#.######
52	#.88#251	-#.#15947	#.334939	#.131759	#.783948	#.##2127	#.######
53	#.868#18	-#.#17452	#.339185	#.118294	#.79#125	#.##2475	#.######
54	#.854941	-#.#19#37	#.343367	#.105#31	#.796#86	#.##2134	#.######
55	#.84#986	-#.#2#7#2	#.347429	#.#9215#	#.8#296#	#.##2329	#.######
56	#.826136	-#.#22444	#.351361	#.#79682	#.8#923#	#.##211#	#.######
57	#.81#388	-#.#24258	#.355#2#	#.#67819	#.814926	#.##2172	#.######
58	#.79376#	-#.#26137	#.358581	#.#56788	#.82#393	#.##2#62	#.######
59	#.776297	-#.#28#7#	#.361691	#.#46925	#.825189	#.##2#56	#.######
6#	#.758#72	-#.#3#943	#.364668	#.#375#9	#.829769	#.##2#53	#.######
61	#.739188	-#.#32#4#	#.366396	#.#32##4	#.832576	#.##1919	#.######
62	#.719777	-#.#34#42	#.366194	#.#32658	#.83266#	#.##1588	#.######
63	#.7#####	-#.#36#28	#.371718	#.#15127	#.839773	#.##295#	#.######
64	#.688#11	-#.#37979	#.372582	#.#1264#	#.84#625	#.##333#	#.######
65	#.66##16	-#.#39873	#.325549	#.161536	#.781338	-#.##9387	#.######
66	#.64##17	-#.#417##	#.4#3063	-#.#866#9	#.875584	#.#17921	#.######
67	#.62##11	-#.#43481	#.61#418	-#.741634	1.245816	-#.##3528	#.######
68	#.6#####	-#.#45191	#.626945	-#.794242	1.286831	-#.#15334	#.######
69	#.579591	-#.#46866	#.626#19	-#.791#86	1.284922	-#.#15229	#.######
7#	#.558263	-#.#48537	#.624681	-#.787#62	1.282377	-#.#15363	#.######
71	#.53611#	-#.#5#183	#.623187	-#.782#69	1.279254	-#.#15332	#.######
72	#.513259	-#.#517##	#.621323	-#.776413	1.275747	-#.#15324	#.######
73	#.489864	-#.#533##	#.619#71	-#.769274	1.271486	-#.#1552[	#.######
74	#.466185	-#.#54717	#.616554	-#.761277	1.266548	-#.#15469	#.######
75	#.442183	-#.#56##4	#.613644	-#.752#48	1.261#41	-#.#15659	#.######
76	#.418382	-#.#57137	#.61#441	-#.741#84	1.254874	-#.#15655	#.######
77	#.394669	-#.#58#97	#.6#691#	-#.73#787	1.248244	-#.#1583.	#.######
78	#.371476	-#.#58869	#.6#3#69	-#.718526	1.24#967	-#.#1588#	#.######
79	#.348893	-#.#59444	#.598849	-#.7#5144	1.2331#5	-#.#16#31	#.######
8#	#.327#65	-#.#5982#	#.594241	-#.69#532	1.224518	-#.#161#8	#.######
81	#.3#61#3	-#.#59999	#.589244	-#.674695	1.215549	-#.#16549	#.######
82	#.286#92	-#.#59989	#.583929	-#.657831	1.2#6216	-#.#17182	#.######
83	#.267###	-#.#59799	#.578318	-#.64####	1.196265	-#.#17598	#.######
84	#.249#94	-#.#59445	#.572458	-#.621452	1.185764	-#.#1776[	#.######
85	#.232136	-#.#58941	#.566397	-#.6#2233	1.175#17	-#.#17954	#.######
86	#.216194	-#.#583#3	#.56#13#	-#.582359	1.163994	-#.#18131	#.######
87	#.2#1225	-#.#57546	#.553674	-#.561974	1.152754	-#.#18341	#.######
88	#.187284	-#.#56686	#.547#49	-#.54#877	1.141314	-#.#18533	#.######
89	#.174#78	-#.#55737	#.54#276	-#.519399	1.129722	-#.#1872	#.######
9#	#.161###	-#.#54711	#.533363	-#.497477	1.118#1#	-#.#1894[	#.######
91	#.15#317	-#.#53619	#.526313	-#.47512#	1.1#6187	-#.#19189	#.######
92	#.139578	-#.#52472	#.519136	-#.452359	1.#94223	-#.#19395	#.######
93	#.129532	-#.#51279	#.511817	-#.429151	1.#82133	-#.#19612	#.######
94	#.12#132	-#.#5##47	#.5#4361	-#.4#55#5	1.#639#3	-#.#19814	#.######
95	#.111334	-#.#48782	#.496754	-#.381385	1.#57525	-#.#2#817	#.######
96	#.1#3#84	-#.#4749#	#.488979	-#.356726	1.#44987	-#.#2#24.	#.######
97	#.#95354	-#.#46175	#.481#25	-#.3315#2	1.#32211	-#.#2#411	#.######
98	#.##81#1	-#.#4484#	#.472865	-#.3#5628	1.#19163	-#.#2#533	#.######
99	#.#81291	-#.#43489	#.464488	-#.279#36	1.##5833	-#.#2#638	#.######

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-5
	NACA 0012: MACH = 0.85, ALPHA = 1			

NACA##12 Mach = #.85# Alpha = 1.### Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-P1/P1inf	1-T1/Tinf
1##	#.#74893	-#.#42123	#.455#4#	-#.251638	#.992144	-#.#2#68_	#.#####
1#1	#.#68877	-#.#4#743	#.446#9#	-#.223317	#.978#26	-#.#2#656	#.#####
1#2	#.#63216	-#.#39352	#.437648	-#.193949	#.963396	-#.#2#529	#.#####
1#3	#.#57086	-#.#37949	#.428#16	-#.163#61	#.948167	-#.#2#28[	#.#####
1#4	#.#52864	-#.#36534	#.417962	-#.131521	#.932226	-#.#19864	#.#####
1#5	#.#48132	-#.#351#7	#.4#7416	-#.#98#75	#.915425	-#.#19249	#.#####
1#6	#.#43674	-#.#33666	#.396326	-#.#629#6	#.897629	-#.#1837?	#.#####
1#7	#.#39463	-#.#32212	#.384577	-#.#25651	#.878#4#	-#.#17195	#.#####
1#8	#.#35496	-#.#30741	#.372136	#.#138#2	#.858173	-#.#156#5	#.#####
1#9	#.#31756	-#.#29263	#.358816	#.#56#41	#.835964	-#.#1353[	#.#####
11#	#.#28231	-#.#27744	#.344#85	#.1#11#8	#.811#86	-#.#1#893	#.#####
111	#.#24914	-#.#26212	#.329216	#.149#87	#.785#76	-#.##7571	#.#####
112	#.#21795	-#.#24654	#.312785	#.2#2266	#.755694	-#.##353	#.#####
113	#.#18869	-#.#23#65	#.294643	#.259644	#.722693	#.##1312	#.#####
114	#.#16132	-#.#21441	#.275283	#.321192	#.686211	#.##6831	#.#####
115	#.#13583	-#.#19779	#.253753	#.389213	#.644#84	#.#1298#	#.#####
116	#.#11221	-#.#18#71	#.238667	#.462425	#.599223	#.#193#9	#.#####
117	#.###45#	-#.#16315	#.2#6126	#.543423	#.547469	#.#25482	#.#####
118	#.##7#78	-#.#145#3	#.177799	#.63#477	#.49#833	#.#3#586	#.#####
119	#.##5316	-#.#12634	#.147912	#.724#55	#.427311	#.#33938	#.#####
12#	#.##3777	-#.#107#5	#.116951	#.823#37	#.359235	#.#34574	#.#####
121	#.##2488	-#.###72#	#.#85378	#.923187	#.284732	#.#32#83	#.#####
122	#.##1447	-#.##6695	#.#56497	1.#14745	#.2##53#	#.#276#5	#.#####
123	#.###675	-#.##4598	#.#327#1	1.##2#9	#.125139	#.#22#55	#.#####
124	#.###176	-#.##236#	#.#19198	1.133#29	#.#41#87	#.#18#38	#.#####
125	#.######	#.######	#.#2#8#6	1.127928	#.#52175	#.#18939	#.#####
126	#.###175	#.##2351	#.#39#23	1.#7#159	#.147588	#.#24291	#.#####
127	#.###666	#.##4563	#.#7##57	#.971745	#.232865	#.#34277	#.#####
128	#.##1415	#.##6622	#.187###	#.953326	#.3166#3	#.#43184	#.#####
129	#.##2486	#.###591	#.145658	#.732#28	#.395128	#.#48577	#.#####
13#	#.##3637	#.#1#511	#.183###	#.611#48	#.479813	#.#49979	#.#####
131	#.##5#83	#.#12364	#.219#37	#.499#86	#.5399#4	#.#47729	#.#####
132	#.##6722	#.#14148	#.251614	#.395996	#.6#431#	#.#42192	#.#####
133	#.###538	#.#15867	#.28#4#5	#.3#4697	#.661576	#.#34745	#.#####
134	#.#1#517	#.#17624	#.3#6657	#.221448	#.713#83	#.#26244	#.#####
135	#.#12647	#.#19124	#.329##5	#.14#841	#.7596#6	#.#1778#	#.#####
136	#.#14923	#.#2#673	#.35#929	#.##1#51	#.###939	#.###673	#.#####
137	#.#17339	#.#22175	#.369699	#.#21531	#.837117	#.##2485	#.#####
138	#.#19892	#.#23636	#.386##5	-#.#32969	#.869649	-#.###798	#.#####
139	#.#22582	#.#25#59	#.4#23##	-#.##1878	#.898313	-#.###33	#.#####
14#	#.#254#9	#.#26448	#.416489	-#.12685#	#.924176	-#.#13361	#.#####
141	#.#28374	#.#27##7	#.429391	-#.167763	#.94728#	-#.#16#11	#.#####
142	#.#314##	#.#29139	#.441316	-#.2#5579	#.968#84	-#.#1956#	#.#####
143	#.#34738	# #3#445	#.452314	-#.24#455	#.987415	-#.#21684	#.#####
144	#.#38129	#.#31729	#.462559	-#.272945	1.##5#18	-#.#23321	#.#####
145	#.#41682	#.#32992	#.472123	-#.3#3273	1.#213#7	-#.#24564	#.#####
146	#.#45395	#.#34235	#.481#87	-#.331764	1.#36497	-#.#26477	#.#####
147	#.#49274	#.#3546#	#.489583	-#.358641	1.#5#77#	-#.#26149	#.#####
148	#.#53327	#.#3666#	#.497614	-#.384111	1.#64252	-#.#26613	#.#####
149	#.#57562	#.#37#61	#.5#5246	-#.4##313	1.#77#61	-#.#26919	#.#####

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-6
	NACA 0012: MACH = 0.85, ALPHA = 1			

NACA##12 Mach = #.85# Alpha = 1.### Results on the airfoil surface

N	X/C	Y/C	1-P/Pinf	Cp	Mach	1-Pt/Ptinf	1-Tt/Ttinf
15#	#.#61988	#.#39#37	#.612631	-#.431414	1.#89261	-#.#27#8	# ######
151	#.#66613	#.#4#199	#.519517	-#.453569	1.1#1##1	-#.#27171	# ######
152	#.#7145#	#.#41345	#.526233	-#.474865	1.112318	-#.#2717#	#.######
153	#.#765##	#.#42477	#.532782	-#.495381	1.123253	-#.#2712#	#.######
154	#.##18#1	#.#43593	#.538962	-#.515233	1.133878	-#.#27##9	#.######
155	#.##7342	#.#44694	#.545#23	-#.534453	1.14423#	-#.#2688#	#.######
156	#.#93144	#.#45779	#.55#92#	-#.553152	1.15435#	-#.#2671#	#.######
157	#.#99223	#.#46846	#.556656	-#.571341	1.164259	-#.#26527	# ######
158	#.1#5595	#.#47895	#.562261	-#.589118	1.173993	-#.#2638#	#.######
159	#.112278	#.#48924	#.567736	-#.6#6479	1.183612	-#.#26141	#.######
16#	#.119291	#.#49931	#.573#97	-#.623479	1.193#82	-#.#2594[illegible]	#.######
161	#.126653	#.#5#914	#.578357	-#.64#161	1.2#2429	-#.#25715	#.######
162	#.134387	#.#51871	#.583529	-#.656563	1.2117##	-#.#25499	#.######
163	#.142514	#.#52799	#.588#86	-#.672662	1.224863	-#.#25269	# ########
164	#.151#6#	#.#53694	#.593685	-#.688513	1.229991	-#.#25#84	#.######
165	#.16###9	#.#54553	#.598527	-#.7#4122	1.239#55	-#.#24898	#.######
166	#.169#8	#.#55371	#.6#3382	-#.719519	1.248#[illegible]1	-#.#2467[illegible]	#.######
167	#.179467	#.#56144	#.6##157	-#.734661	1.256984	-#.#24494	#.######
168	#.189955	#.#56867	#.612872	-#.749614	1.265873	-#.#24291	#.######
169	#.2#1##3	#.#57534	#.617518	-#.764321	1.2747#6	-#.#24111	#.######
17#	#.212641	#.#58138	#.622##3	-#.778822	1.2835#4	-#.#23951	#.######
171	#.2249#4	#.#58672	#.626572	-#.793#58	1.2922#4	-#.#23776	#.######
172	#.237822	#.#59129	#.63#993	-#.8#7#78	1.3##85#	-#.#2366#	#.######
173	#.251428	#.#595#1	#.635327	-#.82##2#	1.3#9398	-#.#2344#	#.######
174	#.265753	#.#59779	#.639567	-#.834267	1.317856	-#.#2336#	#.######
175	#.28#827	#.#59954	#.643719	-#.847435	1.3262##	-#.#23157	#.######
176	#.296674	#.#6##17	#.647737	-#.86#175	1.3339#9	-#.#224#4	#.######
177	#.313317	#.#59959	#.651662	-#.872623	1.341485	-#.#21629	#.######
178	#.33#773	#.#5977#	#.655461	-#.884671	1.349344	-#.#21529	#.######
179	#.349#49	#.#59441	#.659123	-#.896282	1.356985	-#.#21438	#.######
18#	#.368147	#.#58965	#.662635	-#.9#7419	1.364363	-#.#21337	#.######
181	#.388#57	#.#58335	#.665989	-#.918#56	1.371466	-#.#21242	#.######
182	#.4##755	#.#57545	#.669188	-#.928175	1.378276	-#.#21153	#.######
183	#.43#2#5	#.#56592	#.672289	-#.937781	1.384783	-#.#21#61	#.######
184	#.452356	#.#55474	#.675#7#	-#.946854	1.39#978	-#.#2#981	#.######
185	#.475141	#.#54194	#.677751	-#.955356	1.396819	-#.#2#9#3	#.######
186	#.498477	#.#52755	#.68#248	-#.963274	1.4#2277	-#.#2#8#6	# ######
187	#.522266	#.#51163	#.682557	-#.97#697	1.4#7372	-#.#2#743	#.######
188	#.546###	#.#4943#	#.684691	-#.977363	1.412#95	-#.#2#667	#.######
189	#.57#757	#.#47568	#.686662	-#.983615	1.416468	-#.#2#577	#.######
19#	#.595218	#.#45591	#.688495	-#.989426	1.42#574	-#.#2#526	#.######
191	#.619628	#.#43515	#.69#2#9	-#.994862	1.424419	-#.#2#456	#.######
192	#.643881	#.#41358	#.691828	-#.999995	1.428#63	-#.#2#39#	#.######
193	#.667845	#.#39139	#.693359	-1.##485#	1.431523	-#.#2#323	#.######
194	#.691485	#.#36874	#.694823	-1.###492	1.434872	-#.#2#3##	#.######
195	#.714455	#.#34582	#.696226	-1.#13941	1.438#57	-#.#2#225	#.######
196	#.736987	#.#32278	#.697588	-1.#18237	1.441183	-#.#2#2#9	#.######
197	#.758685	#.#29978	#.698898	-1.#22391	1.444169	-#.#2#126	#.######
198	#.779731	#.#27693	#.7##162	-1.#26423	1.447144	-#.#2#14#	# ######
199	#.######	#.#25436	#.7#1455	-1.#3#524	1.45#128	-#.#2####	#.######

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-7
	NACA 0012: MACH = 0.85, ALPHA = 1			

NACA0012 Mach = 0.850 Alpha = 1.000 Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-P1/P1inf	1-T1/T1inf
200	0.020010	0.023154	0.702741	-1.034603	1.453117	-0.020035	0.000000
201	0.040013	0.029017	0.704116	-1.038962	1.456025	-0.019558	0.000038
202	0.060018	0.038426	0.716375	-1.077838	1.503426	-0.046368	0.000000
203	0.080000	0.045978	0.421035	-0.141267	0.847134	0.074205	0.000000
204	0.099950	0.053605	0.269694	0.338664	0.665844	0.016001	0.000000
205	0.919897	0.011437	0.339010	0.147398	0.734726	0.046001	0.000000
206	0.939743	0.069502	0.303713	0.258704	0.701316	0.033043	0.000000
207	0.943592	0.007799	0.302028	0.236126	0.695422	0.035779	0.000000
208	0.954653	0.006312	0.294209	0.260922	0.684850	0.034028	0.000000
209	0.964167	0.005016	0.287262	0.282952	0.675593	0.036532	0.000000
210	0.972368	0.003888	0.279477	0.307638	0.659837	0.034927	0.000000
211	0.979466	0.002902	0.271587	0.332666	0.642920	0.038137	0.000000
212	0.985642	0.002037	0.262161	0.362550	0.627126	0.033269	0.000000
213	0.991043	0.001275	0.252203	0.393076	0.607375	0.038727	0.000000
214	0.995796	0.000600	0.226015	0.477176	0.584463	0.024592	0.000000
215	1.000000	0.000000	0.194562	0.576918	0.556218	0.006227	0.000000
216	1.004000	0.000000	0.235541	0.446967	0.602775	0.022801	-0.000182
217	1.009192	0.000000	0.249221	0.403507	0.625048	0.023053	-0.000014
218	1.015929	0.000000	0.259957	0.369548	0.642796	0.022881	-0.000044
219	1.024674	0.000000	0.270402	0.336163	0.659923	0.022811	-0.000030
220	1.036024	0.000000	0.280116	0.305614	0.675434	0.022792	-0.000025
221	1.050754	0.000000	0.289166	0.276917	0.689994	0.022715	-0.000000
222	1.069072	0.000000	0.297857	0.249351	0.703939	0.022619	-0.000016
223	1.094684	0.000000	0.306201	0.222893	0.717361	0.022448	-0.000018
224	1.126000	0.000000	0.314290	0.197215	0.730394	0.022238	-0.000004
225	1.168683	0.000000	0.322166	0.172265	0.743102	0.021961	0.000003
226	1.222929	0.000000	0.329807	0.148033	0.755507	0.021686	0.000009
227	1.293332	0.000000	0.337206	0.124569	0.767507	0.021176	0.000015
228	1.384785	0.000000	0.344274	0.102156	0.779259	0.020623	0.000021
229	1.503296	0.000000	0.350892	0.081171	0.790357	0.019923	0.000026
230	1.657212	0.000000	0.356906	0.062090	0.800705	0.019020	0.000039
231	1.856973	0.000000	0.362148	0.045476	0.810252	0.017699	0.000058
232	2.116237	0.000000	0.366493	0.031695	0.818959	0.015801	0.000085
233	2.452727	0.000000	0.369906	0.020877	0.826425	0.013659	0.000114
234	2.889447	0.000000	0.372433	0.012861	0.831904	0.012103	0.000129
235	3.456250	0.000000	0.374199	0.007261	0.834940	0.011819	0.000121
236	4.191885	0.000000	0.375361	0.003674	0.835952	0.012630	0.000095
237	5.146642	0.000000	0.376002	0.001239	0.836064	0.013655	0.000047
238	6.385789	0.000000	0.376497	-0.000007	0.836402	0.013969	0.000000
239	7.994038	0.000000	0.376718	-0.000785	0.837530	0.013163	-0.000021
240	10.081329	0.000000	0.376797	-0.000979	0.839410	0.011390	-0.000039
241	12.790356	0.000000	0.376809	-0.001016	0.841604	0.009088	-0.000051
242	16.306313	0.000000	0.376780	-0.000925	0.843975	0.006693	-0.000059
243	20.869555	0.000000	0.376733	-0.000777	0.846025	0.004689	-0.000066
244	26.792036	0.000000	0.376686	-0.000626	0.847689	0.002713	-0.000076
245	34.470630	0.000000	0.376641	-0.000485	0.848918	0.001377	-0.000091
246	44.454000	0.000000	0.376599	-0.000350	0.849683	0.000587	-0.000114
247	57.402550	0.000000	0.376558	-0.000221	0.850062	0.000248	-0.000147
248	74.207001	0.000000	0.376520	-0.000100	0.850157	-0.000112	-0.000189
249	96.000000	0.000000	0.376489	-0.000001	0.850135	-0.000140	-0.000232

FORTRAN STOP
BARTON Job terminated at 16-JUN-1983 10:15:17.90

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-8
	NACA 0012: MACH = 0.85, ALPHA = 1			

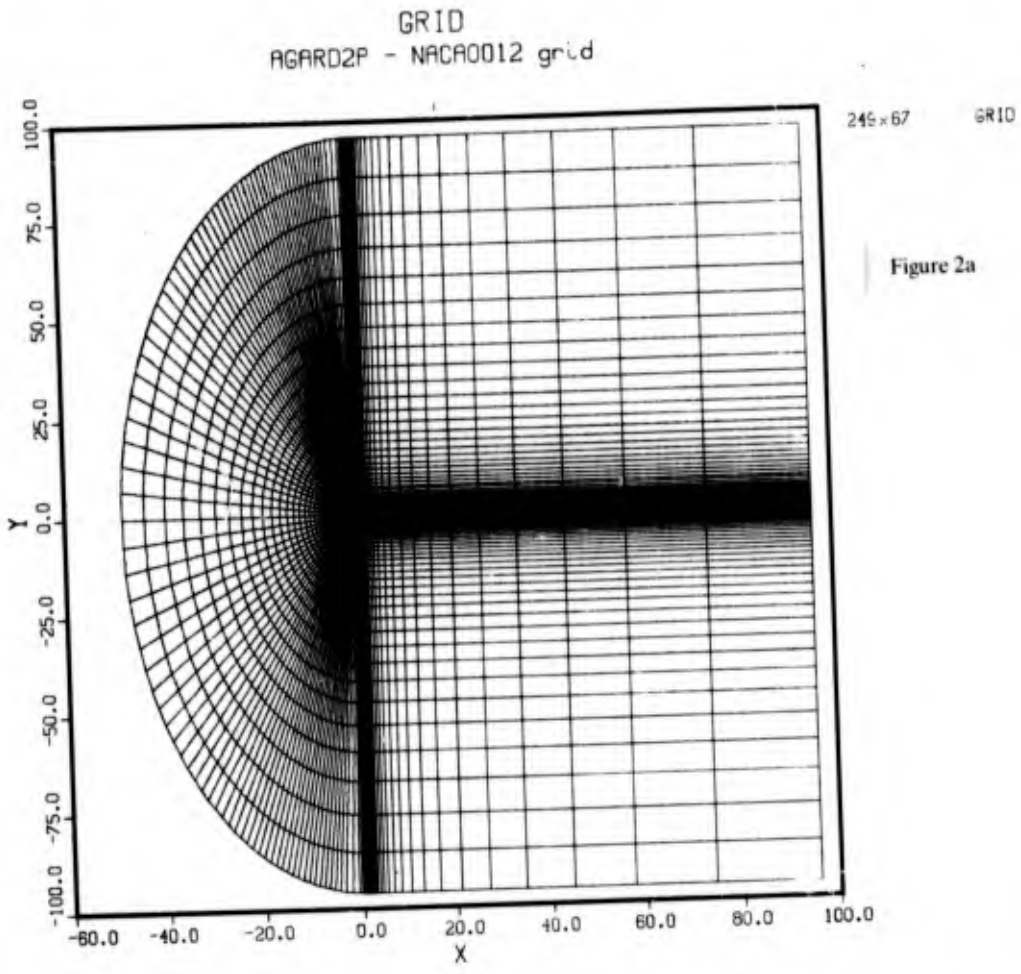


Figure 2a

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-9
	NACA 0012: MACH = 0.85, ALPHA = 1			

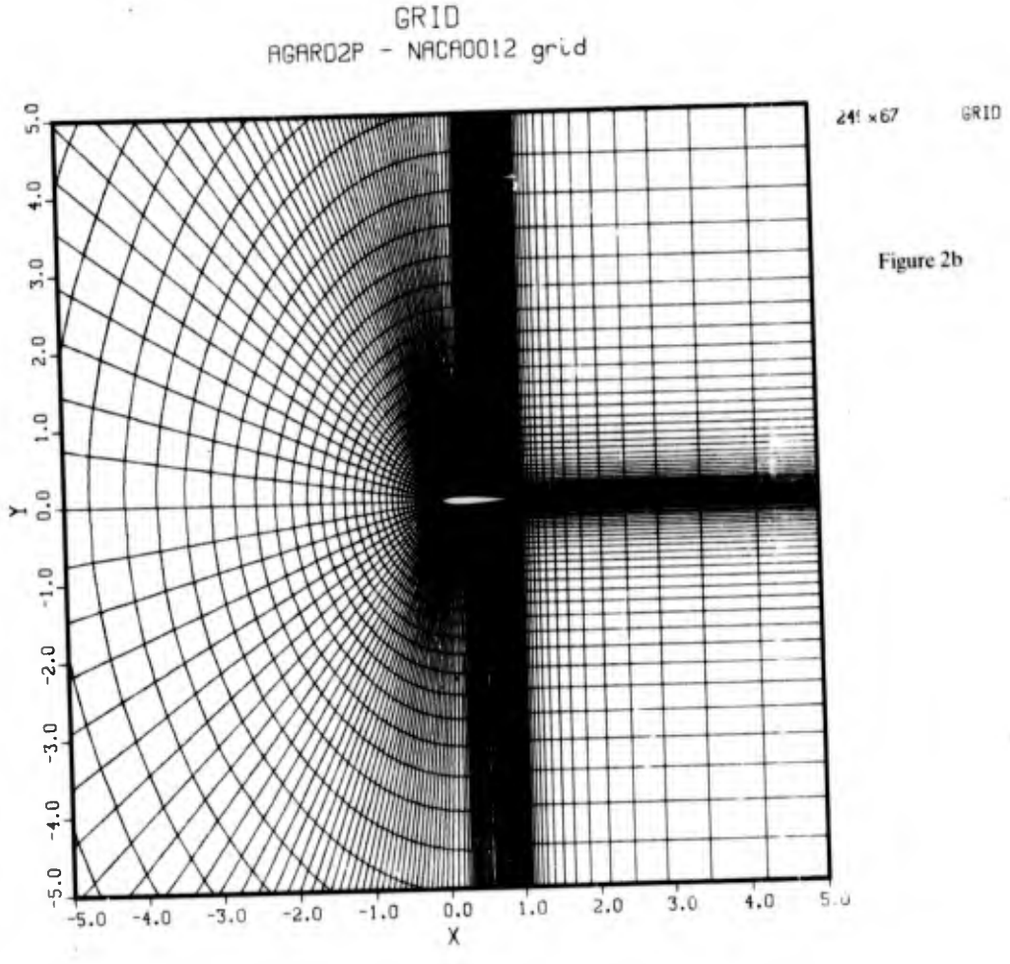


Figure 2b

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-10
	NACA 0012: MACH = 0.85, ALPHA = 1			

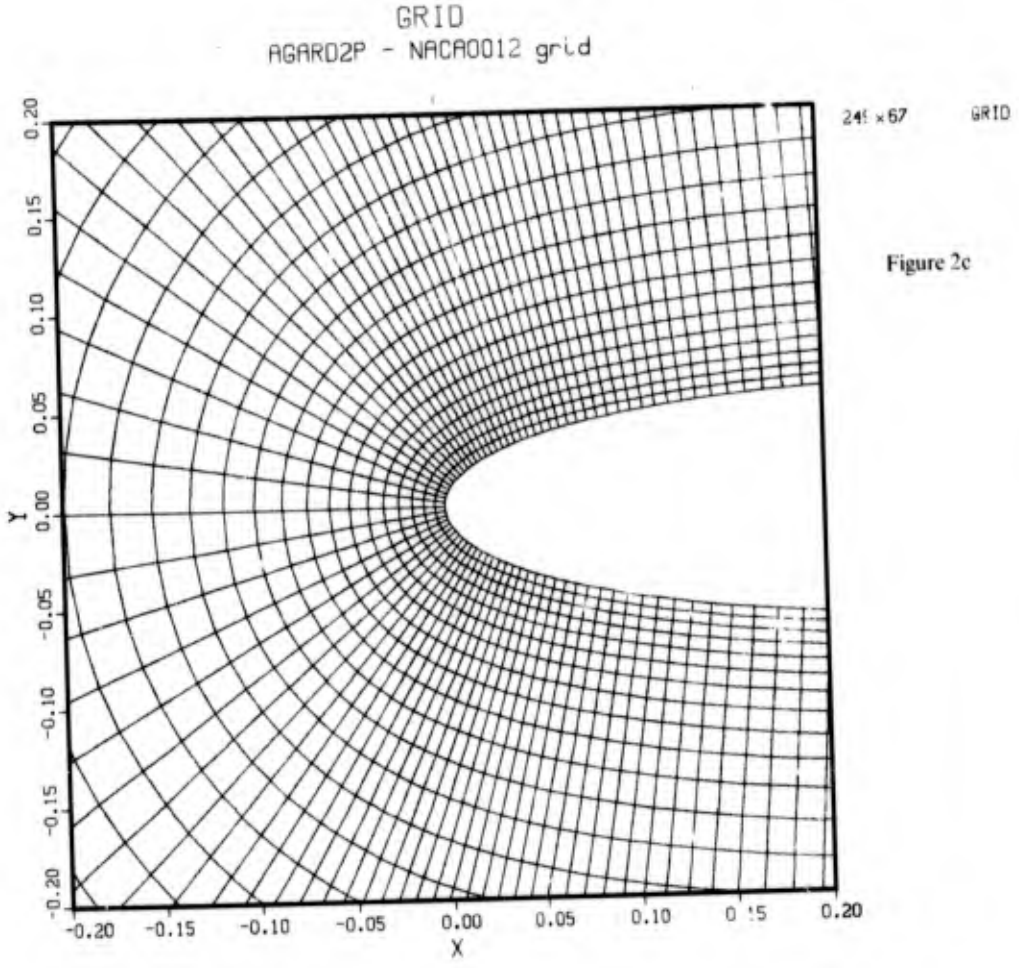


Figure 2c

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-11
	NACA 0012: MACH = 0.85, ALPHA = 1			

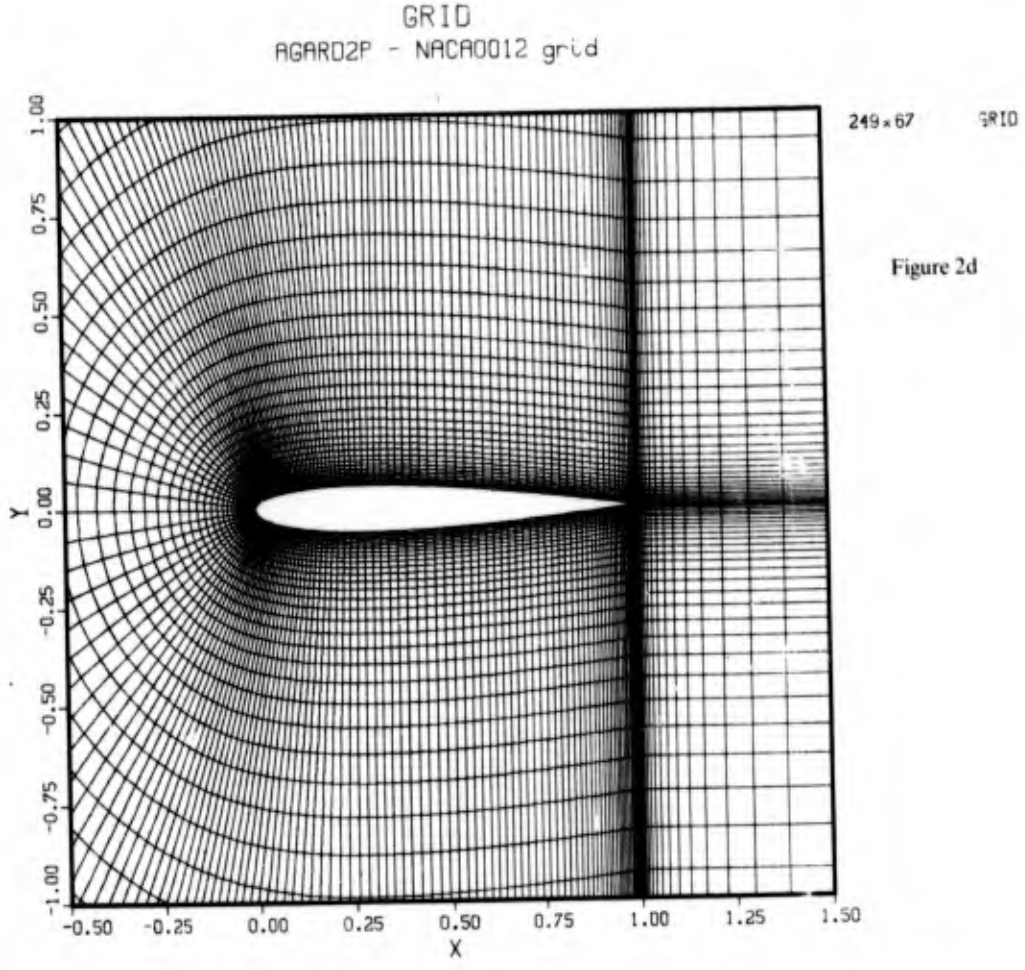


Figure 2d

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-12
	NACA 0012: MACH = 0.85, ALPHA = 1			

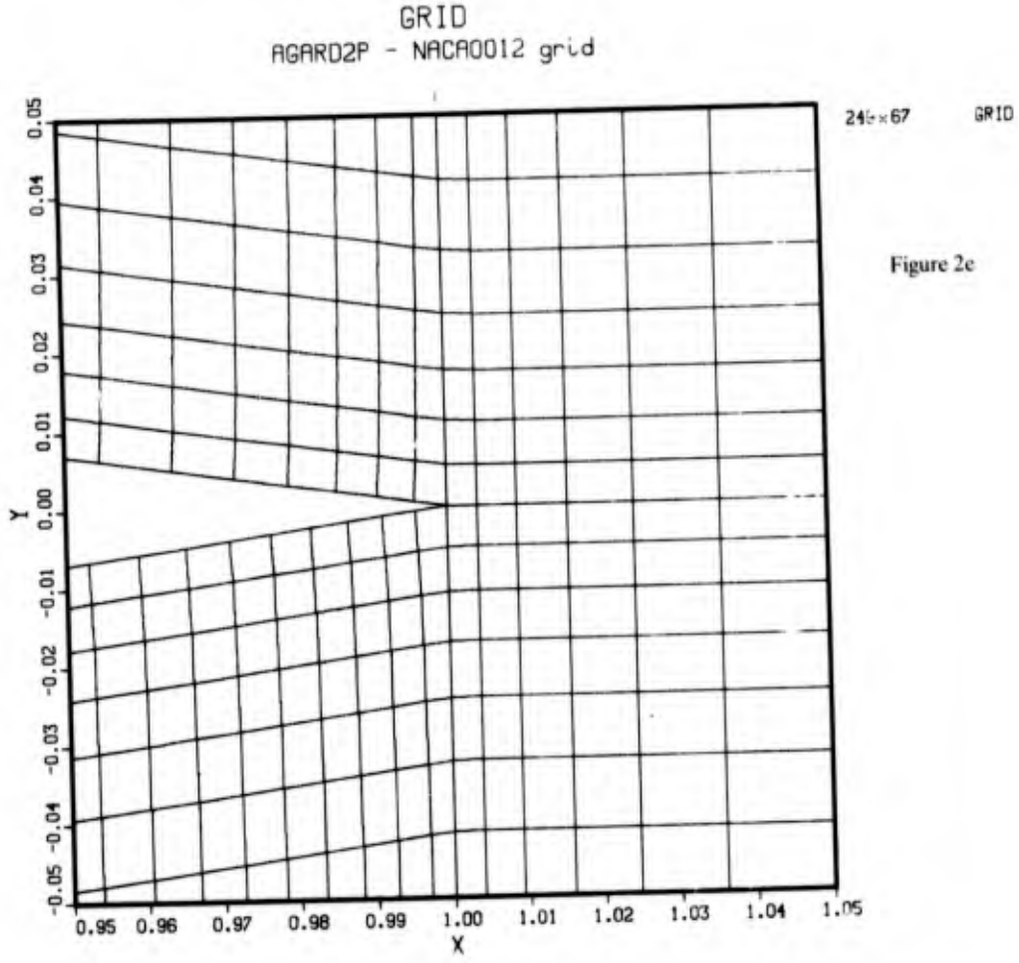


Figure 2e

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-13
	NACA 0012: MACH = 0.85, ALPHA = 1			

ARC2D - 249 x 67 grid, DT-3.
AGARD2P grid, clustering at shocks = .02
Upwinding, spatially variable time step
Mach number = .85, Alpha = 1.0

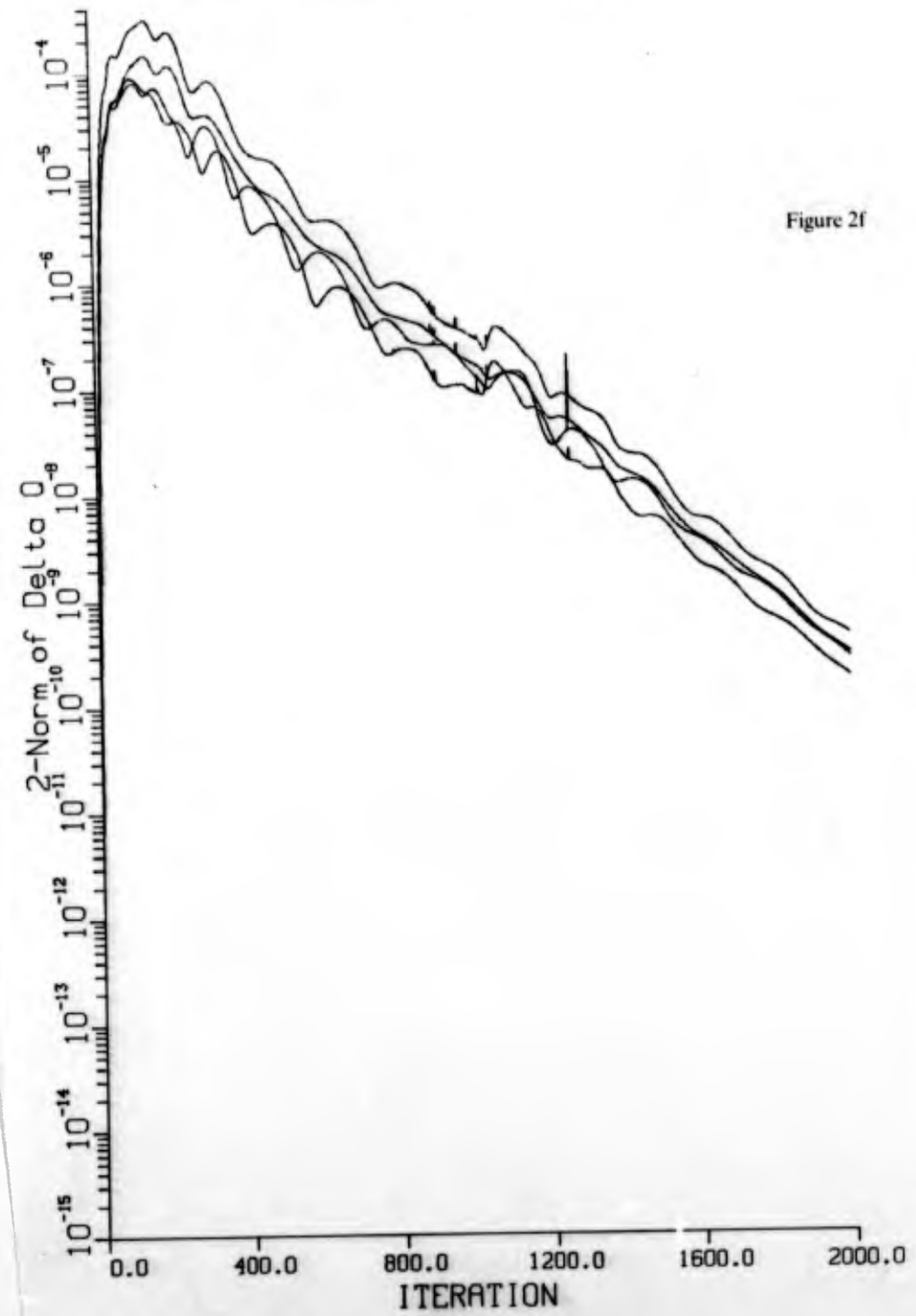


Figure 2f

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-14
	NACA 0012: MACH = 0.85, ALPHA = 1			

ARC2D - 249 × 67 grid, DT-3.
AGARD2P grid, clustering at shocks = .02
Upwinding, spatially variable time step
Mach number = .85, Alpha = 1.0

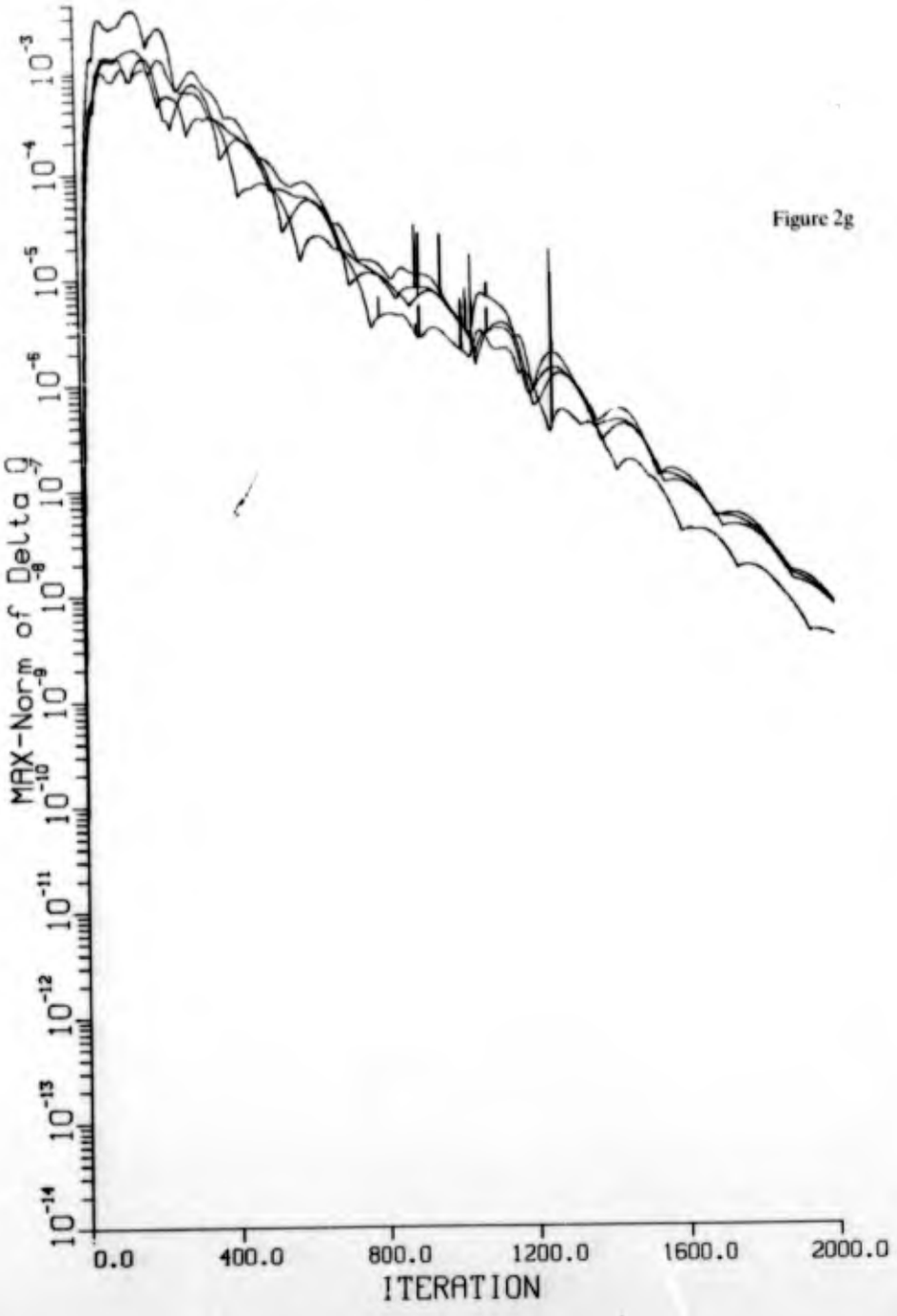


Figure 2g

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-15
	NACA 0012: MACH = 0.85, ALPHA = 1			

ARC2D - 249 x 67 grid, DT-3..
AGARD2P grid, clustering at shocks = .02
Upwinding, spatially variable time step
Mach number = .85, Alpha = 1.0

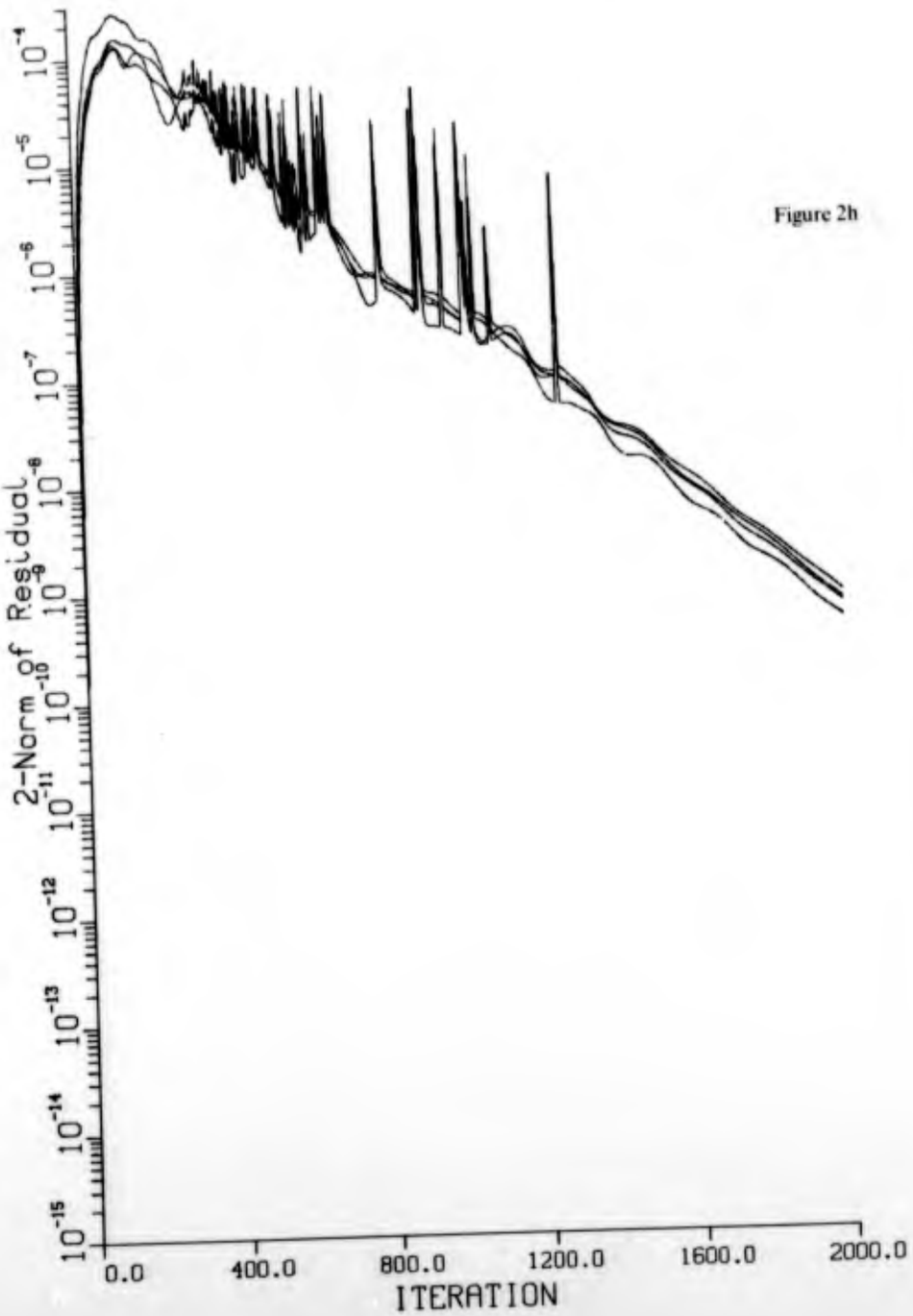


Figure 2h

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-16
	NACA 0012: MACH = 0.85, ALPHA = 1			

ARC2D - 249 x 67 grid, DT-3.
AGARD2P grid, clustering at shocks = .02
Upwinding, spatially variable time step
Mach number = .85, Alpha = 1.0

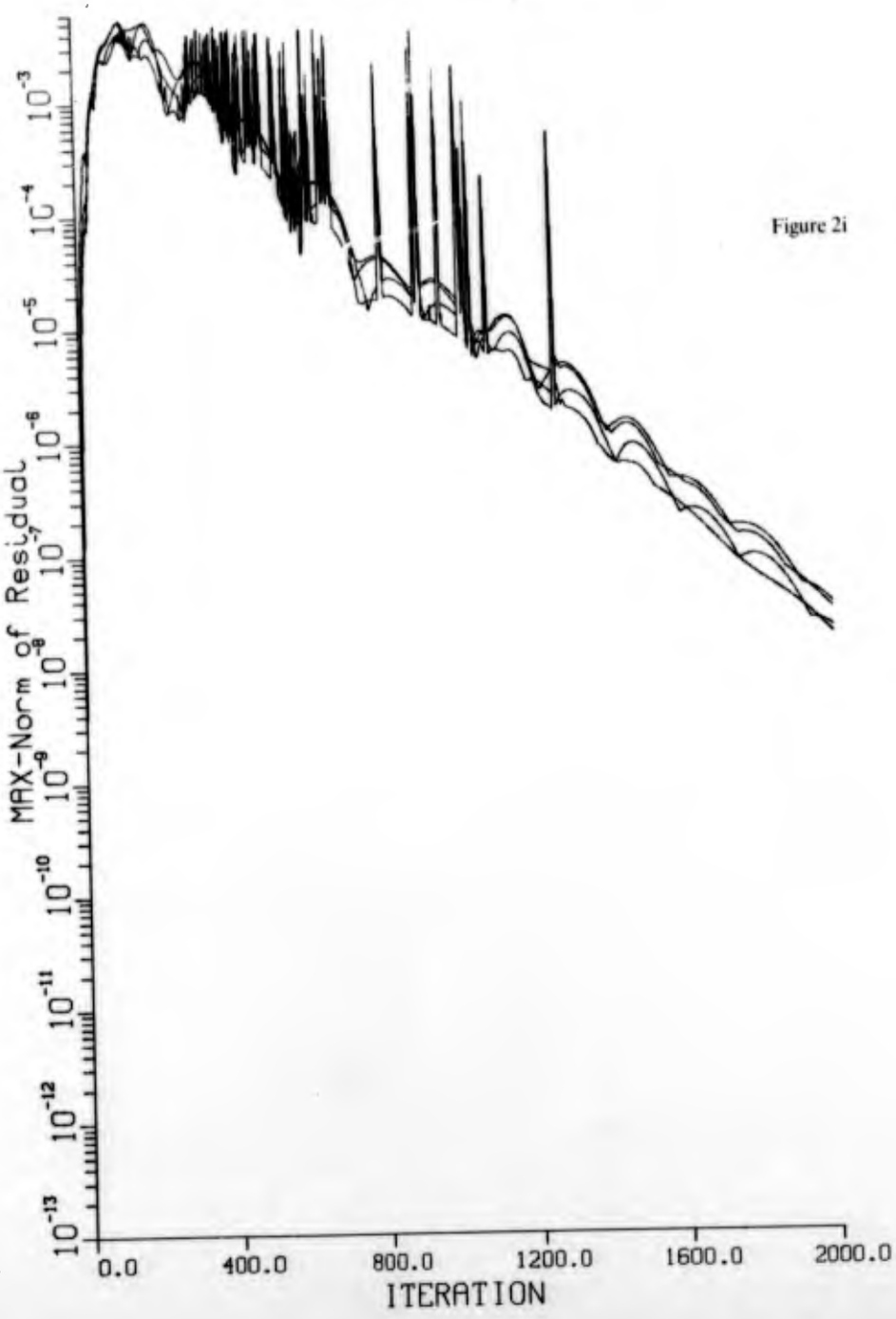


Figure 2i

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-17
	NACA 0012: MACH = 0.85, ALPHA = 1			

ARC2D - 249 x 67 grid, DT-3.
AGARD2P grid, clustering at shocks = .02
Upwinding, spatially variable time step
Mach number = .85, Alpha = 1.0

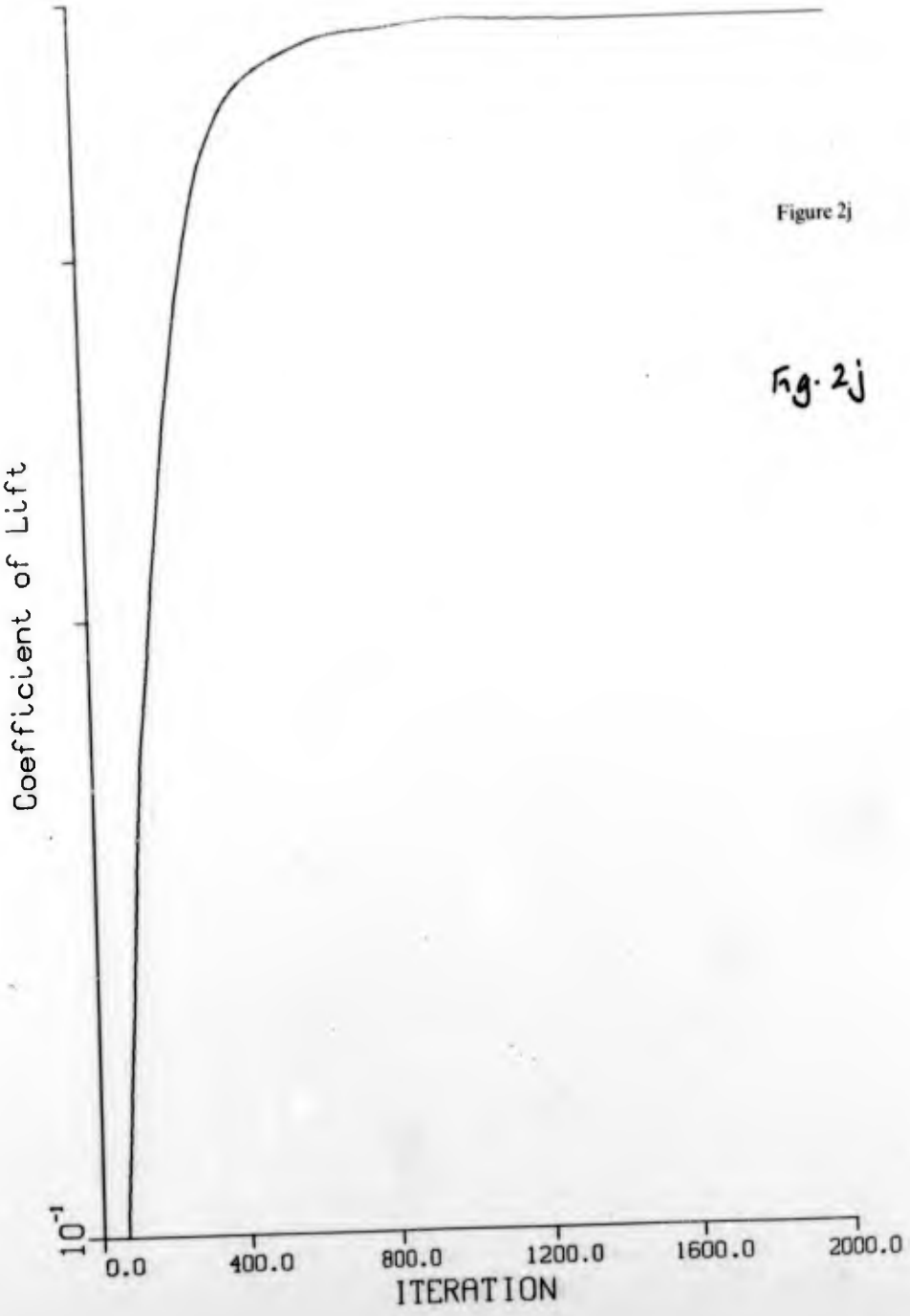


Figure 2j

Fig. 2j

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-18
	NACA 0012: MACH = 0.85, ALPHA = 1			

ARC2D - 249 x 67 grid, DT-3.
AGARD2P grid, clustering at shocks = .02
Upwinding, spatially variable time step
Mach number = .85, Alpha = 1.0

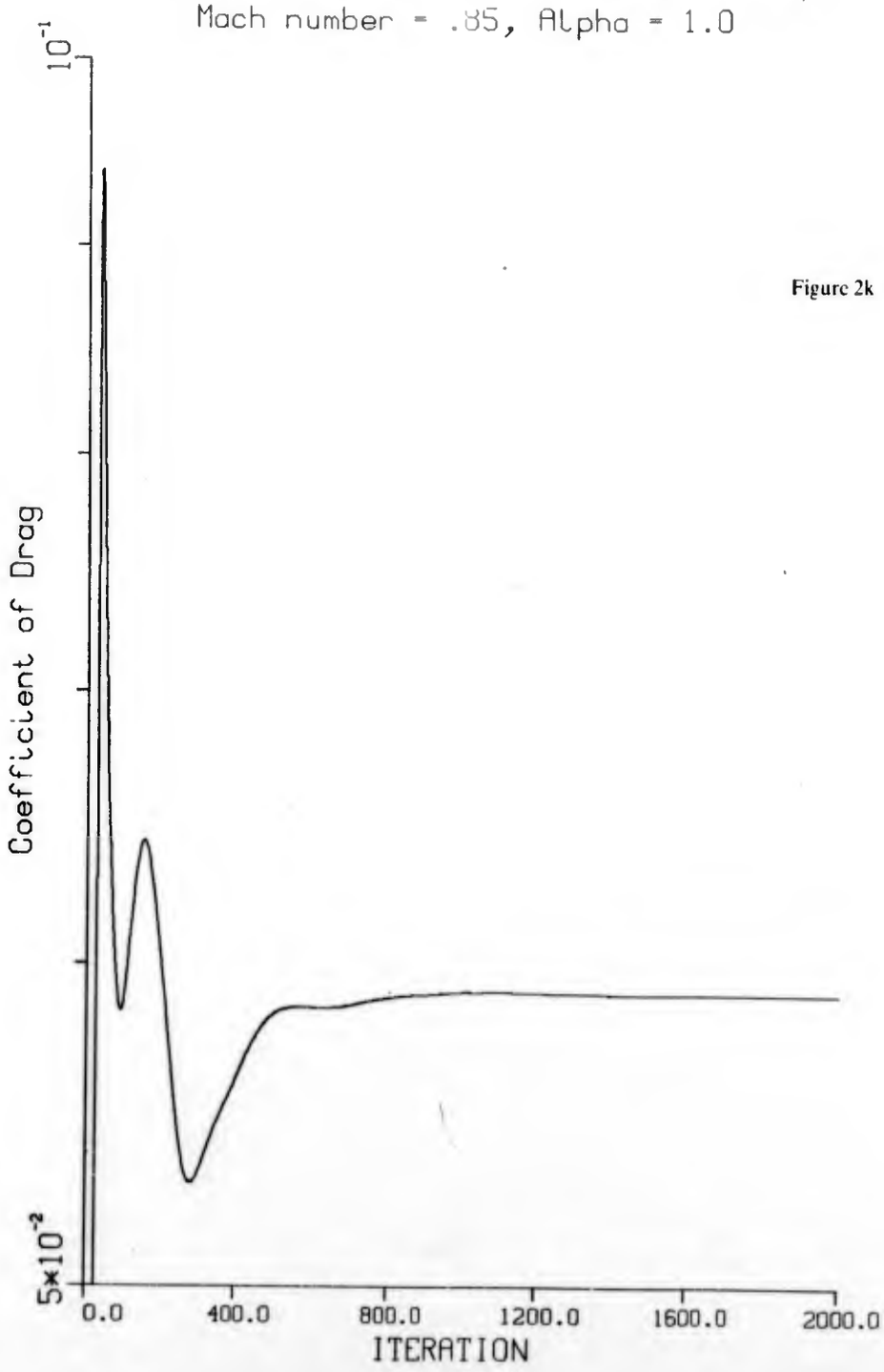


Figure 2k

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-19
	NACA 0012: MACH = 0.85, ALPHA = 1			

ARC2D - 249 × 67 grid, DT-3.
AGARD2P grid, clustering at shocks = .02
Upwinding, spatially variable time step
Mach number = .85, Alpha = 1.0

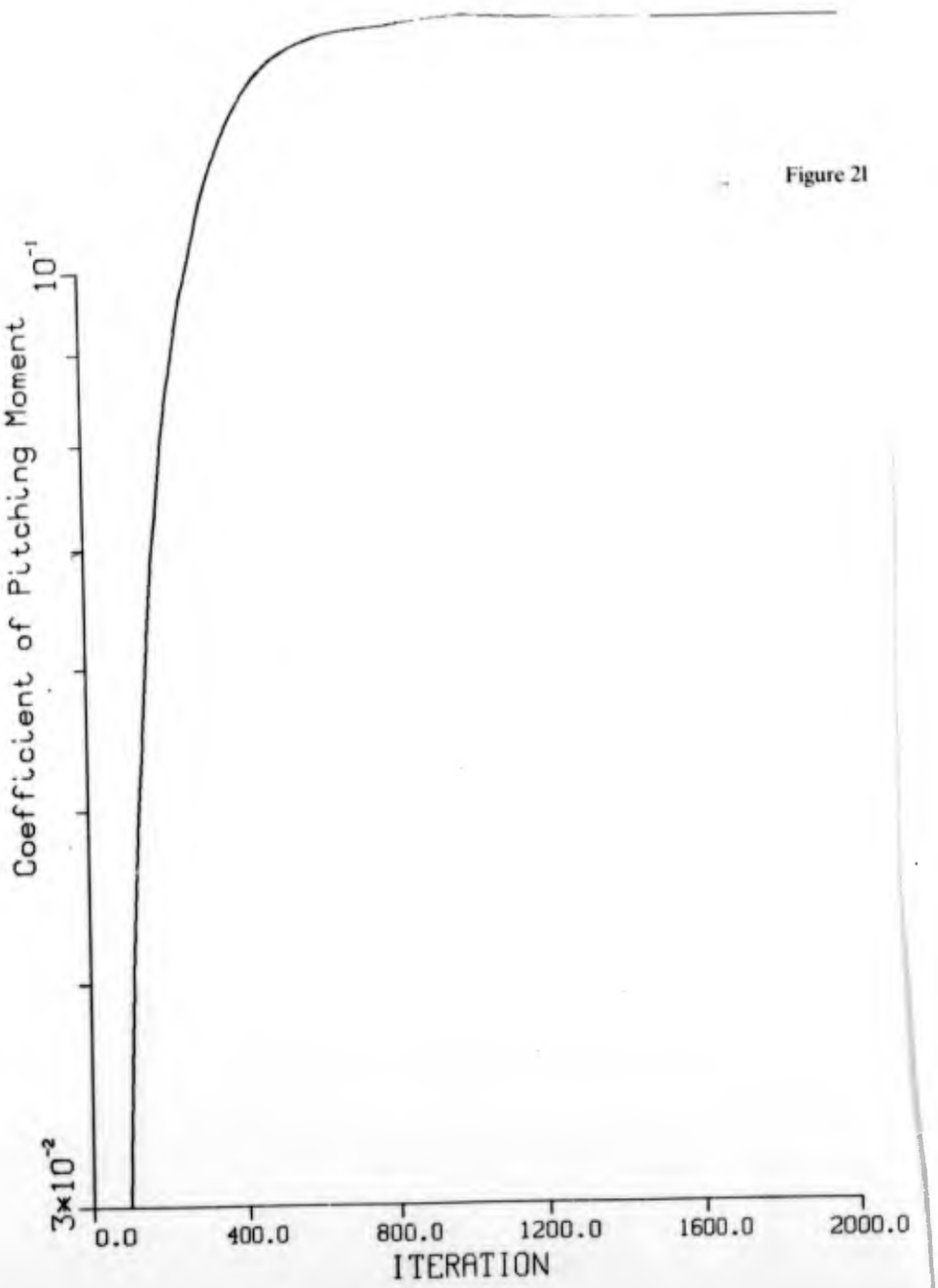


Figure 21

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-20
	NACA 0012: MACH = 0.85, ALPHA = 1			

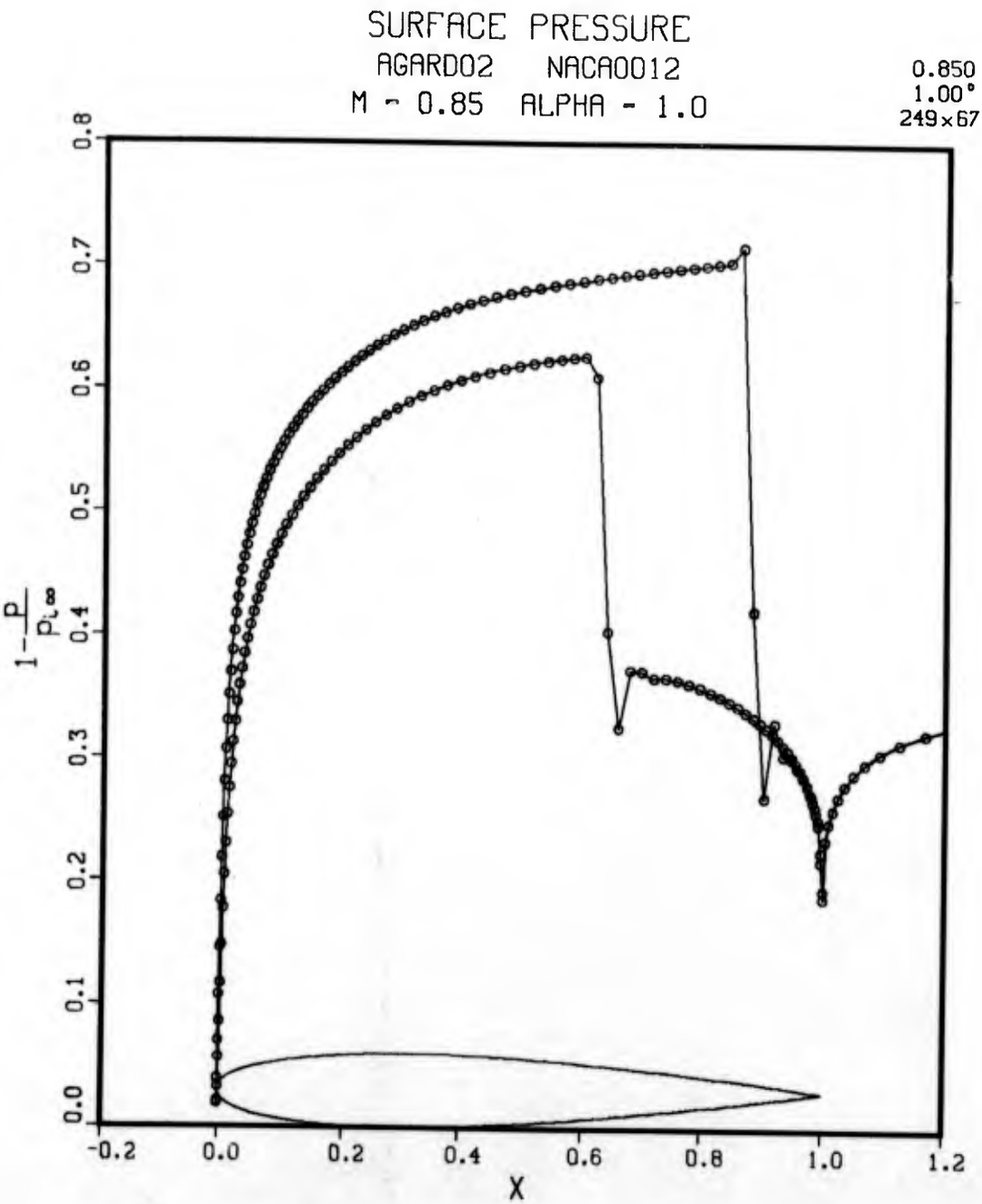


Figure 2m

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-21
	NACA 0012: MACH = 0.85, ALPHA = 1			

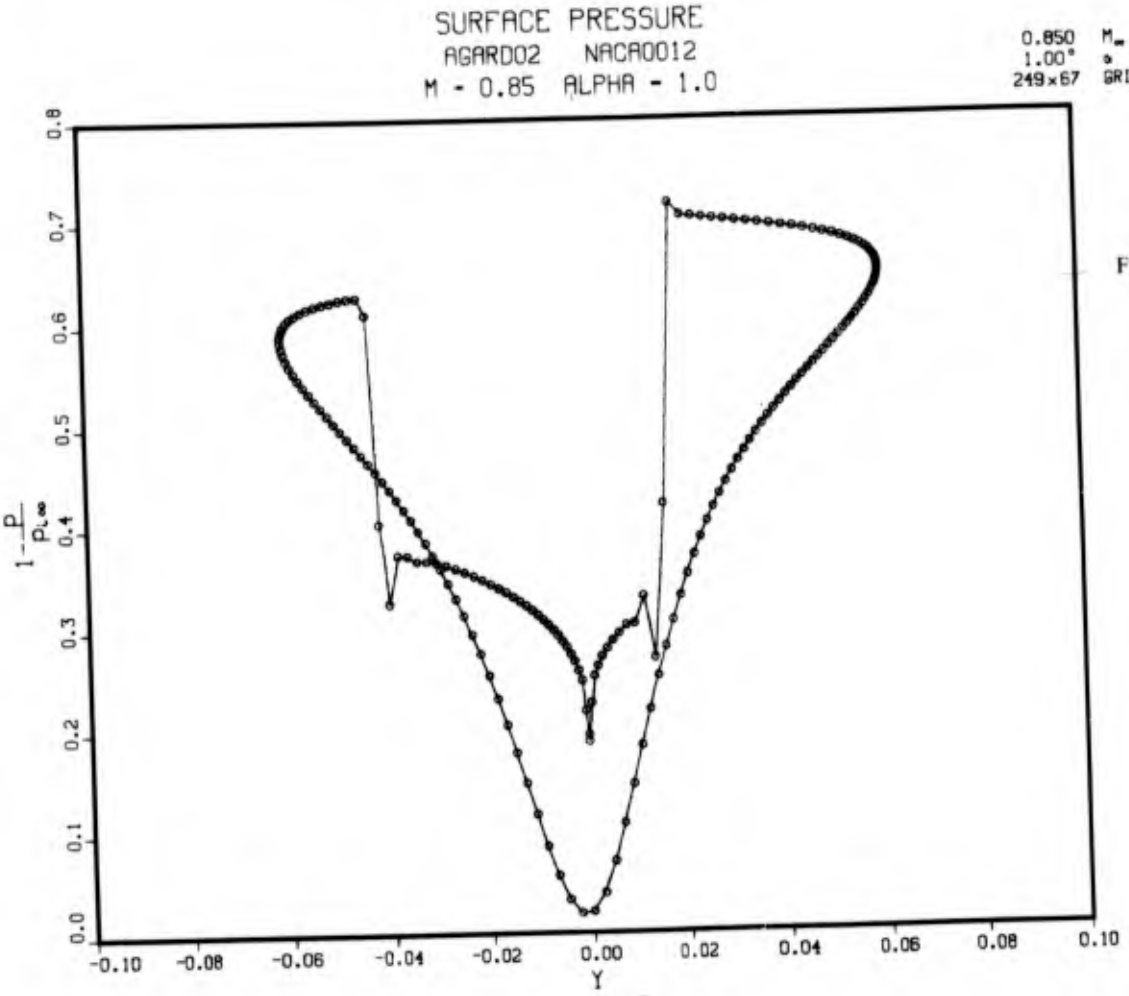


Figure 2n

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-22
	NACA 0012: MACH = 0.85, ALPHA = 1			

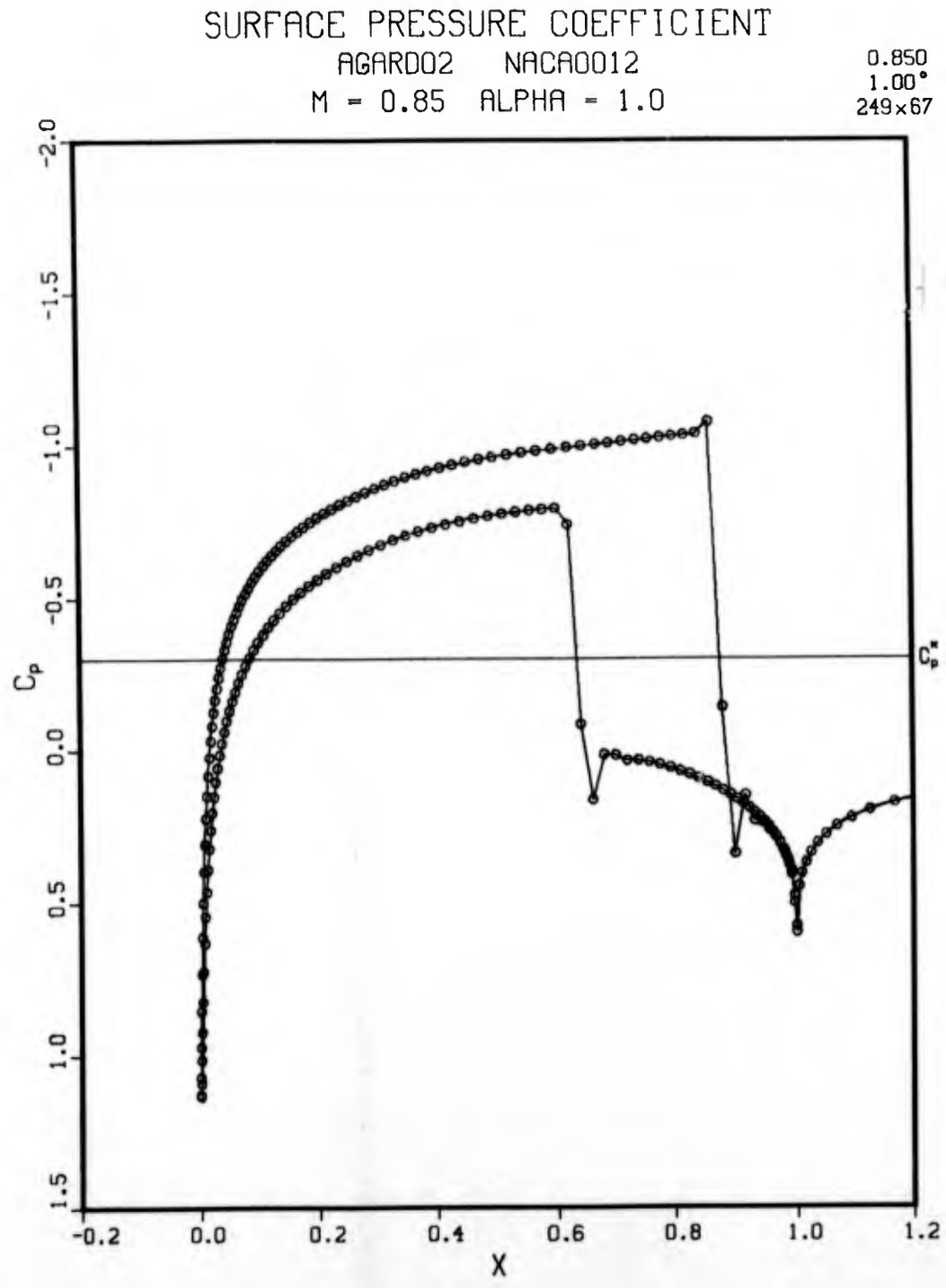


Figure 2o

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-23
	NACA 0012: MACH = 0.85, ALPHA = 1			

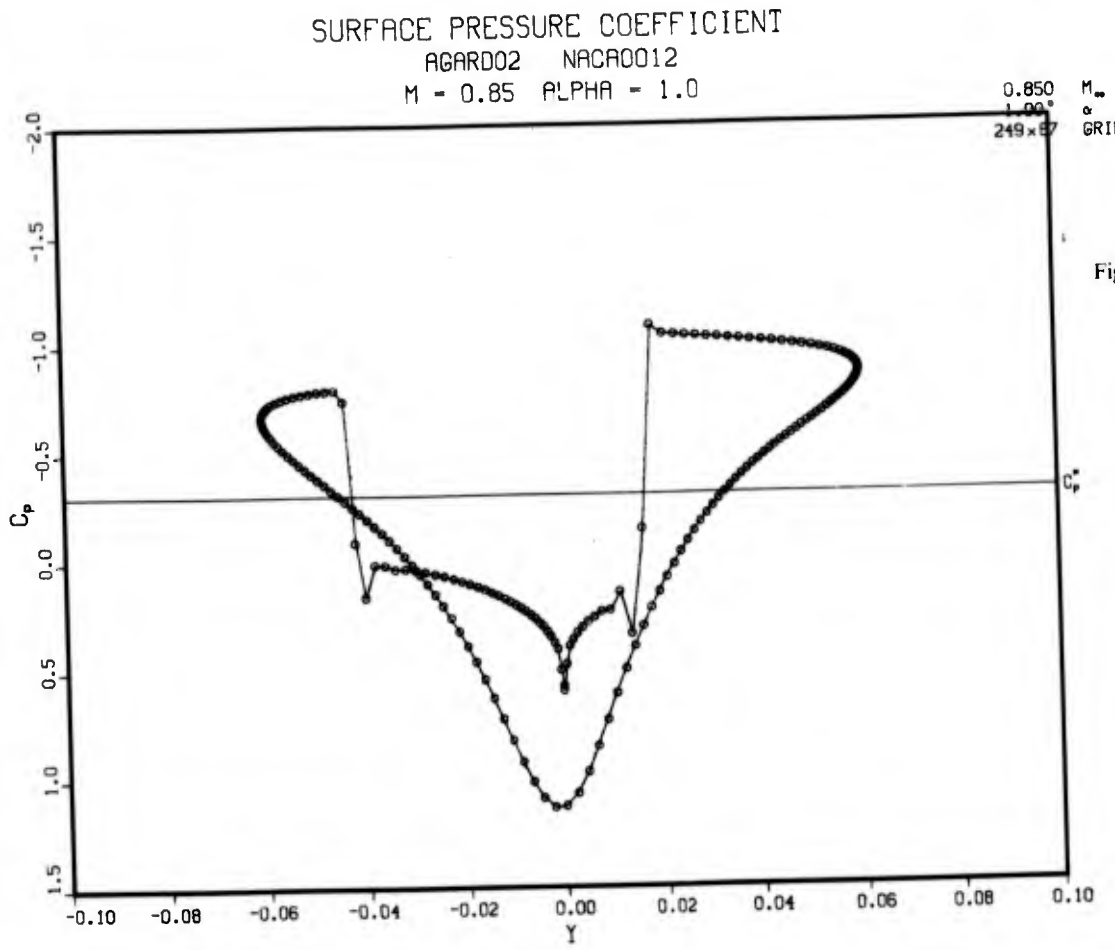


Figure 2p

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-24
	NACA 0012: MACH = 0.85, ALPHA = 1			

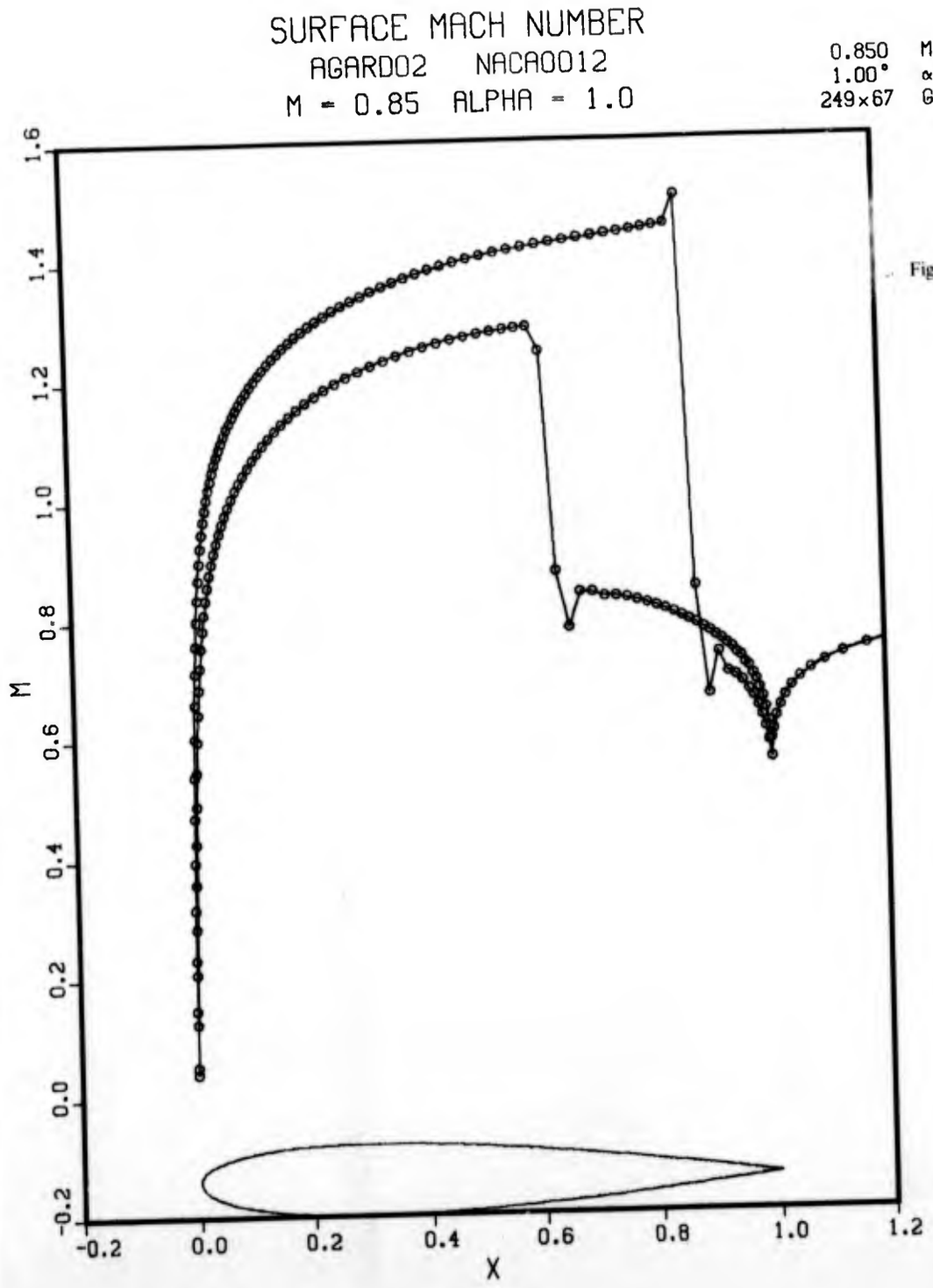


Figure 2q

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-25
	NACA 0012: MACH = 0.85, ALPHA = 1			

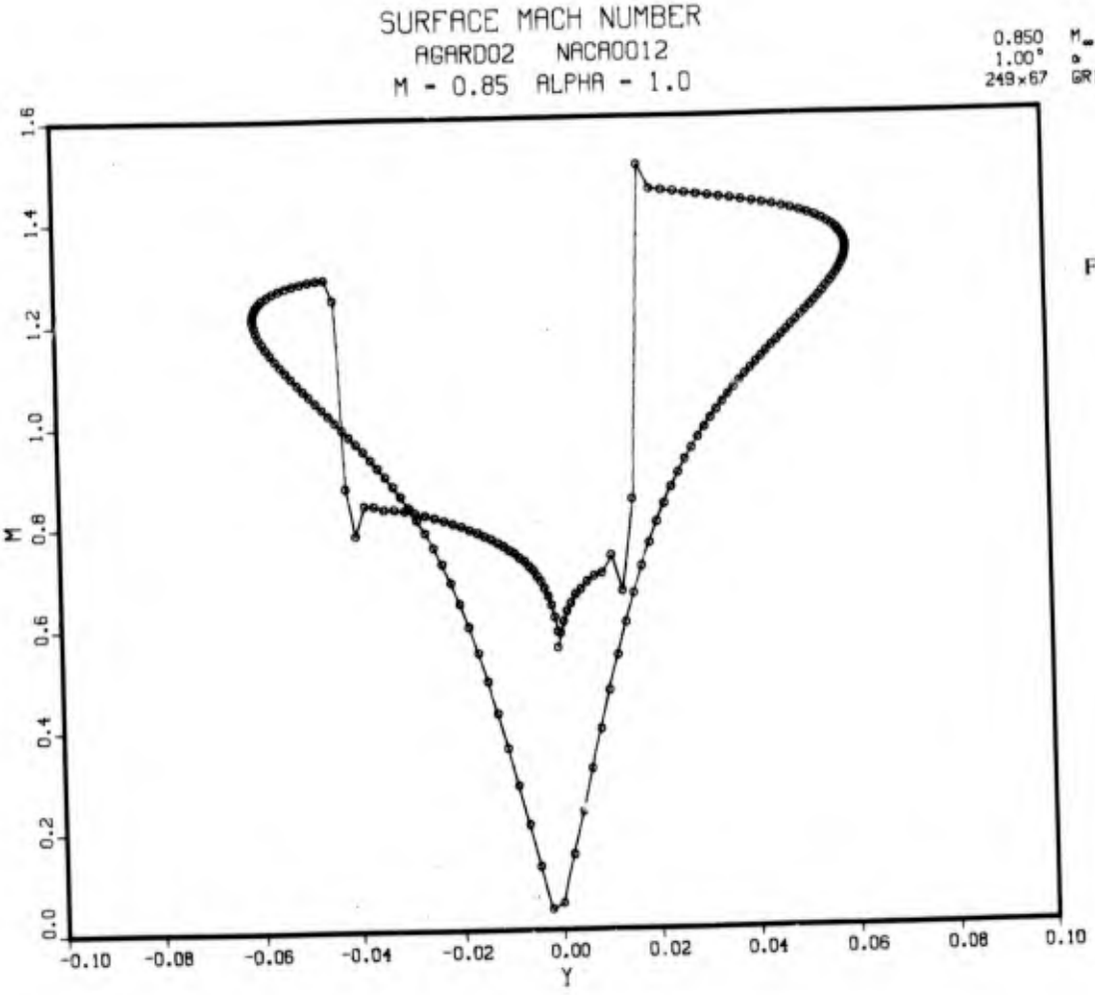


Figure 2r

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-26
	NACA 0012: MACH = 0.85, ALPHA = 1			

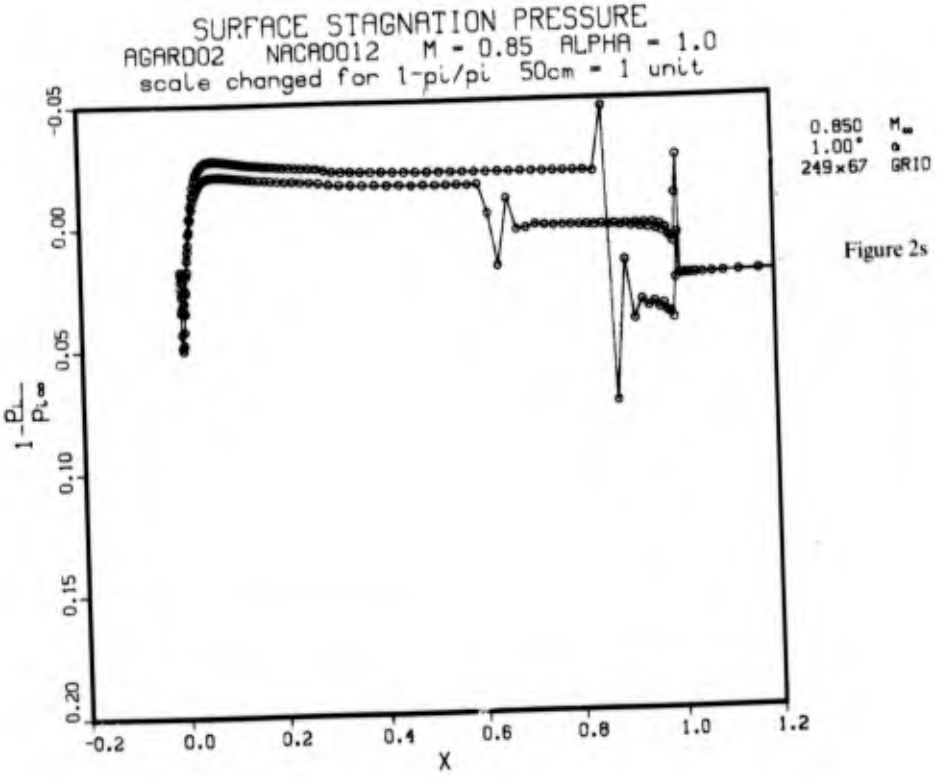


Figure 2s

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-27
	NACA 0012: MACH = 0.85, ALPHA = 1			

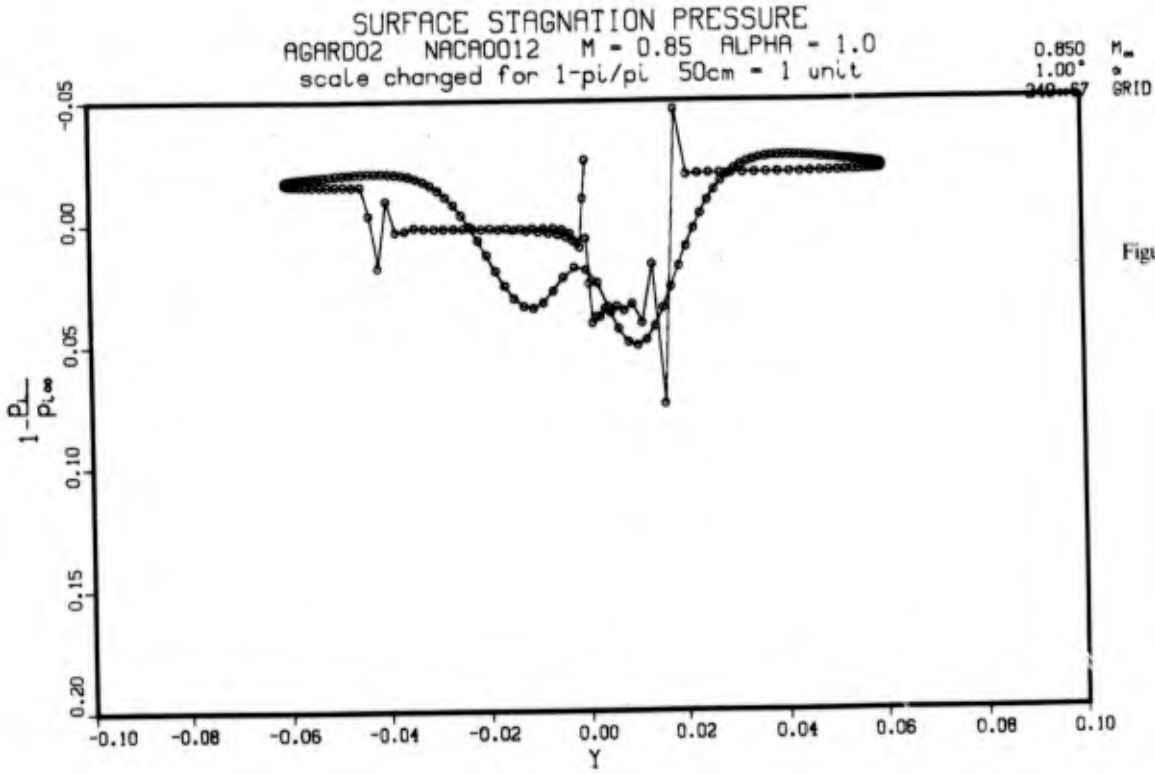


Figure 2t

N.A.S.A. AMES	A.R 211		T.H.Pulliam J.T.Barton	02-5-28
	NACA 0012: MACH = 0.85, ALPHA = 1			

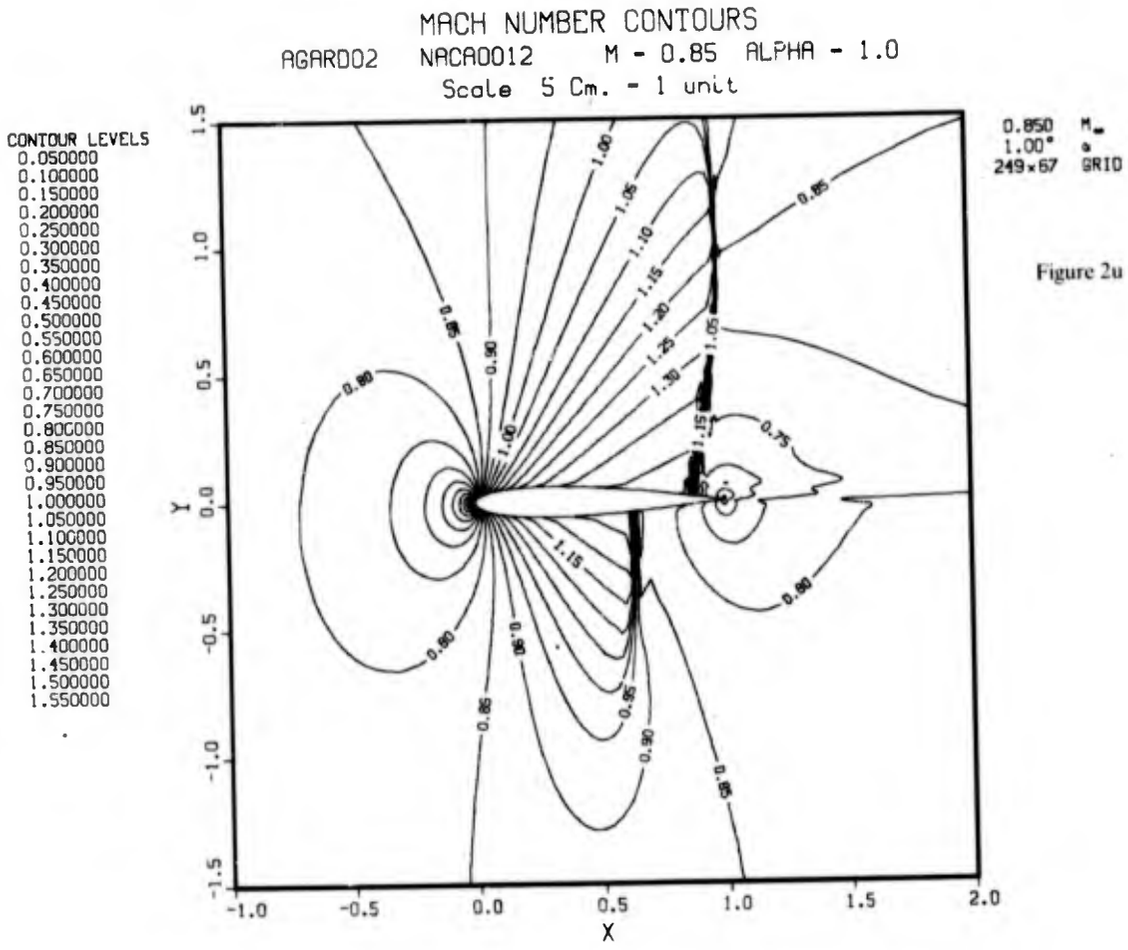


Figure 2u

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-29
	NACA 0012: MACH = 0.85, ALPHA = 1			

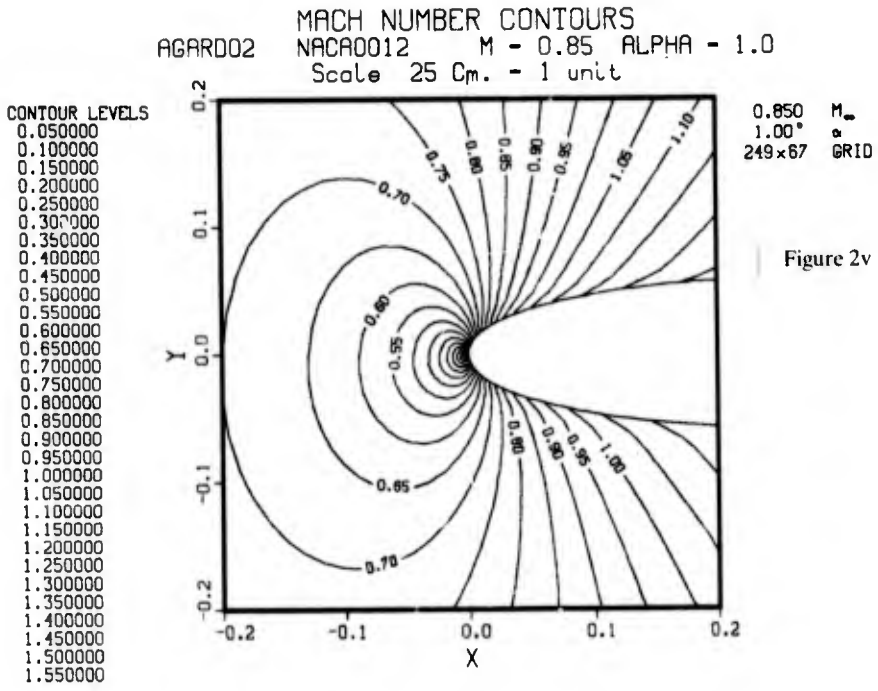


Figure 2v

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-30
	NACA 0012: MACH = 0.85, ALPHA = 1			

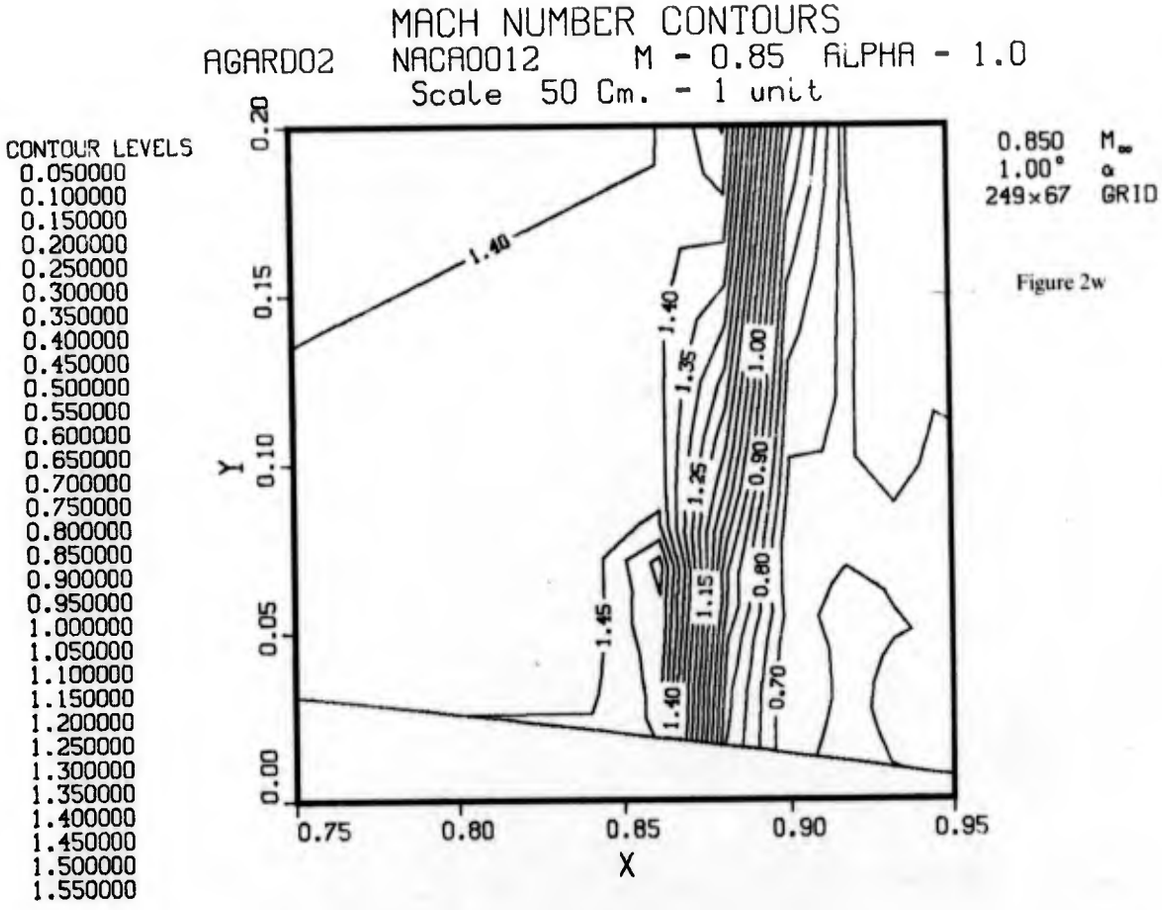


Figure 2w

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-31
	NACA 0012: MACH = 0.85, ALPHA = 1			

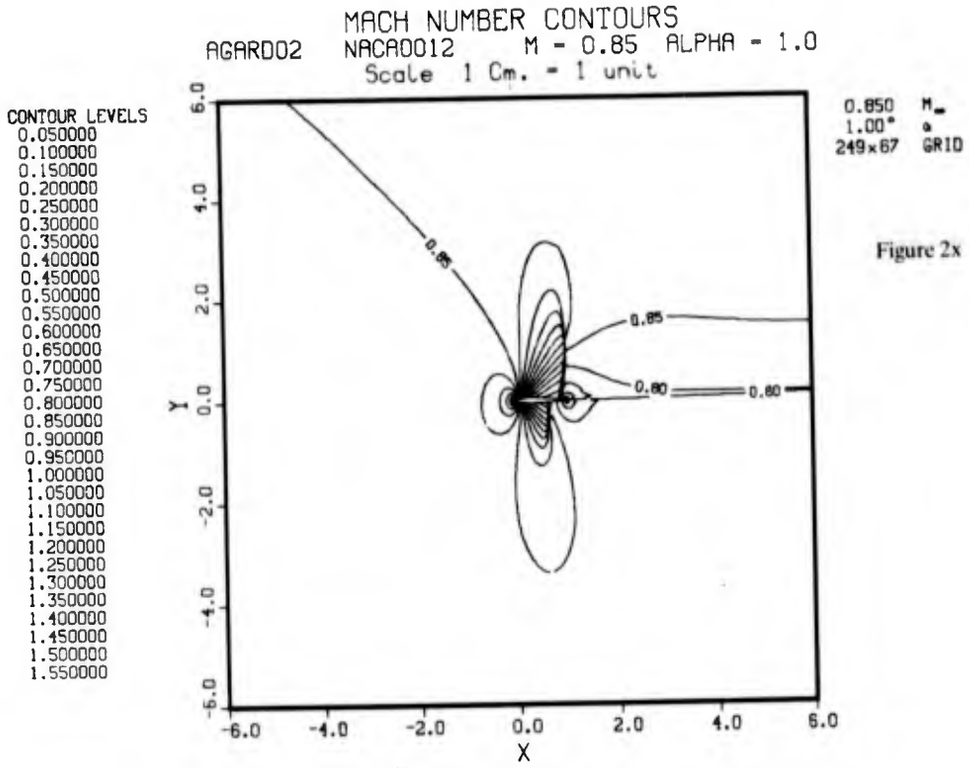


Figure 2x

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-32
	NACA 0012: MACH = 0.85, ALPHA = 1			

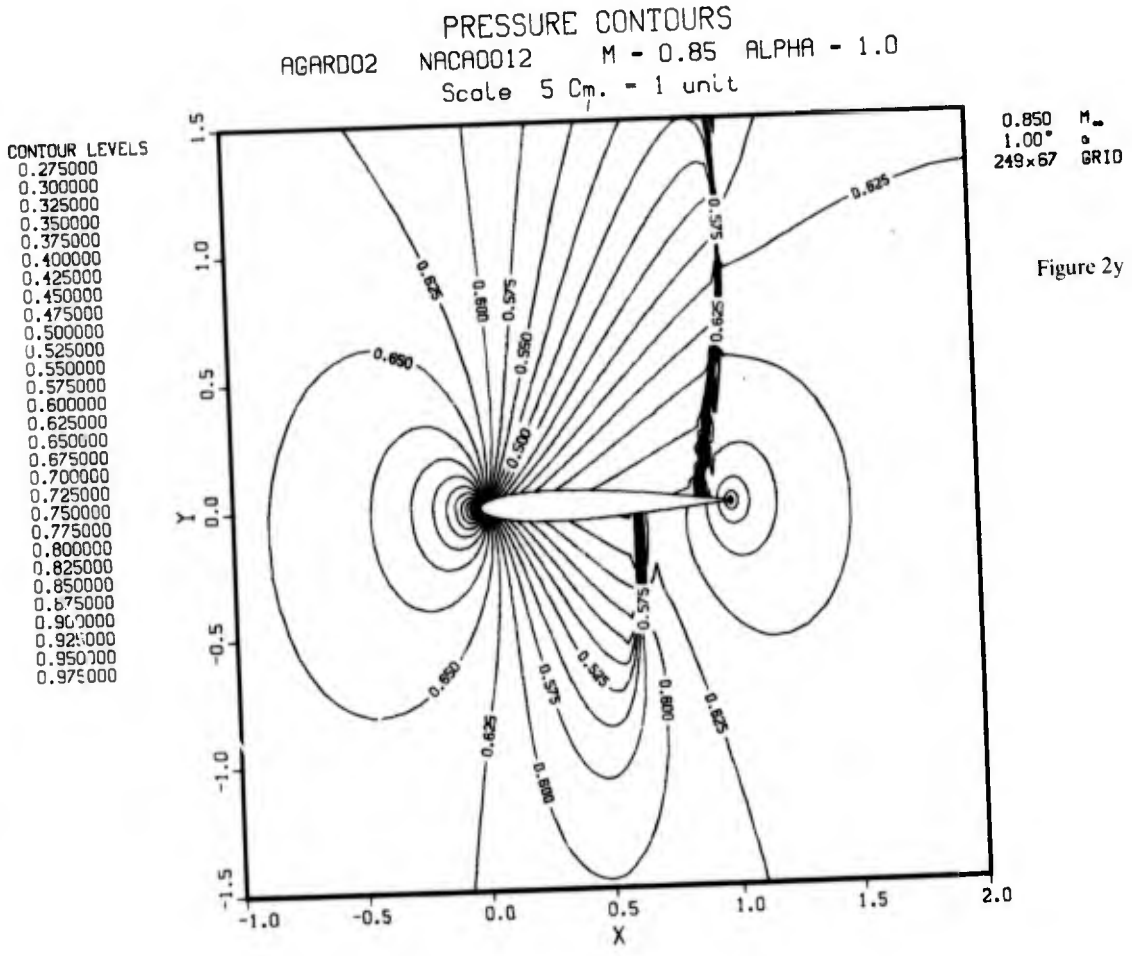


Figure 2y

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-33
	NACA 0012: MACH = 0.85, ALPHA = 1			

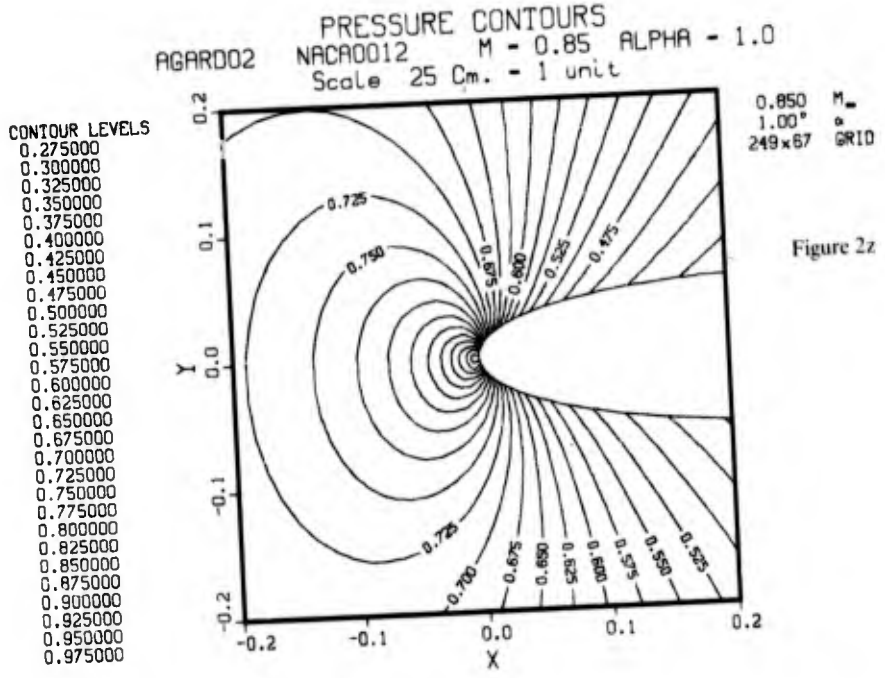


Figure 2z

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-34
	NACA 0012: MACH = 0.85, ALPHA = 1			

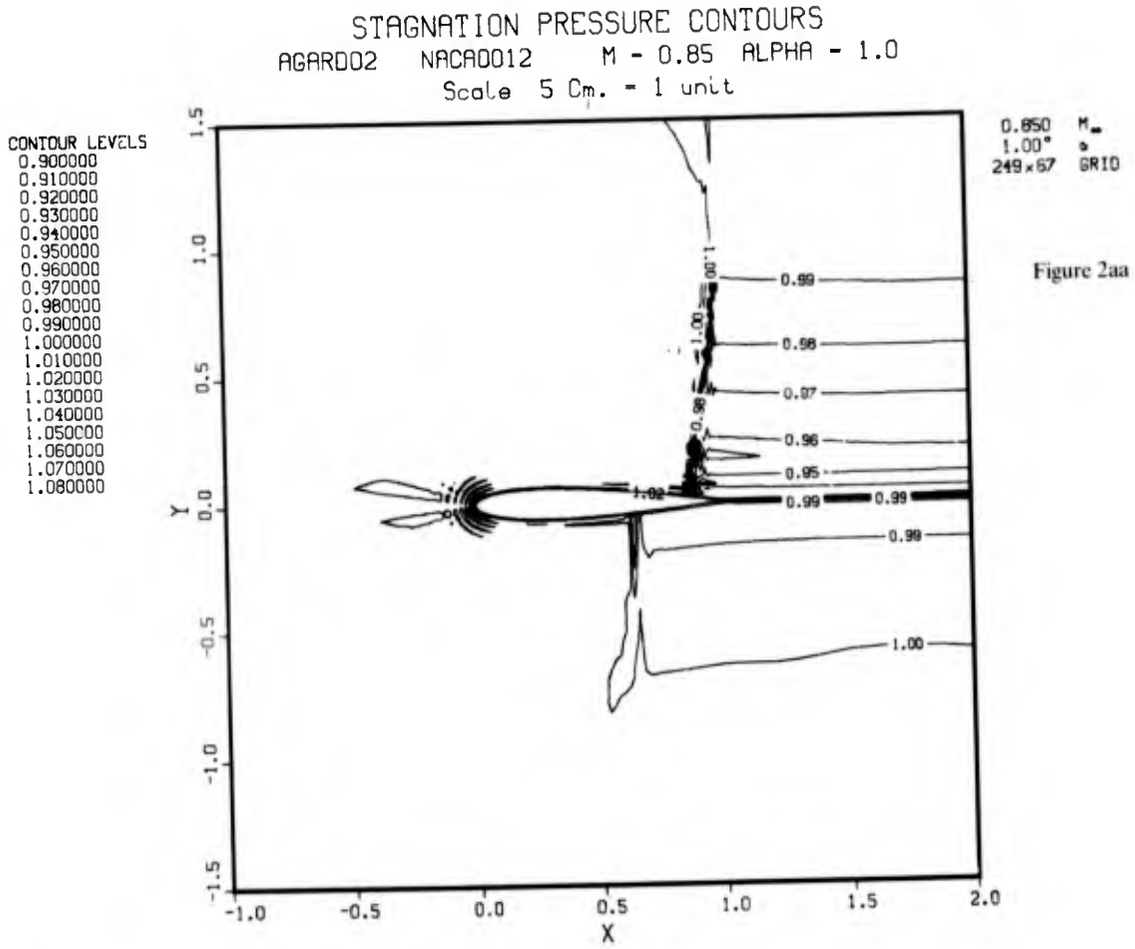


Figure 2aa

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-35
	NACA 0012: MACH = 0.85, ALPHA = 1			

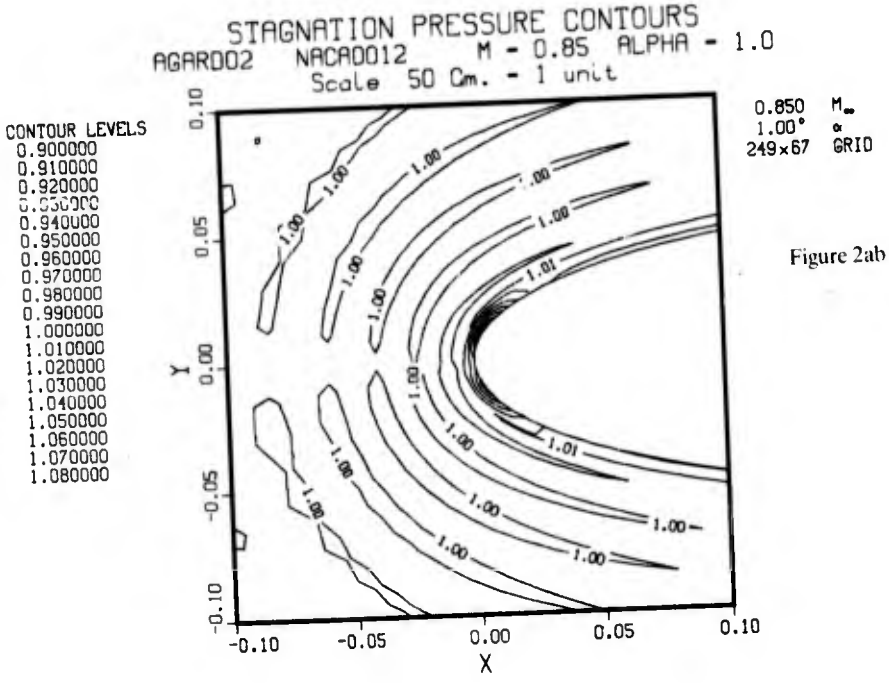


Figure 2ab

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-36
	NACA 0012: MACH = 0.85, ALPHA = 1			

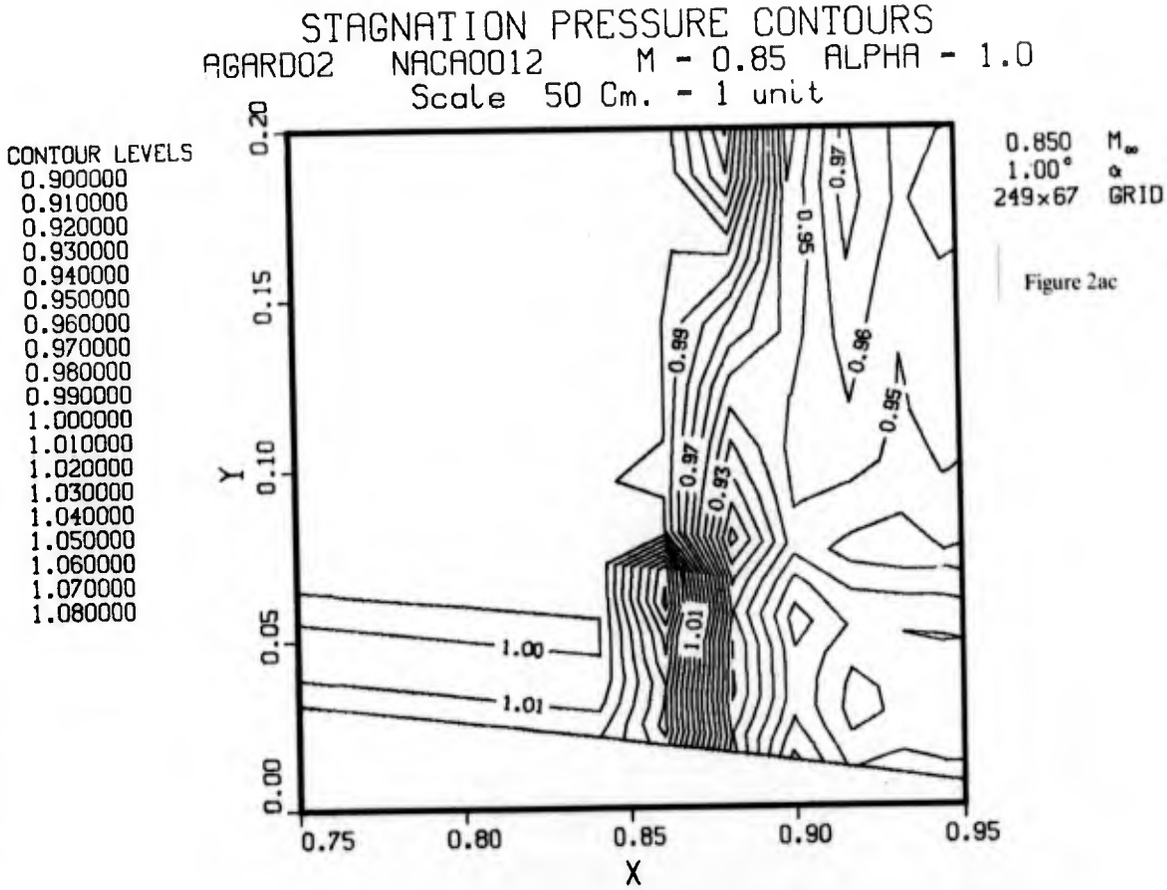


Figure 2ac

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-37
	NACA 0012: MACH = 0.85, ALPHA = 1			

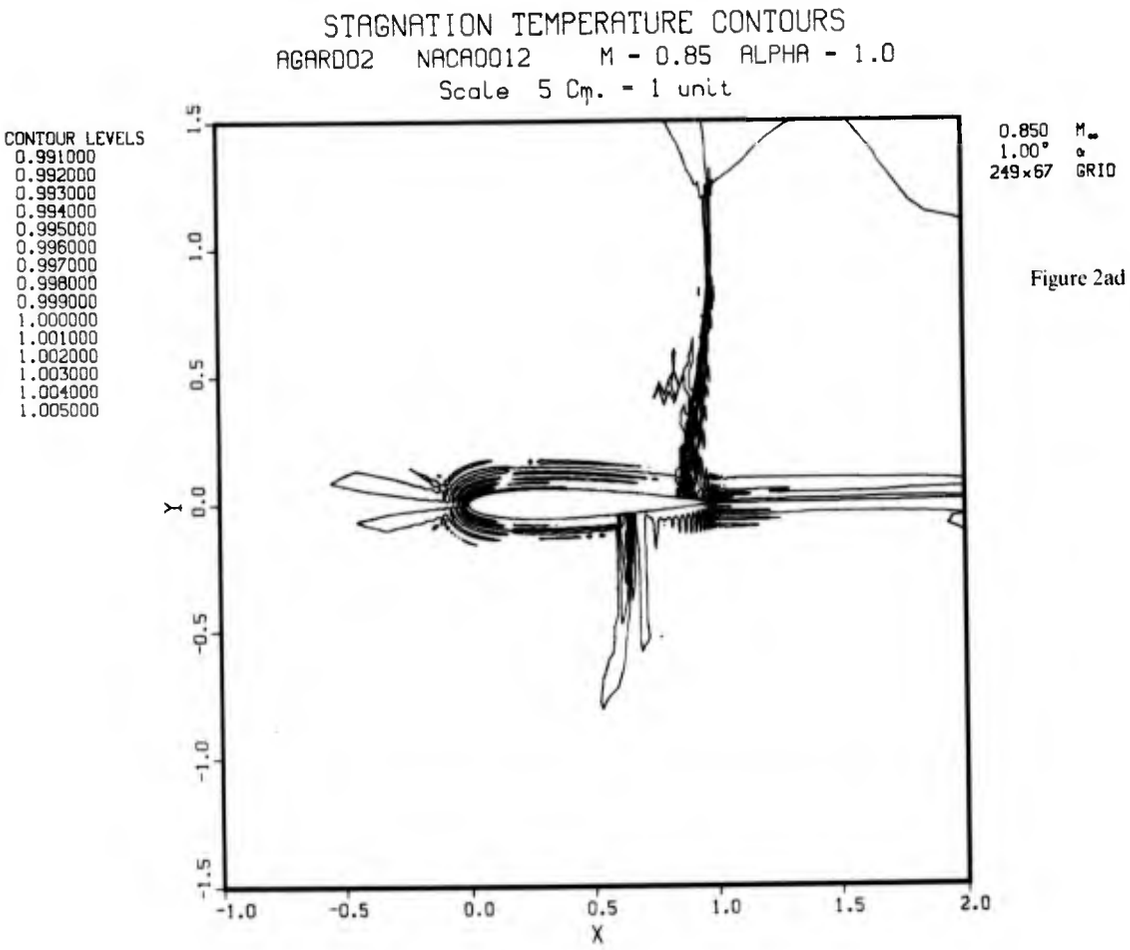


Figure 2ad

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-38
	NACA 0012: MACH = 0.85, ALPHA = 1			

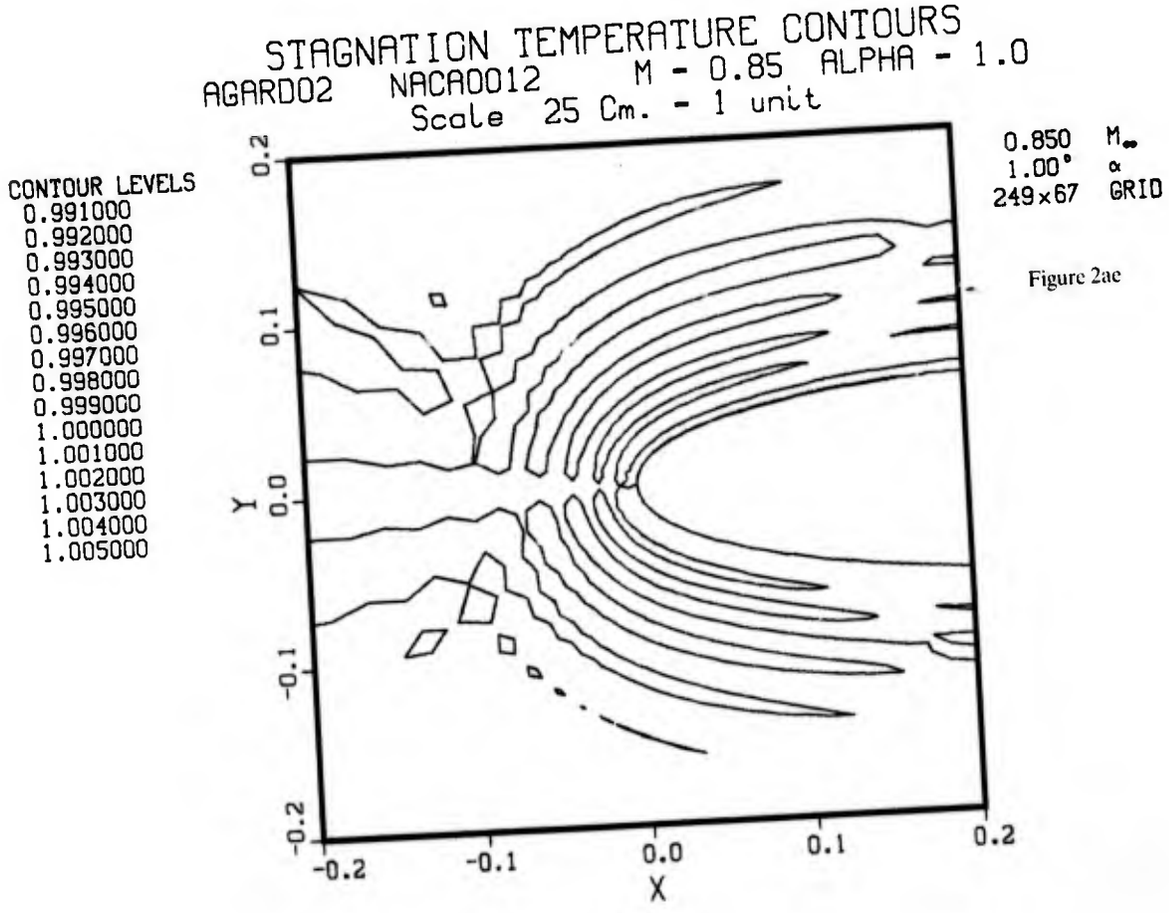


Figure 2ae

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	02-5-39
	NACA 0012: MACH = 0.85, ALPHA = 1			

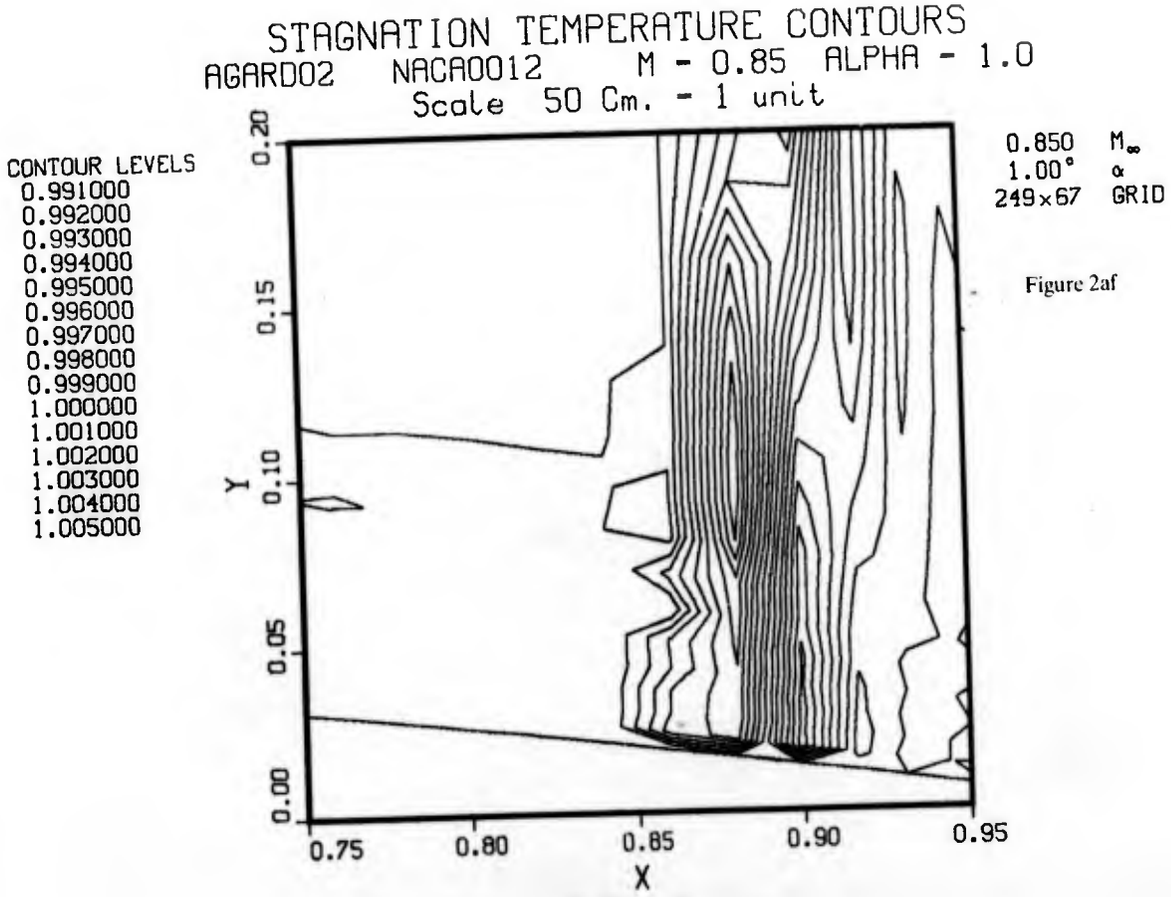


Figure 2af

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 02

NACA 0012: MACH = 0.85, ALPHA = 1

Contributor No 6

M.D.Salas and J.C.South, Jr

(N.A.S.A. — Langley, U.S.A.)

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-1
	NACA 0012: MACH = 0.85, ALPHA = 1			

NASA Langley Research Center - AGARD case 02
NACA 0012 Mach=0.850 alpha=1.000 (deg)
Cl=0.3472 Cd=0.0557 Cl=-0.1167

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-2
	NACA 0012: MACH = 0.85, ALPHA = 1			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piint
1	.000115	.001330	.014270	1.148656	.124907	.003462
2	.000575	.003980	.047588	1.042998	.249357	.005486
3	.001500	.006610	.093762	.896572	.364625	.006581
4	.002890	.009215	.148924	.721645	.475275	.006579
5	.004755	.011790	.203501	.548570	.571500	.006040
6	.007100	.014330	.252512	.393149	.651136	.006148
7	.009915	.016830	.296550	.253496	.720387	.006112
8	.013200	.019290	.334727	.132431	.781617	.004078
9	.016960	.021710	.367866	.02 341	.832885	.003920
10	.021195	.024085	.396258	-.062694	.878460	.002260
11	.025895	.026405	.420141	-.138430	.915285	.002791
12	.031055	.028670	.440246	-.202188	.948391	.001287
13	.036675	.030880	.459221	-.262359	.978089	.001991
14	.042750	.033030	.475245	-.313176	1.005066	.000779
15	.049270	.035115	.489766	-.359224	1.028160	.001601
16	.056235	.037135	.502671	-.400148	1.050631	.000332
17	.063640	.039085	.515153	-.439728	1.071001	.001054
18	.071470	.040960	.525113	-.471314	1.088698	.000117
19	.079725	.042760	.535700	-.504886	1.106532	.000579
20	.088400	.044480	.545529	-.536056	1.124376	-.000337
21	.097480	.046115	.554548	-.564658	1.139871	.000160
22	.106960	.047665	.562576	-.590117	1.154865	-.000718
23	.116830	.049125	.570947	-.616662	1.169734	-.000445
24	.127085	.050495	.577341	-.636938	1.181708	-.000871
25	.137720	.051775	.584698	-.660269	1.195352	-.001011
26	.148720	.052960	.590690	-.679269	1.206497	-.001023
27	.160080	.054050	.597384	-.700497	1.219511	-.001610
28	.171785	.055040	.603106	-.718644	1.230136	-.001308
29	.183825	.055935	.607920	-.733910	1.239717	-.001798
30	.196190	.056730	.613975	-.753111	1.251433	-.001828
31	.208870	.057420	.618996	-.769035	1.261420	-.002087
32	.221860	.058010	.623692	-.783925	1.270708	-.002153
33	.235140	.058500	.628070	-.797809	1.279528	-.002331
34	.248700	.058890	.632424	-.811617	1.288327	-.002451
35	.262530	.059180	.636436	-.824339	1.296497	-.002557
36	.276620	.059370	.640582	-.837486	1.305098	-.002792
37	.290955	.059460	.644243	-.849097	1.312590	-.002778
38	.305520	.059455	.647469	-.859325	1.319370	-.002948
39	.320305	.059355	.650961	-.870401	1.326685	-.003028
40	.335290	.059160	.654182	-.880614	1.333484	-.003110
41	.350465	.058870	.657658	-.891637	1.341021	-.003402
42	.365820	.058490	.659963	-.898948	1.345678	-.003079
43	.381335	.058030	.662130	-.905819	1.350605	-.003508
44	.396995	.057485	.665344	-.916010	1.357429	-.003416
45	.412785	.056855	.667557	-.923030	1.362285	-.003529
46	.428690	.056150	.669556	-.929366	1.366560	-.003450
47	.444695	.055370	.671718	-.936225	1.371453	-.003705
48	.460780	.054520	.673495	-.941859	1.375144	-.003431
49	.476930	.053600	.675972	-.949714	1.381019	-.004032
50	.493130	.052615	.677064	-.953177	1.382808	-.003158

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-3
	NACA 0012: MACH = 0.85, ALPHA = 1			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
51	.509365	.051575	.678514	-.957776	1.386776	-.004221
52	.525615	.050475	.680567	-.964287	1.390649	-.003245
53	.541860	.049320	.681880	-.968450	1.394287	-.004240
54	.558085	.048115	.683444	-.973407	1.397047	-.003191
55	.574270	.046865	.684307	-.976145	1.399753	-.004273
56	.590400	.045575	.685624	-.980322	1.401935	-.003160
57	.606460	.044245	.686910	-.984400	1.405754	-.004451
58	.622430	.042880	.688177	-.988418	1.407600	-.002994
59	.638285	.041485	.688867	-.990607	1.410226	-.004492
60	.654015	.040065	.689908	-.993909	1.411454	-.002868
61	.669600	.038625	.690181	-.994772	1.413321	-.004636
62	.685020	.037160	.693027	-1.003797	1.418710	-.003026
63	.700265	.035680	.691712	-.999630	1.416483	-.004150
64	.715310	.034190	.693952	-1.006730	1.421131	-.003440
65	.730140	.032685	.694607	-1.008809	1.423019	-.003975
66	.744740	.031175	.695350	-1.011164	1.424341	-.003413
67	.759090	.029665	.696354	-1.014350	1.427030	-.003926
68	.773175	.028155	.696579	-1.015061	1.427207	-.003437
69	.786975	.026650	.698269	-1.020421	1.431651	-.004167
70	.800475	.025155	.698160	-1.020077	1.430570	-.002986
71	.813665	.023670	.699459	-1.024195	1.434775	-.004661
72	.826525	.022200	.700714	-1.028176	1.436358	-.002721
73	.839040	.020745	.685761	-.980757	1.394196	.008138
74	.851195	.019310	.536562	-.507622	1.054950	.063588
75	.862975	.017905	.342020	.109304	.741486	.052043
76	.874365	.016525	.327657	.154852	.722260	.048432
77	.885350	.015175	.323557	.167854	.716432	.047708
78	.895915	.013865	.322589	.170923	.714238	.048245
79	.906050	.012590	.318215	.184794	.707341	.048052
80	.915740	.011355	.314923	.195233	.701860	.048148
81	.924970	.010165	.310720	.208562	.694949	.048187
82	.933735	.009025	.306394	.222280	.687823	.048224
83	.942015	.007940	.302713	.233953	.681690	.048303
84	.949795	.006905	.297574	.250252	.673074	.048436
85	.957065	.005930	.292240	.267165	.664486	.048261
86	.963815	.005020	.287488	.282236	.656312	.048507
87	.970035	.004175	.281770	.300366	.646841	.048480
88	.975710	.003395	.276034	.318558	.637139	.048576
89	.980825	.002685	.268262	.343205	.624033	.048613
90	.985370	.002055	.261665	.364124	.613217	.048353
91	.989335	.001505	.253857	.388883	.599012	.049028
92	.992700	.001035	.245421	.415636	.585357	.048396
93	.995450	.000645	.233822	.452418	.563471	.049590
94	.997570	.000345	.219683	.497256	.540053	.048416
95	.999035	.000140	.205329	.542774	.509272	.051457
96	.999800	.000030	.187602	.598990	.450227	.066368
97	.999800	-.000030	.171810	.649069	.472309	.035112
98	.999035	-.000140	.204973	.543903	.551973	.022105
99	.997570	-.000345	.215750	.509728	.580623	.014549
100	.995450	-.000645	.233642	.452988	.605118	.018566

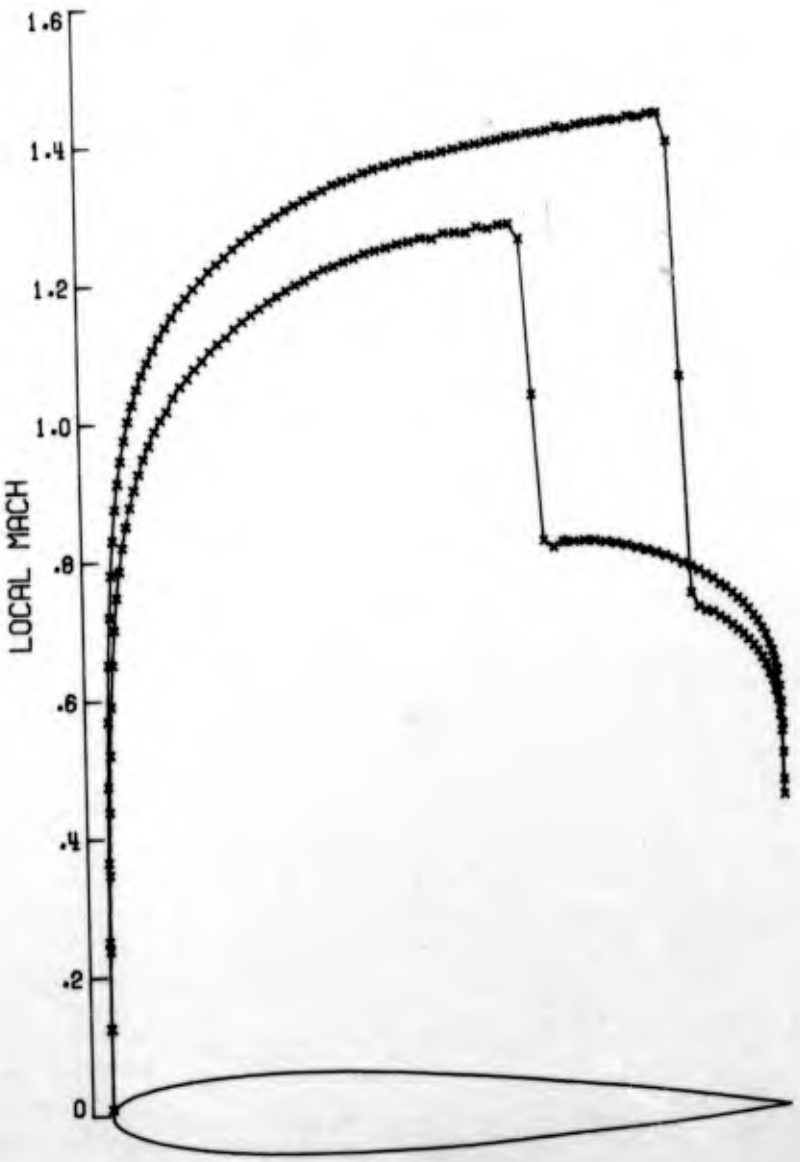
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-4
	NACA 0012: MACH = 0.85, ALPHA = 1			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
101	.992700	-.001035	.244691	.417950	.628010	.014788
102	.989335	-.001505	.254773	.385979	.641038	.017472
103	.985370	-.002055	.262294	.362127	.655982	.015139
104	.980825	-.002685	.269972	.337781	.666329	.016768
105	.975710	-.003395	.277987	.312364	.680392	.015670
106	.970035	-.004175	.284605	.291377	.689934	.016498
107	.963815	-.005020	.290531	.272585	.700088	.015817
108	.957065	-.005930	.295973	.255326	.708230	.016209
109	.949795	-.006905	.301705	.237152	.717602	.015897
110	.942015	-.007940	.307710	.218108	.726632	.016261
111	.933735	-.009025	.311645	.205630	.733317	.015796
112	.924970	-.010165	.316817	.189227	.741001	.016179
113	.915740	-.011355	.321882	.173166	.749227	.015901
114	.906050	-.012585	.325407	.161986	.754638	.015995
115	.895915	-.013860	.330091	.147132	.762010	.015944
116	.885350	-.015175	.333974	.134818	.768144	.015877
117	.874365	-.016525	.338267	.121205	.774724	.015990
118	.862975	-.017905	.341935	.109574	.780606	.015838
119	.851195	-.019310	.344838	.100368	.785140	.015833
120	.839040	-.020745	.348913	.087444	.791456	.015873
121	.826525	-.022200	.351918	.077917	.796271	.015747
122	.813665	-.023670	.354841	.068648	.800755	.015820
123	.800475	-.025155	.357544	.060074	.805126	.015669
124	.786975	-.026650	.359824	.052845	.808647	.015704
125	.773175	-.028155	.362186	.045354	.812415	.015623
126	.759090	-.029665	.364113	.039243	.815432	.015614
127	.744740	-.031175	.365311	.035445	.817432	.015484
128	.730140	-.032685	.366944	.030266	.819874	.015591
129	.715310	-.034185	.366869	.030503	.820035	.015314
130	.700265	-.035675	.366363	.032108	.819120	.015438
131	.685020	-.037155	.366043	.033122	.818733	.015327
132	.669600	-.038620	.361171	.048573	.811349	.015111
133	.654015	-.040065	.368812	.024341	.821182	.017196
134	.638285	-.041485	.504729	-.406672	1.032187	.026225
135	.622430	-.042880	.618813	-.768452	1.258047	.001948
136	.606460	-.044245	.628659	-.799676	1.279814	-.001131
137	.590400	-.045575	.627423	-.795756	1.278349	-.002480
138	.574270	-.046865	.625332	-.789127	1.273277	-.001239
139	.558085	-.048115	.626560	-.793019	1.276374	-.002131
140	.541860	-.049315	.622626	-.780544	1.268270	-.001704
141	.525615	-.050465	.623057	-.781912	1.269018	-.001566
142	.509365	-.051570	.622655	-.780638	1.268420	-.001827
143	.493130	-.052615	.618588	-.767740	1.260435	-.001838
144	.476930	-.053595	.619290	-.769966	1.261372	-.001249
145	.460780	-.054515	.616363	-.760685	1.256315	-.002142
146	.444695	-.055370	.615297	-.757304	1.253359	-.000966
147	.428690	-.056150	.612240	-.747610	1.248319	-.002160
148	.412785	-.056855	.610845	-.743185	1.244550	-.000733
149	.396995	-.057485	.608114	-.734525	1.240323	-.002109
150	.381335	-.058030	.605331	-.725698	1.233910	-.000681

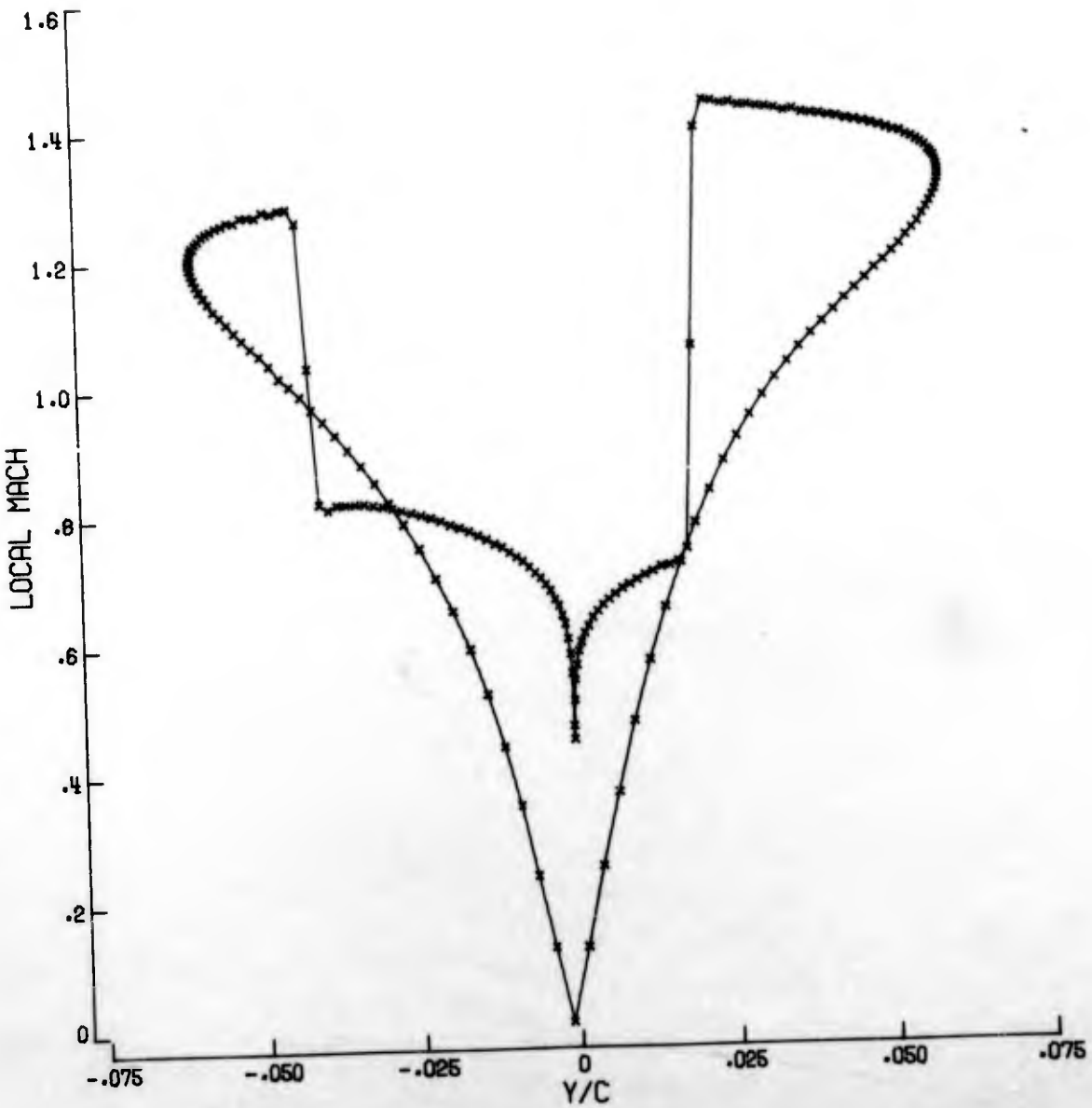
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-5
	NACA 0012: MACH = 0.85, ALPHA = 1			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
151	.365820	-.058490	.602457	-.716585	1.229256	-.001780
152	.350465	-.058865	.599864	-.708363	1.223481	-.000657
153	.335290	-.059155	.597038	-.699401	1.218821	-.001560
154	.320305	-.059355	.593539	-.688305	1.211541	-.000644
155	.305520	-.059455	.589027	-.673997	1.203613	-.001307
156	.290955	-.059460	.586079	-.664647	1.197380	-.000322
157	.276620	-.059370	.581708	-.650787	1.190010	-.001242
158	.262530	-.059180	.577427	-.637212	1.181277	-.000108
159	.248700	-.058890	.572695	-.622204	1.173269	-.000911
160	.235140	-.058500	.568156	-.607810	1.164290	.000062
161	.221860	-.058010	.563043	-.591598	1.155637	-.000636
162	.208870	-.057420	.558059	-.575793	1.146036	.000253
163	.196190	-.056730	.552315	-.557576	1.136292	-.000311
164	.183825	-.055935	.545652	-.536448	1.123985	.000426
165	.171785	-.055040	.539963	-.518407	1.114246	.000185
166	.160080	-.054050	.533818	-.498918	1.103274	.000585
167	.148720	-.052960	.526057	-.474308	1.090088	.000393
168	.137720	-.051775	.519556	-.453692	1.078440	.001085
169	.127085	-.050495	.511466	-.428039	1.065213	.000528
170	.116830	-.049125	.504777	-.406826	1.053172	.001510
171	.106960	-.047665	.495189	-.376422	1.037876	.000708
172	.097480	-.046110	.483518	-.339410	1.017812	.001684
173	.088400	-.044475	.475665	-.314507	1.005134	.001499
174	.079725	-.042760	.466136	-.284288	.989412	.001796
175	.071470	-.040960	.453273	-.243496	.968806	.001688
176	.063640	-.039085	.441825	-.207194	.949888	.002423
177	.056235	-.037135	.427870	-.162940	.928306	.001849
178	.049270	-.035115	.413604	-.117700	.904919	.002911
179	.042750	-.033030	.397441	-.066446	.880337	.002221
180	.036675	-.030880	.380125	-.011533	.852422	.003323
181	.031055	-.028670	.359809	.052892	.821687	.002667
182	.025895	-.026405	.338355	.120928	.787273	.004014
183	.021195	-.024085	.313227	.200611	.749106	.003456
184	.016960	-.021710	.284629	.291301	.703294	.004780
185	.013200	-.019290	.251372	.396763	.651268	.004521
186	.009915	-.016830	.215301	.511152	.591019	.006087
187	.007100	-.014325	.172906	.645592	.520940	.004837
188	.004755	-.011785	.130040	.781528	.439168	.006816
189	.002890	-.009215	.084111	.927176	.345628	.005209
190	.001500	-.006610	.043913	1.054653	.235922	.006141
191	.000575	-.003975	.013738	1.150341	.123859	.003106
192	.000115	-.001325	.003933	1.181436	.003614	.003924

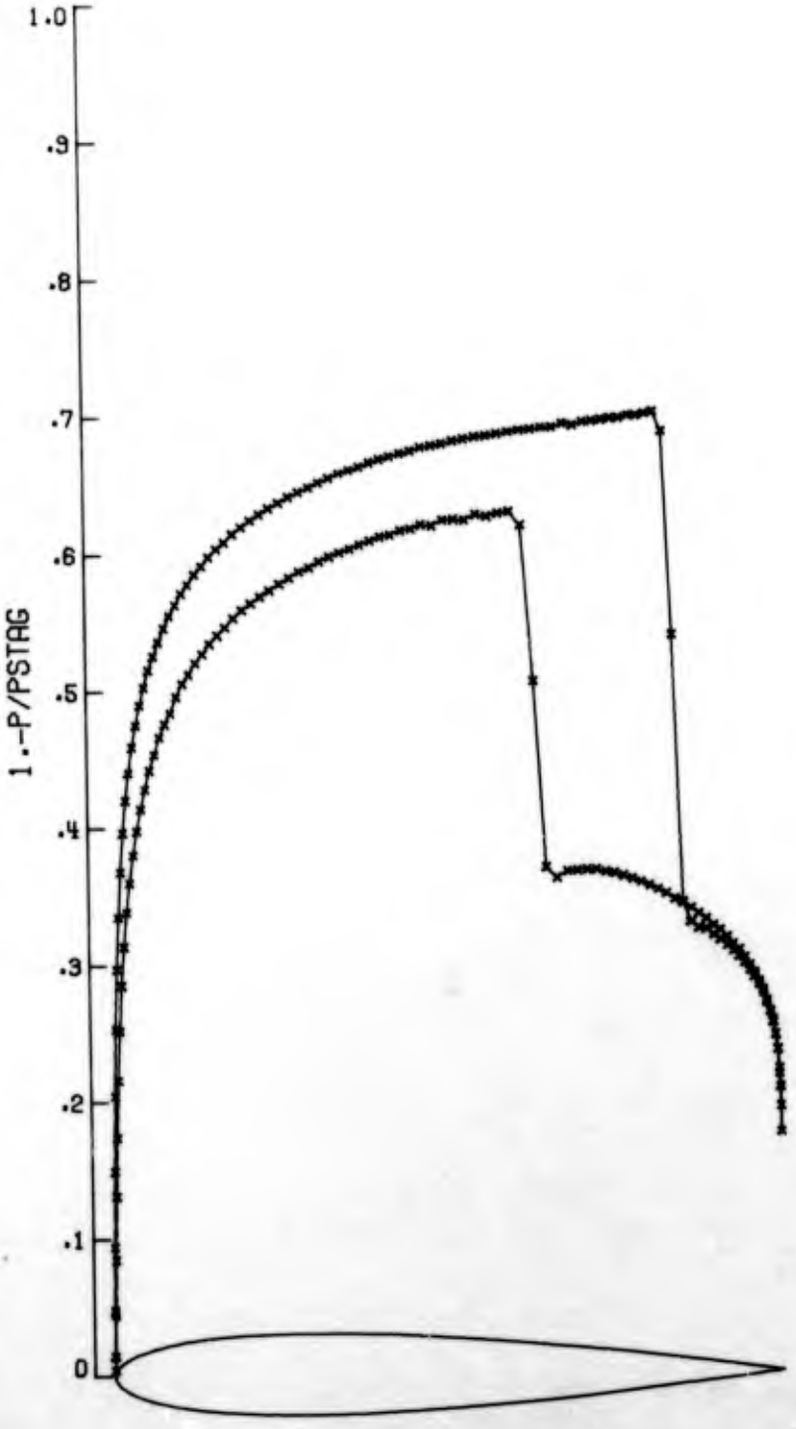
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-6
	NACA 0012: MACH = 0.85, ALPHA = 1			



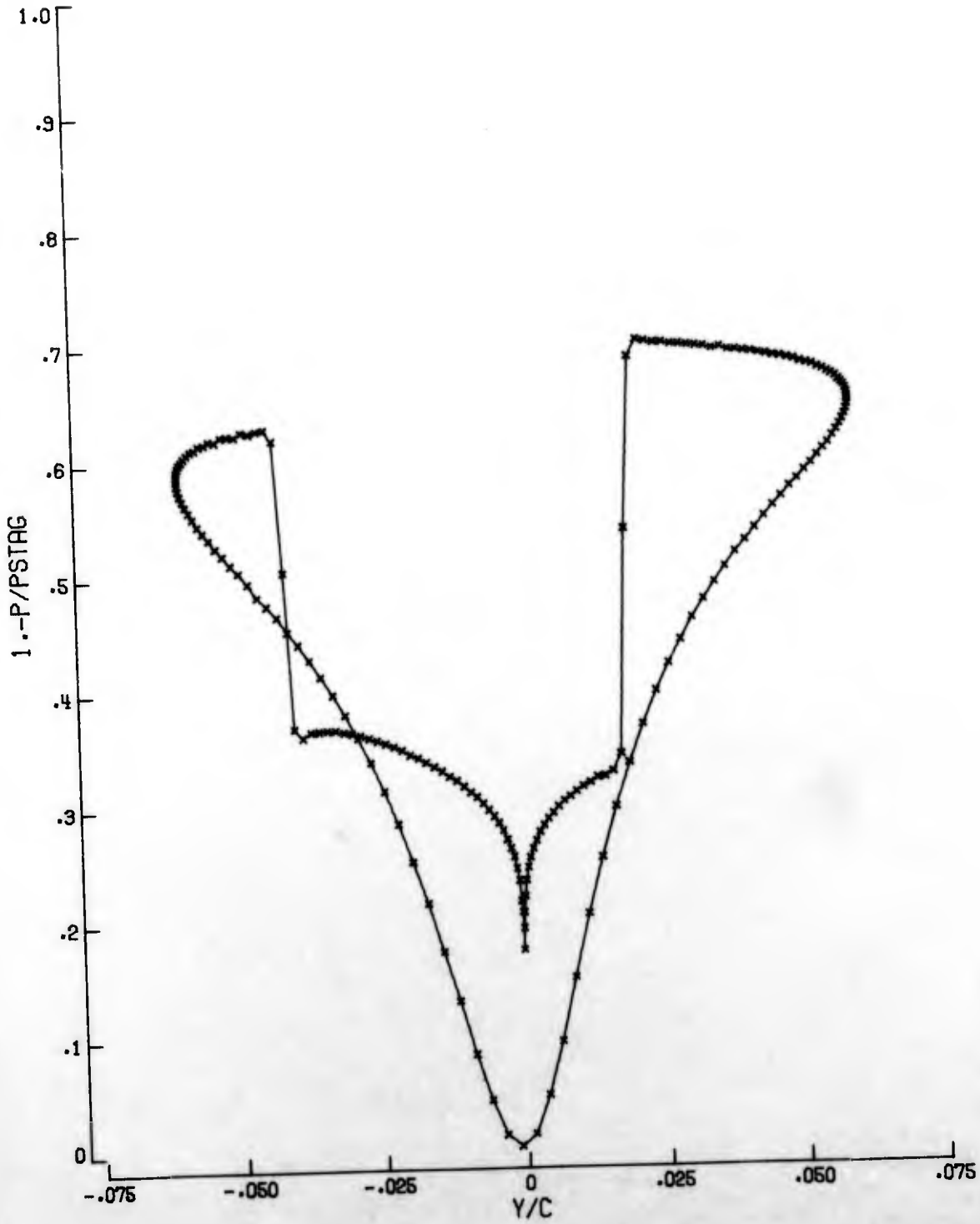
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-7
	NACA 0012: MACH = 0.85, ALPHA = 1			



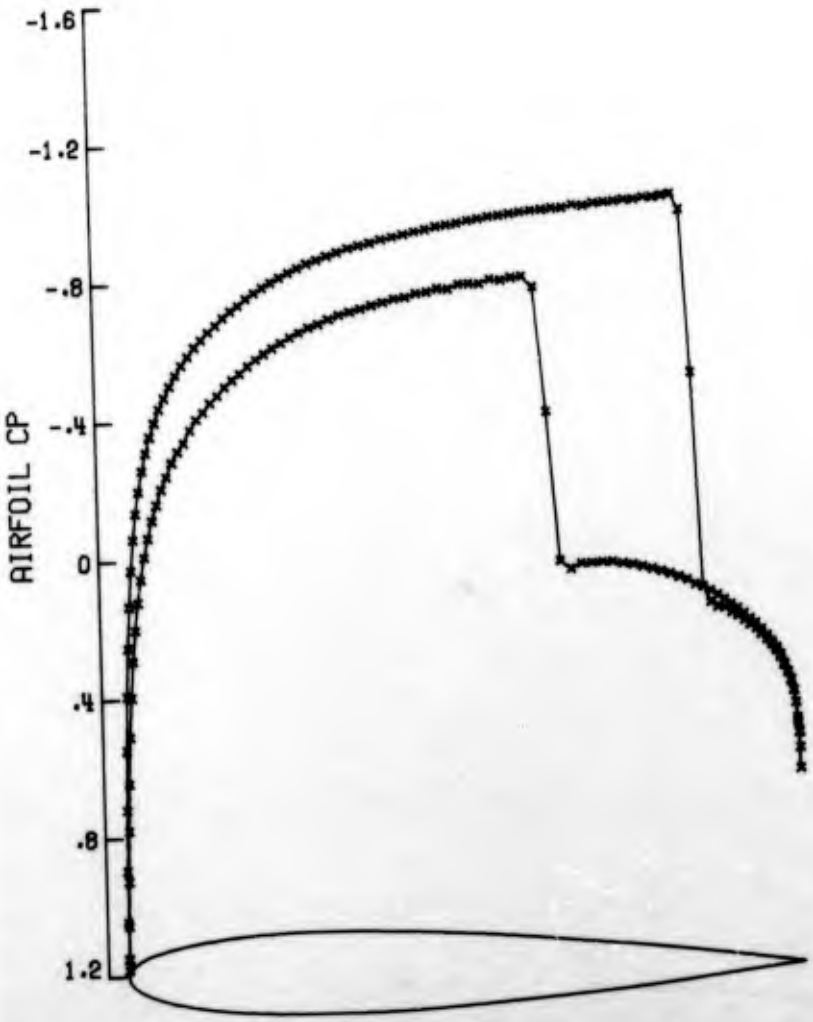
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-8
	NACA 0012: MACH = 0.85, ALPHA = 1			



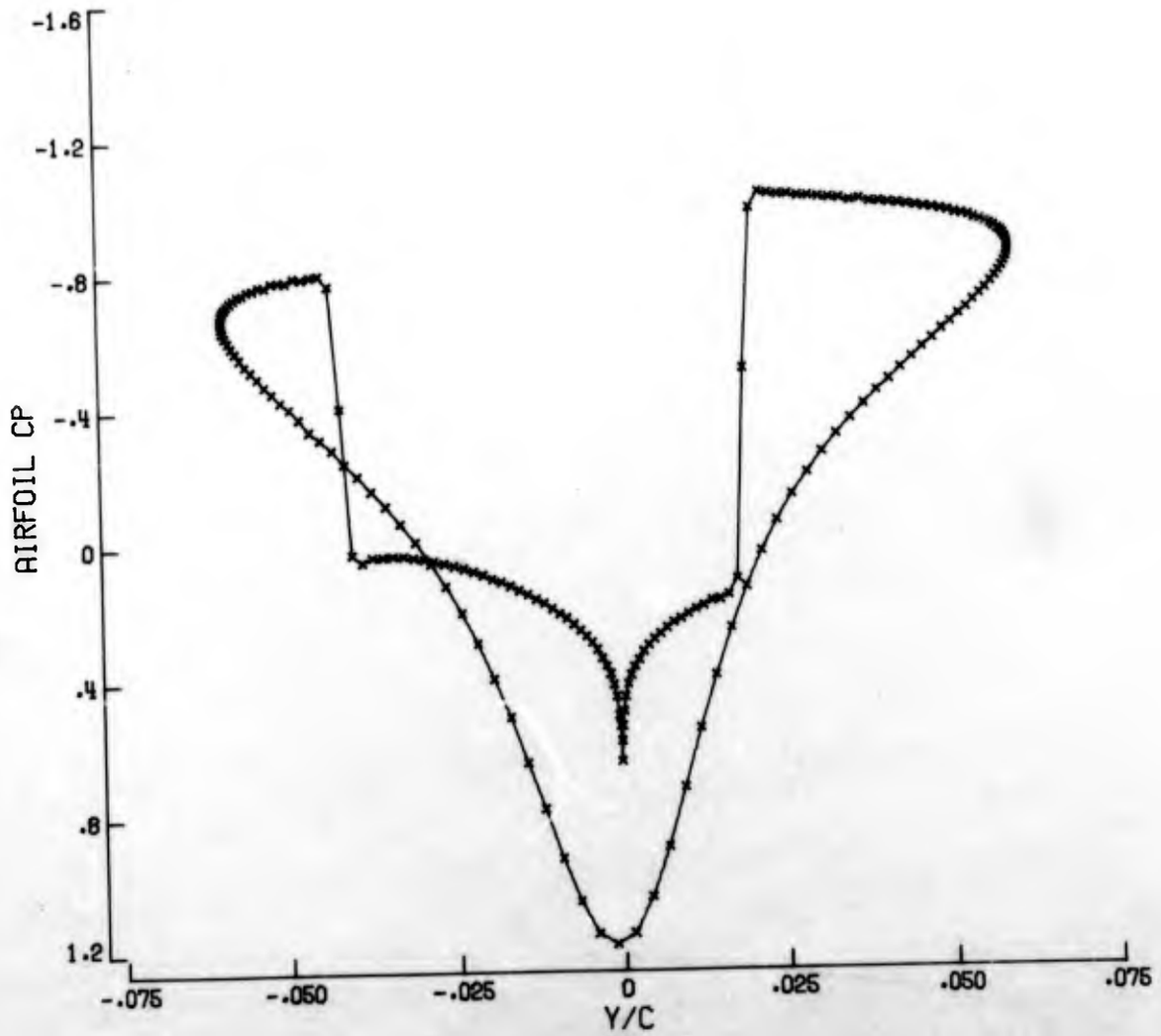
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-9
	NACA 0012: MACH = 0.85, ALPHA = 1			



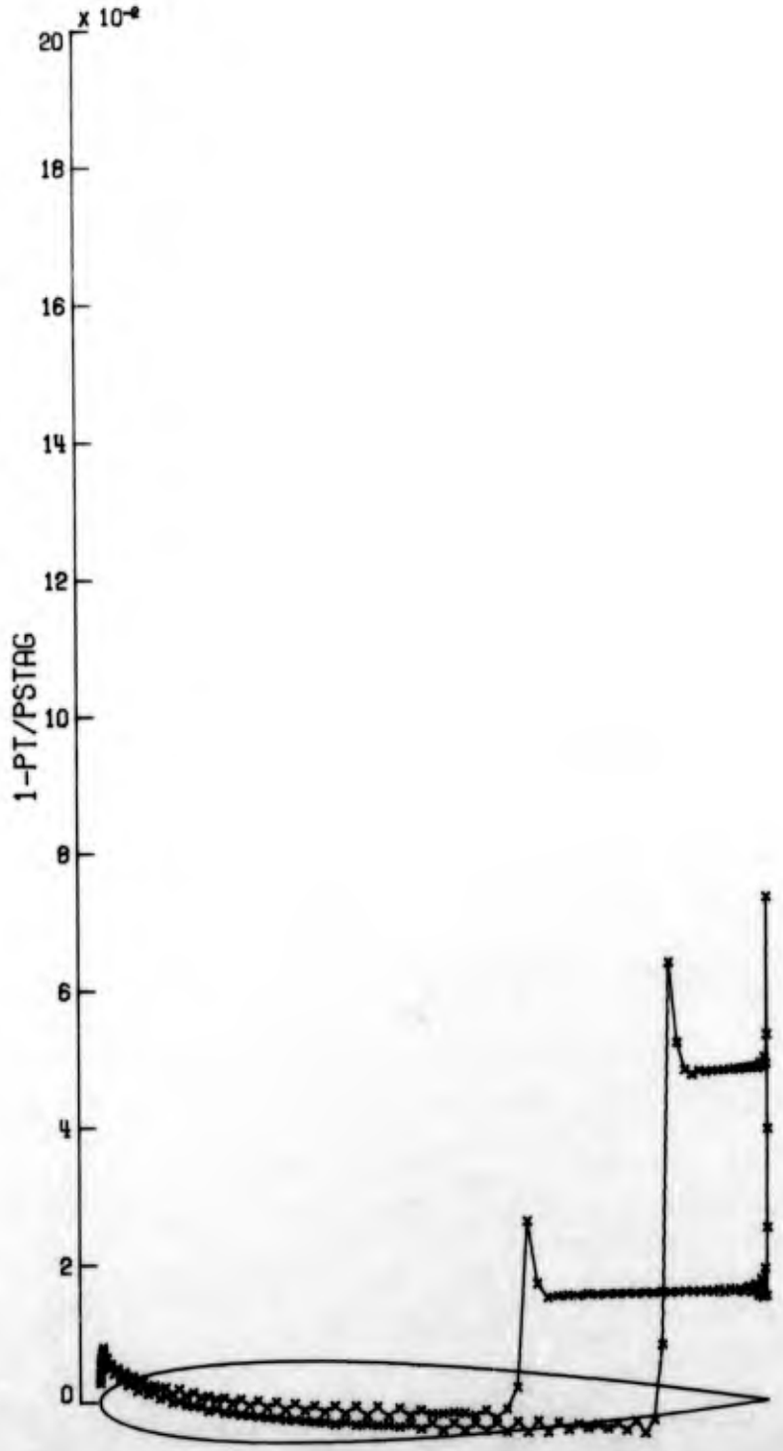
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-10
	NACA 0012: MACH = 0.85, ALPHA = 1			



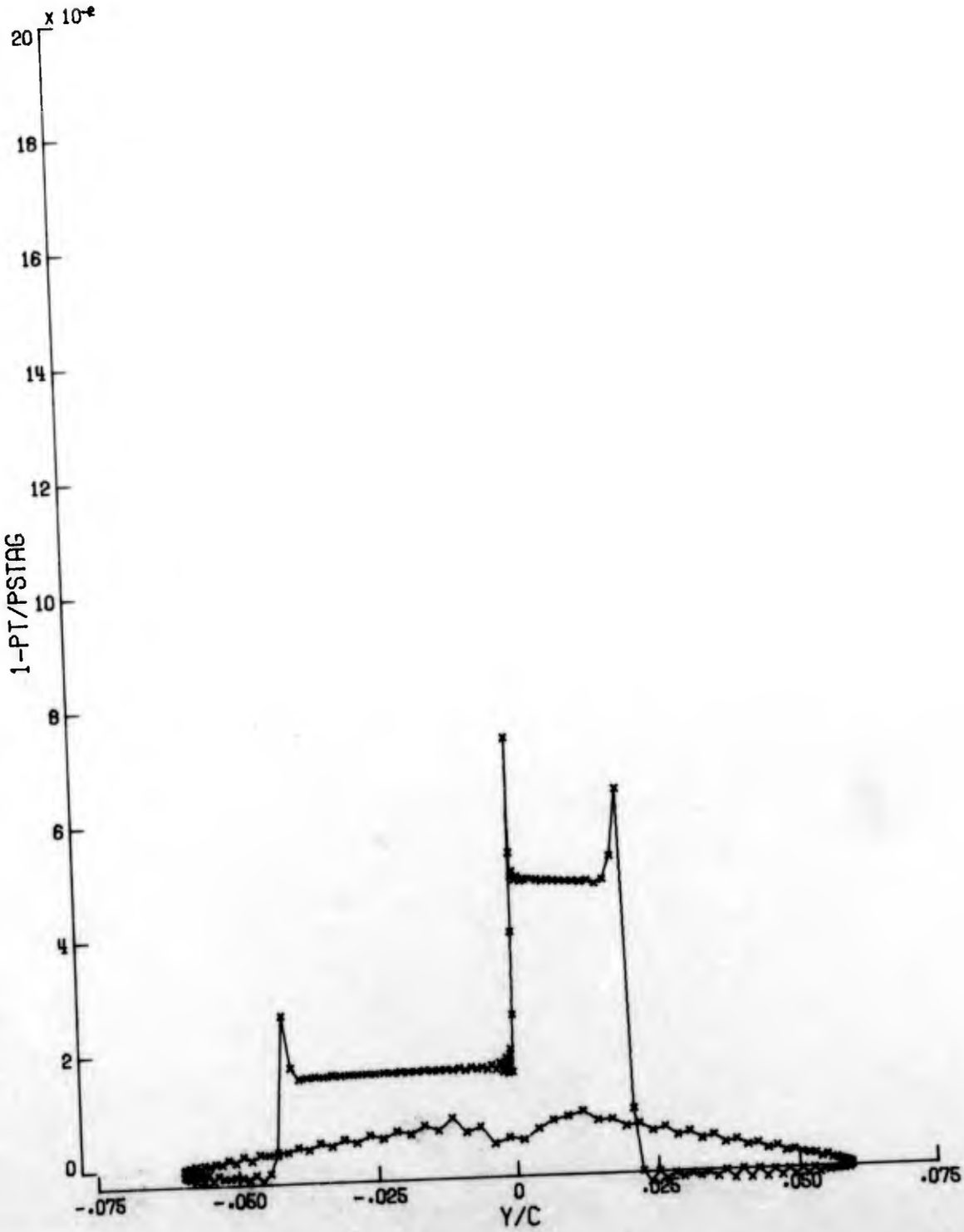
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-11
	NACA 0012: MACH = 0.85, ALPHA = 1			



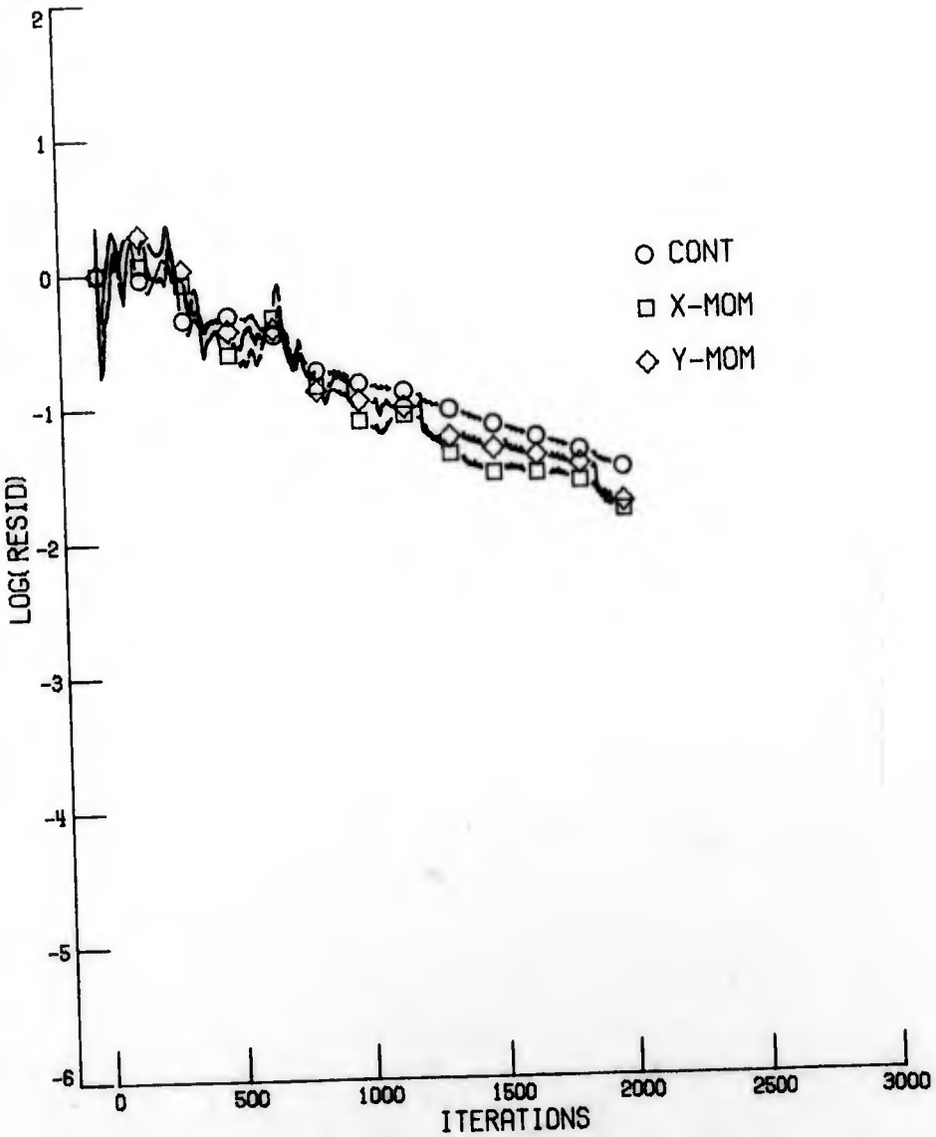
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-12
	NACA 0012: MACH = 0.85, ALPHA = 1			



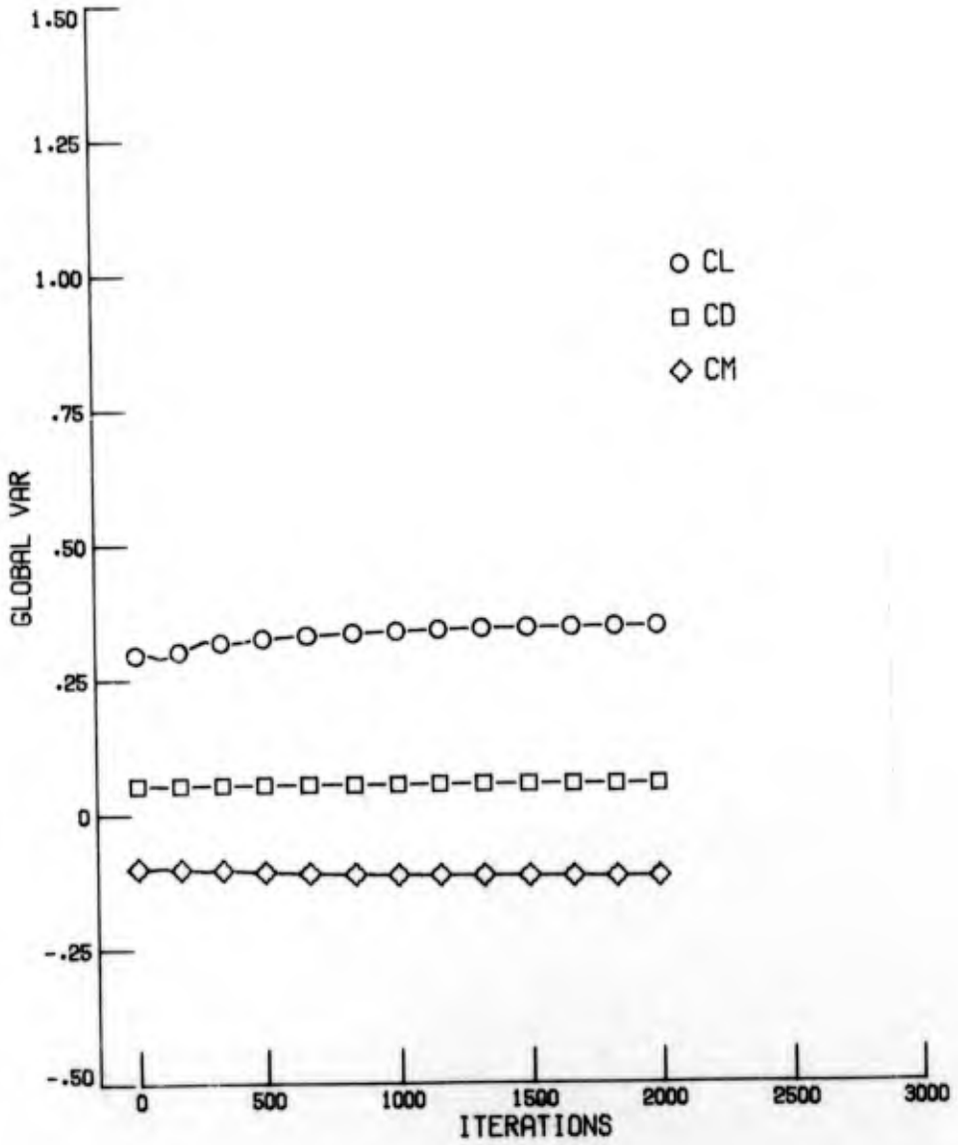
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-13
	NACA 0012: MACH = 0.85, ALPHA = 1			



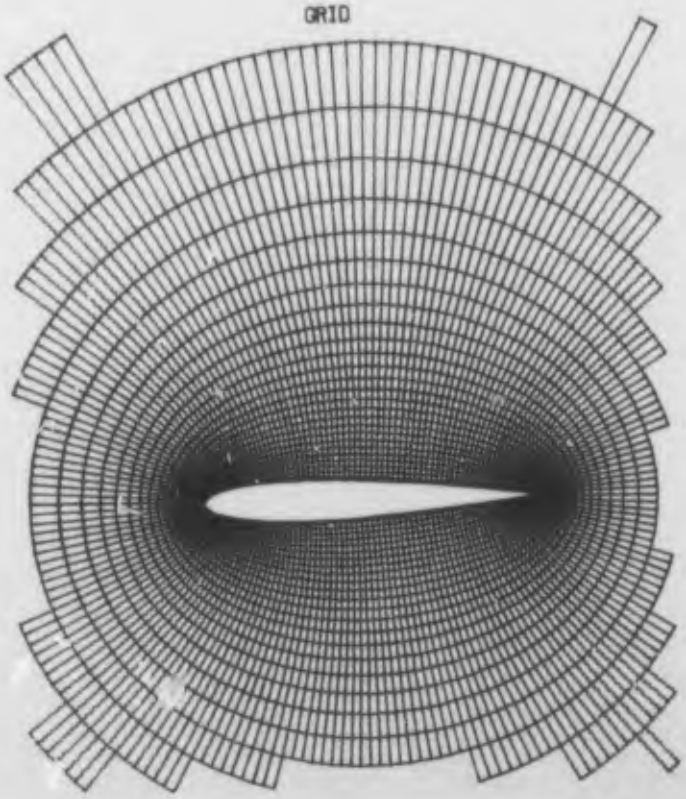
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-14
	NACA 0012: MACH = 0.85, ALPHA = 1			



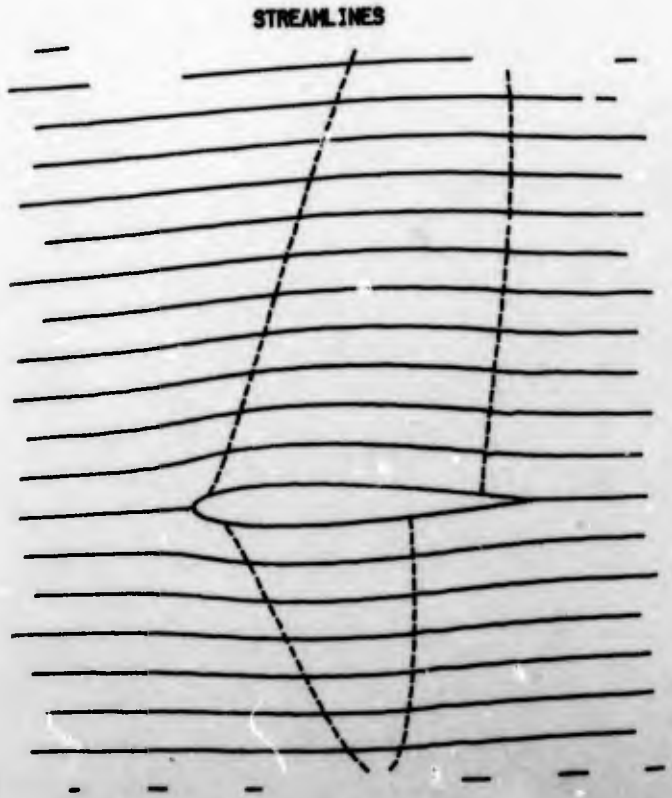
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-15
	NACA 0012: MACH = 0.85, ALPHA = 1			



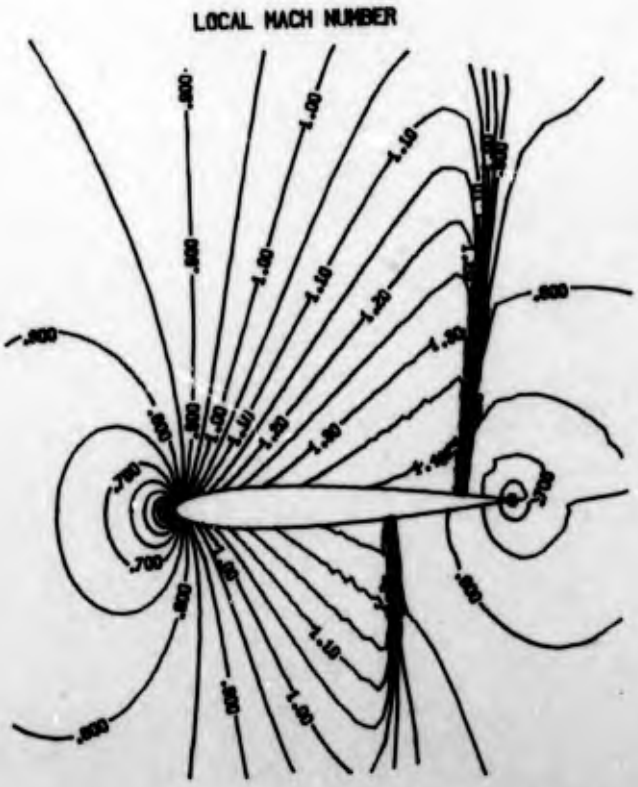
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-16
	NACA 0012: MACH = 0.85, ALPHA = 1			



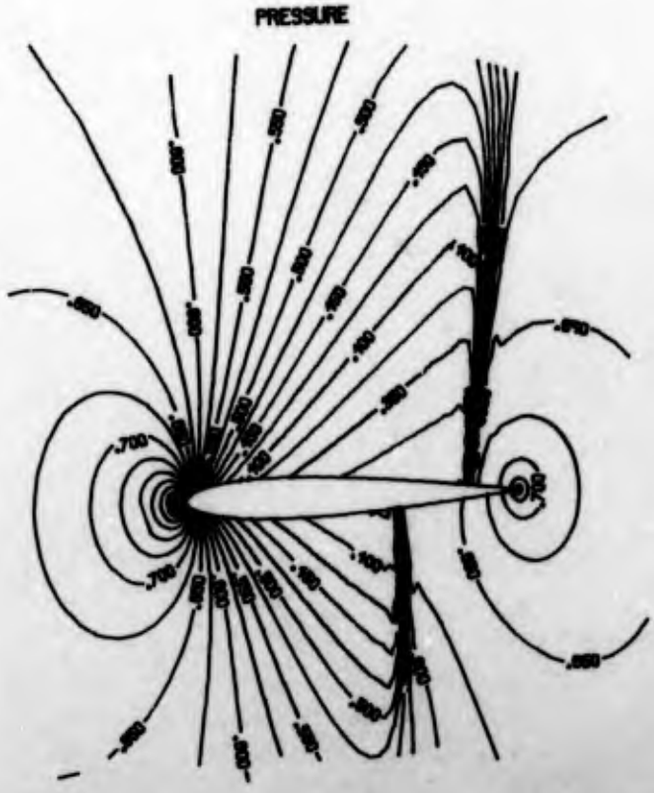
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-17
	NACA 0012: MACH = 0.85, ALPHA = 1			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-18
	NACA 0012: MACH = 0.85, ALPHA = 1			

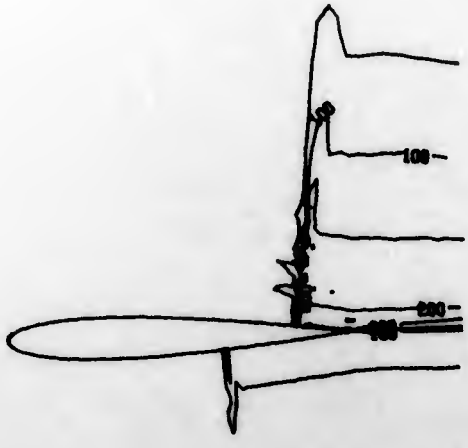


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-19
	NACA 0012: MACH = 0.85, ALPHA = 1			



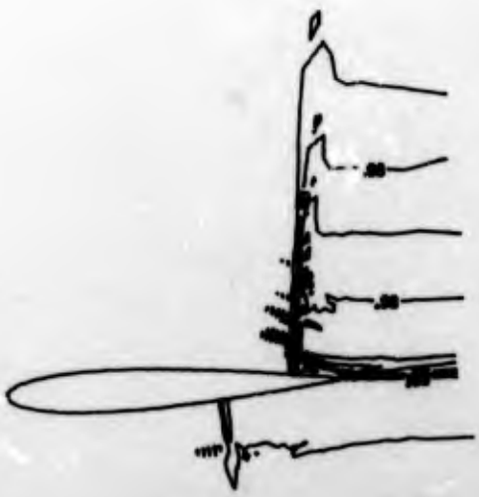
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-20
	NACA 0012: MACH = 0.85, ALPHA = 1			

ENTROPY

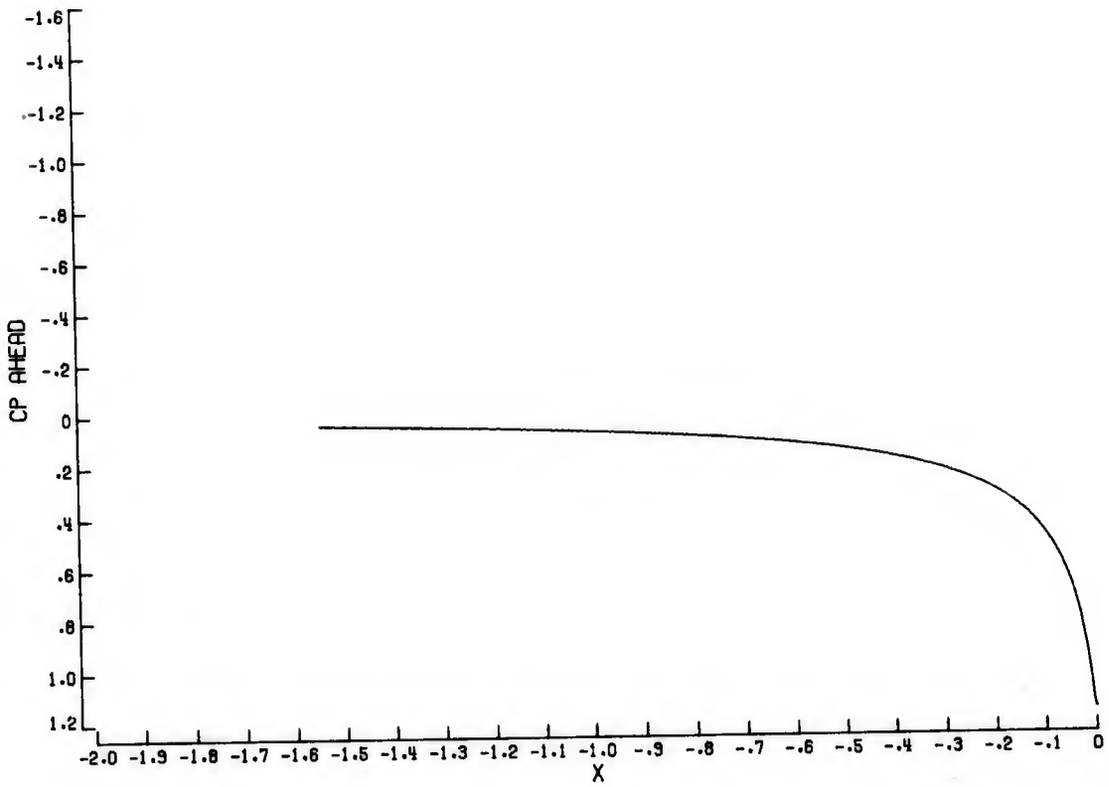


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-21
	NACA 0012: MACH = 0.85, ALPHA = 1			

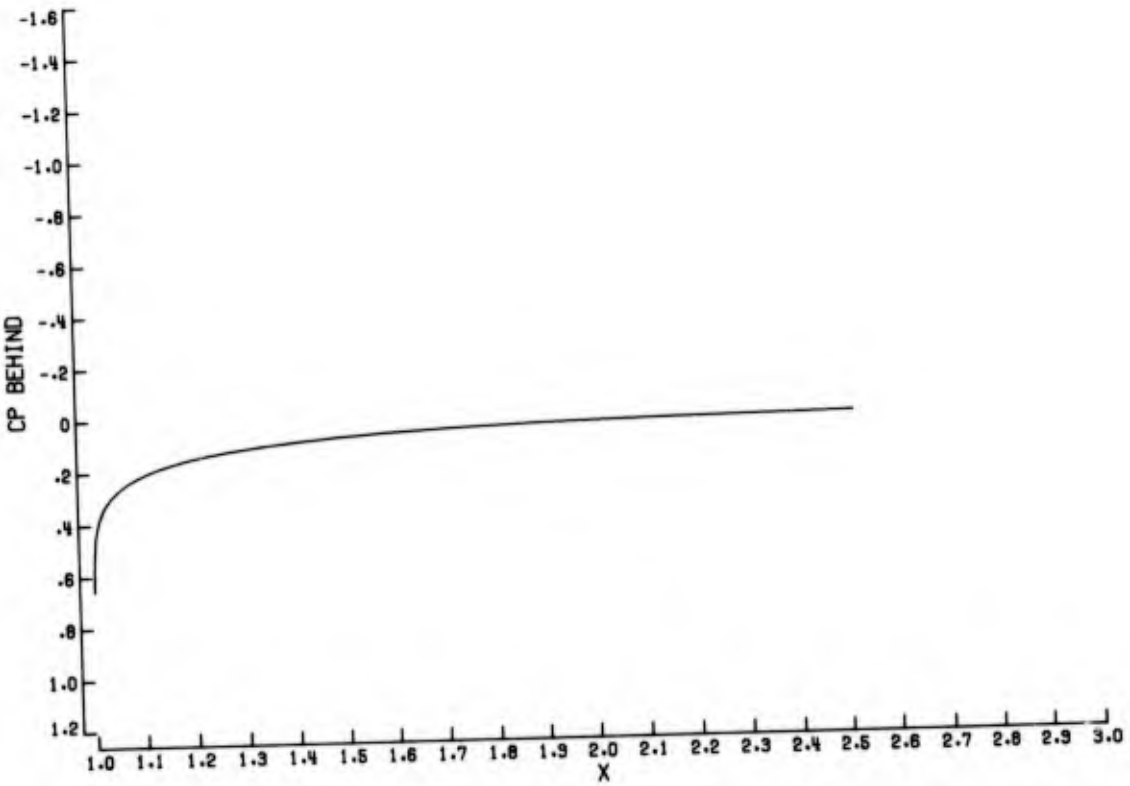
TOTAL PRESSURE



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-22
	NACA 0012: MACH = 0.85, ALPHA = 1			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	02-6-23
	NACA 0012: MACH = 0.85, ALPHA = 1			



AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 02

NACA 0012: MACH = 0.85, ALPHA = 1

Contributor No 8

A.Rizzi

(F.F.A., Sweden)

F.F.A.	AR 211		A.Rizzi	02-8-1
	NACA 0012: MACH = 0.85, ALPHA = 1			

30/6 SOLUTION WITH REDUCED ERROR 1-PI/PIINF AT LEADING EDGE

RESULTS ON AIRFOIL SURFACE

I	X/C	Y/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.998814	-0.000168	0.217103	0.505436	0.570149	0.018893
2	0.994210	-0.000816	0.243770	0.420870	0.602654	0.020154
3	0.985354	-0.002052	0.264079	0.356470	0.632307	0.014088
4	0.972671	-0.003802	0.282290	0.298719	0.657538	0.013637
5	0.956583	-0.005985	0.297987	0.248940	0.713588	0.013634
6	0.937500	-0.008522	0.311225	0.206960	0.734543	0.013718
7	0.915823	-0.011335	0.322992	0.169645	0.752903	0.013849
8	0.891931	-0.014354	0.333505	0.136306	0.769379	0.013824
9	0.866187	-0.017512	0.342853	0.106664	0.783929	0.013874
10	0.838931	-0.020752	0.350940	0.081016	0.796601	0.013817
11	0.810477	-0.024023	0.358034	0.058522	0.807681	0.013783
12	0.781120	-0.027285	0.365067	0.036213	0.818431	0.014005
13	0.751125	-0.030499	0.370515	0.018942	0.826768	0.014186
14	0.720735	-0.033631	0.368262	0.026085	0.824410	0.012949
15	0.690171	-0.036654	0.362321	0.043340	0.817294	0.011213
16	0.659627	-0.039542	0.391370	-0.047194	0.854379	0.018531
17	0.629275	-0.042276	0.502118	-0.398392	1.023731	0.031544
18	0.599267	-0.044837	0.613597	-0.751911	1.247289	0.004662
19	0.569732	-0.047211	0.636191	-0.823560	1.300474	-0.008472
20	0.540782	-0.049386	0.622198	-0.779186	1.267745	-0.002685
21	0.512511	-0.051354	0.617417	-0.764025	1.256991	-0.000288
22	0.484994	-0.053108	0.618132	-0.766294	1.259627	-0.001612
23	0.458294	-0.054646	0.615338	-0.757432	1.254161	-0.001829
24	0.432457	-0.055965	0.611264	-0.744515	1.245966	-0.001550
25	0.407518	-0.057066	0.607815	-0.733578	1.239297	-0.001482
26	0.383502	-0.057952	0.608172	-0.722023	1.232427	-0.001584
27	0.360423	-0.058629	0.600120	-0.709194	1.224666	-0.001503
28	0.338284	-0.059101	0.595537	-0.694957	1.216205	-0.001551
29	0.317065	-0.059378	0.590900	-0.679937	1.207241	-0.001458
30	0.296816	-0.059466	0.585810	-0.663795	1.197784	-0.001506
31	0.277463	-0.059374	0.580454	-0.646810	1.187812	-0.001410
32	0.259007	-0.059114	0.574804	-0.628393	1.177473	-0.001431
33	0.241424	-0.058694	0.568898	-0.610165	1.166674	-0.001345
34	0.224690	-0.058124	0.562701	-0.590511	1.155506	-0.001341
35	0.208777	-0.057415	0.556235	-0.570006	1.143891	-0.001259
36	0.193656	-0.056576	0.549460	-0.548522	1.131972	-0.001241
37	0.179295	-0.055615	0.542410	-0.526165	1.119433	-0.001157
38	0.165666	-0.054542	0.535064	-0.502872	1.106624	-0.001125
39	0.152737	-0.053364	0.527412	-0.478604	1.093360	-0.001050
40	0.140478	-0.052089	0.519435	-0.453309	1.079682	-0.001005
41	0.128861	-0.050722	0.511130	-0.426971	1.065544	-0.000932
42	0.117858	-0.049271	0.502448	-0.399441	1.050907	-0.000881

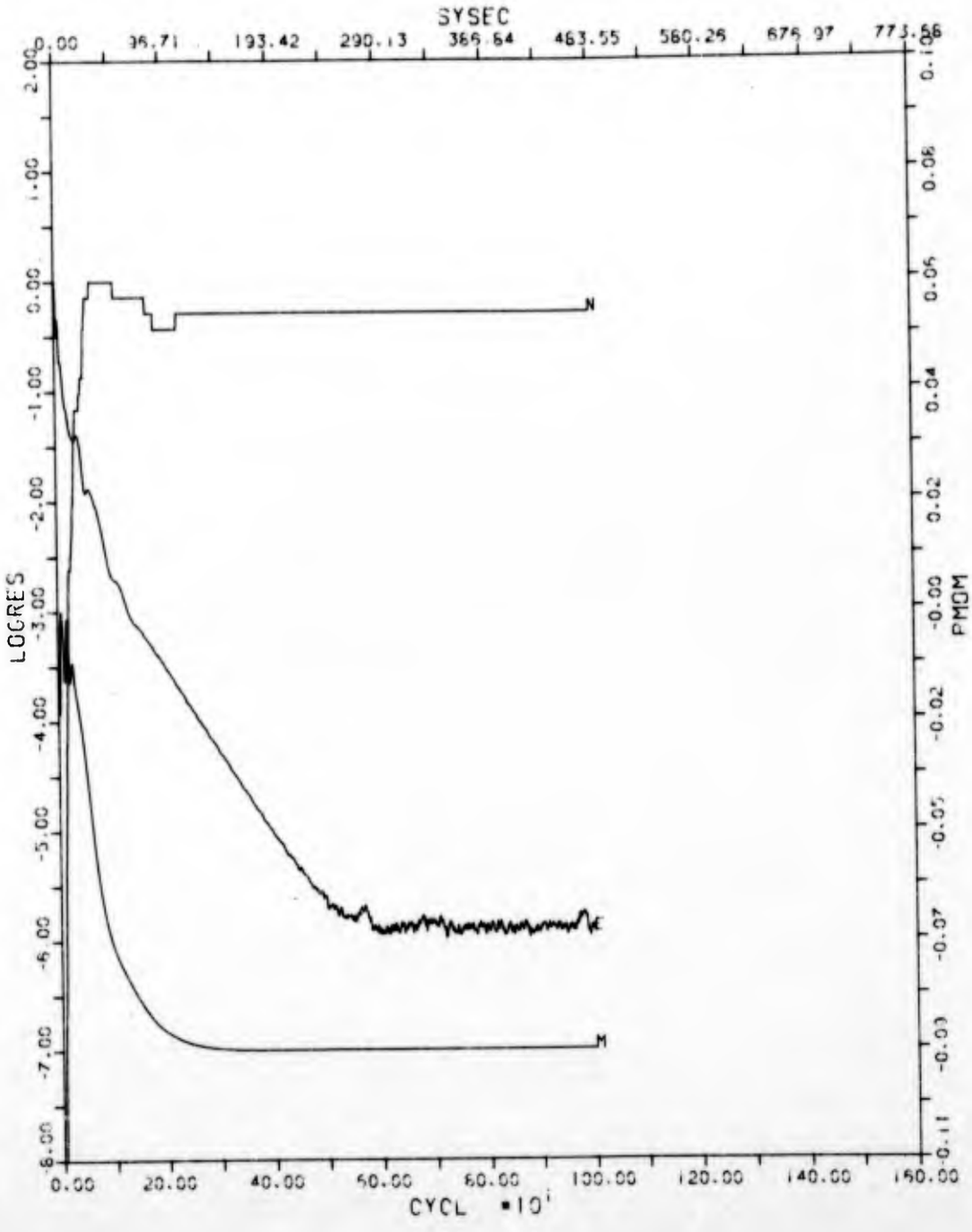
F.F.A.	AR 211		A.Rizzi	02-8-2
	NACA 0012: MACH = 0.85, ALPHA = 1			

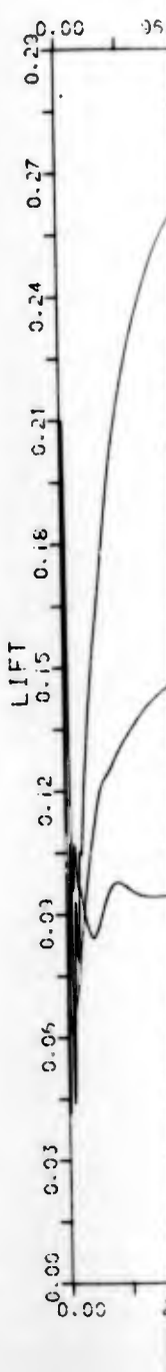
43	0.107442	-0.047741	0.493343	-0.370582	1.035675	-0.000810
44	0.097589	-0.046134	0.482769	-0.340207	1.019787	-0.000755
45	0.088277	-0.044457	0.473652	-0.308123	1.003129	-0.000691
46	0.079484	-0.042711	0.462910	-0.274353	0.985589	-0.000644
47	0.071193	-0.040900	0.451443	-0.237695	0.966995	-0.000601
48	0.063388	-0.039026	0.439141	-0.198582	0.947198	-0.000580
49	0.056055	-0.037090	0.425581	-0.156633	0.926004	-0.000570
50	0.049182	-0.035094	0.411388	-0.110672	0.902969	-0.000623
51	0.042762	-0.033040	0.395336	-0.059770	0.877600	-0.000799
52	0.036788	-0.030928	0.378193	-0.005403	0.850559	-0.000903
53	0.031256	-0.028760	0.359119	0.055081	0.820381	-0.000369
54	0.026164	-0.026534	0.337482	0.123695	0.786276	-0.001197
55	0.021511	-0.024253	0.312993	0.201555	0.747329	-0.001370
56	0.017301	-0.021916	0.285062	0.289969	0.702731	-0.001329
57	0.013535	-0.019525	0.253304	0.390036	0.651049	-0.002177
58	0.010220	-0.017083	0.217426	0.504413	0.591149	-0.002629
59	0.007361	-0.014589	0.177428	0.631253	0.521149	-0.002810
60	0.004963	-0.012043	0.133775	0.769584	0.439155	-0.002699
61	0.003035	-0.009443	0.086683	0.912680	0.343194	-0.001991
62	0.001582	-0.006790	0.047135	1.044435	0.232501	-0.000989
63	0.000609	-0.004092	0.016464	1.140426	0.108950	0.000290
64	0.000122	-0.001367	0.005566	1.176258	0.016595	0.000940
65	0.000122	0.001367	0.017574	1.138177	0.110904	0.000640
66	0.000609	0.004092	0.051457	1.030730	0.243293	-0.000384
67	0.001582	0.006790	0.100552	0.875040	0.366852	-0.001741
68	0.003035	0.009443	0.156056	0.699027	0.477332	-0.002802
69	0.004963	0.012043	0.210306	0.526995	0.573355	-0.003311
70	0.007361	0.014589	0.259339	0.371501	0.655405	-0.003213
71	0.010220	0.017083	0.302126	0.235816	0.725182	-0.002846
72	0.013535	0.019525	0.339129	0.118472	0.784736	-0.002413
73	0.017301	0.021916	0.370973	0.017489	0.835793	-0.002060
74	0.021511	0.024253	0.398290	-0.069137	0.879704	-0.001815
75	0.026164	0.026534	0.421723	-0.143447	0.917603	-0.001693
76	0.031256	0.028760	0.441947	-0.207561	0.950543	-0.001692
77	0.036788	0.030928	0.459498	-0.263237	0.979261	-0.001702
78	0.042762	0.033040	0.475390	-0.313535	1.005572	-0.001676
79	0.049182	0.035094	0.489939	-0.359772	1.029324	-0.001584
80	0.056055	0.037090	0.503102	-0.401514	1.051991	-0.001717
81	0.063388	0.039026	0.515048	-0.439395	1.072319	-0.001779
82	0.071193	0.040900	0.526031	-0.474225	1.091183	-0.001858
83	0.079484	0.042711	0.536228	-0.506560	1.108906	-0.001940
84	0.088277	0.044457	0.545750	-0.536757	1.125647	-0.002019
85	0.097589	0.046134	0.554696	-0.565125	1.141546	-0.002104
86	0.107442	0.047741	0.563155	-0.591953	1.156733	-0.002185
87	0.117858	0.049271	0.571193	-0.617440	1.171372	-0.002268
88	0.128861	0.050722	0.578859	-0.641753	1.185402	-0.002343

89	0.140478	0.052089	0.586193	-0.665026	1.199016	-0.002416
90	0.152737	0.053364	0.593251	-0.687391	1.212241	-0.002482
91	0.165666	0.054542	0.600034	-0.708900	1.225106	-0.002548
92	0.179295	0.055615	0.606554	-0.729578	1.237596	-0.002593
93	0.193656	0.056576	0.612834	-0.749492	1.249757	-0.002656
94	0.208777	0.057415	0.618885	-0.768581	1.261600	-0.002695
95	0.224690	0.058124	0.624692	-0.787096	1.273087	-0.002736
96	0.241424	0.058694	0.630273	-0.804793	1.284227	-0.002767
97	0.259007	0.059114	0.635628	-0.821776	1.295034	-0.002798
98	0.277463	0.059374	0.640764	-0.838063	1.305496	-0.002819
99	0.296816	0.059466	0.645684	-0.853665	1.315632	-0.002846
100	0.317085	0.059378	0.650373	-0.868535	1.325383	-0.002854
101	0.338284	0.059101	0.654795	-0.882553	1.334654	-0.002863
102	0.360423	0.058629	0.658973	-0.895805	1.343485	-0.002875
103	0.383502	0.057952	0.662900	-0.908259	1.351849	-0.002868
104	0.407518	0.057066	0.666602	-0.919959	1.359822	-0.002887
105	0.432457	0.055965	0.670054	-0.930947	1.367288	-0.002852
106	0.458294	0.054646	0.673260	-0.941112	1.374311	-0.002886
107	0.484994	0.053103	0.676219	-0.950497	1.380768	-0.002819
108	0.512511	0.051354	0.678945	-0.959145	1.386851	-0.002901
109	0.540782	0.049386	0.681383	-0.966872	1.392111	-0.002697
110	0.569732	0.047211	0.683814	-0.974582	1.397755	-0.002990
111	0.599267	0.044837	0.686143	-0.981965	1.402892	-0.002717
112	0.629275	0.042276	0.687526	-0.986554	1.405771	-0.002520
113	0.659627	0.039542	0.690163	-0.994715	1.412354	-0.003443
114	0.690171	0.036654	0.691932	-1.000326	1.415965	-0.002499
115	0.720735	0.033631	0.689955	-0.994055	1.408970	0.000421
116	0.751125	0.030499	0.702403	-1.033533	1.445525	-0.011303
117	0.781120	0.027285	0.707528	-1.049782	1.460539	-0.013096
118	0.810477	0.024023	0.622193	-0.779171	1.221557	0.060061
119	0.838931	0.020752	0.454077	-0.246046	0.901171	0.074720
120	0.866187	0.017512	0.350935	0.081033	0.755603	0.050673
121	0.891931	0.014354	0.325427	0.161924	0.720916	0.045995
122	0.915823	0.011335	0.320751	0.176751	0.711035	0.048302
123	0.937500	0.008522	0.309973	0.210930	0.693719	0.047846
124	0.956583	0.005985	0.296341	0.252575	0.671312	0.048244
125	0.972671	0.003802	0.281412	0.301503	0.646183	0.046809
126	0.985354	0.002052	0.265036	0.353433	0.618464	0.050191
127	0.994210	0.000816	0.242840	0.423820	0.557939	0.054277
128	0.998814	0.000165	0.233640	0.452996	0.542559	0.049950

30/6 NONISO INVOR UNORO MESH .85 1.00 NO4 CON SWT

PITCH	-0.087	CCIRC	0.138	CELLS	32X 7
MACH	0.850	ALPHA	1.000	RESAE	0.997E-
RATE	0.986	RESAS	0.840E-01	DRAG	0.621E-
NSUP	53	LIFT	0.265E+00	RESMX	0.238E-
CYCL	1000	SYSEC	0.484E+03		

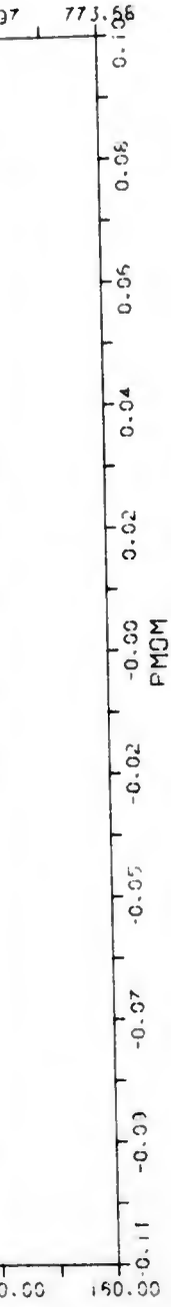


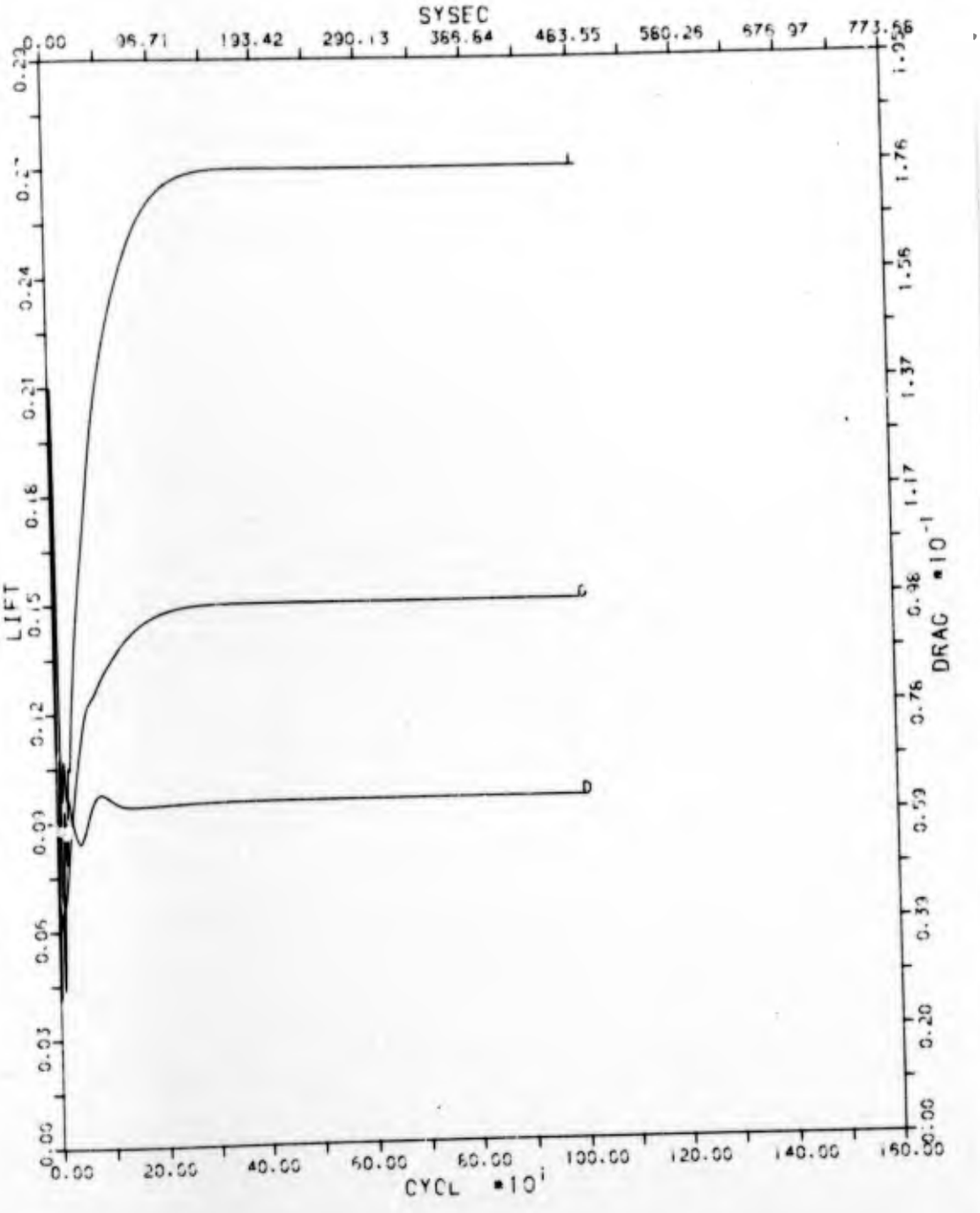


F.F.A.	AR 211		A.Rizzi	02-8-4
	NACA 0012: MACH = 0.85, ALPHA = 1			

5 1.00 NO4 CON SWT .1 .05 .40

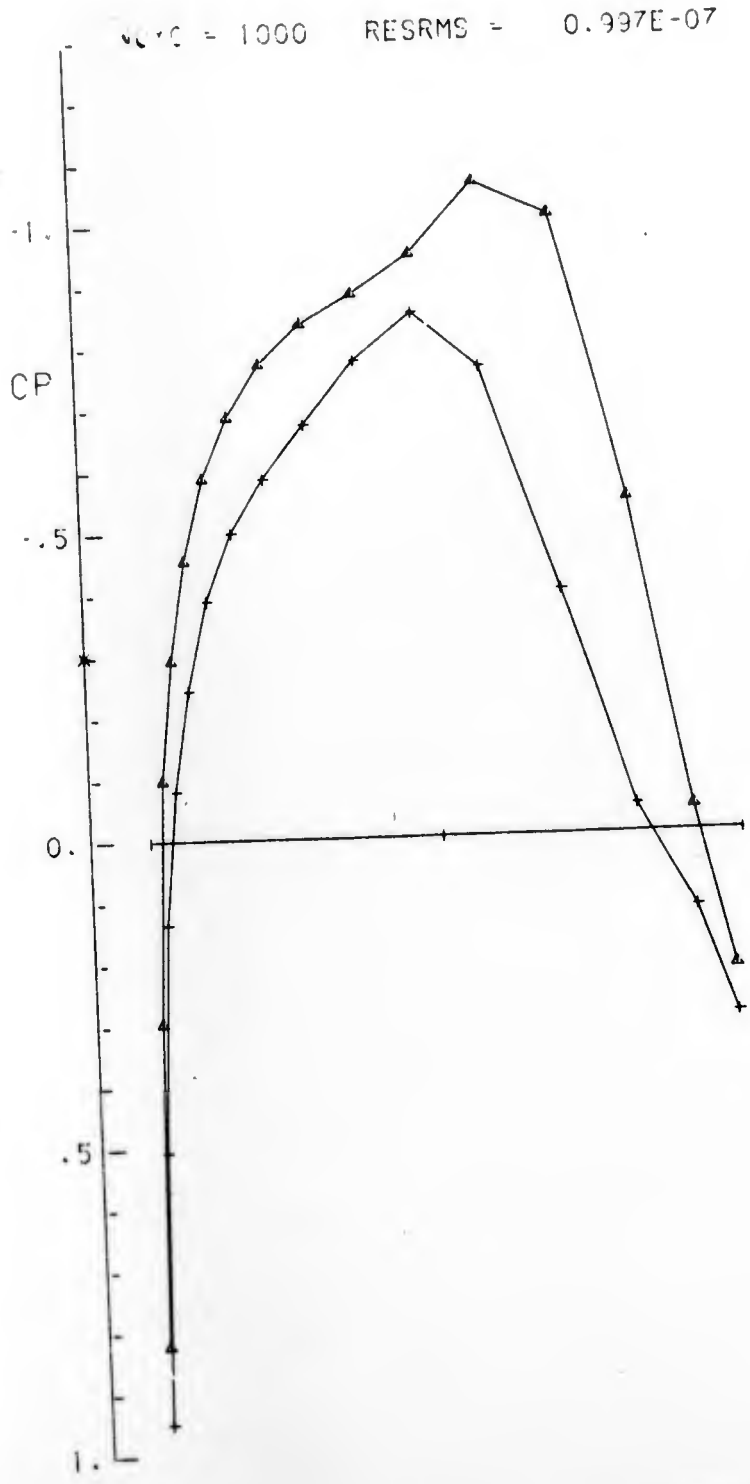
CELLS 32X 7
RESAE 0.997E-07
DRAG 0.621E-01
RESMX 0.238E-06 17 1





F.F.A.	AR 211		A.Rizzi	02-8-5
	NACA 0012: MACH = 0.85, ALPHA = 1			

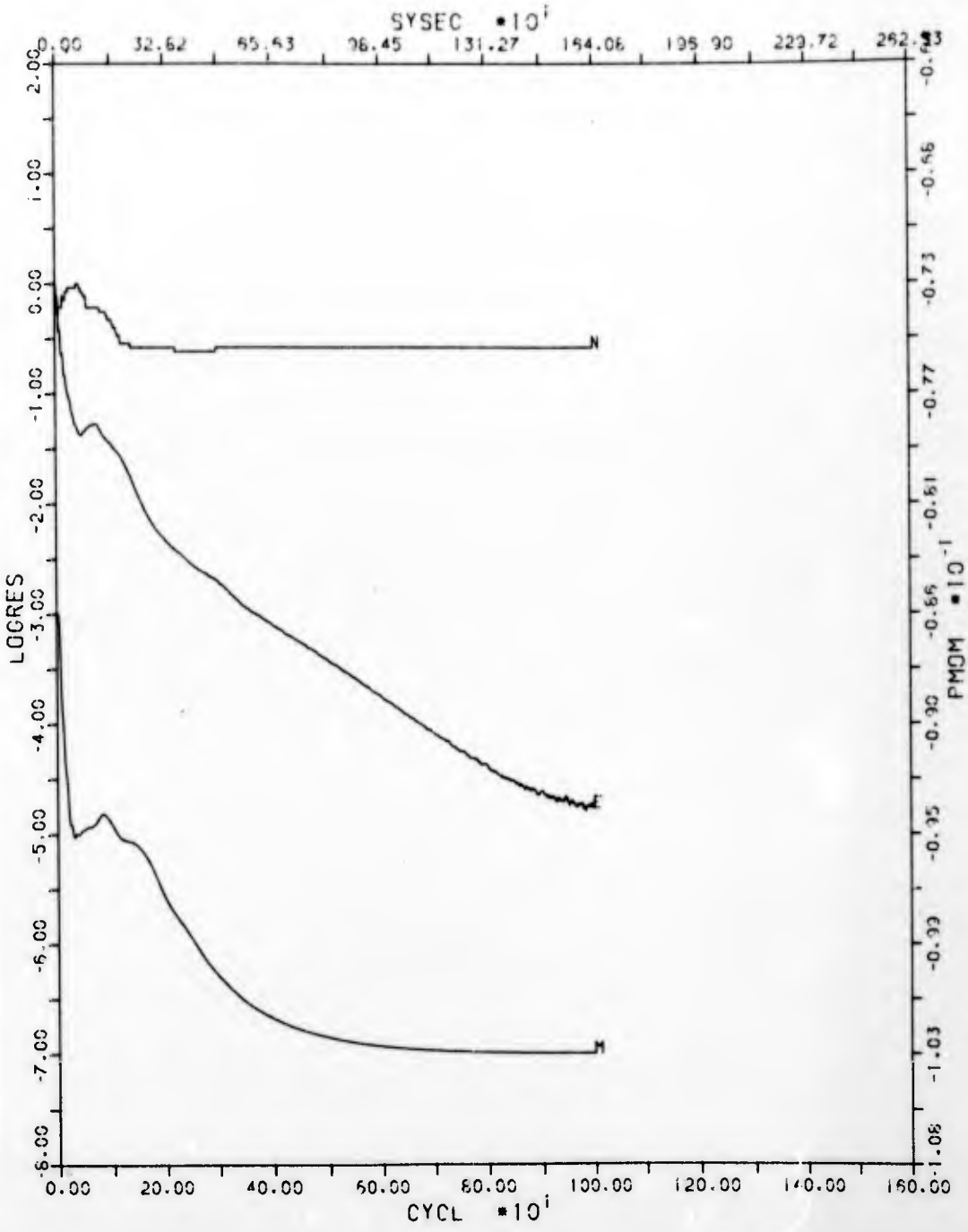
CELLS 32 × 7

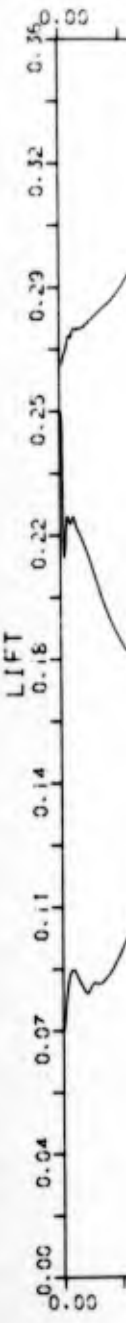


30/6 NONISO INVOR UNORO MESH .85 1.00 NO4 CON SWT

PITCH	-0.103	GCIRC	0.163
MACH	0.850	ALPHA	1.000
RATE	0.989	RESAS	0.684E-02
NSUF	205	LIFT	0.323E+00
CYCL	1000	SYSEC	0.164E+04

CELLS	64X
RESAE	0.118
DRAG	0.552
RESMX	-0.536

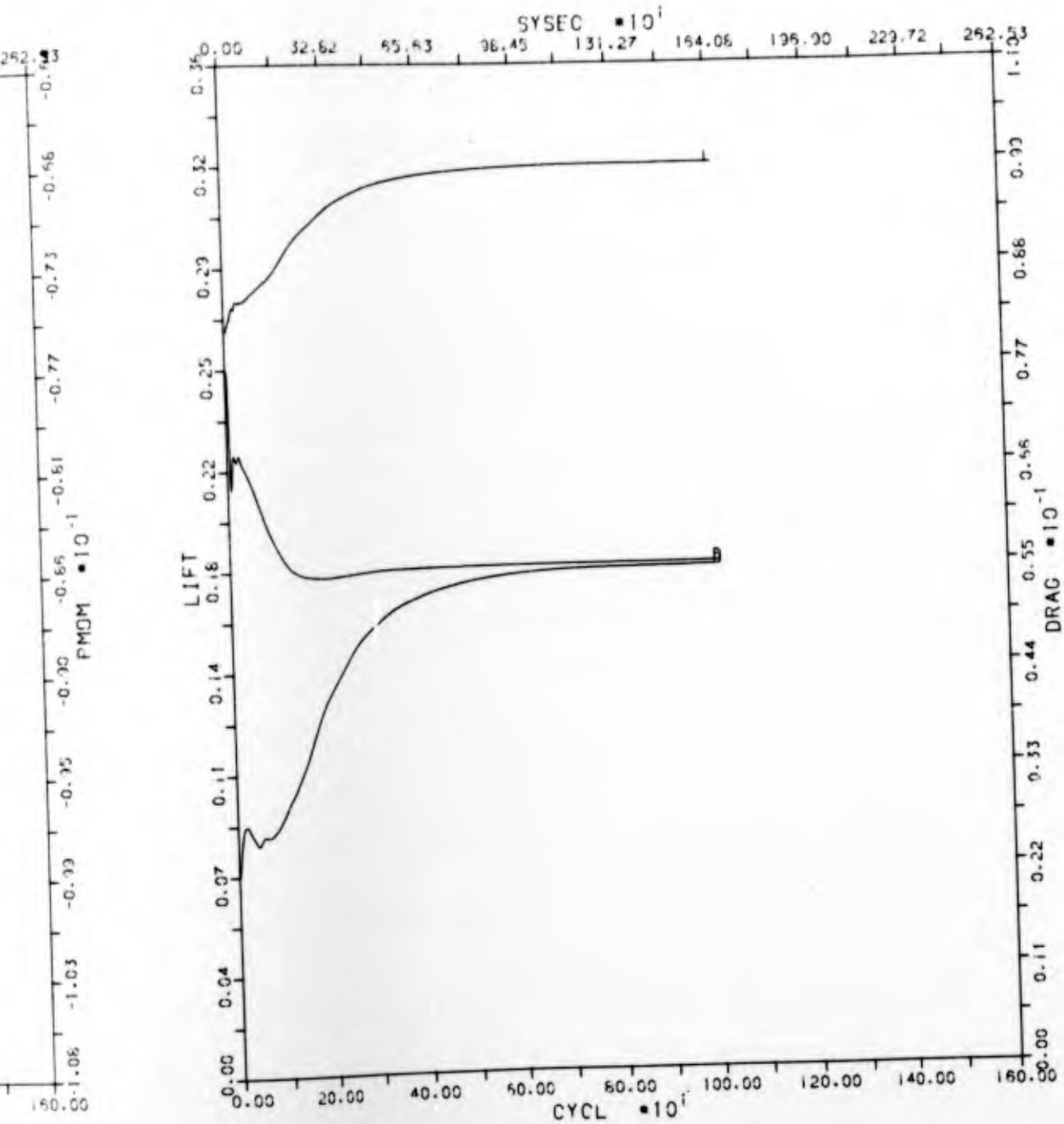




F.F.A.	AR 211		A.Rizzi	02-8-6
	NACA 0012: MACH = 0.85, ALPHA = 1			

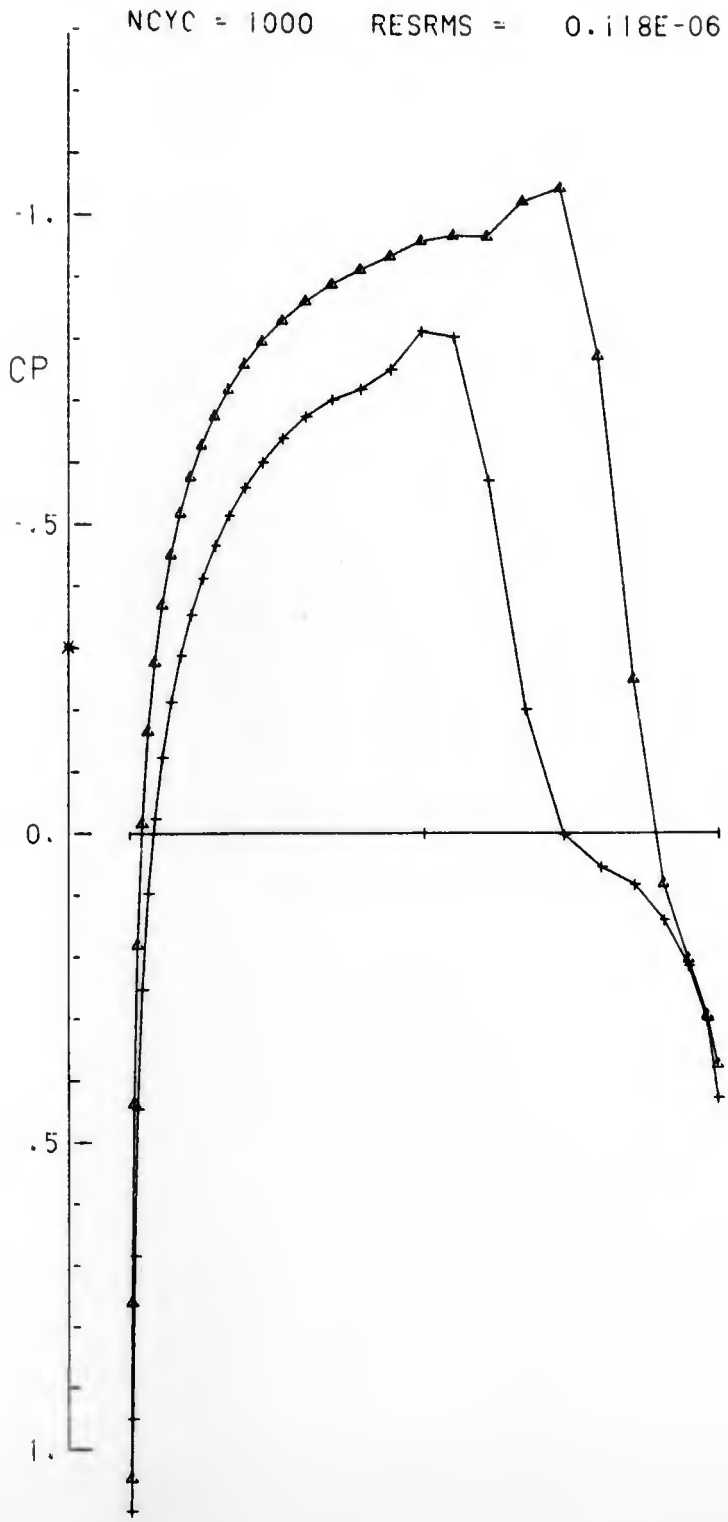
00 NO4 CON SWT .1 .05 .40

CELLS 64X14
RESAE 0.118E-06
DRAG 0.552E-01
RESMX -0.536E-06 60 1



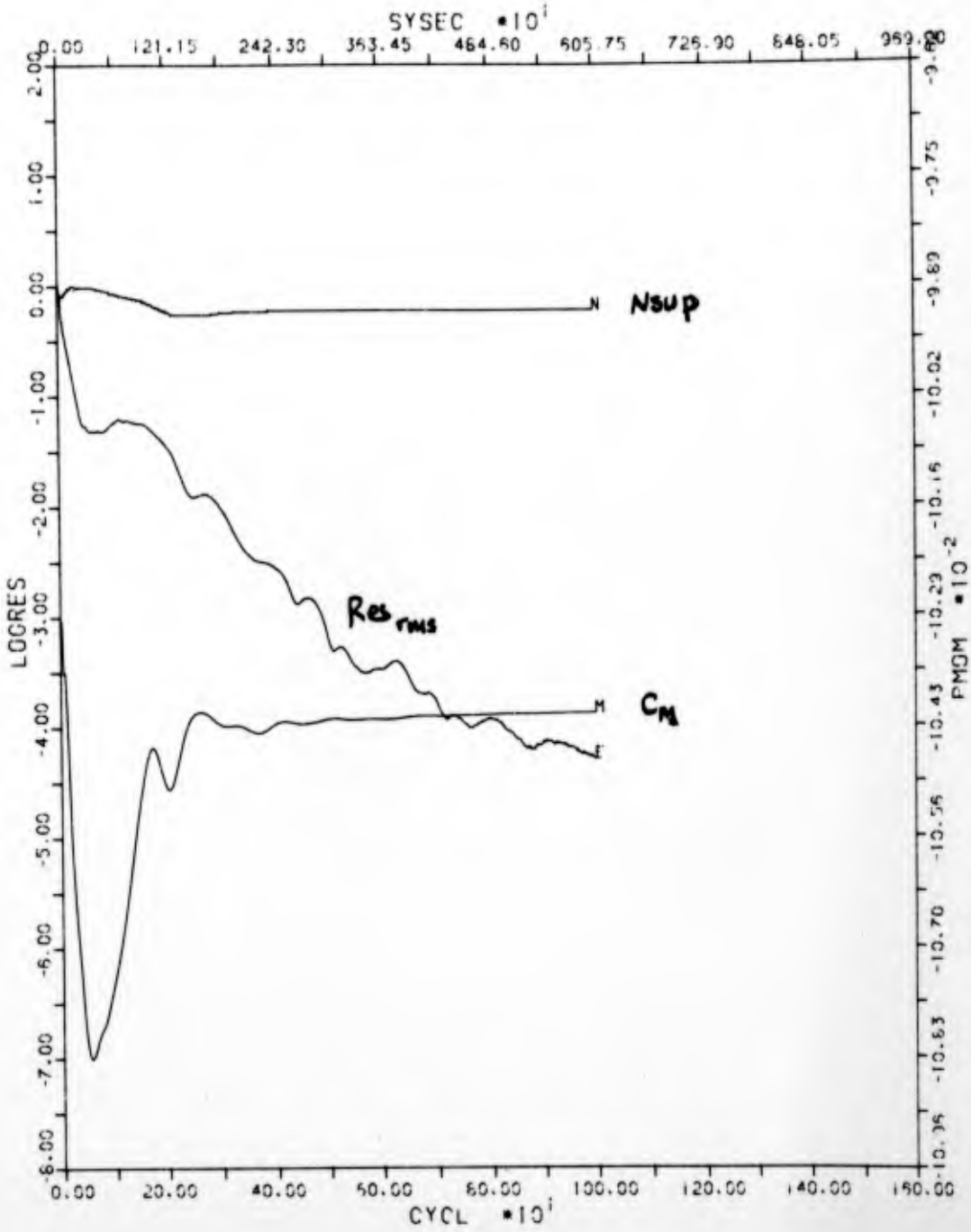
F.F.A.	AR 211		A.Rizzi	02-8-7
	NACA 0012: MACH = 0.85, ALPHA = 1			

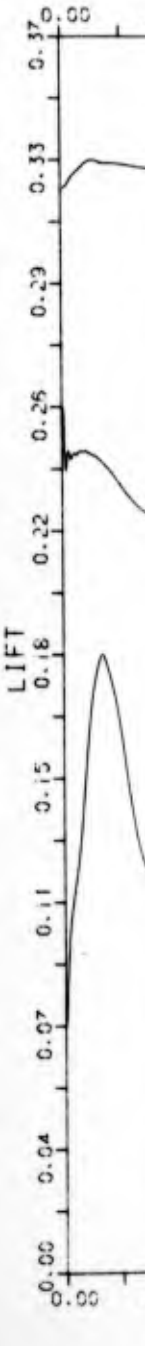
CELLS 64 × 14



30/6 NONISO INVOR UNORO MESH .85 1.00 N04 CON SWT

C_M	PITCH	-0.104	Γ	GCIRC	0.166		CELLS 128X28
	MACH	0.850		ALPHA	1.000		
	RATE	0.990	start	RESAS	0.212E-02	end	$RESAE_{rms}$ 0.110E
	NSUP	798		LIFT	0.330E+00		DRAG 0.528E
	CYCL	1000		SYSEC	0.606E+04		$RESMX_{max}$ 0.536E

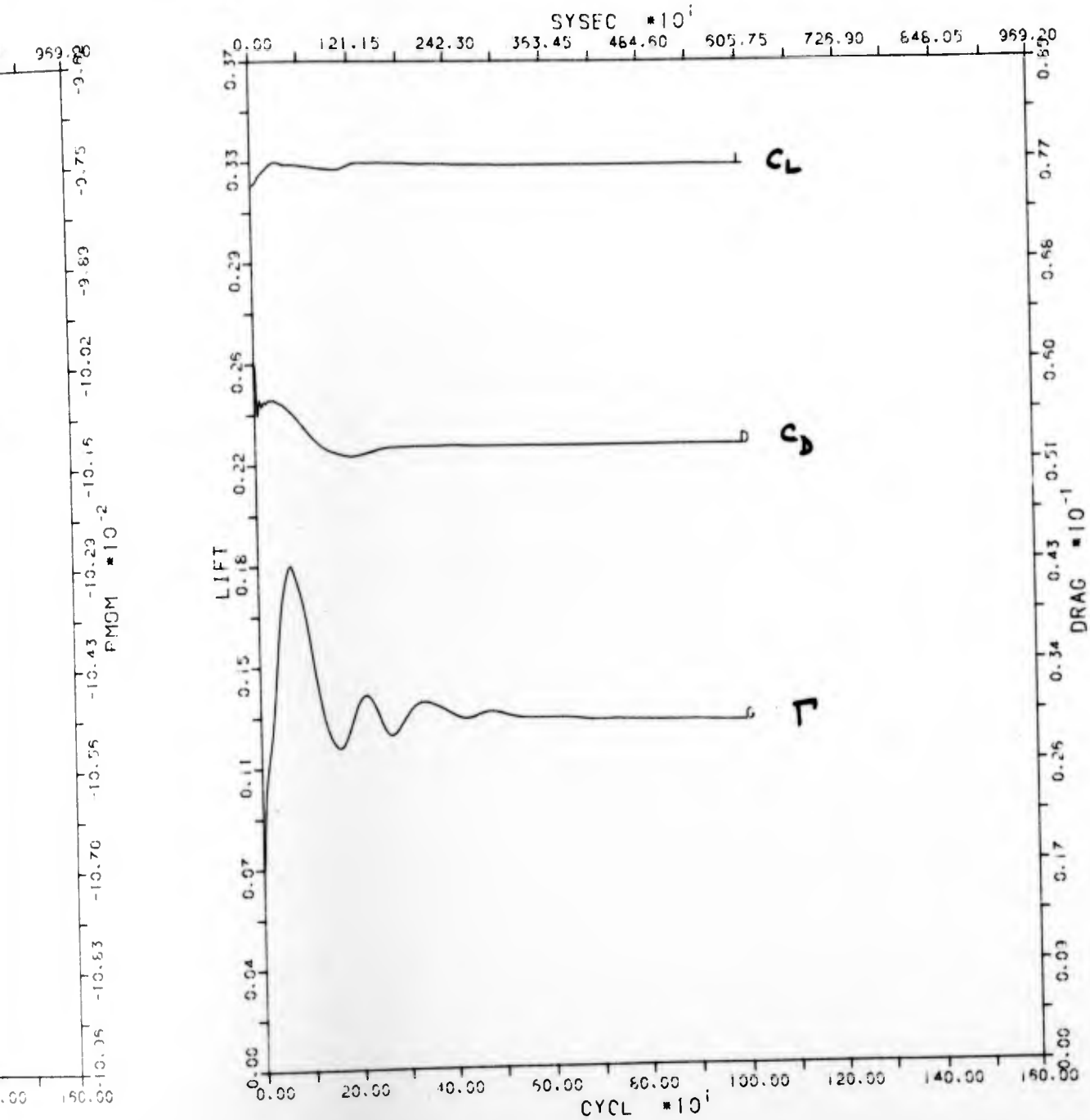




F.F.A.	AR 211		A.Rizzi	02-8-8
	NACA 0012: MACH = 0.85, ALPHA = 1			

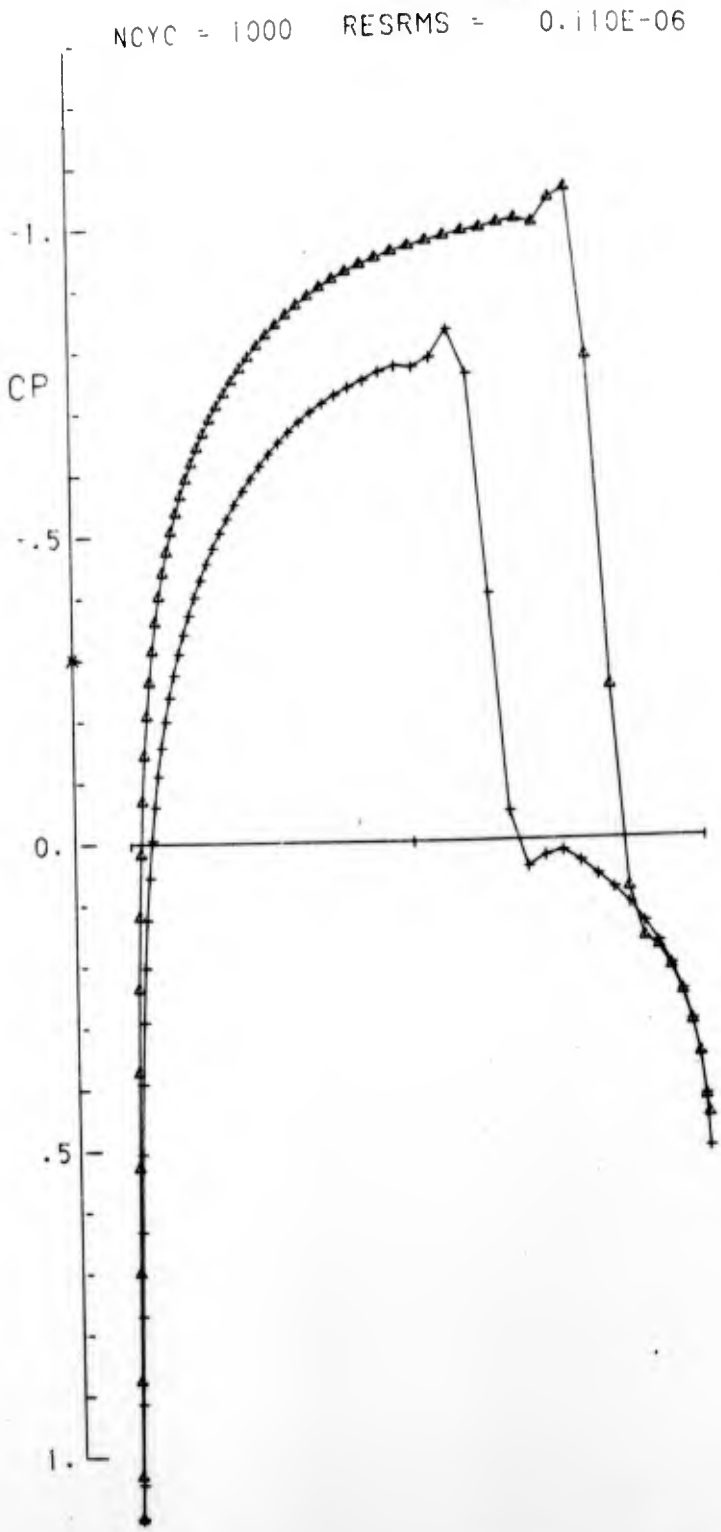
1.00 NO4 CON SWT .1 .05 .40

CELLS 128X28
end RESAE$_{TMS}$ 0.110E-06
DRAG 0.528E-01
RESMX$_{Max}$ 0.536E-06 118 4



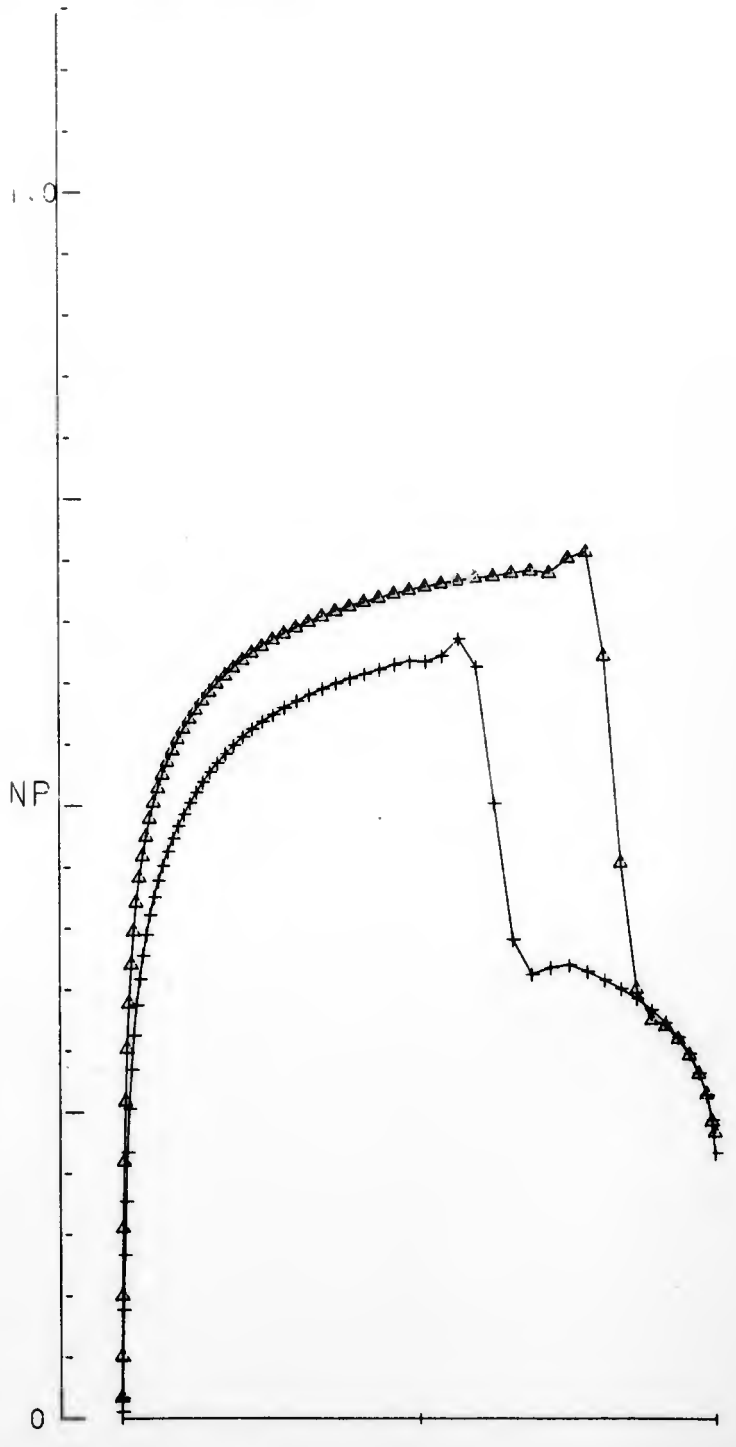
F.F.A.		A.Rizzi	02-8-9
NACA0012: MACH = 0.85, ALPHA = 1			

CELLS 128 × 28



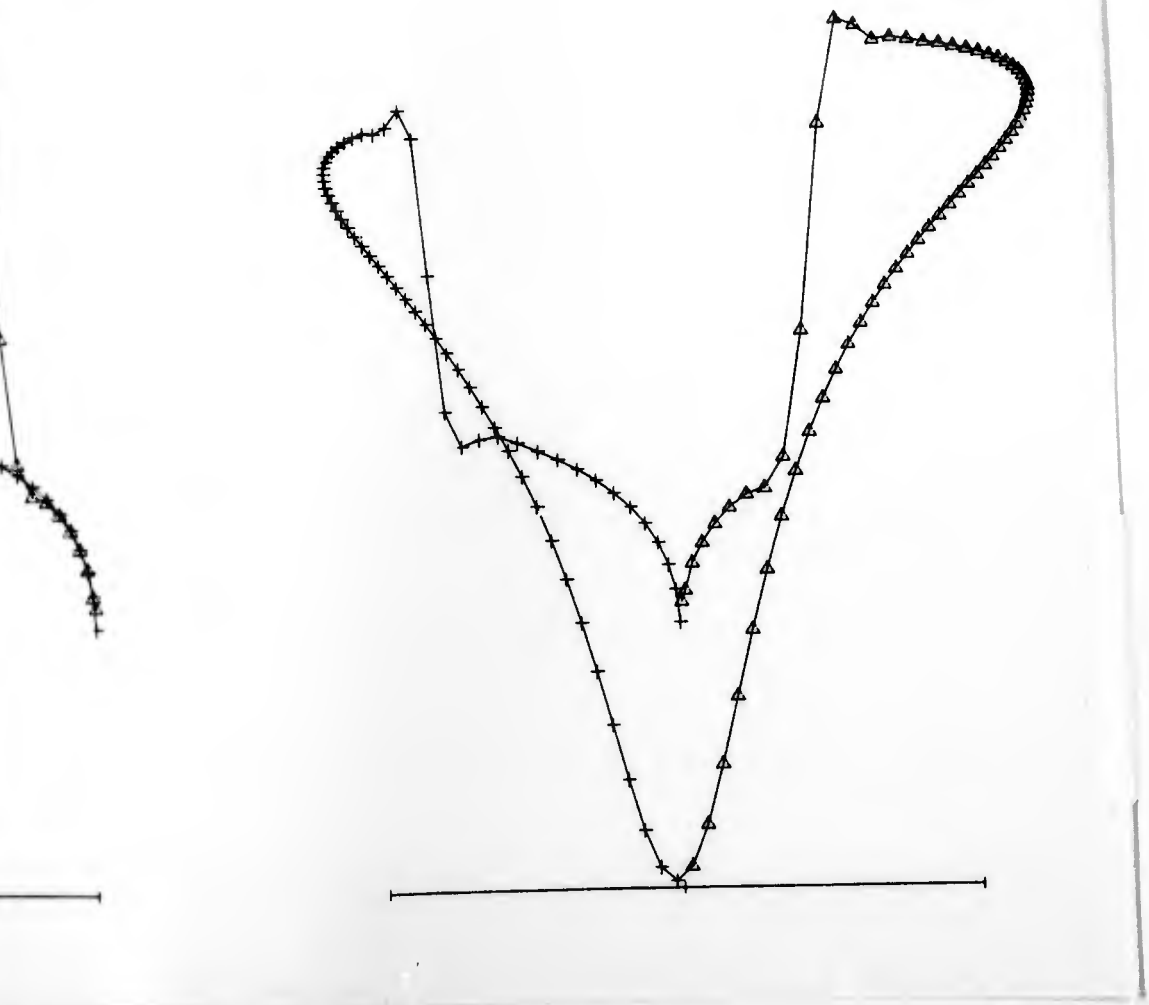
30/6 NONISO INVOR UNORO MESH .85 1.00 No 4 CON SWT .1 .05 .40

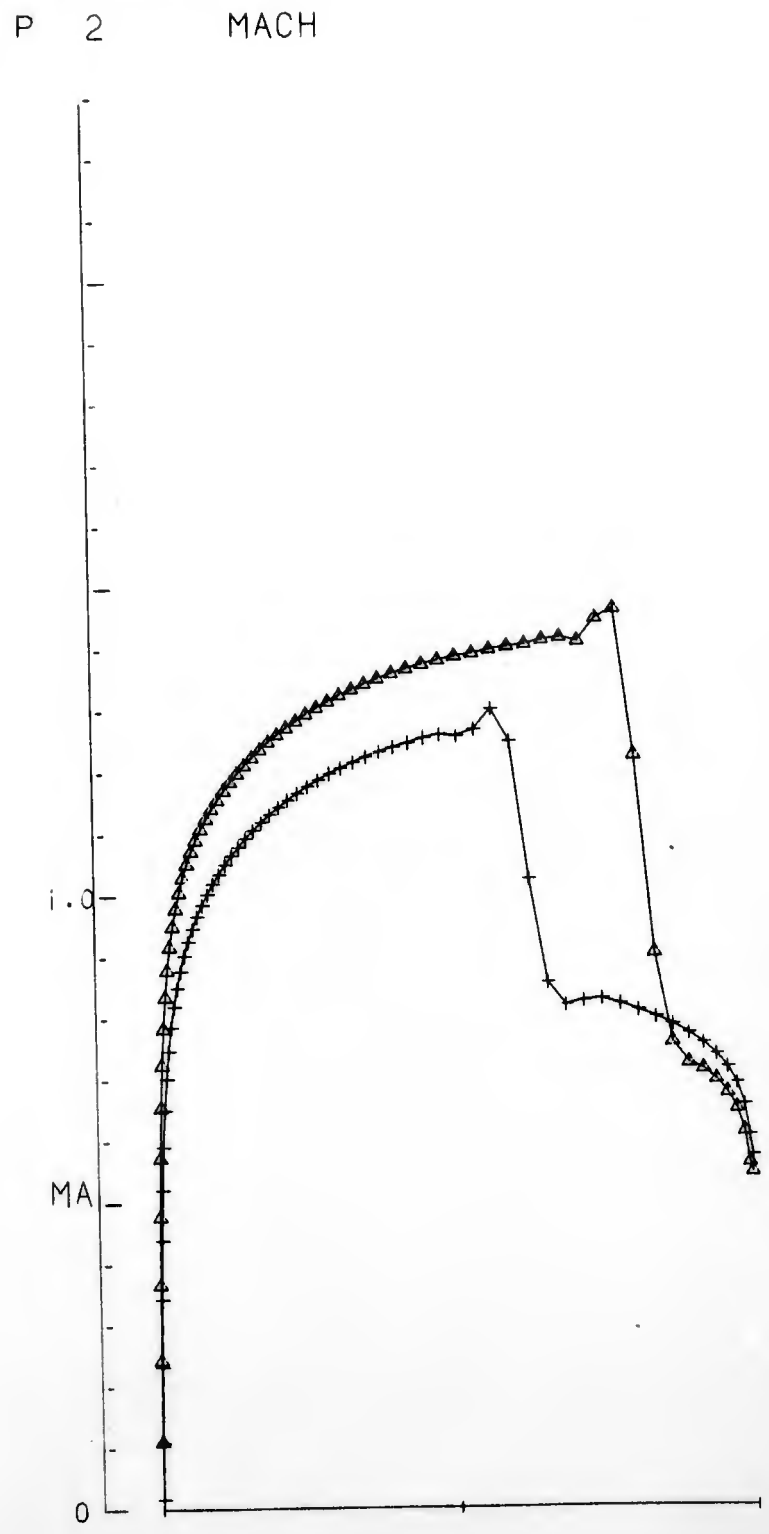
P 1 PRES 1-P/PIINF



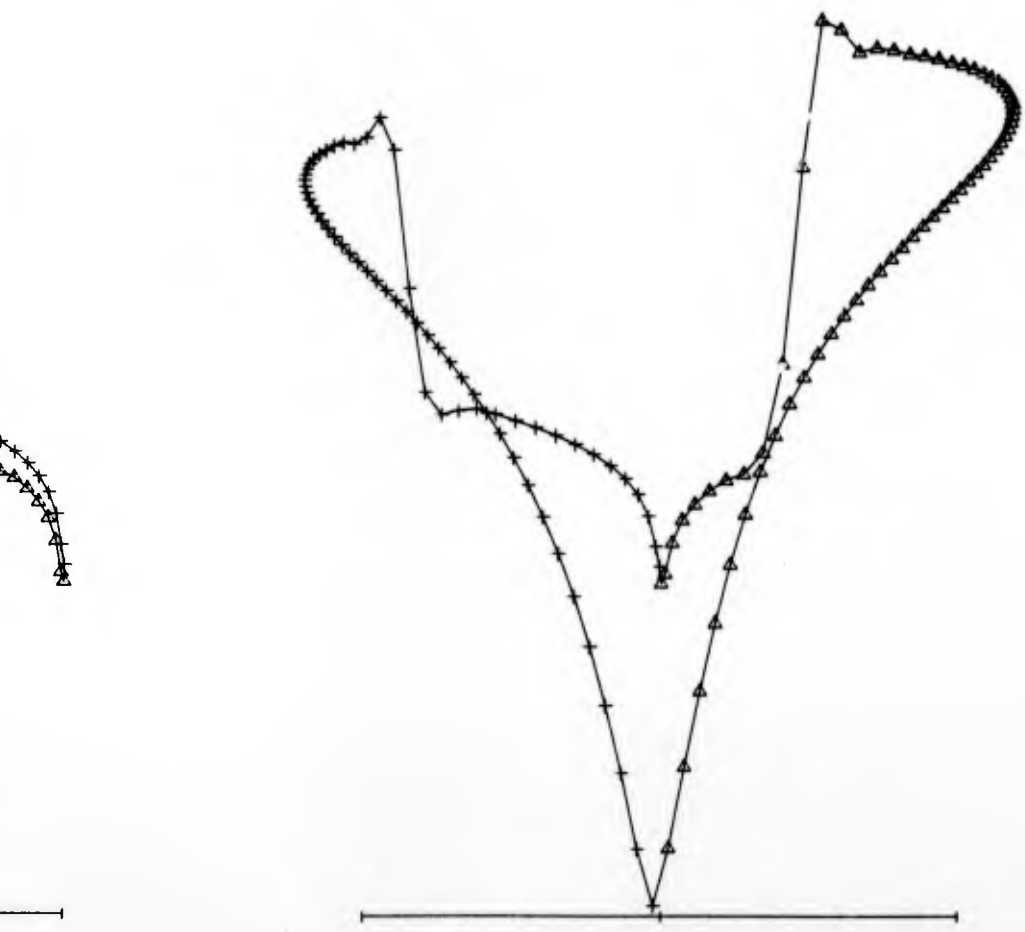
F.F.A.	AR 211		A.Rizzi	02-8-10
	NACA 0012: MACH = 0.85, ALPHA = 1			

.05 .40



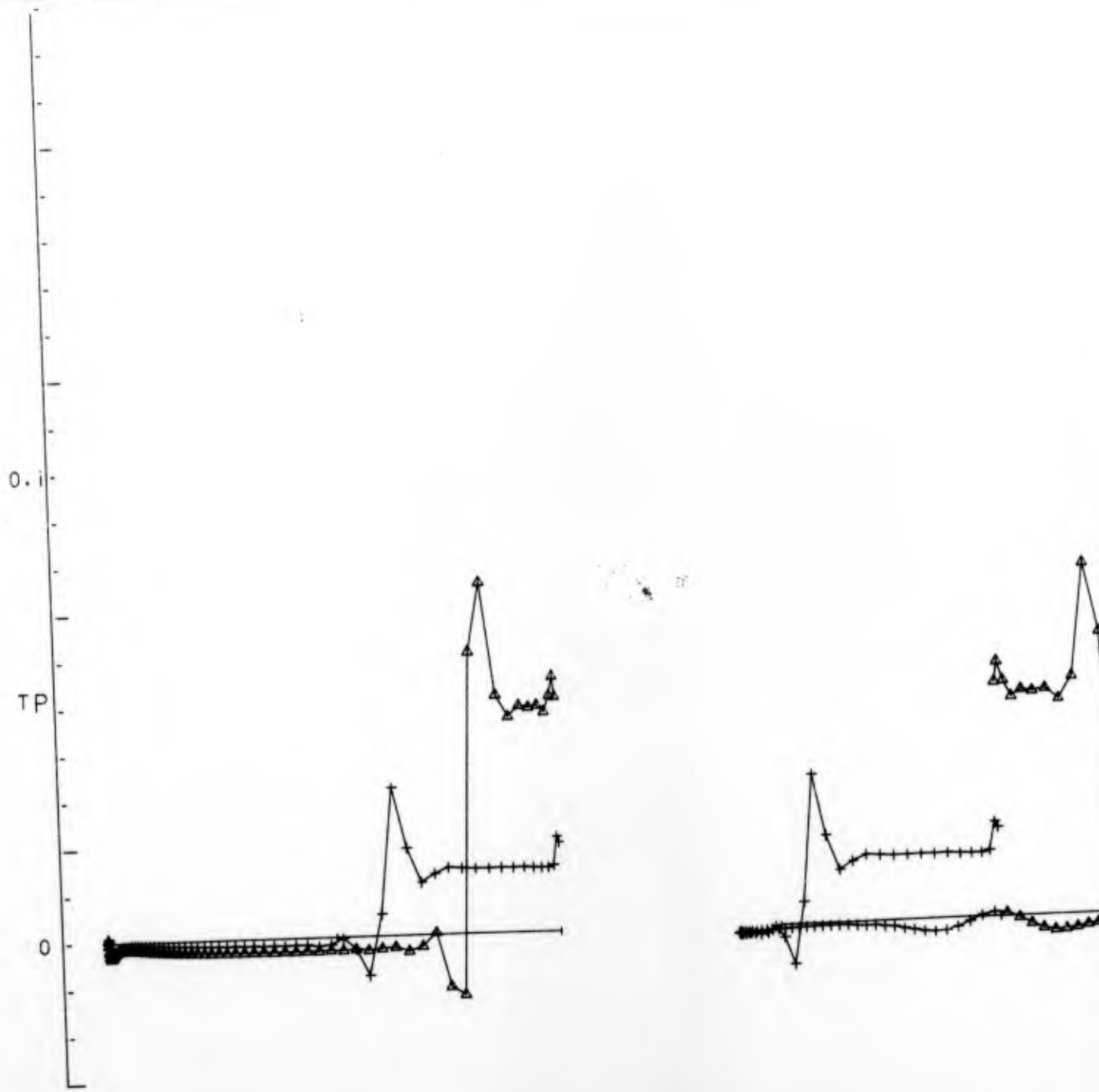

P 2 MACH
1.0
MA
0

F.F.A.	AR 211		A.Rizzi	02-8-11
	NACA 0012: MACH = 0.85, ALPHA = 1			

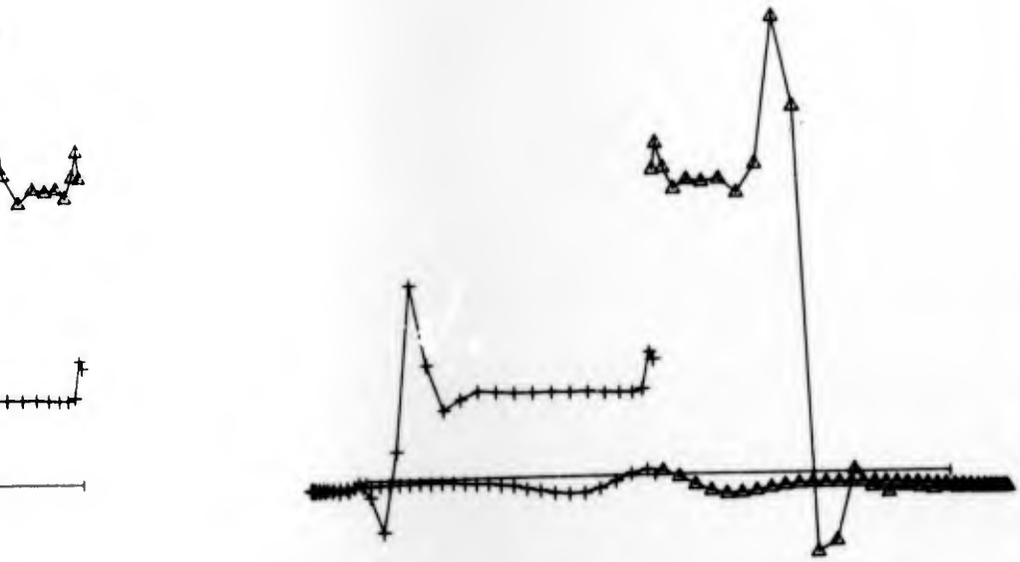


	AR 211
	NACA 00

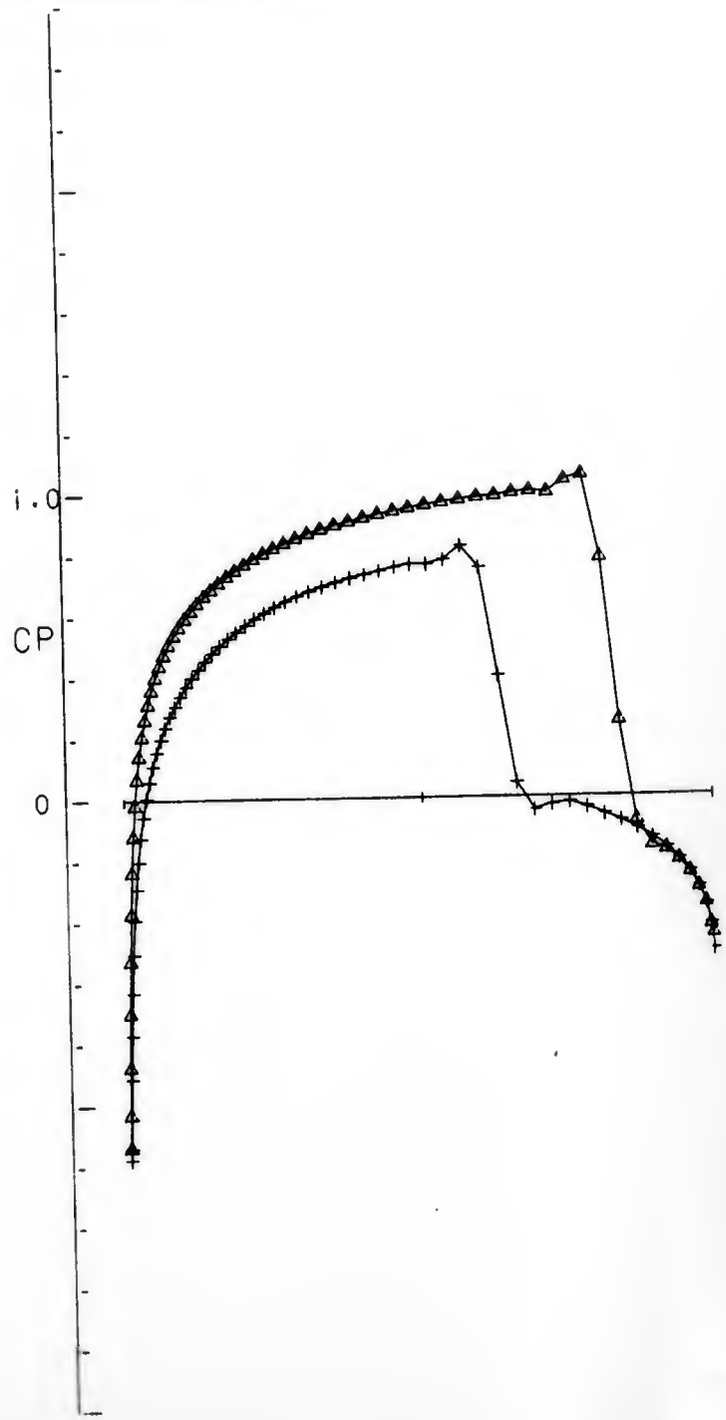
P 3 TOTP 1-PI/PIINF

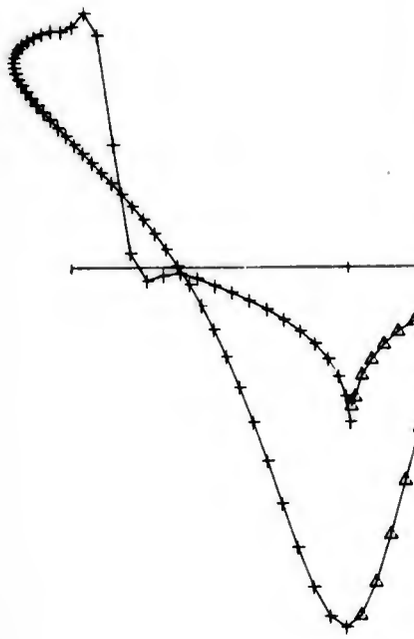


F.F.A.	AR 211		A.Rizzi	02-8-12
	NACA 0012: MACH = 0.85, ALPHA = 1			

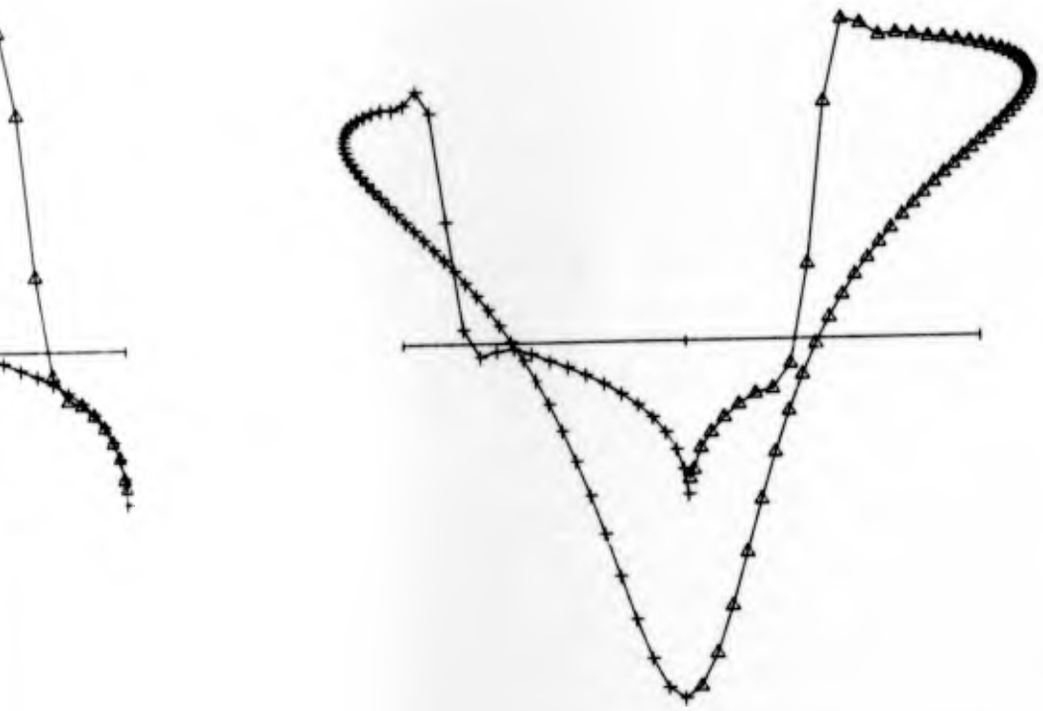


P 4 COEP C_p



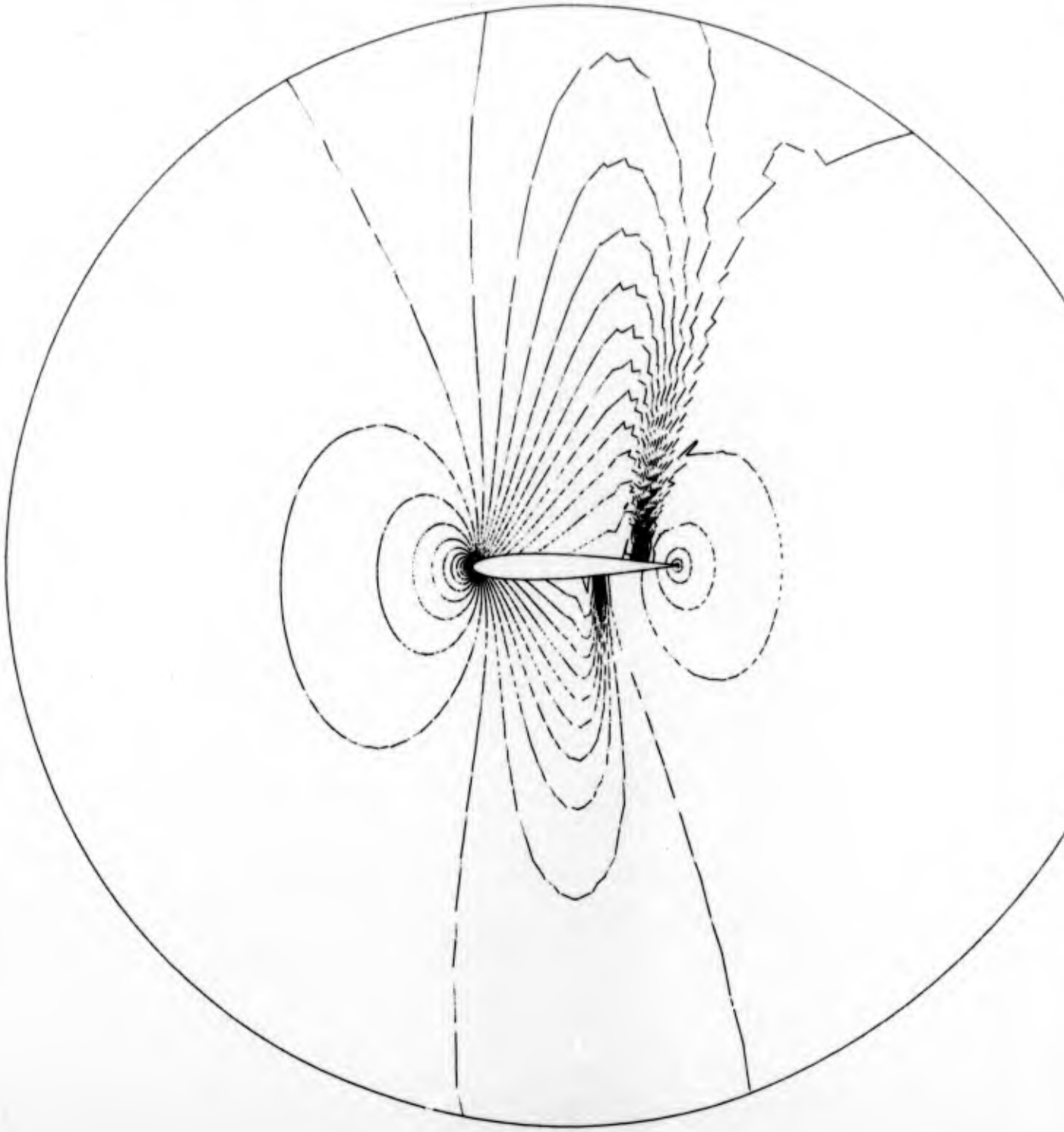


F.F.A.	AR 211		A.Rizzi	02-8-13
	NACA 0012: MACH = 0.85, ALPHA = 1			



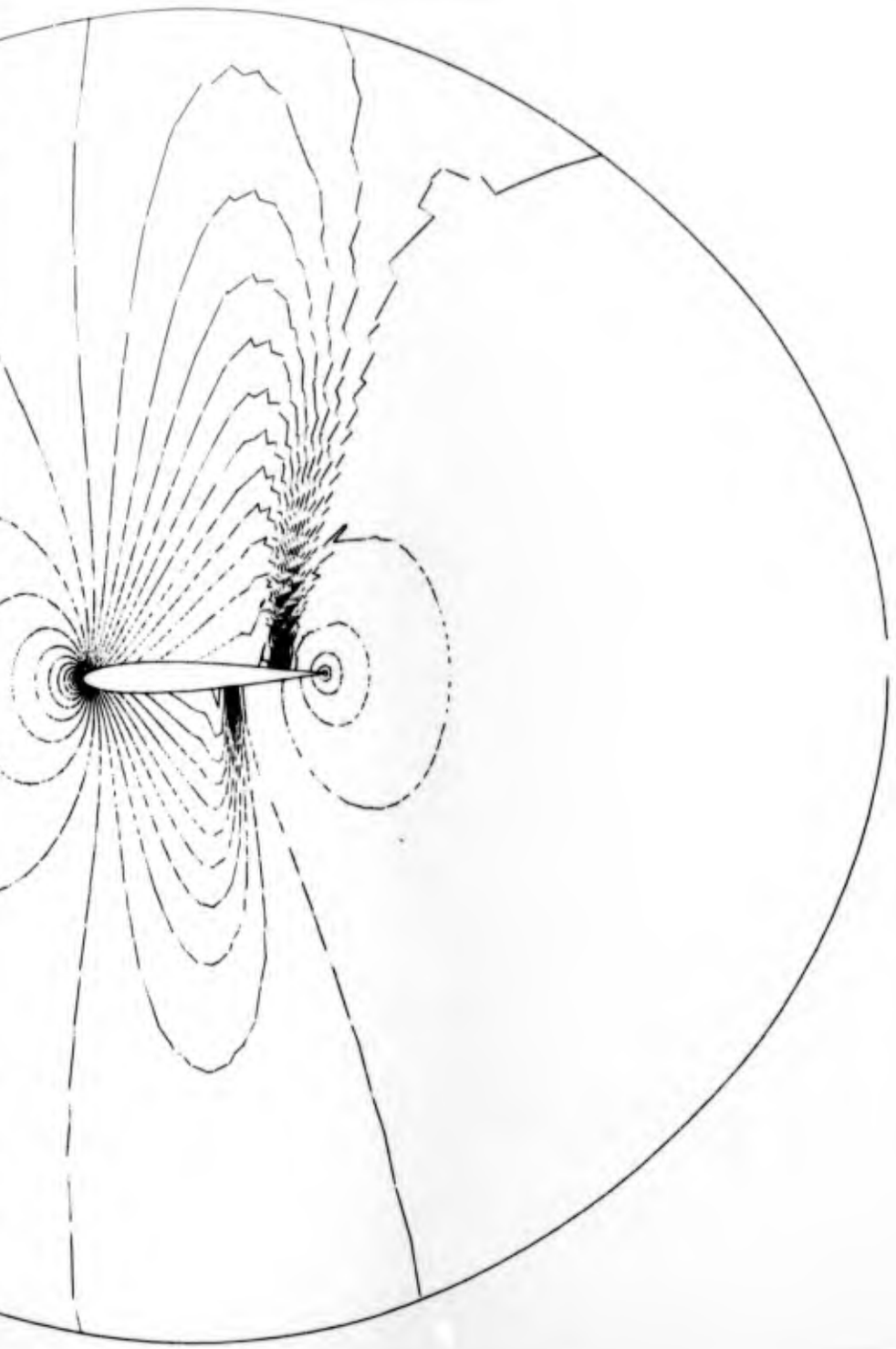
F.F.A.	AR 211
	NACA 001

P 5 PRES 1-P/PINF INC = 0.025 min = 0.025 max = 0.70

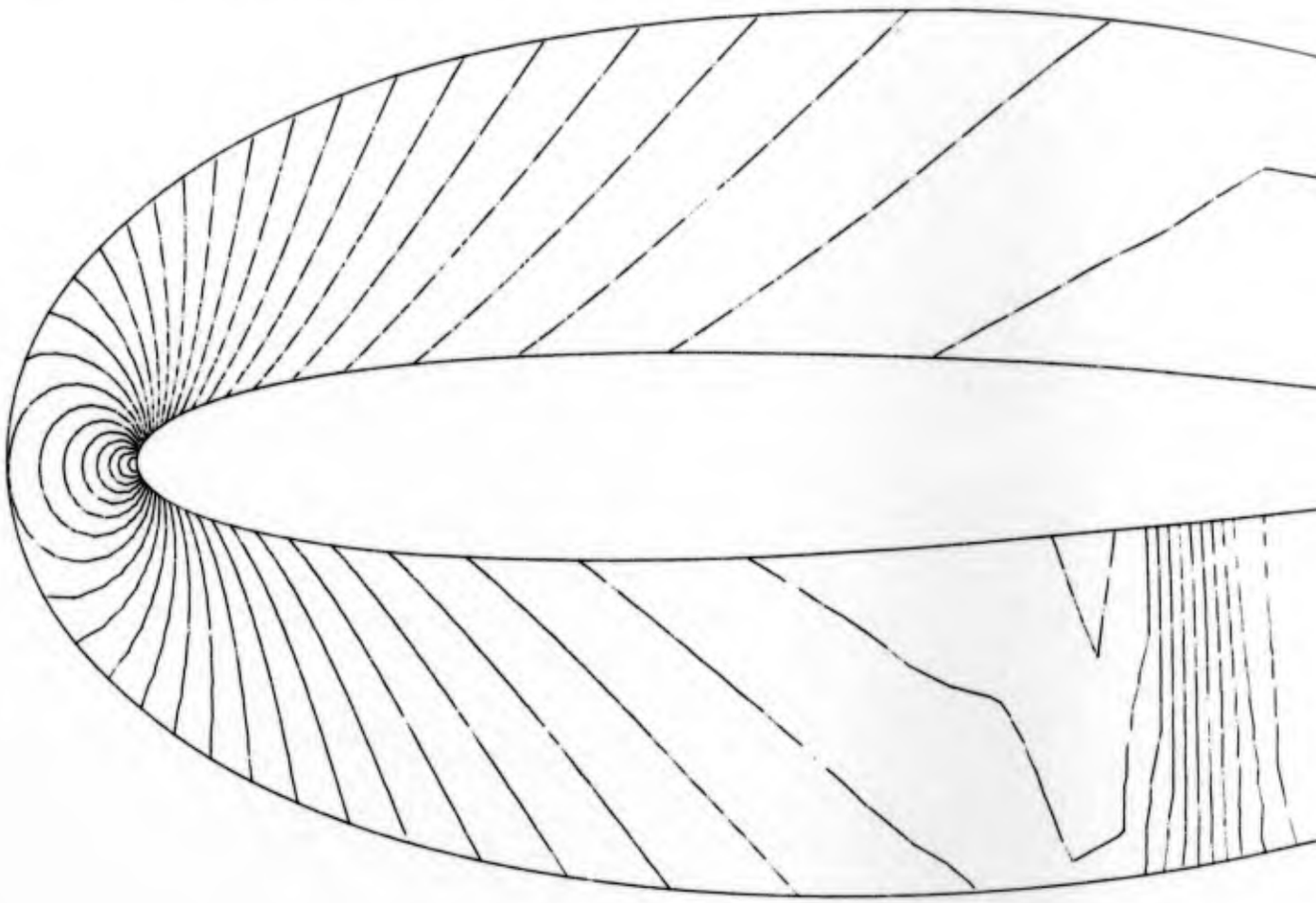


F.F.A.	AR 211		A.Rizzi	02-8-14
	NACA 0012: MACH = 0.85, ALPHA = 1			

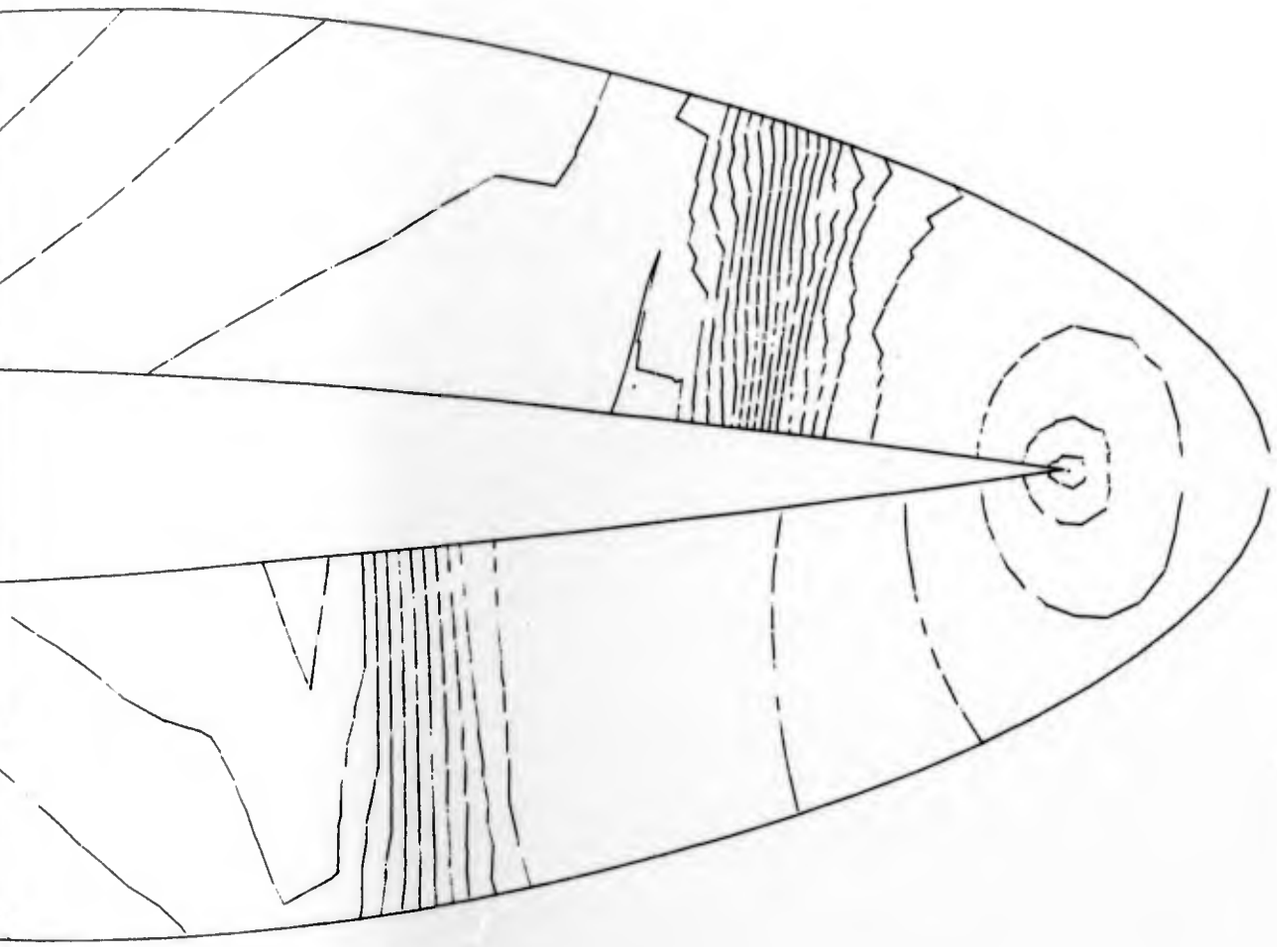
max = 0.70



P 6 PRES 1-P/PINF INC = .025 min = .025 max = .70



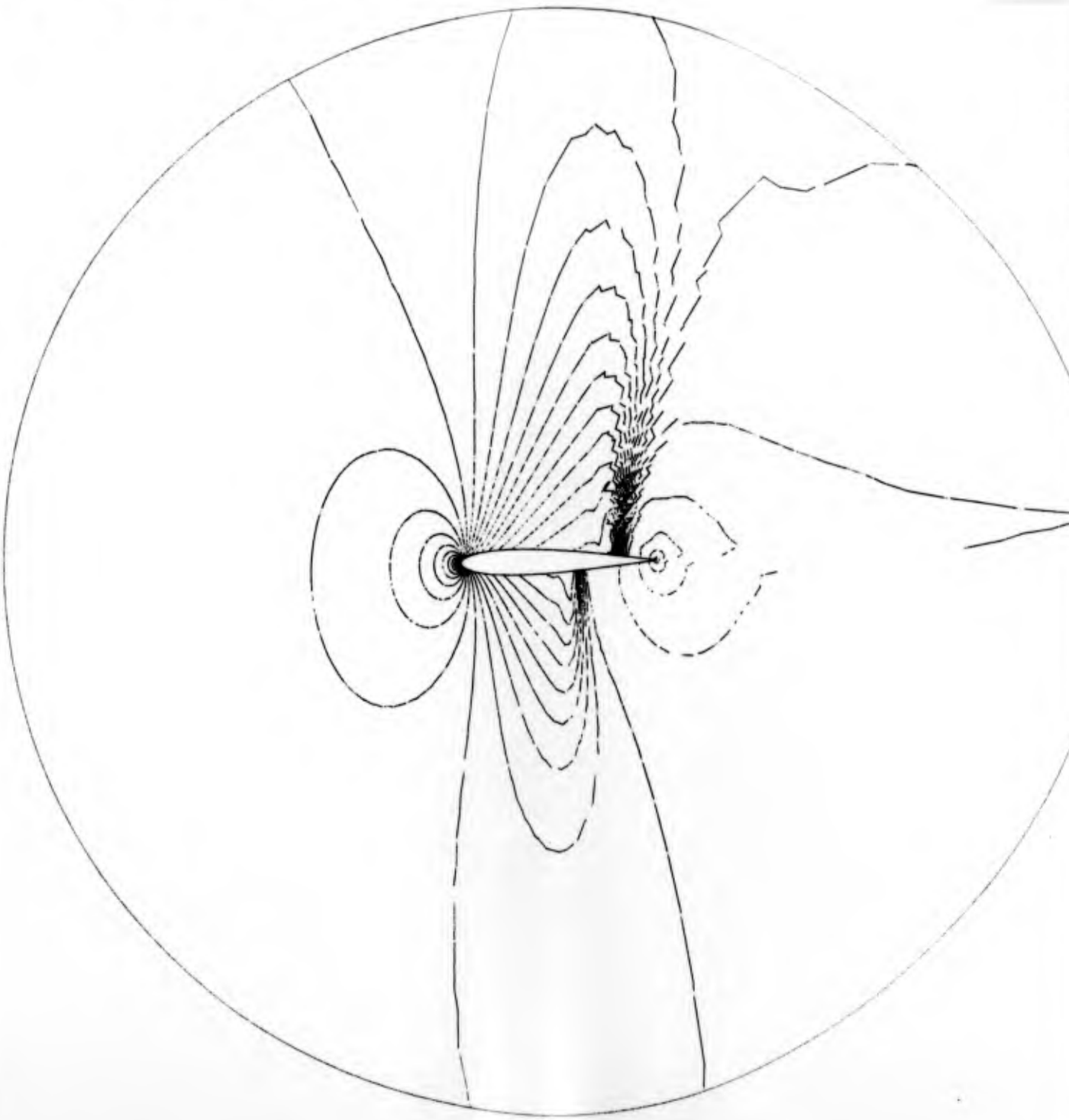
F.F.A.	AR 211		A.Rizzi	02-8-15
	NACA 0012: MACH = 0.85, ALPHA = 1			



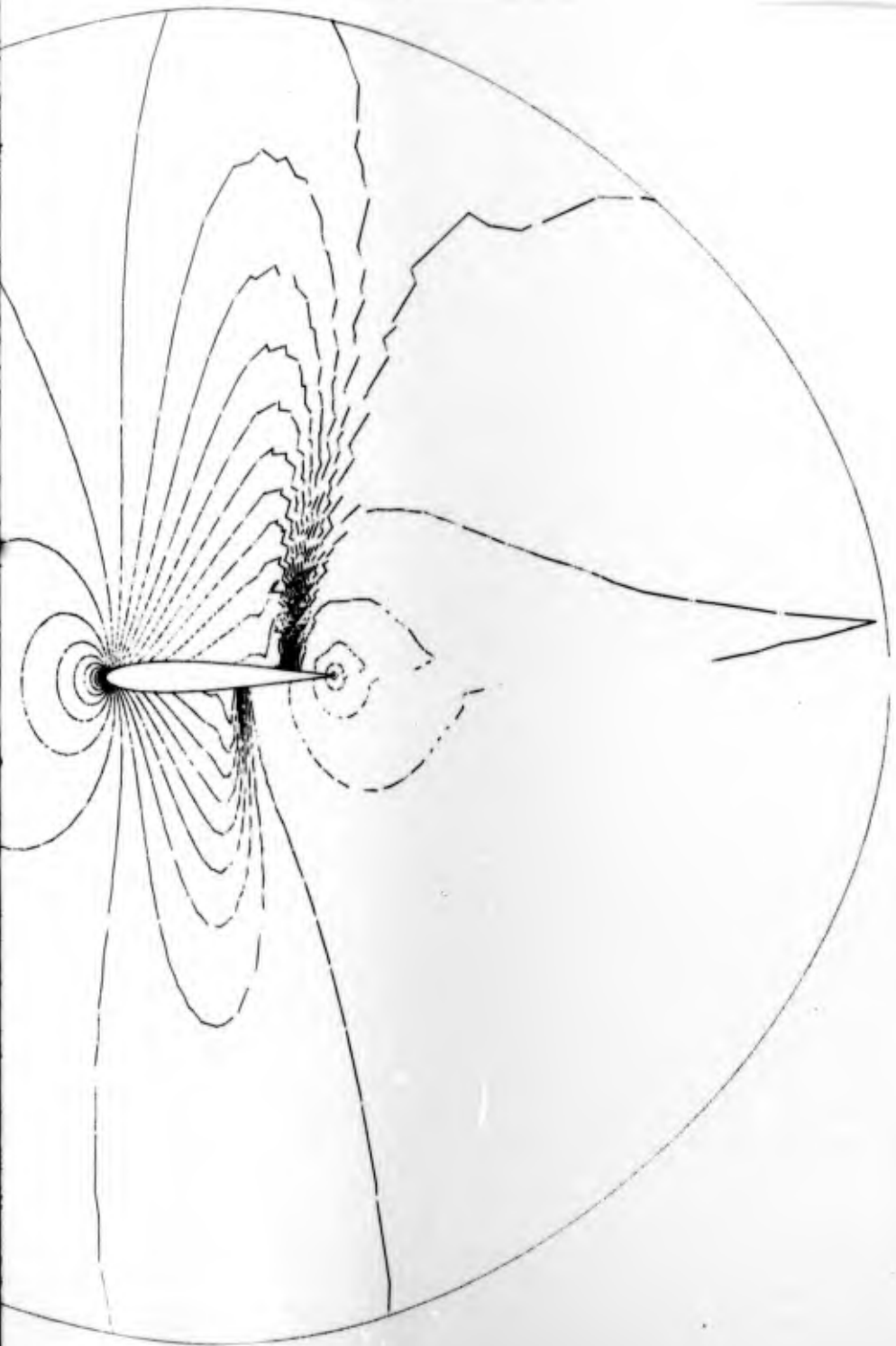
AR 211

NACA 0012: M

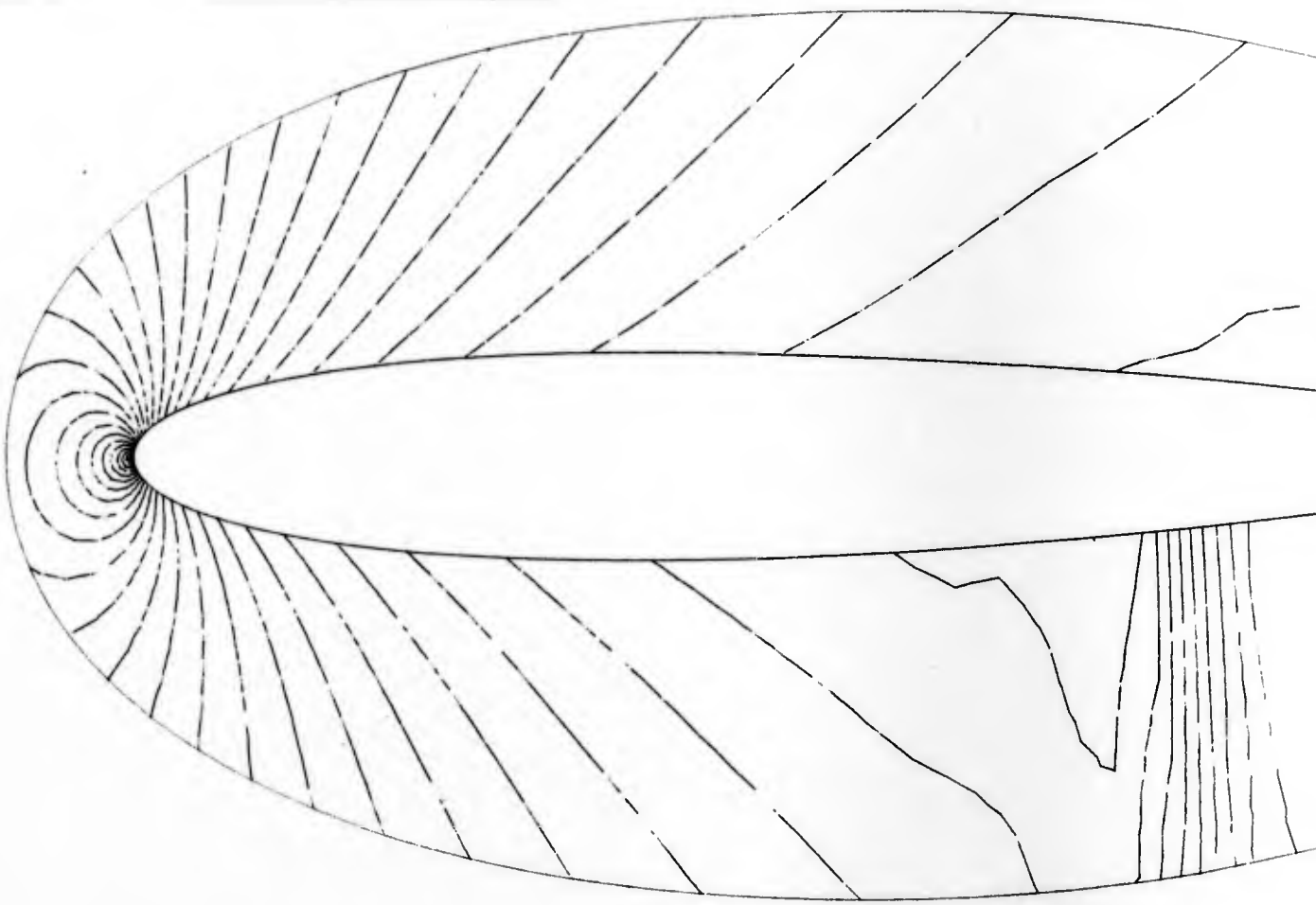
P 7 MACH INC = .05 min = .05 max = 1.45



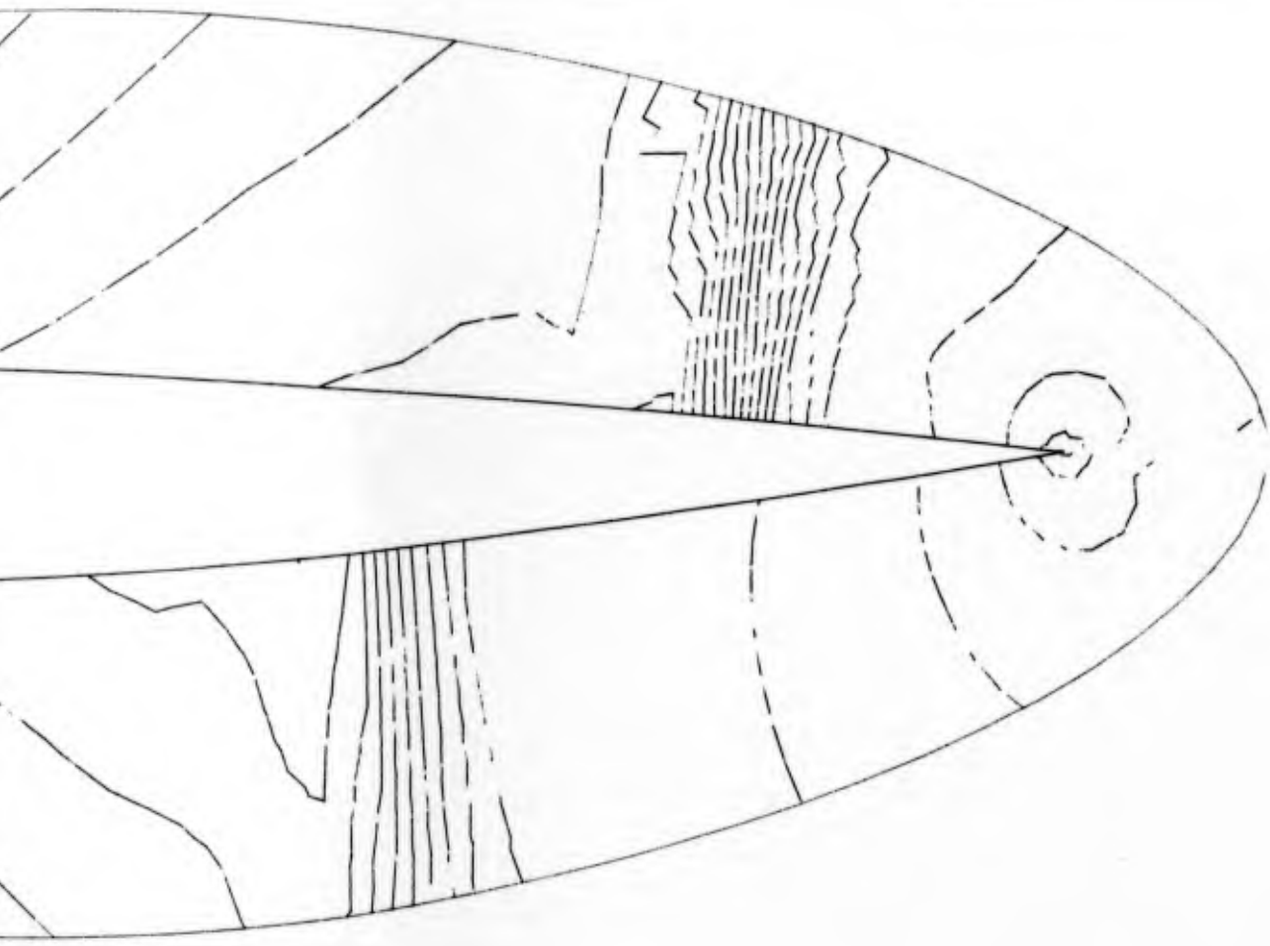
F.F.A.	AR 211		A.Rizzi	02-8-16
	NACA 0012: MACH = 0.85, ALPHA = 1			



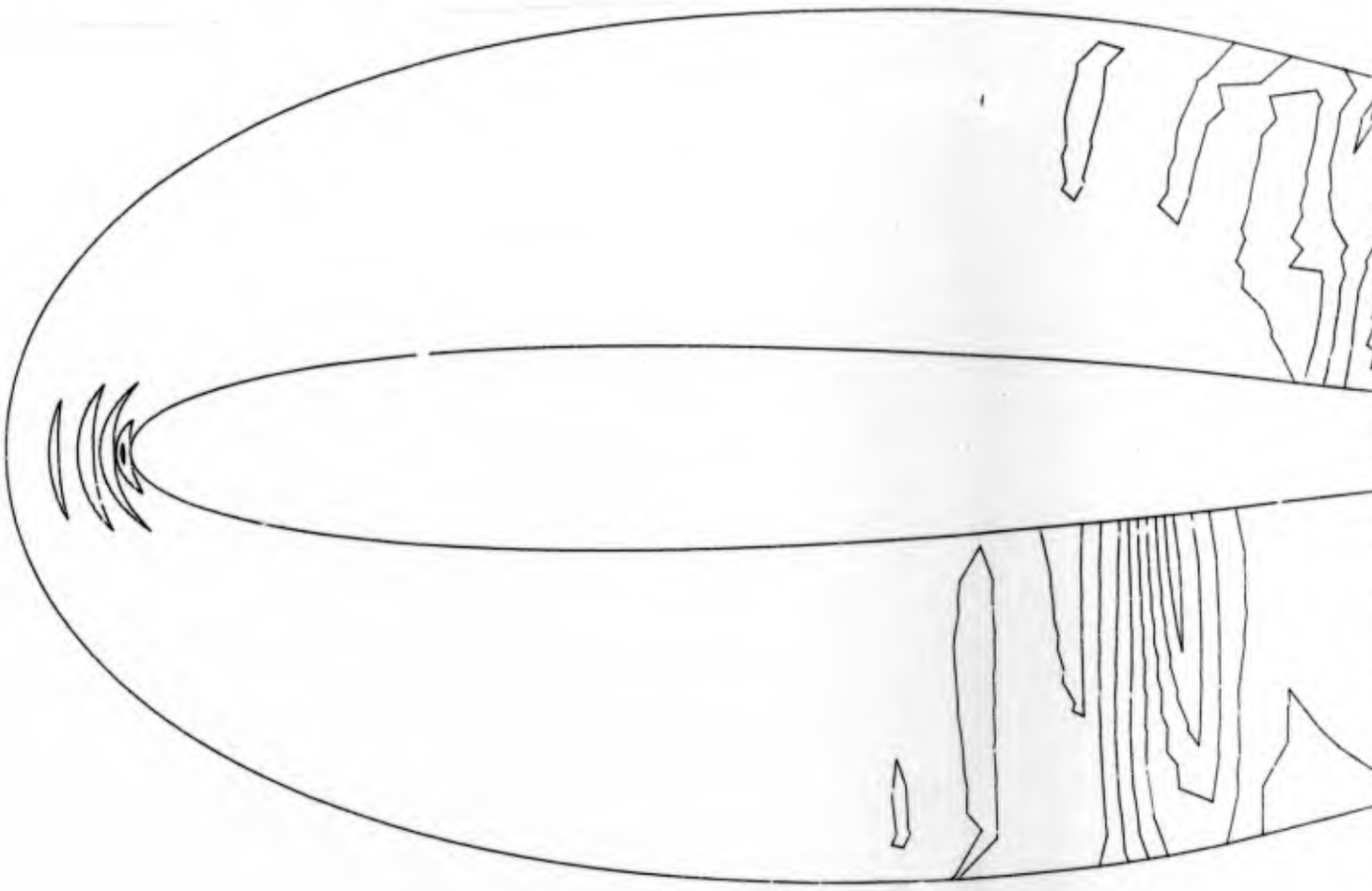
P 8 MACH INC = .05 min = .05 max = 1.45



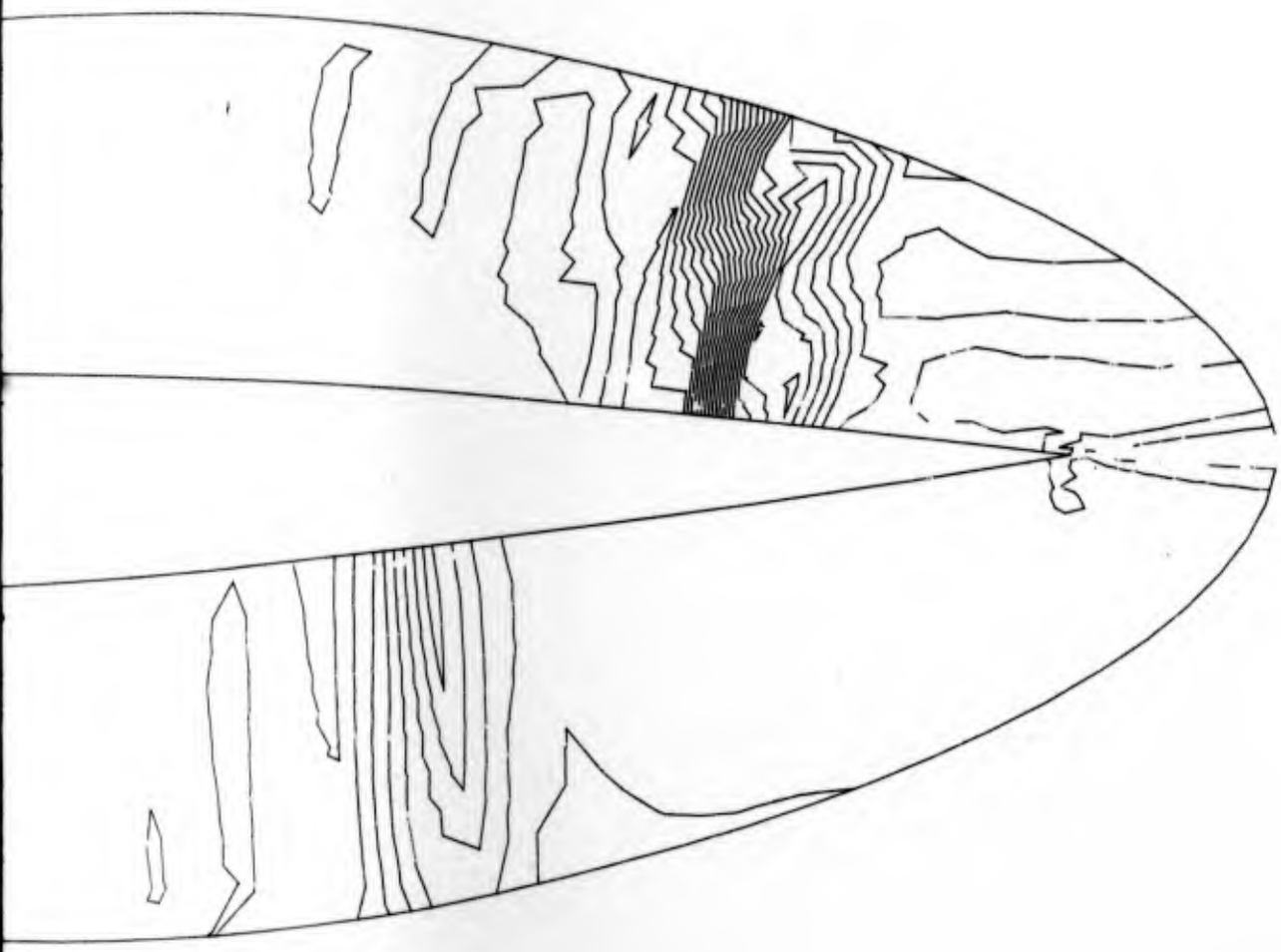
F.F.A.	AR 211		A.Rizzi	02-8-17
	NACA 0012: MACH = 0.85, ALPHA = 1			



P 9 TOTP 1-PI/PIINF INC = .005 min = −.01 max = .075



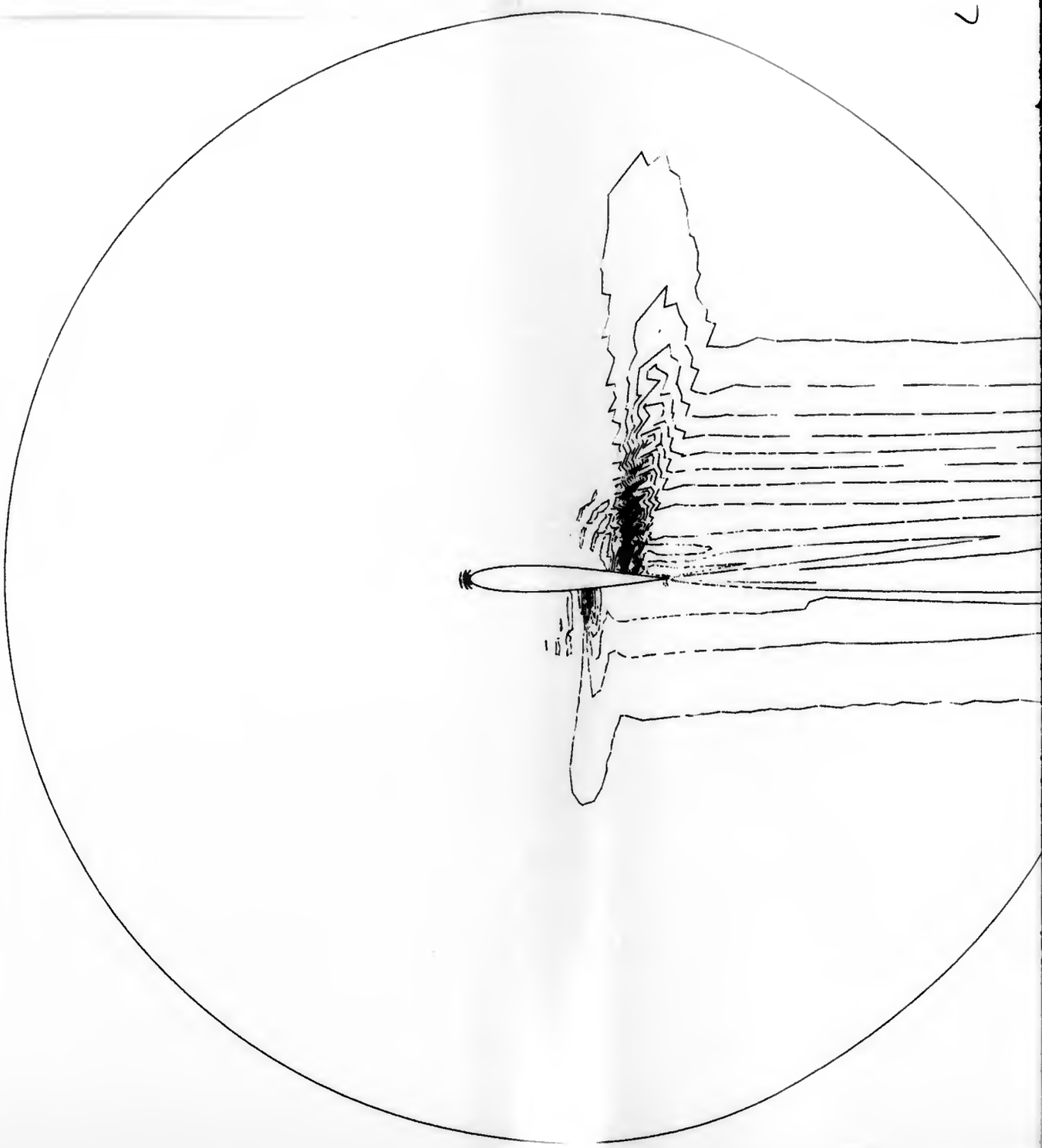
F.F.A.	AR 211		A.Rizzi	02-8-18
	NACA 0012: MACH = 0.85, ALPHA = 1			



AR 211

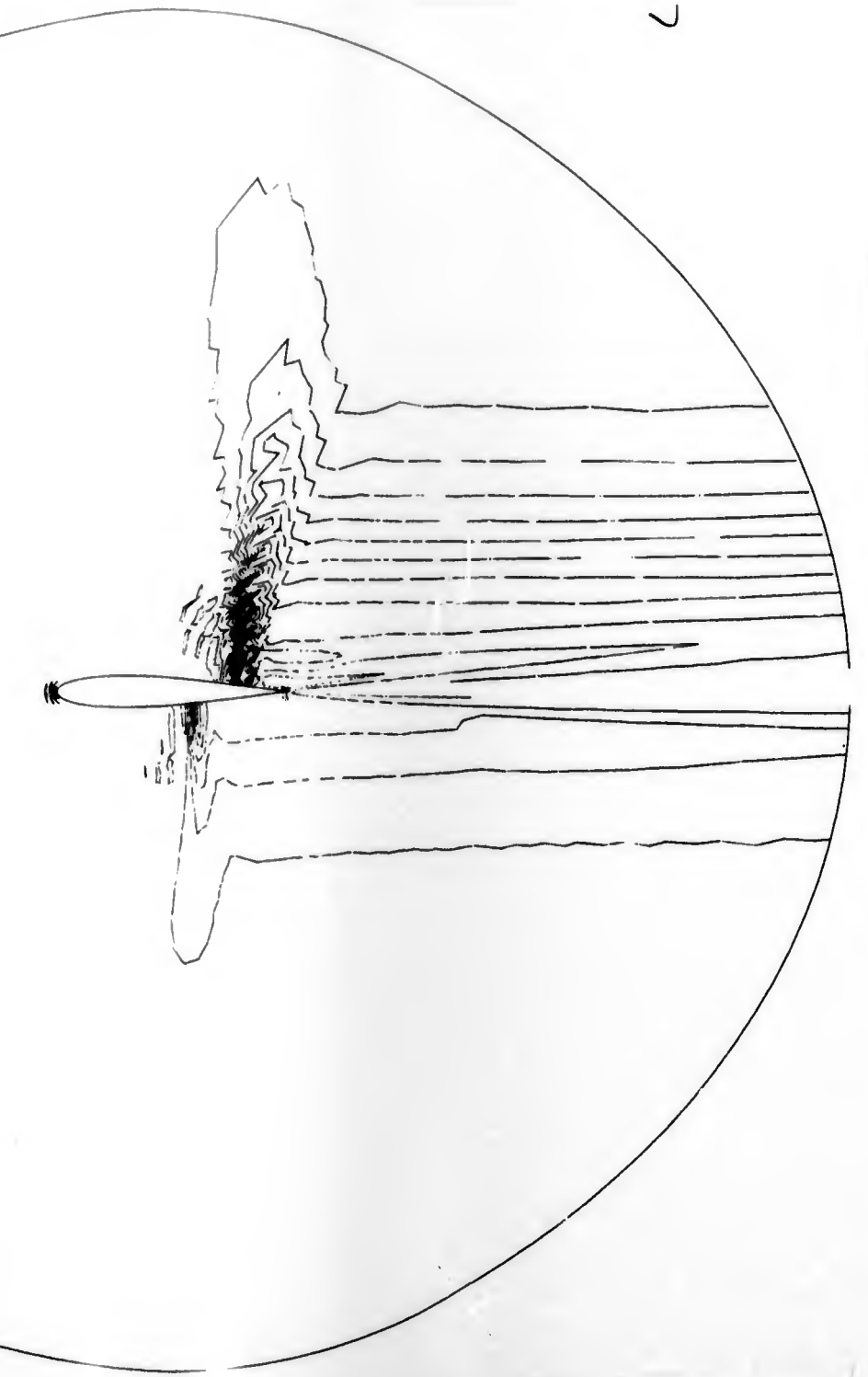
NACA 00

P 10 TOTP 1-PI/PIINF INC = .005 min = -.01 max = .075



FFA	AR 211		A.Rizzi	02-8-19
	NACA 0012: MACH = 0.85, ALPHA = 1			

max = .075



AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 02

NACA 0012: MACH = 0.85, ALPHA = 1

Contributor No 9

W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-1
	NACA 0012: MACH = 0.85, ALPHA = 1			

N	X/C(%)	Z/C(%)	1-P/PIINF	CP	MACH	1-PI/PIINF
2	99.992828	-Ø.ØØ1ØØØ	Ø.155450	Ø.700948	Ø.472855	Ø.Ø15713
3	99.965897	-Ø.ØØ4846	Ø.186701	Ø.601847	Ø.527543	Ø.Ø16932
4	99.914658	-Ø.Ø12110	Ø.200772	Ø.557223	Ø.554142	Ø.Ø15384
5	99.840439	-Ø.Ø22620	Ø.212833	Ø.518978	Ø.573326	Ø.Ø16339
6	99.744003	-Ø.Ø36276	Ø.222192	Ø.489298	Ø.589685	Ø.Ø15833
7	99.625946	-Ø.Ø52983	Ø.230499	Ø.462955	Ø.603070	Ø.Ø16133
8	99.486725	-Ø.Ø72632	Ø.237522	Ø.440683	Ø.614797	Ø.Ø15994
9	99.326721	-Ø.Ø95145	Ø.243007	Ø.420754	Ø.624959	Ø.Ø16080
10	99.146286	-Ø.120481	Ø.249553	Ø.402531	Ø.634309	Ø.Ø16072
11	98.945786	-Ø.148593	Ø.254986	Ø.385303	Ø.643036	Ø.Ø16122
12	98.725494	-Ø.179389	Ø.259896	Ø.369732	Ø.651003	Ø.Ø16077
13	98.485703	-Ø.212798	Ø.264477	Ø.355206	Ø.658313	Ø.Ø16114
14	98.226700	-Ø.248813	Ø.269045	Ø.340719	Ø.665546	Ø.Ø16182
15	97.948761	-Ø.287339	Ø.273267	Ø.327330	Ø.672357	Ø.Ø16120
16	97.652130	-Ø.328249	Ø.277114	Ø.315132	Ø.678465	Ø.Ø16135
17	97.337082	-Ø.371551	Ø.280960	Ø.302934	Ø.684499	Ø.Ø16201
18	97.003891	-Ø.417216	Ø.284716	Ø.291024	Ø.690483	Ø.Ø16174
19	96.652786	-Ø.465119	Ø.288259	Ø.279789	Ø.696084	Ø.Ø16183
20	96.284027	-Ø.515193	Ø.291678	Ø.268945	Ø.701459	Ø.Ø16206
21	95.897858	-Ø.567390	Ø.295010	Ø.258381	Ø.706704	Ø.Ø16216
22	95.494553	-Ø.621635	Ø.298220	Ø.248200	Ø.711752	Ø.Ø16227
23	95.074341	-Ø.677854	Ø.301283	Ø.238487	Ø.716572	Ø.Ø16228
24	94.637466	-Ø.735998	Ø.304258	Ø.229053	Ø.721233	Ø.Ø16241
25	94.184219	-Ø.796038	Ø.307240	Ø.219597	Ø.725888	Ø.Ø16270
26	93.714828	-Ø.857903	Ø.310183	Ø.210265	Ø.730502	Ø.Ø16274
27	93.229553	-Ø.921482	Ø.313016	Ø.201281	Ø.734932	Ø.Ø16285
28	92.728638	-Ø.986685	Ø.315703	Ø.192758	Ø.739142	Ø.Ø16286
29	92.212341	-1.Ø53459	Ø.318305	Ø.184508	Ø.743197	Ø.Ø16303
30	91.680923	-1.121780	Ø.320887	Ø.176319	Ø.747220	Ø.Ø16322
31	91.134644	-1.191594	Ø.323430	Ø.168256	Ø.751193	Ø.Ø16325
32	90.573761	-1.262822	Ø.325934	Ø.160315	Ø.755089	Ø.Ø16345
33	89.998535	-1.335393	Ø.328413	Ø.152452	Ø.758944	Ø.Ø16365
34	89.409225	-1.409214	Ø.330772	Ø.144972	Ø.762635	Ø.Ø16359
35	88.806091	-1.484191	Ø.332981	Ø.137966	Ø.766083	Ø.Ø16360
36	88.189407	-1.560317	Ø.335215	Ø.130882	Ø.769530	Ø.Ø16400
37	87.559418	-1.637572	Ø.337471	Ø.123728	Ø.773045	Ø.Ø16408
38	86.916428	-1.715837	Ø.339617	Ø.116922	Ø.776401	Ø.Ø16404
39	86.260666	-1.795019	Ø.341669	Ø.110415	Ø.779583	Ø.Ø16422
40	85.592407	-1.875083	Ø.343680	Ø.104040	Ø.782706	Ø.Ø16437
41	84.911942	-1.955977	Ø.345649	Ø.097796	Ø.785768	Ø.Ø16449
42	84.219528	-2.037631	Ø.347550	Ø.091766	Ø.788727	Ø.Ø16457
43	83.515427	-2.119970	Ø.349362	Ø.086020	Ø.791544	Ø.Ø16466
44	82.799927	-2.202941	Ø.351101	Ø.080507	Ø.794246	Ø.Ø16480
45	82.073288	-2.286501	Ø.352791	Ø.075147	Ø.796871	Ø.Ø16491
46	81.335815	-2.370600	Ø.354441	Ø.069913	Ø.799432	Ø.Ø16505
47	80.587753	-2.455165	Ø.356021	Ø.064903	Ø.801891	Ø.Ø16514
48	79.829376	-2.540112	Ø.357489	Ø.060249	Ø.804179	Ø.Ø16516
49	79.060974	-2.625375	Ø.358849	Ø.055938	Ø.806291	Ø.Ø16527
50	78.282837	-2.710910	Ø.360125	Ø.051890	Ø.808273	Ø.Ø16538
51	77.495209	-2.796670	Ø.361333	Ø.048058	Ø.810144	Ø.Ø16554
52	76.698410	-2.882581	Ø.362410	Ø.044643	Ø.811826	Ø.Ø16554
53	75.892685	-2.968552	Ø.363294	Ø.041839	Ø.813211	Ø.Ø16548
54	75.078339	-3.054547	Ø.364067	Ø.039390	Ø.814396	Ø.Ø16571
55	74.255630	-3.140560	Ø.364755	Ø.037206	Ø.815464	Ø.Ø16578
56	73.424866	-3.226509	Ø.365263	Ø.035596	Ø.816267	Ø.Ø16568
57	72.586319	-3.312301	Ø.365566	Ø.034636	Ø.816733	Ø.Ø16576
58	71.740265	-3.397891	Ø.365694	Ø.034229	Ø.816926	Ø.Ø16582
59	70.887009	-3.483205	Ø.365600	Ø.034528	Ø.816784	Ø.Ø16576
60	70.026794	-3.568157	Ø.365229	Ø.035703	Ø.816190	Ø.Ø16594
61	69.159943	-3.652738	Ø.364445	Ø.038190	Ø.814979	Ø.Ø16579
62	68.286728	-3.736912	Ø.362994	Ø.042791	Ø.812852	Ø.Ø16441
63	67.407440	-3.820540	Ø.361386	Ø.047890	Ø.810424	Ø.Ø16357
64	66.522354	-3.903537	Ø.354434	Ø.069936	Ø.800787	Ø.Ø15172
65	65.631760	-3.985905	Ø.386167	-Ø.030693	Ø.842056	Ø.Ø23594
66	64.735947	-4.067623	Ø.468643	-Ø.292240	Ø.966157	Ø.Ø32684
67	63.835220	-4.148601	Ø.577575	-Ø.637682	1.168045	Ø.Ø17148
68	62.929840	-4.228698	Ø.623442	-Ø.783133	1.264026	Ø.ØØ6143
69	62.020111	-4.307839	Ø.628422	-Ø.798925	1.279720	-Ø.ØØ1640
70	61.106308	-4.386030	Ø.628953	-Ø.800609	1.278208	Ø.ØØ1828
71	60.188751	-4.463216	Ø.628131	-Ø.798003	1.278569	-Ø.ØØØ870
72	59.267700	-4.539362	Ø.627749	-Ø.796793	1.276464	Ø.ØØØ943
73	58.343460	-4.614206	Ø.627075	-Ø.794654	1.275915	-Ø.ØØØ126
74	57.416321	-4.687847	Ø.626591	-Ø.793119	1.274482	Ø.ØØØ508
75	56.486572	-4.760140	Ø.625928	-Ø.791017	1.273454	Ø.ØØØ117
76	55.554504	-4.831051	Ø.625367	-Ø.789239	1.272142	Ø.ØØØ385
77	54.620422	-4.900533	Ø.624712	-Ø.787159	1.270971	Ø.ØØØ212
78	53.684616	-4.968453	Ø.623969	-Ø.784804	1.269444	Ø.ØØØ290
79	52.747375	-5.034718	Ø.623198	-Ø.782359	1.267935	Ø.ØØØ266
80	51.808990	-5.099324	Ø.622488	-Ø.780108	1.266503	Ø.ØØØ306

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-2
	NACA 0012: MACH = 0.85, ALPHA = 1			

81	50.869781	-5.162216	0.621709	-0.777639	1.265000	0.000263
82	49.930008	-5.223271	0.620840	-0.774883	1.263271	0.000288
83	48.990005	-5.282402	0.619916	-0.771951	1.261456	0.000285
84	48.050049	-5.339531	0.618941	-0.768860	1.259545	0.000282
85	47.110458	-5.394568	0.617915	-0.765605	1.257534	0.000284
86	46.171509	-5.447458	0.616884	-0.762337	1.255505	0.000302
87	45.233521	-5.498161	0.615825	-0.758978	1.253444	0.000296
88	44.296783	-5.546580	0.614670	-0.755315	1.251202	0.000287
89	43.361603	-5.592612	0.613443	-0.751423	1.248807	0.000299
90	42.428284	-5.636191	0.612181	-0.747422	1.246355	0.000306
91	41.497131	-5.677249	0.610856	-0.743220	1.243796	0.000299
92	40.568451	-5.715693	0.609449	-0.738759	1.241082	0.000300
93	39.642548	-5.751444	0.607982	-0.734108	1.238256	0.000301
94	38.719727	-5.784445	0.606493	-0.729385	1.235386	0.000316
95	37.800293	-5.814661	0.604976	-0.724574	1.232475	0.000321
96	36.884567	-5.842010	0.603342	-0.719392	1.229369	0.000301
97	35.972839	-5.866369	0.601584	-0.713818	1.226016	0.000310
98	35.065430	-5.887674	0.599783	-0.708106	1.222580	0.000329
99	34.162659	-5.905882	0.597931	-0.702232	1.219079	0.000322
100	33.264816	-5.920918	0.595988	-0.696071	1.215413	0.000319
101	32.372223	-5.932717	0.593978	-0.689698	1.211622	0.000332
102	31.485199	-5.941235	0.591900	-0.683108	1.207726	0.000333
103	30.604050	-5.946396	0.589710	-0.676164	1.203641	0.000324
104	29.729080	-5.948131	0.587434	-0.668947	1.199393	0.000335
105	28.860626	-5.946407	0.585115	-0.661591	1.195081	0.000347
106	27.998978	-5.941193	0.582720	-0.653996	1.190655	0.000344
107	27.144455	-5.932426	0.580213	-0.646047	1.186038	0.000344
108	26.297394	-5.920048	0.577589	-0.637725	1.181223	0.000346
109	25.458069	-5.904007	0.574863	-0.629080	1.176234	0.000355
110	24.626831	-5.884267	0.572048	-0.620154	1.171107	0.000360
111	23.803986	-5.860794	0.569139	-0.610929	1.165832	0.000366
112	22.989822	-5.833555	0.566115	-0.601339	1.160374	0.000365
113	22.184692	-5.802505	0.562959	-0.591331	1.154706	0.000363
114	21.388901	-5.767619	0.559711	-0.581032	1.148887	0.000375
115	20.602753	-5.728903	0.556408	-0.570558	1.142996	0.000387
116	19.826538	-5.686358	0.553018	-0.559808	1.136984	0.000388
117	19.060608	-5.639968	0.549483	-0.548595	1.130742	0.000392
118	18.305237	-5.589691	0.545755	-0.536774	1.124197	0.000388
119	17.560776	-5.535499	0.541856	-0.524409	1.117376	0.000394
120	16.827515	-5.477386	0.537835	-0.511659	1.110376	0.000401
121	16.105759	-5.415383	0.533742	-0.498679	1.103277	0.000420
122	15.395823	-5.349519	0.529547	-0.485378	1.096050	0.000422
123	14.697994	-5.279799	0.525179	-0.471525	1.088564	0.000423
124	14.012589	-5.206223	0.520607	-0.457027	1.080763	0.000430
125	13.339911	-5.128796	0.515832	-0.441882	1.072659	0.000435
126	12.680262	-5.047531	0.510867	-0.426140	1.064281	0.000438
127	12.033938	-4.962469	0.505780	-0.410006	1.055719	0.000463
128	11.401228	-4.873669	0.500575	-0.393501	1.047011	0.000483
129	10.782431	-4.781145	0.495083	-0.376086	1.037914	0.000455
130	10.177848	-4.684890	0.489298	-0.357740	1.028341	0.000472
131	9.587761	-4.584977	0.483379	-0.338971	1.018574	0.000521
132	9.012450	-4.481469	0.477214	-0.319419	1.008509	0.000505
133	8.452214	-4.374364	0.470651	-0.298606	0.997841	0.000500
134	7.907336	-4.263697	0.463759	-0.276752	0.986667	0.000535
135	7.378089	-4.149546	0.456574	-0.253968	0.975097	0.000550
136	6.864746	-4.031963	0.449031	-0.230048	0.963017	0.000563
137	6.367586	-3.910989	0.441048	-0.204730	0.950308	0.000563
138	5.886880	-3.786671	0.432655	-0.178115	0.936994	0.000591
139	5.422886	-3.659085	0.423889	-0.150318	0.923135	0.000641
140	4.975878	-3.528265	0.414469	-0.120446	0.908395	0.000607
141	4.546138	-3.394206	0.404257	-0.088060	0.892450	0.000612
142	4.133910	-3.257002	0.393534	-0.054057	0.875698	0.000702
143	3.739435	-3.116738	0.382118	-0.017854	0.858032	0.000690
144	3.363000	-2.973392	0.369640	0.021715	0.838797	0.000669
145	3.004866	-2.826992	0.356179	0.064403	0.818017	0.000733
146	2.665271	-2.677608	0.341648	0.110483	0.795675	0.000740
147	2.344483	-2.525252	0.325764	0.160853	0.771289	0.000725
148	2.042769	-2.369932	0.308405	0.215901	0.744566	0.000737
149	1.760388	-2.211676	0.289453	0.276003	0.715293	0.000734
150	1.497621	-2.050486	0.268700	0.341814	0.683012	0.000726
151	1.254779	-1.886312	0.245835	0.414322	0.647075	0.000680
152	1.032200	-1.719143	0.220703	0.494019	0.606844	0.000634
153	0.830213	-1.548982	0.193400	0.580602	0.561895	0.000618
154	0.649191	-1.375844	0.164027	0.673748	0.511579	0.000595
155	0.489575	-1.199747	0.132891	0.772487	0.455056	0.000558
156	0.351844	-1.020777	0.100821	0.874186	0.391832	0.000418
157	0.236489	-0.839120	0.069439	0.973704	0.321663	0.000282
158	0.143964	-0.655104	0.041053	1.063720	0.244779	0.000229
159	0.074616	-0.469198	0.018476	1.135314	0.162246	0.000273
160	0.028571	-0.281985	0.004575	1.179398	0.077357	0.000402

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-3
	NACA 0012: MACH = 0.85, ALPHA = 1			

161	0.005686	-0.094065	0.001392	1.189491	0.336420	0.000466
162	0.005686	0.094065	0.009662	1.163265	0.115899	0.000319
163	0.028571	0.281985	0.029076	1.101703	0.205505	0.000071
164	0.074616	0.469198	0.057966	1.010086	0.293641	-0.000126
165	0.143964	0.655104	0.093505	0.897386	0.377433	-0.000154
166	0.236489	0.839120	0.132403	0.774033	0.455056	-0.000003
167	0.351844	1.020777	0.171807	0.649078	0.525780	0.000160
168	0.489575	1.199747	0.209562	0.529349	0.589214	0.000215
169	0.649191	1.375844	0.244669	0.418020	0.645675	0.000303
170	0.830213	1.548982	0.276724	0.316367	0.695860	0.000436
171	1.032200	1.719143	0.305637	0.224679	0.740543	0.000509
172	1.254779	1.886312	0.331594	0.142366	0.780385	0.000591
173	1.497621	2.050480	0.354696	0.069106	0.815797	0.000670
174	1.760388	2.211676	0.375257	0.003903	0.847436	0.000692
175	2.042769	2.369932	0.393748	-0.054734	0.876026	0.000706
176	2.344483	2.525252	0.410479	-0.107791	0.902078	0.000692
177	2.665271	2.677608	0.425605	-0.155760	0.925767	0.000714
178	3.004866	2.826992	0.439274	-0.199104	0.947360	0.000711
179	3.363000	2.973392	0.451827	-0.238912	0.967417	0.000634
180	3.739435	3.116738	0.463374	-0.275530	0.986936	0.000661
181	4.133910	3.257002	0.473812	-0.308630	1.002813	0.000690
182	4.546138	3.394206	0.483543	-0.339491	1.018760	0.000587
183	4.975878	3.528265	0.492826	-0.368926	1.034081	0.000572
184	5.422886	3.659085	0.501360	-0.395990	1.048204	0.000622
185	5.886880	3.786671	0.509217	-0.420906	1.061387	0.000581
186	6.367586	3.910989	0.516679	-0.444570	1.073597	0.000551
187	6.864746	4.031963	0.523755	-0.467008	1.086025	0.000554
188	7.378089	4.149546	0.530426	-0.488163	1.097459	0.000548
189	7.907336	4.263697	0.536777	-0.508303	1.108430	0.000541
190	8.452214	4.374364	0.542892	-0.527695	1.119095	0.000506
191	9.012450	4.481469	0.548741	-0.546244	1.129342	0.000510
192	9.587761	4.584977	0.554226	-0.563636	1.139000	0.000542
193	10.177848	4.684890	0.559469	-0.580265	1.148356	0.000501
194	10.782431	4.781145	0.564603	-0.596545	1.157568	0.000476
195	11.401228	4.873669	0.569483	-0.612020	1.166337	0.000514
196	12.033938	4.962469	0.574089	-0.626627	1.174707	0.000505
197	12.680262	5.047531	0.578572	-0.640843	1.182916	0.000488
198	13.339911	5.128796	0.582942	-0.654701	1.190955	0.000487
199	14.012589	5.206223	0.587153	-0.668054	1.198751	0.000490
200	14.697994	5.279799	0.591197	-0.680878	1.206291	0.000488
201	15.395823	5.349519	0.595071	-0.693164	1.213556	0.000490
202	16.105759	5.415383	0.598791	-0.704960	1.220573	0.000495
203	16.827515	5.477386	0.602414	-0.716451	1.227462	0.000487
204	17.560776	5.535499	0.605973	-0.727737	1.234263	0.000482
205	18.305237	5.589691	0.609434	-0.738710	1.240914	0.000482
206	19.060608	5.639968	0.612756	-0.749247	1.247331	0.000492
207	19.826538	5.686358	0.615919	-0.759277	1.253478	0.000495
208	20.602753	5.728903	0.618954	-0.768902	1.259411	0.000497
209	21.388901	5.767619	0.621910	-0.778275	1.265224	0.000493
210	22.184692	5.802505	0.624818	-0.787498	1.270978	0.000486
211	22.989822	5.833555	0.627651	-0.796481	1.276600	0.000495
212	23.803986	5.860794	0.630372	-0.805110	1.282030	0.000504
213	24.626831	5.884267	0.632994	-0.813425	1.287294	0.000504
214	25.458069	5.904007	0.635535	-0.821483	1.292422	0.000504
215	26.297394	5.920048	0.638003	-0.829308	1.297426	0.000504
216	27.144455	5.932426	0.640388	-0.836871	1.302282	0.000510
217	27.998978	5.941193	0.642675	-0.844125	1.306964	0.000512
218	28.860626	5.946407	0.644867	-0.851077	1.311465	0.000521
219	29.729080	5.948131	0.646993	-0.857817	1.315858	0.000519
220	30.604050	5.946396	0.649084	-0.864449	1.320202	0.000510
221	31.485199	5.941235	0.651106	-0.870862	1.324405	0.000525
222	32.372223	5.932717	0.653033	-0.876970	1.328428	0.000536
223	33.264816	5.920918	0.654901	-0.882896	1.332360	0.000528
224	34.162659	5.905882	0.656716	-0.888652	1.336185	0.000533
225	35.065430	5.887674	0.658454	-0.894161	1.339851	0.000548
226	35.972839	5.866369	0.660146	-0.899529	1.343455	0.000541
227	36.884567	5.842010	0.661808	-0.904797	1.347003	0.000534
228	37.800293	5.814661	0.663369	-0.909750	1.350327	0.000561
229	38.719727	5.784445	0.664829	-0.914380	1.353461	0.000564
230	39.642548	5.751444	0.666263	-0.918926	1.356556	0.000557
231	40.568451	5.715693	0.667681	-0.923423	1.359621	0.000557
232	41.497131	5.677249	0.669054	-0.927777	1.362593	0.000563
233	42.428284	5.636191	0.670359	-0.931914	1.365420	0.000580
234	43.361603	5.592612	0.671607	-0.935874	1.368143	0.000582
235	44.296783	5.546580	0.672830	-0.939749	1.370825	0.000570
236	45.233521	5.498161	0.673997	-0.943452	1.373376	0.000585
237	46.171509	5.447458	0.675084	-0.946899	1.375756	0.000601
238	47.110458	5.394568	0.676146	-0.950266	1.378106	0.000590
239	48.050049	5.339531	0.677207	-0.953630	1.380450	0.000592
240	48.990005	5.282402	0.678228	-0.956870	1.382704	0.000608

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-4
	NACA 0012: MACH = 0.85, ALPHA = 1			

241	49.930000	5.223271	0.679209	-0.959979	1.384881	0.000608
242	50.869781	5.162216	0.680151	-0.962966	1.386983	0.000602
243	51.808990	5.099324	0.681015	-0.965708	1.388893	0.000630
244	52.747375	5.034718	0.681824	-0.968273	1.390697	0.000636
245	53.684616	4.968453	0.682676	-0.970976	1.392630	0.000607
246	54.620422	4.900533	0.683535	-0.973696	1.394544	0.000624
247	55.554504	4.831051	0.684296	-0.976112	1.396234	0.000658
248	56.486572	4.760140	0.685016	-0.978395	1.397865	0.000646
249	57.416321	4.687847	0.685755	-0.980739	1.399538	0.000640
250	58.343460	4.614206	0.686482	-0.983044	1.401174	0.000653
251	59.267700	4.539302	0.687178	-0.985251	1.402745	0.000662
252	60.188751	4.463216	0.687843	-0.987359	1.404256	0.000658
253	61.106308	4.386030	0.688456	-0.989303	1.405638	0.000675
254	62.020111	4.307839	0.689034	-0.991137	1.406945	0.000689
255	62.929840	4.228698	0.689662	-0.993126	1.408398	0.000660
256	63.835220	4.148601	0.690325	-0.995231	1.409907	0.000668
257	64.735947	4.067623	0.690911	-0.997089	1.411228	0.000695
258	65.631760	3.985905	0.691416	-0.998691	1.412377	0.000708
259	66.522354	3.903537	0.691915	-1.000272	1.413519	0.000712
260	67.407440	3.820540	0.692482	-1.002069	1.414843	0.000680
261	68.286728	3.736912	0.693082	-1.003972	1.416216	0.000692
262	69.159943	3.652738	0.693590	-1.005585	1.417353	0.000741
263	70.026794	3.568157	0.694054	-1.007054	1.418430	0.000728
264	70.887009	3.483205	0.694572	-1.008697	1.419640	0.000709
265	71.740265	3.397891	0.695094	-1.010353	1.420835	0.000725
266	72.586319	3.312301	0.695590	-1.011926	1.421969	0.000746
267	73.424866	3.226509	0.696091	-1.013515	1.423149	0.000723
268	74.255630	3.140560	0.696573	-1.015043	1.424247	0.000753
269	75.078339	3.054547	0.696999	-1.016394	1.425238	0.000752
270	75.892685	2.968552	0.697456	-1.017842	1.426287	0.000773
271	76.698410	2.882581	0.697960	-1.019443	1.427509	0.000705
272	77.495209	2.796670	0.698468	-1.021051	1.428607	0.000827
273	78.282837	2.710910	0.698914	-1.022467	1.429758	0.000673
274	79.060974	2.625375	0.699397	-1.023998	1.430700	0.000939
275	79.829376	2.540112	0.699829	-1.025369	1.432010	0.000517
276	80.587753	2.455165	0.700393	-1.027156	1.432869	0.001174
277	81.335815	2.370600	0.700744	-1.028271	1.434417	0.000147
278	82.073288	2.286501	0.701328	-1.030122	1.434602	0.001836
279	82.799927	2.202941	0.701560	-1.030857	1.436996	-0.000794
280	83.515427	2.119970	0.702561	-1.034033	1.436804	0.002838
281	84.219528	2.037631	0.701947	-1.032084	1.438582	-0.001757
282	84.911942	1.955977	0.696970	-1.016302	1.417163	0.012026
283	85.592407	1.875083	0.646388	-0.855898	1.285489	0.039329
284	86.260666	1.795019	0.511066	-0.426768	0.992154	0.082896
285	86.916428	1.715837	0.388143	-0.036961	0.797973	0.069197
286	87.559418	1.637572	0.319951	0.179289	0.708655	0.049351
287	88.189407	1.560317	0.328124	0.153369	0.717957	0.052825
288	88.806091	1.484191	0.325030	0.163182	0.713505	0.052307
289	89.409225	1.409214	0.322610	0.170856	0.709796	0.052095
290	89.998535	1.335393	0.320786	0.176640	0.706706	0.052186
291	90.573761	1.262822	0.318802	0.182932	0.703386	0.052246
292	91.134644	1.191594	0.316612	0.189877	0.699794	0.052248
293	91.680923	1.121780	0.314359	0.197020	0.696086	0.052257
294	92.212341	1.053459	0.312069	0.204283	0.692321	0.052259
295	92.728638	0.986685	0.309739	0.211671	0.688488	0.052261
296	93.229553	0.921482	0.307311	0.219372	0.684482	0.052268
297	93.714828	0.857903	0.304741	0.227522	0.680243	0.052269
298	94.184219	0.796038	0.302063	0.236013	0.675818	0.052271
299	94.637466	0.735998	0.299333	0.244671	0.671324	0.052254
300	95.074341	0.677854	0.296591	0.253365	0.666790	0.052246
301	95.494553	0.621635	0.293755	0.262360	0.662083	0.052246
302	95.897858	0.567390	0.290778	0.271800	0.657139	0.052240
303	96.284027	0.515193	0.287683	0.281614	0.651988	0.052234
304	96.652786	0.465119	0.284495	0.291725	0.646687	0.052214
305	97.003891	0.417216	0.281183	0.302227	0.641148	0.052207
306	97.337082	0.371551	0.277671	0.313365	0.635223	0.052227
307	97.652130	0.328249	0.274059	0.324821	0.629212	0.052168
308	97.948761	0.287339	0.270423	0.336350	0.623085	0.052154
309	98.226700	0.248813	0.266440	0.348982	0.616260	0.052205
310	98.485703	0.212798	0.262135	0.362632	0.609009	0.052142
311	98.725494	0.179389	0.257791	0.376409	0.601616	0.052111
312	98.945786	0.148593	0.253119	0.391222	0.593535	0.052143
313	99.146286	0.120481	0.247964	0.407571	0.584675	0.052102
314	99.326721	0.095145	0.242490	0.424931	0.575144	0.052099
315	99.486725	0.072632	0.236499	0.443929	0.564712	0.052039
316	99.625946	0.052983	0.229793	0.465193	0.552717	0.052121
317	99.744003	0.036276	0.221952	0.490058	0.538952	0.051931
318	99.840439	0.022620	0.213050	0.518290	0.522293	0.052251
319	99.914658	0.012110	0.201831	0.553865	0.502583	0.051570
320	99.965897	0.004846	0.188766	0.595297	0.475845	0.052743
321	99.992828	0.001020	0.164385	0.672613	0.427723	0.052393

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-5
	NACA 0012: MACH = 0.85, ALPHA = 1			

NACA 0012 M=0.85, ALPHA=1.00
RESULTS AT FAR-FIELD BOUNDARY

I	X/C(%)	Z/C(%)	RHO	U	V	P
2	1858.61133	-17.744659	0.999832	1.006464	0.016714	0.999579
3	1857.91431	-53.227142	0.999016	1.004526	0.016454	0.999322
4	1856.52051	-88.689102	0.999339	1.004735	0.016688	0.999584
5	1854.43018	-124.116882	0.999452	1.005510	0.016475	0.999475
6	1851.64453	-159.496811	0.999627	1.005664	0.016527	0.999606
7	1848.16479	-194.815277	0.999531	1.005485	0.016445	0.999561
8	1843.99170	-230.058624	0.999572	1.005387	0.016484	0.999630
9	1839.12720	-265.213135	0.999550	1.005359	0.016436	0.999617
10	1833.57324	-300.265625	0.999582	1.005331	0.016448	0.999657
11	1827.33203	-335.202393	0.999573	1.005298	0.016422	0.999658
12	1820.40576	-370.010010	0.999592	1.005270	0.016425	0.999684
13	1812.79712	-404.674805	0.999591	1.005242	0.016409	0.999691
14	1804.50928	-439.183838	0.999604	1.005217	0.016406	0.999712
15	1795.54541	-473.523682	0.999608	1.005189	0.016395	0.999723
16	1785.90869	-507.680908	0.999618	1.005164	0.016390	0.999741
17	1775.60303	-541.642334	0.999625	1.005137	0.016381	0.999756
18	1764.63257	-575.395264	0.999635	1.005111	0.016375	0.999773
19	1753.00122	-608.926514	0.999643	1.005084	0.016366	0.999790
20	1740.71387	-642.222900	0.999654	1.005056	0.016359	0.999808
21	1727.77466	-675.271973	0.999664	1.005029	0.016350	0.999827
22	1714.18921	-708.061035	0.999676	1.004999	0.016342	0.999847
23	1699.96240	-740.576904	0.999688	1.004971	0.016333	0.999867
24	1685.09985	-772.807617	0.999701	1.004940	0.016325	0.999889
25	1669.60718	-804.740723	0.999715	1.004909	0.016316	0.999912
26	1653.49072	-836.363770	0.999730	1.004878	0.016306	0.999936
27	1636.75610	-867.664551	0.999746	1.004845	0.016297	0.999961
28	1619.41016	-898.630859	0.999762	1.004811	0.016287	0.999988
29	1601.45972	-929.251221	0.999780	1.004776	0.016277	1.000015
30	1582.91113	-959.513672	0.999799	1.004741	0.016268	1.000044
31	1563.77222	-989.406494	0.999819	1.004704	0.016257	1.000074
32	1544.04980	-1018.91797	0.999839	1.004667	0.016247	1.000106
33	1523.75195	-1048.03735	0.999861	1.004629	0.016237	1.000139
34	1502.88623	-1076.75269	0.999884	1.004590	0.016227	1.000174
35	1481.46045	-1105.05347	0.999908	1.004550	0.016217	1.000209
36	1459.48340	-1132.92871	0.999933	1.004508	0.016207	1.000246
37	1436.96313	-1160.36768	0.999960	1.004466	0.016197	1.000285
38	1413.90845	-1187.35962	0.999987	1.004422	0.016187	1.000325
39	1390.32837	-1213.89429	1.000015	1.004378	0.016177	1.000366
40	1366.23169	-1239.96143	1.000045	1.004333	0.016168	1.000409
41	1341.62793	-1265.55127	1.000076	1.004286	0.016159	1.000454
42	1316.52637	-1290.65356	1.000108	1.004239	0.016150	1.000499
43	1290.93701	-1315.25903	1.000141	1.004190	0.016142	1.000546
44	1264.86914	-1339.35791	1.000175	1.004141	0.016135	1.000594
45	1238.33325	-1362.94116	1.000210	1.004090	0.016128	1.000644
46	1211.33960	-1385.99951	1.000245	1.004041	0.016123	1.000694
47	1183.89819	-1408.52441	1.000281	1.003989	0.016118	1.000746
48	1156.01978	-1430.50684	1.000319	1.003937	0.016114	1.000798
49	1127.71509	-1451.93848	1.000357	1.003884	0.016111	1.000851
50	1098.99512	-1472.81104	1.000395	1.003831	0.016110	1.000904
51	1069.87085	-1493.11670	1.000434	1.003778	0.016111	1.000958
52	1040.35327	-1512.84741	1.000472	1.003725	0.016112	1.001012
53	1010.45386	-1531.99585	1.000511	1.003673	0.016116	1.001066
54	980.184326	-1550.55444	1.000549	1.003620	0.016122	1.001120
55	949.556152	-1568.51587	1.000587	1.003571	0.016129	1.001172
56	918.581055	-1585.87378	1.000624	1.003520	0.016139	1.001224
57	887.270996	-1602.62109	1.000660	1.003472	0.016151	1.001273
58	855.637939	-1618.75122	1.000695	1.003426	0.016165	1.001321
59	823.694092	-1634.25830	1.000728	1.003382	0.016182	1.001367
60	791.451904	-1649.13647	1.000759	1.003341	0.016202	1.001410
61	758.923340	-1663.37964	1.000788	1.003304	0.016224	1.001450
62	726.121338	-1676.98242	1.000814	1.003268	0.016248	1.001486
63	693.058350	-1689.93945	1.000837	1.003239	0.016275	1.001517
64	659.747070	-1702.24609	1.000857	1.003214	0.016305	1.001545
65	626.200195	-1713.89746	1.000875	1.003192	0.016337	1.001568
66	592.430908	-1724.88916	1.000888	1.003177	0.016371	1.001586
67	558.451904	-1735.21655	1.000897	1.003166	0.016408	1.001598
68	524.276367	-1744.87622	1.000904	1.003160	0.016446	1.001606
69	489.917236	-1753.86377	1.000906	1.003161	0.016486	1.001608
70	455.367939	-1762.17651	1.000904	1.003167	0.016527	1.001605
71	420.701904	-1769.81055	1.000899	1.003179	0.016568	1.001596
72	385.872070	-1776.76318	1.000892	1.003195	0.016611	1.001584
73	350.911865	-1783.03198	1.000881	1.003216	0.016654	1.001567
74	315.834961	-1788.61426	1.000868	1.003242	0.016697	1.001546
75	280.654541	-1793.50757	1.000853	1.003271	0.016739	1.001523
76	245.384491	-1797.71045	1.000837	1.003303	0.016781	1.001498
77	210.038055	-1801.22119	1.000822	1.003336	0.016822	1.001473
78	174.628922	-1804.03833	1.000807	1.003372	0.016862	1.001448
79	139.170700	-1806.16089	1.000787	1.003416	0.016901	1.001414
80	103.677017	-1807.58765	1.000776	1.003452	0.016939	1.001393

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-6
	NACA 0012: MACH = 0.85, ALPHA = 1			

81	68.161499	-1808.31836	1.000817	1.003430	0.016973	1.001441
82	32.637817	-1808.35278	1.000829	1.003401	0.016990	1.001461
83	-2.880385	-1807.69067	1.000847	1.003393	0.017019	1.001481
84	-38.379456	-1806.33203	1.000853	1.003383	0.017042	1.001491
85	-73.845734	-1804.27783	1.000864	1.003377	0.017068	1.001503
86	-109.265610	-1801.52856	1.000873	1.003368	0.017094	1.001514
87	-144.625443	-1798.08545	1.000885	1.003360	0.017121	1.001529
88	-179.911652	-1793.94946	1.000896	1.003350	0.017148	1.001543
89	-215.110641	-1789.12231	1.000912	1.003339	0.017177	1.001560
90	-250.208893	-1783.60596	1.000926	1.003327	0.017206	1.001578
91	-285.192871	-1777.40210	1.000942	1.003315	0.017237	1.001598
92	-320.049072	-1770.51343	1 000959	1.003302	0.017269	1.001618
93	-354.764160	-1762.94238	1.000977	1.003289	0.017301	1.001639
94	-389.324951	-1754.69189	1.000994	1.003277	0.017335	1.001660
95	-423.717773	-1745.76514	1.001011	1.003265	0.017370	1.001680
96	-457.929687	-1736.16553	1.001028	1.003254	0.017406	1.001700
97	-491.947510	-1725.89648	1.001044	1.003243	0.017443	1.001719
98	-525.757812	-1714.96191	1.001059	1.003237	0.017480	1.001737
99	-559.347900	-1703.36621	1.001073	1.003229	0.017518	1.001752
100	-592.704834	-1691.11377	1.001085	1.003225	0.017556	1.001765
101	-625.815430	-1678.20923	1.001097	1.003222	0.017594	1.001777
102	-658.667480	-1664.65723	1.001106	1.003222	0 017633	1.001787
103	-691.247803	-1650.46313	1.001115	1.003222	0.017671	1.001794
104	-723.543945	-1635.63257	1.001122	1.003226	0.017710	1.001800
105	-755.543701	-1620.17090	1.001126	1.003232	0.017748	1.001802
106	-787.234375	-1604.08423	1.001129	1.003240	0.017785	1.001804
107	-818.604248	-1587.37842	1.001132	1.003249	0.017823	1.001802
108	-849.640625	-1570.06030	1.001132	1.003261	0.017859	1.001800
109	-880.332031	-1552.13599	1.001131	1.003274	0.017896	1.001795
110	-910.666504	-1533.61255	1.001129	1.003288	0.017931	1.001788
111	-940.632080	-1514.49731	1.001125	1.003304	0.017966	1.001781
112	-970.217285	-1494.79712	1.001122	1.003322	0.018000	1.001770
113	-999.410889	-1474.52002	1.001116	1.003341	0.018033	1.001760
114	-1028.20142	-1453.67334	1.001109	1.003361	0.018066	1.001746
115	-1056.57764	-1432.26514	1.001101	1.003383	0.018098	1.001733
116	-1084.52905	-1410.30371	1.001093	1.003405	0.018129	1.001718
117	-1112.04443	-1387.79785	1.001084	1.003428	0.018159	1.001702
118	-1139.11328	-1364.75537	1.001075	1.003451	0.018189	1.001685
119	-1165.72534	-1341.18579	1.001064	1.003475	0.018218	1.001668
120	-1191.86987	-1317.09790	1.001053	1.003501	0.018246	1.001650
121	-1217.53711	-1292.50098	1.001041	1.003527	0.018273	1.001631
122	-1242.71680	-1267.40430	1.001030	1.003552	0.018300	1.001611
123	-1267.39966	-1241.81763	1.001018	1.003579	0.018326	1.001592
124	-1291.57593	-1215.75098	1.001005	1.003606	0.018351	1.001571
125	-1315.23608	-1189.21387	1.000993	1.003633	0.018376	1.001551
126	-1338.37109	-1162.21704	1.000979	1.003660	0.018400	1.001529
127	-1360.97217	-1134.77051	1.000966	1.003688	0.018424	1.001508
128	-1383.03027	-1106.88501	1.000953	1.003716	0.018447	1.001487
129	-1404.53711	-1078.57129	1.000939	1.003743	0.018469	1.001465
130	-1425.48413	-1049.84009	1.000926	1.003772	0.018491	1.001443
131	-1445.86328	-1020.70239	1.000912	1.003800	0.018513	1.001421
132	-1465.66675	-991.169678	1.000898	1.003828	0.018534	1.001399
133	-1484.88672	-961.252930	1.000884	1.003857	0.018554	1.001377
134	-1503.51587	-930.964111	1.000871	1.003884	0.018575	1.001355
135	-1521.54687	-900.314453	1.000856	1.003913	0.018595	1.001332
136	-1538.97290	-869.316162	1.000843	1.003941	0.018614	1.001310
137	-1555.78711	-837.980713	1.000829	1.003969	0.018633	1.001288
138	-1571.98291	-806.320557	1.000814	1.003998	0.018652	1.001266
139	-1587.55420	-774.347656	1.000801	1.004025	0.018671	1.001244
140	-1602.49463	-742.074463	1.000787	1.004054	0.018689	1.001222
141	-1616.79858	-709.513184	1.000773	1.004082	0.018707	1.001200
142	-1630.46045	-676.676514	1.000759	1.004111	0.018724	1.001178
143	-1643.47510	-643.577393	1.000746	1.004139	0.018742	1.001156
144	-1655.83716	-610.228027	1.000731	1.004168	0.018759	1.001134
145	-1667.54175	-576.641357	1.000718	1.004196	0.018776	1.001111
146	-1678.58472	-542.830811	1.000704	1.004225	0.018792	1.001089
147	-1688.96143	-508.808838	1.000690	1.004253	0.018809	1.001067
148	-1698.66748	-474.588623	1.000677	1.004281	0.018825	1.001045
149	-1707.69946	-440.183838	1.000663	1.004311	0.018841	1.001023
150	-1716.05347	-405.606934	1.000649	1.004339	0.018857	1.001001
151	-1723.72607	-370.872070	1.000636	1.004368	0.018872	1.000979
152	-1730.71387	-335.991943	1.000623	1.004396	0.018887	1.000957
153	-1737.01343	-300.980225	1.000608	1.004426	0.018902	1.000936
154	-1742.62231	-265.850586	1.000595	1.004456	0.018917	1.000914
155	-1747.53711	-230.616425	1.000582	1.004484	0.018932	1.000892
156	-1751.75513	-195.291397	1.000568	1.004514	0.018947	1.000870
157	-1755.27344	-159.889282	1.000555	1.004542	0.018961	1.000847
158	-1758.09009	-124.423950	1.000541	1.004573	0.018975	1.000825
159	-1760.20288	-88.909393	1.000527	1.004602	0.018989	1.000803
160	-1761.61133	-53.359665	1.000514	1.004631	0.019003	1.000781

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-7
	NACA 0012: MACH = 0.85, ALPHA = 1			

161	-1762.31494	-17.788895	1.000500	1.004659	0.019016	1.000759
162	-1762.31494	17.788895	1.000485	1.004684	0.019030	1.000736
163	-1761.61133	53.359665	1.000470	1.004711	0.019044	1.000714
164	-1760.20288	88.909393	1.000455	1.004737	0.019058	1.000691
165	-1758.09009	124.423950	1.000440	1.004764	0.019073	1.000669
166	-1755.27344	159.889282	1.000423	1.004790	0.019088	1.000645
167	-1751.75513	195.291397	1.000408	1.004817	0.019103	1.000621
168	-1747.53711	230.616425	1.000392	1.004846	0.019119	1.000597
169	-1742.62231	265.850586	1.000376	1.004873	0.019135	1.000572
170	-1737.01343	300.980225	1.000360	1.004902	0.019151	1.000547
171	-1730.71387	335.991943	1.000342	1.004931	0.019167	1.000523
172	-1723.72607	370.872070	1.000325	1.004961	0.019184	1.000496
173	-1716.05347	405.606934	1.000307	1.004992	0.019201	1.000469
174	-1707.69946	440.183838	1.000289	1.005024	0.019219	1.000443
175	-1698.66748	474.588623	1.000270	1.005056	0.019236	1.000414
176	-1688.96143	508.808838	1.000251	1.005090	0.019254	1.000385
177	-1678.58472	542.830811	1.000232	1.005123	0.019272	1.000356
178	-1667.54175	576.641357	1.000211	1.005158	0.019291	1.000325
179	-1655.83716	610.228027	1.000190	1.005195	0.019310	1.000294
180	-1643.47510	643.577393	1.000168	1.005232	0.019329	1.000261
181	-1630.46045	676.676514	1.000146	1.005270	0.019348	1.000227
182	-1616.79858	709.513184	1.000122	1.005310	0.019368	1.000193
183	-1602.49463	742.074463	1.000098	1.005350	0.019388	1.000156
184	-1587.55420	774.347656	1.000072	1.005393	0.019409	1.000119
185	-1571.98291	806.320557	1.000047	1.005436	0.019430	1.000080
186	-1555.78711	837.980713	1.000019	1.005482	0.019451	1.000040
187	-1538.97290	869.316162	0.999991	1.005527	0.019472	0.999999
188	-1521.54687	900.314453	0.999962	1.005576	0.019494	0.999955
189	-1503.51587	930.964111	0.999931	1.005626	0.019516	0.999909
190	-1484.88672	961.252930	0.999899	1.005678	0.019538	0.999862
191	-1465.66675	991.169678	0.999865	1.005733	0.019561	0.999812
192	-1445.86328	1020.70239	0.999829	1.005789	0.019584	0.999761
193	-1425.48413	1049.84009	0.999792	1.005848	0.019607	0.999706
194	-1404.53711	1078.57129	0.999753	1.005909	0.019631	0.999650
195	-1383.03027	1106.88501	0.999712	1.005974	0.019655	0.999590
196	-1360.97217	1134.77051	0.999669	1.006041	0.019679	0.999528
197	-1338.37109	1162.21704	0.999624	1.006111	0.019703	0.999462
198	-1315.23608	1189.21387	0.999577	1.006185	0.019728	0.999394
199	-1291.57593	1215.75098	0.999526	1.006261	0.019753	0.999321
200	-1267.39966	1241.81763	0.999474	1.006341	0.019778	0.999245
201	-1242.71680	1267.40430	0.999418	1.006425	0.019803	0.999165
202	-1217.53711	1292.50098	0.999359	1.006514	0.019828	0.999081
203	-1191.86987	1317.09790	0.999297	1.006606	0.019854	0.998993
204	-1165.72534	1341.18579	0.999232	1.006704	0.019879	0.998899
205	-1139.11328	1364.75537	0.999163	1.006805	0.019904	0.998801
206	-1112.04443	1387.79785	0.999090	1.006913	0.019929	0.998697
207	-1084.52905	1410.30371	0.999013	1.007027	0.019953	0.998587
208	-1056.57764	1432.26514	0.998931	1.007145	0.019977	0.998472
209	-1028.20142	1453.67334	0.998846	1.007269	0.020000	0.998350
210	-999.410889	1474.52002	0.998755	1.007401	0.020023	0.998221
211	-970.217285	1494.79712	0.998659	1.007538	0.020044	0.998086
212	-940.632080	1514.49731	0.998558	1.007683	0.020064	0.997943
213	-910.666504	1533.61255	0.998452	1.007835	0.020082	0.997793
214	-880.332031	1552.13599	0.998340	1.007996	0.020099	0.997636
215	-849.640625	1570.06030	0.998223	1.008162	0.020113	0.997470
216	-818.604248	1587.37842	0.998099	1.008337	0.020125	0.997297
217	-787.234375	1604.08423	0.997970	1.008520	0.020134	0.997115
218	-755.543701	1620.17090	0.997835	1.008711	0.020139	0.996925
219	-723.543945	1635.63257	0.997694	1.008910	0.020140	0.996727
220	-691.247803	1650.46313	0.997548	1.009115	0.020137	0.996522
221	-658.667480	1664.65723	0.997396	1.009329	0.020128	0.996309
222	-625.815430	1678.20923	0.997240	1.009549	0.020114	0.996090
223	-592.704834	1691.11377	0.997079	1.009774	0.020094	0.995864
224	-559.347900	1703.36621	0.996915	1.010004	0.020067	0.995635
225	-525.757812	1714.96191	0.996749	1.010239	0.020032	0.995401
226	-491.947510	1725.89648	0.996580	1.010474	0.019989	0.995165
227	-457.929687	1736.16553	0.996412	1.010714	0.019938	0.994929
228	-423.717773	1745.76514	0.996242	1.010949	0.019878	0.994692
229	-389.324951	1754.69189	0.996077	1.011186	0.019808	0.994459
230	-354.764160	1762.94238	0.995913	1.011414	0.019729	0.994230
231	-320.049072	1770.51343	0.995758	1.011638	0.019640	0.994012
232	-285.192871	1777.40210	0.995607	1.011848	0.019541	0.993801
233	-250.208893	1783.60596	0.995471	1.012052	0.019432	0.993607
234	-215.110641	1789.12231	0.995337	1.012233	0.019315	0.993422
235	-179.911652	1793.94946	0.995227	1.012411	0.019189	0.993261
236	-144.625443	1798.08545	0.995109	1.012560	0.019056	0.993101
237	-109.265610	1801.52856	0.995023	1.012722	0.018918	0.992969
238	-73.845734	1804.27783	0.994889	1.012854	0.018776	0.992799
239	-38.379456	1806.33203	0.994784	1.013076	0.018630	0.992631
240	-2.880385	1807.69067	0.994497	1.013309	0.018483	0.992277

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-8
	NACA 0012: MACH = 0.85, ALPHA = 1			

241	32.637817	1808.35278	0.994245	1.013785	0.018326	0.991890
242	68.161499	1808.31836	0.994489	1.013674	0.018166	0.992165
243	103.677017	1807.58765	0.994807	1.013453	0.018017	0.992547
244	139.170700	1806.16089	0.995065	1.013285	0.017875	0.992854
245	174.628922	1804.03833	0.995300	1.013130	0.017740	0.993133
246	210.038055	1801.22119	0.995536	1.012959	0.017612	0.993419
247	245.384491	1797.71045	0.995779	1.012767	0.017492	0.993717
248	280.654541	1793.50757	0.996030	1.012556	0.017383	0.994029
249	315.834961	1788.61426	0.996292	1.012322	0.017284	0.994357
250	350.911865	1783.03198	0.996561	1.012071	0.017197	0.994698
251	385.872070	1776.76318	0.996830	1.011810	0.017120	0.995043
252	420.701904	1769.81055	0.997092	1.011551	0.017051	0.995379
253	455.387939	1762.17651	0.997340	1.011299	0.016989	0.995699
254	489.917236	1753.86377	0.997571	1.011060	0.016933	0.995999
255	524.276367	1744.87622	0.997787	1.010834	0.016880	0.996280
256	558.451904	1735.21655	0.997989	1.010617	0.016833	0.996544
257	592.430908	1724.88916	0.998178	1.010409	0.016789	0.996794
258	626.200195	1713.89746	0.998358	1.010209	0.016749	0.997030
259	659.747070	1702.24609	0.998526	1.010016	0.016712	0.997254
260	693.058350	1689.93945	0.998683	1.009831	0.016678	0.997464
261	726.121338	1676.98242	0.998829	1.009656	0.016646	0.997661
262	758.923340	1663.37964	0.998964	1.009489	0.016615	0.997844
263	791.451904	1649.13647	0.999088	1.009331	0.016585	0.998013
264	823.694092	1634.25830	0.999202	1.009181	0.016556	0.998170
265	855.637939	1618.75122	0.999306	1.009038	0.016528	0.998315
266	887.270996	1602.62109	0.999400	1.008904	0.016500	0.998449
267	918.581055	1585.87378	0.999486	1.008775	0.016472	0.998572
268	949.556152	1568.51587	0.999564	1.008653	0.016444	0.998684
269	980.184326	1550.55444	0.999634	1.008537	0.016416	0.998788
270	1010.45386	1531.99585	0.999696	1.008427	0.016387	0.998882
271	1040.35327	1512.84741	0.999752	1.008321	0.016359	0.998968
272	1069.87085	1493.11670	0.999801	1.008220	0.016330	0.999046
273	1098.99512	1472.81104	0.999844	1.008123	0.016301	0.999117
274	1127.71509	1451.93848	0.999882	1.008030	0.016272	0.999182
275	1156.01978	1430.50684	0.999914	1.007941	0.016243	0.999240
276	1183.89819	1408.52441	0.999942	1.007854	0.016214	0.999293
277	1211.33960	1385.99951	0.999966	1.007771	0.016185	0.999341
278	1238.33325	1362.94116	0.999985	1.007690	0.016156	0.999383
279	1264.86914	1339.35791	1.000000	1.007613	0.016127	0.999422
280	1290.93701	1315.25903	1.000012	1.007536	0.016098	0.999456
281	1316.52637	1290.65356	1.000021	1.007463	0.016070	0.999487
282	1341.62793	1265.55127	1.000028	1.007389	0.016042	0.999514
283	1366.23169	1239.96143	1.000031	1.007318	0.016015	0.999538
284	1390.32837	1213.89429	1.000031	1.007248	0.015988	0.999559
285	1413.90845	1187.35962	1.000031	1.007178	0.015961	0.999577
286	1436.96313	1160.36768	1.000027	1.007112	0.015936	0.999593
287	1459.48340	1132.92871	1.000022	1.007045	0.015911	0.999607
288	1481.46045	1105.05347	1.000014	1.006980	0.015887	0.999619
289	1502.88623	1076.75269	1.000006	1.006916	0.015863	0.999629
290	1523.75195	1048.03735	0.999996	1.006851	0.015841	0.999637
291	1544.04980	1018.91797	0.999985	1.006788	0.015819	0.999644
292	1563.77222	989.406494	0.999973	1.006727	0.015798	0.999649
293	1582.91113	959.513672	0.999959	1.006666	0.015779	0.999654
294	1601.45972	929.251221	0.999945	1.006607	0.015760	0.999657
295	1619.41016	898.630859	0.999930	1.006549	0.015742	0.999658
296	1636.75610	867.664551	0.999915	1.006492	0.015726	0.999659
297	1653.49072	836.363770	0.999899	1.006435	0.015710	0.999660
298	1669.60718	804.740723	0.999882	1.006382	0.015696	0.999659
299	1685.09985	772.807617	0.999866	1.006329	0.015683	0.999658
300	1699.96240	740.576904	0.999850	1.006279	0.015671	0.999656
301	1714.18921	708.061035	0.999833	1.006230	0.015660	0.999653
302	1727.77466	675.271973	0.999818	1.006186	0.015650	0.999650
303	1740.71387	642.222900	0.999801	1.006145	0.015642	0.999646
304	1753.00122	608.926514	0.999787	1.006107	0.015634	0.999643
305	1764.63257	575.395264	0.999771	1.006074	0.015627	0.999637
306	1775.60303	541.642334	0.999758	1.006042	0.015619	0.999632
307	1785.90869	507.680908	0.999740	1.006015	0.015612	0.999623
308	1795.54541	473.523682	0.999726	1.005985	0.015600	0.999617
309	1804.50928	439.183838	0.999700	1.005948	0.015591	0.999602
310	1812.79712	404.674805	0.999677	1.005894	0.015567	0.999594
311	1820.40576	370.010010	0.999625	1.005802	0.015550	0.999569
312	1827.33203	335.202393	0.999572	1.005650	0.015504	0.999560
313	1833.57324	300.265625	0.999450	1.005372	0.015475	0.999517
314	1839.12720	265.213135	0.999307	1.004897	0.015389	0.999511
315	1843.99170	230.058624	0.999023	1.004160	0.015361	0.999439
316	1848.16479	194.815277	0.998700	1.002988	0.015242	0.999451
317	1851.64453	159.496811	0.997931	1.000706	0.015226	0.999334
318	1854.43018	124.116882	0.996845	0.996637	0.015045	0.999405
319	1856.52051	88.689102	0.995264	0.991694	0.015351	0.999215
320	1857.91431	53.227142	0.994637	0.988609	0.015580	0.999453
321	1858.61133	17.744659	0.994403	0.988770	0.016514	0.999168
322	1593.30811	262.947021	0.999832	1.006464	0.016714	0.999579

DORNIER/JAMESON	AR 211		W Schmidt A Jameson	02-9-9
	NACA 0012: MACH = 0.85, ALPHA = 1			

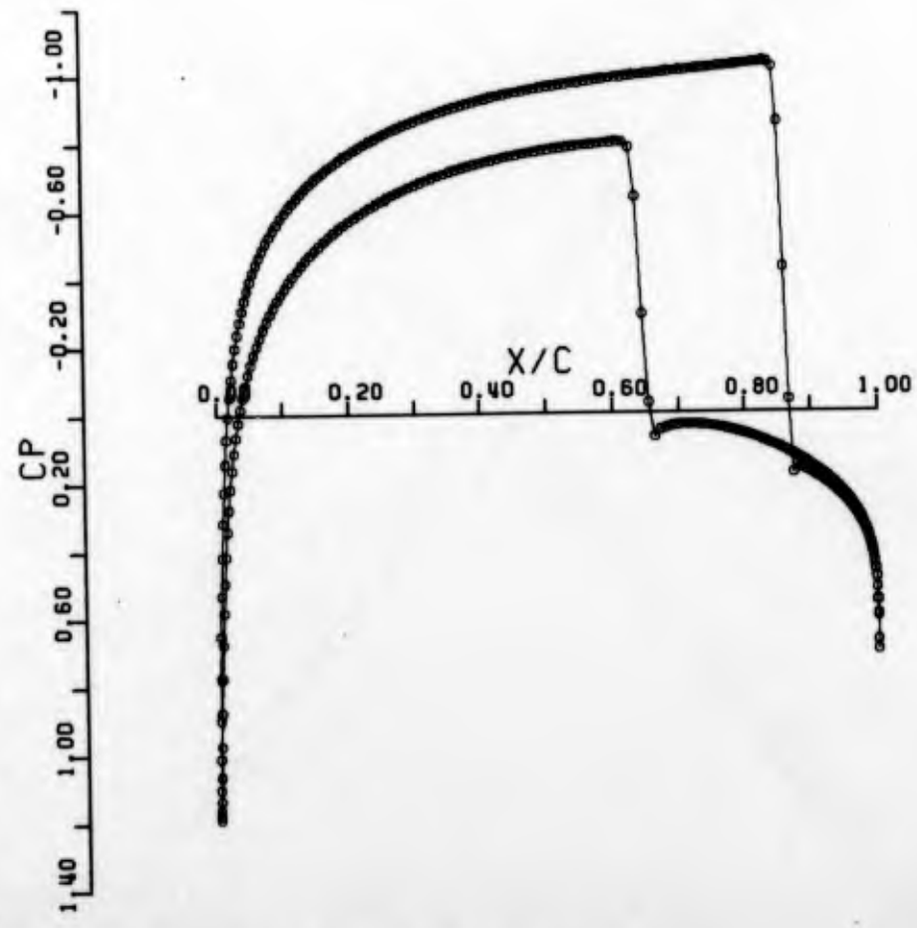


FIG. : CP(X/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-10
	NACA 0012: MACH = 0.85, ALPHA = 1			

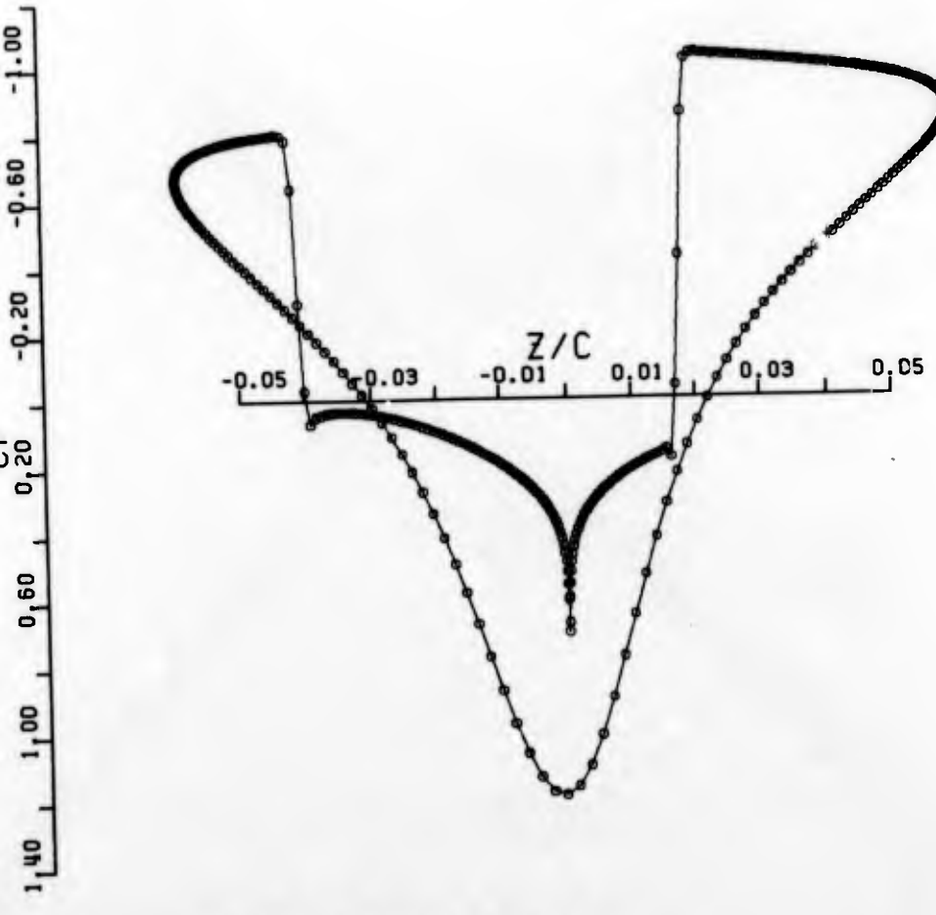


FIG. : CP(Z/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-11
	NACA 0012: MACH = 0.85, ALPHA = 1			

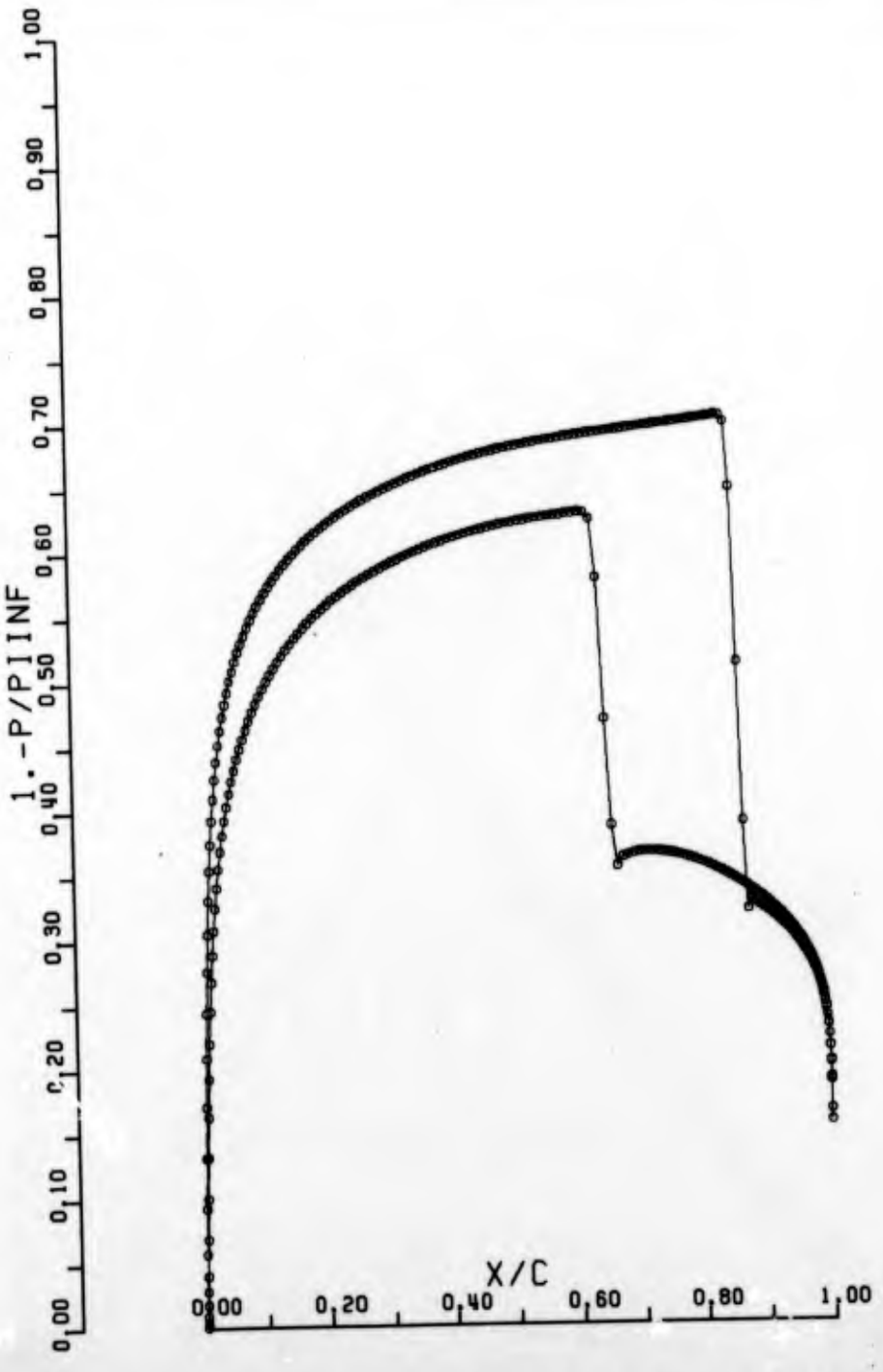


FIG. : 1.-P/PIINF VS. X/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-12
	NACA 0012: MACH = 0.85, ALPHA = 1			

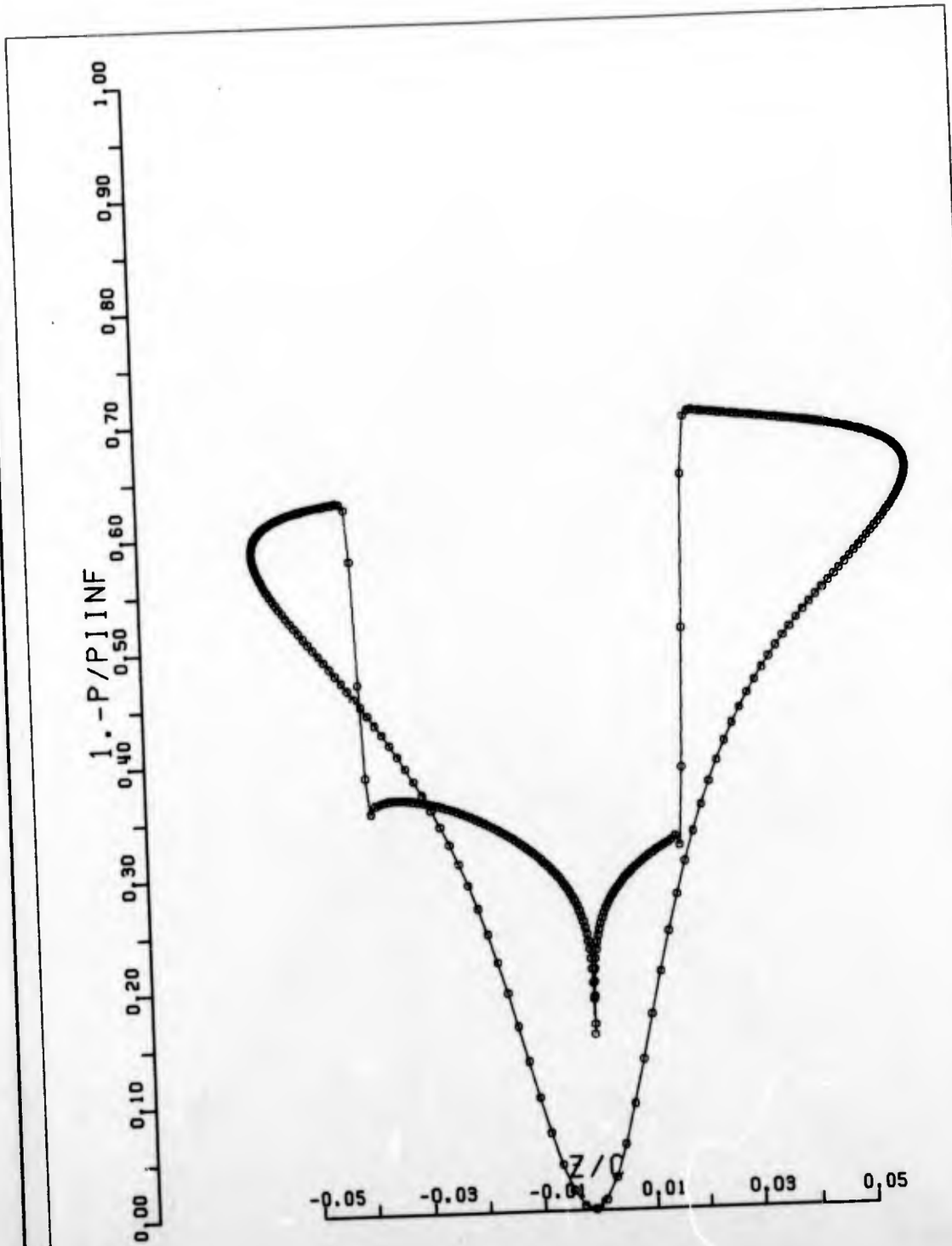


FIG. : 1.-P/PIINF VS. Z/C ON NACA 0012

DORNIER JAMESON	AR 211		W.Schmidt A.Jameson	02-9-13
	NACA 0012: MACH = 0.85, ALPHA = 1			

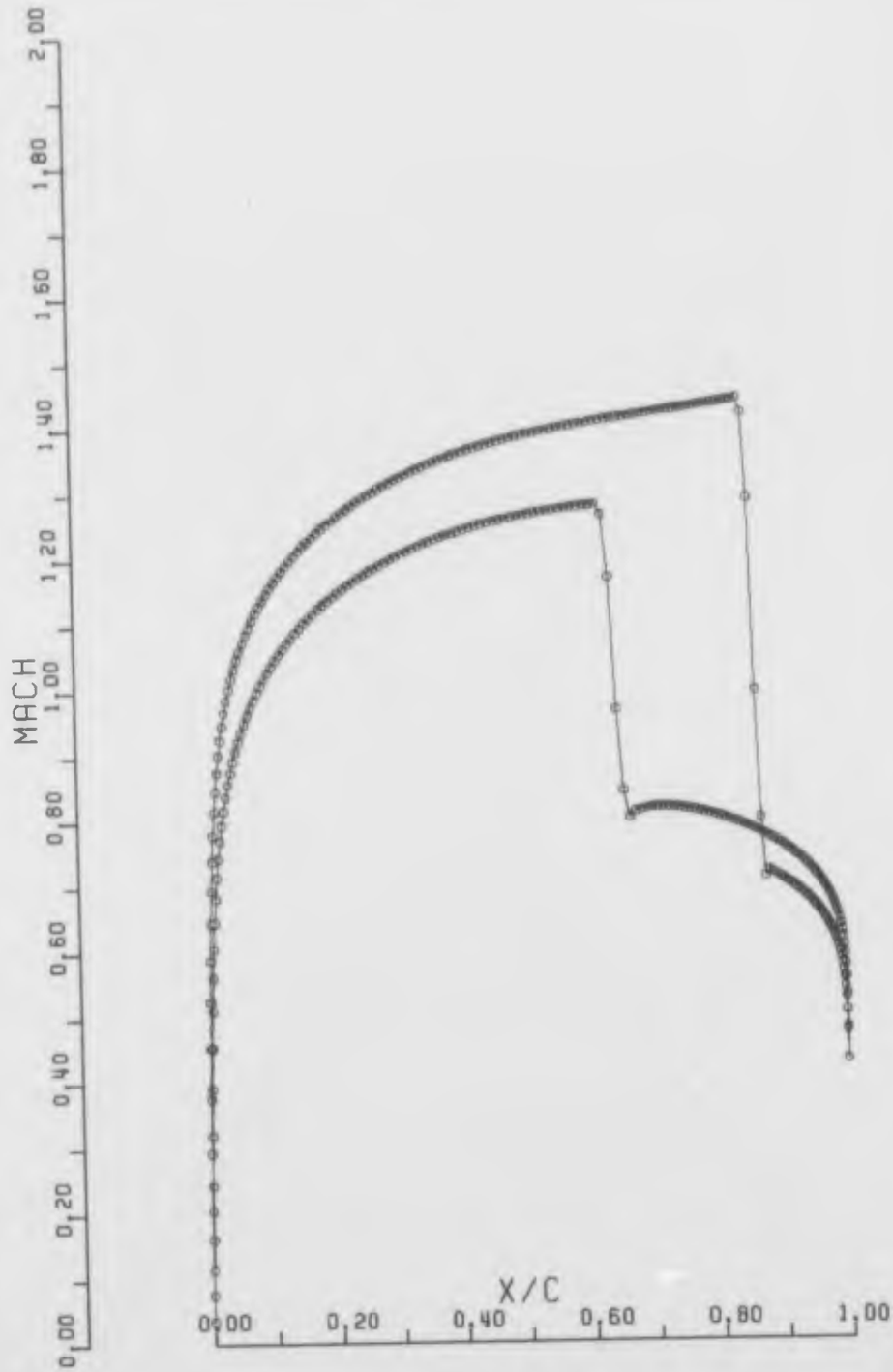


FIG. : MACH(X/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W Schmidt A Jameson	02-9-14
	NACA 0012: MACH = 0.85, ALPHA = 1			

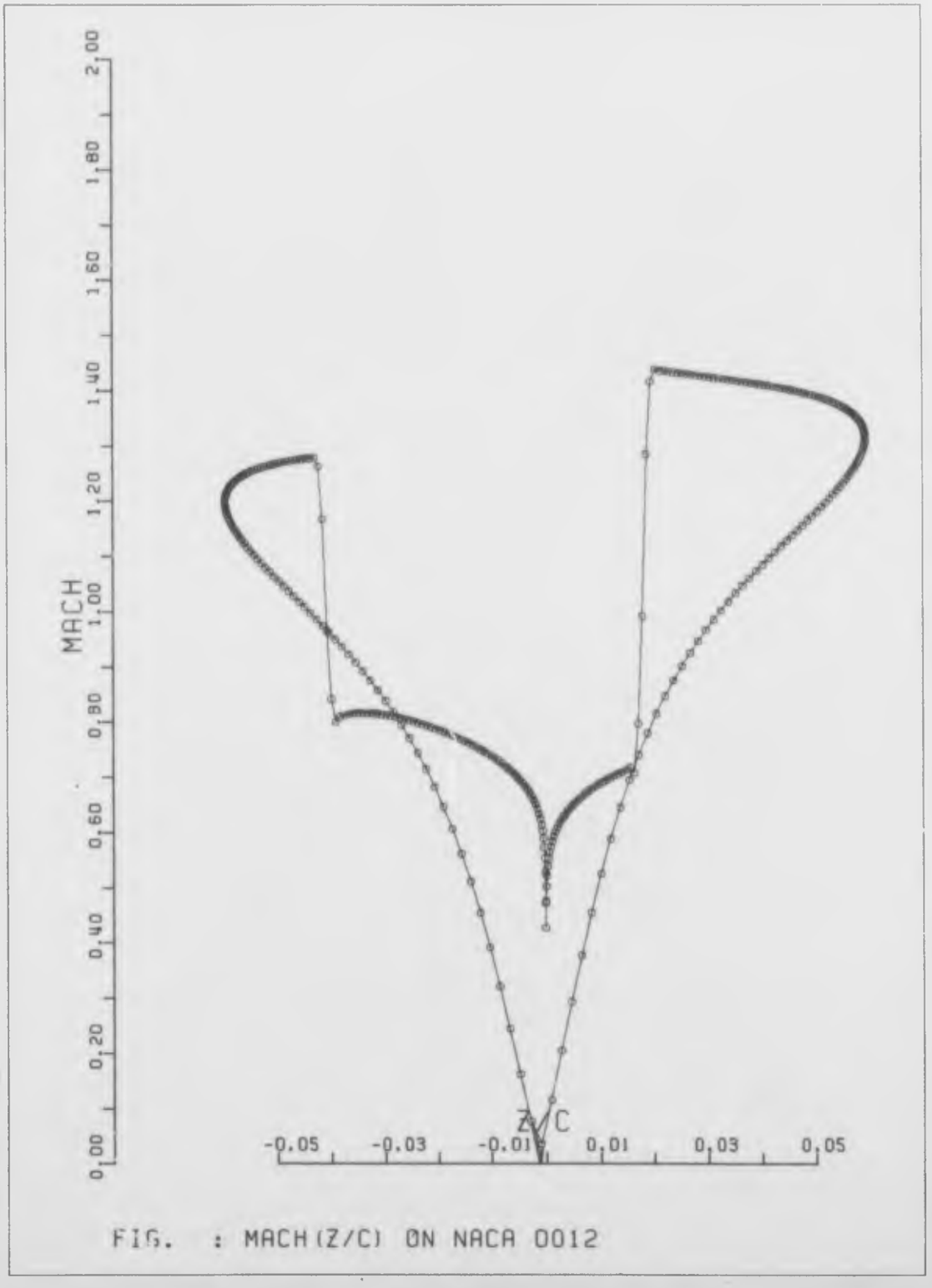


FIG. : MACH(Z/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W Schmidt A Jameson	02-9-15
	NACA 0012: MACH = 0.85, ALPHA = 1			

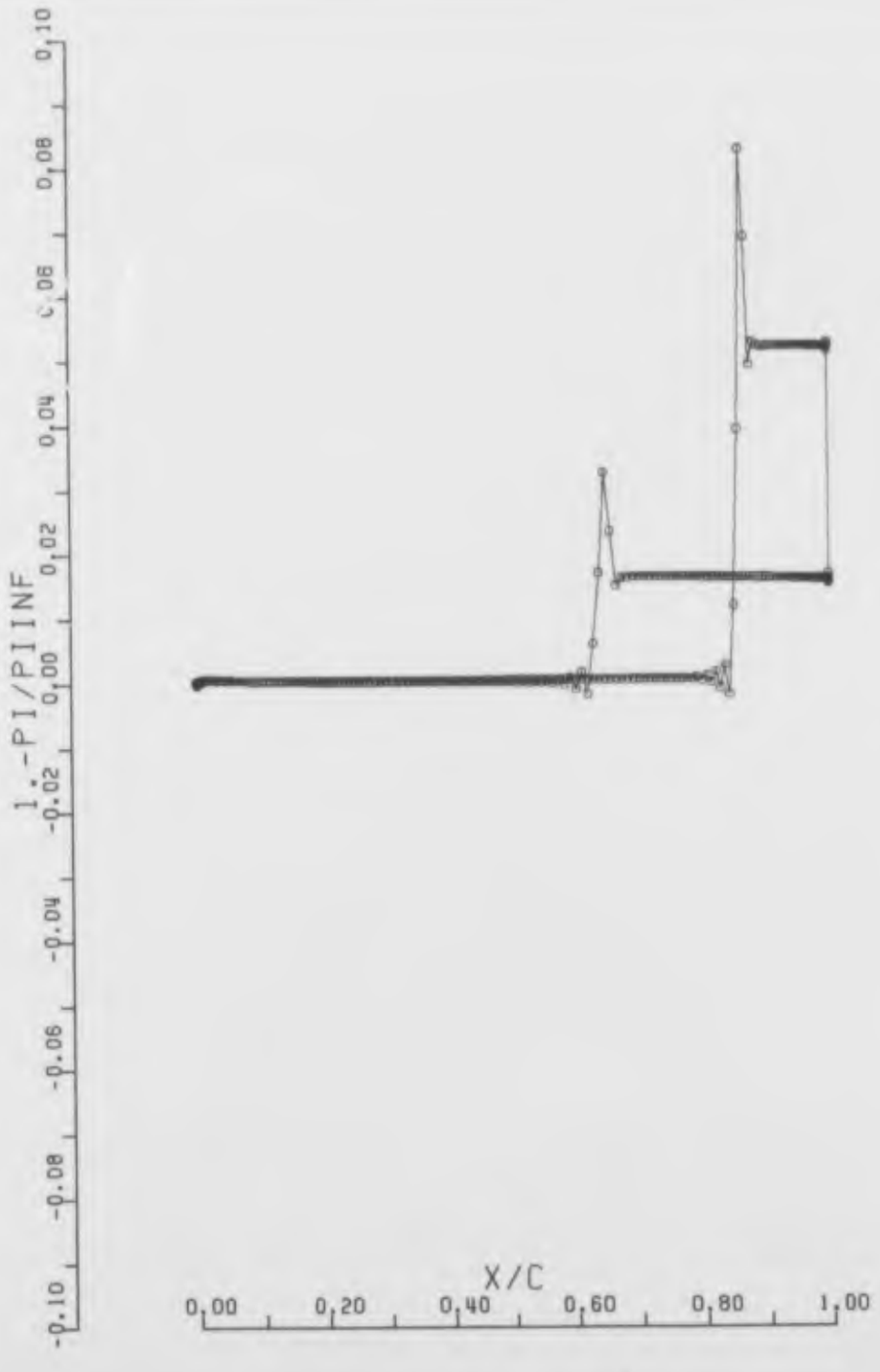


FIG. : 1.-PI/PIINF VS. X/C ON NACA 0012

DORNIER JAMESON	AR 211		W.Schmidt A.Jameson	02-9-16
	NACA 0012: MACH = 0.85, ALPHA = 1			

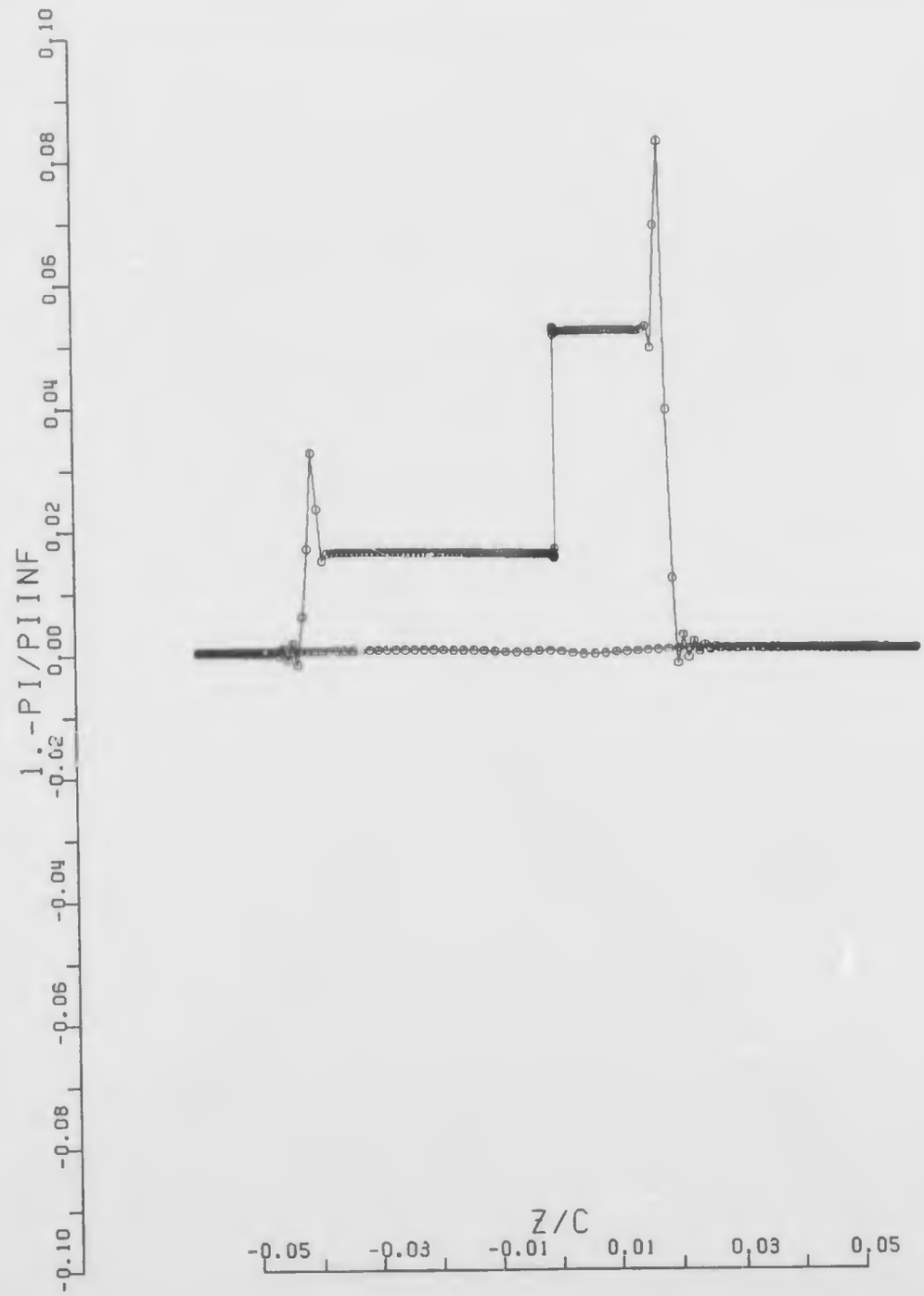
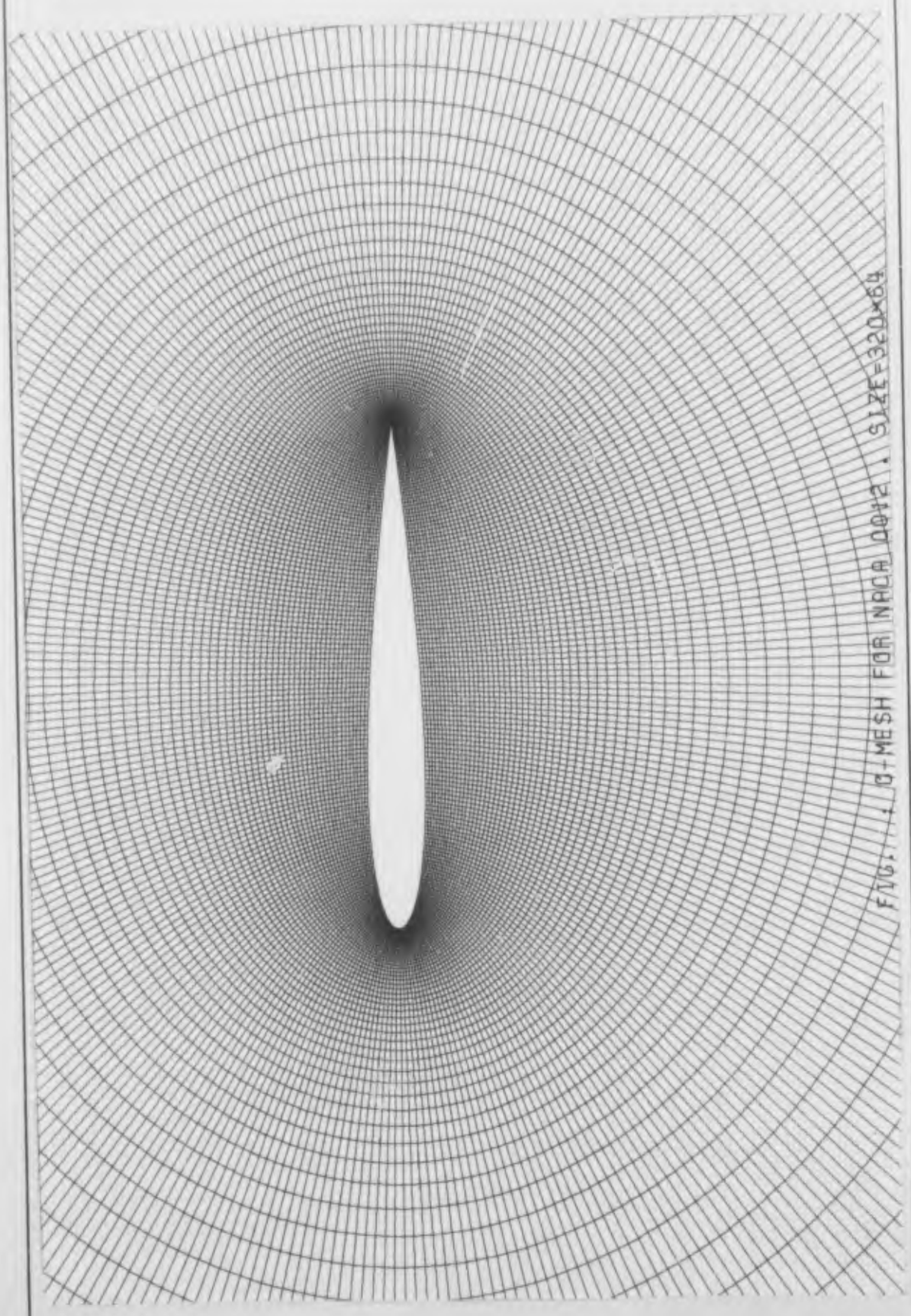
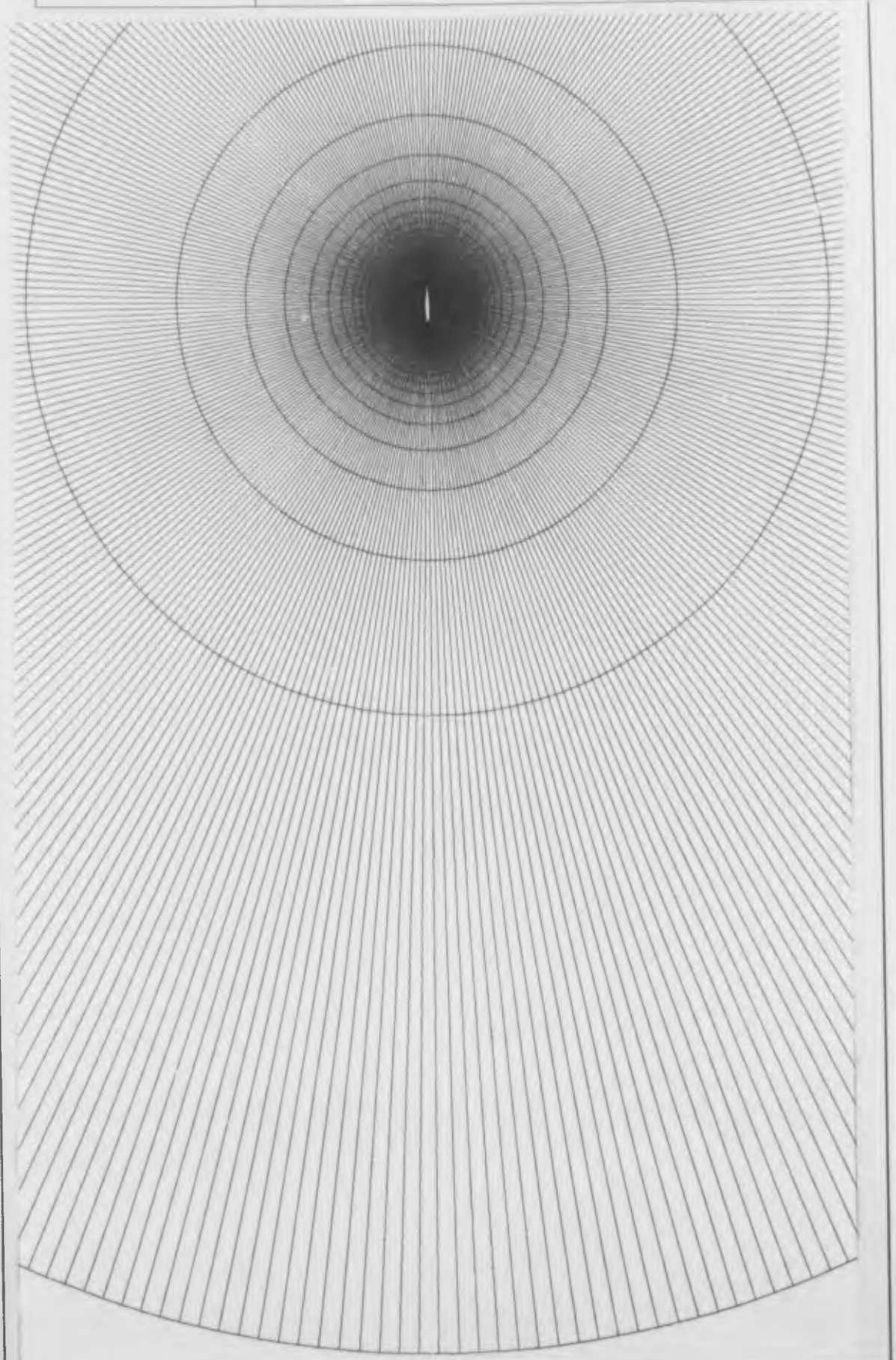


FIG. : 1.-PI/PIINF VS. Z/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-17
	NACA 0012: MACH = 0.85, ALPHA = 1			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-18
	NACA 0012: MACH = 0.85, ALPHA = 1			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-19
	NACA 0012: MACH = 0.85, ALPHA = 1			

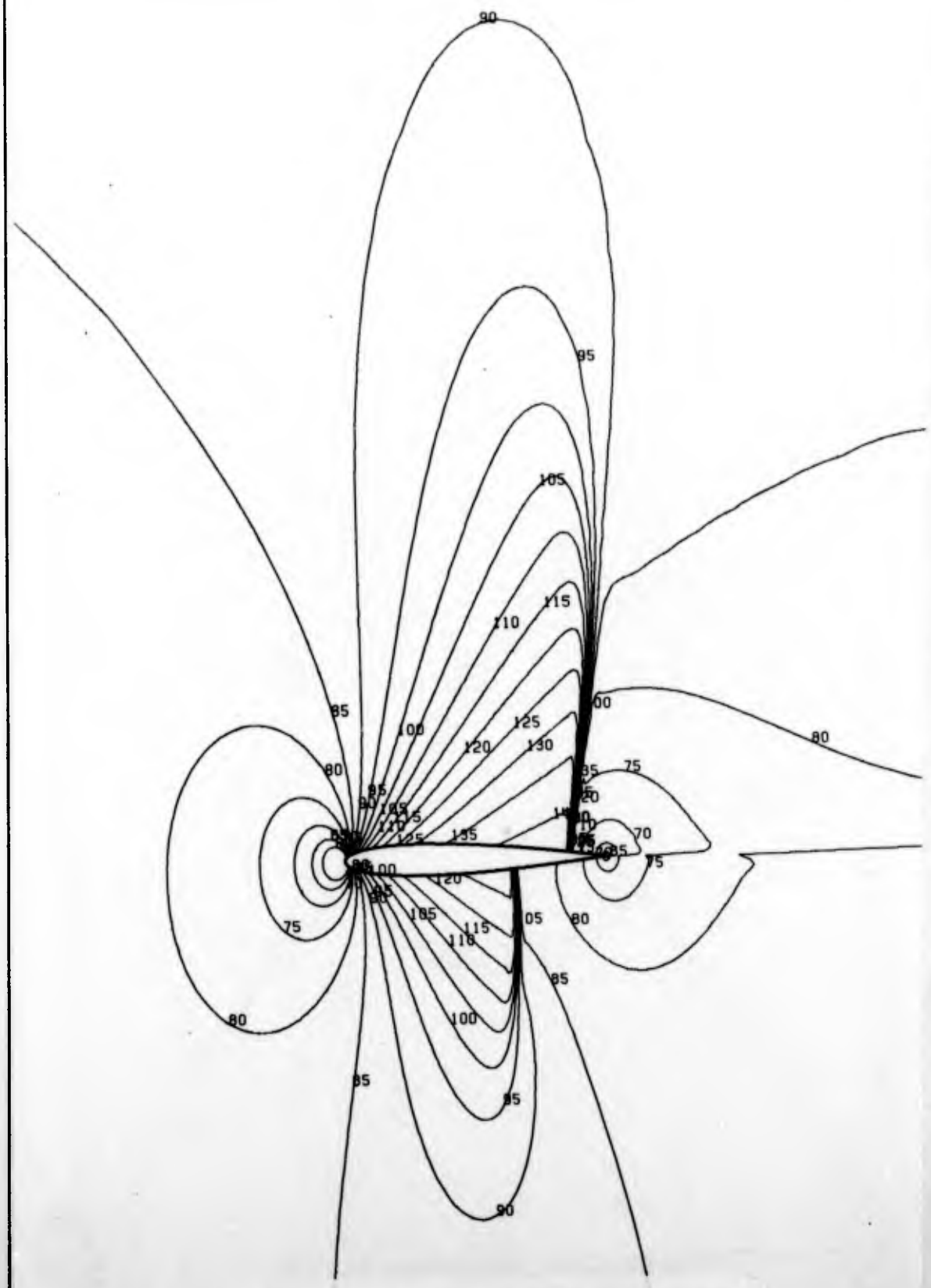


FIG. : ISO-MACH (DELTA = 0.050)

××× VALUES OF CURVE PARAMETER = 100×MACH ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-20
	NACA 0012: MACH = 0.85, ALPHA = 1			

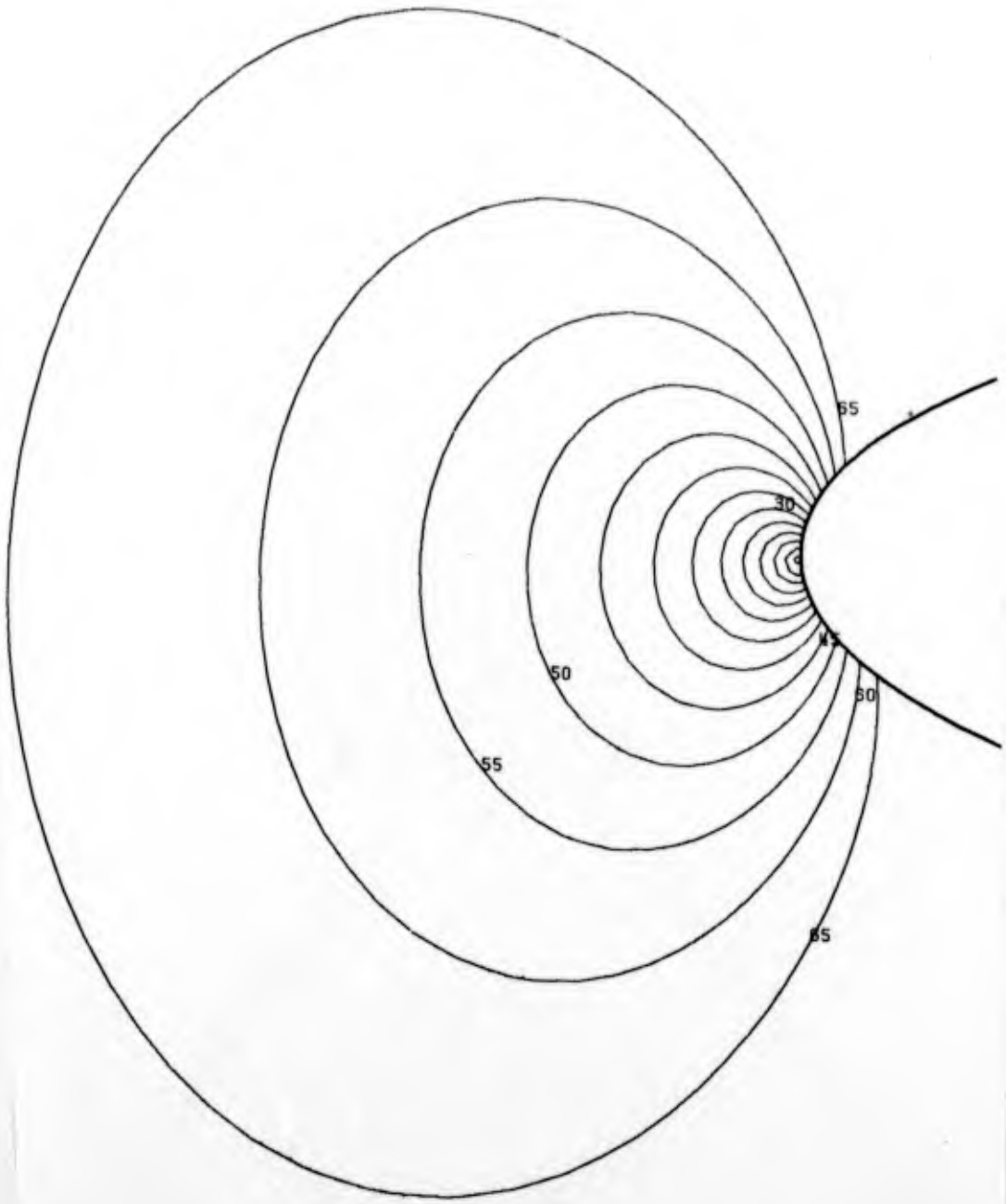


FIG. : ISO-MACH (DELTA = 0.050)

××× VALUES OF CURVE PARAMETER = 100×MACH ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-21
	NACA 0012: MACH = 0.85, ALPHA = 1			

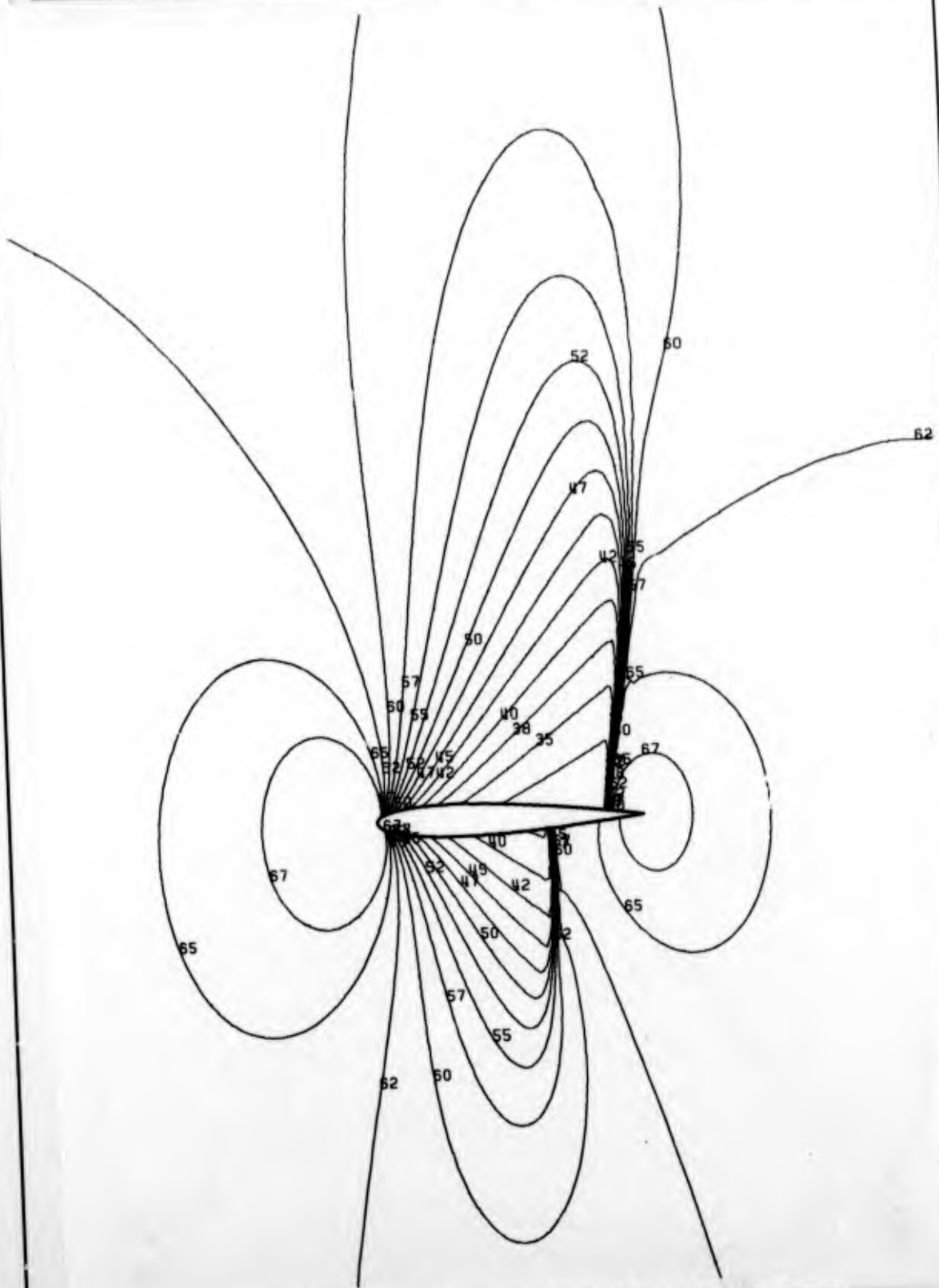


FIG. : ISO-P/PIINF (DELTA = 0.025)

××× VALUES OF CURVE PARAMETER = 100×P/PIINF ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-22
	NACA 0012: MACH = 0.85, ALPHA = 1			

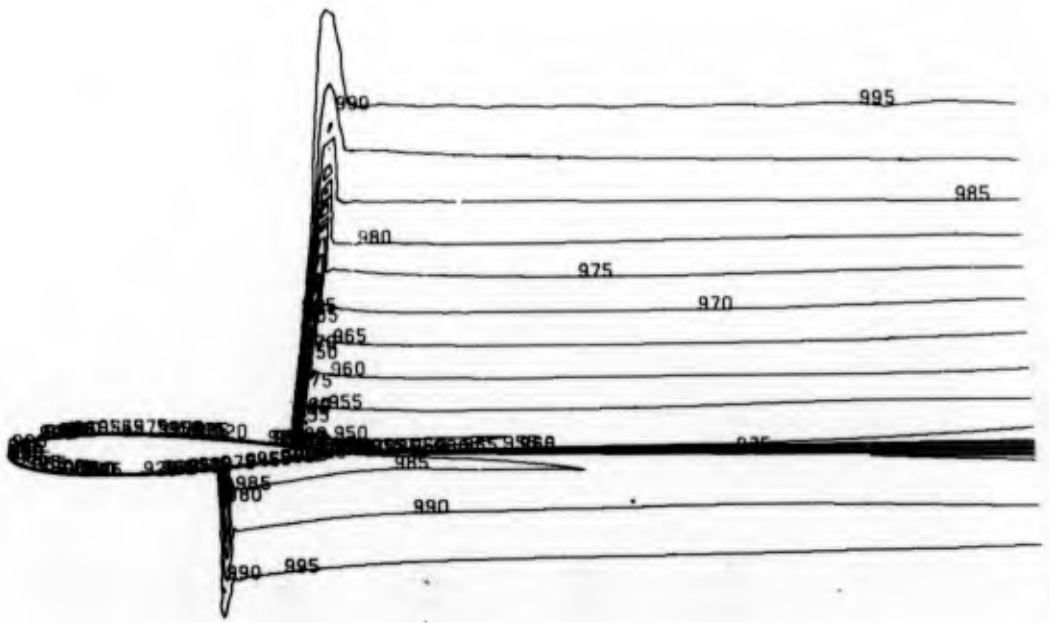


FIG. : ISO-PI/PIINF (DELTA = 0.005)

*** VALUES OF CURVE PARAMETER = 1000*PI/PIINF ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-23
	NACA 0012: MACH = 0.85, ALPHA = 1			

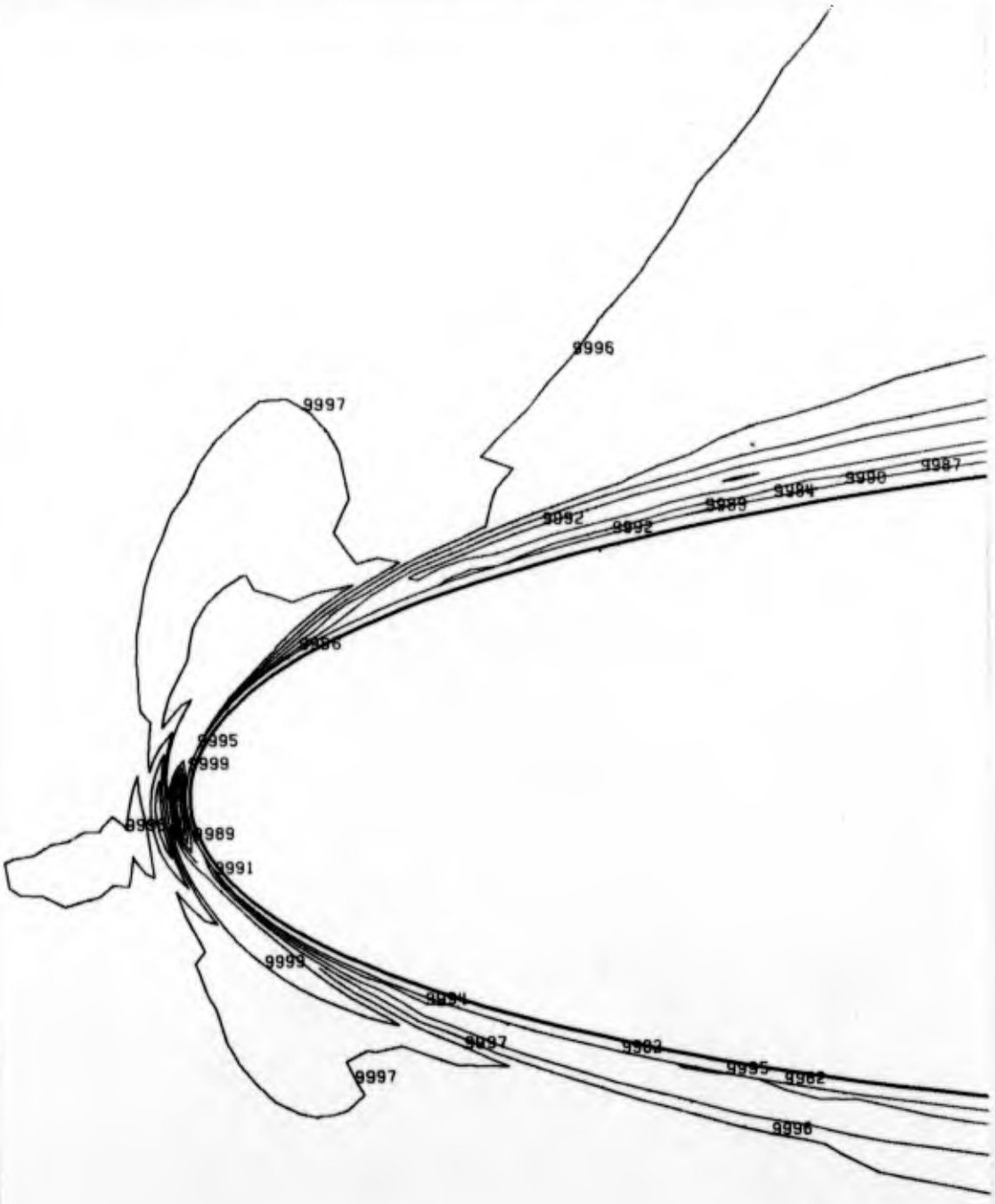


FIG. : ISO-PI/PIINF (DELTA = 0.0001)

*** VALUES OF CURVE PARAMETER = 10000*PI/PIINF ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	02-9-24
	NACA 0012: MACH = 0.85, ALPHA = 1			

MESH	C_L	C_D	C_M	n=1	$(\Delta S/\Delta t)_{local}$ n = CYCLE	CYCLE
80 x 16	0.2364	0.0485	- 0.0699	0.24	$0.20 \cdot 10^{-4}$	200
160 x 32	0.3503	0.0574	- 0.1192	0.19	$0.33 \cdot 10^{-8}$	750
320 x 64	0.3584	0.0580	- 0.1228	0.33	$0.40 \cdot 10^{-3}$	750

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 03

NACA 0012: MACH = 0.95, ALPHA = 0

Contributor No 1

J.P.Veuillot and A.M.Vuillot

(O.N.E.R.A., France)

COMMENTS ON CALCULATION FOR TEST CASE 03

* The computational domain is inscribed in the rectangle

  - $7.43 \leq x/c \leq 11.86$, $-14.86 \leq z/c \leq 14.86$

* Number of mesh points : 439 x 37 = 16 243 (201 mesh points on the profile)

* Artificial viscosity ;

  D_1 term : $Q_{1i} = Q_{1j} = 0.5\ 10^{-2}$

  D_2 term : $Q_{2i} = 0.2$, $Q_{2j} = 0.2$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-2
	NACA 0012: MACH = 0.95, ALPHA = 0			

WALL VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	:-PI/PIINF
1	0.000000	0.000000	-0.003217	1.255541	0.000000	-0.003217
2	0.000044	0.001178	-0.000034	1.246534	0.057067	-0.002315
3	0.000179	0.002358	0.008019	1.223750	0.114111	-0.001052
4	0.000406	0.003542	0.020353	1.188855	0.170708	0.000223
5	0.000729	0.004733	0.036456	1.143294	0.226567	0.001386
6	0.001152	0.005931	0.055779	1.088621	0.281455	0.002375
7	0.001679	0.007138	0.077602	1.026878	0.334997	0.003086
8	0.002314	0.008355	0.101302	0.959821	0.386945	0.003532
9	0.003064	0.009583	0.126120	0.889601	0.436966	0.003638
10	0.003935	0.010824	0.151308	0.818337	0.484752	0.003313
11	0.004933	0.012078	0.176574	0.746850	0.530303	0.002760
12	0.006066	0.013346	0.201310	0.676864	0.573272	0.001976
13	0.007343	0.014630	0.225196	0.609281	0.613658	0.000996
14	0.008772	0.015931	0.248371	0.543713	0.651744	0.000130
15	0.010365	0.017249	0.270314	0.481627	0.687169	-0.000709
16	0.012131	0.018585	0.291018	0.423050	0.720175	-0.001511
17	0.014081	0.019939	0.310868	0.366887	0.751306	-0.002047
18	0.016229	0.021311	0.329389	0.314483	0.780126	-0.002455
19	0.018586	0.022700	0.346589	0.265820	0.806869	-0.002860
20	0.021164	0.024107	0.363110	0.219077	0.832382	-0.003059
21	0.023978	0.025530	0.378803	0.174676	0.856542	-0.003107
22	0.027040	0.026967	0.393319	0.133603	0.878994	-0.003167
23	0.030363	0.028416	0.406915	0.095138	0.900137	-0.003236
24	0.033961	0.029877	0.419992	0.058137	0.920521	-0.003224
25	0.037847	0.031345	0.432320	0.023258	0.939872	-0.003223
26	0.042032	0.032819	0.443987	-0.009752	0.958321	-0.003229
27	0.046530	0.034294	0.455032	-0.041004	0.975889	-0.003201
28	0.051350	0.035768	0.465507	-0.070641	0.992727	-0.003229
29	0.056505	0.037237	0.475745	-0.099606	1.009276	-0.003209
30	0.062004	0.038696	0.485432	-0.127014	1.025077	-0.003202
31	0.067856	0.040141	0.494518	-0.152723	1.040024	-0.003195
32	0.074068	0.041568	0.503274	-0.177496	1.054554	-0.003194
33	0.080647	0.042972	0.511828	-0.201698	1.068873	-0.003190
34	0.087599	0.044348	0.520106	-0.225121	1.082859	-0.003193
35	0.094928	0.045691	0.528006	-0.247472	1.096303	-0.003166
36	0.102637	0.046996	0.535439	-0.268501	1.109076	-0.003155
37	0.110727	0.048260	0.542675	-0.288974	1.121629	-0.003153
38	0.119199	0.049476	0.549756	-0.309008	1.134007	-0.003129
39	0.128052	0.050640	0.556511	-0.328121	1.145935	-0.003122
40	0.137284	0.051748	0.563044	-0.346605	1.157562	-0.003097
41	0.146892	0.052795	0.569337	-0.364412	1.168869	-0.003081
42	0.156872	0.053778	0.575438	-0.381673	1.179932	-0.003070
43	0.167219	0.054692	0.581356	-0.398415	1.190747	-0.003046
44	0.177926	0.055534	0.587032	-0.414476	1.201220	-0.003028
45	0.188987	0.056301	0.592502	-0.429952	1.211391	-0.003000
46	0.200394	0.056990	0.597764	-0.444840	1.221267	-0.002980
47	0.212139	0.057599	0.602855	-0.459244	1.230903	-0.002960
48	0.224213	0.058125	0.607746	-0.473083	1.240231	-0.002928
49	0.236606	0.058567	0.612403	-0.486260	1.249187	-0.002899
50	0.249310	0.058924	0.616913	-0.499020	1.257937	-0.002879
51	0.262314	0.059194	0.621283	-0.511385	1.266480	-0.002854
52	0.275608	0.059376	0.625427	-0.523110	1.274638	-0.002821
53	0.289182	0.059471	0.629392	-0.534328	1.282510	-0.002798
54	0.303026	0.059478	0.633220	-0.545158	1.290157	-0.002764
55	0.317129	0.059397	0.636837	-0.555392	1.297440	-0.002735
56	0.331481	0.059230	0.640309	-0.565214	1.304482	-0.002713
57	0.346072	0.058976	0.643635	-0.574626	1.311264	-0.002674
58	0.360890	0.058637	0.646760	-0.583467	1.317686	-0.002649
59	0.375924	0.058215	0.649793	-0.592048	1.323957	-0.002623
60	0.391164	0.057709	0.652676	-0.600205	1.329951	-0.002591
61	0.406597	0.057123	0.655381	-0.607858	1.335611	-0.002566
62	0.422211	0.056458	0.657975	-0.615198	1.341061	-0.002528
63	0.437993	0.055716	0.660429	-0.622142	1.346256	-0.002505
64	0.453927	0.054900	0.662785	-0.628808	1.351265	-0.002479
65	0.469998	0.054011	0.664998	-0.635070	1.355988	-0.002445
66	0.486187	0.053054	0.667074	-0.640942	1.360440	-0.002414
67	0.502475	0.052031	0.669084	-0.646630	1.364774	-0.002386
68	0.518840	0.050945	0.670991	-0.652026	1.368907	-0.002362
69	0.535259	0.049800	0.672795	-0.657130	1.372828	-0.002335
70	0.551705	0.048600	0.674515	-0.661997	1.376581	-0.002304
71	0.568151	0.047349	0.676142	-0.666599	1.380146	-0.002280
72	0.584570	0.046052	0.677685	-0.670964	1.383532	-0.002246
73	0.600933	0.044713	0.679140	-0.675082	1.386741	-0.002216
74	0.617211	0.043338	0.680573	-0.679136	1.389916	-0.002195
75	0.633376	0.041929	0.681951	-0.683034	1.392981	-0.002177

AC VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-3
	NACA 0012: MACH = 0.95, ALPHA = 0			

WALL VALUES - UPPER SIDE (Cont.)

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
76	0.649402	0.040493	0.683241	-0.686685	1.395851	-0.002146
77	0.665267	0.039033	0.684499	-0.690245	1.398657	-0.002113
78	0.680949	0.037554	0.685741	-0.693758	1.401448	-0.002099
79	0.696433	0.036058	0.686934	-0.697134	1.404135	-0.002082
80	0.711707	0.034550	0.688058	-0.700312	1.406661	-0.002050
81	0.726765	0.033032	0.689173	-0.703469	1.409172	-0.002011
82	0.741603	0.031506	0.690281	-0.706602	1.411688	-0.001996
83	0.756226	0.029973	0.691400	-0.709770	1.414244	-0.001988
84	0.770639	0.028433	0.692473	-0.712805	1.416692	-0.001969
85	0.784854	0.026888	0.693554	-0.715863	1.419157	-0.001938
86	0.798887	0.025335	0.694648	-0.718959	1.421671	-0.001924
87	0.812754	0.023775	0.695704	-0.721947	1.424101	-0.001904
88	0.826474	0.022206	0.696783	-0.725000	1.426579	-0.001868
89	0.840070	0.020626	0.697876	-0.728092	1.429107	-0.001847
90	0.853562	0.019033	0.699010	-0.731301	1.431749	-0.001840
91	0.866971	0.017424	0.700141	-0.734501	1.434390	-0.001831
92	0.880317	0.015798	0.701301	-0.737781	1.437094	-0.001806
93	0.893620	0.014151	0.702495	-0.741159	1.439892	-0.001786
94	0.906896	0.012482	0.703698	-0.744565	1.442724	-0.001769
95	0.920161	0.010788	0.704938	-0.748072	1.445634	-0.001728
96	0.933427	0.009067	0.706239	-0.751754	1.448754	-0.001763
97	0.946702	0.007317	0.707725	-0.755957	1.451925	-0.001225
98	0.959994	0.005537	0.708529	-0.758232	1.453791	-0.001139
99	0.973307	0.003725	0.712351	-0.769046	1.466565	-0.006265
100	0.986643	0.001879	0.718972	-0.787781	1.519023	-0.060549
101	1.000000	0.000000	0.643477	-0.574177	1.314017	-0.006901

SLIP LINE VALUES

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
102	1.012389	0.000000	0.553866	-0.320638	1.105400	0.041034
103	1.026815	0.000000	0.568894	-0.363156	1.151647	0.017773
104	1.040288	0.000000	0.571951	-0.371807	1.185708	-0.018895
105	1.053823	0.000000	0.566633	-0.356760	1.163715	-0.002725
106	1.067433	0.000000	0.564803	-0.351583	1.150634	0.009733
107	1.081139	0.000000	0.564922	-0.351919	1.151643	0.008729
108	1.094962	0.000000	0.564659	-0.351175	1.153586	0.005670
109	1.108923	0.000000	0.563906	-0.349046	1.152485	0.005349
110	1.123047	0.000000	0.563118	-0.346816	1.150411	0.006181
111	1.137358	0.000000	0.562444	-0.344909	1.148928	0.006526
112	1.151881	0.000000	0.561812	-0.343120	1.147891	0.006402
113	1.166640	0.000000	0.561156	-0.341264	1.146797	0.006297
114	1.181656	0.000000	0.560476	-0.339341	1.145539	0.006347
115	1.196949	0.000000	0.559792	-0.337405	1.144246	0.006434
116	1.212536	0.000000	0.559110	-0.335474	1.142996	0.006472
117	1.228428	0.000000	0.558425	-0 333537	1.141769	0.006476
118	1.244635	0.000000	0.557733	-0.331579	1.140525	0.006486
119	1.261159	0.000000	0.557034	-0.329601	1.139258	0.006511
120	1.278000	0.000000	0.556332	-0.327616	1.137987	0.006538
121	1.295152	0.000000	0.555629	-0.325627	1.136720	0.006558
122	1.312604	0.000000	0.554924	-0.323631	1.135454	0.006572
123	1.330341	0.000000	0.554220	-0.321638	1.134192	0.006585
124	1.348346	0.000000	0.553521	-0.319661	1.132939	0.006599
125	1.366597	0.000000	0.552827	-0.317699	1.131697	0.006615
126	1.385073	0.000000	0.552139	-0.315751	1.130465	0.006629
127	1.403749	0.000000	0.551457	-0.313821	1.129247	0.006643
128	1.422602	0.000000	0.550781	-0.311910	1.128041	0.006655
129	1.441608	0.000000	0.550110	-0.310012	1.126846	0.006668
130	1.460746	0.000000	0.549448	-0.308137	1.125666	0.006679
131	1.479995	0.000000	0.548800	-0.306304	1.124514	0.006691
132	1.499336	0.000000	0.548164	-0.304506	1.123384	0.006703
133	1.518755	0.000000	0.547530	-0.302711	1.122257	0.006715
134	1.538237	0.000000	0.546890	-0.300901	1.121121	0.006727
135	1.557770	0.000000	0.546255	-0.299105	1.119995	0.006739

AL-VEUILLOT

SLIP LINE VALUES (Cont.)

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
136	1.577346	0.000000	0.545641	-0.297366	1.118906	0.006749
137	1.596957	0.000000	0.545051	-0.295698	1.117863	0.006760
138	1.616597	0.000000	0.544474	-0.294066	1.116842	0.006770
139	1.636262	0.000000	0.543889	-0.292411	1.115807	0.006781
140	1.655947	0.000000	0.543288	-0.290711	1.114744	0.006793
141	1.675652	0.000000	0.542683	-0.288998	1.113675	0.006805
142	1.695373	0.000000	0.542096	-0.287336	1.112638	0.006816
143	1.715109	0.000000	0.541540	-0.285764	1.111659	0.006826
144	1.734860	0.000000	0.541013	-0.284272	1.110729	0.006836
145	1.754624	0.000000	0.540495	-0.282806	1.109816	0.006846
146	1.774401	0.000000	0.539964	-0.281306	1.108882	0.006857
147	1.794190	0.000000	0.539412	-0.279741	1.107909	0.006869
148	1.813990	0.000000	0.538842	-0.278129	1.106906	0.006880
149	1.833802	0.000000	0.538273	-0.276520	1.105906	0.006891
150	1.853625	0.000000	0.537726	-0.274971	1.104945	0.006902
151	1.873459	0.000000	0.537211	-0.273516	1.104043	0.006911
152	1.893302	0.000000	0.536721	-0.272129	1.103183	0.006921
153	1.913156	0.000000	0.536230	-0.270740	1.102319	0.006935
154	1.933019	0.000000	0.535743	-0.269362	1.101461	0.006950
155	1.952891	0.000000	0.535328	-0.268188	1.100743	0.006947
156	1.972772	0.000000	0.534977	-0.267194	1.100151	0.006925
157	1.992661	0.000000	0.534306	-0.265296	1.098959	0.006962
158	2.012559	0.000000	0.532886	-0.261280	1.096347	0.007151
159	2.032465	0.000000	0.531984	-0.258727	1.094708	0.007248
160	2.052379	0.000000	0.535148	-0.267678	1.100726	0.006584
161	2.072300	0.000000	0.540859	-0.283837	1.111785	0.005193
162	2.092228	0.000000	0.530367	-0.254152	1.091944	0.007214
163	2.112163	0.000000	0.490736	-0.142021	1.021403	0.011415
164	2.132105	0.000000	0.450455	-0.028052	0.956179	0.010845
165	2.152054	0.000000	0.437744	0.007912	0.936564	0.010026
166	2.172008	0.000000	0.440738	-0.000560	0.940891	0.010526
167	2.191969	0.000000	0.442437	-0.005366	0.943312	0.010853
168	2.211936	0.000000	0.441026	-0.001376	0.941030	0.010882
169	2.231908	0.000000	0.439413	0.003189	0.938460	0.010874
170	2.251885	0.000000	0.438476	0.005841	0.936925	0.010917
171	2.271868	0.000000	0.437770	0.007838	0.935747	0.010974
172	2.291856	0.000000	0.437034	0.009919	0.934532	0.011020
173	2.311849	0.000000	0.436304	0.011986	0.933329	0.011062
174	2.331846	0.000000	0.435625	0.013905	0.932210	0.011103
175	2.351848	0.000000	0.434994	0.015691	0.931167	0.011145
176	2.371855	0.000000	0.434398	0.017379	0.930180	0.011185
177	2.391865	0.000000	0.433832	0.018978	0.929243	0.011225
178	2.411880	0.000000	0.433299	0.020488	0.928358	0.011264
179	2.431898	0.000000	0.432796	0.021911	0.927523	0.011302
180	2.451921	0.000000	0.432322	0.023251	0.926735	0.011340
181	2.471946	0.000000	0.431877	0.024511	0.925993	0.011377
182	2.491976	0.000000	0.431459	0.025693	0.925295	0.011413
183	2.512008	0.000000	0.431068	0.026799	0.924641	0.011448
184	2.532044	0.000000	0.430703	0.027833	0.924029	0.011483
185	2.552083	0.000000	0.430363	0.028795	0.923457	0.011517
186	2.572125	0.000000	0.430047	0.029689	0.922924	0.011551
187	2.592170	0.000000	0.429755	0.030515	0.922429	0.011584
188	2.612218	0.000000	0.429485	0.031277	0.921971	0.011617
189	2.632268	0.000000	0.429238	0.031976	0.921550	0.011649
190	2.652321	0.000000	0.429013	0.032613	0.921163	0.011681
191	2.672376	0.000000	0.428809	0.033190	0.920810	0.011712
192	2.692434	0.000000	0.428626	0.033709	0.920490	0.011744
193	2.712494	0.000000	0.428463	0.034169	0.920202	0.011775
194	2.732556	0.000000	0.428321	0.034573	0.919947	0.011806
195	2.752620	0.000000	0.428198	0.034920	0.919723	0.011838
196	2.772687	0.000000	0.428096	0.035210	0.919531	0.011870
197	2.792755	0.000000	0.428013	0.035443	0.919370	0.011902
198	2.812825	0.000000	0.427951	0.035619	0.919241	0.011936
199	2.832897	0.000000	0.427909	0.035737	0.919143	0.011970
200	2.852971	0.000000	0.427888	0.035796	0.919078	0.012005

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-5
	NACA 0012: MACH = 0.95, ALPHA = 0			

SLIP LINE VALUES (Cont.)

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
201	2.873046	0.000000	0.427889	0.035794	0.919045	0.012042
202	2.893123	0.000000	0.427912	0.035730	0.919045	0.012081
203	2.913202	0.000000	0.427957	0.035602	0.919080	0.012121
204	2.933282	0.000000	0.428025	0.035409	0.919149	0.012164
205	2.953363	0.000000	0.428116	0.035151	0.919252	0.012210
206	2.973443	0.000000	0.428231	0.034827	0.919390	0.012257
207	2.993778	0.000000	0.428369	0.034437	0.919562	0.012308
208	3.016065	0.000000	0.428530	0.033980	0.919766	0.012366
209	3.044974	0.000000	0.428724	0.033432	0.920005	0.012440
210	3.088270	0.000000	0.428978	0.032713	0.920308	0.012550
211	3.156351	0.000000	0.429352	0.031654	0.920746	0.012721
212	3.263675	0.000000	0.429938	0.029998	0.921428	0.012991
213	3.432005	0.000000	0.430853	0.027407	0.922526	0.013383
214	3.694519	0.000000	0.432215	0.023554	0.924281	0.013834
215	4.101328	0.000000	0.434051	0.018358	0.926859	0.014217
216	4.727351	0.000000	0.436206	0.012262	0.930078	0.014459
217	5.683498	0.000000	0.438349	0.006199	0.933328	0.014651
218	7.132381	0.000000	0.439990	0.001557	0.935861	0.014754
219	9.211811	0.000000	0.440719	-0.000505	0.937214	0.014550
220	11.861689	0.000000	0.440540	0.000000	0.937253	0.014192

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-6
	NACA 0012: MACH = 0.95, ALPHA = 0			

UPPER SURFACE

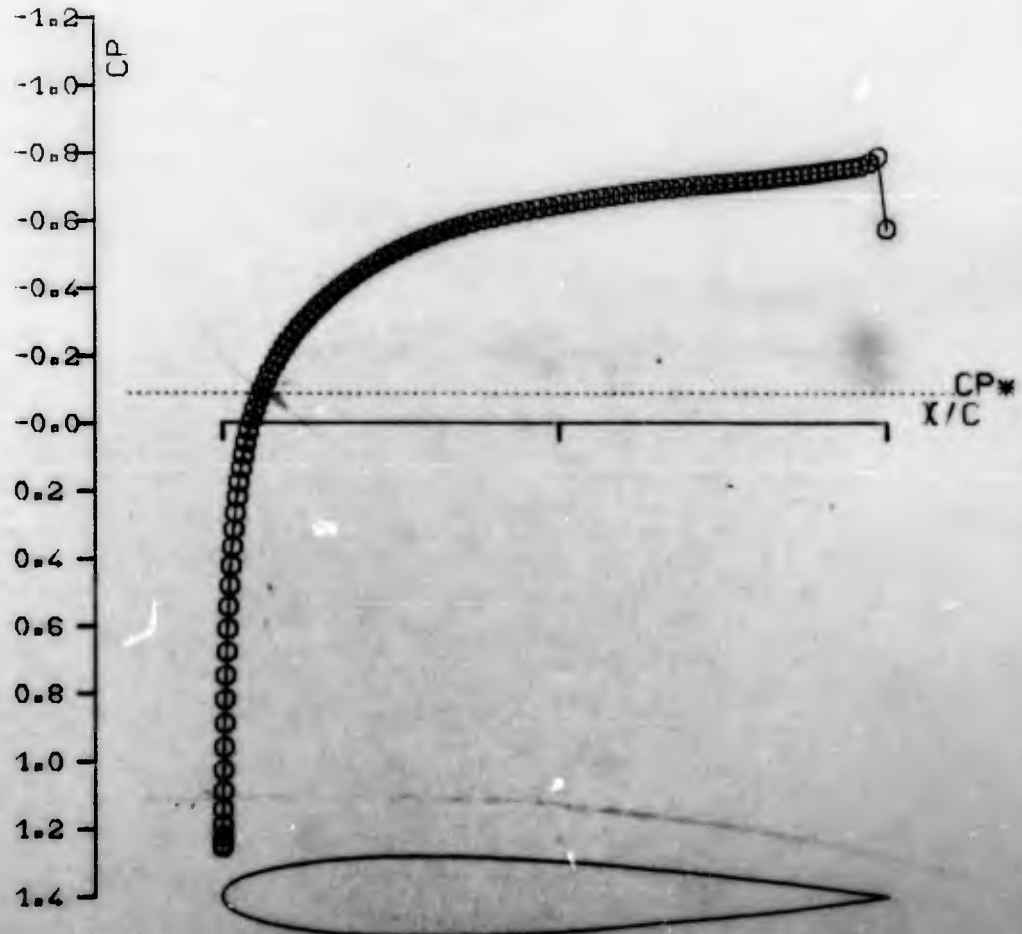
LOWER SURFACE

CL= -0.0000

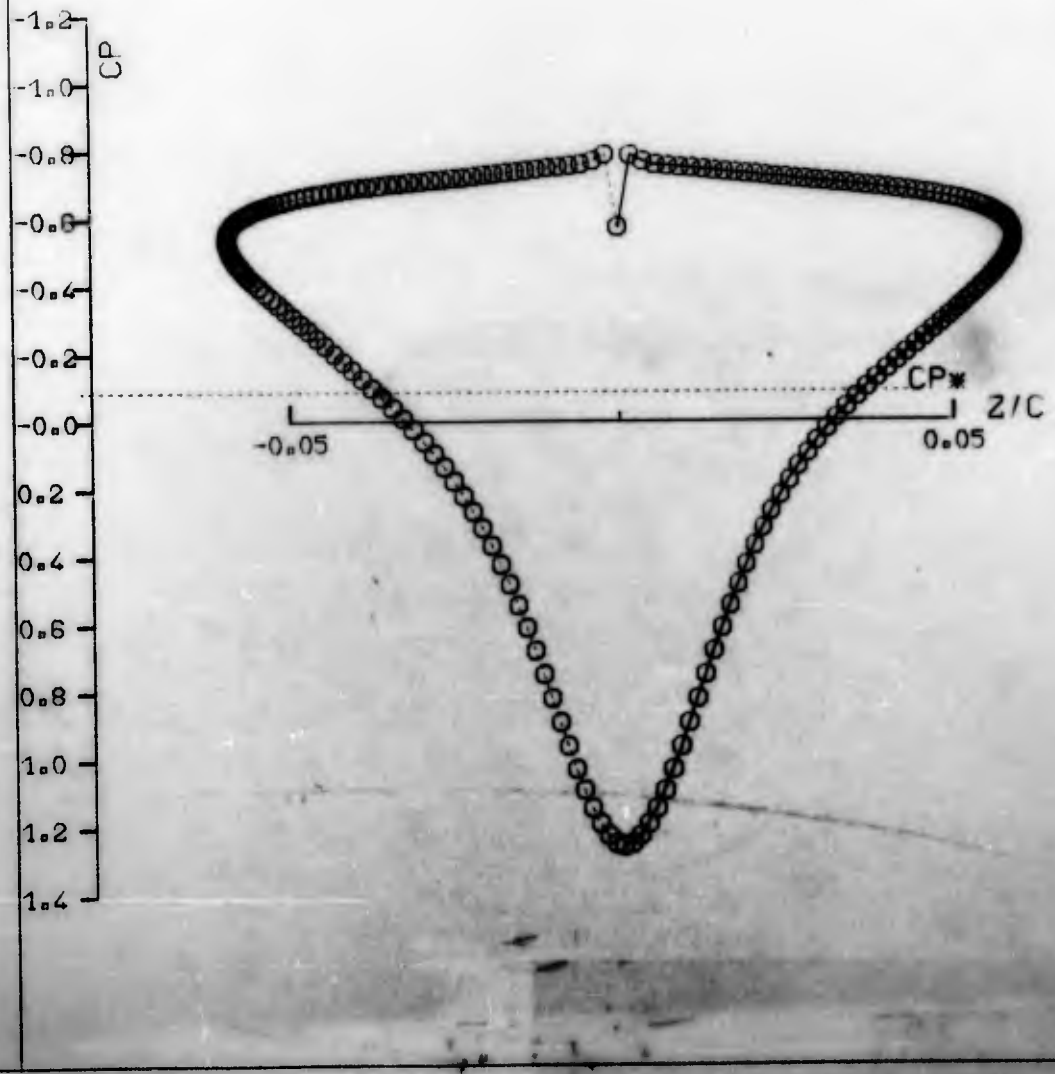
CD= 0.1080

CM= -0.0000

Γ = 0.0000

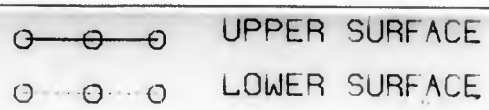


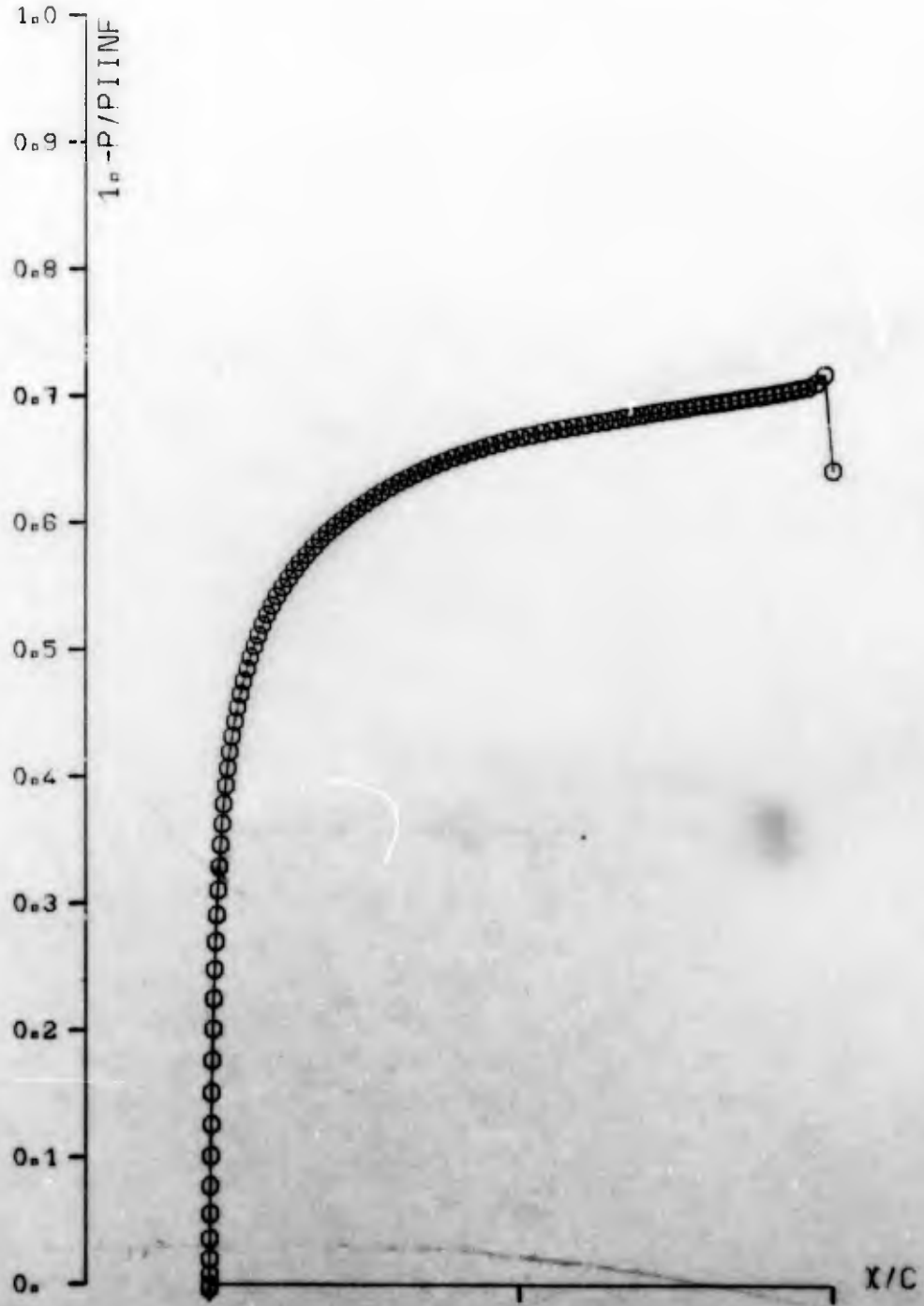
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-7
	NACA 0012: MACH = 0.95, ALPHA = 0			



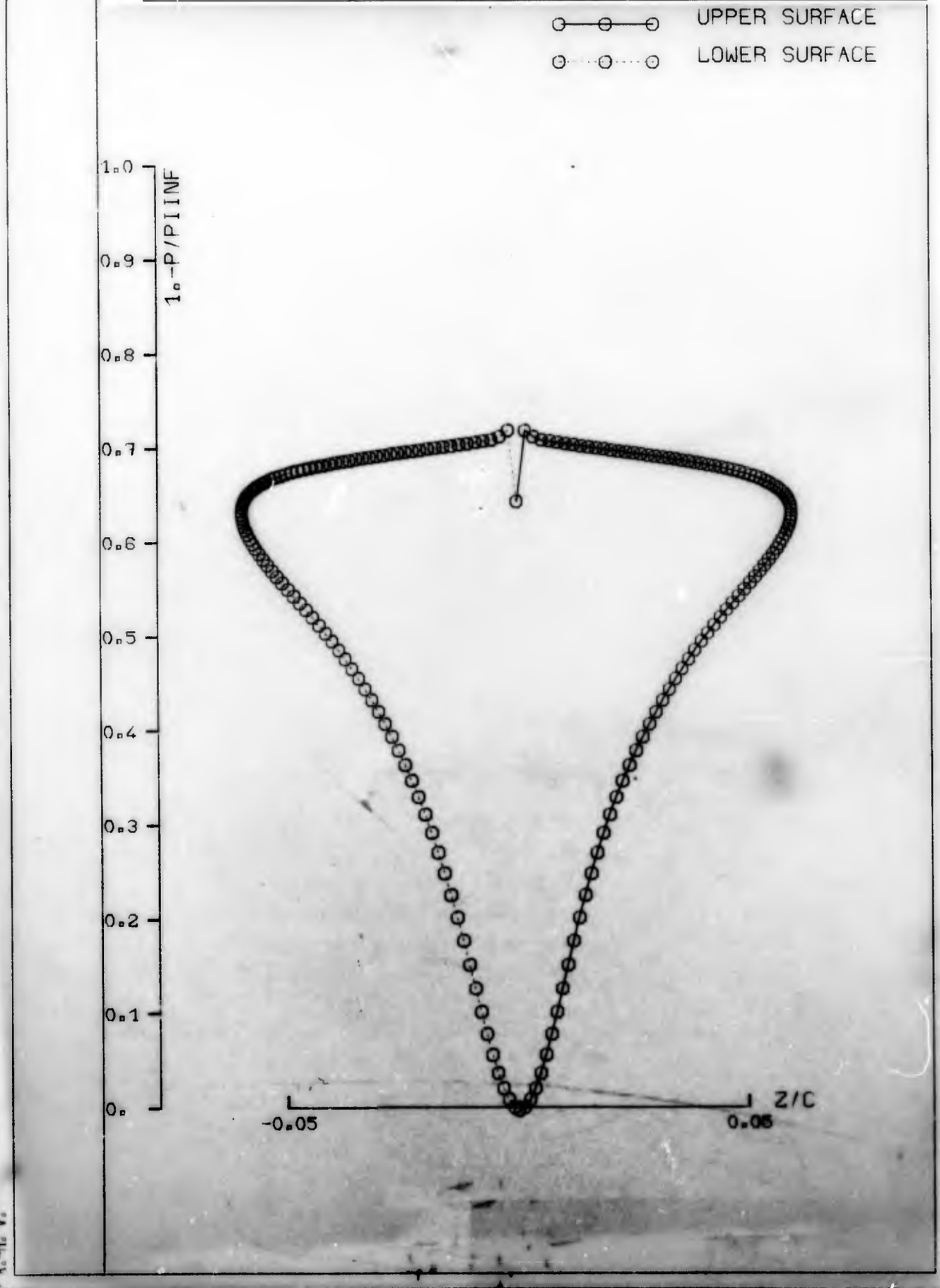
$A_\infty - M_\infty V_\infty$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-8
	NACA 0012: MACH = 0.95, ALPHA = 0			

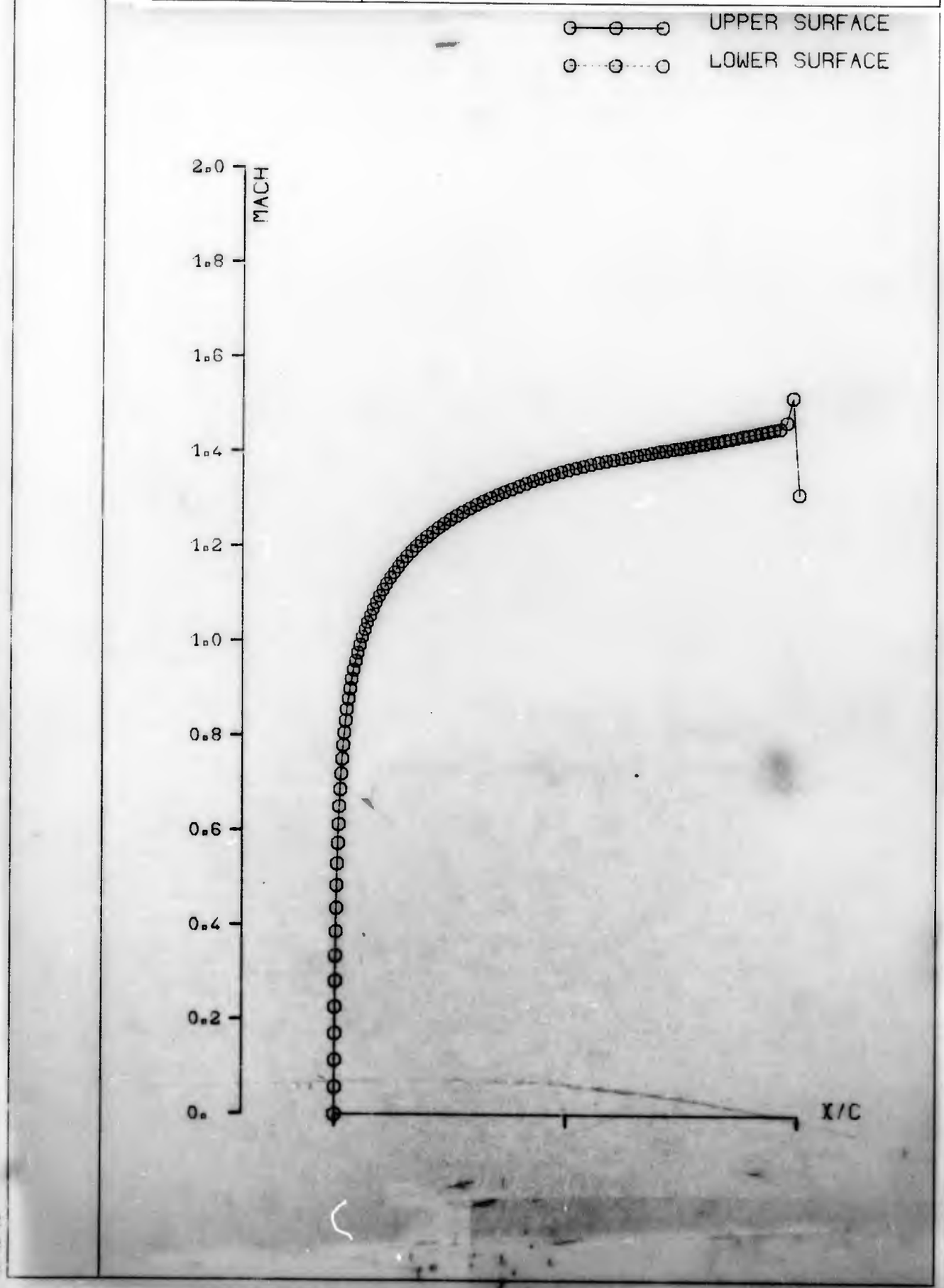




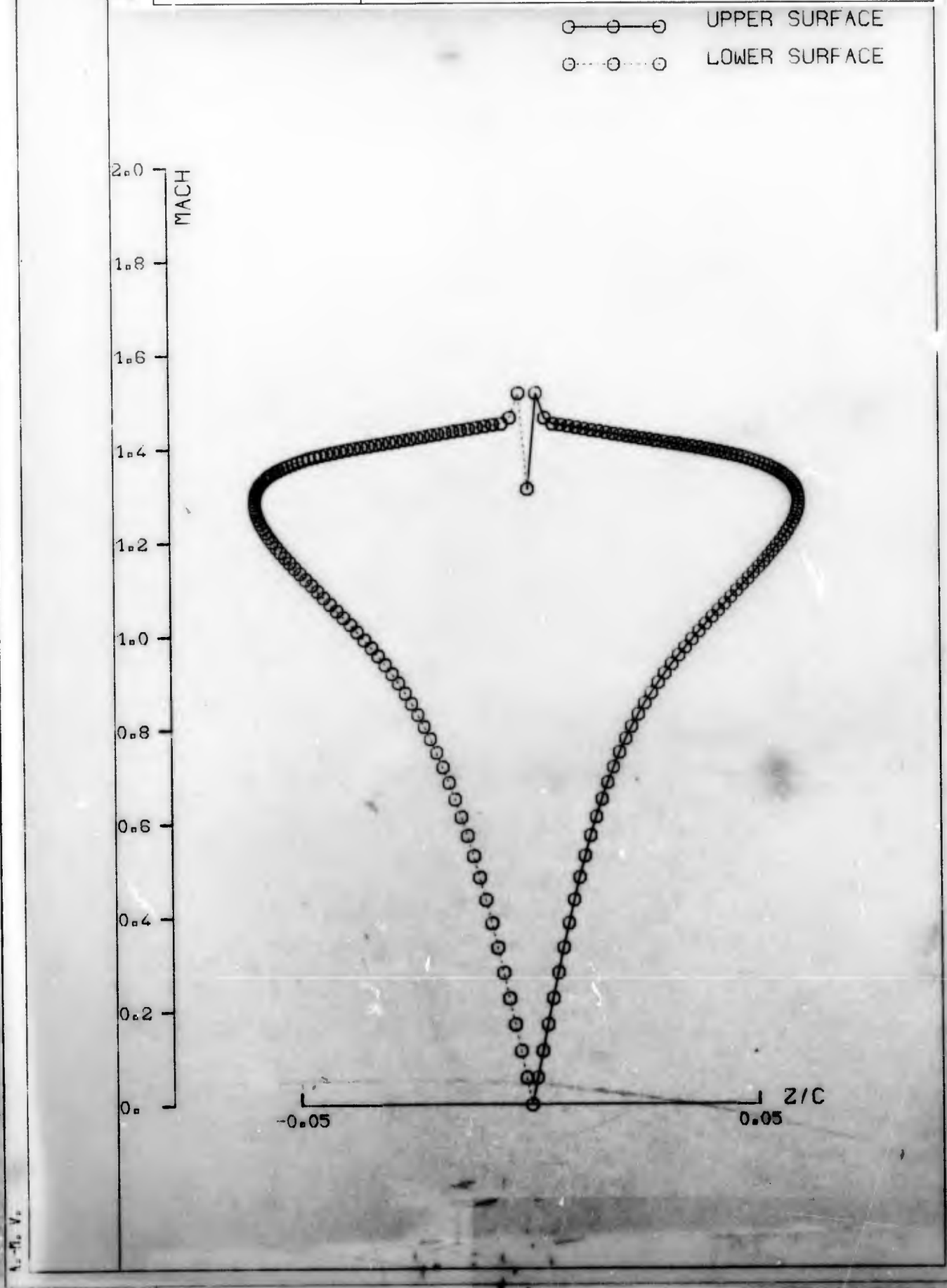
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-9
	NACA 0012: MACH = 0.95, ALPHA = 0			



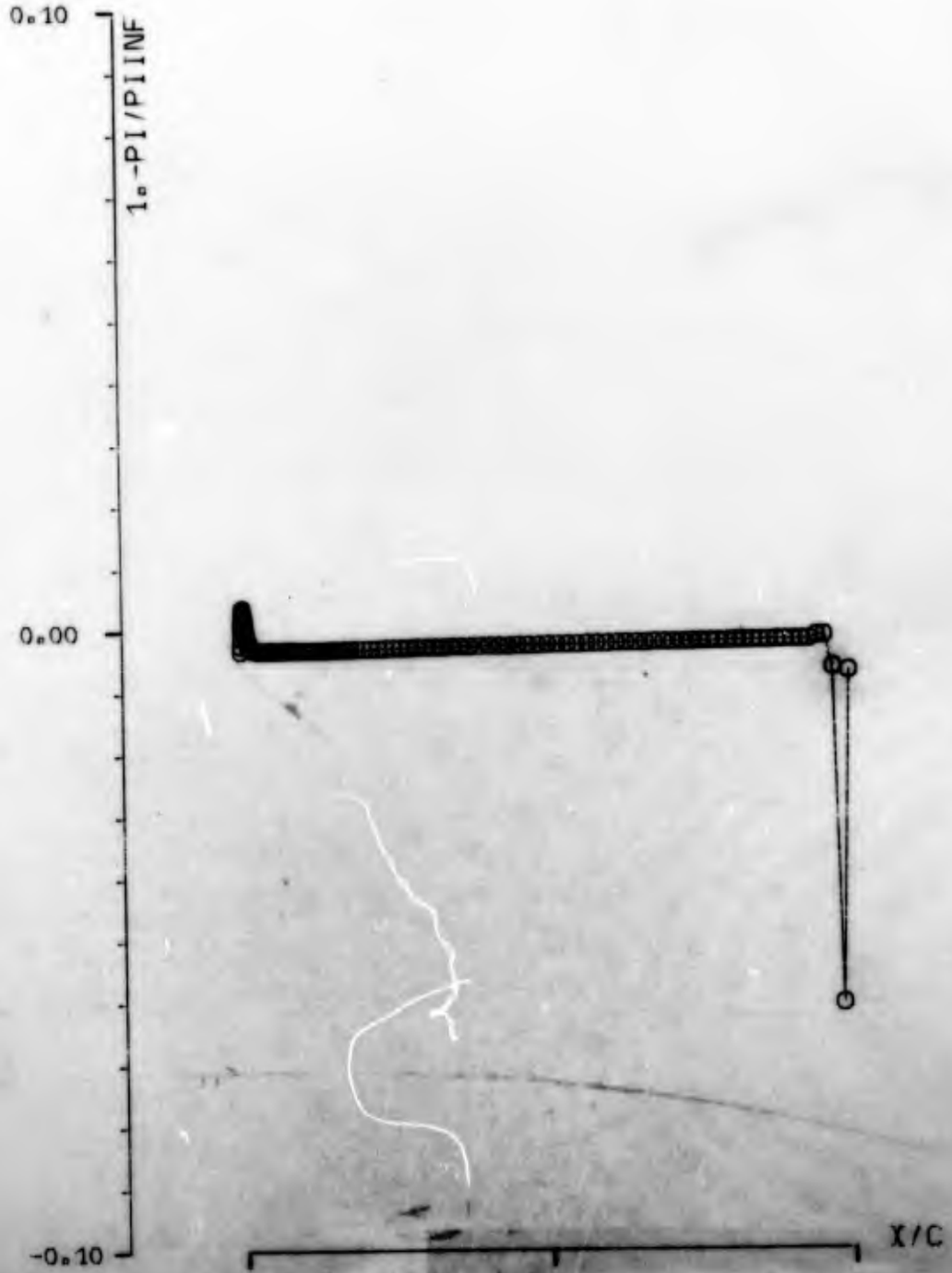
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-10
	NACA 0012: MACH = 0,95, ALPHA = 0			



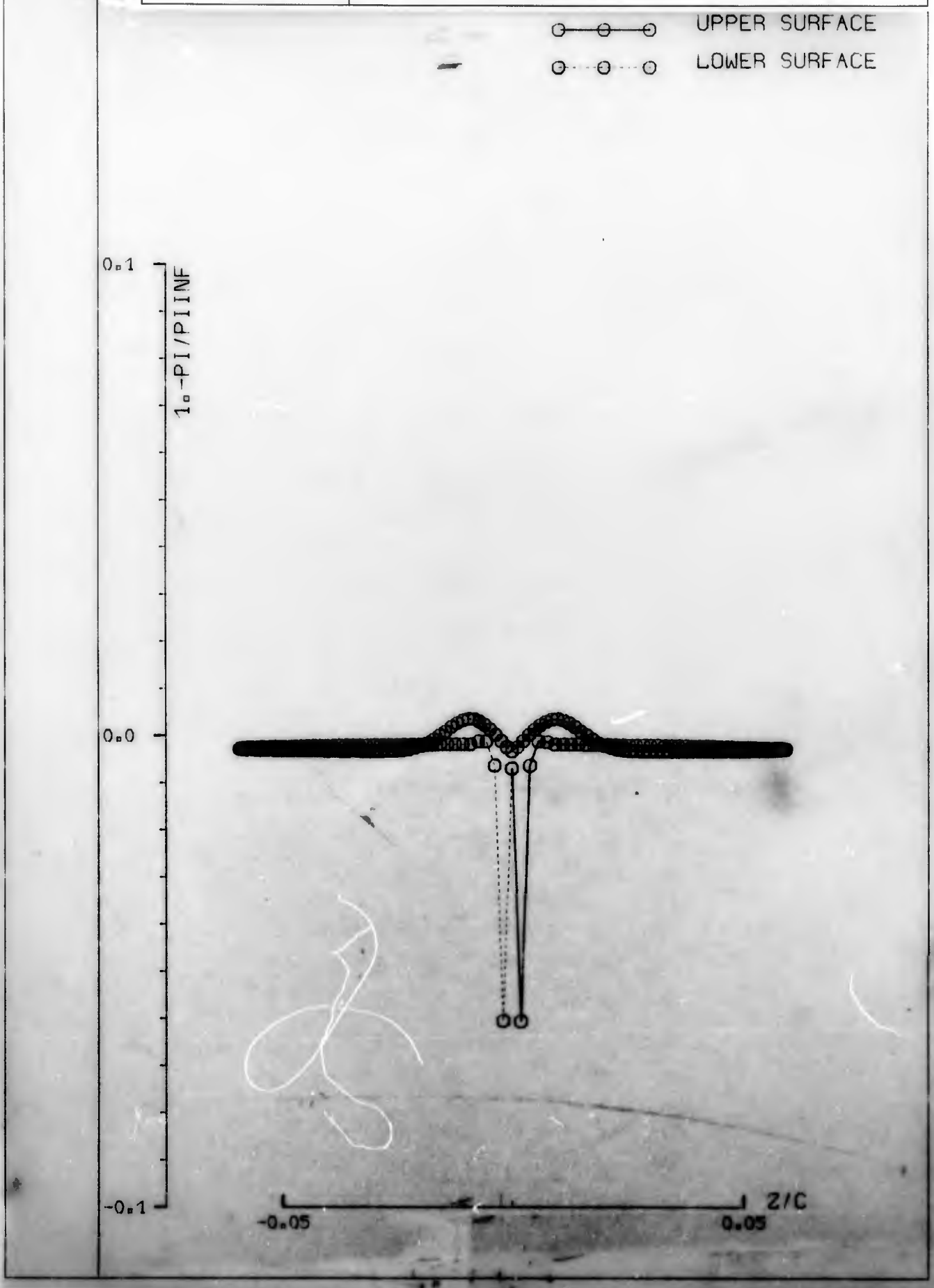
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-11
	NACA 0012: MACH = 0.95, ALPHA = 0			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-12
	NACA 0012: MACH = 0.95, ALPHA = 0			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-13
	NACA 0012: MACH = 0.95, ALPHA = 0			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-14
	NACA 0012: MACH = 0.95, ALPHA = 0			

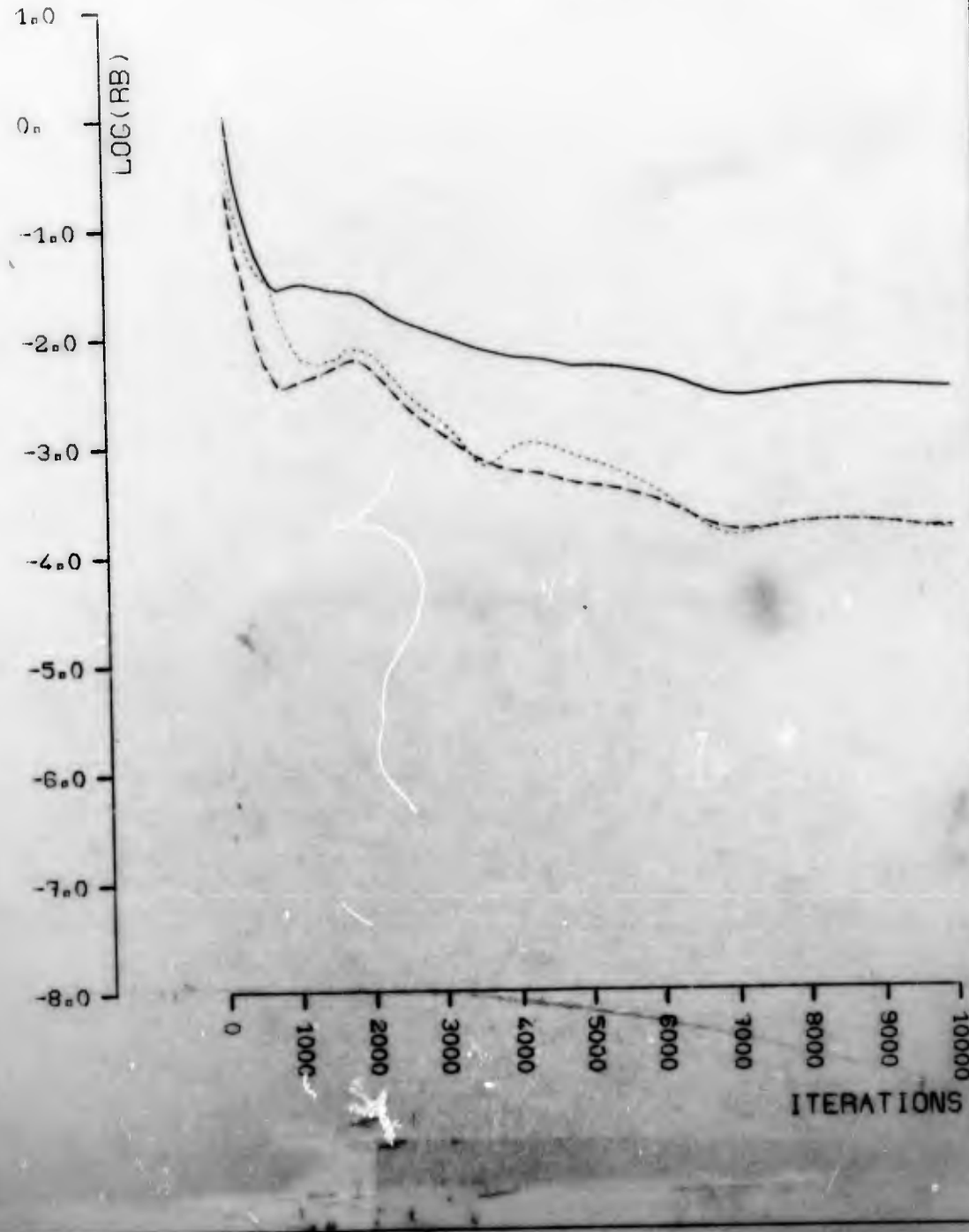
RESIDUAL MEAN

RB=R.M.S. OF $(F^{N+1} - F^{N})/DT$

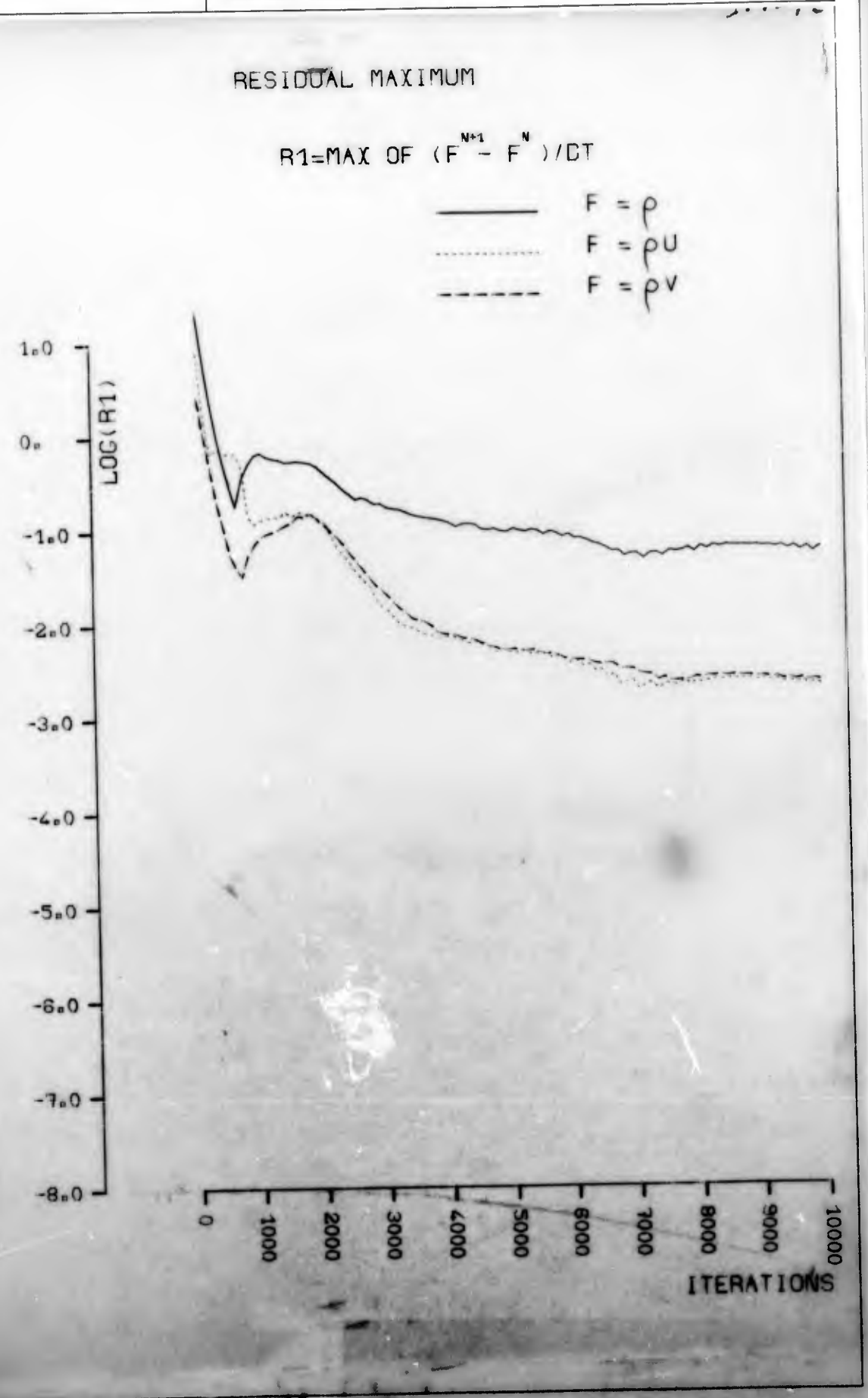
——— $F = \rho$

..... $F = \rho U$

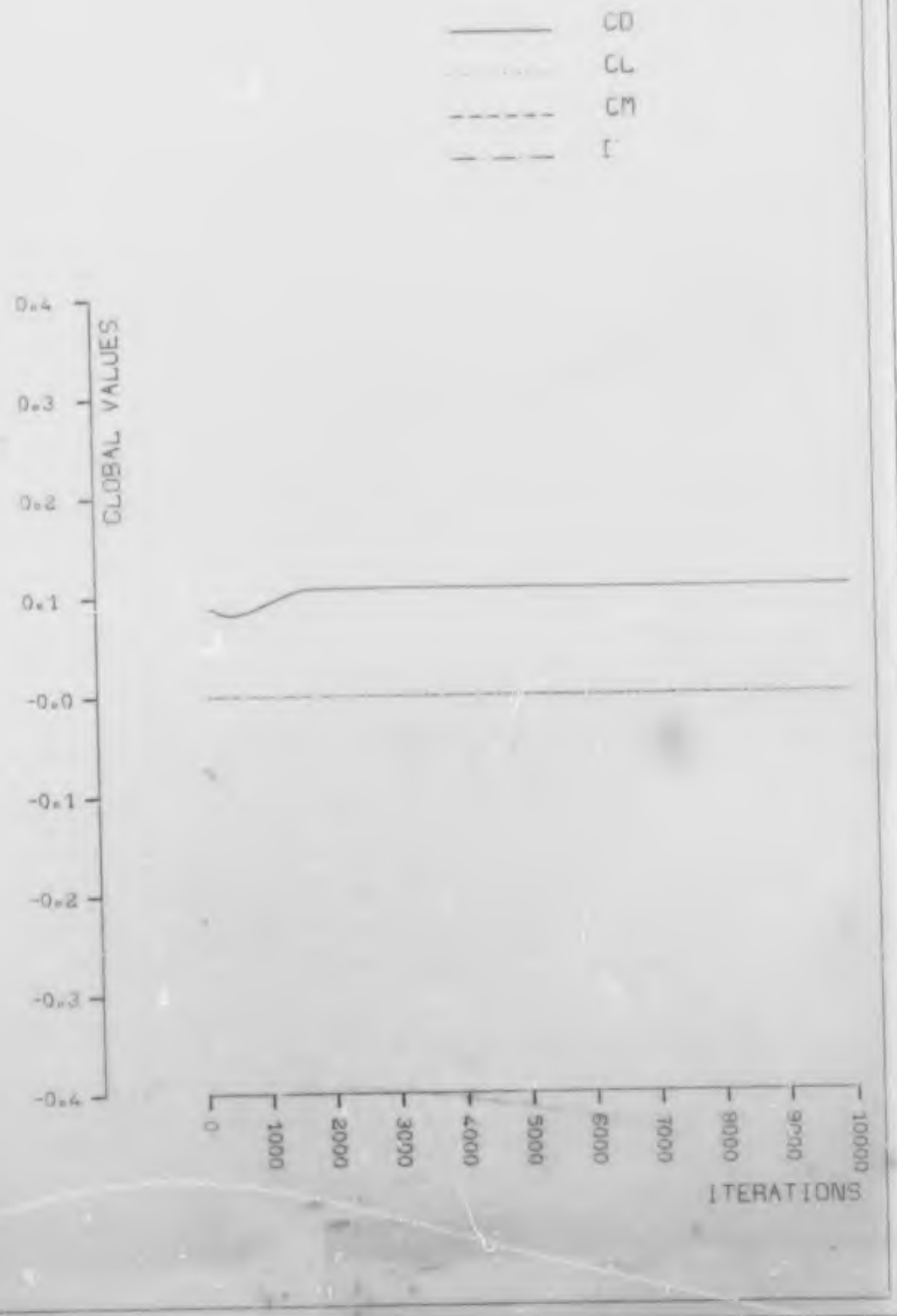
– – – – $F = \rho V$



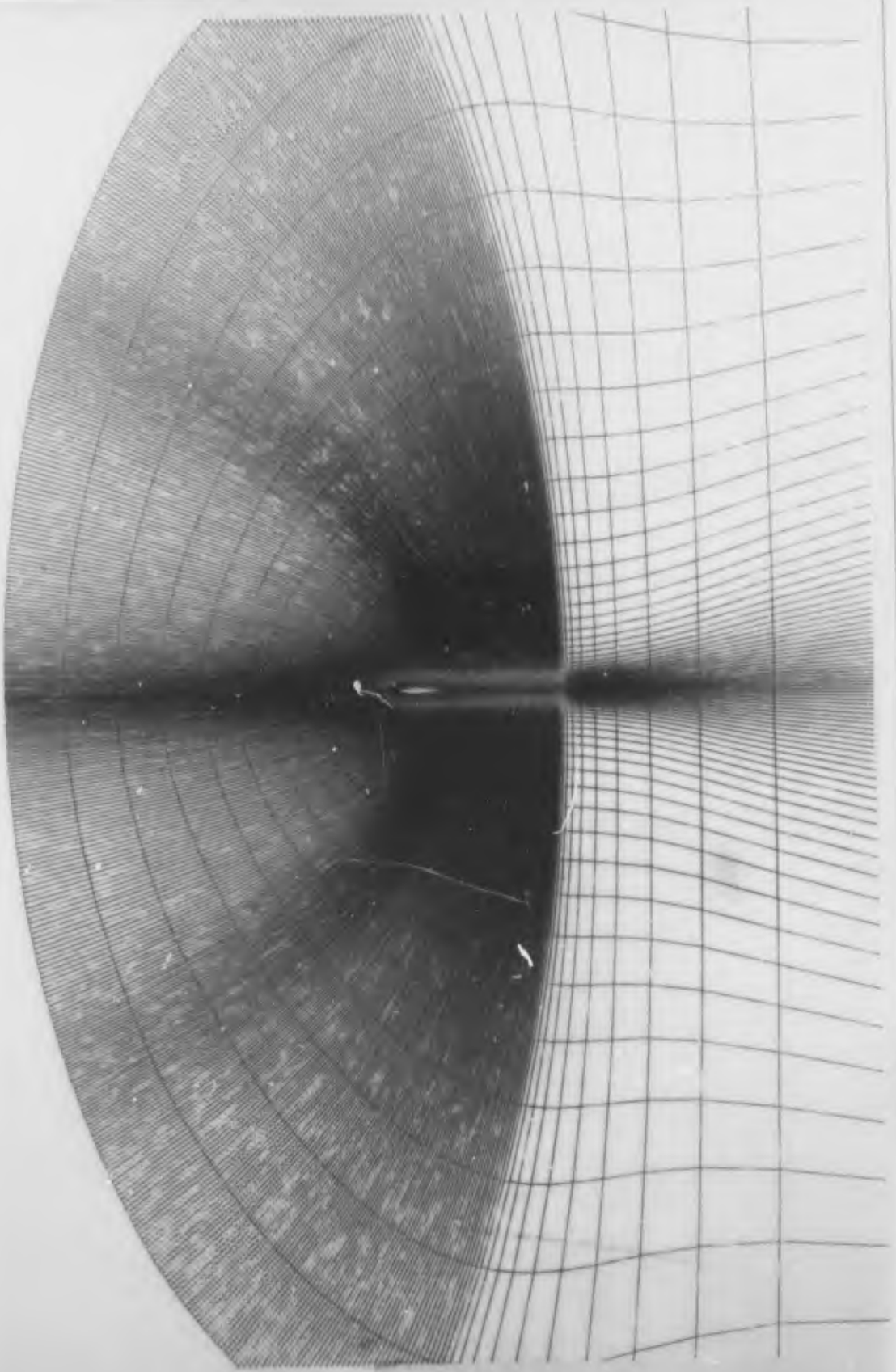
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-15
	NACA 0012: MACH = 0.95, ALPHA = 0			



ONERA	AR 211		J.P.Veuillot A.M.Vuillot	03-1-16
	NACA 0012: MACH = 0.95, ALPHA = 0			

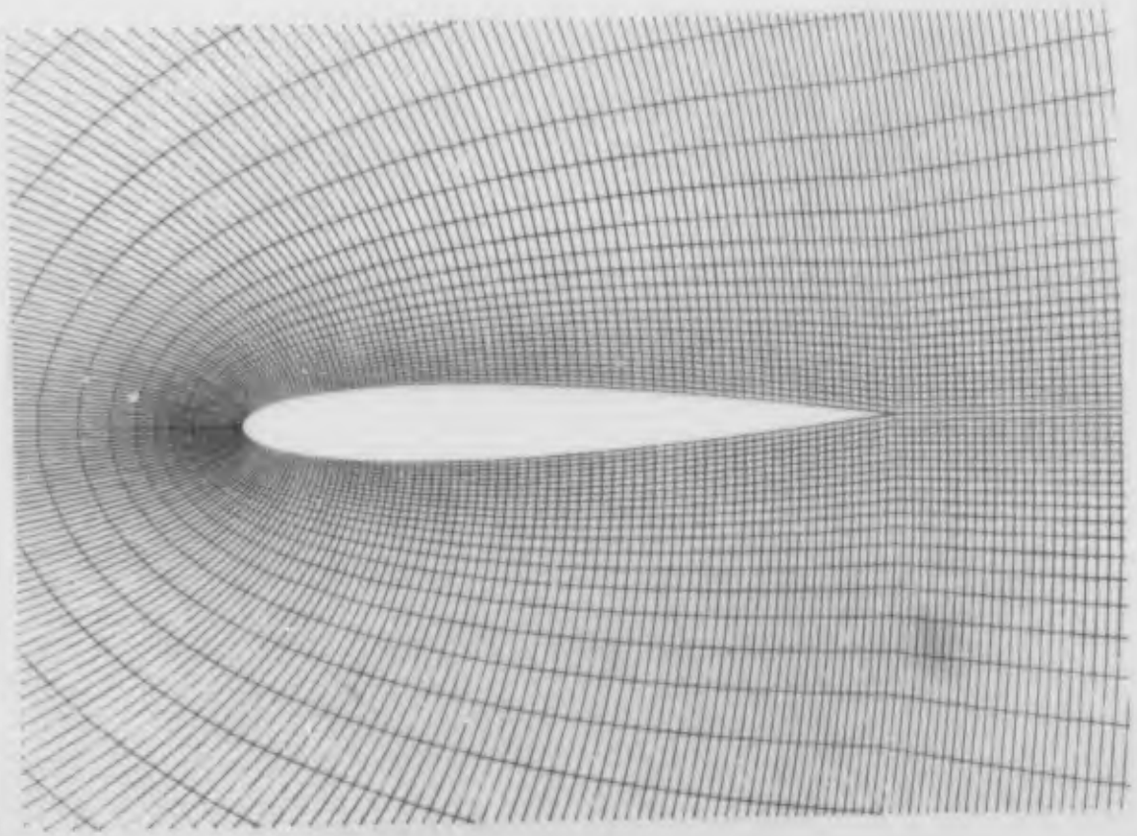


ONERA	AR 211		J.P.Veuillot A.M.Vuillot	03-1-17
	NACA 0012: MACH = 0.95, ALPHA = 0			



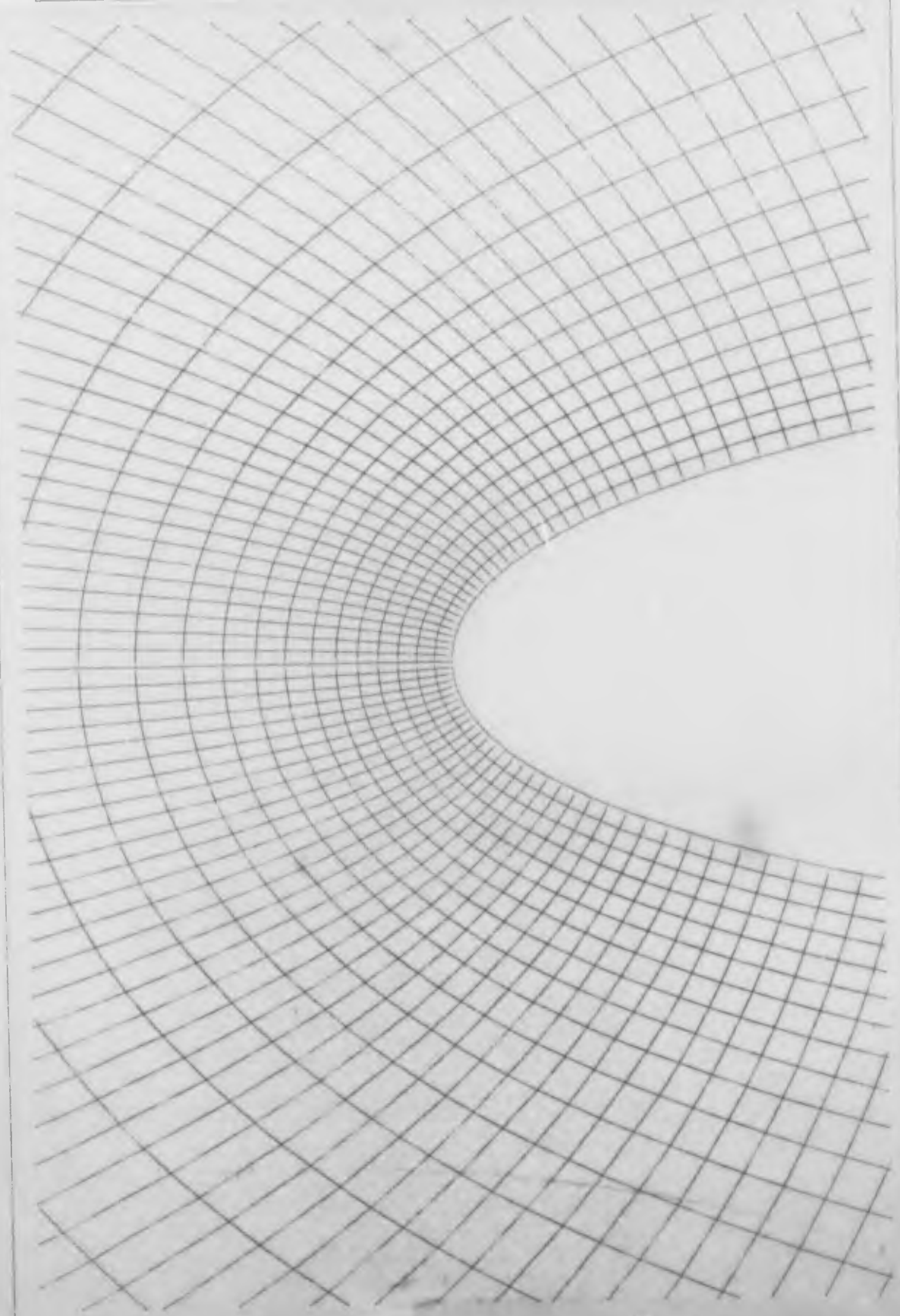
439X37 MESH (1CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-18
	NACA 0012: MACH = 0.95, ALPHA = 0			



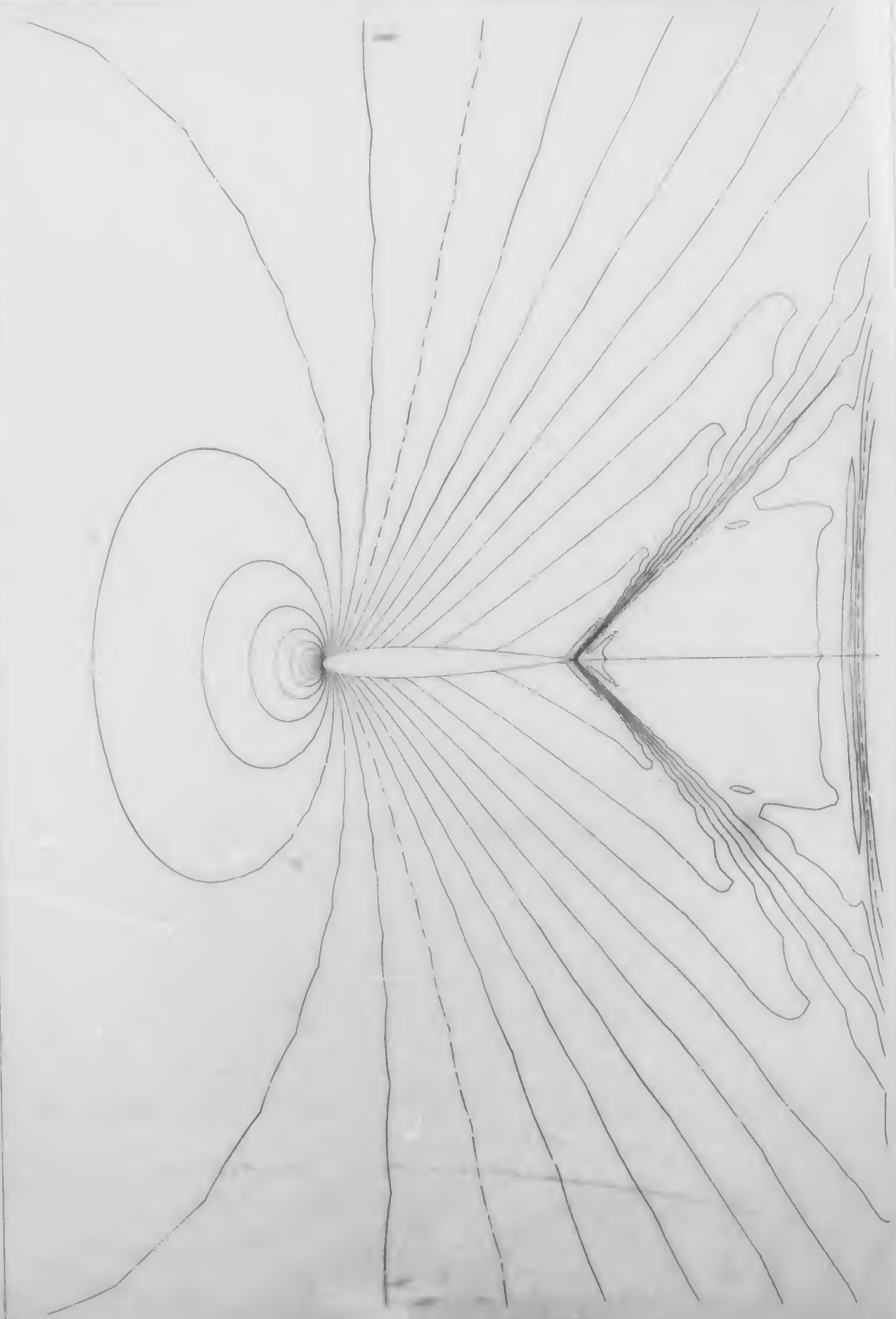
439X37 MESH PARTIAL VIEW (10CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-19
	NACA 0012: MACH = 0.95, ALPHA = 0			



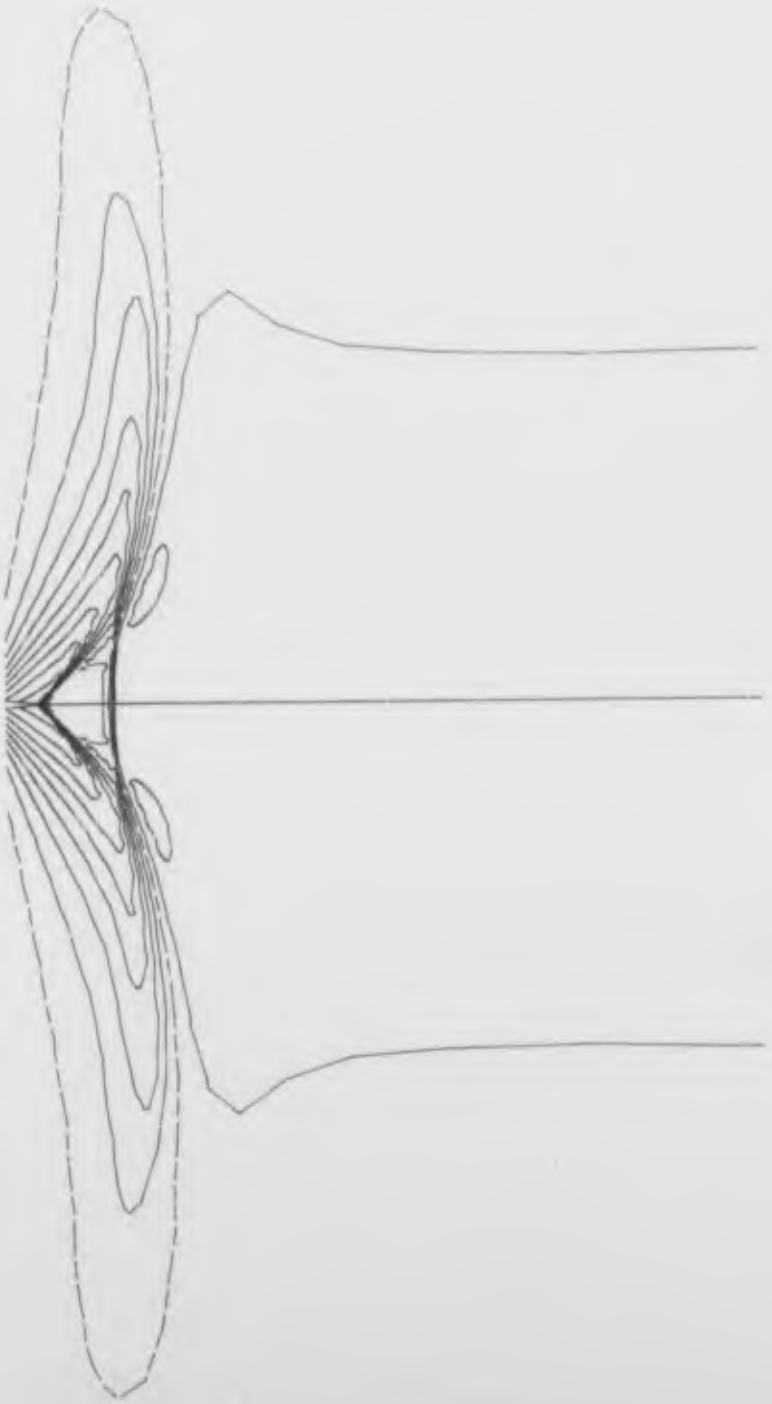
439X37 MESH PARTIAL VIEW (100CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-20
	NACA 0012: MACH = 0.95, ALPHA = 0			



ISO-MACH LINES

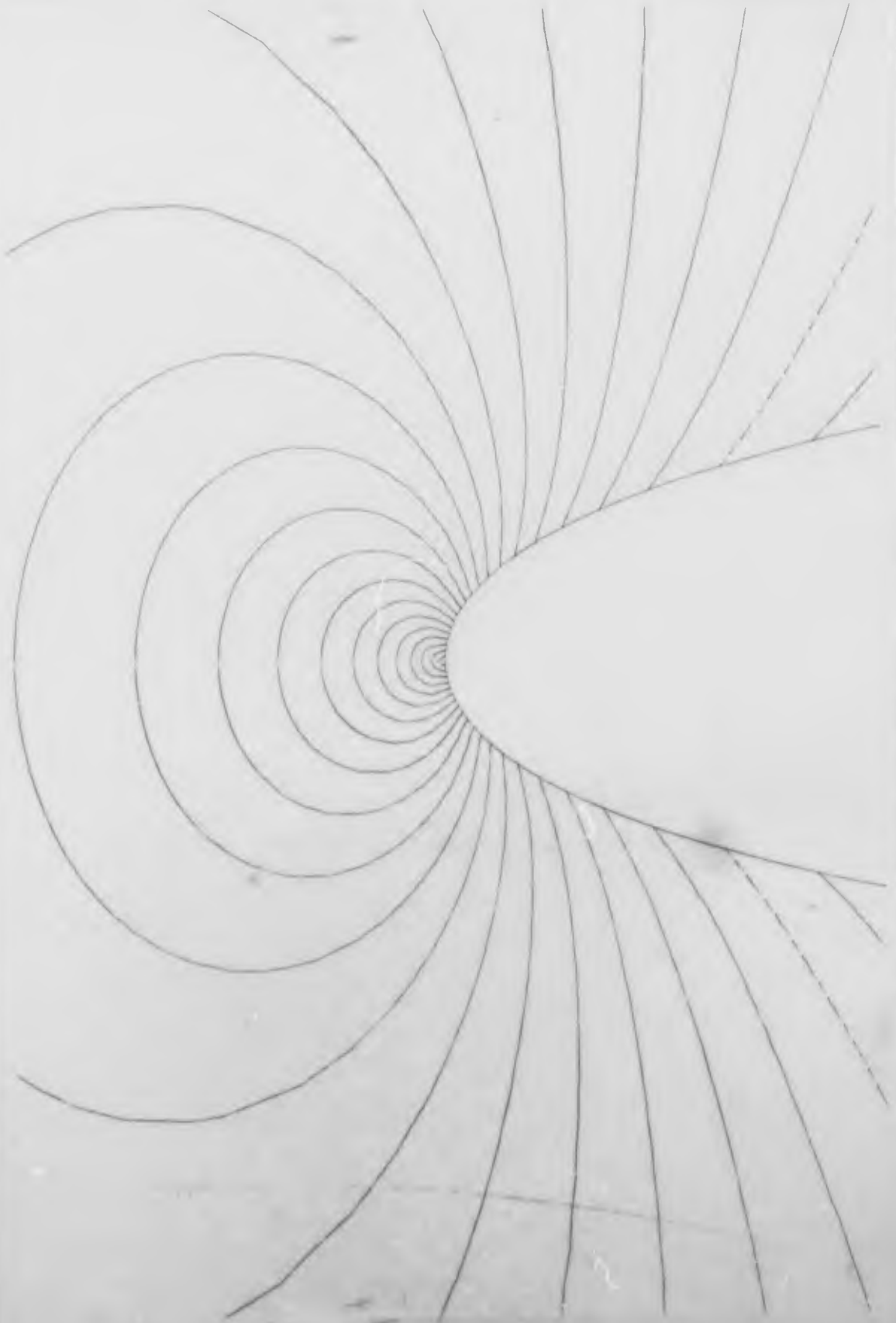
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-21
	NACA 0012: MACH = 0.95, ALPHA = 0			



ISO-MACH LINES (DM=.05 1CM CHORD)

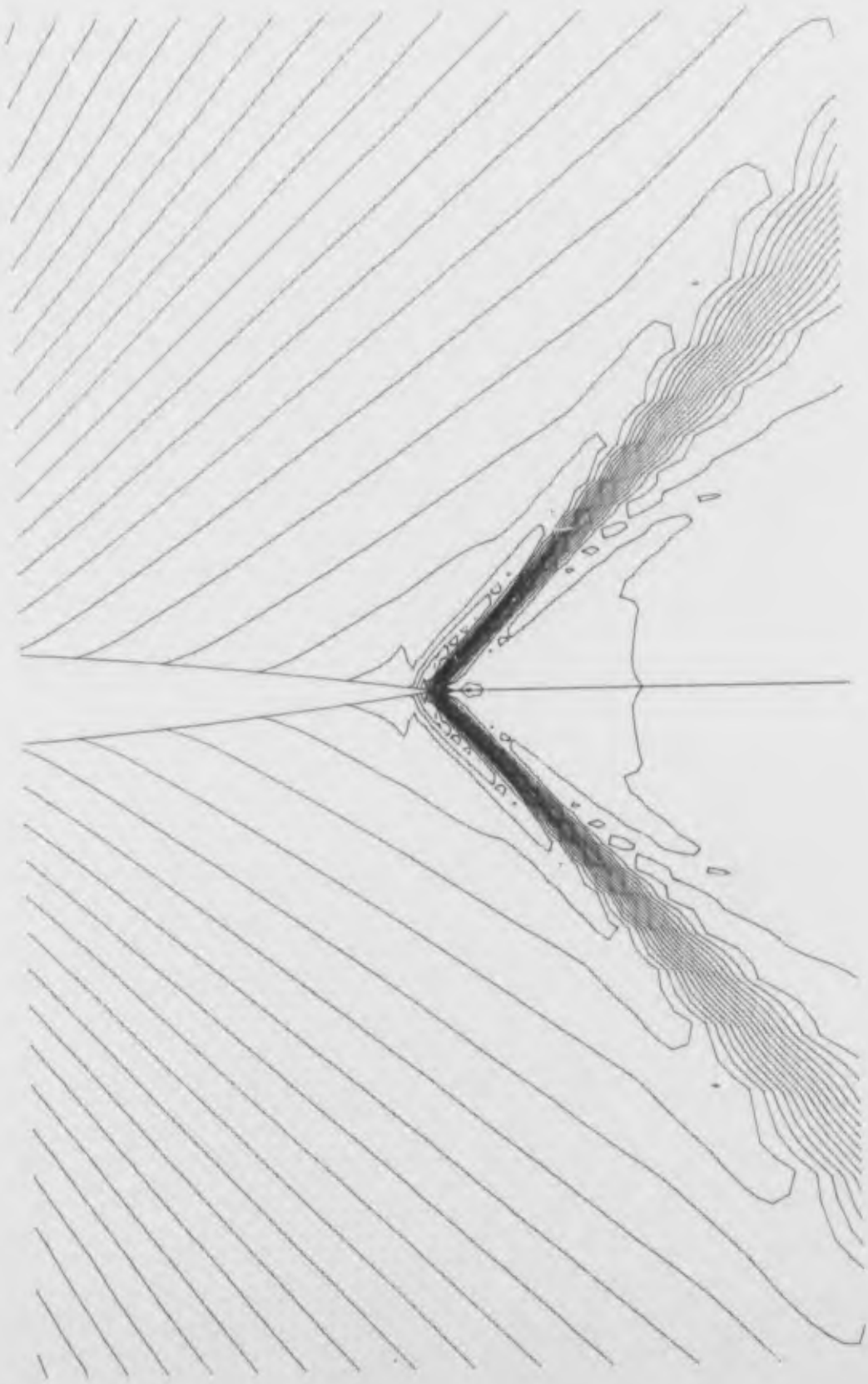
$A_\infty - M_\infty V_\infty$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-22
	NACA 0012: MACH = 0.95, ALPHA = 0			



ISO-MACH LINES (DM=.05 100CM CHORD)

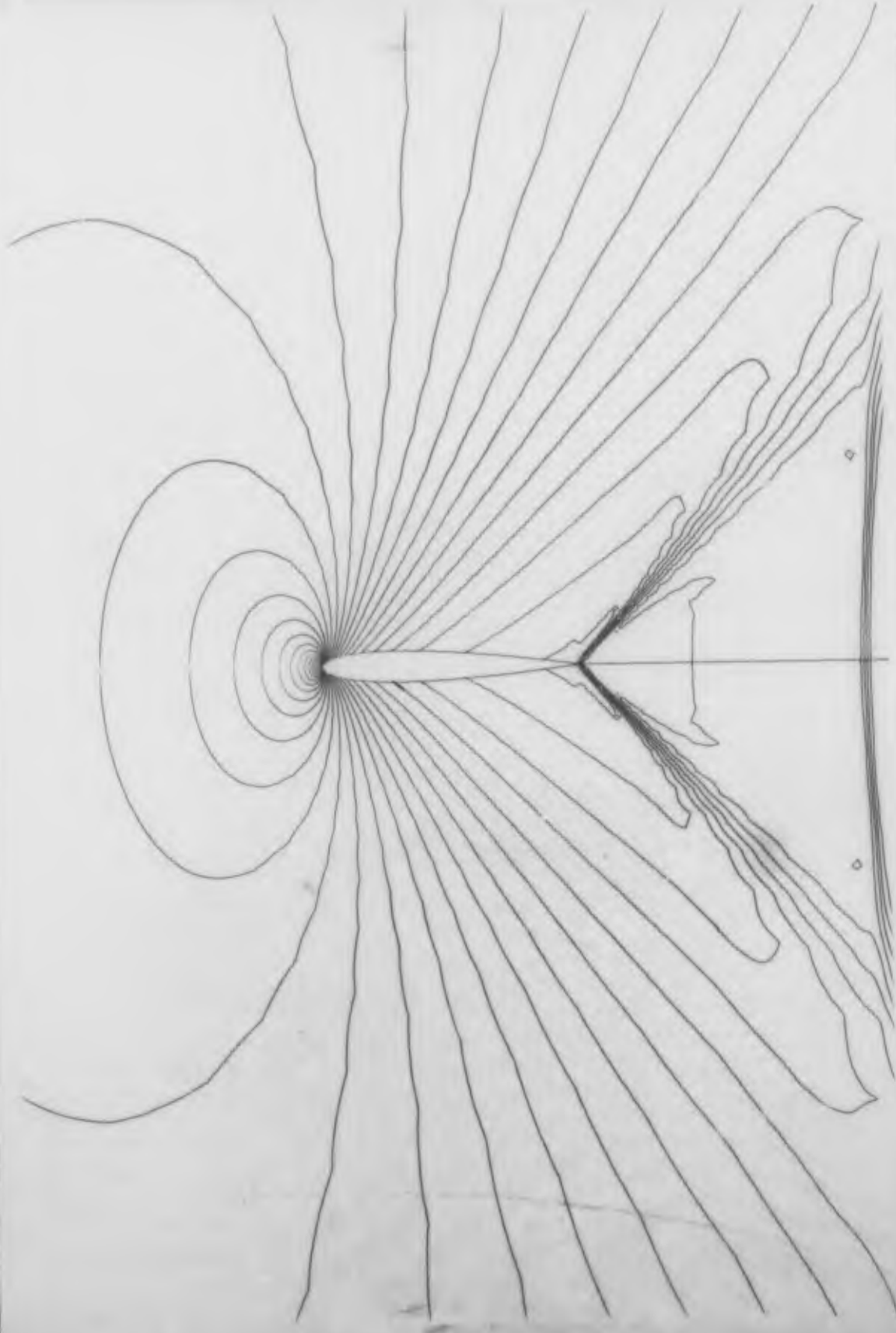
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-23
	NACA 0012: MACH = 0.95, ALPHA = 0			



ISO-MACH LINES (DM=.02 15CM CHORD)

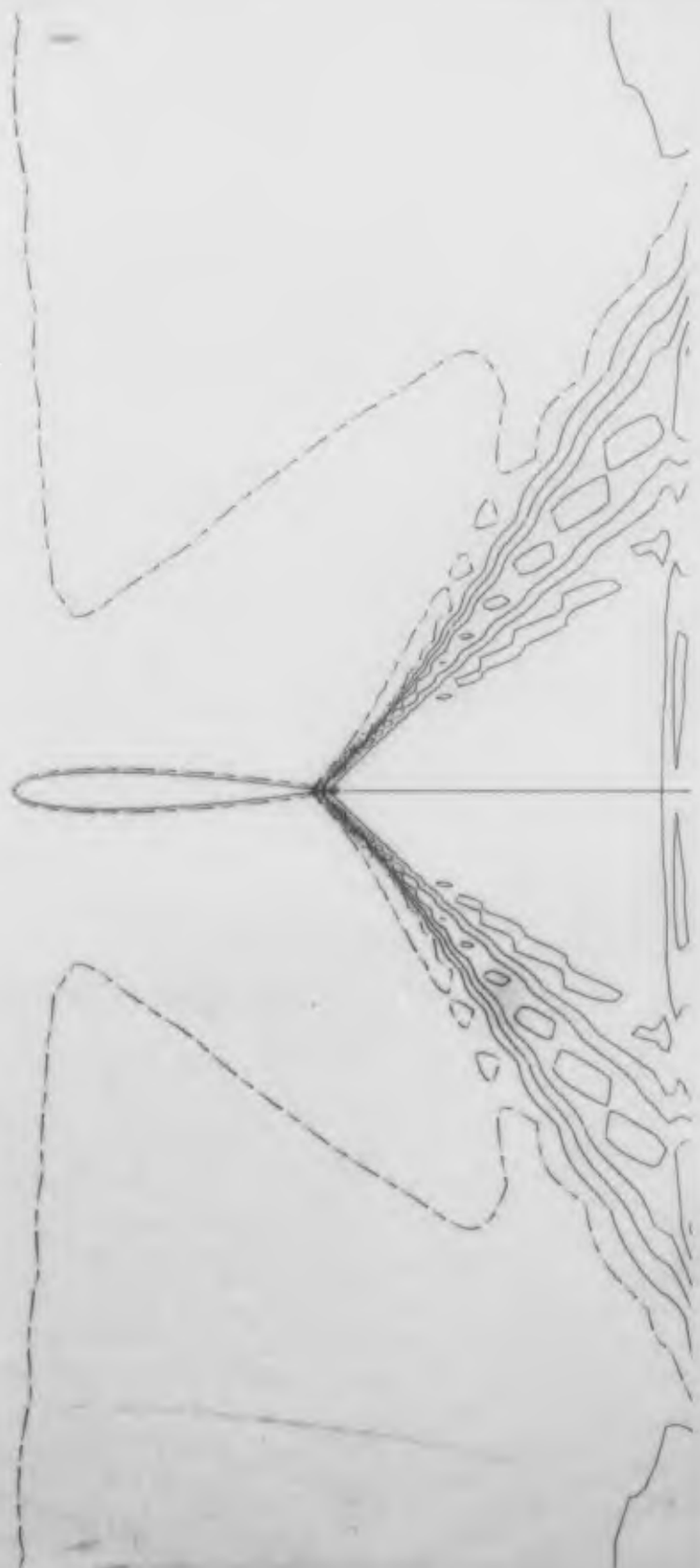
$A_\infty - M_\infty V_\infty$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Veuillot	03-1-24
	NACA 0012: MACH = 0.95, ALPHA = 0			



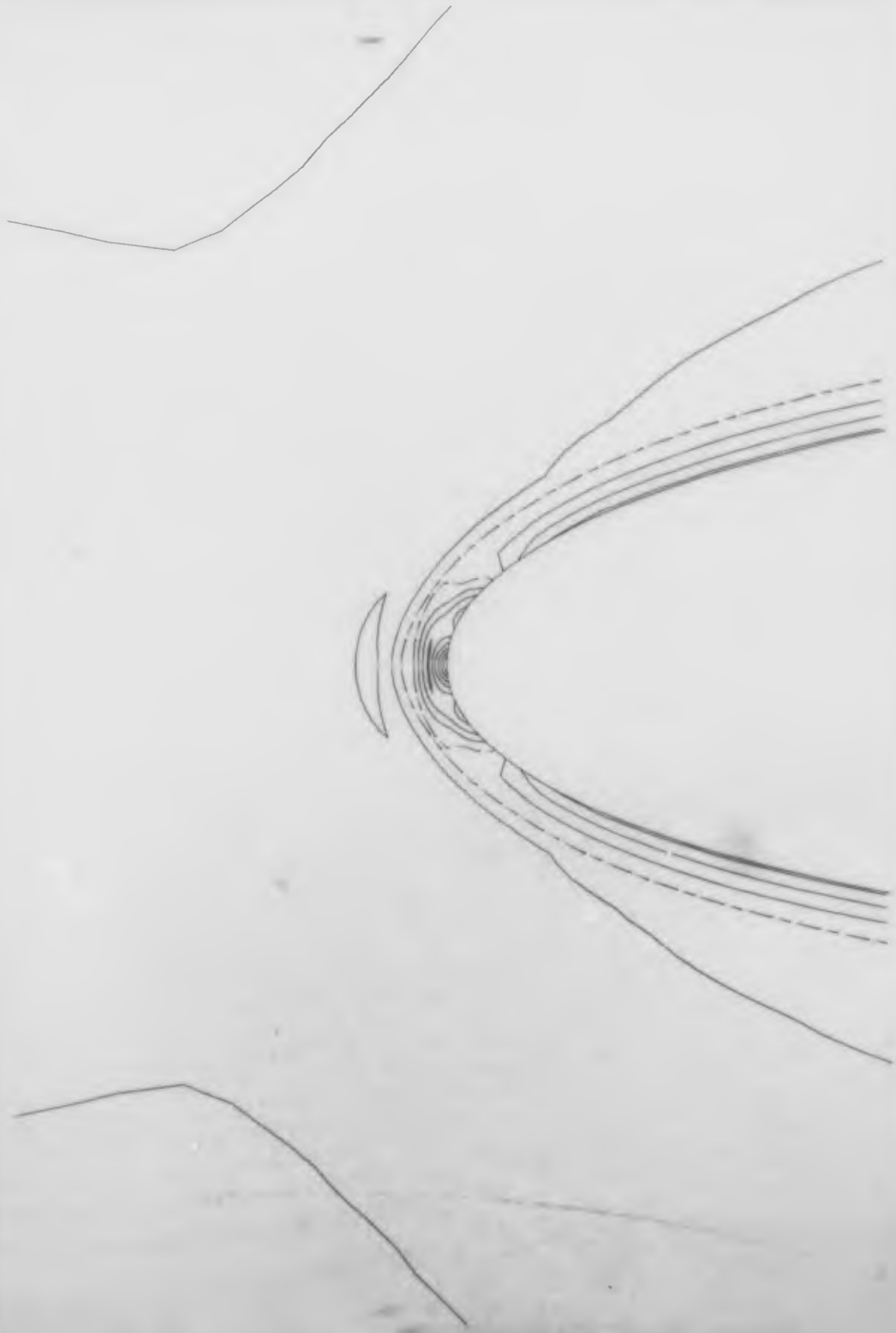
ISO-P/PIINF_LINES

O.N.E.R.A.	AR 211		J.P Veuillot A.M.Vuillot	03-1-25
	NACA 0012: MACH = 0.95, ALPHA = 0			



ISO-PI/PIINF LINES (DPI/PIINF=.005)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	03-1-26
	NACA 0012: MACH = 0.95, ALPHA = 0			



ISO-PI/PIINF LINES (DPI/PIINF=.001)

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 03

NACA 0012: MACH = 0.95, ALPHA = 0

Contributor No 3

C.C.Lytton

(R.A.E., G.B.)

R.A.E.	AR 211		C.C.Lytton	03-3-1
	NACA 0012: MACH = 0.95, ALPHA = 0			

NACA0012 MACH 0.950 ALPHA 0.000 BY FORMULA 0<X<1:

VERSION 87: KEEPS WALL CELLS ROUGHLY SAME ASPECT RATIO

AFTER K=1, CELL DEPTHS INCREASE IN GEOMETRIC PROGRESSION

TOTAL CELL DEPTH =24.0*CHORD

FULL MESH: TWO TRIANGULAR CELLS AT T.E.

ANGLE RATIO CHANGED SMOOTHLY FROM L.E. TO T.E.

MESH KINKS SWEPT OUT AND FIDDLED TOGETHER AS NEEDED

SMALL MESH ASPECT RATIO FR= 0.5306

JL	KL	NEND	NPRNT
160	24	0	0

CP*	P(CR)	CPS	P(ST)
-0.0882	0.7473	1.2464	1.4147

J	X/C	Z/C	1-P/H	CP	M	1-PI/H
81	0.000	0.0018	-0.0062	1.2639	0.1124	-0.0151
82	0.001	0.0052	0.0370	1.1418	0.2640	-0.0108
83	0.003	0.0086	0.1091	0.9378	0.4189	-0.0053
84	0.005	0.0120	0.1768	0.7463	0.5407	-0.0044
85	0.008	0.0153	0.2372	0.5754	0.6388	-0.0039
86	0.012	0.0184	0.2891	0.4285	0.7205	-0.0046
87	0.017	0.0216	0.3316	0.3081	0.7868	-0.0056
88	0.022	0.0246	0.3673	0.2072	0.8411	-0.0055
89	0.028	0.0275	0.3959	0.1263	0.8856	-0.0060
90	0.035	0.0304	0.4212	0.0547	0.9251	-0.0062
91	0.043	0.0331	0.4434	-0.0081	0.9607	-0.0070
92	0.052	0.0358	0.4629	-0.0632	0.9916	-0.0068
93	0.061	0.0383	0.4798	-0.1111	1.0185	-0.0063
94	0.070	0.0407	0.4956	-0.1557	1.0445	-0.0065
95	0.081	0.0430	0.5090	-0.1937	1.0665	-0.0061
96	0.092	0.0452	0.5216	-0.2292	1.0875	-0.0058
97	0.104	0.0472	0.5349	-0.2670	1.1103	-0.0058
98	0.116	0.0491	0.5442	-0.2934	1.1263	-0.0055
99	0.129	0.0508	0.5554	-0.3249	1.1453	-0.0048
100	0.143	0.0524	0.5648	-0.3515	1.1621	-0.0049
101	0.157	0.0538	0.5729	-0.3744	1.1760	-0.0041
102	0.172	0.0551	0.5817	-0.3995	1.1918	-0.0036
103	0.187	0.0562	0.5897	-0.4221	1.2066	-0.0035
104	0.203	0.0571	0.5967	-0.4420	1.2196	-0.0033
105	0.219	0.0579	0.6036	-0.4613	1.2322	-0.0029
106	0.236	0.0585	0.6099	-0.4792	1.2442	-0.0026
107	0.253	0.0590	0.6157	-0.4956	1.2552	-0.0024
108	0.270	0.0593	0.6215	-0.5119	1.2663	-0.0022
109	0.288	0.0594	0.6269	-0.5272	1.2770	-0.0021
110	0.306	0.0594	0.6318	-0.5412	1.2868	-0.0020

R.A.E.	AR 211		C.C.Lytton	03-3-2
	NACA 0012: MACH = 0.95, ALPHA = 0			

111	0.325	0.0593	0.6365	-0.5543	1.2960	-0.0019
112	0.344	0.0590	0.6408	-0.5666	1.3047	-0.0017
113	0.363	0.0586	0.6448	-0.5780	1.3129	-0.0016
114	0.382	0.0580	0.6486	-0.5887	1.3207	-0.0014
115	0.401	0.0573	0.6522	-0.5988	1.3279	-0.0013
116	0.421	0.0565	0.6555	-0.6081	1.3347	-0.0011
117	0.441	0.0556	0.6586	-0.6169	1.3412	-0.0009
118	0.460	0.0545	0.6615	-0.6251	1.3472	-0.0008
119	0.480	0.0534	0.6642	-0.6327	1.3528	-0.0006
120	0.500	0.0522	0.6667	-0.6398	1.3582	-0.0005
121	0.520	0.0509	0.6690	-0.6464	1.3631	-0.0004
122	0.540	0.0495	0.6712	-0.6525	1.3678	-0.0003
123	0.559	0.0480	0.6732	-0.6582	1.3723	-0.0003
124	0.579	0.0465	0.6751	-0.6637	1.3765	-0.0003
125	0.599	0.0449	0.6769	-0.6689	1.3805	-0.0003
126	0.618	0.0433	0.6787	-0.6738	1.3844	-0.0003
127	0.637	0.0416	0.6804	-0.6786	1.3881	-0.0002
128	0.656	0.0399	0.6820	-0.6831	1.3916	-0.0002
129	0.675	0.0381	0.6835	-0.6875	1.3950	-0.0001
130	0.694	0.0363	0.6850	-0.6916	1.3983	0.0000
131	0.712	0.0345	0.6864	-0.6957	1.4014	0.0001
132	0.730	0.0327	0.6878	-0.6996	1.4045	0.0002
133	0.747	0.0309	0.6892	-0.7035	1.4075	0.0003
134	0.764	0.0291	0.6905	-0.7072	1.4105	0.0004
135	0.781	0.0273	0.6918	-0.7109	1.4135	0.0005
136	0.797	0.0255	0.6931	-0.7145	1.4164	0.0005
137	0.813	0.0238	0.6943	-0.7181	1.4192	0.0006
138	0.828	0.0220	0.6956	-0.7216	1.4220	0.0006
139	0.843	0.0203	0.6968	-0.7250	1.4248	0.0007
140	0.857	0.0186	0.6980	-0.7284	1.4275	0.0008
141	0.871	0.0170	0.6991	-0.7316	1.4300	0.0009
142	0.884	0.0154	0.7002	-0.7348	1.4326	0.0011
143	0.896	0.0138	0.7013	-0.7379	1.4350	0.0012
144	0.908	0.0124	0.7024	-0.7409	1.4375	0.0013
145	0.919	0.0109	0.7034	-0.7438	1.4398	0.0014
146	0.930	0.0096	0.7044	-0.7466	1.4422	0.0015
147	0.939	0.0083	0.7054	-0.7494	1.4444	0.0016
148	0.948	0.0071	0.7063	-0.7520	1.4466	0.0016
149	0.957	0.0060	0.7072	-0.7545	1.4487	0.0017
150	0.965	0.0049	0.7080	-0.7569	1.4507	0.0016
151	0.972	0.0040	0.7088	-0.7590	1.4525	0.0015
152	0.978	0.0031	0.7095	-0.7608	1.4542	0.0015
153	0.983	0.0024	0.7100	-0.7625	1.4556	0.0015
154	0.988	0.0017	0.7106	-0.7640	1.4569	0.0014
155	0.992	0.0011	0.7110	-0.7653	1.4581	0.0012
156	0.995	0.0007	0.7114	-0.7664	1.4591	0.0012
157	0.997	0.0004	0.7117	-0.7673	1.4599	0.0011
158	0.999	0.0001	0.7122	-0.7687	1.4627	-0.0012
159	1.000	0.0000	0.6863	-0.6953	1.4037	-0.0034

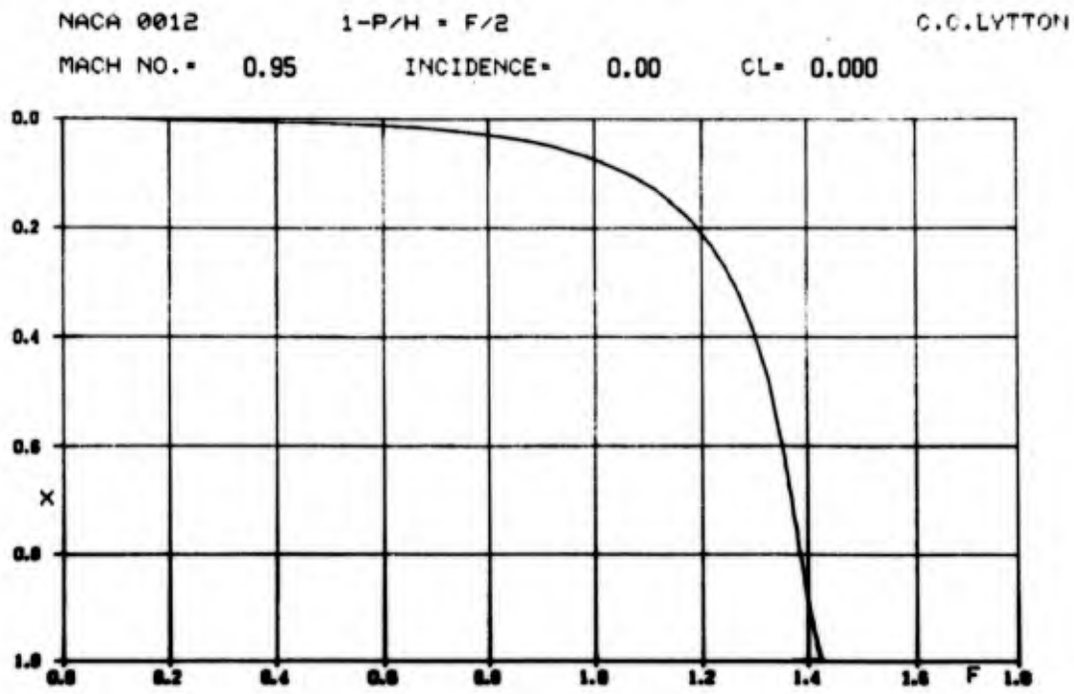
R.A.E.	AR 211		C.C.Lytton	03-3-3
	NACA 0012: MACH = 0.95, ALPHA = 0			

CL= 0.00000 CD= 0.10848 CM= 0.00000

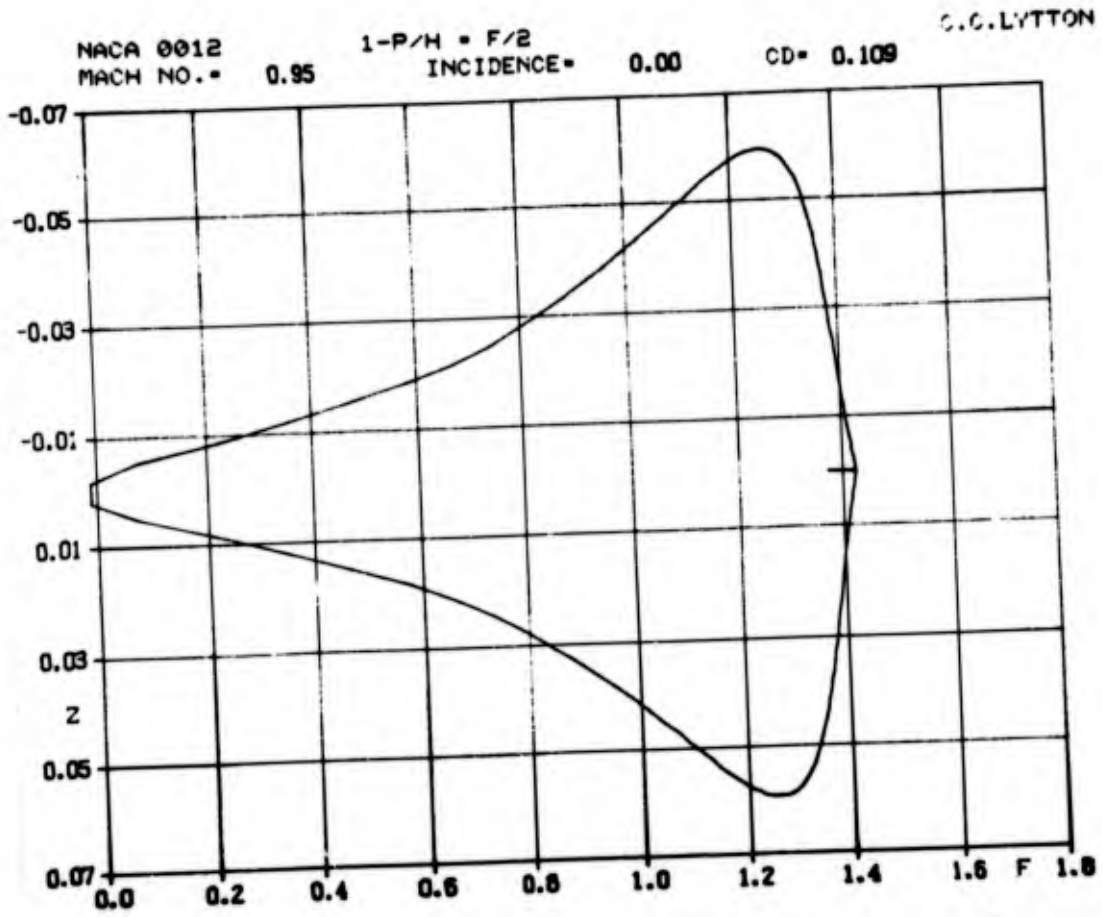
GAMMA AROUND PROFILE = 0.00000

K	X/C	Z/C	1-P/H	CP	M	1-PI/H
1	1.000	-0.0002	0.5618	-0.3431	1.1542	-0.0017
2	1.001	-0.0004	0.5841	-0.4062	1.2043	-0.0142
3	1.002	-0.0005	0.5815	-0.3987	1.2027	-0.0186
4	1.006	-0.0007	0.5673	-0.3588	1.1700	-0.0092
5	1.015	-0.0011	0.5691	-0.3637	1.1675	-0.0019
6	1.033	-0.0015	0.5634	-0.3475	1.1538	0.0024
7	1.065	-0.0022	0.5638	-0.3487	1.1524	0.0052
8	1.118	-0.0033	0.5617	-0.3428	1.1468	0.0075
9	1.203	-0.0050	0.5569	-0.3292	1.1363	0.0100
10	1.330	-0.0075	0.5529	-0.3178	1.1300	0.0088
11	1.502	-0.0108	0.5453	-0.2965	1.1180	0.0072
12	1.725	-0.0152	0.5397	-0.2806	1.1068	0.0089
13	2.013	-0.0208	0.5363	-0.2710	1.0994	0.0107
14	2.385	-0.0281	0.5327	-0.2609	1.0930	0.0109
15	2.865	-0.0376	0.5071	-0.1884	1.0478	0.0126
16	3.483	-0.0497	0.4300	0.0297	0.9237	0.0107
17	4.278	-0.0653	0.4274	0.0371	0.9199	0.0103
18	5.302	-0.0854	0.4277	0.0363	0.9204	0.0102
19	6.620	-0.1113	0.4265	0.0398	0.9191	0.0096
20	8.316	-0.1446	0.4316	0.0253	0.9277	0.0091
21	10.499	-0.1875	0.4350	0.0156	0.9336	0.0085
22	13.313	-0.2428	0.4380	0.0073	0.9387	0.0081
23	16.963	-0.3145	0.4391	0.0040	0.9408	0.0077
24	22.105	-0.4152	0.4401	0.0013	0.9428	0.0073

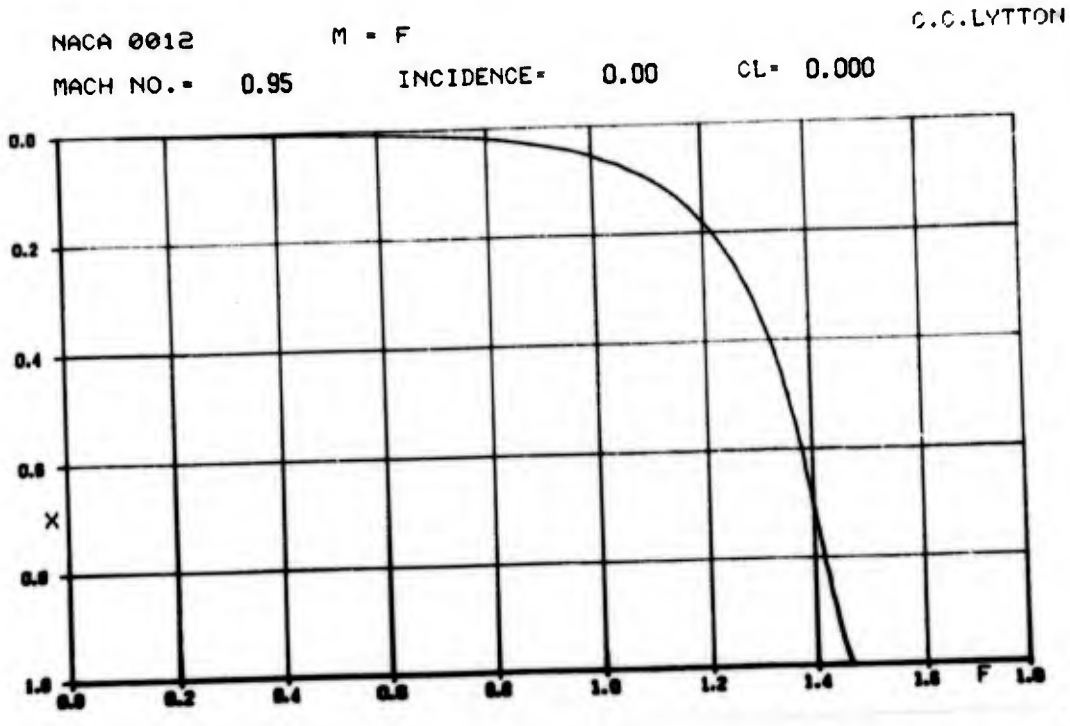
R.A.E.	AR 211		C.C.Lytton	03-3-4
	NACA 0012: MACH = 0.95, ALPHA = 0			



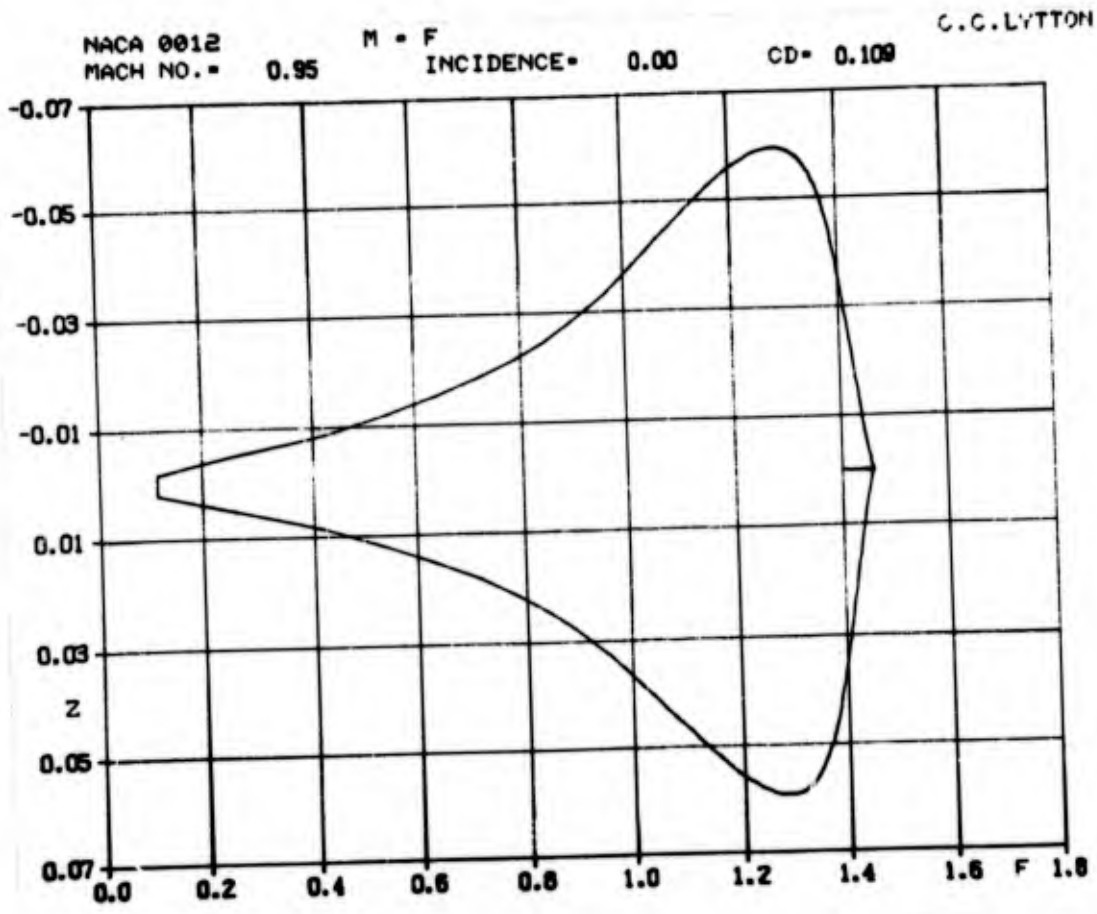
R.A.E.	AR 211		C.C.Lytton	03-3-5
	NACA 0012: MACH = 0.95, ALPHA = 0			



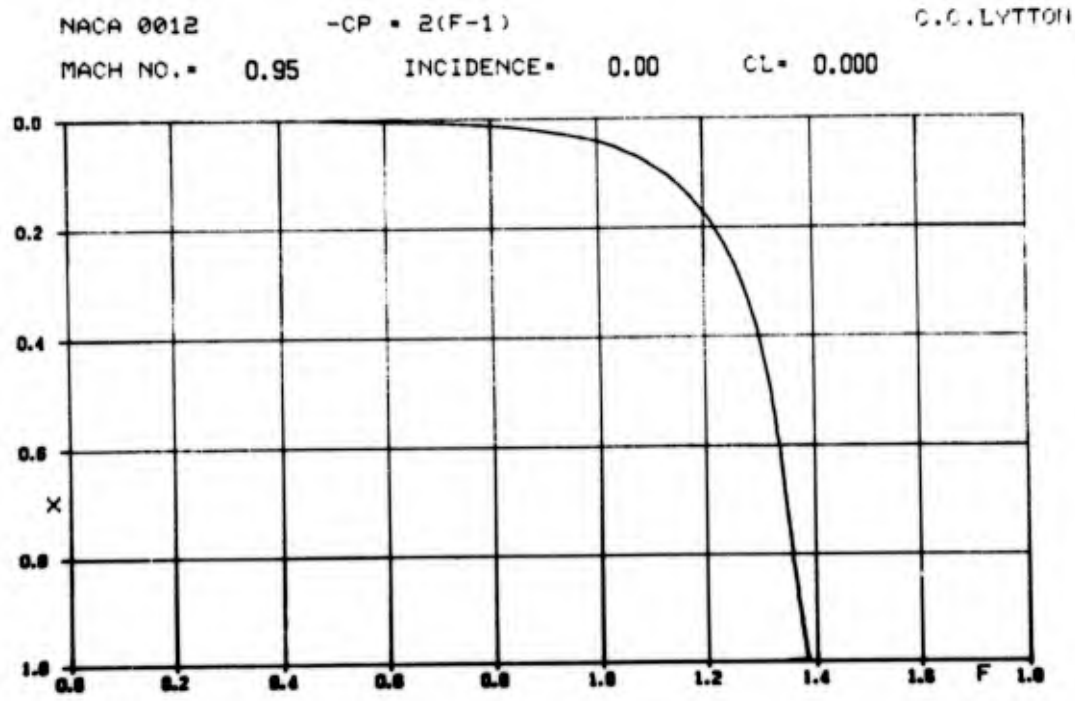
R.A.E.	AR 211		C.C.Lytton	03-3-6
	NACA 0012: MACH = 0.95, ALPHA = 0			



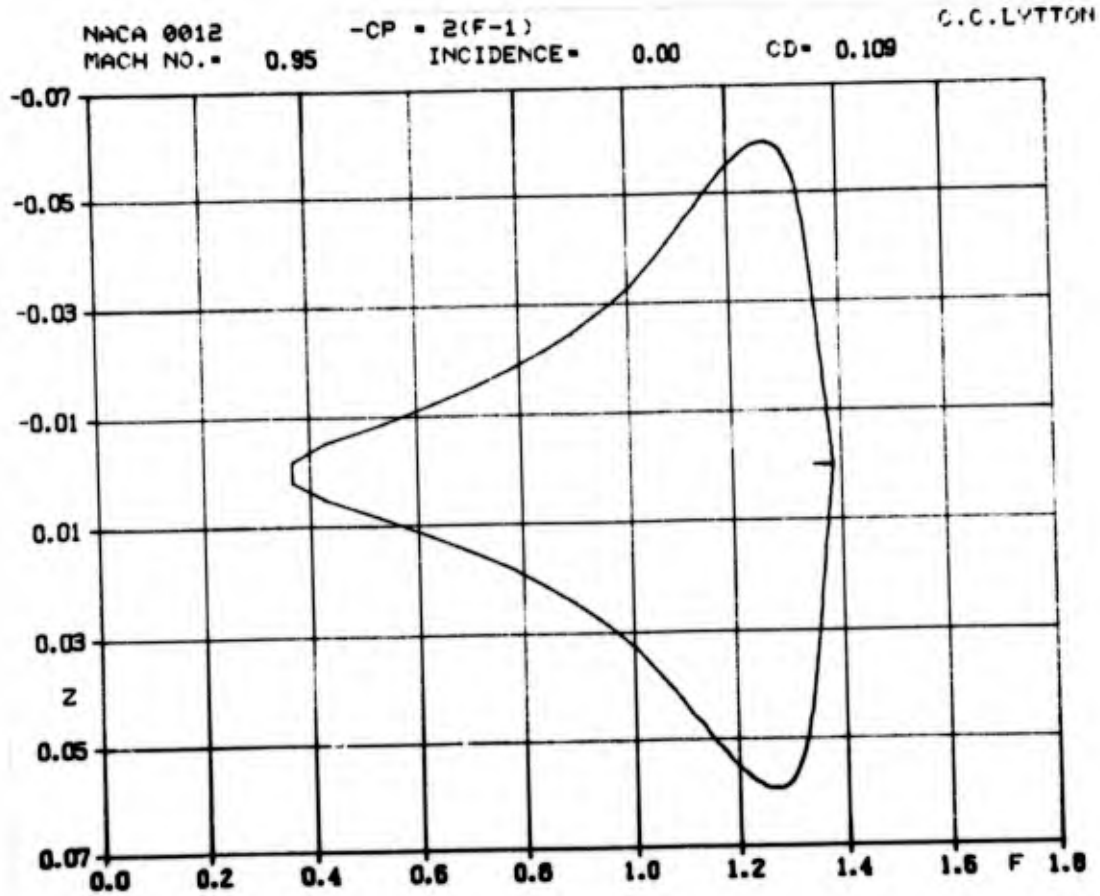
R.A.E.	AR 211		C.C.Lytton	03-3-7
	NACA 0012: MACH = 0.95, ALPHA = 0			



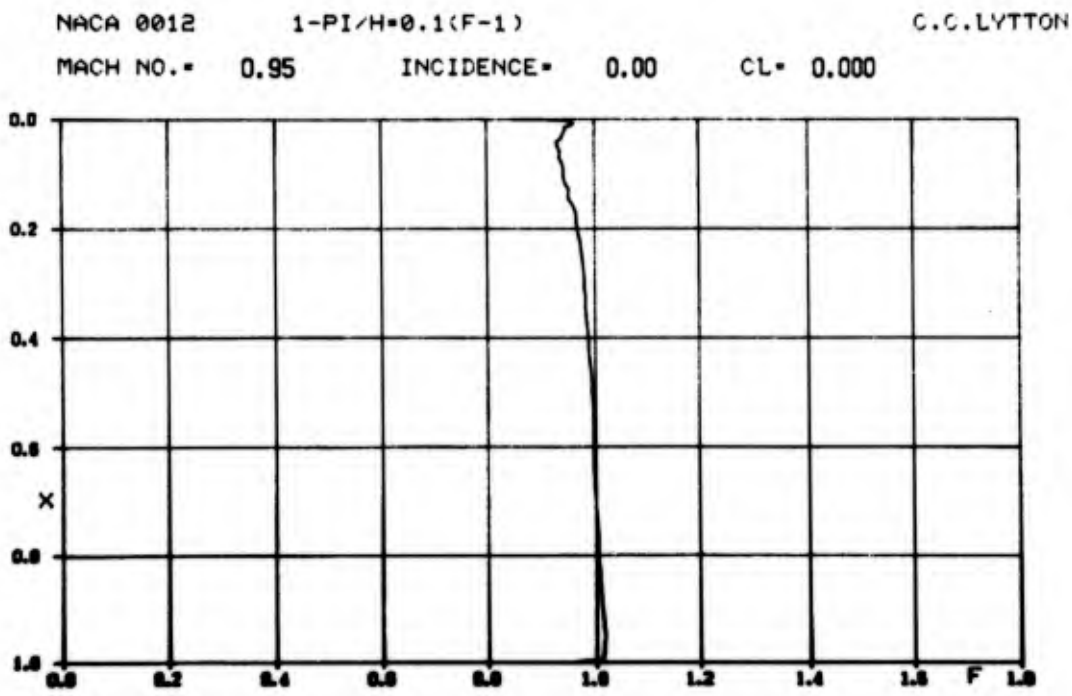
R.A.E.	AR 211		C.C.Lytton	03-3-8
	NACA 0012: MACH = 0.95, ALPHA = 0			



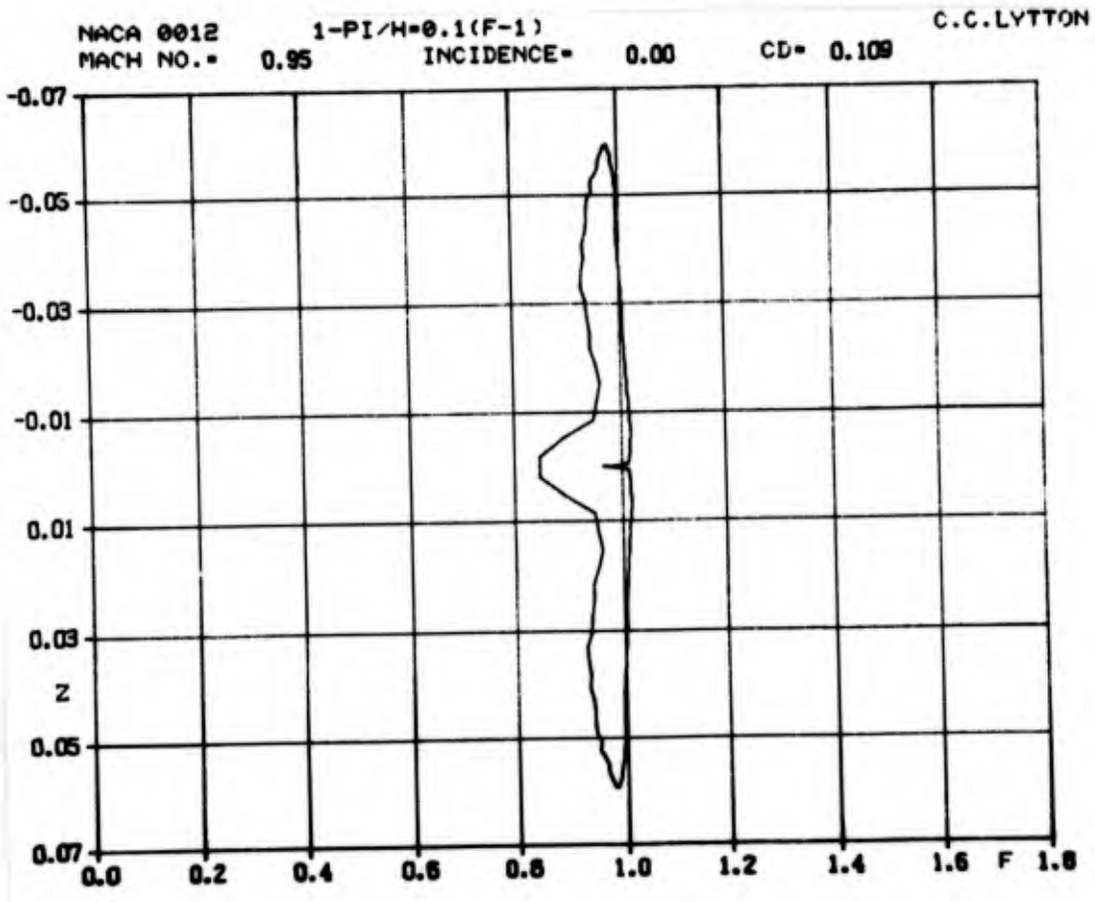
R.A.E.	AR 211		C.C.Lytton	03-3-9
	NACA 0012: MACH = 0.95, ALPHA = 0			



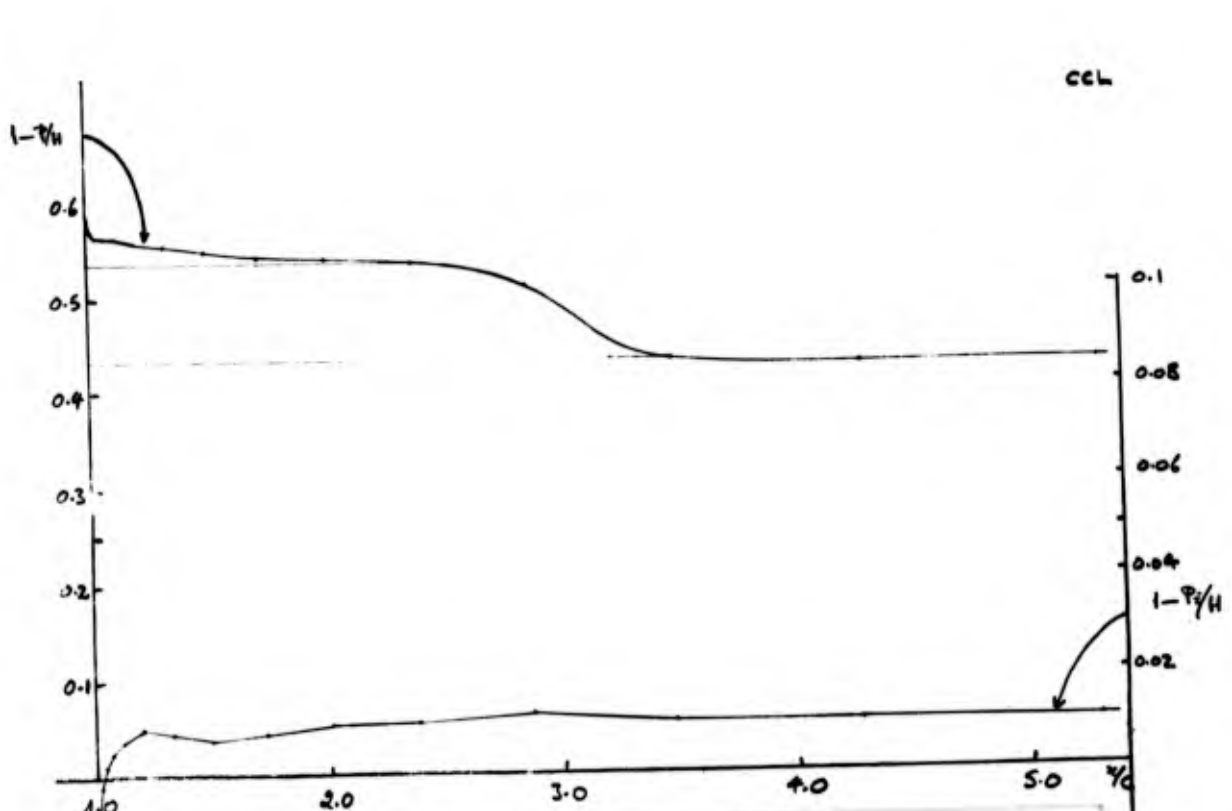
R.A.E.	AR 211		C.C.Lytton	03-3-10
	NACA 0012: MACH = 0.95, ALPHA = 0			



R.A.E.	AR 211		C.C.Lytton	03-3-11
	NACA 0012: MACH = 0.95, ALPHA = 0			

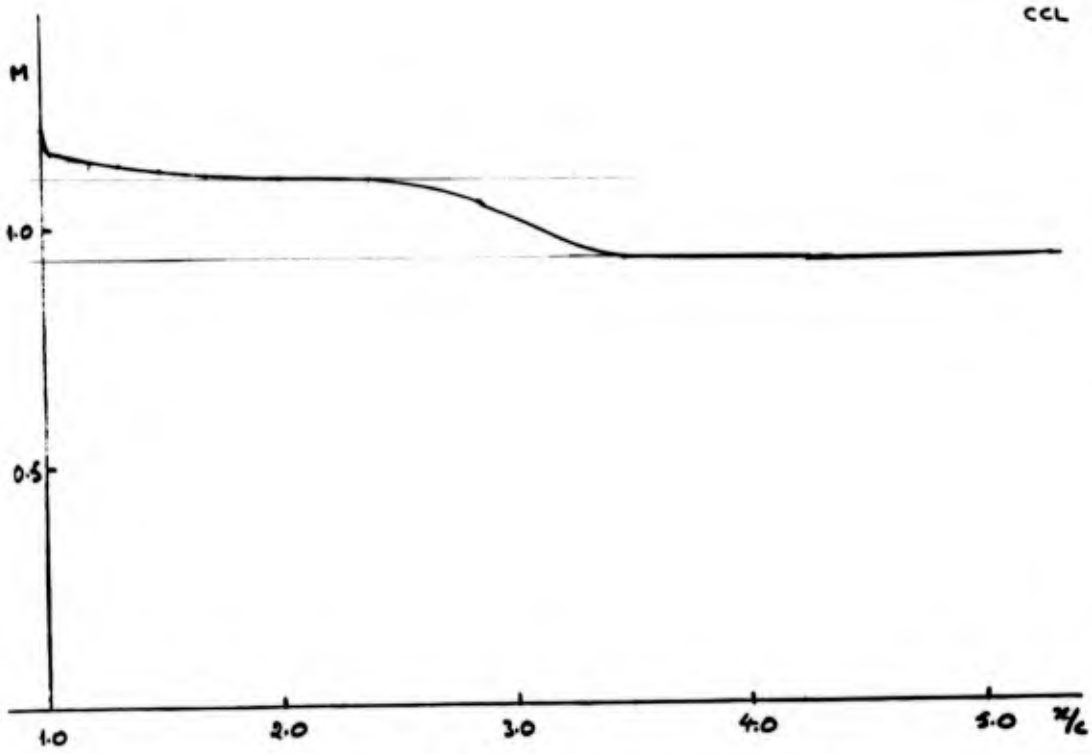


R.A.E.	AR 211		C.C.Lytton	03-3-12
	NACA 0012: MACH = 0.95, ALPHA = 0			



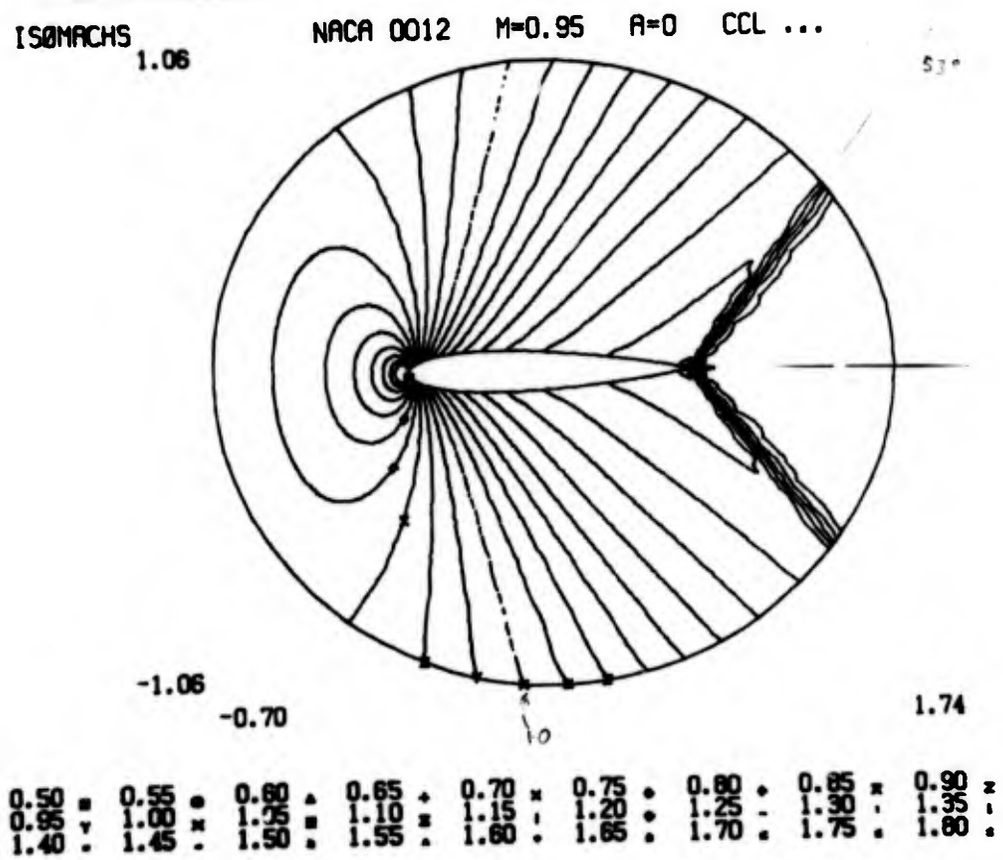
NACA 0012: $M_\infty = 0.95$, $\alpha = 0$ (Case 3). Downstream plot

R.A.E.	AR 211		C.C.Lytton	03-3-13
	NACA 0012: MACH = 0.95, ALPHA = 0			



NACA 0012: $M_\infty = 0.95$, $\alpha = 0$ (Case 3). Downstream plot

R.A.E.	AR 211		C.C.Lytton	03-3-14
	NACA 0012: MACH = 0.95, ALPHA = 0			



AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 03

NACA 0012: MACH = 0.95, ALPHA = 0

Contributor No 6

M.D.Salas and J.C.South, Jr

(N.A.S.A. – Langley, U.S.A.)

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-1
	NACA 0012: MACH = 0.95, ALPHA = 0			

NASA Langley Research Center - AGARD case 03
NACA 0012 Mach=0.950 alpha=0.000 (deg)
Cl=0.0000 Cd=0.1086 Cm=0.0000

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-2
	NACA 0012: MACH = 0.95, ALPHA = 0			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
1	.000115	.001330	.006118	1.229130	.061786	.003459
2	.000575	.003980	.029031	1.164302	.185837	.005354
3	.001500	.006610	.066729	1.057640	.300871	.006240
4	.002890	.009215	.115920	.918461	.411310	.006721
5	.004755	.011790	.166688	.774821	.507433	.006571
6	.007100	.014330	.214021	.640901	.588917	.006079
7	.009915	.016830	.257319	.518395	.658535	.006351
8	.013200	.019290	.295547	.410236	.720491	.004598
9	.016960	.021710	.329215	.314978	.772557	.004618
10	.021195	.024085	.358379	.232461	.819089	.003064
11	.025895	.026405	.383357	.161790	.857132	.003633
12	.031055	.028670	.404658	.101522	.891696	.002093
13	.036675	.030880	.424755	.044662	.922512	.002826
14	.042750	.033030	.441861	-.003736	.950720	.001550
15	.049270	.035115	.457588	-.048235	.975079	.002433
16	.056235	.037135	.471575	-.087810	.998828	.001096
17	.063640	.039085	.485080	-.126018	1.020180	.001916
18	.071470	.040960	.496160	-.157368	1.039373	.000841
19	.079725	.042760	.508018	-.190918	1.058685	.001412
20	.088400	.044480	.518762	-.221316	1.077647	.000405
21	.097480	.046115	.528588	-.249117	1.093898	.001044
22	.106960	.047665	.537419	-.274104	1.109969	.000008
23	.116830	.049125	.546564	-.299979	1.125550	.000468
24	.127085	.050495	.553622	-.319948	1.138483	-.000159
25	.137720	.051775	.561717	-.342853	1.152826	-.000078
26	.148720	.052960	.568299	-.361475	1.164841	-.000312
27	.160080	.054050	.575728	-.382494	1.178598	-.000660
28	.171785	.055040	.581997	-.400230	1.190030	-.000578
29	.183825	.055935	.587462	-.415693	1.200350	-.000847
30	.196190	.056730	.594120	-.434530	1.212985	-.001108
31	.208870	.057420	.599779	-.450541	1.223656	-.001102
32	.221860	.058010	.605014	-.465354	1.233893	-.001461
33	.235140	.058500	.610025	-.479530	1.243415	-.001329
34	.248700	.058890	.614870	-.493239	1.253143	-.001790
35	.262530	.059180	.619473	-.506262	1.261959	-.001557
36	.276620	.059370	.624082	-.519304	1.271489	-.002164
37	.290955	.059460	.628281	-.531185	1.279532	-.001767
38	.305520	.059455	.631908	-.541446	1.287225	-.002362
39	.320305	.059355	.635936	-.552843	1.295082	-.002008
40	.335290	.059160	.639511	-.562956	1.302744	-.002561
41	.350465	.058870	.643486	-.574204	1.310727	-.002359
42	.365820	.058490	.646118	-.581652	1.316331	-.002609
43	.381335	.058030	.648803	-.589248	1.321774	-.002449
44	.396995	.057485	.652320	-.599198	1.329483	-.002974
45	.412785	.056855	.654976	-.606714	1.334679	-.002455
46	.428690	.056150	.657268	-.613198	1.339985	-.003108
47	.444695	.055370	.659916	-.620690	1.345216	-.002578
48	.460780	.054520	.661919	-.626356	1.349911	-.003172
49	.476930	.053600	.664848	-.634645	1.355976	-.002876
50	.493130	.052615	.666116	-.638233	1.358794	-.002999

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-3
	NACA 0012: MACH = 0.95, ALPHA = 0			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
51	.509365	.051575	.668119	-.643900	1.363141	-.003026
52	.525615	.050475	.670317	-.650117	1.368003	-.003155
53	.541860	.049320	.672093	-.655142	1.371750	-.002977
54	.558085	.048115	.673815	-.660015	1.375710	-.003240
55	.574270	.046865	.675161	-.663824	1.378452	-.002936
56	.590400	.045575	.676668	-.668088	1.382073	-.003355
57	.606460	.044245	.678380	-.672931	1.385606	-.002994
58	.622430	.042880	.679644	-.676509	1.388651	-.003325
59	.638285	.041485	.681079	-.680566	1.391622	-.003008
60	.654015	.040065	.681740	-.682439	1.393276	-.003256
61	.669600	.038625	.683294	-.686834	1.396697	-.003172
62	.685020	.037160	.685078	-.691882	1.400851	-.003370
63	.700265	.035680	.685355	-.692665	1.401064	-.002788
64	.715310	.034190	.686905	-.697051	1.405207	-.003691
65	.730140	.032685	.688379	-.701222	1.407878	-.002737
66	.744740	.031175	.689152	-.703408	1.410280	-.003649
67	.759090	.029665	.690175	-.706303	1.411906	-.002647
68	.773175	.028155	.691354	-.709639	1.415500	-.003920
69	.786975	.026650	.692337	-.712421	1.416704	-.002428
70	.800475	.025155	.693292	-.715122	1.420111	-.004149
71	.813665	.023670	.694388	-.718222	1.421270	-.002207
72	.826525	.022200	.695176	-.720452	1.424655	-.004433
73	.839040	.020745	.697094	-.725879	1.427506	-.002159
74	.851195	.019310	.697383	-.726697	1.429759	-.004411
75	.862975	.017905	.698024	-.728511	1.429508	-.001925
76	.874365	.016525	.699812	-.733571	1.435994	-.005221
77	.885350	.015175	.700488	-.735483	1.434696	-.001108
78	.895915	.013865	.700950	-.736790	1.439091	-.005838
79	.906050	.012590	.702601	-.741460	1.439402	-.000729
80	.915740	.011355	.703152	-.743021	1.444773	-.006553
81	.924970	.010165	.704878	-.747902	1.444241	.000058
82	.933735	.009025	.704254	-.746138	1.447842	-.007219
83	.942015	.007940	.705648	-.750081	1.445547	.000807
84	.949795	.006905	.706961	-.753795	1.455537	-.009043
85	.957065	.005930	.708145	-.757147	1.450000	.002963
86	.963815	.005020	.706882	-.753573	1.456527	-.010744
87	.970035	.004175	.709341	-.760530	1.451738	.004578
88	.975710	.003395	.708979	-.759505	1.463545	-.013658
89	.980825	.002685	.712471	-.769385	1.456888	.008014
90	.985370	.002055	.707299	-.754754	1.461832	-.017006
91	.989335	.001505	.712654	-.769904	1.454847	.011538
92	.992700	.001035	.709293	-.760396	1.469853	-.021774
93	.995450	.000645	.717491	-.783589	1.460459	.020335
94	.997570	.000345	.700219	-.734722	1.455060	-.031550
95	.999035	.000140	.730867	-.821435	1.505048	.004751
96	.999800	.000030	.714904	-.776270	1.460654	.011088
97	.999800	-.000030	.714711	-.775724	1.459495	.012062
98	.999035	-.000140	.730778	-.821184	1.504648	.005000
99	.997570	-.000345	.700253	-.734817	1.454899	-.031198
100	.995450	-.000645	.717484	-.783570	1.460493	.020263

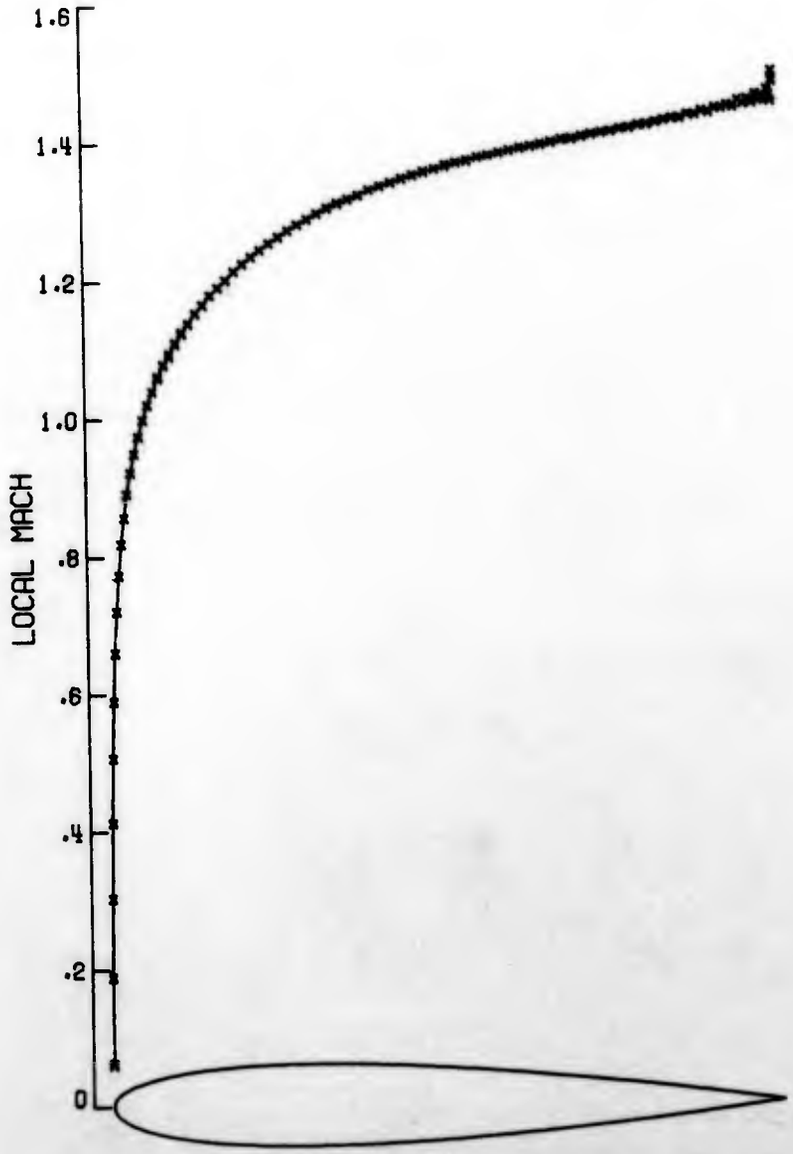
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-4
	NACA 0012: MACH = 0.95, ALPHA = 0			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
101	.992700	-.001035	.709312	-.760448	1.469751	-.021559
102	.989335	-.001505	.712617	-.769800	1.454789	.011494
103	.985370	-.002055	.707315	-.754797	1.461761	-.016850
104	.980825	-.002685	.712514	-.769508	1.456981	.008031
105	.975710	-.003395	.709039	-.759676	1.463637	-.013581
106	.970035	-.004175	.709360	-.760585	1.451814	.004536
107	.963815	-.005020	.706842	-.753459	1.456431	-.010745
108	.957065	-.005930	.708061	-.756909	1.449828	.002921
109	.949795	-.006905	.706935	-.753723	1.455455	-.009012
110	.942015	-.007940	.705757	-.750391	1.445805	.000810
111	.933735	-.009025	.704445	-.746678	1.448241	-.007144
112	.924970	-.010165	.704870	-.747881	1.444273	-.000015
113	.915740	-.011355	.702859	-.742189	1.444155	-.006661
114	.906050	-.012585	.701803	-.739203	1.437506	-.000706
115	.895915	-.013860	.701928	-.739555	1.441112	-.005442
116	.885350	-.015175	.700624	-.735868	1.435370	-.001612
117	.874365	-.016525	.699561	-.732860	1.435142	-.004843
118	.862975	-.017905	.698147	-.728860	1.429951	-.002148
119	.851195	-.019310	.697369	-.726658	1.429572	-.004189
120	.839040	-.020745	.697094	-.725879	1.427624	-.002327
121	.826525	-.022200	.695181	-.720467	1.424540	-.004252
122	.813665	-.023670	.694451	-.718402	1.421498	-.002322
123	.800475	-.025155	.693295	-.715130	1.420039	-.004039
124	.786975	-.026650	.692305	-.712330	1.416685	-.002506
125	.773175	-.028155	.691331	-.709574	1.415380	-.003824
126	.759090	-.029665	.690232	-.706464	1.412064	-.002687
127	.744740	-.031175	.689222	-.703607	1.410404	-.003598
128	.730140	-.032685	.688343	-.701119	1.407848	-.002812
129	.715310	-.034185	.686385	-.695581	1.404018	-.003672
130	.700265	-.035675	.685858	-.694088	1.402097	-.002643
131	.685020	-.037155	.684580	-.690473	1.399926	-.003648
132	.669600	-.038620	.683724	-.688051	1.397324	-.002694
133	.654015	-.040065	.682002	-.683179	1.394172	-.003693
134	.638285	-.041485	.680985	-.680303	1.391157	-.002646
135	.622430	-.042880	.679684	-.676620	1.388947	-.003619
136	.606460	-.044245	.678277	-.672640	1.385199	-.002743
137	.590400	-.045575	.676746	-.668309	1.382335	-.003480
138	.574270	-.046865	.675299	-.664214	1.378636	-.002769
139	.558085	-.048115	.673808	-.659995	1.375810	-.003402
140	.541860	-.049315	.671375	-.653110	1.370163	-.002950
141	.525615	-.050465	.670330	-.650156	1.367948	-.003035
142	.509365	-.051570	.668922	-.646172	1.364873	-.003014
143	.493130	-.052615	.666117	-.638236	1.358923	-.003175
144	.476930	-.053595	.664188	-.632778	1.354468	-.002751
145	.460780	-.054515	.662495	-.627987	1.351050	-.003042
146	.444695	-.055370	.660101	-.621213	1.345792	-.002832
147	.428690	-.056150	.657168	-.612914	1.339631	-.002912
148	.412785	-.056855	.655022	-.606842	1.334847	-.002554
149	.396995	-.057485	.652342	-.599260	1.329445	-.002858
150	.381335	-.058030	.648902	-.589529	1.322027	-.002514

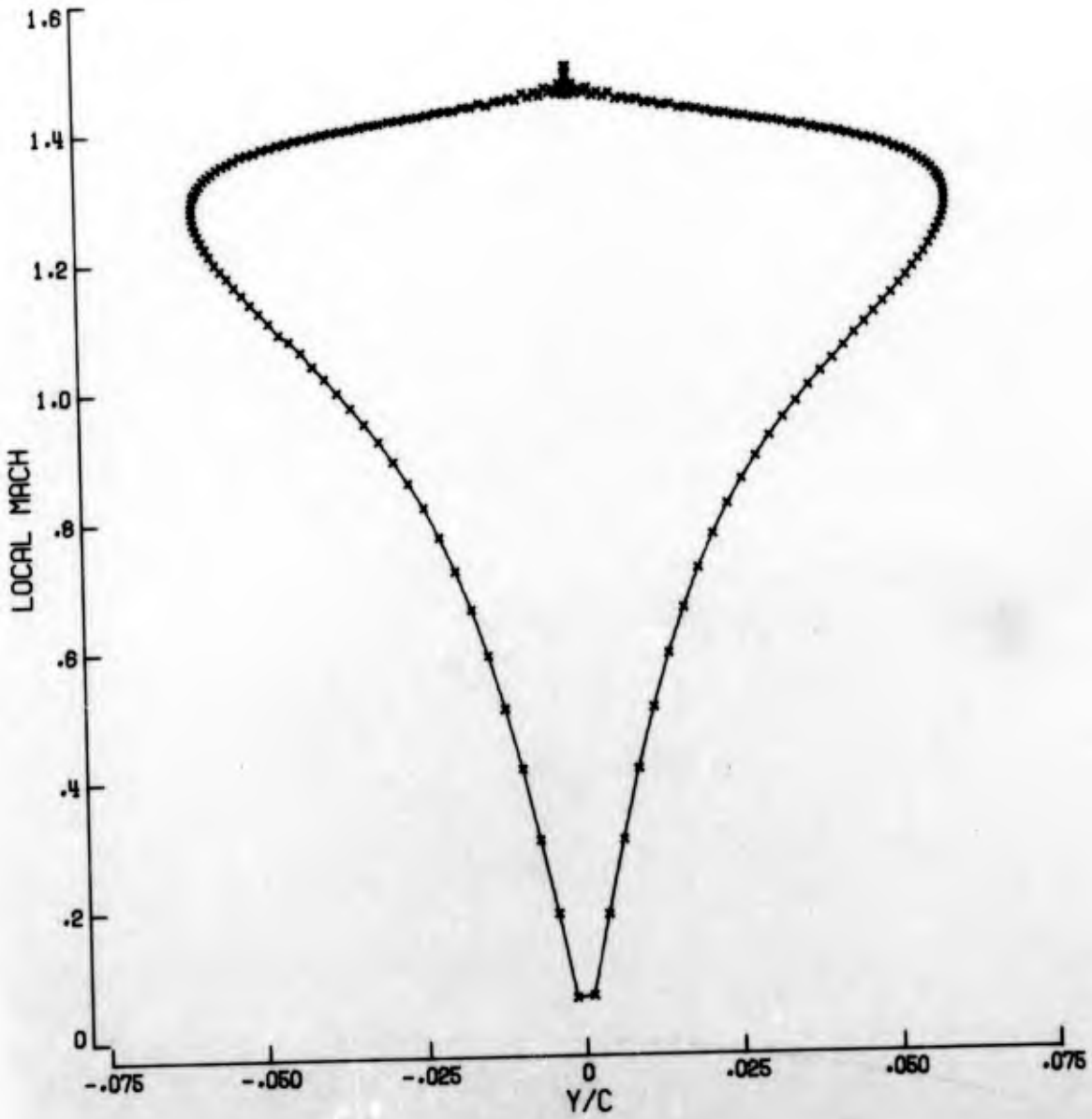
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-5
	NACA 0012: MACH = 0.95, ALPHA = 0			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
151	.365820	-.058490	.646069	-.581511	1.316167	-.002525
152	.350465	-.058865	.642864	-.572444	1.309513	-.002444
153	.335290	-.059155	.640120	-.564680	1.303809	-.002320
154	.320305	-.059355	.636175	-.553517	1.295859	-.002409
155	.305520	-.059455	.631816	-.541185	1.286805	-.002042
156	.290955	-.059460	.628362	-.531413	1.279864	-.002000
157	.276620	-.059370	.624086	-.519314	1.271356	-.001976
158	.262530	-.059180	.619525	-.506409	1.262180	-.001716
159	.248700	-.058890	.614889	-.493294	1.253085	-.001662
160	.235140	-.058500	.610049	-.479599	1.243551	-.001448
161	.221860	-.058010	.605026	-.465387	1.233844	-.001366
162	.208870	-.057420	.599772	-.450521	1.223712	-.001194
163	.196190	-.056730	.594098	-.434467	1.212893	-.001041
164	.183825	-.055935	.587396	-.415507	1.200283	-.000919
165	.171785	-.055040	.581892	-.399933	1.189796	-.000523
166	.160080	-.054050	.575544	-.381972	1.178306	-.000717
167	.148720	-.052960	.568021	-.360687	1.164305	-.000270
168	.137720	-.051775	.561262	-.341564	1.152046	-.000122
169	.127085	-.050495	.552935	-.318005	1.137241	-.000125
170	.116830	-.049125	.545596	-.297240	1.123915	.000391
171	.106960	-.047665	.536141	-.270489	1.107674	.000110
172	.097480	-.046110	.526144	-.242204	1.089938	.000764
173	.088400	-.044475	.519862	-.224430	1.079184	.000812
174	.079725	-.042760	.509804	-.195972	1.062269	.000706
175	.071470	-.040960	.496603	-.158620	1.039846	.001154
176	.063640	-.039085	.485345	-.126770	1.020939	.001534
177	.056235	-.037135	.471689	-.088131	.998844	.001292
178	.049270	-.035115	.457665	-.048454	.975481	.002114
179	.042750	-.033030	.441943	-.003969	.950743	.001672
180	.036675	-.030880	.424801	.044532	.922833	.002553
181	.031055	-.028670	.404723	.101339	.891750	.002143
182	.025895	-.026405	.383435	.161569	.857528	.003346
183	.021195	-.024095	.358392	.232425	.819151	.003021
184	.016960	-.021710	.329363	.314559	.773123	.004293
185	.013200	-.019290	.295381	.410704	.720439	.004413
186	.009915	-.016830	.257988	.516502	.659977	.006029
187	.007100	-.014325	.213042	.643670	.588441	.005207
188	.004755	-.011785	.166898	.774227	.507192	.006983
189	.002890	-.009215	.115521	.919592	.412198	.005780
190	.001500	-.006610	.067547	1.055326	.301045	.007040
191	.000575	-.003975	.027688	1.168101	.186654	.003768
192	.000115	-.001325	.007005	1.226620	.058269	.004643

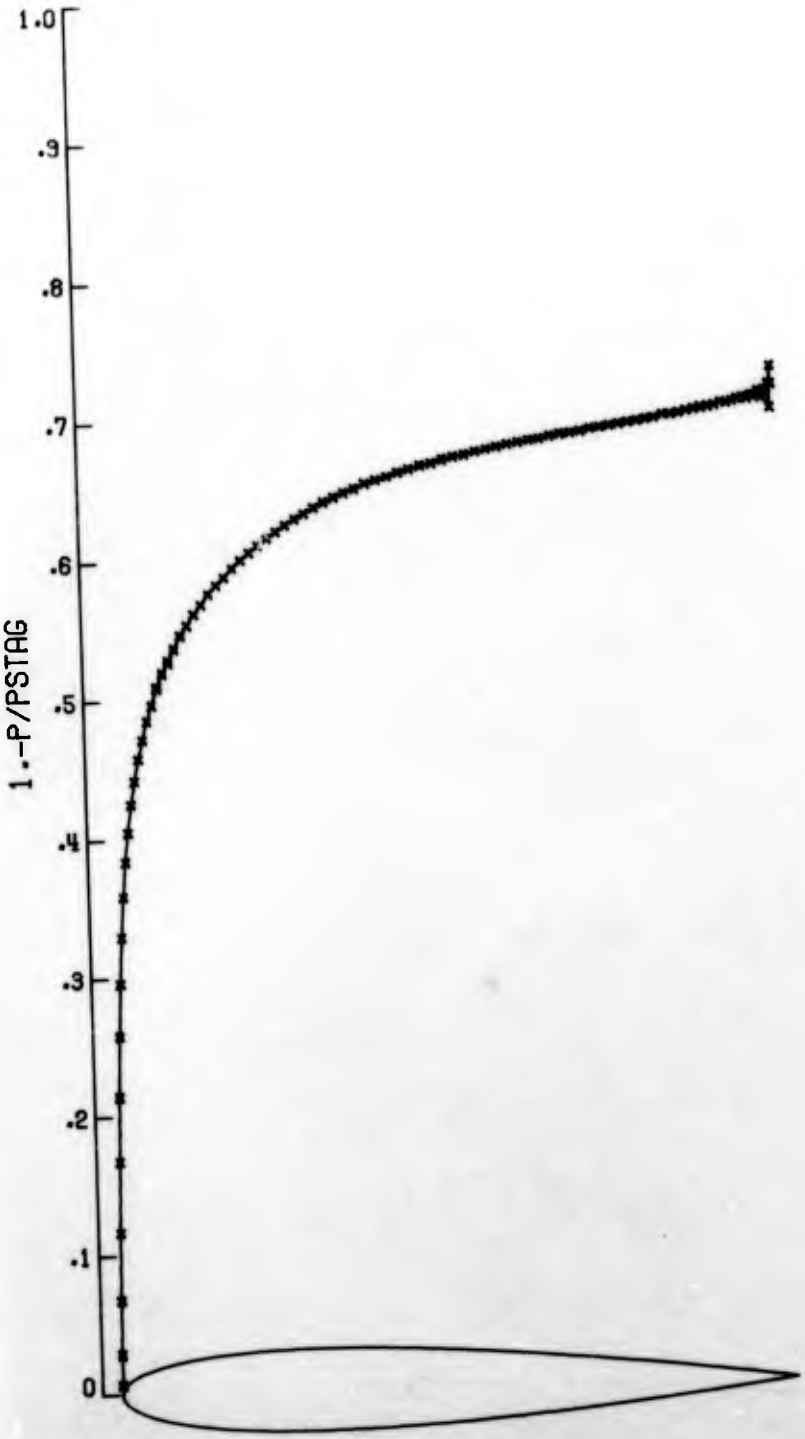
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-6
	NACA 0012: MACH = 0.95, ALPHA = 0			



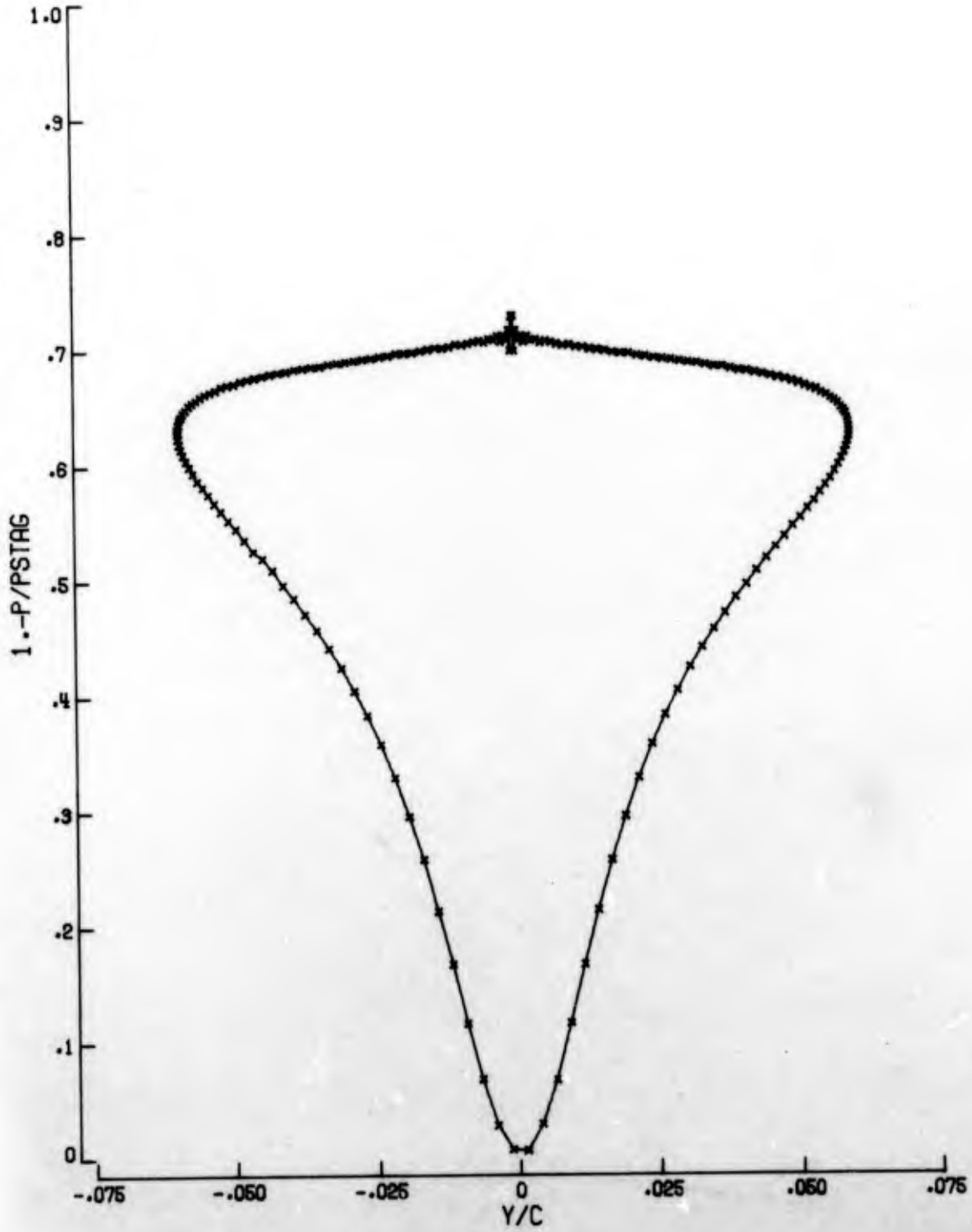
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-7
	NACA 0012: MACH = 0.95, ALPHA = 0			



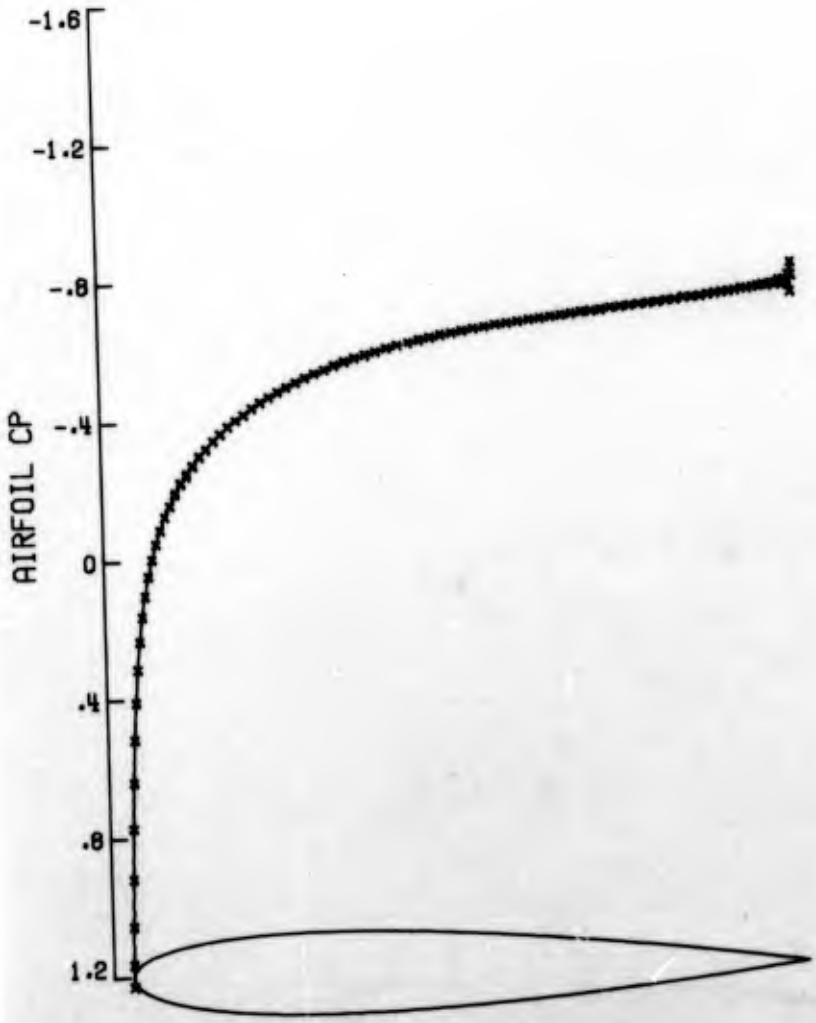
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-8
	NACA 0012: MACH = 0.95, ALPHA = 0			



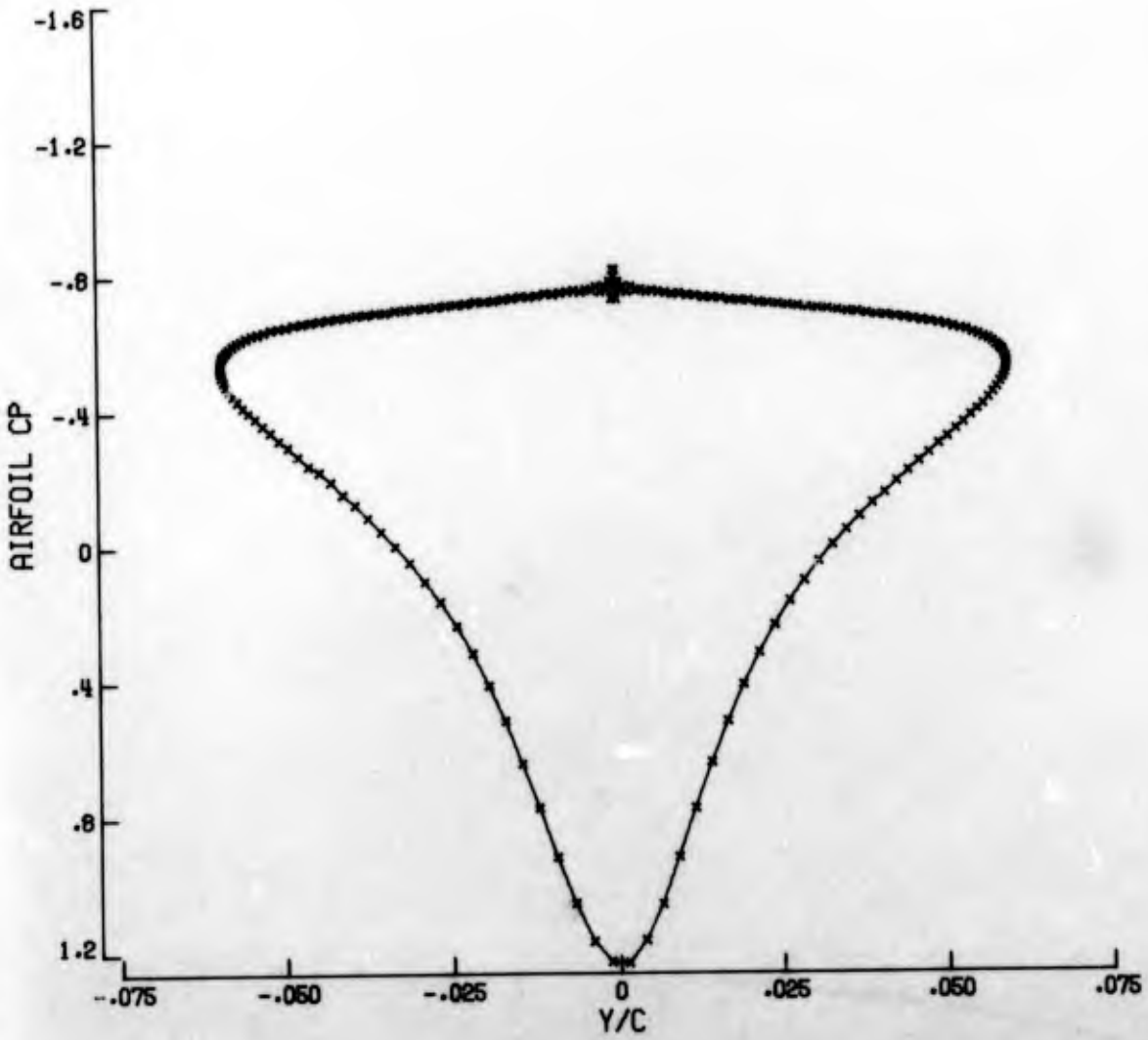
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-9
	NACA 0012: MACH = 0.95, ALPHA = 0			



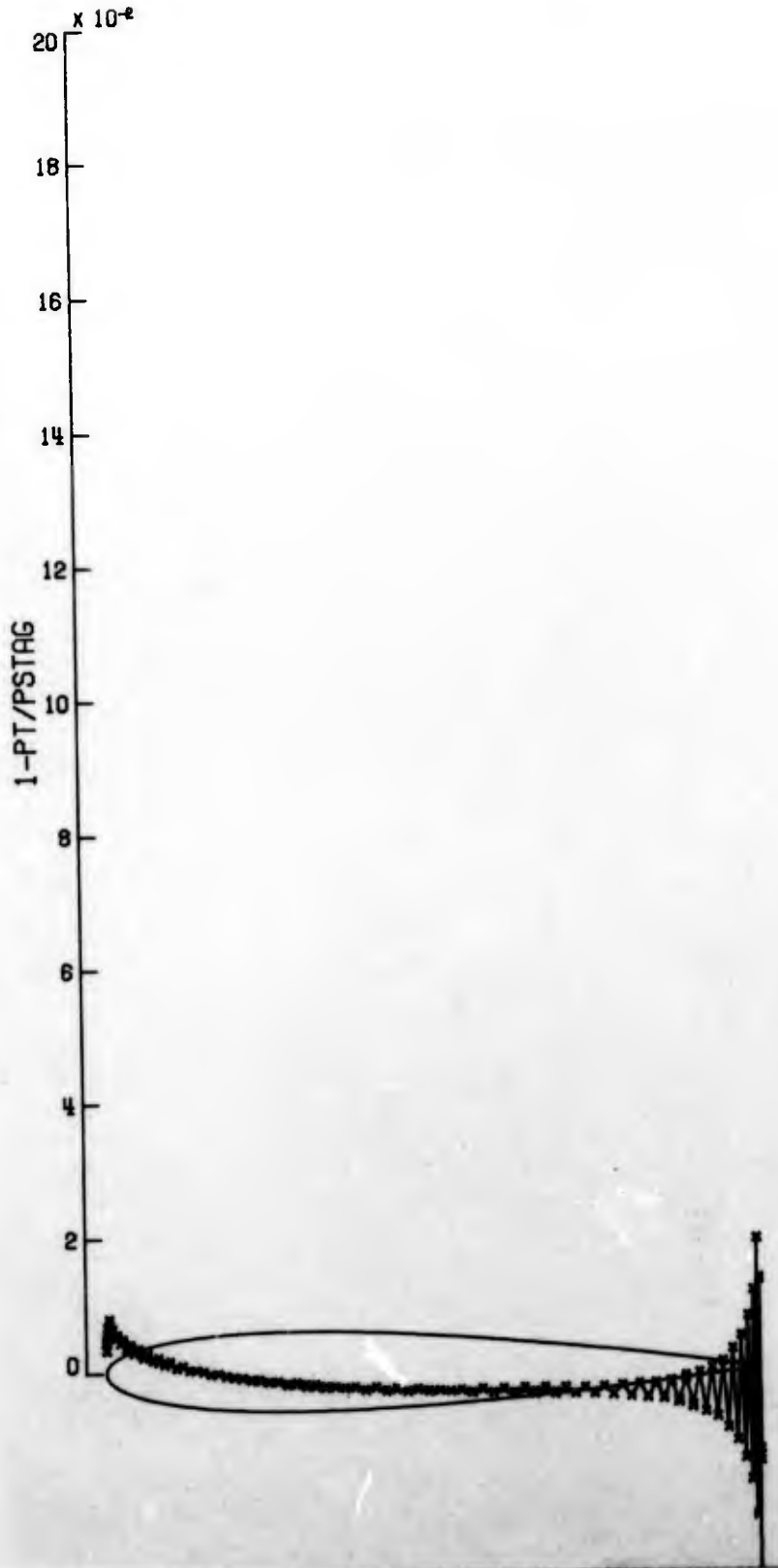
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-10
	NACA 0012: MACH = 0.95, ALPHA = 0			



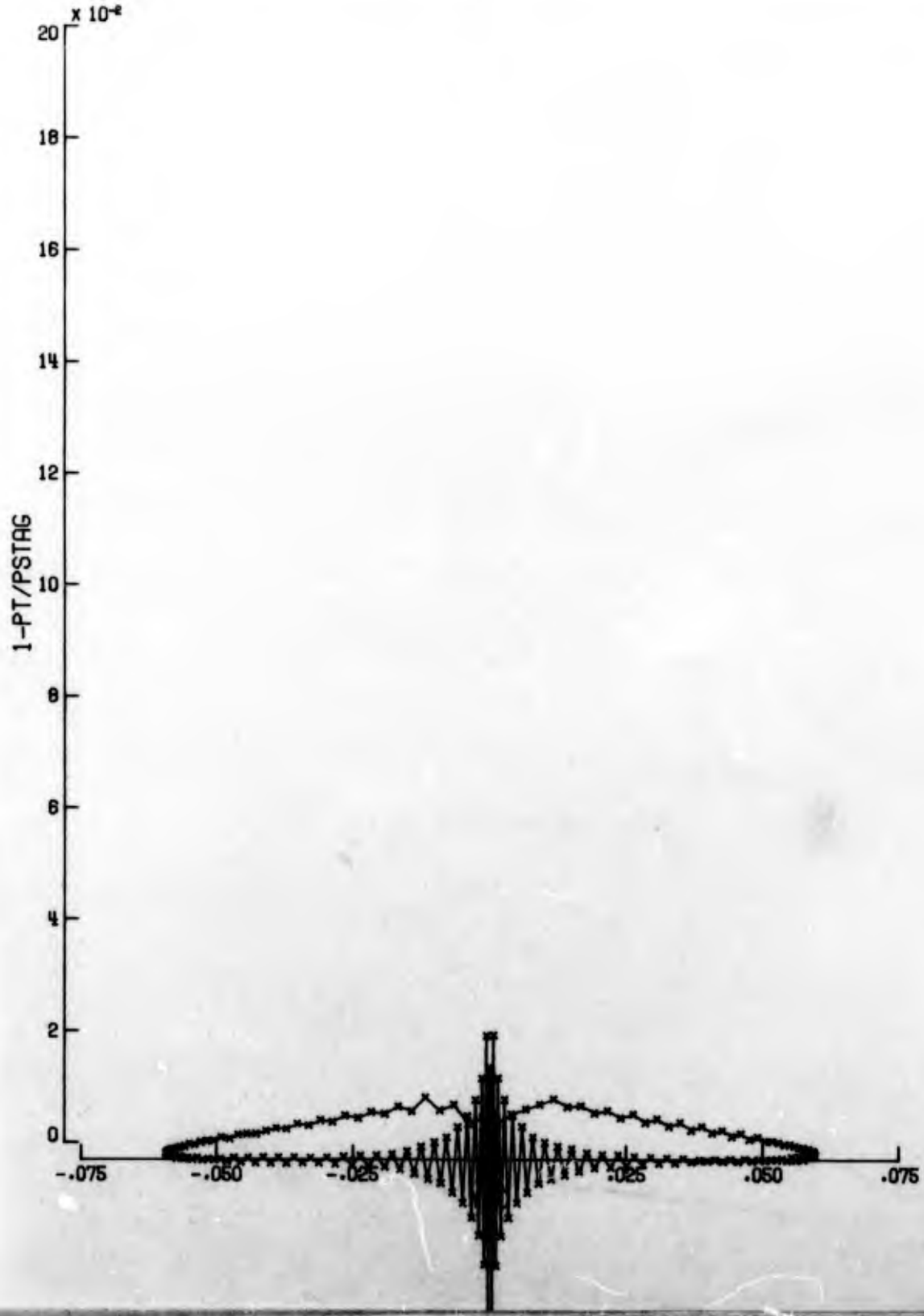
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C South, Jr	03-6-11
	NACA 0012: MACH = 0.95, ALPHA = 0			



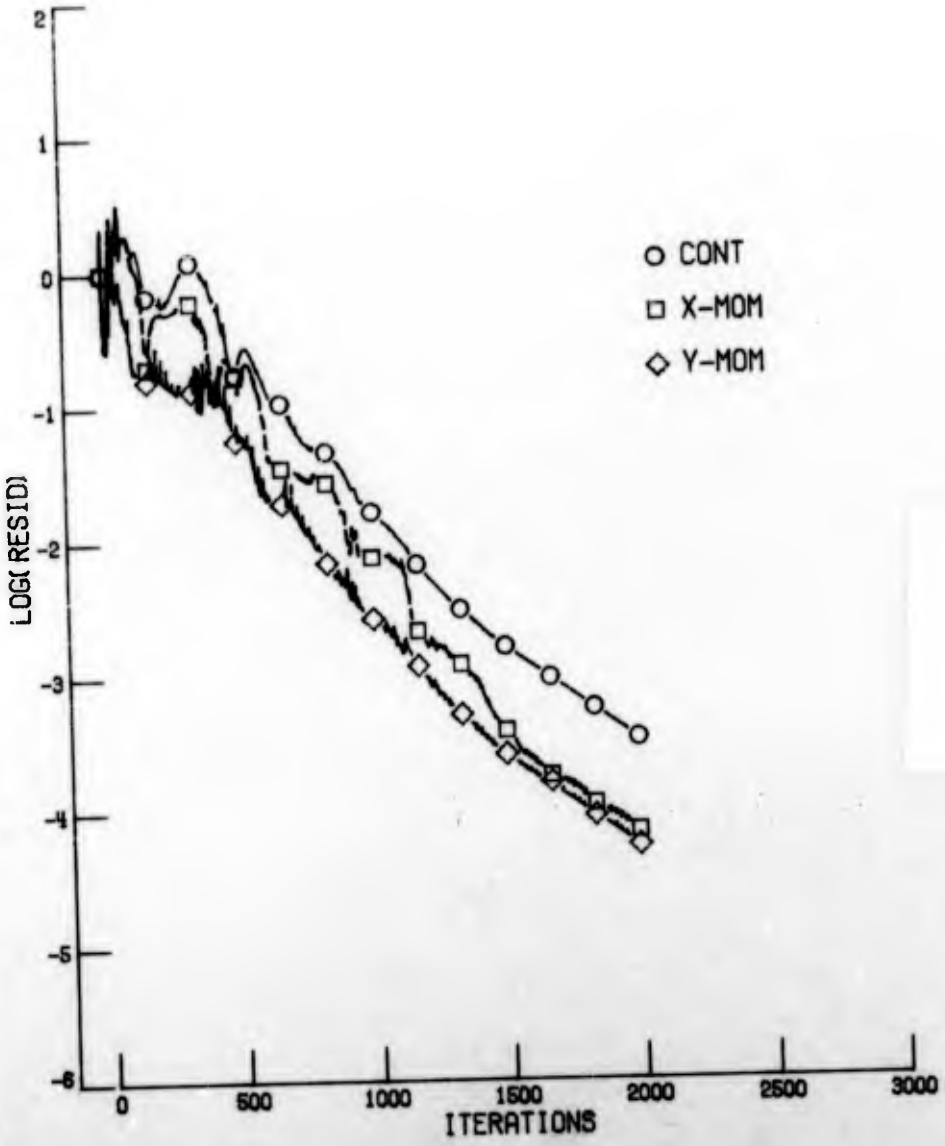
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-12
	NACA 0012: MACH = 0.95, ALPHA = 0			



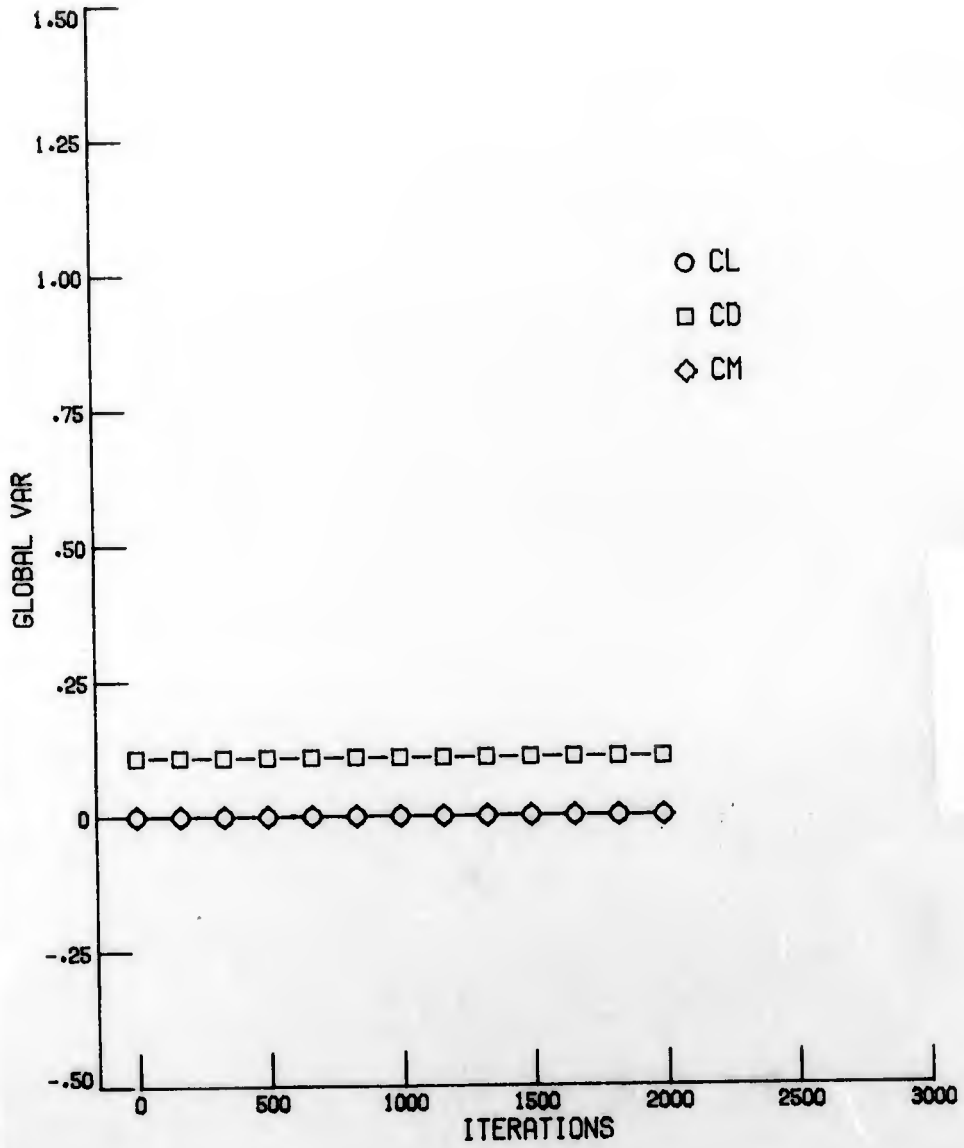
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-13
	NACA 0012: MACH = 0.95, ALPHA = 0			



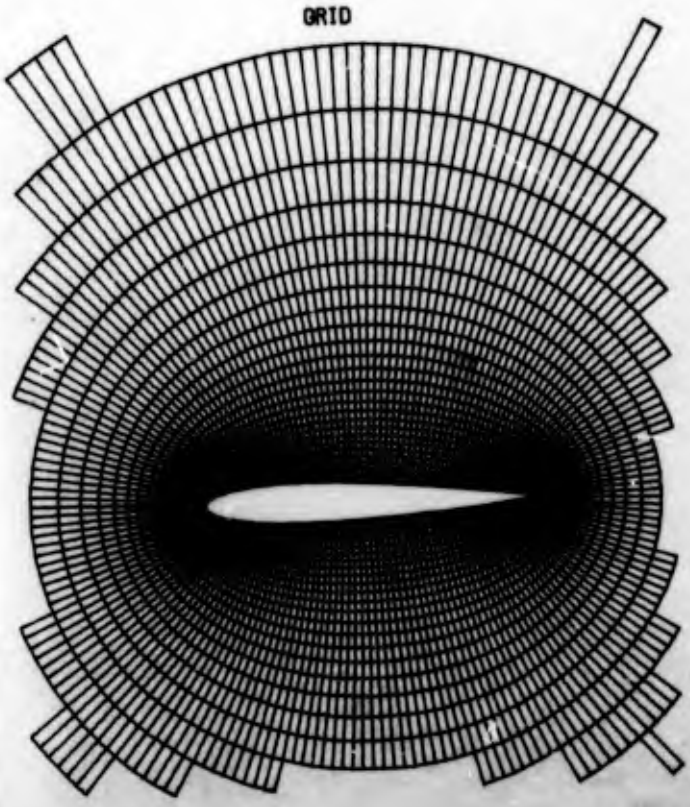
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-14
	NACA 0012: MACH = 0.95, ALPHA = 0			



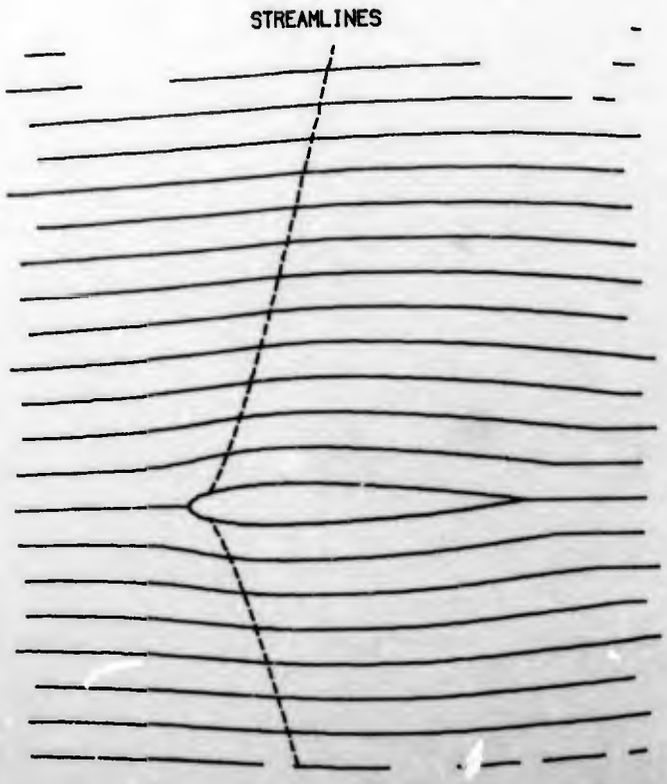
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-15
	NACA 0012: MACH = 0.95, ALPHA = 0			



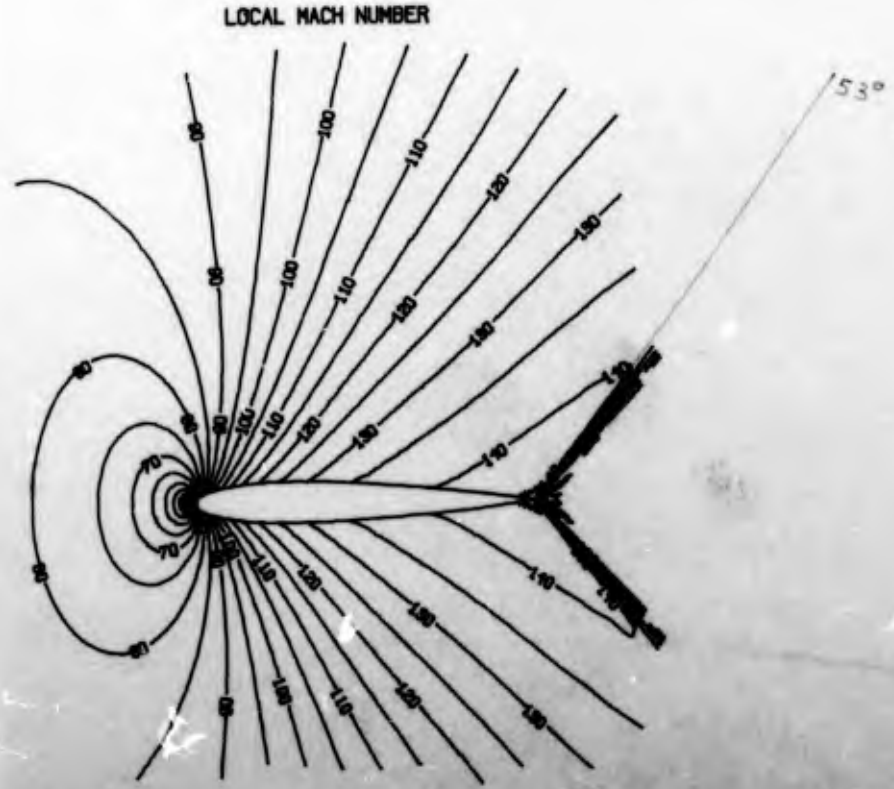
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-16
	NACA 0012: MACH = 0.95, ALPHA = 0			



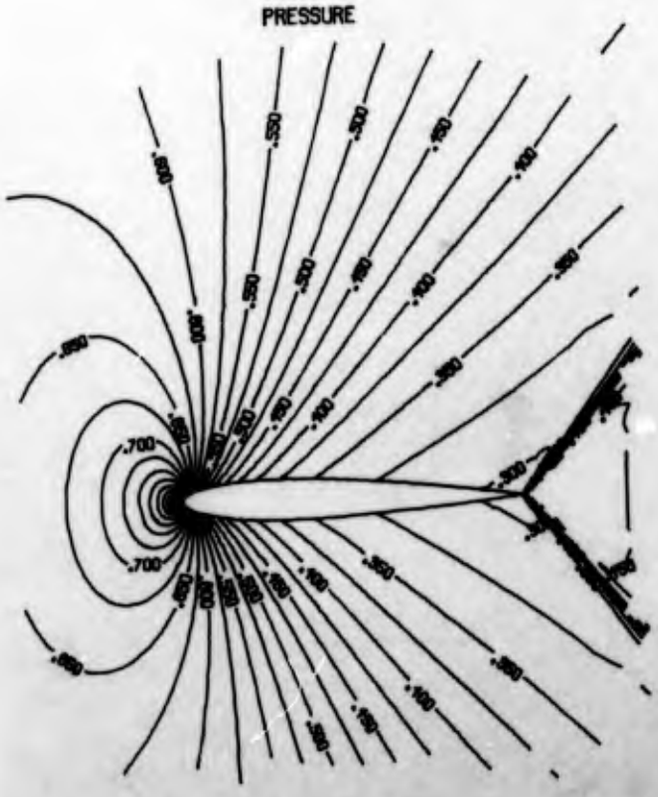
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-17
	NACA 0012: MACH = 0.95, ALPHA = 0			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-18
	NACA 0012: MACH = 0.95, ALPHA = 0			

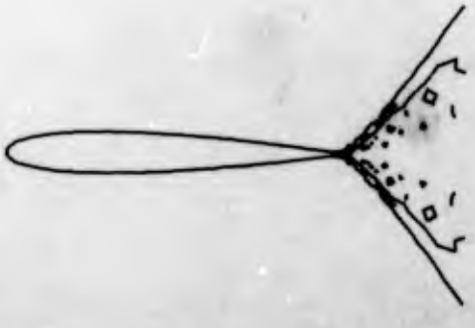


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-19
	NACA 0012: MACH = 0.95, ALPHA = 0			



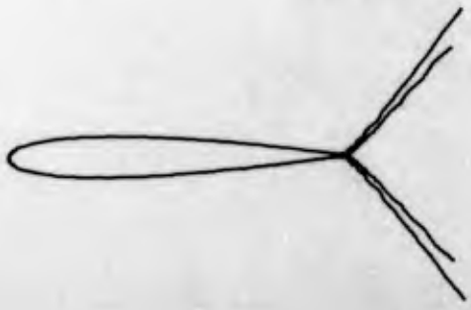
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-20
	NACA 0012: MACH = 0.95, ALPHA = 0			

TOTAL PRESSURE

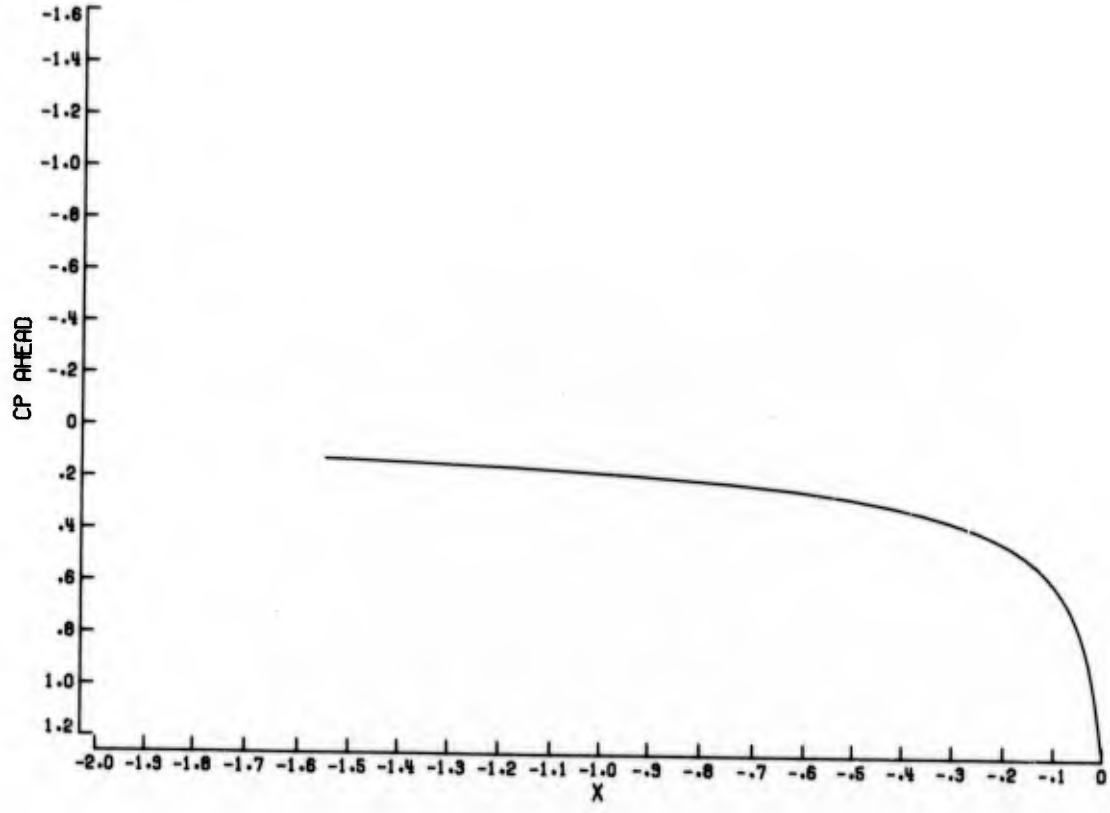


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-21
	NACA 0012: MACH = 0.95, ALPHA = 0			

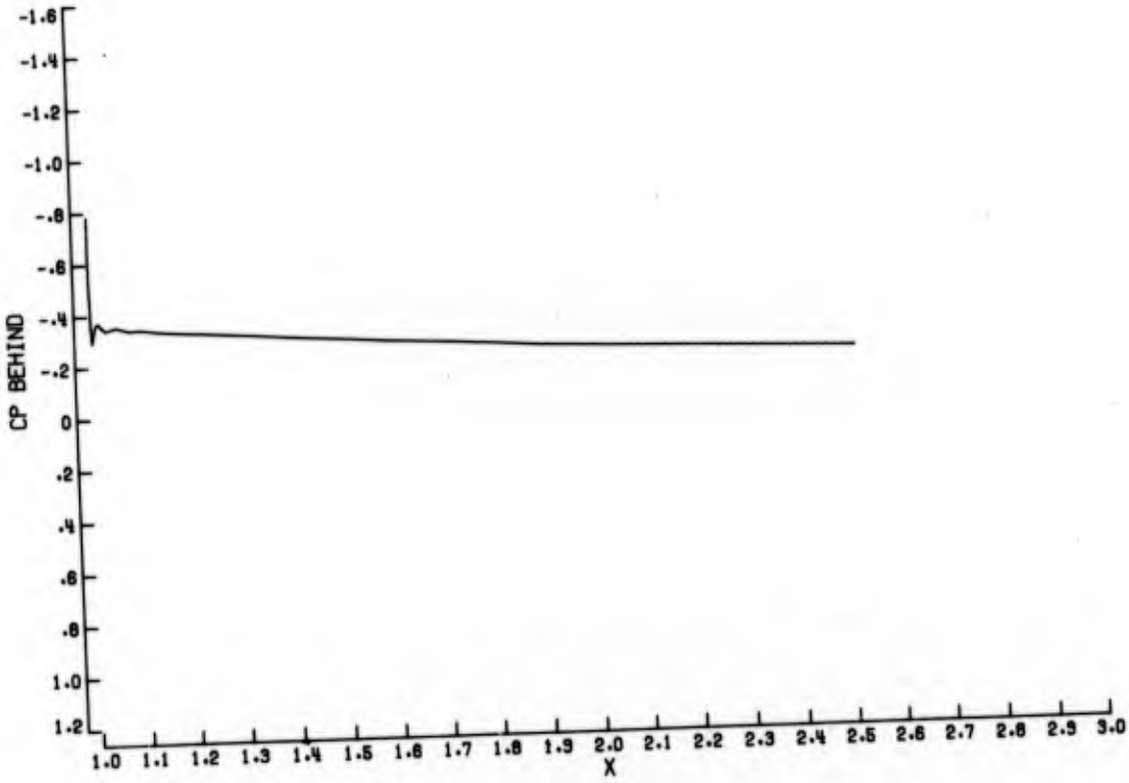
ENTROPY



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-22
	NACA 0012: MACH = 0.95, ALPHA = 0			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	03-6-23
	NACA 0012: MACH = 0.95, ALPHA = 0			



AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 03

NACA 0012: MACH = 0.95, ALPHA = 0

Contributor No 8

A.Rizzi

(F.F.A., Sweden)

F.F.A.	AR 211		A.Rizzi	03-8-1
	NACA 0012: MACH = 0.95, ALPHA = 0			

MESH: 128 × (28 + 4) basic mesh, same as for Test Case 01 outer boundary at 10 chords.

I		X/C	Y/C	1-P/PIINF	CF	MACH	1-PI/PIINF
1	UPSTREAM	-0.001496	0.000000	0.007912	1.224053	0.090710	0.002186
2		-0.004822	0.000000	0.029988	1.161594	0.168477	0.010577
3		-0.008861	0.000000	0.042878	1.125124	0.249991	0.000343
4		-0.013733	0.000000	0.069104	1.050921	0.312014	0.004107
5		-0.019634	0.000000	0.090789	0.989565	0.371341	-0.000041
6		-0.026842	0.000000	0.116570	0.916823	0.421253	0.001877
7		-0.035739	0.000000	0.139399	0.850617	0.469030	0.000004
8		-0.046819	0.000000	0.164371	0.781378	0.511701	0.000921
9		-0.060718	0.000000	0.187339	0.716394	0.552448	0.000068
10		-0.078227	0.000000	0.210237	0.651607	0.589937	0.000509
11		-0.100325	0.000000	0.231799	0.590600	0.625286	0.000190
12		-0.128212	0.000000	0.252520	0.531974	0.658070	0.000324
13		-0.163338	0.000000	0.271876	0.477208	0.688579	0.000193
14		-0.207457	0.000000	0.289997	0.425938	0.716704	0.000216
15		-0.262566	0.000000	0.306715	0.378636	0.742583	0.000153
16		-0.331475	0.000000	0.322084	0.335153	0.766240	0.000138
17		-0.416867	0.000000	0.336093	0.295503	0.787800	0.000101
18		-0.522383	0.000000	0.348827	0.259500	0.807360	0.000078
19		-0.652217	0.000000	0.360323	0.226961	0.825056	0.000053
20		-0.811323	0.000000	0.370689	0.197653	0.841027	0.000035
21		-1.005547	0.000000	0.380011	0.171258	0.855418	0.000019
22		-1.241774	0.000000	0.388383	0.147571	0.868370	0.000007
23		-1.528109	0.000000	0.395893	0.126323	0.880019	-0.000005
24		-1.874077	0.000000	0.402636	0.107244	0.890507	-0.000016
25		-2.290869	0.000000	0.408729	0.090005	0.900006	-0.000025
26		-2.791620	0.000000	0.414304	0.074230	0.908715	-0.000027
27		-3.391740	0.000000	0.419469	0.059617	0.916796	-0.000021
28		-4.109295	0.000000	0.424241	0.046117	0.924277	-0.000012
29		-4.965463	0.000000	0.428524	0.033993	0.931016	-0.000012
30		-5.985052	0.000000	0.432182	0.023647	0.936900	-0.000029
31		-7.197122	0.000000	0.435193	0.015123	0.941584	-0.000060
32		-8.635695	0.000000	0.437306	0.007737	0.945732	-0.000075

F.F.A.	AR 211		A.Rizzi	03-8-2
	NACA 0012: MACH = 0.95, ALPHA = 0			

AIRFOIL

1	0.998814	-0.000168	0.581671	-0.399309	1.166605	0.008568
2	0.994210	-0.000816	0.670206	-0.649805	1.272356	0.049432
3	0.985354	-0.002052	0.723538	-0.800699	1.475592	-0.003279
4	0.972671	-0.003802	0.719634	-0.789653	1.485559	-0.004785
5	0.956583	-0.005985	0.706435	-0.752309	1.447209	0.001306
6	0.937500	-0.008522	0.703567	-0.744193	1.438761	0.003291
7	0.915823	-0.011355	0.704577	-0.747052	1.442309	0.001998
8	0.891931	-0.014354	0.701303	-0.737801	1.435113	0.001014
9	0.866187	-0.017512	0.698878	-0.730928	1.428349	0.002503
10	0.838931	-0.020752	0.696630	-0.724566	1.423873	0.001415
11	0.810477	-0.024023	0.694399	-0.718254	1.418216	0.002113
12	0.781120	-0.027285	0.692080	-0.711692	1.413234	0.001604
13	0.751125	-0.030499	0.689881	-0.705471	1.407929	0.001991
14	0.720735	-0.033631	0.687567	-0.698923	1.402876	0.001686
15	0.690171	-0.036654	0.685273	-0.692433	1.397515	0.001933
16	0.659627	-0.039542	0.682875	-0.685648	1.392246	0.001754
17	0.629275	-0.042276	0.680417	-0.678694	1.386646	0.001916
18	0.599267	-0.044837	0.677921	-0.671349	1.380946	0.001823
19	0.569732	-0.047211	0.675073	-0.663574	1.374804	0.001926
20	0.540782	-0.049386	0.672137	-0.655269	1.368384	0.001895
21	0.512511	-0.051354	0.669019	-0.646445	1.361532	0.001977
22	0.484994	-0.053108	0.665685	-0.637012	1.354319	0.001984
23	0.458294	-0.054646	0.662125	-0.626940	1.346626	0.002061
24	0.432457	-0.055965	0.658303	-0.616126	1.338458	0.002090
25	0.407518	-0.057066	0.654218	-0.604569	1.329761	0.002170
26	0.383502	-0.057952	0.649889	-0.592320	1.320649	0.002232
27	0.360423	-0.058629	0.645322	-0.579393	1.311110	0.002322
28	0.338284	-0.059101	0.640500	-0.565754	1.301144	0.002402
29	0.317085	-0.059378	0.635417	-0.551375	1.290718	0.002505
30	0.296816	-0.059466	0.630060	-0.536218	1.279837	0.002599
31	0.277463	-0.059374	0.624453	-0.520363	1.268564	0.002725
32	0.259007	-0.059114	0.618633	-0.503886	1.256976	0.002845
33	0.241424	-0.058694	0.612573	-0.486740	1.245037	0.002981
34	0.224690	-0.058124	0.606277	-0.468926	1.232765	0.003127
35	0.208777	-0.057415	0.599739	-0.450428	1.220147	0.003282
36	0.193656	-0.056576	0.592942	-0.431195	1.207165	0.003445
37	0.179295	-0.055615	0.585897	-0.411265	1.193850	0.003625
38	0.165666	-0.054542	0.578595	-0.390606	1.180197	0.003807
39	0.152737	-0.053364	0.571012	-0.369150	1.166161	0.004003
40	0.140478	-0.052089	0.563133	-0.346873	1.151743	0.004210
41	0.128861	-0.050722	0.554958	-0.323728	1.136920	0.004426
42	0.117856	-0.049271	0.546431	-0.299600	1.121624	0.004650
43	0.107442	-0.047741	0.537506	-0.274351	1.105779	0.004884
44	0.097589	-0.046134	0.528132	-0.247829	1.089304	0.005128
45	0.088277	-0.044457	0.518241	-0.219343	1.072093	0.005382
46	0.079484	-0.042711	0.507747	-0.190152	1.054013	0.005644
47	0.071193	-0.040900	0.496551	-0.158473	1.034914	0.005912
48	0.063388	-0.039026	0.484541	-0.124493	1.014627	0.006184
49	0.056055	-0.037090	0.471573	-0.087802	0.992923	0.006447
50	0.049182	-0.035094	0.457455	-0.047857	0.969504	0.006694
51	0.042762	-0.033040	0.441990	-0.004104	0.944083	0.006920
52	0.036788	-0.030928	0.424954	0.044097	0.916307	0.007093
53	0.031256	-0.028760	0.405892	0.098032	0.885440	0.007156
54	0.026164	-0.026534	0.384283	0.159171	0.850699	0.006987
55	0.021511	-0.024253	0.359569	0.229095	0.811180	0.006549
56	0.017301	-0.021916	0.331174	0.309434	0.765906	0.005765

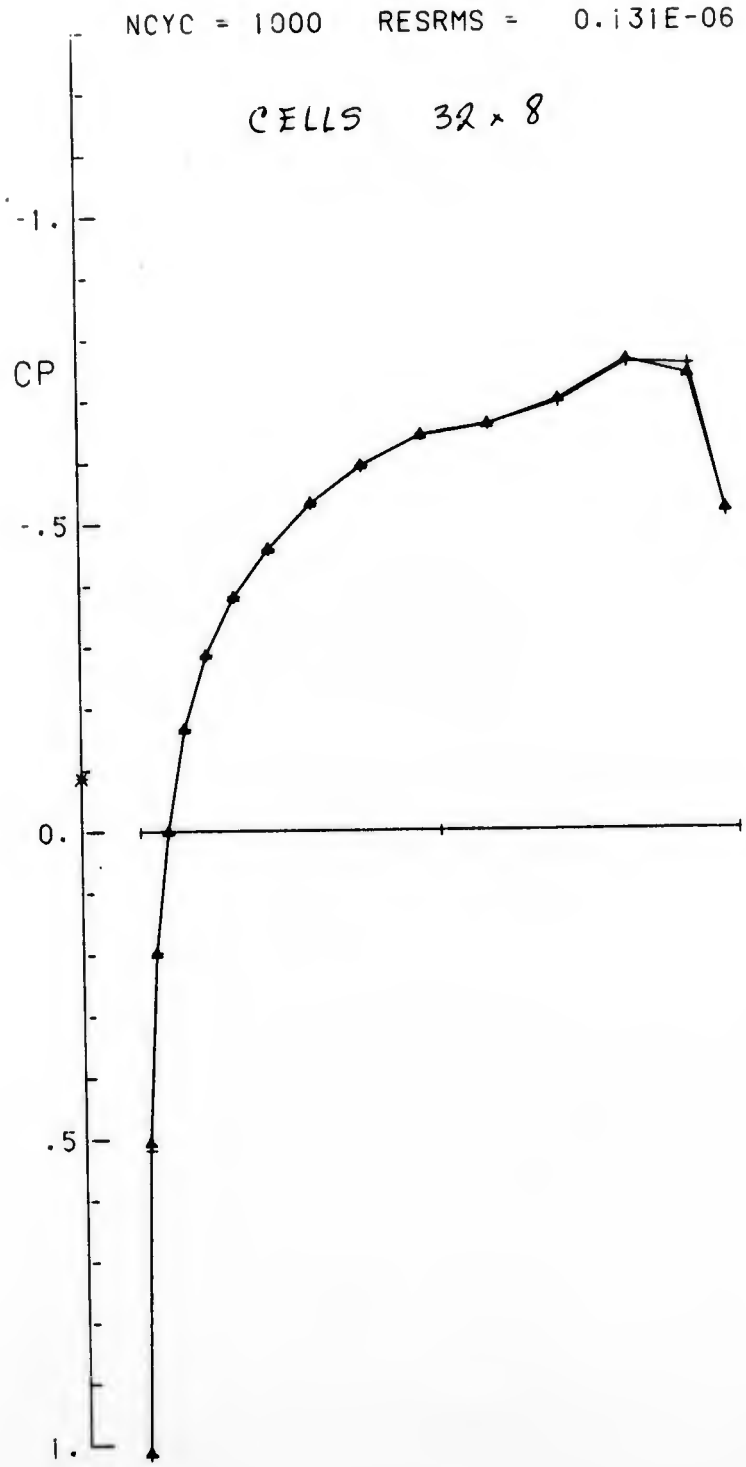
F.F.A.	AR 211		A.Rizzi	03-8-3
	NACA 0012: MACH = 0.95, ALPHA = 0			

57	0.013535	-0.019525	0.298553	0.401730	0.713749	0.004642
58	0.010220	-0.017083	0.261317	0.507085	0.653448	0.003255
59	0.007361	-0.014589	0.219320	0.625907	0.583597	0.001849
60	0.004963	-0.012043	0.172626	0.758022	0.502109	0.000881
61	0.003035	-0.009443	0.122374	0.900201	0.407173	0.000151
62	0.001582	-0.006790	0.072636	1.040928	0.297786	-0.000863
63	0.000609	-0.004092	0.031691	1.156775	0.175806	-0.001779
64	0.000122	-0.001367	0.008391	1.222693	0.051890	-0.002043
65	0.000122	0.001367	0.008406	1.222656	0.051763	-0.001976
66	0.000609	0.004092	0.031734	1.156652	0.175790	-0.001655
67	0.001582	0.006790	0.072663	1.040852	0.297940	-0.000817
68	0.003035	0.009443	0.122383	0.900175	0.407445	0.000083
69	0.004963	0.012043	0.172642	0.757975	0.502493	0.000715
70	0.007361	0.014589	0.219352	0.625818	0.584026	0.001613
71	0.010220	0.017083	0.261360	0.506963	0.653920	0.002956
72	0.013535	0.019525	0.298586	0.401638	0.714216	0.004287
73	0.017301	0.021916	0.331193	0.309381	0.766354	0.005370
74	0.021511	0.024253	0.359576	0.229076	0.811601	0.006131
75	0.026164	0.026534	0.384280	0.159179	0.851094	0.006562
76	0.031256	0.028760	0.405883	0.098056	0.885809	0.006736
77	0.036788	0.030928	0.424946	0.044122	0.916657	0.006691
78	0.042762	0.033040	0.441983	-0.004083	0.944416	0.006529
79	0.049182	0.035094	0.457447	-0.047836	0.969818	0.006320
80	0.056055	0.037090	0.471566	-0.087783	0.993219	0.006089
81	0.063388	0.039026	0.484534	-0.124475	1.014909	0.005840
82	0.071193	0.040900	0.496545	-0.158453	1.035183	0.005582
83	0.079484	0.042711	0.507745	-0.190145	1.054274	0.005326
84	0.088277	0.044457	0.518240	-0.219940	1.072345	0.005075
85	0.097589	0.046134	0.528131	-0.247325	1.089544	0.004831
86	0.107442	0.047741	0.537505	-0.274348	1.106010	0.004597
87	0.117858	0.049271	0.546430	-0.299599	1.121847	0.004371
88	0.128861	0.050722	0.554958	-0.323727	1.137135	0.004155
89	0.140478	0.052089	0.563138	-0.346872	1.151950	0.003947
90	0.152737	0.053364	0.571011	-0.369143	1.166360	0.003743
91	0.165666	0.054542	0.578595	-0.390606	1.180393	0.003558
92	0.179295	0.055615	0.585897	-0.411264	1.194040	0.003381
93	0.193656	0.056576	0.592942	-0.431196	1.207347	0.003207
94	0.208777	0.057415	0.599738	-0.450427	1.220325	0.003048
95	0.224690	0.058124	0.606276	-0.468925	1.232938	0.002898
96	0.241424	0.058694	0.612572	-0.486738	1.245206	0.002757
97	0.259007	0.059114	0.618633	-0.503885	1.257141	0.002625
98	0.277463	0.059374	0.624458	-0.520366	1.268726	0.002508
99	0.296816	0.059466	0.630060	-0.536216	1.279994	0.002388
100	0.317085	0.059373	0.635416	-0.551372	1.290873	0.002294
101	0.338284	0.059101	0.640499	-0.565753	1.301295	0.002195
102	0.360423	0.058629	0.645321	-0.579395	1.311259	0.002117

F.F.A.	AR 211		A.Rizzi	03-8-4
	NACA 0012: MACH = 0.95, ALPHA = 0			

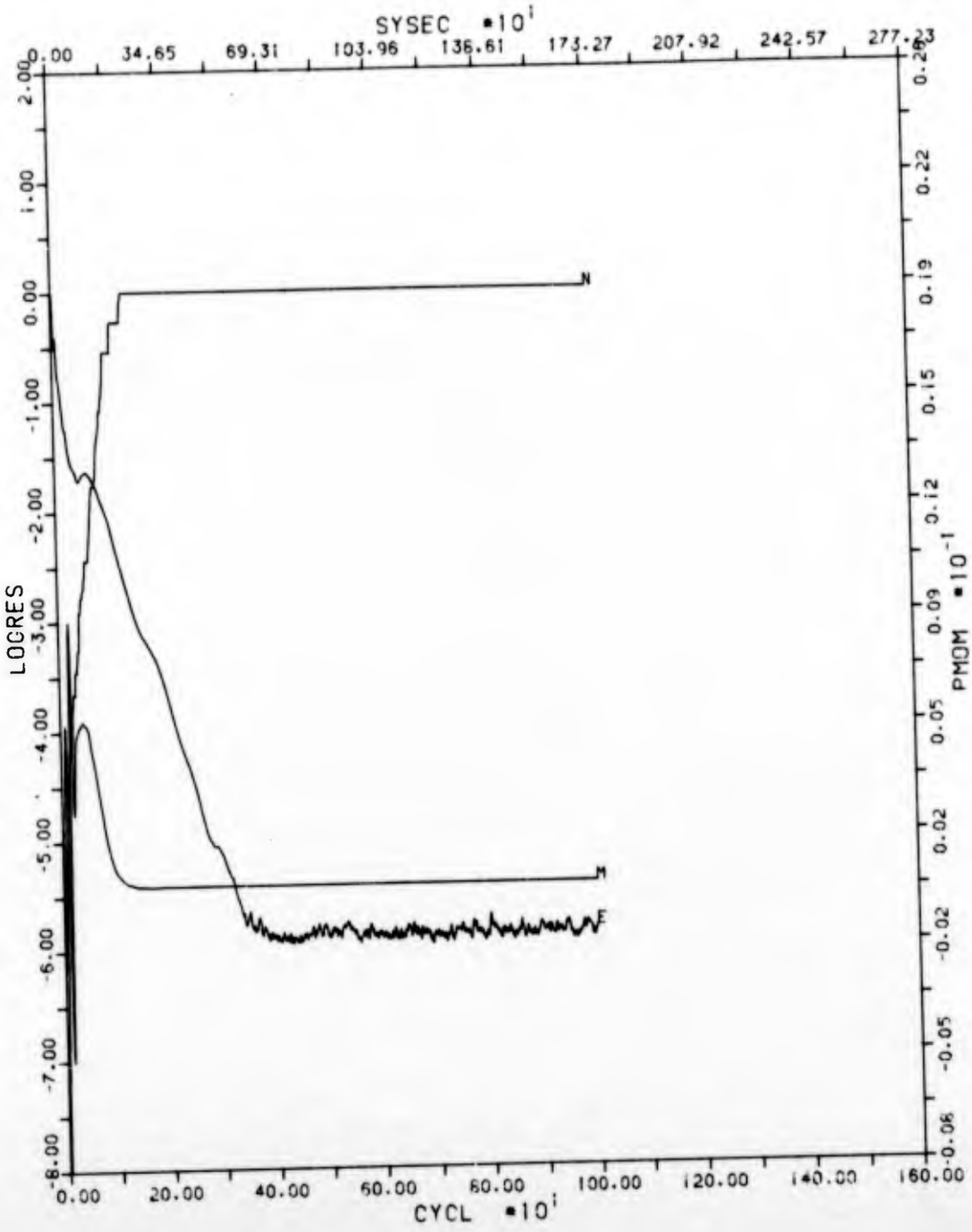
103	0.383502	0.057952	0.649383	-0.592317	1.320793	0.002032
104	0.407513	0.057066	0.654217	-0.604566	1.329906	0.001969
105	0.432457	0.055965	0.658303	-0.616125	1.338599	0.001895
106	0.458294	0.054646	0.662124	-0.626939	1.346769	0.001864
107	0.484994	0.053108	0.665684	-0.637010	1.354457	0.001793
108	0.512511	0.051354	0.669019	-0.646442	1.361670	0.001782
109	0.540782	0.049386	0.672137	-0.655269	1.368519	0.001708
110	0.569732	0.047211	0.675072	-0.663571	1.374941	0.001731
111	0.599267	0.044837	0.677821	-0.671349	1.381076	0.001641
112	0.629275	0.042276	0.680415	-0.678690	1.386783	0.001720
113	0.659627	0.039542	0.682875	-0.685649	1.392373	0.001577
114	0.690171	0.036654	0.685271	-0.692427	1.397653	0.001734
115	0.720735	0.033631	0.687569	-0.698929	1.403001	0.001516
116	0.751125	0.030499	0.689377	-0.705461	1.408066	0.001786
117	0.781120	0.027285	0.692083	-0.711703	1.413358	0.001443
118	0.810477	0.024023	0.694398	-0.718252	1.418369	0.001894
119	0.838931	0.020752	0.696620	-0.724539	1.423950	0.001274
120	0.866187	0.017512	0.698866	-0.730892	1.428471	0.002286
121	0.891931	0.014354	0.701421	-0.738123	1.435575	0.000755
122	0.915823	0.011335	0.704378	-0.746483	1.441769	0.002071
123	0.937500	0.008522	0.708462	-0.743896	1.438781	0.002896
124	0.956583	0.005985	0.707192	-0.754451	1.449338	0.000979
125	0.972671	0.003802	0.719653	-0.789706	1.485659	-0.005433
126	0.985354	0.002052	0.720813	-0.792982	1.466655	-0.000638
127	0.994210	0.000816	0.658746	-0.645673	1.271241	0.049716
128	0.998814	0.000163	0.585904	-0.411286	1.167359	0.012603

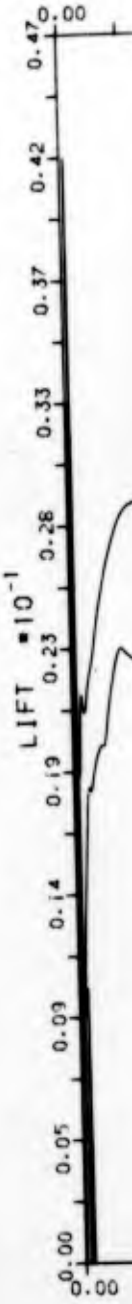
F.F.A.	AR 211		A.Rizzi	03-8-6
	NACA 0012: MACH = 0.95, ALPHA = 0			



15 JUN AFVTOQO NOVOR OUTTOQO MSHX NO6 BAS BAS4 .05

PITCH	0.000	GCIRC	0.002	CELLS	32X
MACH	0.950	ALPHA	0.000	RESAE	0.131
RATE	0.987	RESAS	0.858E-01	DRAG	0.105
NSUP	118	LIFT	-0.311E-03	RESMX	0.596
CYCL	1000	SYSEC	0.173E+04		

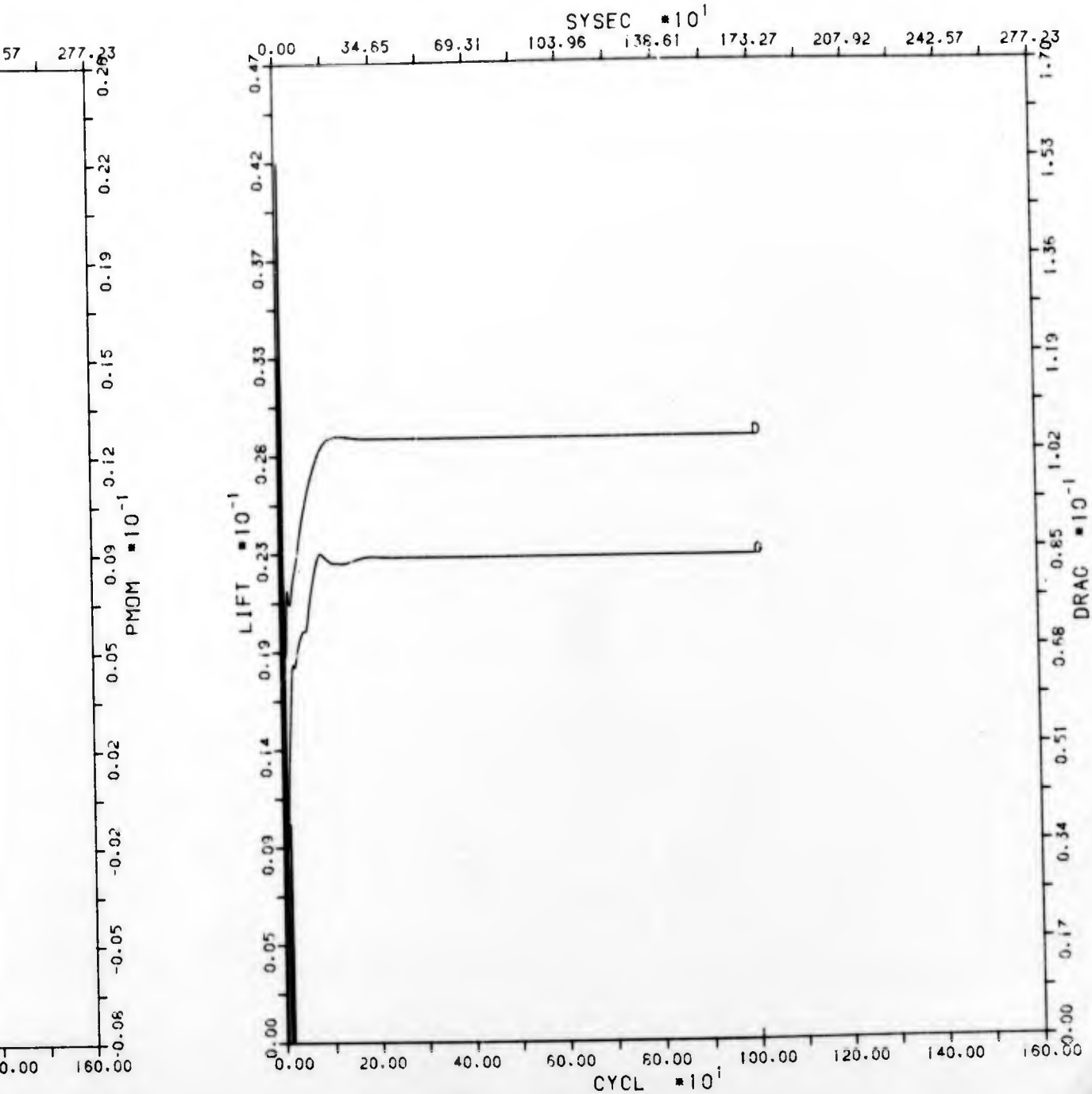




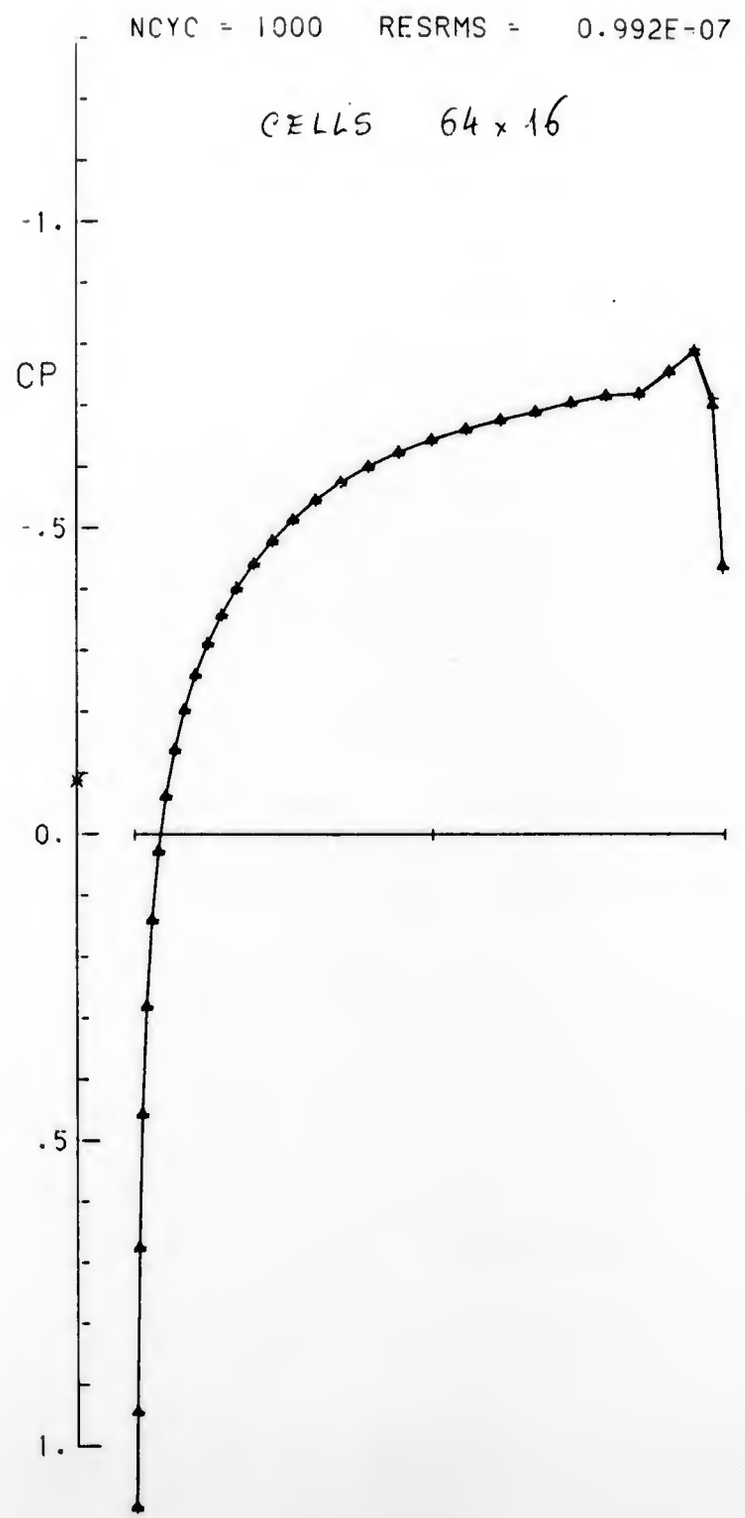
F.F.A.	AR 211		A.Rizzi	03-8-7
	NACA 0012: MACH = 0.95, ALPHA = 0			

HX NO6 BAS BAS4 .05 0. .01

CELLS 32X 8
RESAE 0.131E-06
DRAG 0.105E+00
RESMX 0.596E-06 18 2

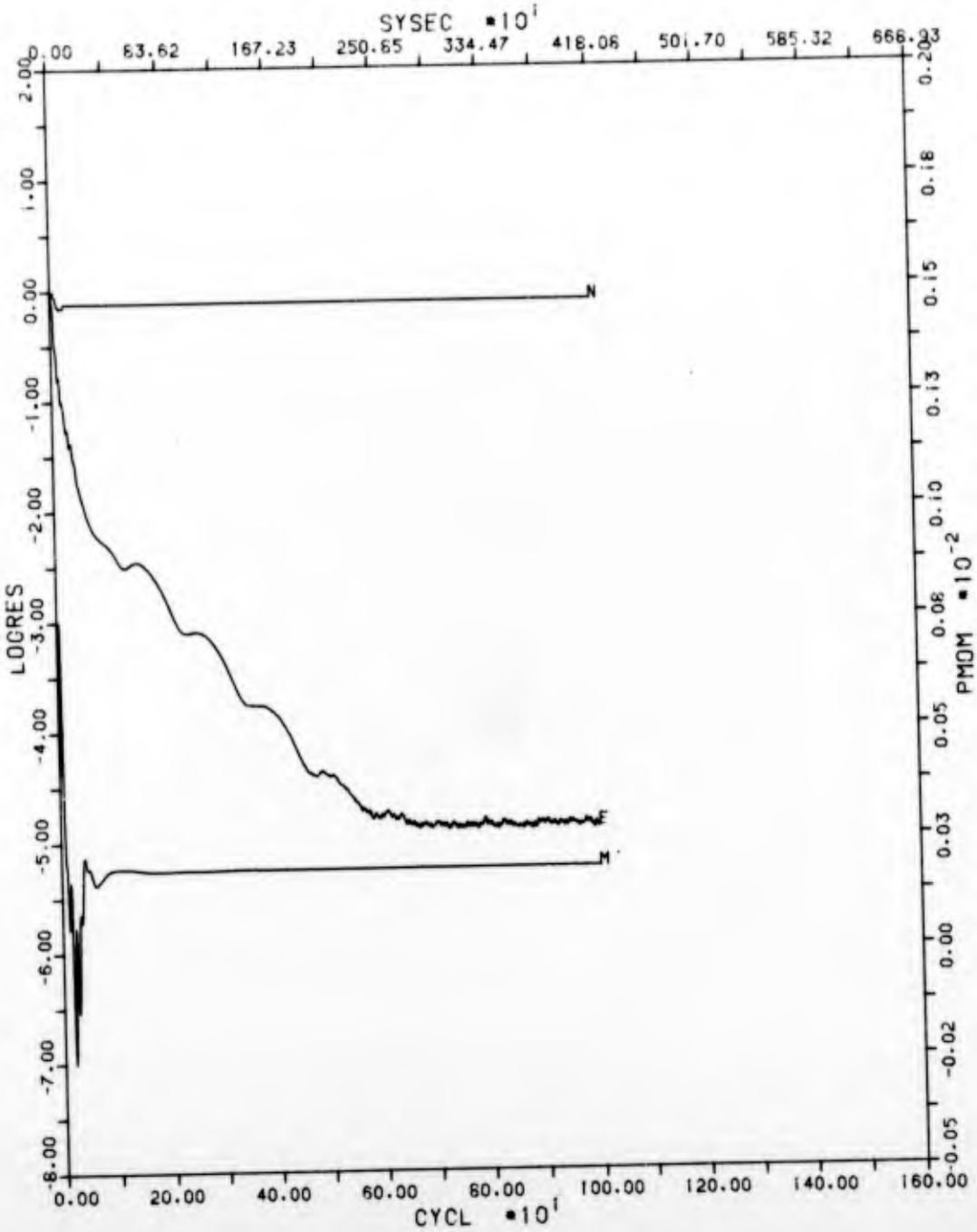


F.F.A.	AR 211		A.Rizzi	03-8-8
	NACA 0012: MACH = 0.95, ALPHA = 0			



15 JUN AFVTOQO NOVOR OUTTOQO MSHX N06 BAS BAS4 .05

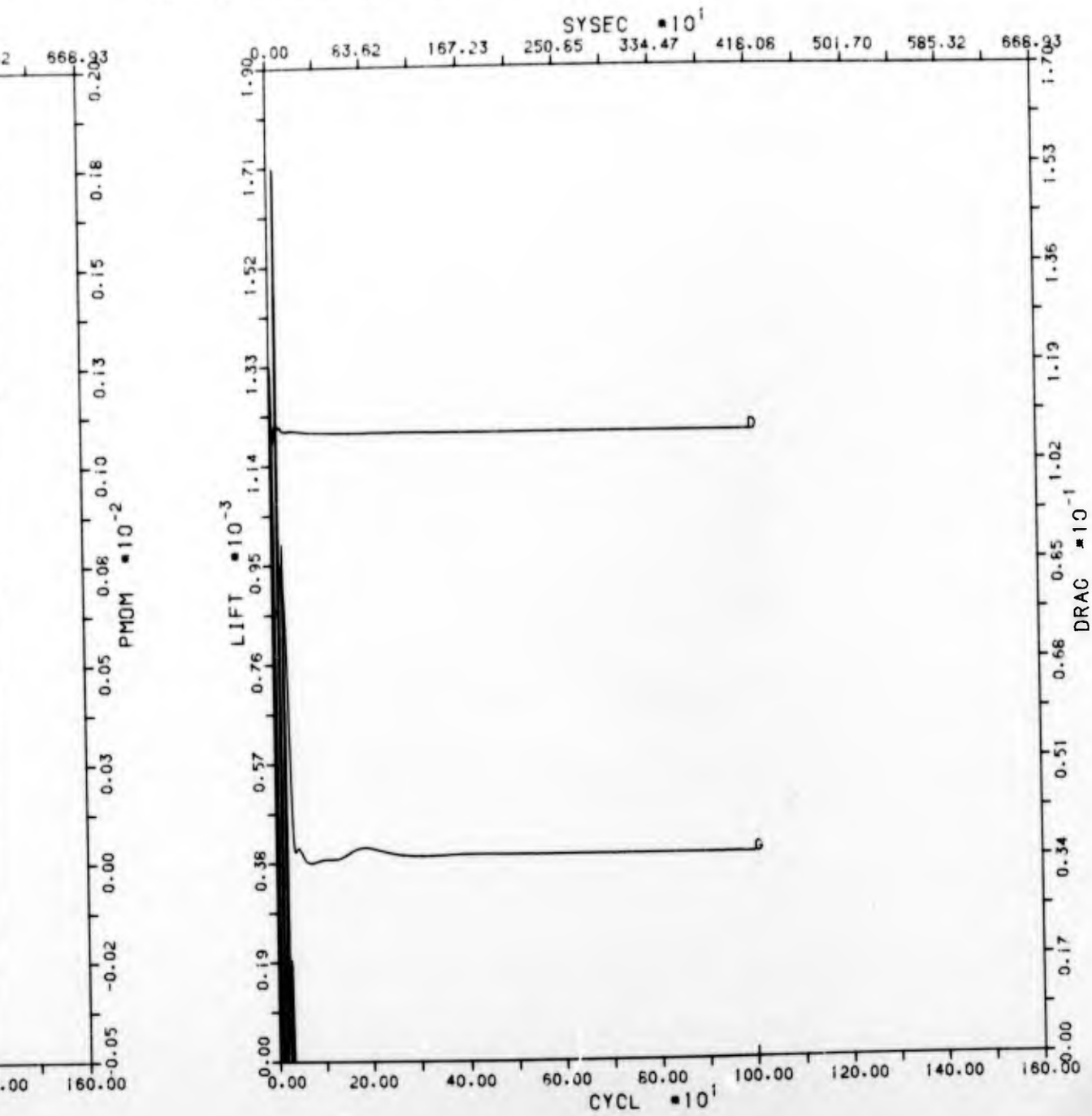
PITCH	0.000	GCIRC	0.000	CELLS	64X16
MACH	0.950	ALPHA	0.000	RESAE	0.992E-0
RATE	0.989	RESAS	0.771E-02	DRAG	0.108E+0
NSUP	462	LIFT	-0.275E-03	RESMX	0.358E-0
CYCL.	1000	SYSEC	0.418E+04		



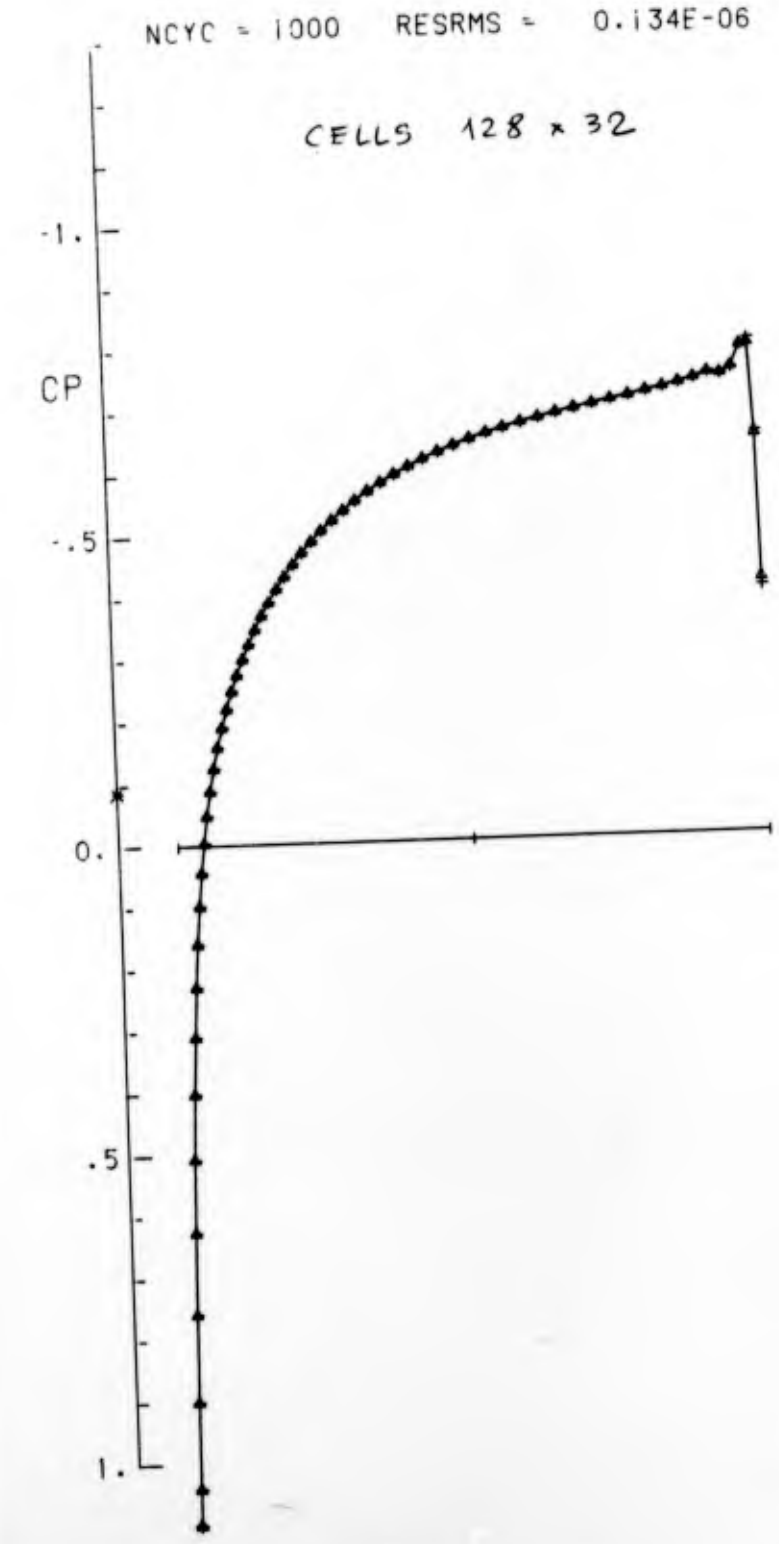
F.F.A.	AR 211		A.Rizzi	03-8-9
	NACA 0012: MACH = 0.95, ALPHA = 0			

X N06 BAS BAS4 .05 0. .01

CELLS 64X16
RESAE 0.992E-07
DRAG 0.108E+00
RESMX 0.358E-06 28 1

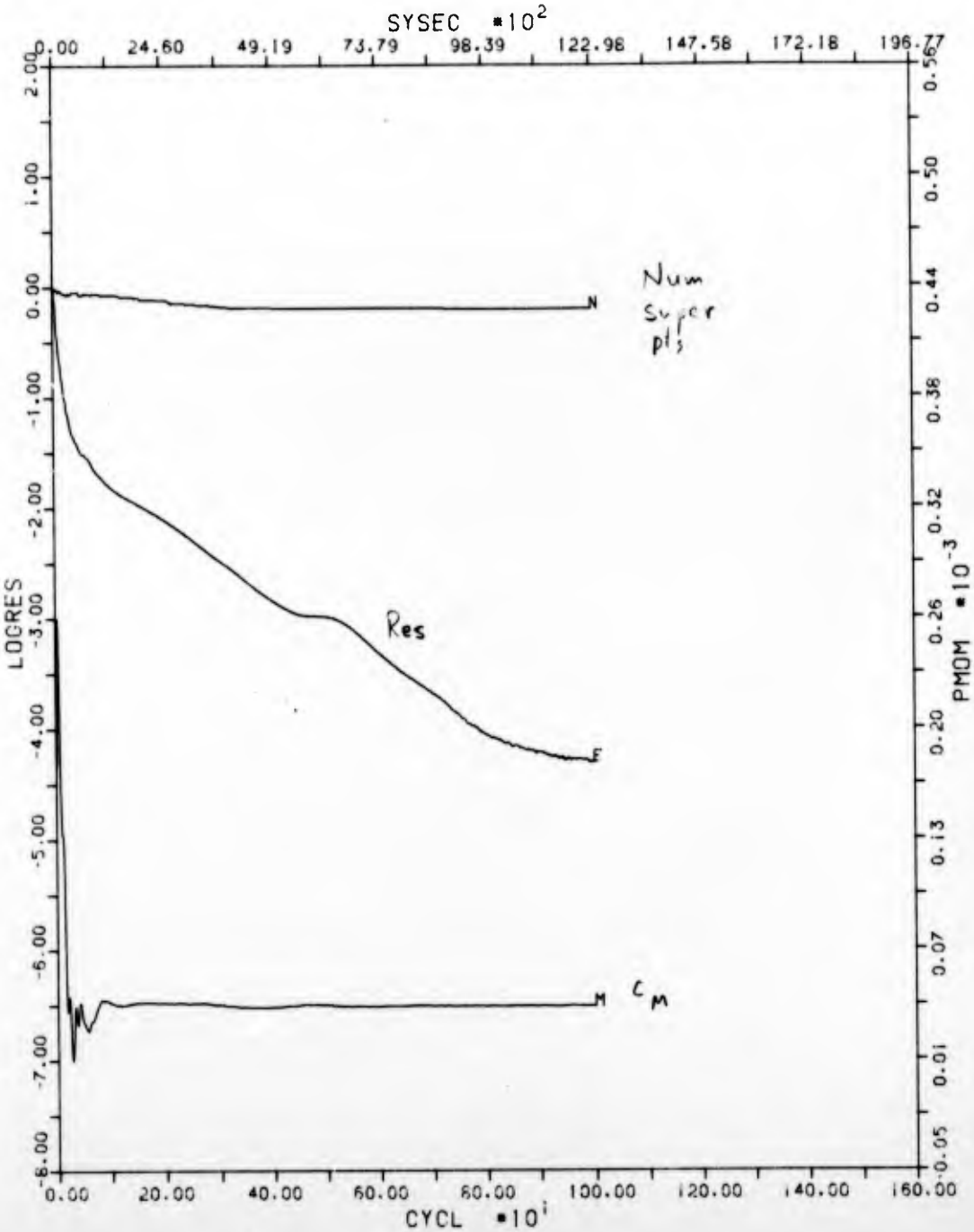


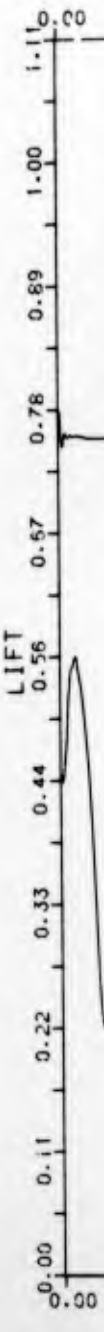
F.F.A.	AR 211		A.Rizzi	03-8-10
	NACA 0012: MACH = 0.95, ALPHA = 0			



15 JUN AFVTOQO NOVOR OUTTOQO MSHX NO6 BAS BAS4 .

C_M	PITCH	0.000	T'	GCIRC	0.000		
	MACH	0.950		ALPHA	0.000		CELLS 128X
	RATE	0.990	start	RESAS	0.266E-02	END	RESAE 0.1
Num super pts	NSUP	1805	C_L	LIFT	-0.580E-04	C_D	DRAG 0.1
	CYCL	1000		SYSEC	0.123E+05		RESMX 0.65 max

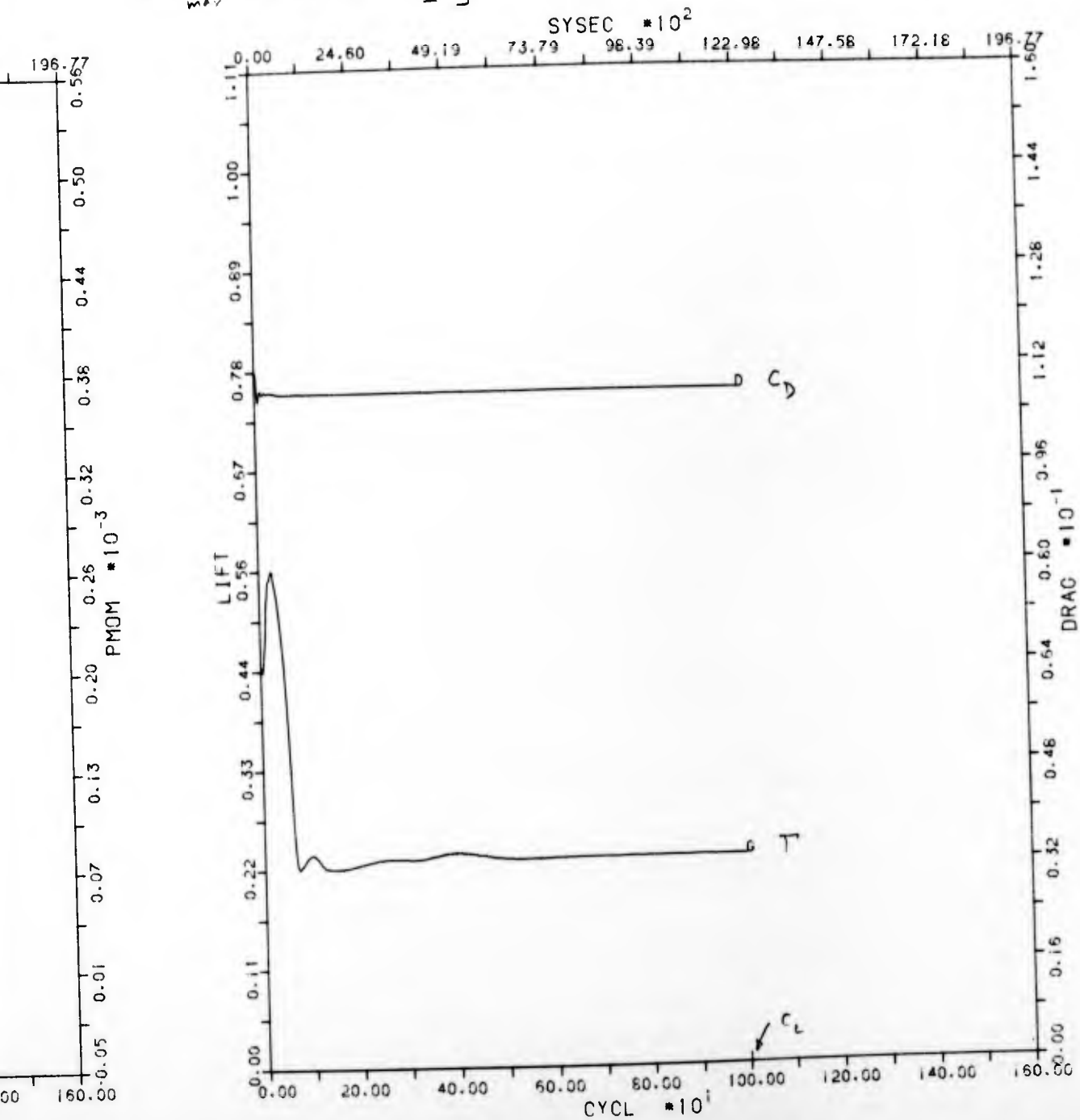




F.F.A.	AR 211		A.Rizzi	03-8-11
	NACA 0012: MACH = 0.95, ALPHA = 0			

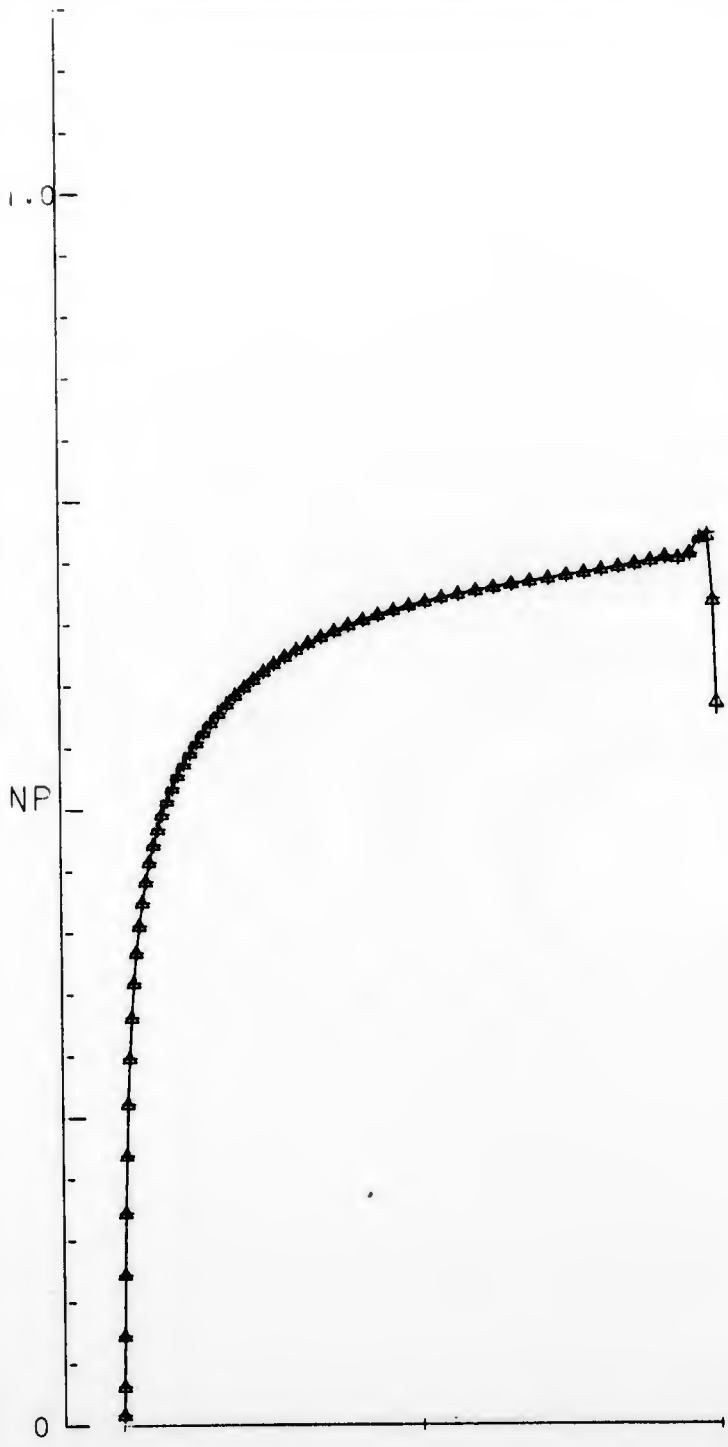
N06 BAS BAS4 .05 0. .01

CELLS 128X32
RESAE 0.134E-06
DRAG 0.108E+00
RESMX 0.656E-06 114 25

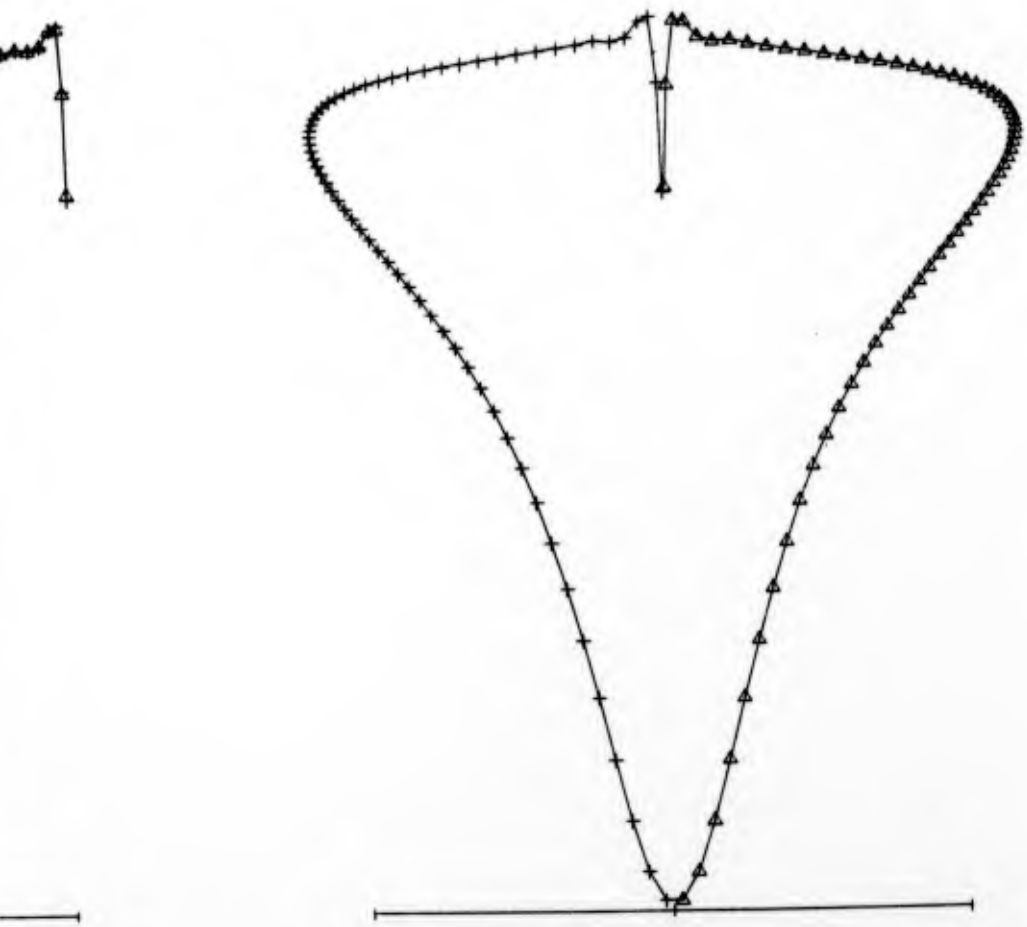


F.F.A.

P 1 PRES 1-P/PIINF

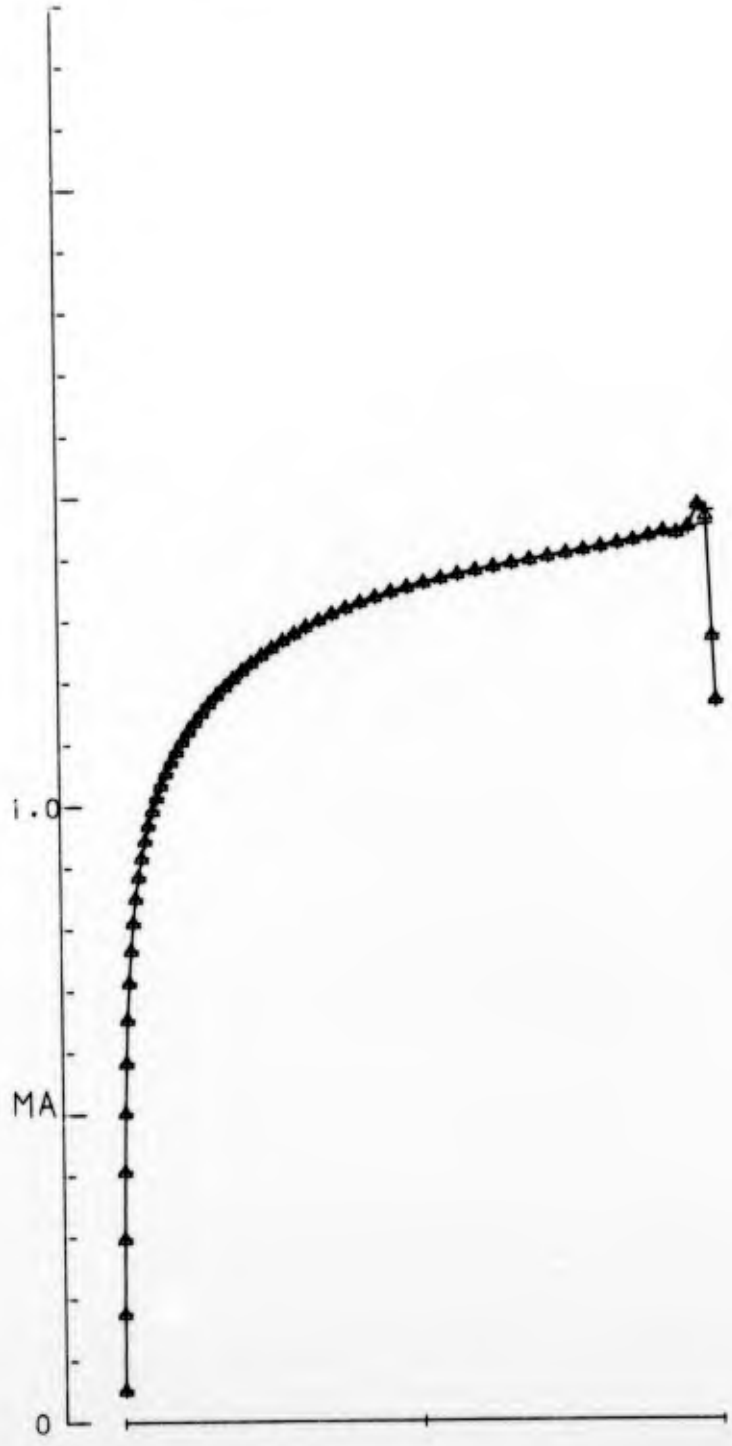


F.F.A.	AR 211		A.Rizzi	03-8-12
	NACA 0012: MACH = 0.95, ALPHA = 0			

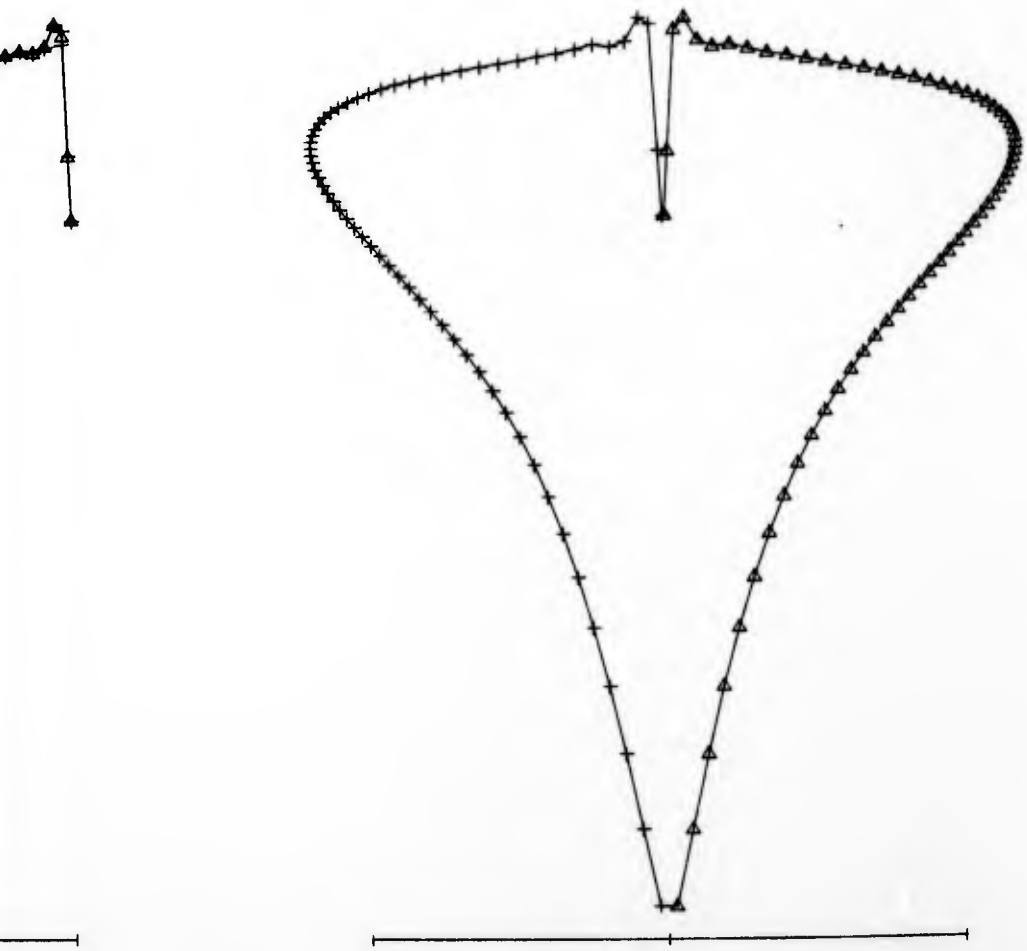


F.F.A.

P 2 MACH

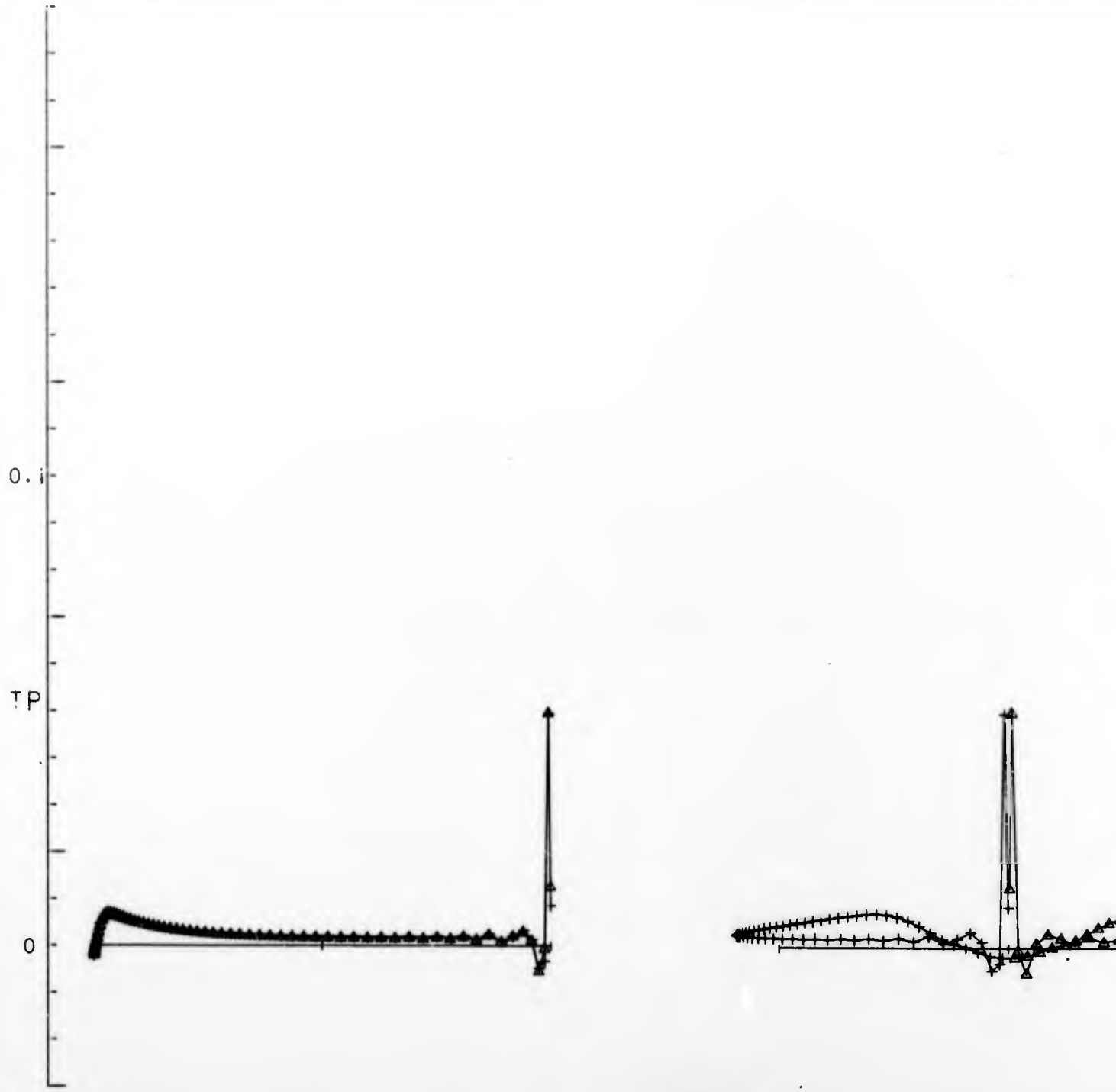


F.F.A.	AR 211		A.Rizzi	03-8-13
	NACA 0012: MACH = 0.95, ALPHA = 0			

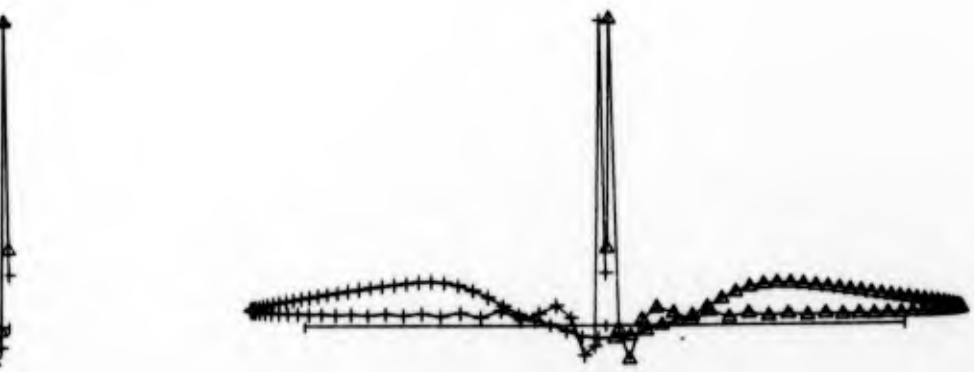


F.F.A.

P 3 TOTP 1-PI/PIINF

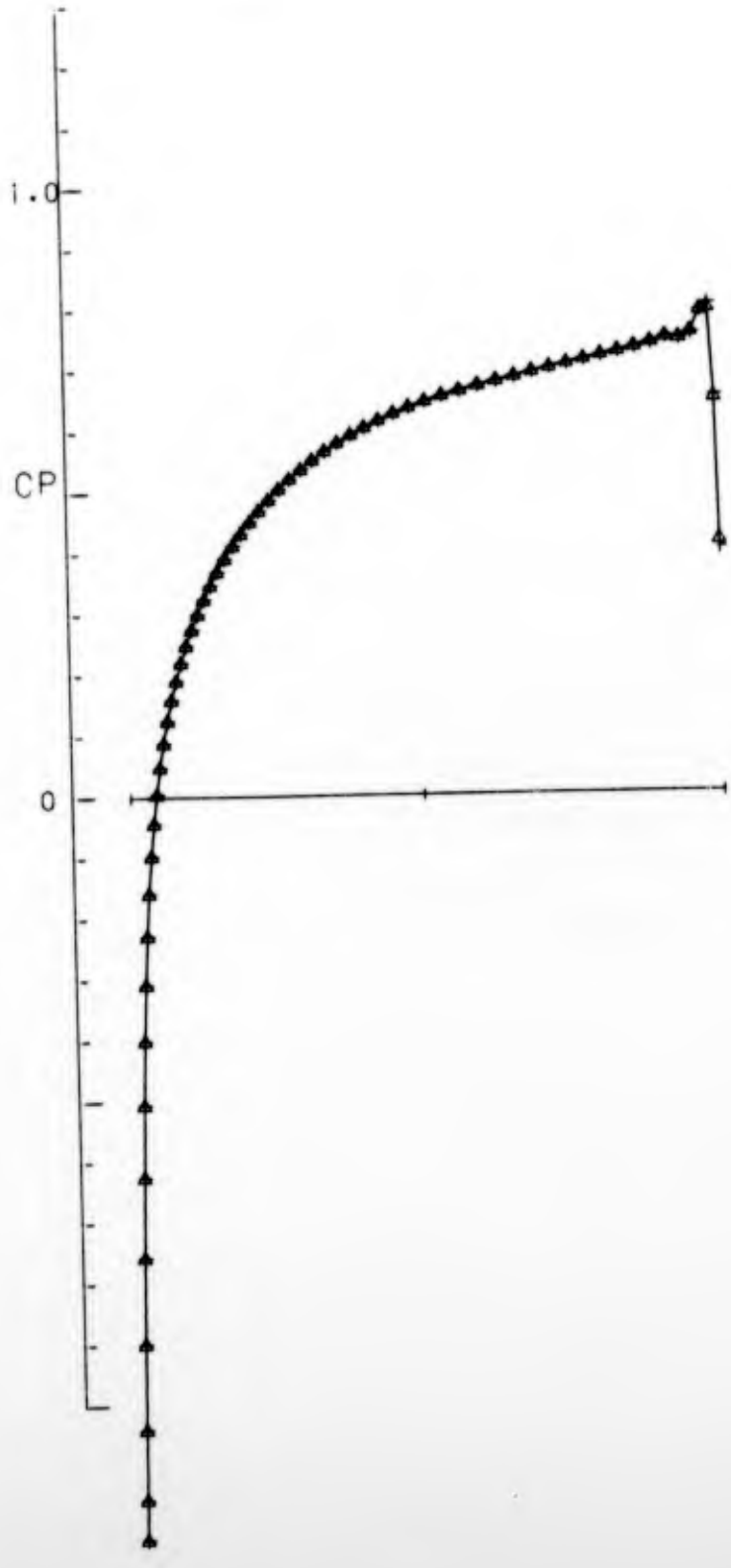


F.F.A.	AR 211		A.Rizzi	03-8-14
	NACA 0012: MACH = 0.95, ALPHA = 0			

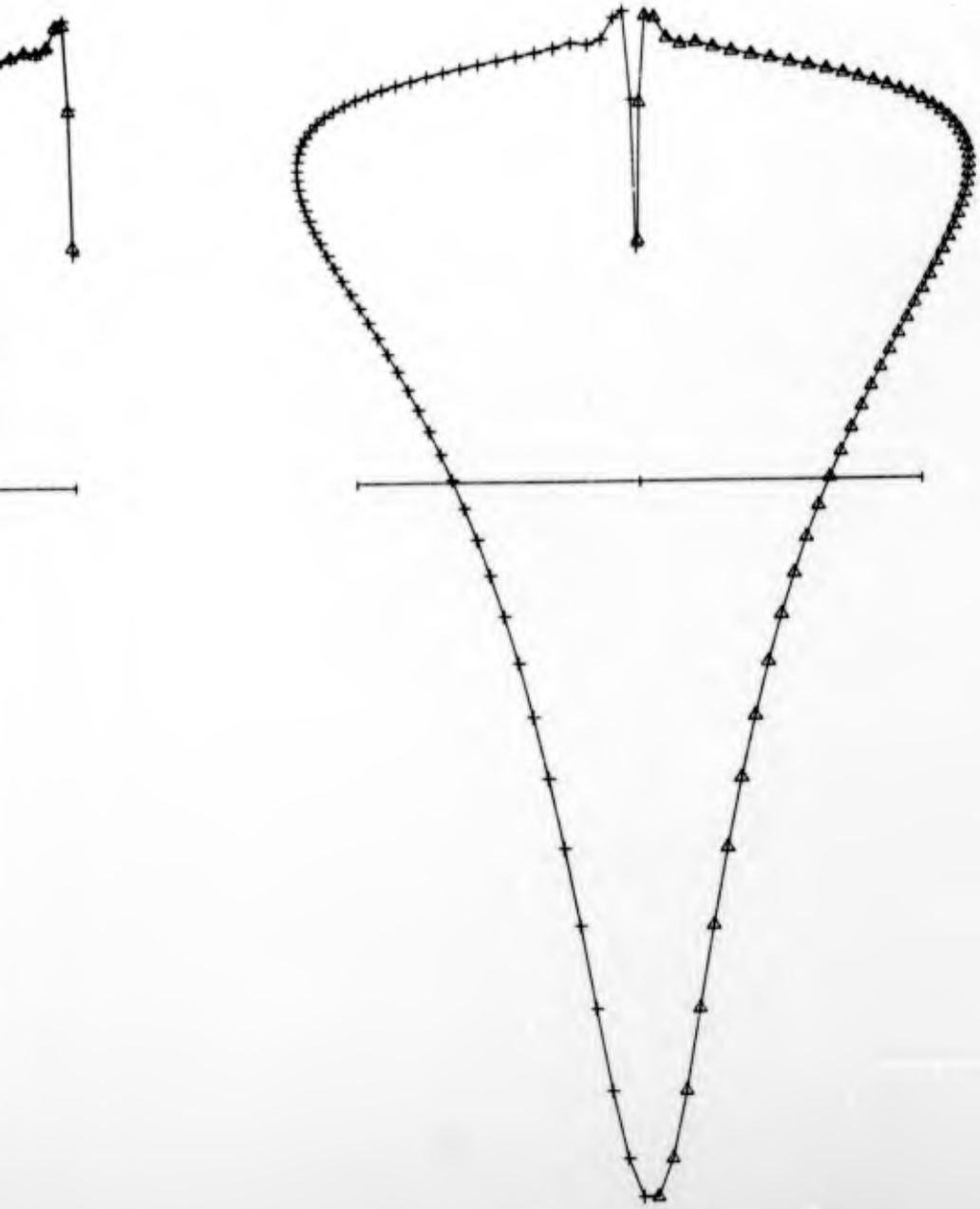


F.F.A.

P 4 COEP. C_p

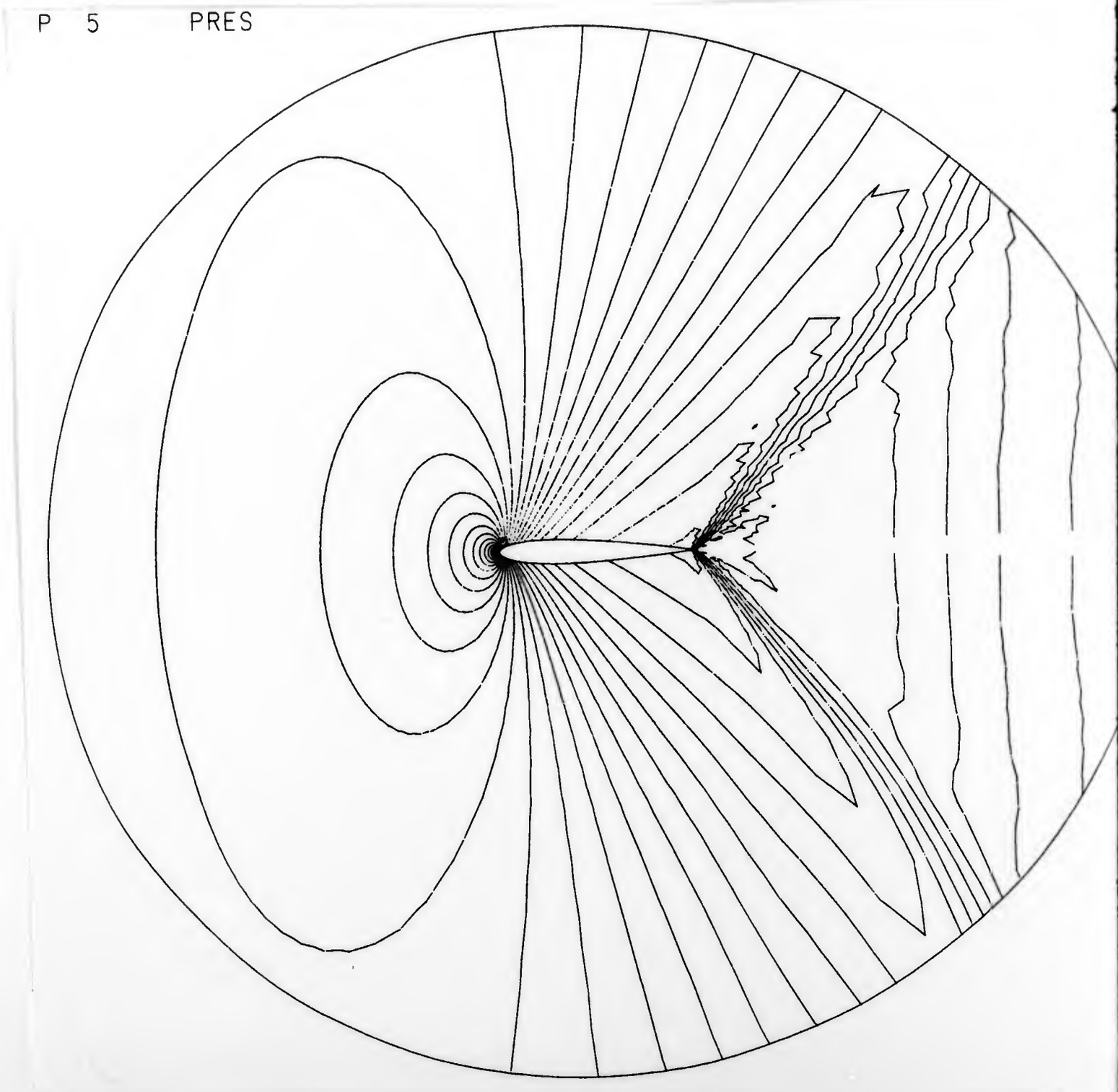


F.F.A.	AR 211		A.Rizzi	03-8-15
	NACA 0012: MACH = 0.95, ALPHA = 0			



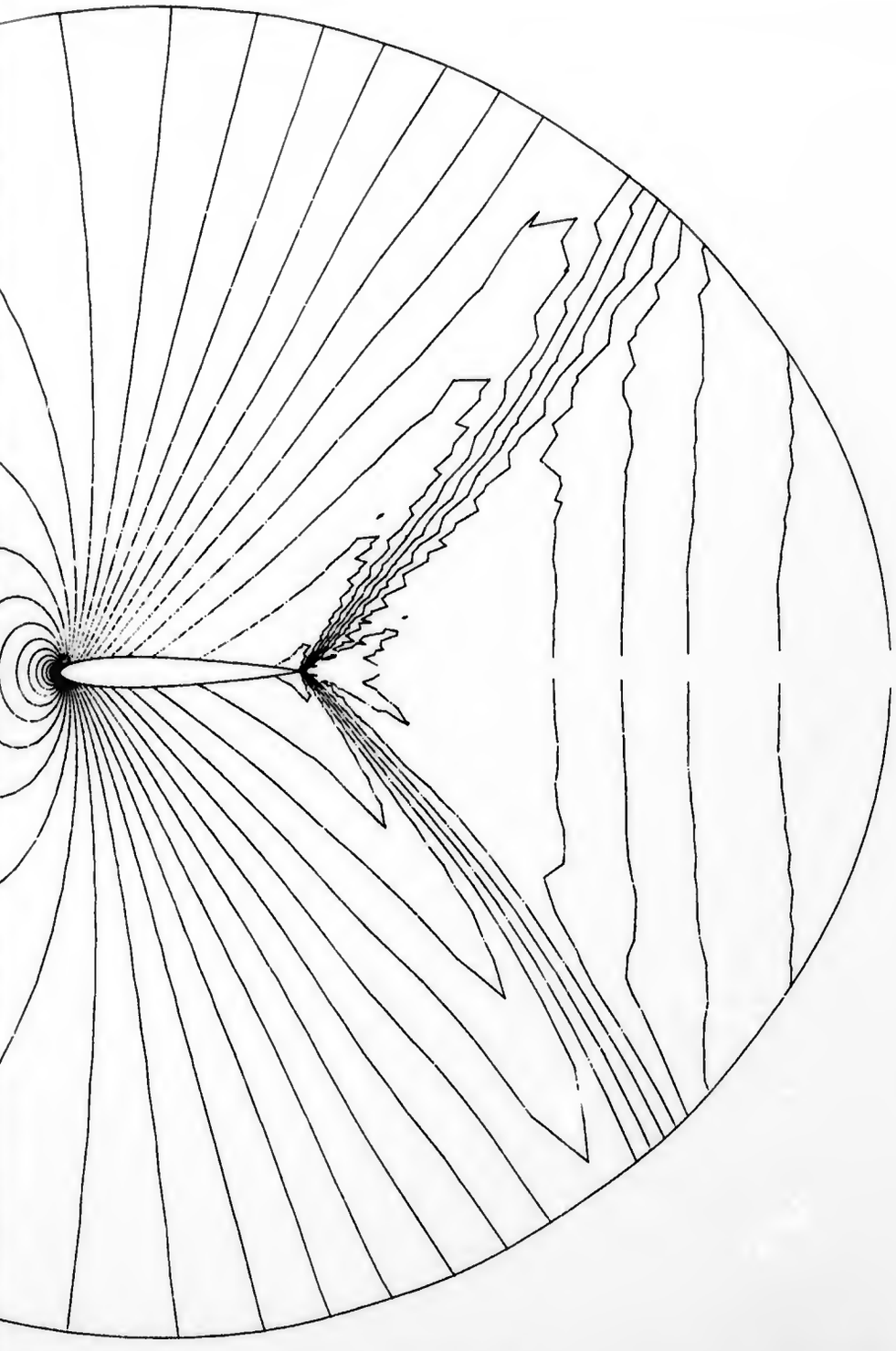
F.F.A.	AR 211
	NACA 0012: MA

1-P/PIINF INC = .025 min = .025 max = .700



F.F.A.	AR 211		A.Rizzi	03-8-16
	NACA 0012: MACH = 0.95, ALPHA = 0			

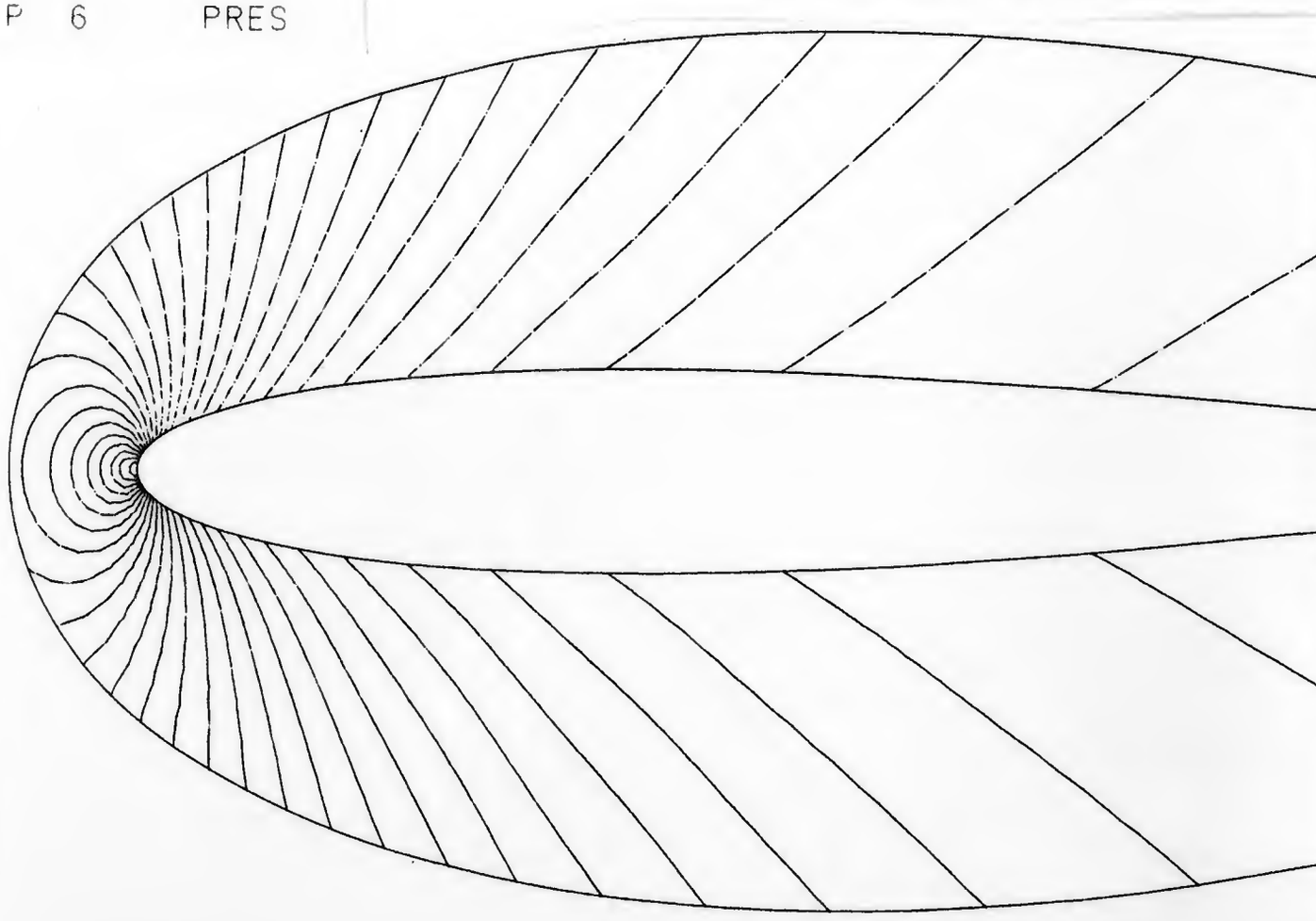
P/PINF INC = .025 min = .025 max = .700



F.F.A

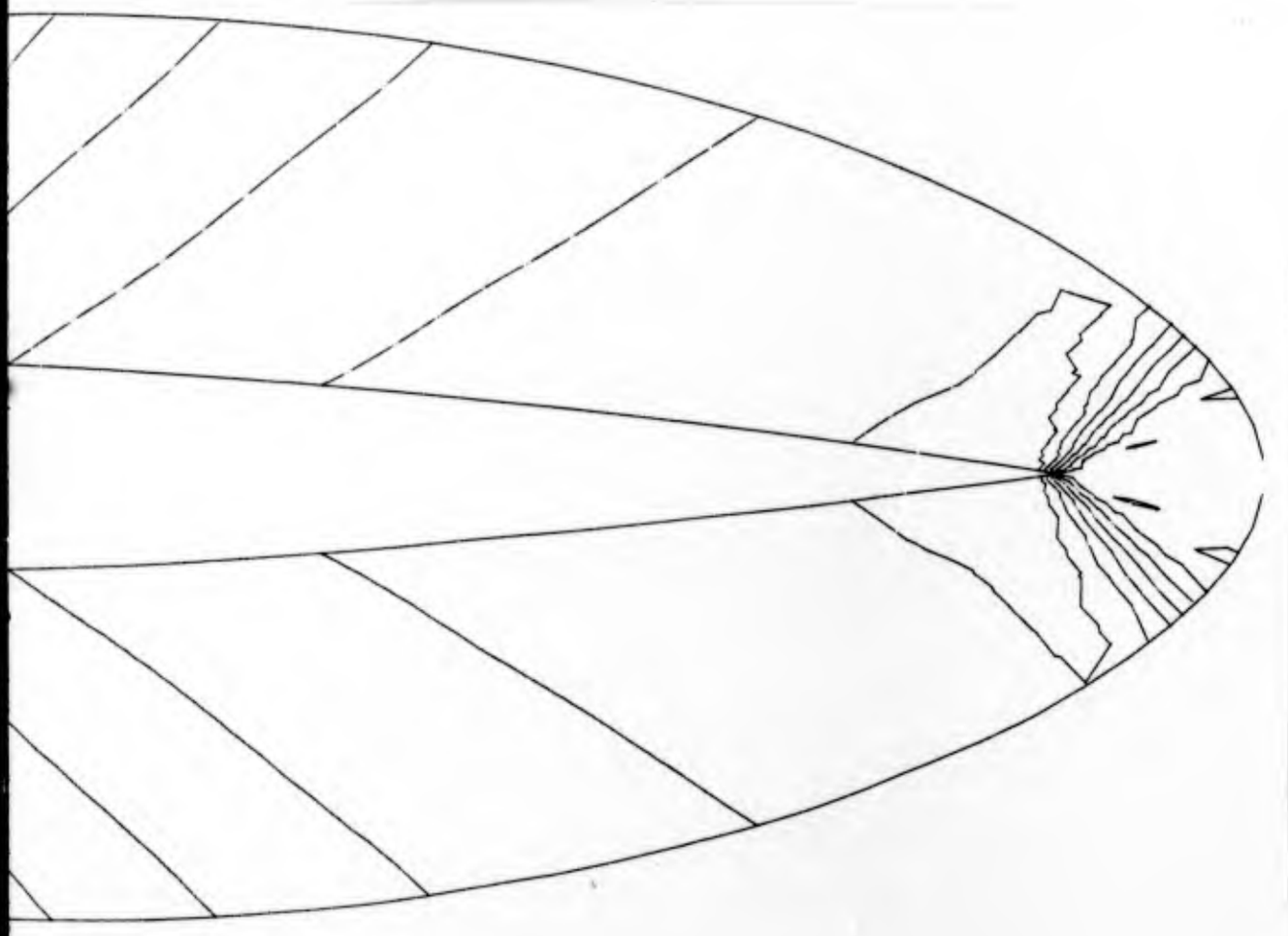
1-P/PIINF INC = .025 min = .025 max = .700

P 6 PRES



F.F.A.	AR 211		A.Rizzi	03-8-17
	NACA 0012: MACH = 0.95, ALPHA = 0			

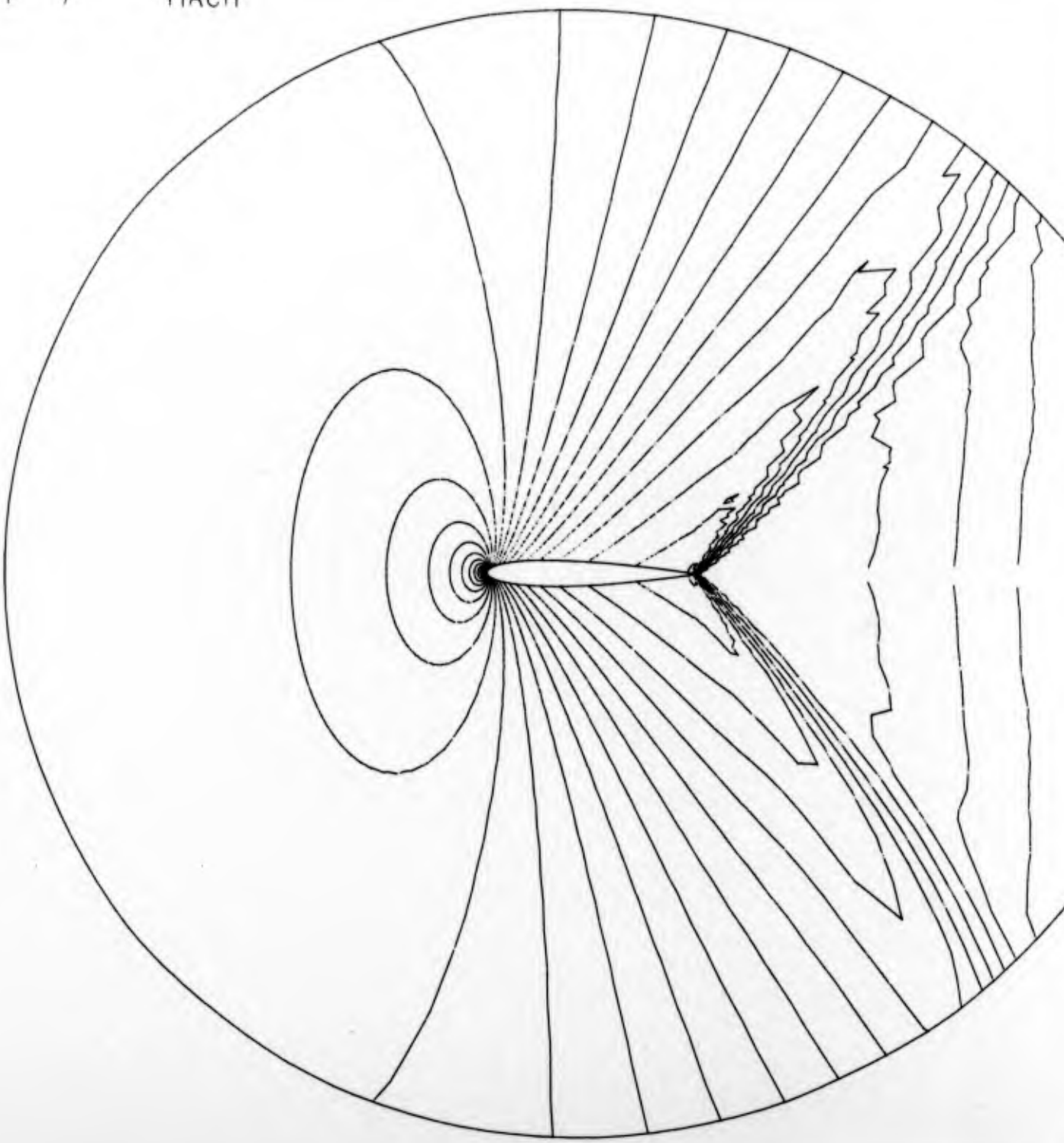
1-P/PIINF INC = .025 min = .025 max = .700



F.F.A.

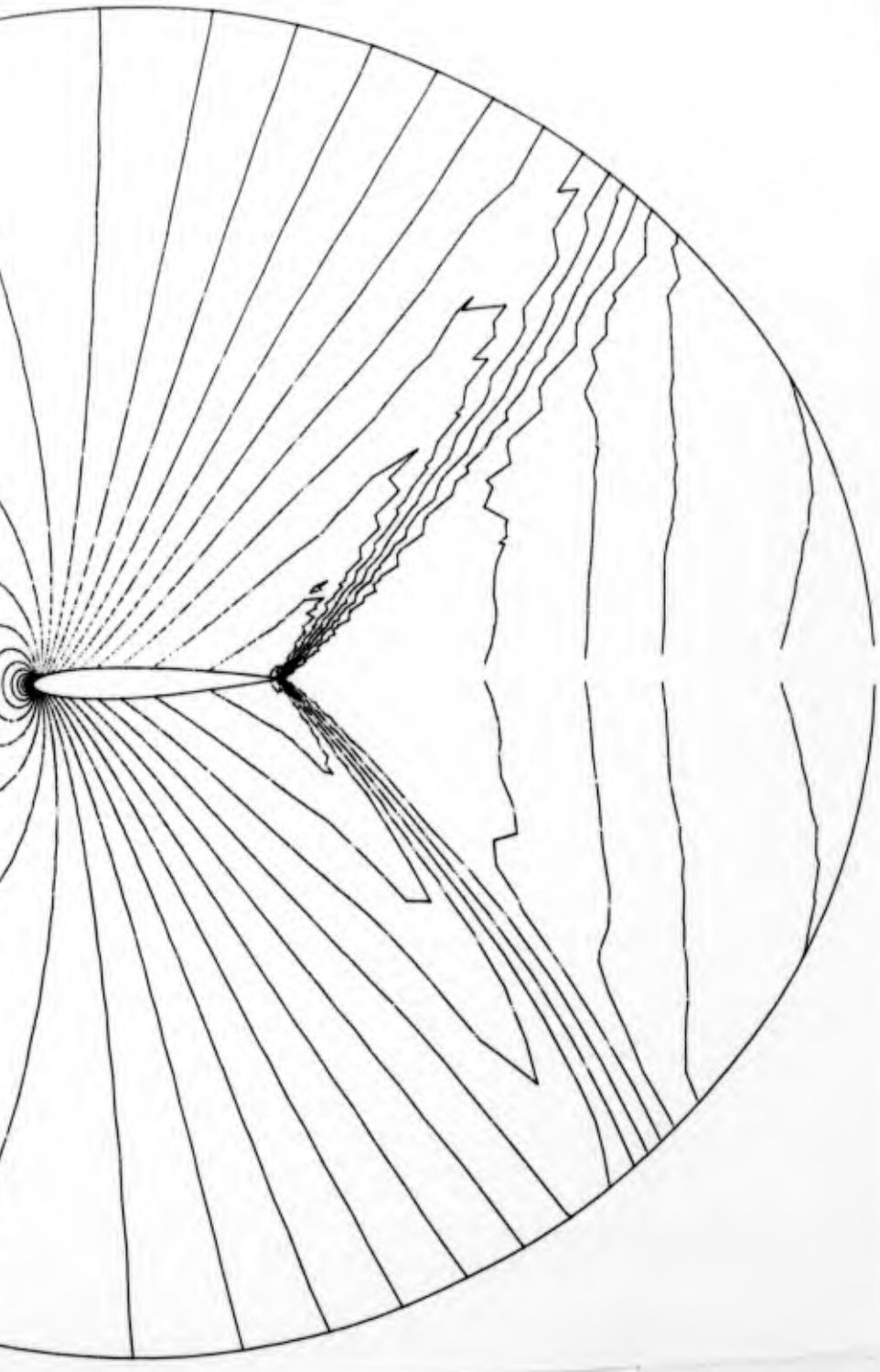
INC = .05 min = .1 max = 1.45

P 7 MACH



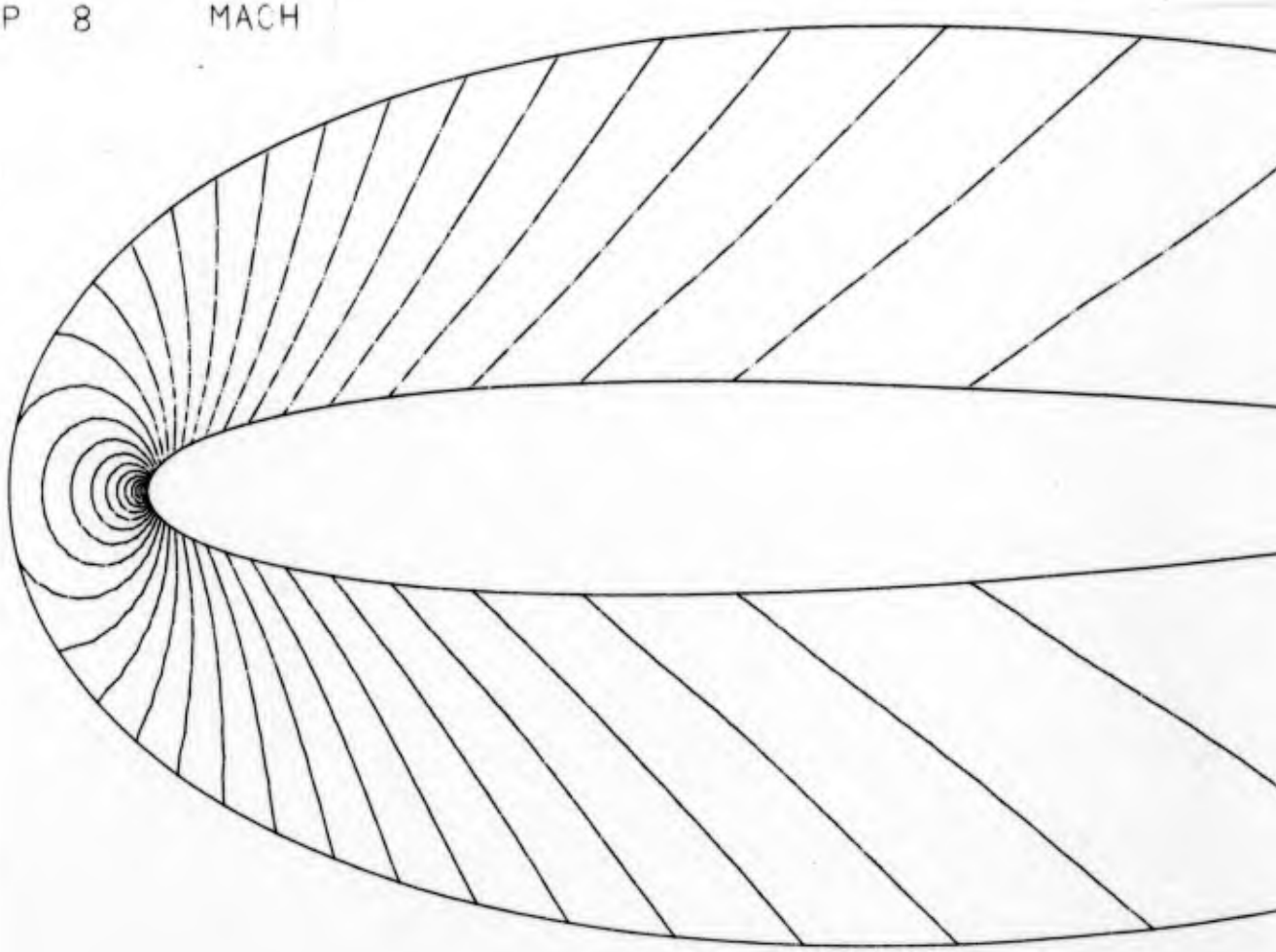
F.F.A.	AR 211		A.Rizzi	03-8-18
	NACA 0012: MACH = 0.95, ALPHA = 0			

INC = .05 min = .1 max = 1.45



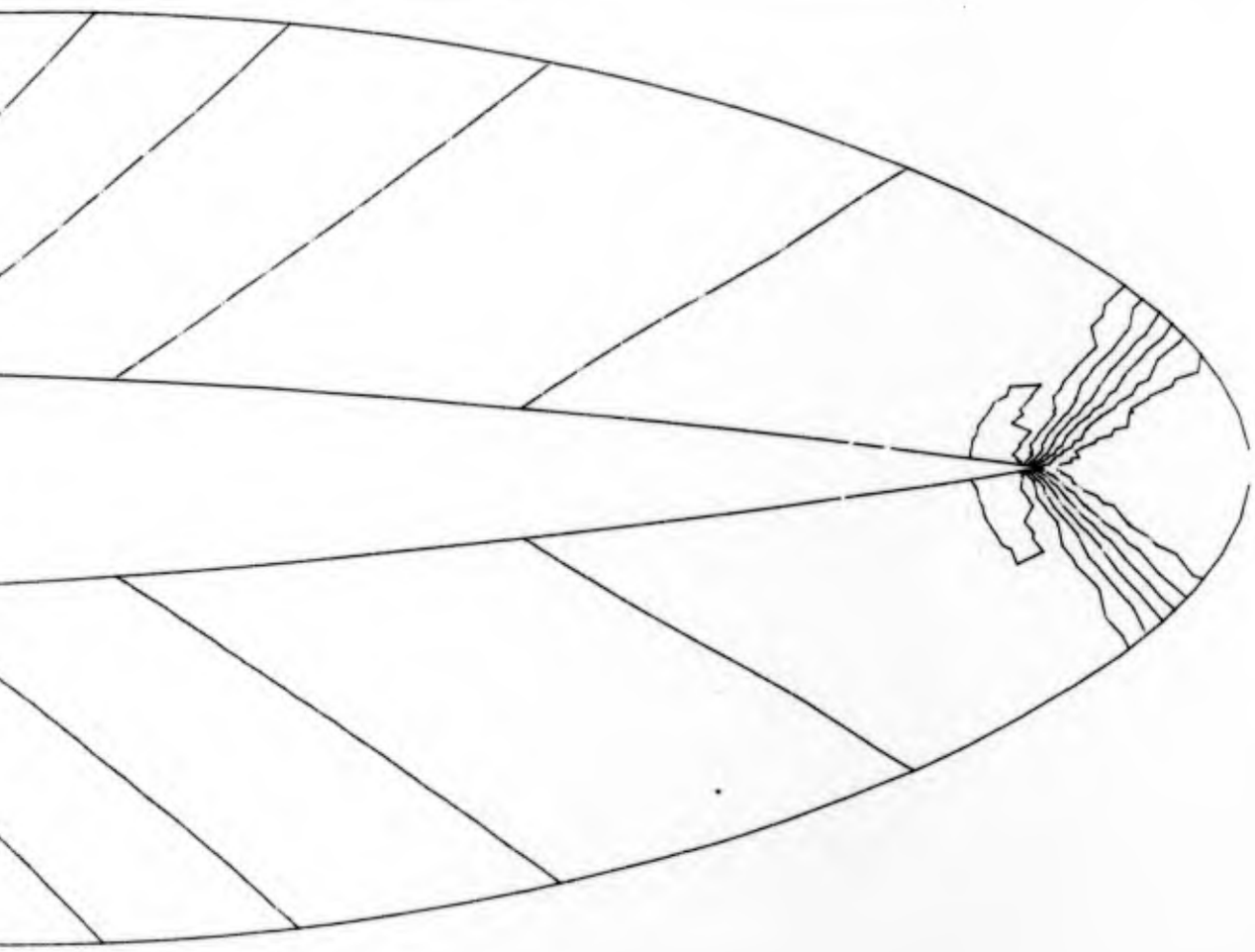
INC = .05 min = .1 max = 1.45

P 8 MACH



F.F.A.	AR 211		A.Rizzi	03-8-19
	NACA 0012: MACH = 0.95, ALPHA = 0			

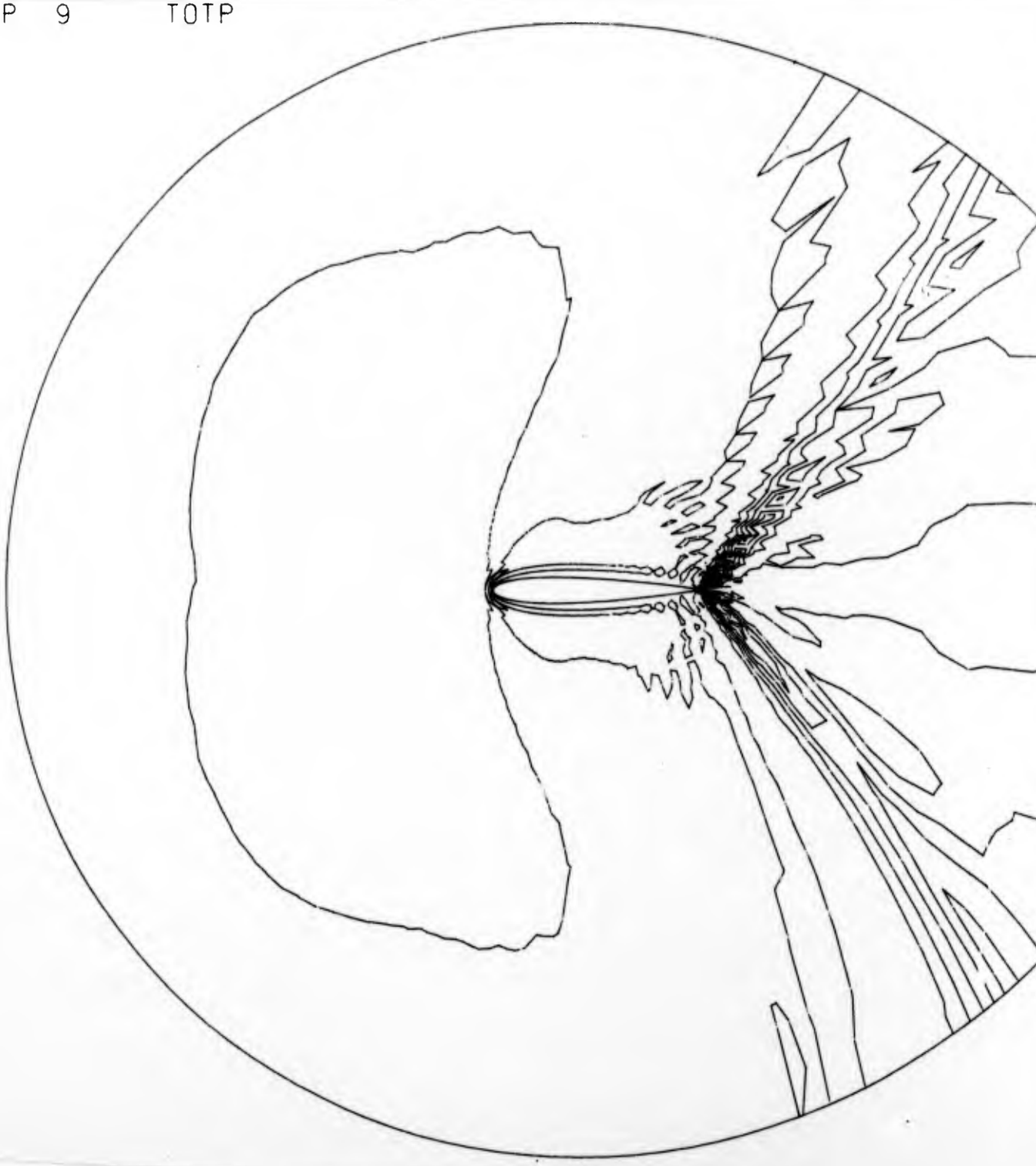
INC = .05 min = .1 max = 1.45



F.F.A.

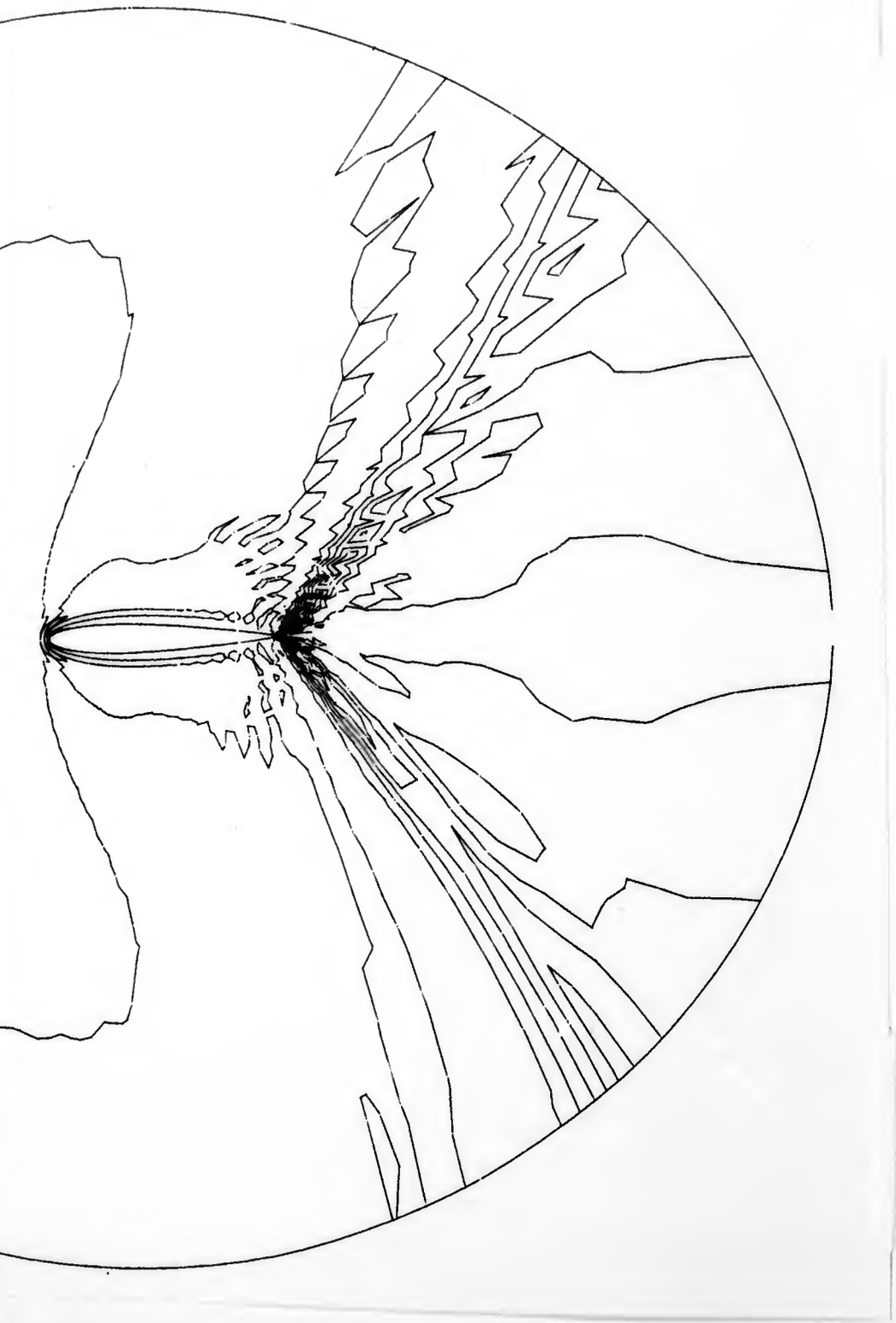
1-PI/PIINF INC = .005 min = −.005 max = .055

P 9 TOTP



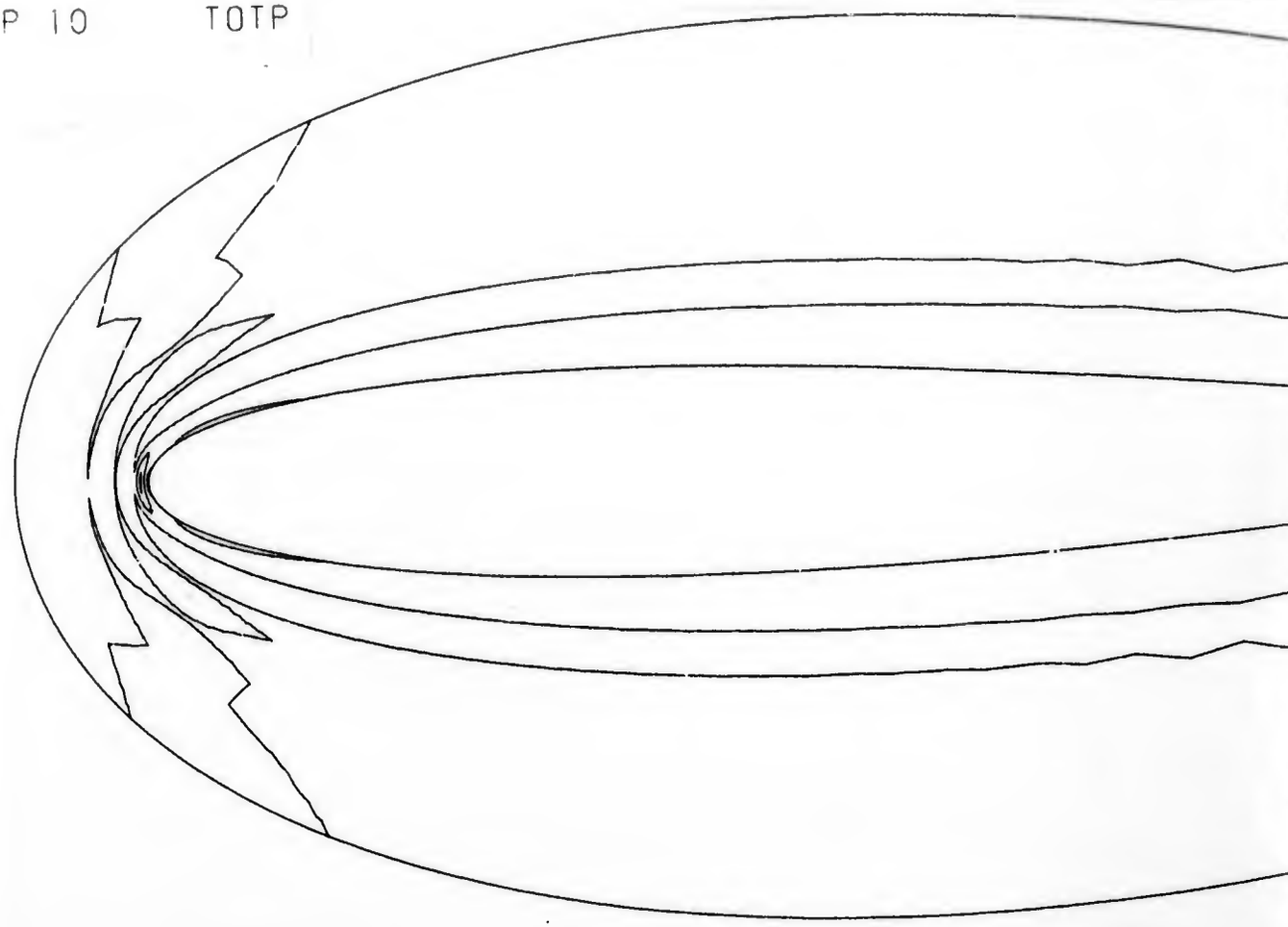
F.F.A.	AR 211		A.Rizzi	03-8-20
	NACA 0012: MACH = 0.95, ALPHA = 0			

PIINF INC = .005 min = -.005 max = .055



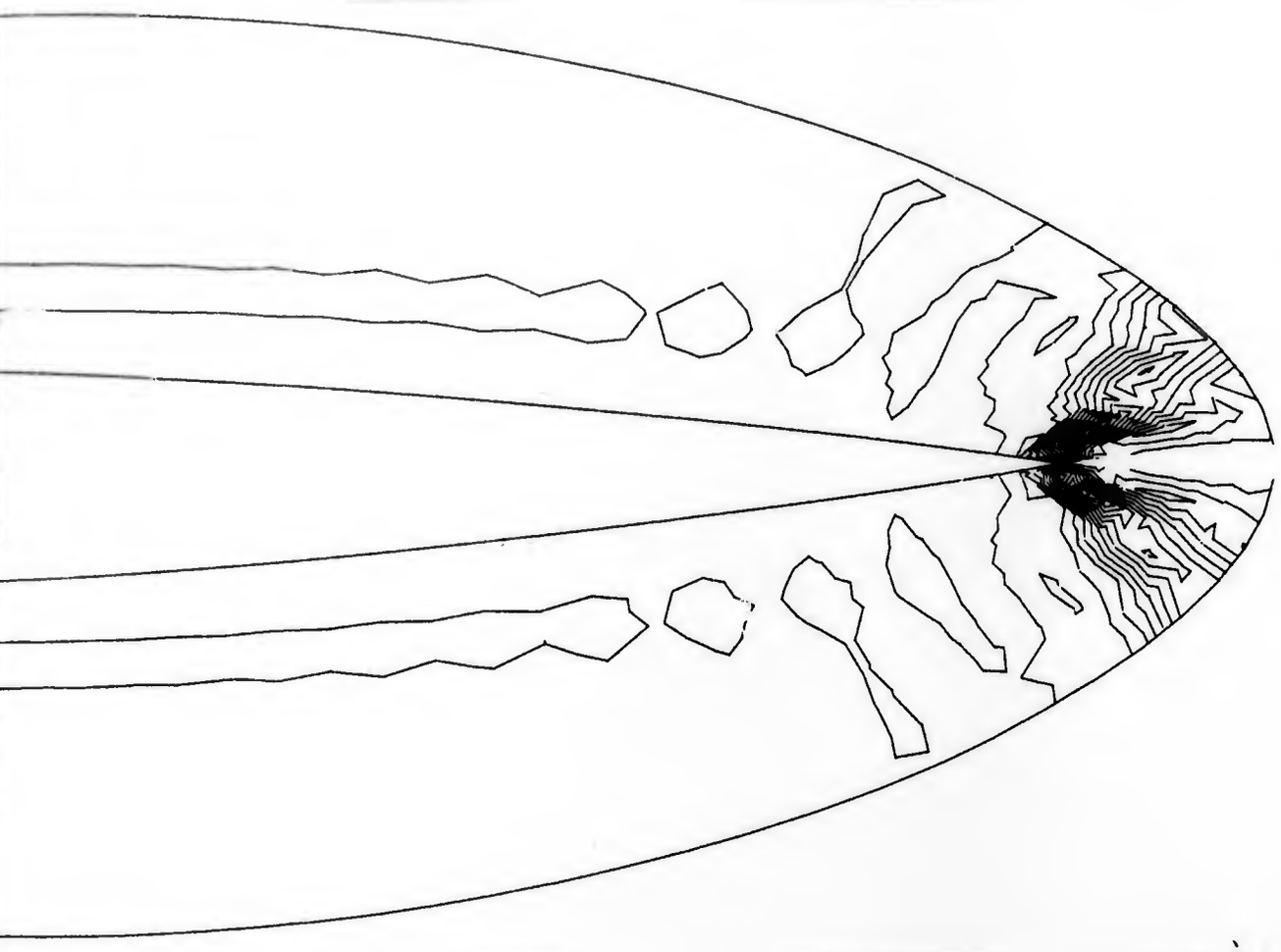
1-PI/PIINF INC = .005 min = -.005 max = .055

P 10 TOTP



F.F.A.	AR 211		A.Rizzi	03-8-21
	NACA 0012: MACH = 0.95, ALPHA = 0			

-PI/PINF INC = .005 min = -.005 max = .055



AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 03

NACA 0012: MACH = 0.95, ALPHA = 0

Contributor No 9

W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-1
	NACA 0012: MACH = 0.95, ALPHA = 0			

N	X/C(%)	Z/C(%)	1-P/PIINF	CP	MACH	1-PI/PIINF
2	99.992828	-Ø.ØØ1ØZØ	Ø.518416	-Ø.22ØZ4Ø	1.Ø49458	Ø.ØZ3357
3	99.965897	-Ø.ØØ4846	Ø.679789	-Ø.676694	1.34ØØ85	Ø.Ø62446
4	99.914658	-Ø.Ø12118	Ø.783158	-Ø.743Ø39	1.435113	Ø.ØØ723Ø
5	99.84Ø439	-Ø.Ø22628	Ø.718266	-Ø.763158	1.452341	Ø.ØØ6893
6	99.744ØØ3	-Ø.Ø36276	Ø.711594	-Ø.766986	1.461586	-Ø.ØØ1616
7	99.625946	-Ø.Ø52983	Ø.711951	-Ø.767917	1.459213	Ø.ØØ2988
8	99.486725	-Ø.Ø72632	Ø.718755	-Ø.764533	1.458127	Ø.ØØØ323
9	99.326721	-Ø.Ø95145	Ø.718875	-Ø.764872	1.457856	Ø.ØØ2278
1Ø	99.146286	-Ø.12Ø481	Ø.718626	-Ø.764169	1.457368	Ø.ØØØ966
11	98.945786	-Ø.148593	Ø.718538	-Ø.763919	1.456636	Ø.ØØ1787
12	98.725494	-Ø.179389	Ø.718178	-Ø.762988	1.456181	Ø.ØØ1231
13	98.485783	-Ø.212798	Ø.789956	-Ø.762273	1.455388	Ø.ØØ1612
14	98.226788	-Ø.248813	Ø.789772	-Ø.761752	1.455885	Ø.ØØ1482
15	97.948761	-Ø.287339	Ø.789365	-Ø.768688	1.454842	Ø.ØØ1377
16	97.652138	-Ø.328249	Ø.788922	-Ø.759346	1.452987	Ø.ØØ1477
17	97.337882	-Ø.371551	Ø.788718	-Ø.758771	1.452384	Ø.ØØ1527
18	97.ØØ3891	-Ø.417216	Ø.788428	-Ø.757927	1.451761	Ø.ØØ1394
19	96.652786	-Ø.465119	Ø.787977	-Ø.756674	1.458658	Ø.ØØ1464
2Ø	96.284Ø27	-Ø.515193	Ø.787564	-Ø.755885	1.449648	Ø.ØØ1483
21	95.897858	-Ø.567398	Ø.787148	-Ø.754328	1.448672	Ø.ØØ1455
22	95.494553	-Ø.621635	Ø.786683	-Ø.753Ø12	1.447562	Ø.ØØ1453
23	95.Ø74341	-Ø.677854	Ø.786223	-Ø.751718	1.446454	Ø.ØØ1469
24	94.637466	-Ø.735998	Ø.785821	-Ø.758574	1.445478	Ø.ØØ1494
25	94.184219	-Ø.796838	Ø.785449	-Ø.749521	1.444591	Ø.ØØ1499
26	93.714828	-Ø.857983	Ø.784988	-Ø.748217	1.443518	Ø.ØØ1465
27	93.229553	-Ø.921482	Ø.784437	-Ø.746658	1.442284	Ø.ØØ1471
28	92.728638	-Ø.986685	Ø.783873	-Ø.745Ø61	1.448862	Ø.ØØ1478
29	92.212341	-1.Ø53459	Ø.783368	-Ø.743632	1.439651	Ø.ØØ1499
3Ø	91.688923	-1.121788	Ø.782915	-Ø.742351	1.438581	Ø.ØØ1498
31	91.134644	-1.191594	Ø.782443	-Ø.741Ø15	1.437471	Ø.ØØ1491
32	9Ø.573761	-1.262822	Ø.781932	-Ø.739569	1.436256	Ø.ØØ1586
33	89.998535	-1.335393	Ø.781386	-Ø.738Ø25	1.434978	Ø.ØØ1494
34	89.489225	-1.489214	Ø.788791	-Ø.736341	1.433592	Ø.ØØ1475
35	88.886Ø91	-1.484191	Ø.788289	-Ø.734695	1.432283	Ø.ØØ1588
36	88.189487	-1.568317	Ø.699728	-Ø.733335	1.431855	Ø.ØØ1537
37	87.559418	-1.637572	Ø.699228	-Ø.731928	1.429918	Ø.ØØ1489
38	86.916428	-1.715837	Ø.698629	-Ø.738225	1.428517	Ø.ØØ1498
39	86.268666	-1.795819	Ø.698Ø39	-Ø.728555	1.427115	Ø.ØØ1524
4Ø	85.592487	-1.875Ø83	Ø.697489	-Ø.727888	1.425839	Ø.ØØ1516
41	84.911942	-1.955977	Ø.696938	-Ø.725419	1.424543	Ø.ØØ1518
42	84.219528	-2.Ø37631	Ø.696346	-Ø.723764	1.423185	Ø.ØØ1588
43	83.515427	-2.119978	Ø.695754	-Ø.722Ø91	1.421811	Ø.ØØ1512
44	82.799927	-2.282941	Ø.695186	-Ø.728485	1.428489	Ø.ØØ1528
45	82.Ø73288	-2.286581	Ø.694638	-Ø.718933	1.419219	Ø.ØØ1521
46	81.335815	-2.378688	Ø.694Ø83	-Ø.717361	1.417937	Ø.ØØ1528
47	8Ø.587753	-2.455165	Ø.693495	-Ø.715788	1.416588	Ø.ØØ1512
48	79.829376	-2.548112	Ø.692884	-Ø.713969	1.415176	Ø.ØØ1514
49	79.Ø68974	-2.625375	Ø.692285	-Ø.712276	1.413793	Ø.ØØ1524
5Ø	78.282837	-2.718918	Ø.691784	-Ø.718631	1.412457	Ø.ØØ1527
51	77.495289	-2.796678	Ø.691116	-Ø.788967	1.411111	Ø.ØØ1523
52	76.698418	-2.882581	Ø.698491	-Ø.787199	1.489692	Ø.ØØ1585
53	75.892685	-2.968552	Ø.689849	-Ø.785383	1.488219	Ø.ØØ1515
54	75.Ø78339	-3.Ø54547	Ø.689265	-Ø.783738	1.486868	Ø.ØØ1538
55	74.255638	-3.148568	Ø.688785	-Ø.782147	1.485685	Ø.ØØ1521
56	73.424866	-3.226589	Ø.688Ø91	-Ø.788489	1.484215	Ø.ØØ1589
57	72.586319	-3.312381	Ø.687453	-Ø.698685	1.482753	Ø.ØØ1529
58	71.748265	-3.397891	Ø.686821	-Ø.696816	1.481323	Ø.ØØ1524
59	7Ø.887889	-3.483285	Ø.686158	-Ø.694941	1.399837	Ø.ØØ1582
6Ø	7Ø.Ø26794	-3.568157	Ø.685499	-Ø.693875	1.398327	Ø.ØØ1528
61	69.159943	-3.652738	Ø.684895	-Ø.691366	1.396951	Ø.ØØ1546
62	68.286728	-3.736912	Ø.684245	-Ø.689529	1.395518	Ø.ØØ1513
63	67.487448	-3.828548	Ø.683499	-Ø.687417	1.393844	Ø.ØØ1485
64	66.522354	-3.983537	Ø.682783	-Ø.685391	1.392218	Ø.ØØ1538
65	65.631768	-3.985985	Ø.682136	-Ø.683561	1.398759	Ø.ØØ1529
66	64.735947	-4.Ø67623	Ø.681484	-Ø.681715	1.389381	Ø.ØØ1525
67	63.835228	-4.148681	Ø.688748	-Ø.679633	1.387674	Ø.ØØ1581
68	62.929848	-4.228698	Ø.679938	-Ø.677318	1.385851	Ø.ØØ1499
69	62.Ø28111	-4.387839	Ø.679145	-Ø.675897	1.384Ø81	Ø.ØØ1538
7Ø	61.186388	-4.386838	Ø.678418	-Ø.673819	1.382454	Ø.ØØ1522
71	6Ø.188751	-4.463216	Ø.677648	-Ø.678839	1.388755	Ø.ØØ1587
72	59.267788	-4.539382	Ø.676815	-Ø.668587	1.378925	Ø.ØØ1513
73	58.343468	-4.614286	Ø.675957	-Ø.666879	1.377838	Ø.ØØ1518
74	57.416321	-4.687847	Ø.675Ø65	-Ø.663555	1.375Ø69	Ø.ØØ1583
75	56.486572	-4.768148	Ø.674158	-Ø.668988	1.373Ø66	Ø.ØØ1512
76	55.554584	-4.831Ø51	Ø.673271	-Ø.658478	1.371186	Ø.ØØ1528
77	54.628422	-4.988533	Ø.672341	-Ø.655846	1.369Ø88	Ø.ØØ1497
78	53.684616	-4.968453	Ø.671389	-Ø.652926	1.366843	Ø.ØØ1482
79	52.747375	-5.Ø34718	Ø.678279	-Ø.658Ø14	1.364571	Ø.ØØ1521
8Ø	51.888988	-5.Ø99324	Ø.669294	-Ø.647227	1.362438	Ø.ØØ1518

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-2
	NACA 0012: MACH = 0.95, ALPHA = 0			

81	50.869781	-5.162216	0.668252	-0.644277	1.360181	0.001493
82	49.930008	-5.223271	0.667128	-0.641096	1.357740	0.001504
83	48.990005	-5.282402	0.665962	-0.637798	1.355221	0.001505
84	48.050049	-5.339531	0.664752	-0.634374	1.352621	0.001493
85	47.110458	-5.394568	0.663499	-0.630830	1.349929	0.001495
86	46.171509	-5.447458	0.662244	-0.627279	1.347228	0.001512
87	45.233521	-5.498161	0.660962	-0.623653	1.344498	0.001501
88	44.296783	-5.546580	0.659595	-0.619785	1.341595	0.001488
89	43.361603	-5.592612	0.658169	-0.615750	1.338557	0.001501
90	42.428284	-5.636191	0.656714	-0.611633	1.335474	0.001504
91	41.497131	-5.677249	0.655200	-0.607349	1.332287	0.001493
92	40.568451	-5.715693	0.653613	-0.602860	1.328953	0.001490
93	39.642548	-5.751444	0.651977	-0.598230	1.325521	0.001490
94	38.719727	-5.784445	0.650322	-0.593547	1.322056	0.001501
95	37.800293	-5.814661	0.648639	-0.588785	1.318550	0.001504
96	36.884567	-5.842010	0.646849	-0.583721	1.314855	0.001481
97	35.972839	-5.866369	0.644952	-0.578354	1.310930	0.001488
98	35.065430	-5.887674	0.643019	-0.572886	1.306942	0.001504
99	34.162659	-5.905882	0.641039	-0.567283	1.302892	0.001492
100	33.264816	-5.920918	0.638975	-0.561444	1.298681	0.001488
101	32.372223	-5.932717	0.636853	-0.555440	1.294358	0.001500
102	31.485199	-5.941235	0.634669	-0.549260	1.289940	0.001493
103	30.604050	-5.946396	0.632382	-0.542790	1.285338	0.001485
104	29.729080	-5.948131	0.630020	-0.536107	1.280592	0.001494
105	28.860626	-5.946407	0.627619	-0.529313	1.275790	0.001500
106	27.998978	-5.941193	0.625146	-0.522317	1.270879	0.001493
107	27.144455	-5.932426	0.622571	-0.515032	1.265783	0.001494
108	26.297394	-5.920048	0.619891	-0.507448	1.260506	0.001492
109	25.458069	-5.904007	0.617120	-0.499607	1.255073	0.001495
110	24.626831	-5.884267	0.614268	-0.491539	1.249510	0.001499
111	23.803986	-5.860794	0.611328	-0.483221	1.243806	0.001500
112	22.989822	-5.833555	0.608282	-0.474601	1.237928	0.001499
113	22.184692	-5.802505	0.605114	-0.465640	1.231855	0.001492
114	21.388901	-5.767619	0.601863	-0.456441	1.225641	0.001501
115	20.602753	-5.728903	0.598558	-0.447090	1.219362	0.001509
116	19.826538	-5.686358	0.595167	-0.437496	1.212960	0.001511
117	19.060608	-5.639968	0.591639	-0.427515	1.206339	0.001508
118	18.305237	-5.589691	0.587939	-0.417045	1.199436	0.001503
119	17.560776	-5.535499	0.584087	-0.406147	1.192286	0.001507
120	16.827515	-5.477386	0.580127	-0.394943	1.184978	0.001514
121	16.105759	-5.415383	0.576096	-0.383538	1.177578	0.001526
122	15.395823	-5.349519	0.571964	-0.371846	1.170048	0.001525
123	14.697994	-5.279799	0.567666	-0.359687	1.162266	0.001525
124	14.012589	-5.206223	0.563185	-0.347008	1.154197	0.001530
125	13.339911	-5.128796	0.558523	-0.333817	1.145858	0.001530
126	12.680262	-5.047531	0.553688	-0.320139	1.137266	0.001532
127	12.033938	-4.962469	0.548732	-0.306117	1.128498	0.001554
128	11.401228	-4.873669	0.543648	-0.291732	1.119569	0.001568
129	10.782431	-4.781145	0.538276	-0.276532	1.110234	0.001533
130	10.177848	-4.684890	0.532627	-0.260548	1.100436	0.001556
131	9.587761	-4.584977	0.526850	-0.244204	1.090467	0.001600
132	9.012450	-4.481469	0.520819	-0.227139	1.080190	0.001573
133	8.452214	-4.374364	0.514395	-0.208964	1.069297	0.001570
134	7.907336	-4.263697	0.507669	-0.189934	1.057940	0.001607
135	7.378089	-4.149546	0.500677	-0.170152	1.046238	0.001618
136	6.864746	-4.031963	0.493349	-0.149417	1.034060	0.001627
137	6.367586	-3.910989	0.485602	-0.127501	1.021285	0.001627
138	5.886880	-3.786671	0.477466	-0.104478	1.007937	0.001654
139	5.422886	-3.659085	0.468942	-0.080363	0.994037	0.001702
140	4.975878	-3.528265	0.459738	-0.054322	0.979216	0.001655
141	4.546138	-3.394206	0.449750	-0.026062	0.963193	0.001664
142	4.133910	-3.257002	0.439275	0.003575	0.946422	0.001769
143	3.739435	-3.116738	0.428093	0.035214	0.928754	0.001746
144	3.363000	-2.973392	0.415812	0.069960	0.909476	0.001721
145	3.004866	-2.826993	0.402526	0.107551	0.888657	0.001788
146	2.665271	-2.677608	0.388135	0.148268	0.866296	0.001792
147	2.344483	-2.525252	0.372322	0.193008	0.841862	0.001772
148	2.042769	-2.369932	0.354949	0.242163	0.815079	0.001785
149	1.760388	-2.211676	0.335876	0.296126	0.785754	0.001774
150	1.497621	-2.050480	0.314844	0.355633	0.753403	0.001757
151	1.254779	-1.886312	0.291456	0.421806	0.717345	0.001691
152	1.032200	-1.719143	0.265473	0.495319	0.676927	0.001627
153	0.830213	-1.548982	0.236889	0.576195	0.631736	0.001577
154	0.649191	-1.375844	0.205662	0.664546	0.581121	0.001498
155	0.489575	-1.159747	0.172051	0.759641	0.524314	0.001476
156	0.351844	-1.020777	0.136546	0.860099	0.460546	0.001405
157	0.236489	-0.839120	0.100553	0.961934	0.389828	0.001185
158	0.143964	-0.655104	0.066386	1.058605	0.312215	0.001115
159	0.074616	-0.469198	0.036864	1.142133	0.228665	0.001150
160	0.028571	-0.281985	0.015141	1.203592	0.141204	0.001329

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-3
	NACA 0012: MACH = 0.95, ALPHA = 0			

161	ø.øø5686	-Ø.Ø94Ø65	Ø.ØØ368Ø	1.236Ø21	Ø.Ø5588Ø	Ø.ØØ15Ø4
162	Ø.øø5686	Ø.Ø94Ø65	Ø.ØØ368Ø	1.236Ø21	Ø.Ø5588Ø	Ø.ØØ15Ø4
163	Ø.Ø28571	Ø.281985	Ø.Ø15141	1.2Ø3592	Ø.141Ø24	Ø.ØØ1329
164	Ø.Ø74616	Ø.469198	Ø.Ø36864	1.142133	Ø.228665	Ø.ØØ115Ø
165	Ø.143964	Ø.655104	Ø.Ø66386	1.Ø58605	Ø.312215	Ø.ØØ1115
166	Ø.236489	Ø.839120	Ø.1ØØ553	Ø.961934	Ø.389828	Ø.ØØ1185
167	Ø.351844	1.ØØØ777	Ø.136546	Ø.86ØØ99	Ø.46Ø546	Ø.ØØ14Ø5
168	Ø.489575	1.199747	Ø.172Ø51	Ø.759641	Ø.524314	Ø.ØØ1476
169	Ø.649191	1.375844	Ø.2Ø5662	Ø.664546	Ø.581121	Ø.ØØ1498
17Ø	Ø.83Ø213	1.548982	Ø.236889	Ø.576195	Ø.631736	Ø.ØØ1577
171	1.Ø322ØØ	1.719143	Ø.265473	Ø.495319	Ø.676927	Ø.ØØ1627
172	1.254779	1.886312	Ø.291456	Ø.421Ø86	Ø.717345	Ø.ØØ1691
173	1.497621	2.Ø5Ø48Ø	Ø.314844	Ø.355633	Ø.753Ø3	Ø.ØØ1757
174	1.76Ø388	2.211676	Ø.335876	Ø.296126	Ø.785754	Ø.ØØ1774
175	2.Ø42769	2.369932	Ø.354949	Ø.242163	Ø.815Ø79	Ø.ØØ1785
176	2.344483	2.525252	Ø.372322	Ø.193ØØ8	Ø.841862	Ø.ØØ1772
177	2.665271	2.677608	Ø.388135	Ø.148268	Ø.866296	Ø.ØØ1792
178	3.ØØ4866	2.826992	Ø.4Ø2526	Ø.1Ø7551	Ø.888657	Ø.ØØ1788
179	3.363ØØØ	2.973392	Ø.415812	Ø.Ø69960	Ø.9Ø9476	Ø.ØØ1721
18Ø	3.739435	3.116738	Ø.428Ø93	Ø.Ø35214	Ø.928754	Ø.ØØ1746
181	4.133910	3.257ØØ2	Ø.439275	Ø.ØØ3575	Ø.946422	Ø.ØØ1769
182	4.546138	3.394206	Ø.449750	-Ø.Ø26Ø62	Ø.963193	Ø.ØØ1664
183	4.975878	3.528265	Ø.459738	-Ø.Ø54322	Ø.979216	Ø.ØØ1655
184	5.422886	3.659Ø85	Ø.468942	-Ø.ØØØ363	Ø.994Ø37	Ø.ØØ17Ø2
185	5.886888	3.786671	Ø.477466	-Ø.1Ø4478	1.ØØ7937	Ø.ØØ1654
186	6.367586	3.91Ø989	Ø.485602	-Ø.127501	1.Ø21285	Ø.ØØ1627
187	6.864746	4.Ø31963	Ø.493349	-Ø.149417	1.Ø34Ø6Ø	Ø.ØØ1627
188	7.378Ø89	4.149546	Ø.5ØØ677	-Ø.17Ø152	1.Ø46238	Ø.ØØ1618
189	7.9Ø7336	4.263697	Ø.5Ø7669	-Ø.189934	1.Ø57948	Ø.ØØ16Ø7
19Ø	8.452214	4.374364	Ø.514395	-Ø.2Ø8964	1.Ø69297	Ø.ØØ157Ø
191	9.Ø12450	4.481469	Ø.52Ø819	-Ø.227139	1.Ø8Ø19Ø	Ø.ØØ1573
192	9.587761	4.584977	Ø.526850	-Ø.244204	1.Ø9Ø467	Ø.ØØ16ØØ
193	1Ø.177848	4.684890	Ø.532627	-Ø.26Ø548	1.1ØØ436	Ø.ØØ1556
194	1Ø.782431	4.781145	Ø.538276	-Ø.276532	1.11Ø234	Ø.ØØ1533
195	11.4Ø1228	4.873669	Ø.543648	-Ø.291732	1.119569	Ø.ØØ1568
196	12.Ø33938	4.962469	Ø.548732	-Ø.3Ø6117	1.128498	Ø.ØØ1554
197	12.68Ø262	5.Ø47531	Ø.553688	-Ø.32Ø139	1.137266	Ø.ØØ1532
198	13.339911	5.128796	Ø.558523	-Ø.333817	1.145858	Ø.ØØ153Ø
199	14.Ø12589	5.2Ø6223	Ø.563185	-Ø.347ØØ8	1.154197	Ø.ØØ153Ø
2ØØ	14.697994	5.279799	Ø.567666	-Ø.359687	1.162266	Ø.ØØ1525
2Ø1	15.395823	5.349519	Ø.571964	-Ø.371846	1.17ØØ48	Ø.ØØ1525
2Ø2	16.1Ø5759	5.415383	Ø.576Ø96	-Ø.383538	1.177578	Ø.ØØ1526
2Ø3	16.827515	5.477386	Ø.58Ø127	-Ø.394943	1.184978	Ø.ØØ1514
2Ø4	17.56Ø776	5.535499	Ø.584Ø87	-Ø.4Ø6147	1.192286	Ø.ØØ15Ø7
2Ø5	18.3Ø5237	5.589691	Ø.587939	-Ø.417Ø45	1.199436	Ø.ØØ15Ø3
2Ø6	19.Ø6Ø6Ø8	5.639968	Ø.591639	-Ø.427515	1.2Ø6339	Ø.ØØ15Ø8
2Ø7	19.826538	5.686358	Ø.595167	-Ø.437496	1.212960	Ø.ØØ1511
2Ø8	2Ø.6Ø2753	5.728903	Ø.598558	-Ø.447Ø9Ø	1.219362	Ø.ØØ15Ø9
2Ø9	21.388901	5.767619	Ø.6Ø1863	-Ø.456441	1.225641	Ø.ØØ1501
21Ø	22.184692	5.8Ø2585	Ø.6Ø5114	-Ø.465640	1.231855	Ø.ØØ1492
211	22.989822	5.833555	Ø.6Ø8282	-Ø.474601	1.237928	Ø.ØØ1499
212	23.8Ø3986	5.86Ø794	Ø.611328	-Ø.483221	1.243Ø86	Ø.ØØ15ØØ
213	24.626831	5.884267	Ø.614268	-Ø.491539	1.249510	Ø.ØØ1499
214	25.458Ø69	5.9Ø4ØØ7	Ø.617120	-Ø.499607	1.255Ø73	Ø.ØØ1495
215	26.297394	5.92ØØ48	Ø.619891	-Ø.5Ø7448	1.26Ø5Ø6	Ø.ØØ1492
216	27.144455	5.932426	Ø.622571	-Ø.515Ø32	1.265783	Ø.ØØ1494
217	27.998978	5.941193	Ø.625146	-Ø.522317	1.27Ø879	Ø.ØØ1493
218	28.86Ø626	5.946407	Ø.627619	-Ø.529313	1.275790	Ø.ØØ15ØØ
219	29.729Ø8Ø	5.948131	Ø.63ØØ2Ø	-Ø.5361Ø7	1.28Ø592	Ø.ØØ1494
22Ø	3Ø.6Ø4Ø5Ø	5.946396	Ø.632382	-Ø.542790	1.285338	Ø.ØØ1485
221	31.485199	5.941235	Ø.634669	-Ø.549260	1.289940	Ø.ØØ1493
222	32.372223	5.932717	Ø.636853	-Ø.555440	1.294358	Ø.ØØ15ØØ
223	33.264816	5.92Ø918	Ø.638975	-Ø.561444	1.298681	Ø.ØØ1488
224	34.162659	5.9Ø5882	Ø.641Ø39	-Ø.567283	1.3Ø2892	Ø.ØØ1492
225	35.Ø65430	5.887674	Ø.643Ø19	-Ø.572886	1.3Ø6942	Ø.ØØ15Ø4
226	35.972839	5.866369	Ø.644952	-Ø.578354	1.31Ø93Ø	Ø.ØØ1488
227	36.884567	5.842Ø1Ø	Ø.646849	-Ø.583721	1.314855	Ø.ØØ1481
228	37.8ØØ293	5.814661	Ø.648639	-Ø.588785	1.318550	Ø.ØØ15Ø4
229	38.719727	5.784445	Ø.65Ø322	-Ø.593547	1.322Ø56	Ø.ØØ15Ø1
23Ø	39.642548	5.751444	Ø.651977	-Ø.598230	1.325521	Ø.ØØ149Ø
231	4Ø.568451	5.715693	Ø.653613	-Ø.6Ø2860	1.328953	Ø.ØØ149Ø
232	41.497131	5.677249	Ø.655200	-Ø.6Ø7349	1.332287	Ø.ØØ1493
233	42.428204	5.636191	Ø.656714	-Ø.611633	1.335474	Ø.ØØ15Ø4
234	43.361603	5.592612	Ø.658169	-Ø.615750	1.338557	Ø.ØØ15Ø1
235	44.296783	5.546580	Ø.659595	-Ø.619785	1.341595	Ø.ØØ1488
236	45.233521	5.498161	Ø.66Ø962	-Ø.623653	1.344498	Ø.ØØ15Ø1
237	46.171509	5.447458	Ø.662244	-Ø.627279	1.347228	Ø.ØØ1512
238	47.11Ø458	5.394568	Ø.663499	-Ø.63Ø83Ø	1.349929	Ø.ØØ1495
239	48.Ø5ØØ49	5.339531	Ø.664752	-Ø.634374	1.352621	Ø.ØØ1493
24Ø	48.99ØØØ5	5.282402	Ø.665962	-Ø.637798	1.355221	Ø.ØØ15Ø5

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-4
	NACA 0012: MACH = 0.95, ALPHA = 0			

241	49.930000	5.223271	0.667128	-0.641096	1.357740	0.001504
242	50.869781	5.162216	0.668252	-0.644277	1.360181	0.001493
243	51.808990	5.099324	0.669294	-0.647227	1.362430	0.001518
244	52.747375	5.034718	0.670279	-0.650014	1.364571	0.001521
245	53.684616	4.968453	0.671309	-0.652926	1.366843	0.001482
246	54.620422	4.900533	0.672341	-0.655846	1.369088	0.001497
247	55.554504	4.831051	0.673271	-0.658478	1.371106	0.001528
248	56.486572	4.760140	0.674158	-0.660988	1.373066	0.001512
249	57.416321	4.687847	0.675065	-0.663555	1.375069	0.001503
250	58.343460	4.614206	0.675957	-0.666079	1.377030	0.001510
251	59.267700	4.539302	0.676815	-0.668507	1.378925	0.001513
252	60.188751	4.463216	0.677640	-0.670839	1.380755	0.001507
253	61.106308	4.386030	0.678410	-0.673019	1 382454	0.001522
254	62.020111	4.307839	0.679145	-0.675097	1.384081	0.001530
255	62.929840	4.228698	0.679930	-0.677318	1.385851	0.001499
256	63.835220	4.148601	0.680748	-0.679633	1.387674	0.001501
257	64.735947	4.067623	0.681484	-0.681715	1.389301	0.001525
258	65.631760	3.985905	0.682136	-0.683561	1.390759	0.001529
259	66.522354	3.903537	0.682783	-0.685391	1.392210	0.001530
260	67.407440	3.820540	0.683499	-0.687417	1.393844	0.001495
261	68.286728	3.736912	0.684245	-0.689529	1.395518	0.001503
262	69.159943	3.652738	0.684895	-0.691366	1.396951	0.001546
263	70.026794	3.568157	0.685499	-0.693075	1.398327	0.001526
264	70.887009	3.483205	0.686158	-0.694941	1.399837	0.001502
265	71.740265	3.397891	0.686821	-0.696816	1.401323	0.001524
266	72.586319	3.312301	0.687453	-0.698605	1.402753	0.001529
267	73.424866	3.226509	0.688091	-0.700409	1.404215	0.001509
268	74.255630	3.140560	0.688705	-0.702147	1.405605	0.001521
269	75.078339	3.054547	0.689265	-0.703730	1.406868	0.001538
270	75.892685	2.968552	0.689849	-0.705383	1.408219	0.001515
271	76.698410	2.882581	0.690491	-0.707199	1.409692	0.001505
272	77.495209	2.796670	0.691116	-0.708967	1.411111	0.001523
273	78.282837	2.710910	0.691704	-0.710631	1.412457	0.001527
274	79.060974	2.625375	0.692285	-0.712276	1.413793	0.001524
275	79.829376	2.540112	0.692884	-0.713969	1.415176	0.001514
276	80.587753	2.455165	0.693495	-0.715700	1.416588	0.001512
277	81.335815	2.370600	0.694083	-0.717361	1.417937	0.001520
278	82.073288	2.286501	0.694638	-0.718933	1.419219	0.001521
279	82.799927	2.202941	0.695186	-0.720485	1.420489	0.001520
280	83.515427	2.119970	0.695754	-0.722091	1.421811	0.001512
281	84.219528	2.037631	0.696346	-0.723764	1.423185	0.001508
282	84.911942	1.955977	0.696930	-0.725419	1.424543	0.001510
283	85.592407	1.875083	0.697489	-0.727000	1.425839	0.001516
284	86.260666	1.795019	0.698039	-0.728555	1.427115	0.001524
285	86.916428	1.715837	0.698629	-0.730225	1.428517	0.001490
286	87.559418	1.637572	0.699228	-0.731920	1.429918	0.001489
287	88.189407	1.560317	0.699728	-0.733335	1.431055	0.001537
288	88.806091	1.484191	0.700209	-0.734695	1.432203	0.001508
289	89.409225	1.409214	0.700791	-0.736341	1.433592	0.001475
290	89.998535	1.335393	0.701386	-0.738025	1.434978	0.001494
291	90.573761	1.262822	0.701932	-0.739569	1.436256	0.001506
292	91.134644	1.191594	0.702443	-0.741015	1.437471	0.001491
293	91.680923	1.121780	0.702915	-0.742351	1.438581	0.001498
294	92.212341	1.053459	0.703368	-0.743632	1.439651	0.001499
295	92.728638	0.986685	0.703873	-0.745061	1.440862	0.001478
296	93.229553	0.921482	0.704437	-0.746658	1.442204	0.001471
297	93.714828	0.857903	0.704988	-0.748217	1.443518	0.001465
298	94.184219	0.796038	0.705449	-0.749521	1.444591	0.001499
299	94.637466	0.735998	0.705821	-0.750574	1.445478	0.001494
300	95.074341	0.677854	0.706223	-0.751710	1.446454	0.001469
301	95.494553	0.621635	0.706683	-0.753012	1.447562	0.001453
302	95.897858	0.567390	0.707148	-0.754328	1.448672	0.001455
303	96.284027	0.515193	0.707564	-0.755505	1.449648	0.001483
304	96.652786	0.465119	0.707977	-0.756674	1.450650	0.001464
305	97.003891	0.417216	0.708420	-0.757927	1.451761	0.001394
306	97.337082	0.371551	0.708718	-0.758771	1.452384	0.001527
307	97.652130	0.328249	0.708922	-0.759346	1.452907	0.001477
308	97.948761	0.287339	0.709365	-0.760600	1.454042	0.001377
309	98.226700	0.248813	0.709772	-0.761752	1.455005	0.001402
310	98.485703	0.212798	0.709956	-0.762273	1.455300	0.001612
311	98.725494	0.179389	0.710178	-0.762900	1.456101	0.001231
312	98.945786	0.148593	0.710538	-0.763919	1.456636	0.001707
313	99.146286	0.120481	0.710626	-0.764169	1.457368	0.000966
314	99.326721	0.095145	0.710875	-0.764872	1.457956	0.002270
315	99.486725	0.072632	0.710755	-0.764533	1.458127	0.000323
316	99.625946	0.052983	0.711951	-0.767917	1.459213	0.002908
317	99.744003	0.036276	0.711594	-0.766906	1.461506	-0.001616
318	99.840439	0.022620	0.710266	-0.763150	1.452341	0.006893
319	99.914658	0.012110	0.703158	-0.743039	1.435113	0.007230
320	99.965897	0.004846	0.679709	-0.676694	1.340085	0.062446
321	99.992828	0.001020	0.518416	-0.220340	1.049450	0.033357

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-5
	NACA 0012: MACH = 0.95, ALPHA = 0			

NACA 0012 M=0.95, ALPHA=0.0
VALUES ON X-AXIS UPSTREAM OF LEADING EDGE

J	X/C(%)	Z/C(%)	1-P/PINF	CP	MACH	1-PI/PINF
2	-0.066177	0.000000	0.003553	1.236379	0.053793	0.001536
3	-0.204744	0.000000	0.008017	1.223749	0.093216	0.001971
4	-0.356041	0.000000	0.014220	1.206201	0.136833	0.001242
5	-0.520694	0.000000	0.023235	1.180692	0.176804	0.001697
6	-0.699376	0.000000	0.032751	1.153769	0.213887	0.001425
7	-0.892805	0.000000	0.043256	1.124048	0.247717	0.001528
8	-1.101754	0.000000	0.053908	1.093683	0.278927	0.001461
9	-1.327055	0.000000	0.064943	1.062690	0.307736	0.001476
10	-1.569596	0.000000	0.075888	1.031721	0.334492	0.001468
11	-1.830337	0.000000	0.086754	1.000977	0.359421	0.001472
12	-2.110308	0.000000	0.097460	0.970686	0.382749	0.001469
13	-2.410620	0.000000	0.107965	0.940963	0.404650	0.001468
14	-2.732471	0.000000	0.118239	0.911894	0.425280	0.001468
15	-3.077155	0.000000	0.128265	0.883528	0.444768	0.001467
16	-3.446071	0.000000	0.138033	0.855892	0.463230	0.001464
17	-3.840734	0.000000	0.147539	0.828994	0.480762	0.001466
18	-4.262787	0.000000	0.156785	0.802835	0.497451	0.001464
19	-4.714013	0.000000	0.165773	0.777404	0.513373	0.001463
20	-5.196353	0.000000	0.174510	0.752685	0.528592	0.001461
21	-5.711921	0.000000	0.183002	0.728659	0.543168	0.001461
22	-6.263024	0.000000	0.191257	0.705303	0.557152	0.001460
23	-6.852186	0.000000	0.199283	0.682594	0.570592	0.001460
24	-7.482173	0.000000	0.207090	0.660506	0.583528	0.001459
25	-8.156018	0.000000	0.214686	0.639014	0.595999	0.001459
26	-8.877065	0.000000	0.222080	0.618094	0.608038	0.001457
27	-9.648993	0.000000	0.229281	0.597720	0.619677	0.001454
28	-10.475878	0.000000	0.236298	0.577867	0.630942	0.001452
29	-11.362229	0.000000	0.243139	0.558511	0.641861	0.001453
30	-12.313064	0.000000	0.249812	0.539630	0.652457	0.001451
31	-13.333968	0.000000	0.256326	0.521199	0.662750	0.001451
32	-14.431187	0.000000	0.262688	0.503199	0.672763	0.001450
33	-15.611721	0.000000	0.268907	0.485605	0.682512	0.001448
34	-16.883438	0.000000	0.274988	0.468399	0.692015	0.001444
35	-18.255249	0.000000	0.280940	0.451558	0.701290	0.001443
36	-19.737213	0.000000	0.286770	0.435064	0.710350	0.001442
37	-21.340790	0.000000	0.292483	0.418898	0.719211	0.001439
38	-23.079071	0.000000	0.298088	0.403040	0.727887	0.001437
39	-24.967102	0.000000	0.303590	0.387473	0.736390	0.001435
40	-27.022202	0.000000	0.308997	0.372177	0.744733	0.001435
41	-29.264465	0.000000	0.314313	0.357135	0.752928	0.001433
42	-31.717346	0.000000	0.319546	0.342328	0.760988	0.001432
43	-34.408340	0.000000	0.324703	0.327739	0.768924	0.001430
44	-37.369934	0.000000	0.329789	0.313349	0.776748	0.001429
45	-40.640778	0.000000	0.334812	0.299138	0.784472	0.001427
46	-44.267197	0.000000	0.339778	0.285085	0.792108	0.001425
47	-48.305267	0.000000	0.344696	0.271171	0.799669	0.001425
48	-52.823441	0.000000	0.349572	0.257375	0.807167	0.001422
49	-57.906250	0.000000	0.354414	0.243676	0.814615	0.001422
50	-63.659195	0.000000	0.359231	0.230046	0.822028	0.001424
51	-70.215820	0.000000	0.364038	0.216446	0.829429	0.001422
52	-77.747650	0.000000	0.368852	0.202827	0.836845	0.001426
53	-86.478714	0.000000	0.373686	0.189148	0.844296	0.001433
54	-96.707367	0.000000	0.378539	0.175419	0.851784	0.001440
55	-108.839966	0.000000	0.383398	0.161671	0.859299	0.001436
56	-123.444702	0.000000	0.388298	0.147807	0.866894	0.001429
57	-141.341370	0.000000	0.393376	0.133439	0.874770	0.001427
58	-163.758469	0.000000	0.398867	0.117902	0.883266	0.001465
59	-192.625519	0.000000	0.404960	0.100665	0.892661	0.001561
60	-231.159912	0.000000	0.411610	0.081849	0.902898	0.001721
61	-285.167480	0.000000	0.418401	0.062634	0.913368	0.001904
62	-366.344727	0.000000	0.424690	0.044842	0.923105	0.002061
63	-502.499512	0.000000	0.429778	0.030445	0.931056	0.002141
64	-781.729248	0.000000	0.433089	0.021078	0.936419	0.001996
65	-1762.49097	0.000000	0.434306	0.017633	0.939007	0.001257

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-6
	NACA 0012: MACH = 0.95, ALPHA = 0			

NACA 0012 M=0.95, ALPHA=0.0
VALUES ON X-AXIS DOWNSTREAM OF TRAILING EDGE

J	X/C(%)	Z/C(%)	1-P/PIINF	CP	MACH	1-PI/PIINF
2	100.004654	0.0	0.516718	-0.215536	1.046500	0.033387
3	100.022430	0.0	0.487560	-0.133039	0.985561	0.046115
4	100.056946	0.0	0.507105	-0.188340	1.010255	0.055719
5	100.108124	0.0	0.536397	-0.271215	1.062775	0.054337
6	100.176270	0.0	0.558910	-0.334914	1.104512	0.052924
7	100.261856	0.0	0.576206	-0.383848	1.137323	0.051836
8	100.365479	0.0	0.582305	-0.401106	1.149746	0.050634
9	100.487854	0.0	0.578346	-0.389902	1.144696	0.047769
10	100.629761	0.0	0.571569	-0.370728	1.134172	0.045271
11	100.792053	0.0	0.566781	-0.357181	1.129421	0.040371
12	100.975723	0.0	0.564521	-0.350789	1.127951	0.037152
13	101.181778	0.0	0.564593	-0.350990	1.130010	0.034808
14	101.411392	0.0	0.565016	-0.352189	1.132453	0.032770
15	101.665817	0.0	0.565268	-0.352901	1.134295	0.031081
16	101.946396	0.0	0.565352	-0.353138	1.135499	0.029794
17	102.254608	0.0	0.565274	-0.352918	1.136252	0.028695
18	102.592087	0.0	0.565087	-0.352388	1.136704	0.027722
19	102.960571	0.0	0.564774	-0.351503	1.136932	0.026742
20	103.361984	0.0	0.564417	-0.350495	1.137068	0.025777
21	103.798431	0.0	0.564094	-0.349581	1.137198	0.024894
22	104.272171	0.0	0.563832	-0.348837	1.137363	0.024102
23	104.785736	0.0	0.563597	-0.348174	1.137508	0.023399
24	105.341873	0.0	0.563348	-0.347468	1.137574	0.022760
25	105.943604	0.0	0.563060	-0.346653	1.137532	0.022167
26	106.594238	0.0	0.562735	-0.345733	1.137406	0.021596
27	107.297485	0.0	0.562379	-0.344727	1.137213	0.021039
28	108.057373	0.0	0.561992	-0.343631	1.136944	0.020505
29	108.878433	0.0	0.561565	-0.342424	1.136582	0.019998
30	109.765671	0.0	0.561091	-0.341083	1.136116	0.019519
31	110.724655	0.0	0.560576	-0.339625	1.135557	0.019060
32	111.761627	0.0	0.560035	-0.338095	1.134939	0.018619
33	112.883591	0.0	0.559484	-0.336536	1.134290	0.018198
34	114.098419	0.0	0.558930	-0.334970	1.133627	0.017786
35	115.414993	0.0	0.558364	-0.333368	1.132935	0.017384
36	116.843399	0.0	0.557725	-0.331558	1.132099	0.016998
37	118.395096	0.0	0.556890	-0.329198	1.130880	0.016655
38	120.083160	0.0	0.555774	-0.326040	1.129111	0.016373
39	121.922623	0.0	0.554547	-0.322568	1.127124	0.016122
40	123.930847	0.0	0.553767	-0.320360	1.126011	0.015777
41	126.127914	0.0	0.554088	-0.321270	1.127030	0.015224
42	128.537262	0.0	0.555326	-0.324772	1.129869	0.014443
43	131.186401	0.0	0.555153	-0.324282	1.129910	0.014006
44	134.107819	0.0	0.547420	-0.302403	1.115477	0.014879
45	137.340179	0.0	0.527040	-0.244742	1.078063	0.017103
46	140.929810	0.0	0.498582	-0.164225	1.028223	0.018781
47	144.932770	0.0	0.473845	-0.094234	0.987276	0.018640
48	149.417572	0.0	0.460657	-0.056920	0.966396	0.017877
49	154.468674	0.0	0.456866	-0.046195	0.960616	0.017457
50	160.191650	0.0	0.456918	-0.046341	0.960788	0.017359
51	166.720047	0.0	0.457168	-0.047050	0.961199	0.017353
52	174.225357	0.0	0.456345	-0.044721	0.959895	0.017320
53	182.931641	0.0	0.454590	-0.039756	0.957139	0.017221
54	193.137253	0.0	0.452554	-0.033996	0.953985	0.017068
55	205.248581	0.0	0.450772	-0.028954	0.951263	0.016892
56	219.833817	0.0	0.449457	-0.025232	0.949281	0.016736
57	237.712753	0.0	0.448560	-0.022695	0.948030	0.016521
58	260.113770	0.0	0.447962	-0.021002	0.947303	0.016259
59	288.966797	0.0	0.447586	-0.019938	0.946603	0.016363
60	327.488770	0.0	0.447297	-0.019121	0.946176	0.016320
61	381.486084	0.0	0.446992	-0.018257	0.946933	0.014940
62	462.654297	0.0	0.446866	-0.017901	0.946804	0.014858
63	598.802246	0.0	0.446314	-0.016340	0.943319	0.017727
64	878.027344	0.0	0.444335	-0.010742	0.941058	0.016709
65	1858.78564	0.0	0.443988	-0.009759	0.943781	0.013089

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-7
	NACA 0012: MACH = 0.95, ALPHA = 0			

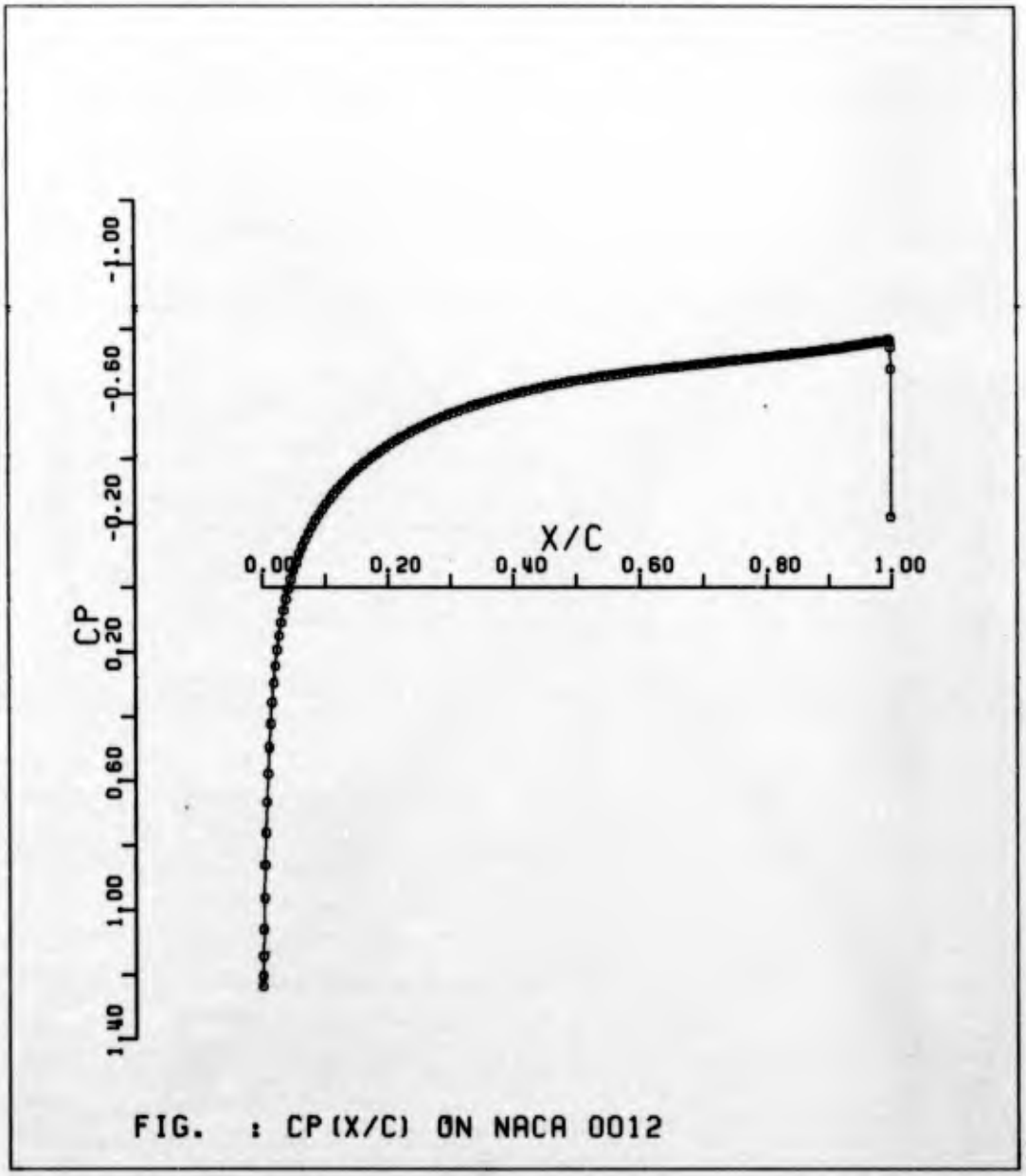


FIG. : CP(X/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-8
	NACA 0012: MACH = 0.95, ALPHA = 0			

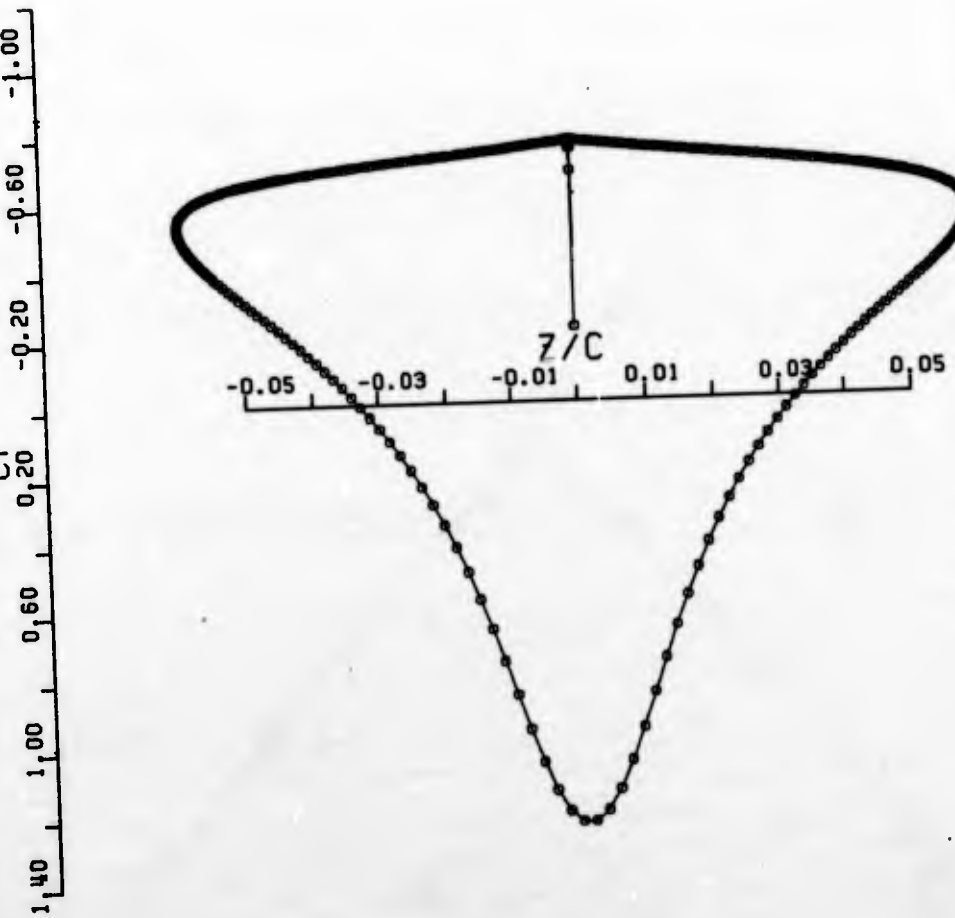


FIG. : CP(Z/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-9
	NACA 0012: MACH = 0.95, ALPHA = 0			

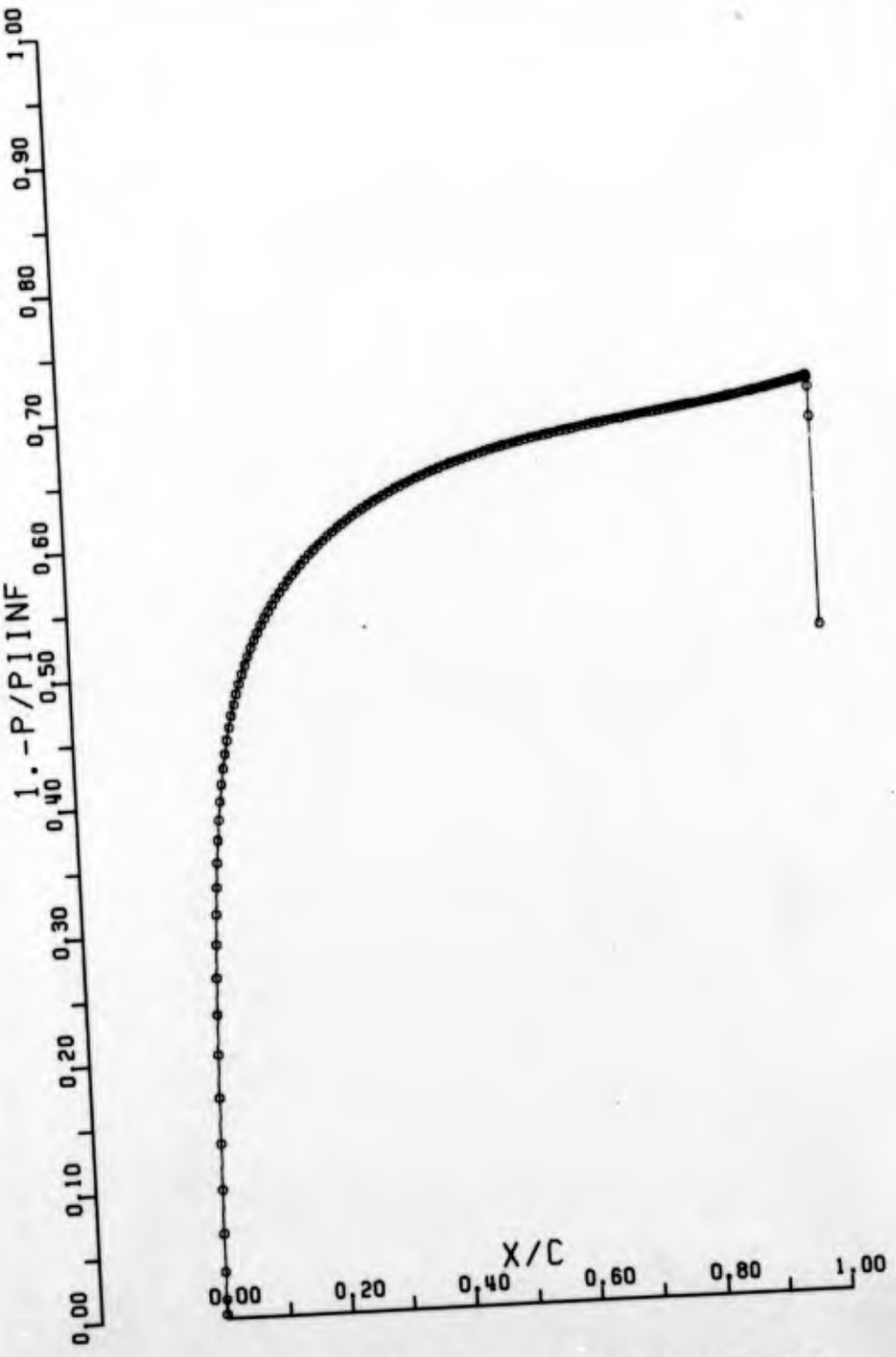


FIG. : 1.-P/PIINF VS. X/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-10
	NACA 0012: MACH = 0.95, ALPHA = 0			

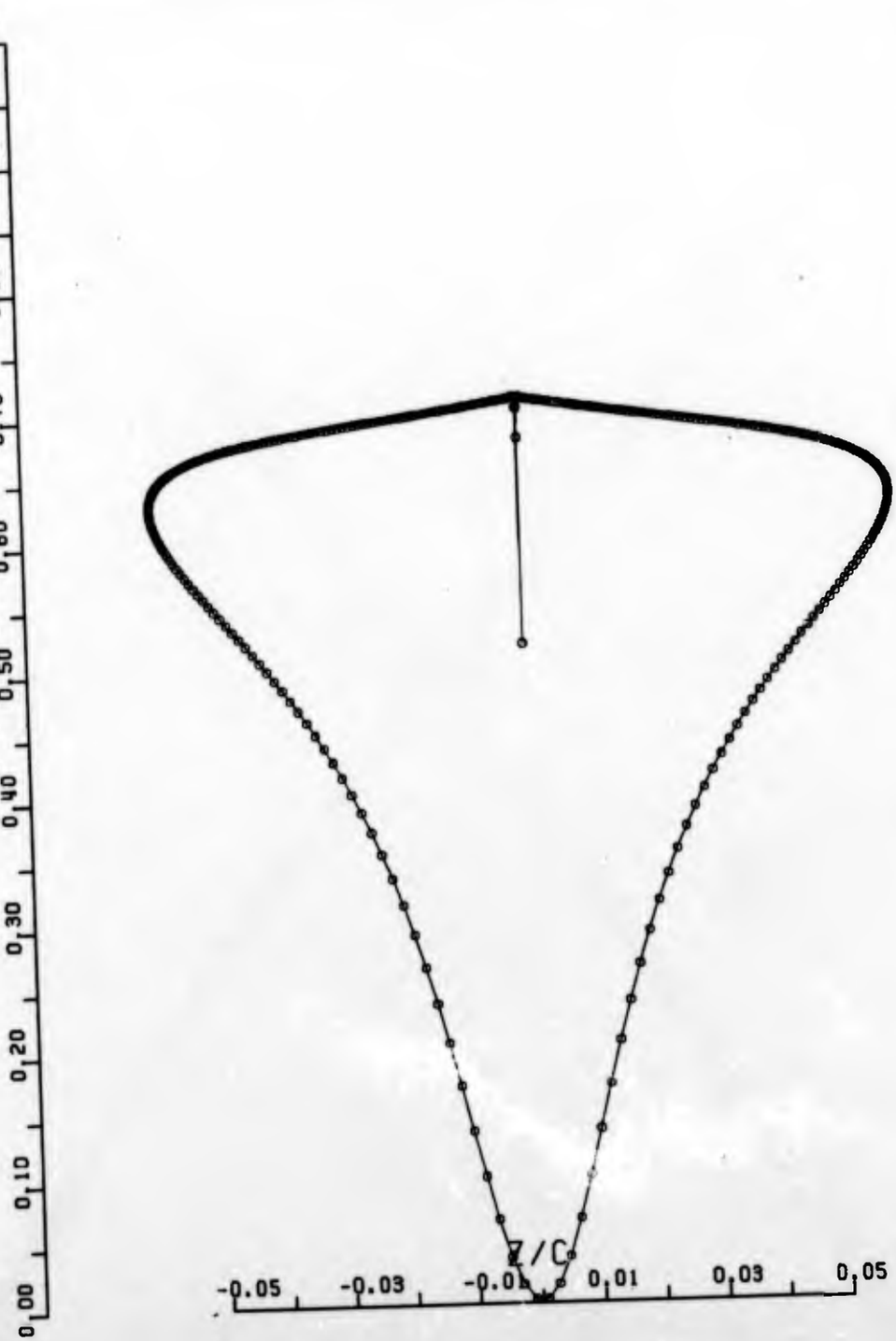


FIG. : 1.-P/PIINF VS. Z/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-11
	NACA 0012: MACH = 0.95, ALPHA = 0			

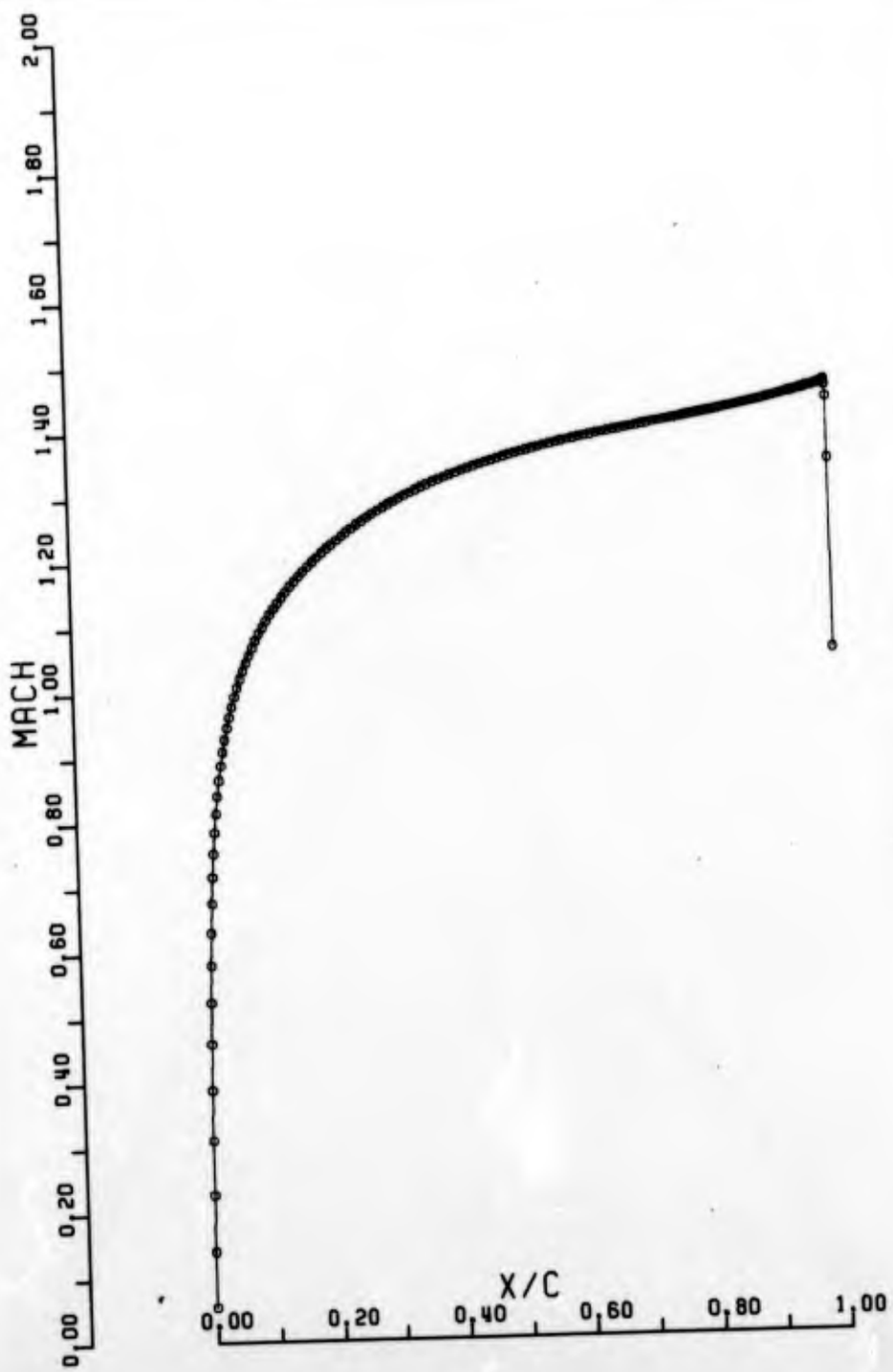


FIG. : MACH(X/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-12
	NACA 0012: MACH = 0.95, ALPHA = 0			

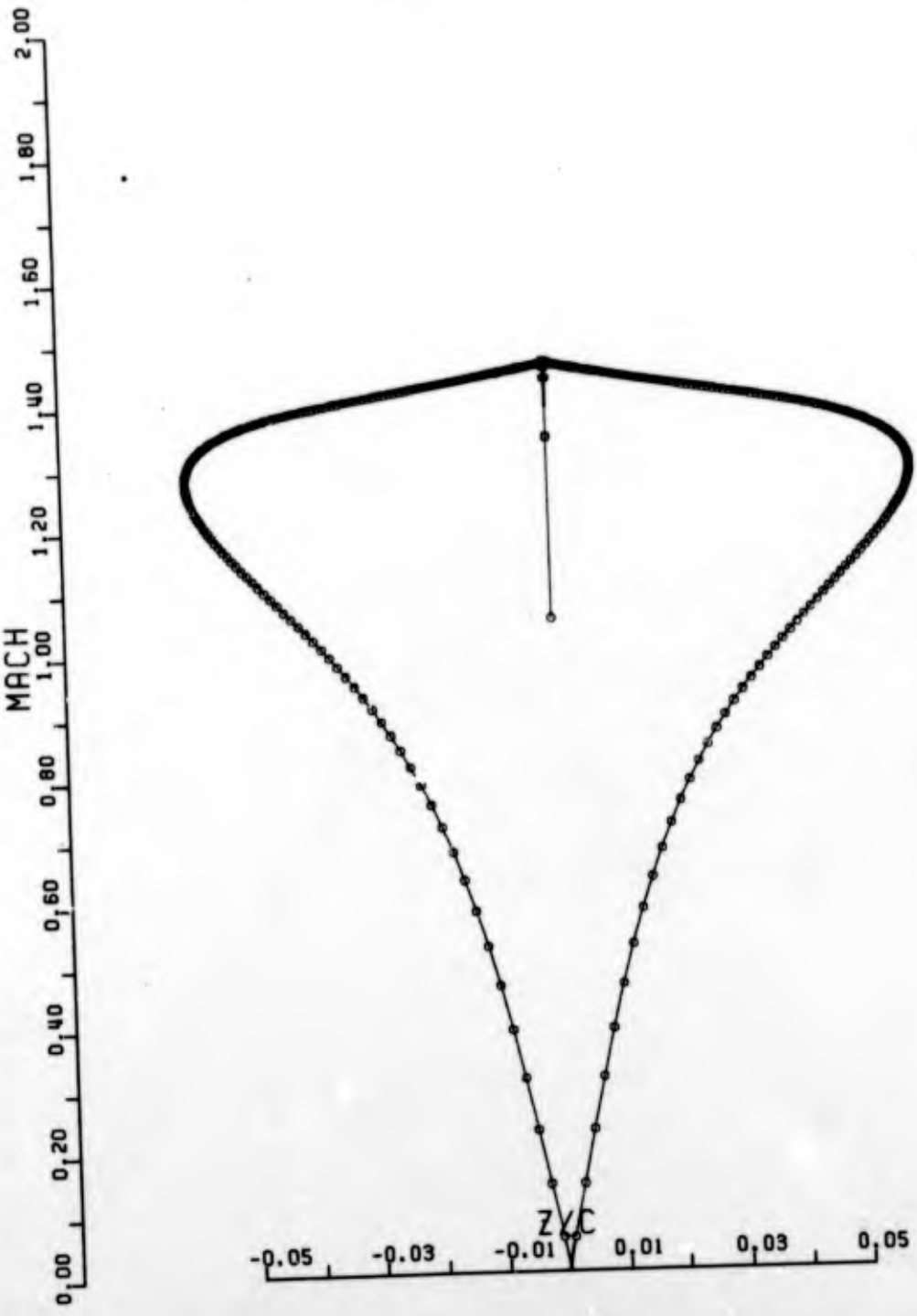


FIG. : MACH (Z/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-13
	NACA 0012: MACH = 0.95, ALPHA = 0			

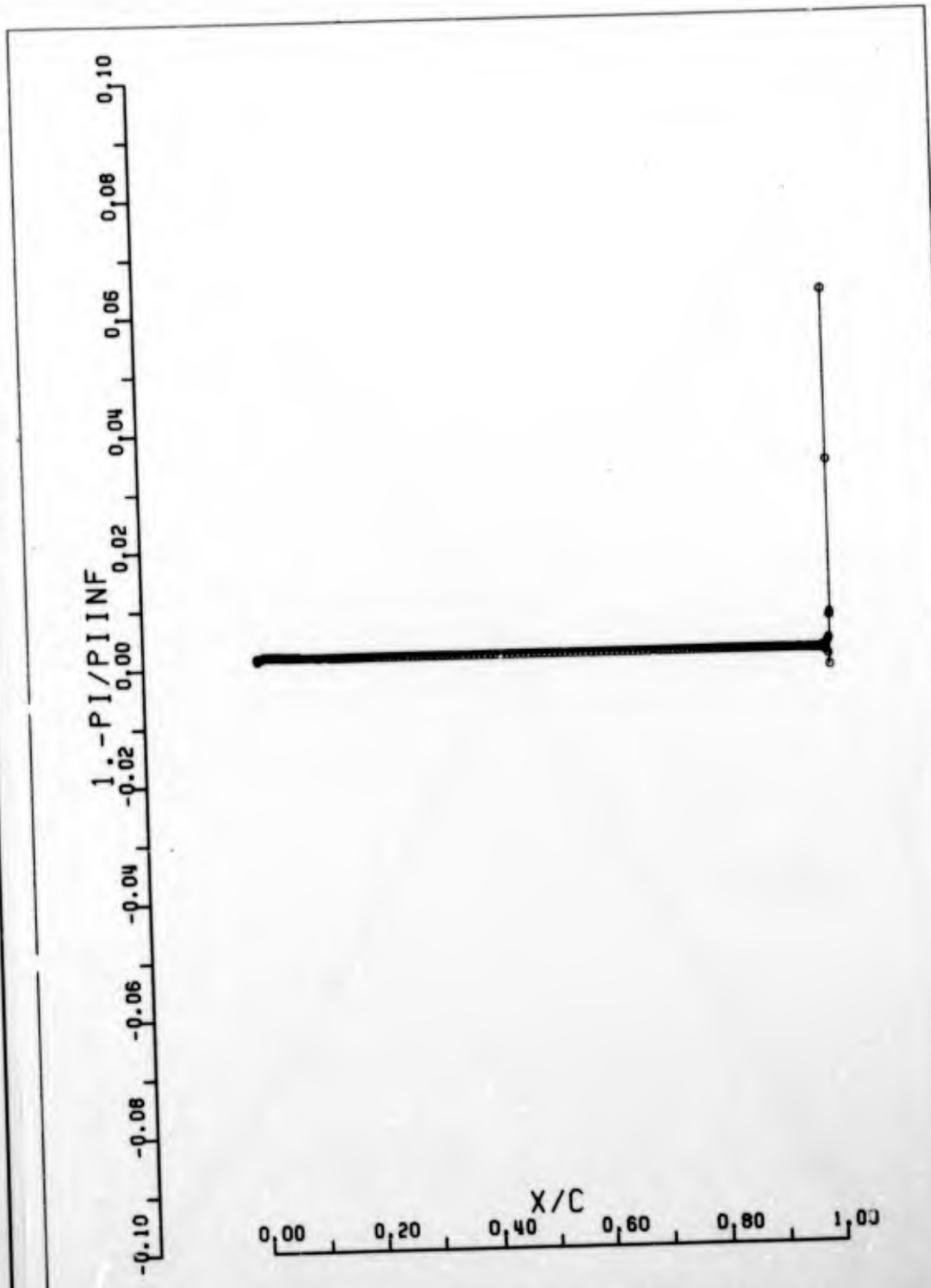


FIG. : 1.-PI/PIINF VS. X/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-14
	NACA 0012: MACH = 0.95, ALPHA = 0			

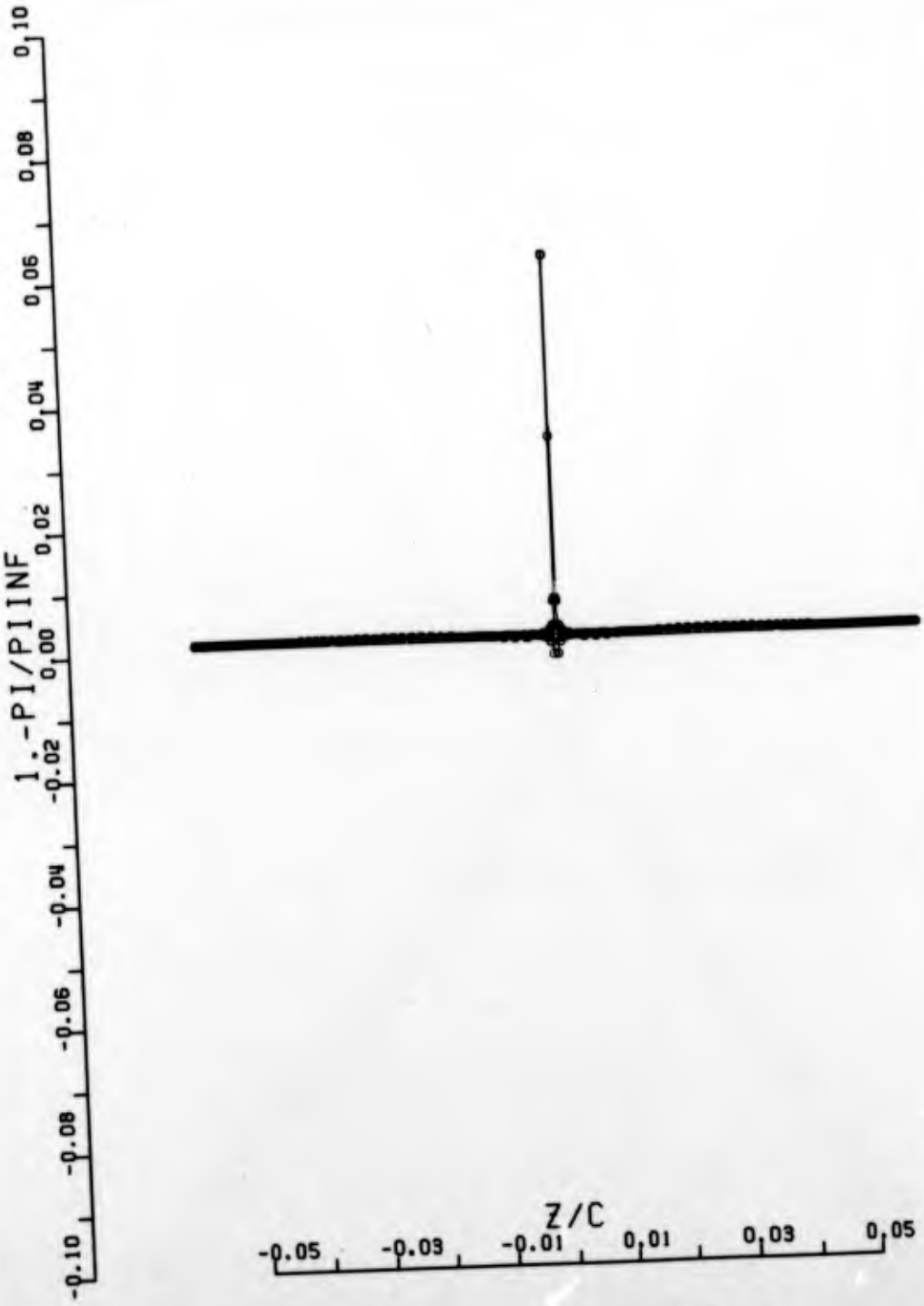
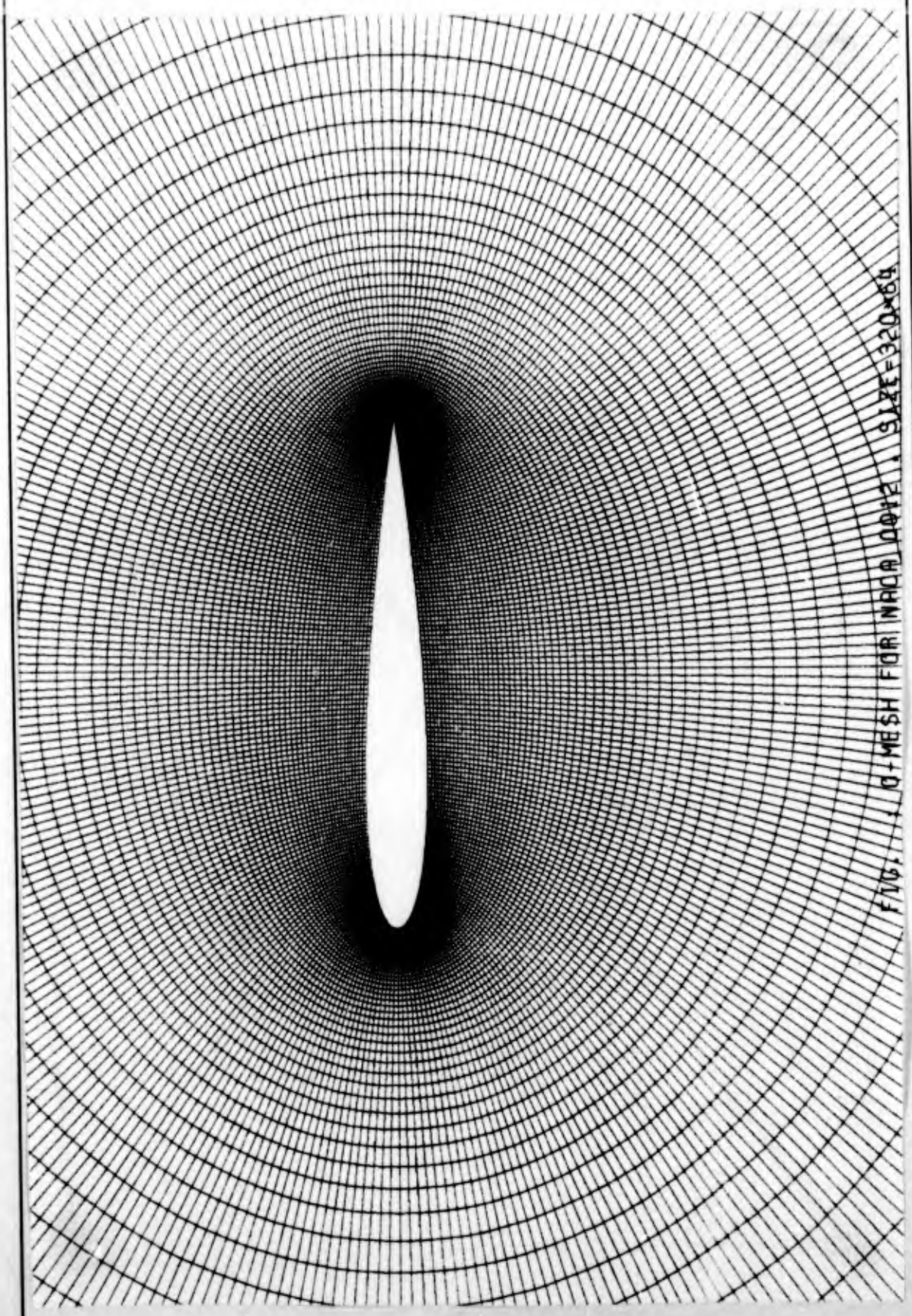
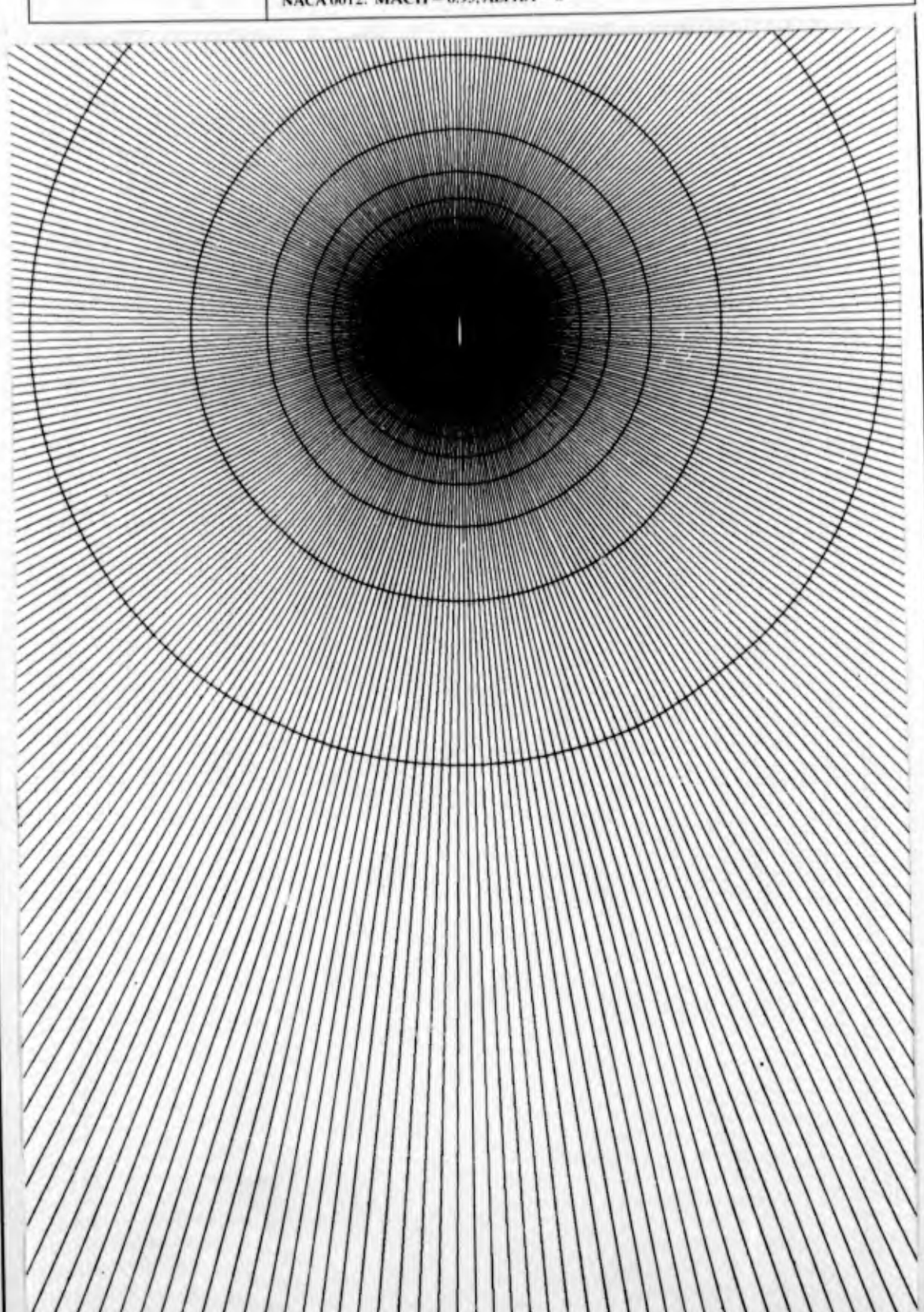


FIG. : 1.-PI/PIINF VS. Z/C ON NACA 00.2

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-15
	NACA 0012: MACH = 0.95, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-16
	NACA 0012: MACH = 0.95, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-17
	NACA 0012: MACH = 0.95, ALPHA = 0			

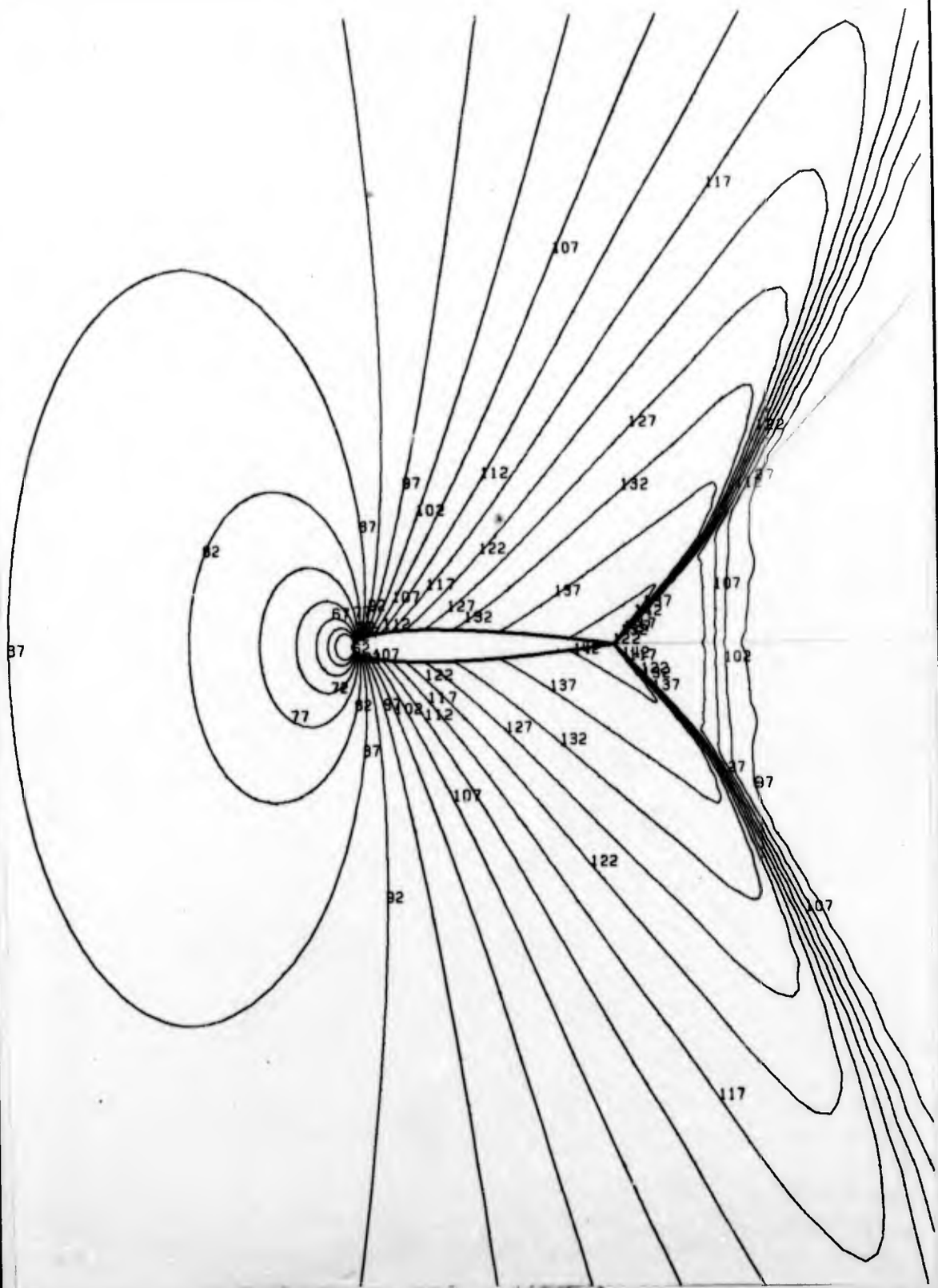


FIG. : ISO-MACH (DELTA = 0.050)

*** VALUES OF CURVE PARAMETER = 100*MACH ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-18
	NACA 0012: MACH = 0.95, ALPHA = 0			

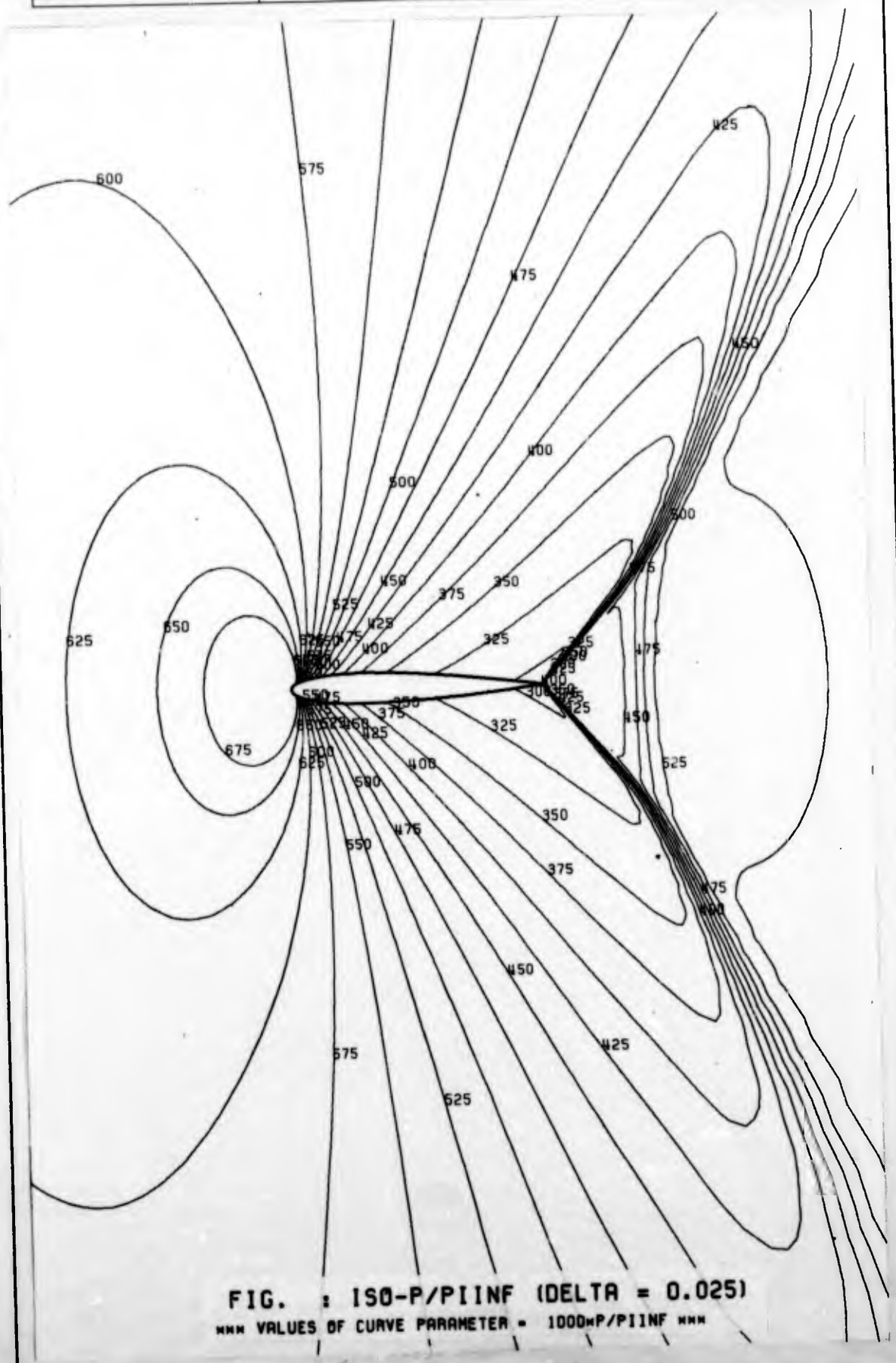


FIG. : ISO-P/PIINF (DELTA = 0.025)

*** VALUES OF CURVE PARAMETER = 1000*P/PIINF ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-19
	NACA 0012: MACH = 0.95, ALPHA = 0			

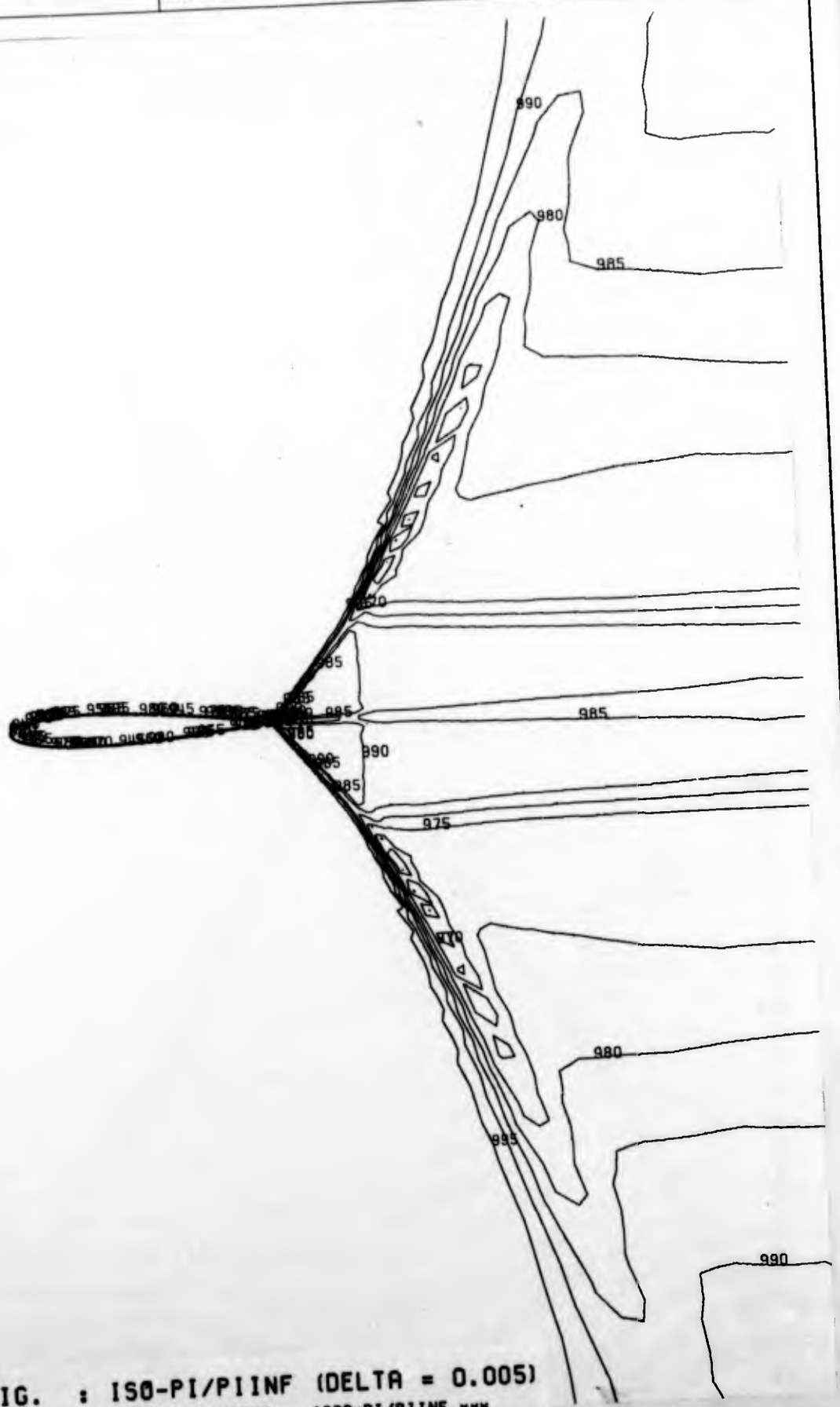


FIG. : ISO-PI/PIINF (DELTA = 0.005)

**** VALUES OF CURVE PARAMETER = 1000*PI/PIINF ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-20
	NACA 0012: MACH = 0.95, ALPHA = 0			

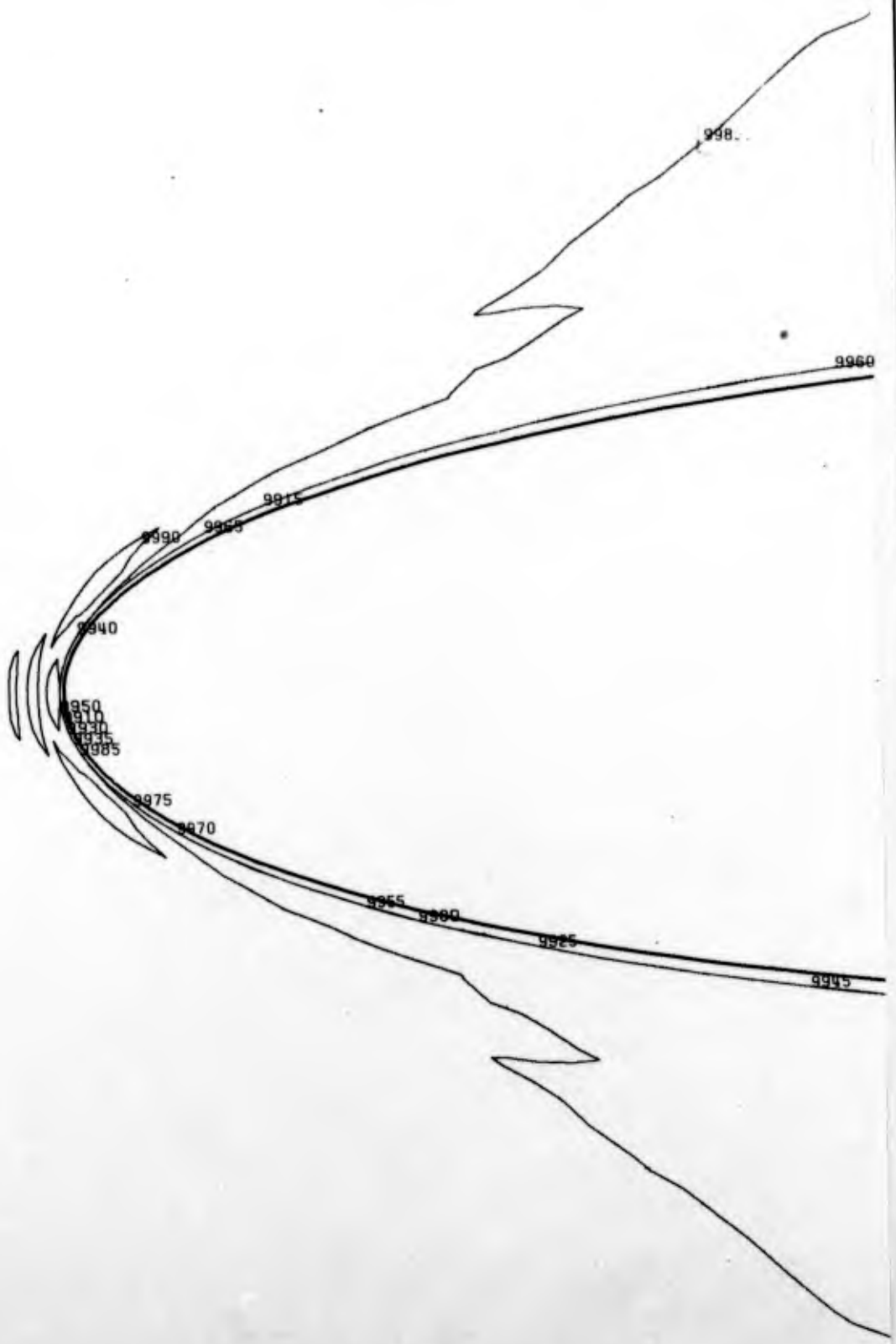


FIG. : ISO-PI/PIINF (DELTA = 0.0001)

NNN VALUES OF CURVE PARAMETER = 10000*PI/PIINF NNN

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-21
	NACA 0012: MACH = 0.95, ALPHA = 0			

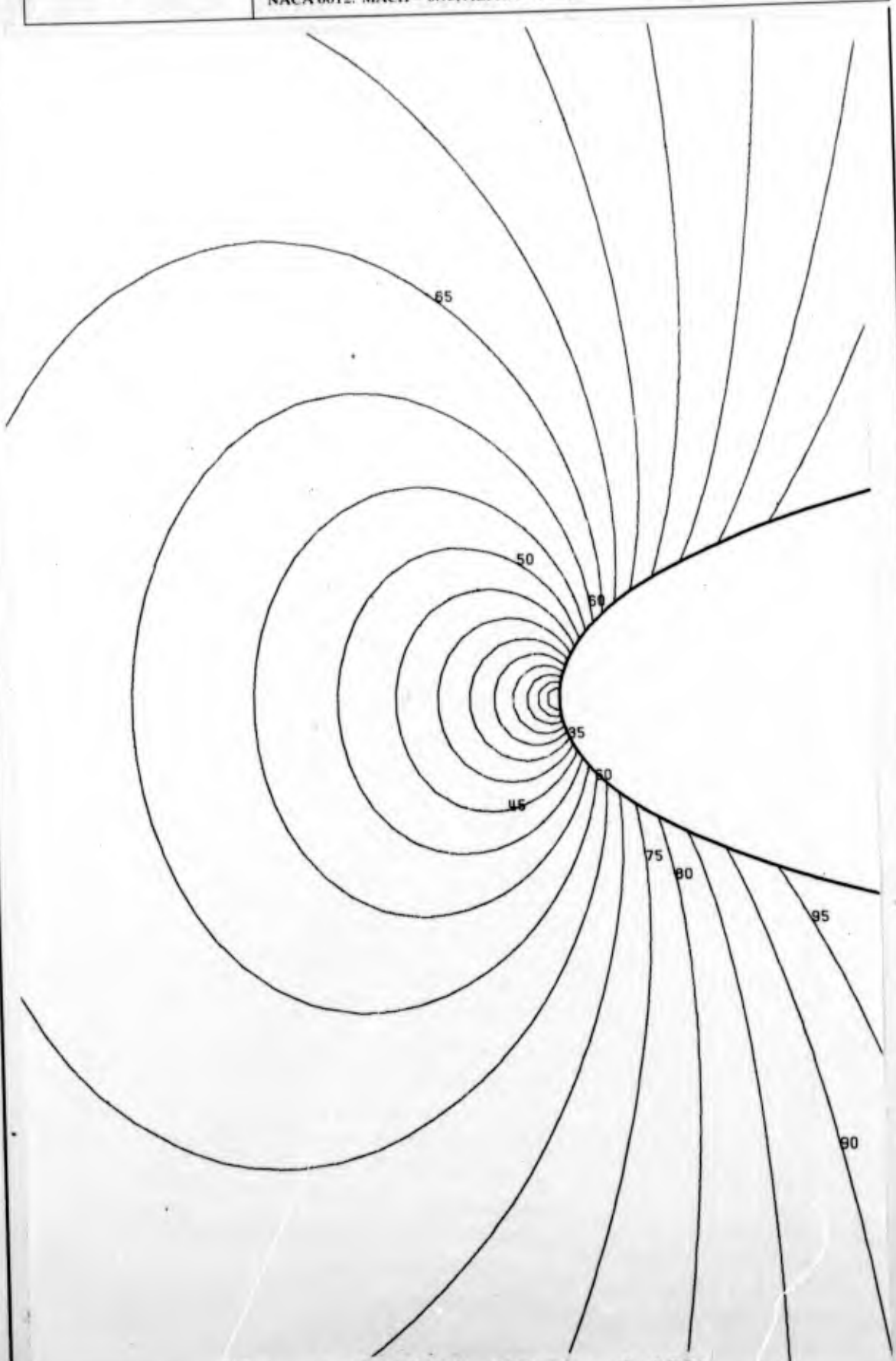


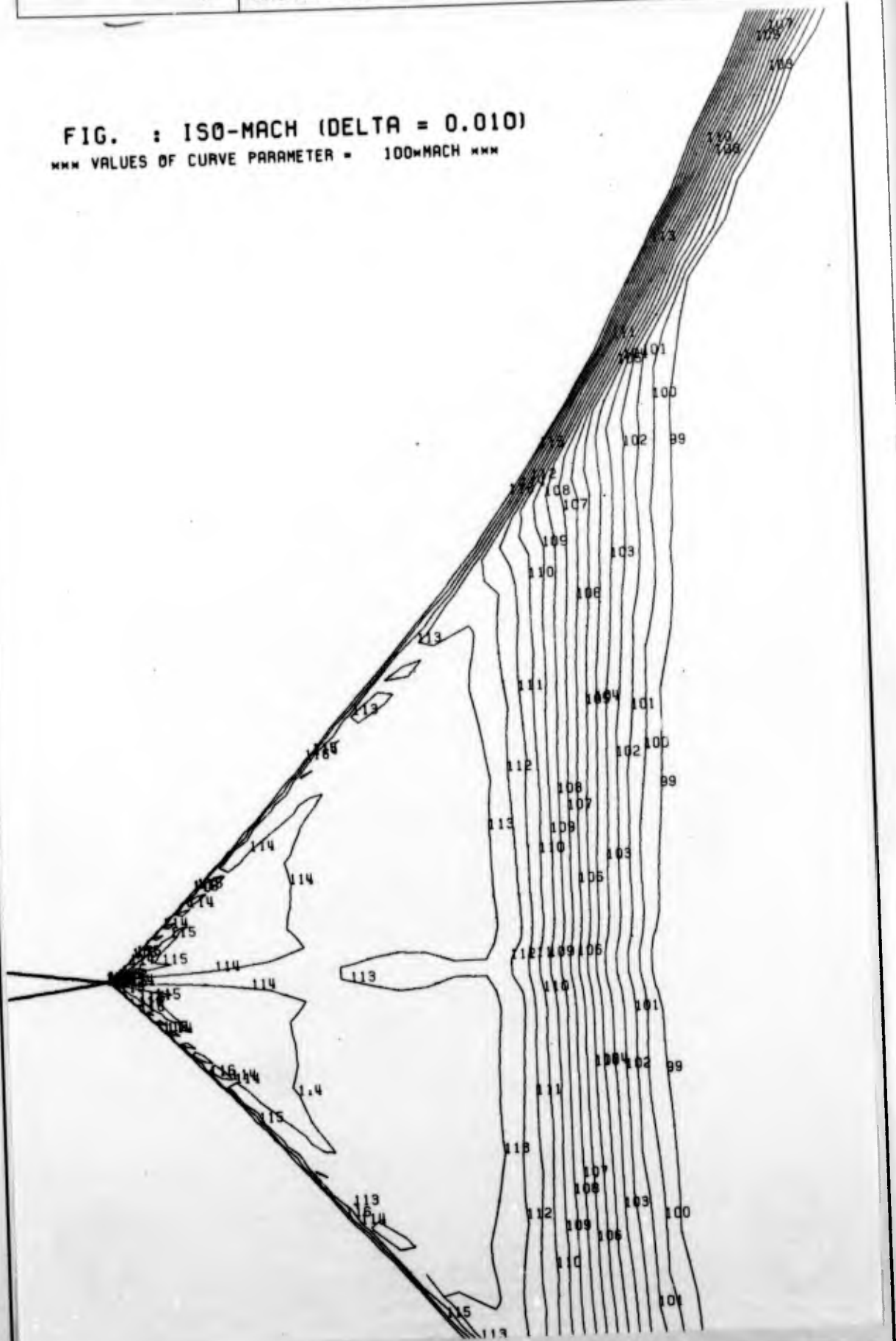
FIG. : ISO-MACH (DELTA = 0.050)

*** VALUES OF CURVE PARAMETER = 100*MACH ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	83-9-22
	NACA 0012: MACH = 0.95, ALPHA = 0			

FIG. : ISO-MACH (DELTA = 0.010)

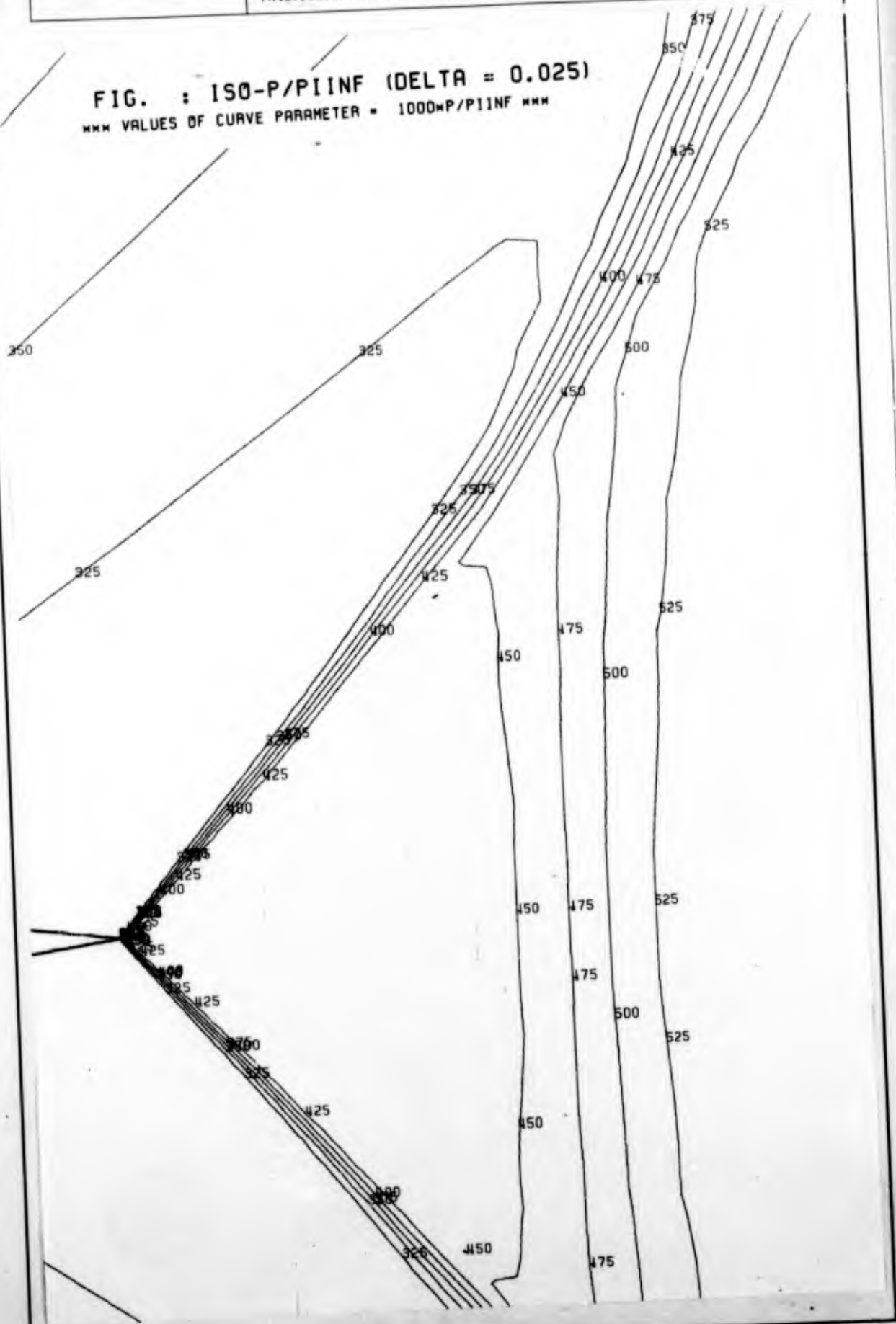
*** VALUES OF CURVE PARAMETER = 100*MACH ***



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-23
	NACA 0012: MACH = 0.95, ALPHA = 0			

FIG. : ISO-P/PIINF (DELTA = 0.025)

*** VALUES OF CURVE PARAMETER = 1000*P/PIINF ***



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	03-9-24
	NACA 0012: MACH = 0.95, ALPHA = 0			

MESH	C_L	C_D	C_M	$(\Delta\mathcal{P}/\Delta t)_{local}$ n-1	$(\Delta\mathcal{P}/\Delta t)_{local}$ n=CYCLE	CYCLE
80 x 16	0.0	0.1039	0.0	0.27	$0.94 \cdot 10^{-7}$	500
160 x 32	0.0	0.1083	0.0	0.25	$0.18 \cdot 10^{-2}$	750
320 x 64	0.0	0.1084	0 0	0.80	$0.95 \cdot 10^{-3}$	750

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 03

NACA 0012: MACH = 0.95, ALPHA = 0

Contributor No 10

R-H.Ni

(Pratt & Whitney, U.S.A.)

PRATT & WHITNEY	AR 211		R-H.Ni	03-10-1
	NACA 0012: MACH = 0.95, ALPHA = 0			

Summary:

Numerical results of seven planar transonic/supersonic test cases (Table I) designated by AGARD Fluid Dynamic Panel (FDP) Work Group 07 (WG-07) are given in the report. The objectives of this study are (1) to assist the development of numerical methods for steady, transonic and supersonic flows in two and three dimensions, (2) to enhance the overall flow simulations capability for design applications.

General Descriptions:

(a) Numerical Method: A Multiple Grid Scheme For Solving The Euler Equations, AIAA paper 81-1025, 1981. Also AIAA Journal, Volume 20, Number 11, Nov. 1982, pages 1565-1571.

(b) Computational Mesh: C Type with 129 X 25 nodes. The outer boundary is about 9 chord away, see Fig. 1.

(c) Initial Condition: Uniform flow field of given far field condition and zero airfoil surface normal velocity.

(d) Far Field Boundary Conditions: Inflow: Isentropic
Outflow: Radiation

(e) Convergence Limits: None. 350 iterations with 3 levels of multigrid.

Results:

Numerical solution of each of the test cases is presented in following order:

(a) Airfoil surface aerodynamics

(b) Surface plots

(c) Convergence plots

(d) Flow field contour plots

(e) Close-up view of computational mesh

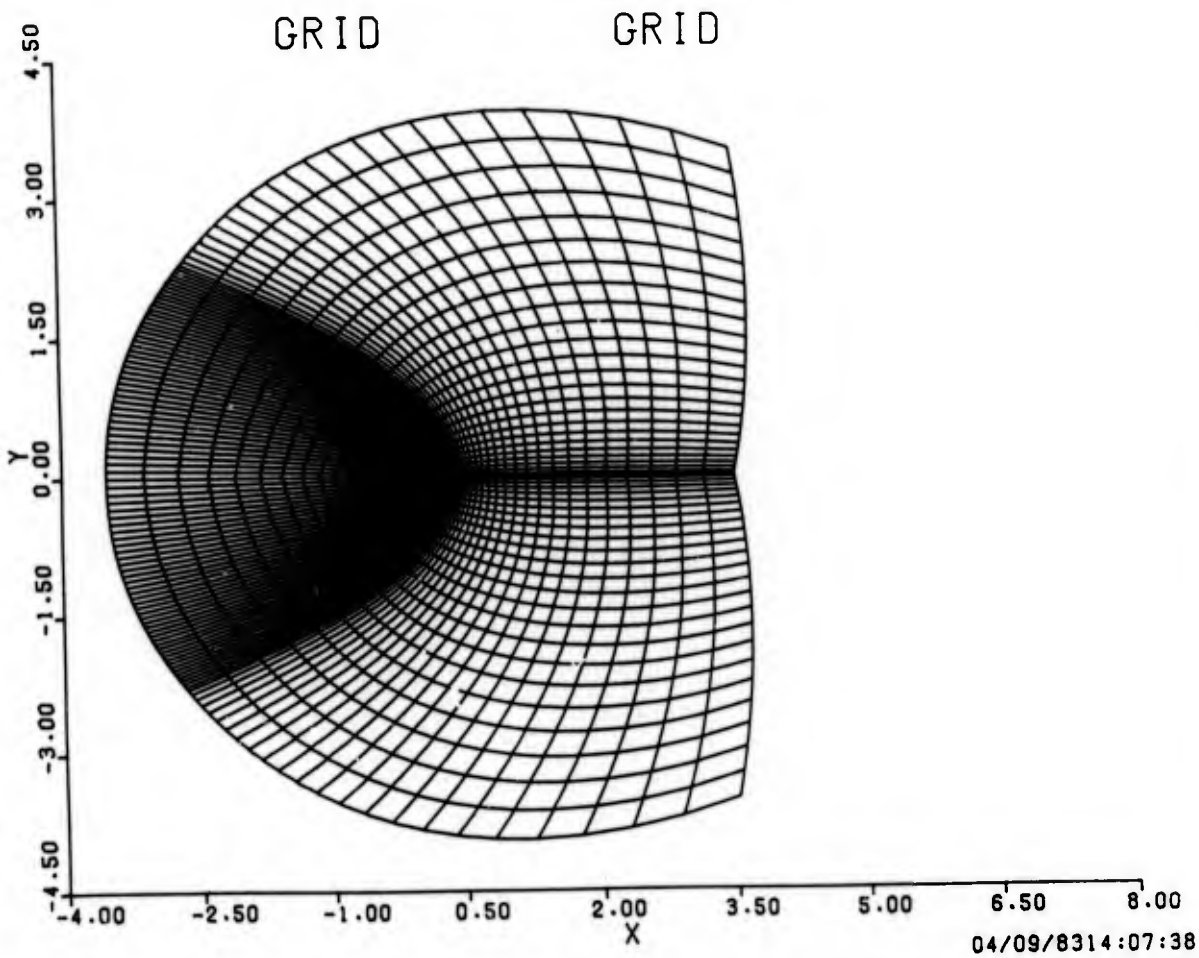


FIG.1. COMPUTIONAL MESH FOR NACA0012

PRATT & WHITNEY	AR 211		R-H.Ni	03-10-3
	NACA 0012: MACH = 0.95, ALPHA = 0			

NACA0012

MACH 0.95
ALPHA 0.00

N	X/C	Y/C	1-P/PIINF	CP	MACH	1-PI/PIINF
25	1.000000	0.0	0.663570	-0.631025	1.351620	-0.000650
26	0.966960	-0.004590	0.696080	-0.723007	1.430460	-0.009730
27	0.933930	-0.009010	0.699150	-0.731693	1.423900	0.009750
28	0.900910	-0.013240	0.702340	-0.740719	1.434920	0.004780
29	0.867930	-0.017310	0.696750	-0.724903	1.420000	0.007320
30	0.835000	-0.021220	0.695420	-0.721140	1.417760	0.006140
31	0.802140	-0.024970	0.692240	-0.712142	1.410000	0.006710
32	0.769370	-0.028570	0.690150	-0.706229	1.405410	0.006430
33	0.736710	-0.032010	0.687560	-0.698901	1.399400	0.006580
34	0.704180	-0.035300	0.685240	-0.692337	1.394210	0.006500
35	0.671810	-0.038420	0.682740	-0.685264	1.388530	0.006530
36	0.639630	-0.041370	0.680240	-0.678190	1.382960	0.006500
37	0.607650	-0.044150	0.677610	-0.670749	1.377110	0.006510
38	0.575910	-0.046740	0.674830	-0.662884	1.370970	0.006490
39	0.544440	-0.049130	0.671770	-0.654226	1.364250	0.006480
40	0.513270	-0.051320	0.668410	-0.644719	1.356940	0.006460
41	0.482440	-0.053280	0.664710	-0.634251	1.348940	0.006450
42	0.451990	-0.055000	0.660620	-0.622679	1.340180	0.006430
43	0.421950	-0.056470	0.656100	-0.609890	1.330600	0.006410
44	0.392370	-0.057670	0.651120	-0.595800	1.320150	0.006390
45	0.363300	-0.058580	0.645580	-0.580125	1.308660	0.006360
46	0.334800	-0.059180	0.639400	-0.562640	1.295980	0.006330
47	0.306900	-0.059470	0.632500	-0.543118	1.282010	0.006300
48	0.279670	-0.059420	0.624860	-0.521501	1.266740	0.006260
49	0.253180	-0.059010	0.616470	-0.497763	1.250240	0.006220
50	0.227480	-0.058250	0.607240	-0.471649	1.232380	0.006190
51	0.202660	-0.057110	0.597070	-0.442874	1.213010	0.006140
52	0.178780	-0.055590	0.585870	-0.411186	1.192050	0.006090
53	0.155930	-0.053690	0.573320	-0.375677	1.169000	0.006020
54	0.134190	-0.051390	0.559230	-0.335812	1.143630	0.005950
55	0.113660	-0.048690	0.543470	-0.291222	1.115800	0.005870
56	0.094430	-0.045610	0.525120	-0.239303	1.084130	0.005740
57	0.076620	-0.042130	0.504390	-0.180651	1.049080	0.005650
58	0.060330	-0.038260	0.480870	-0.114105	1.010220	0.005500
59	0.045670	-0.034020	0.449770	-0.026112	0.960180	0.005120
60	0.032780	-0.029410	0.414020	0.075037	0.903620	0.005030
61	0.021770	-0.024420	0.361920	0.222445	0.823560	0.004060
62	0.012790	-0.019050	0.294710	0.412605	0.719990	0.003870
63	0.005970	-0.013240	0.189650	0.709855	0.554140	0.001690
64	0.001540	-0.006890	0.064650	1.063521	0.306200	0.001810
65	0.0	0.0	0.002890	1.238263	0.0	0.002890
66	0.001540	0.006890	0.064650	1.063521	0.306200	0.001810
67	0.005970	0.013240	0.189650	0.709855	0.554140	0.001690
68	0.012790	0.019050	0.294710	0.412605	0.720000	0.003870
69	0.021770	0.024420	0.361920	0.222445	0.823570	0.004060
70	0.032780	0.029410	0.414020	0.075037	0.903630	0.005030
71	0.045670	0.034020	0.449770	-0.026112	0.960180	0.005120
72	0.060330	0.038260	0.480860	-0.114076	1.010210	0.005500
73	0.076620	0.042130	0.504400	-0.180679	1.049090	0.005650
74	0.094430	0.045610	0.525130	-0.239331	1.084140	0.005750
75	0.113660	0.048690	0.543470	-0.291222	1.115800	0.005870
76	0.134190	0.051390	0.559240	-0.335840	1.143630	0.005960
77	0.155930	0.053690	0.573320	-0.375677	1.169010	0.006030
78	0.178780	0.055590	0.585870	-0.411186	1.192050	0.006090
79	0.202660	0.057110	0.597070	-0.442874	1.213010	0.006140
80	0.227480	0.058250	0.607250	-0.471677	1.232380	0.006190
81	0.253180	0.059010	0.616470	-0.497763	1.250240	0.006230

82	0.279670	0.059420	0.624860	-0.521501	1.266740	0.006270
83	0.306900	0.059470	0.632500	-0.543118	1.282010	0.006300
84	0.334800	0.059180	0.639410	-0.562668	1.295980	0.006340
85	0.363300	0.058580	0.645580	-0.580125	1.308650	0.006360
86	0.392370	0.057670	0.651120	-0.595800	1.320150	0.006390
87	0.421950	0.056470	0.656100	-0.609890	1.330600	0.006420
88	0.451990	0.055000	0.660620	-0.622679	1.340170	0.006430
89	0.482440	0.053280	0.664710	-0.634251	1.348940	0.006450
90	0.513270	0.051320	0.668410	-0.644719	1.356940	0.006470
91	0.544440	0.049130	0.671770	-0.654226	1.364250	0.006480
92	0.575910	0.046740	0.674830	-0.662884	1.370970	0.006490
93	0.607650	0.044150	0.677620	-0.670777	1.377120	0.006510
94	0.639630	0.041370	0.680240	-0.678190	1.382960	0.006500
95	0.671810	0.038420	0.682740	-0.685264	1.388540	0.006530
96	0.704180	0.035300	0.685250	-0.692365	1.394210	0.006490
97	0.736710	0.032010	0.687560	-0.698901	1.399410	0.006580
98	0.769370	0.028570	0.690150	-0.706229	1.405410	0.006430
99	0.802140	0.024970	0.692230	-0.712114	1.409990	0.006710
100	0.835000	0.021220	0.695420	-0.721140	1.417760	0.006140
101	0.867930	0.017310	0.696750	-0.724903	1.420000	0.007320
102	0.900910	0.013240	0.702340	-0.740719	1.434920	0.004780
103	0.933930	0.009010	0.699150	-0.731693	1.423890	0.009750
104	0.966960	0.004590	0.696080	-0.723007	1.430450	-0.009730
105	1.000000	0.0	0.663570	-0.631025	1.351620	-0.000650

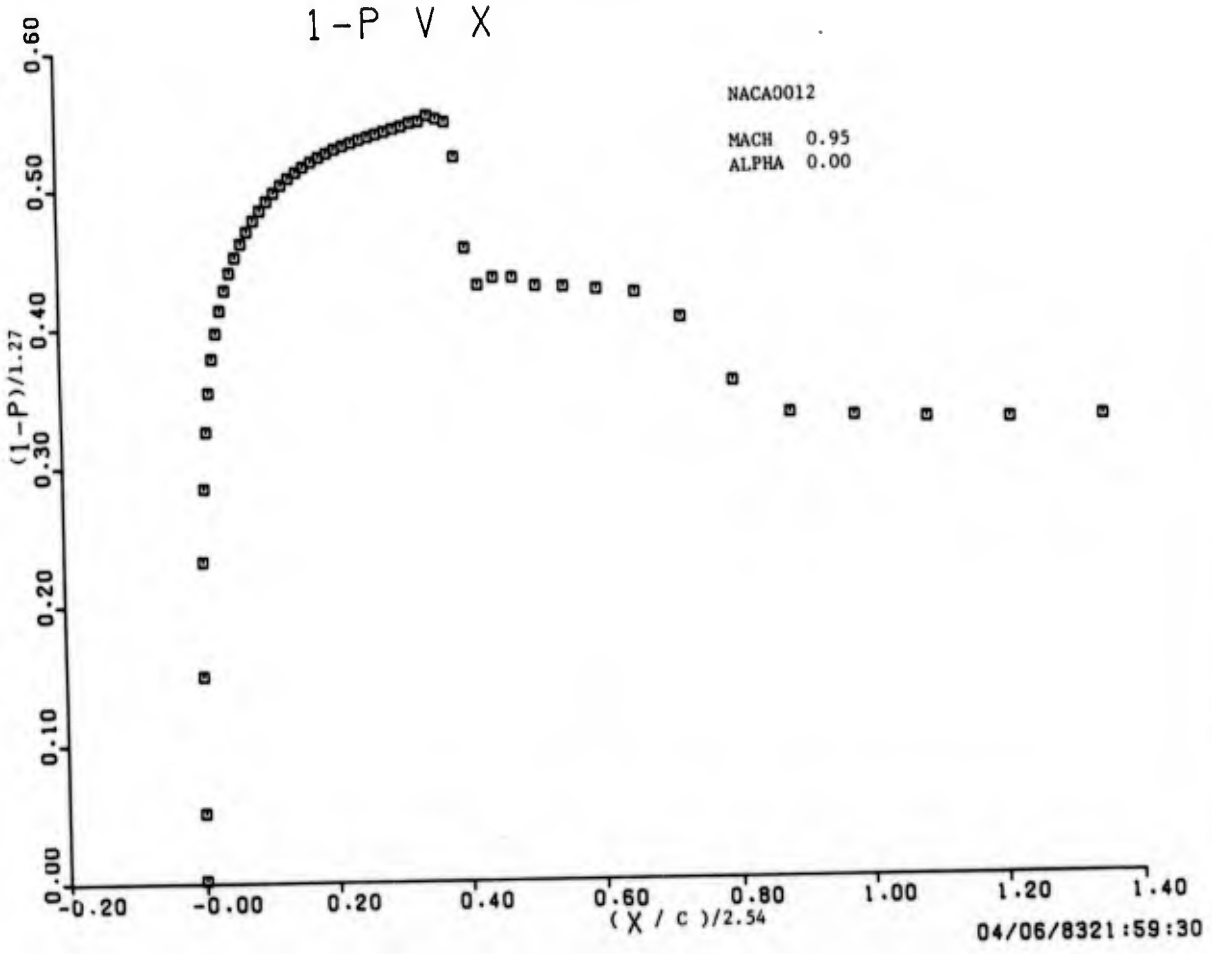
NACA0012

...

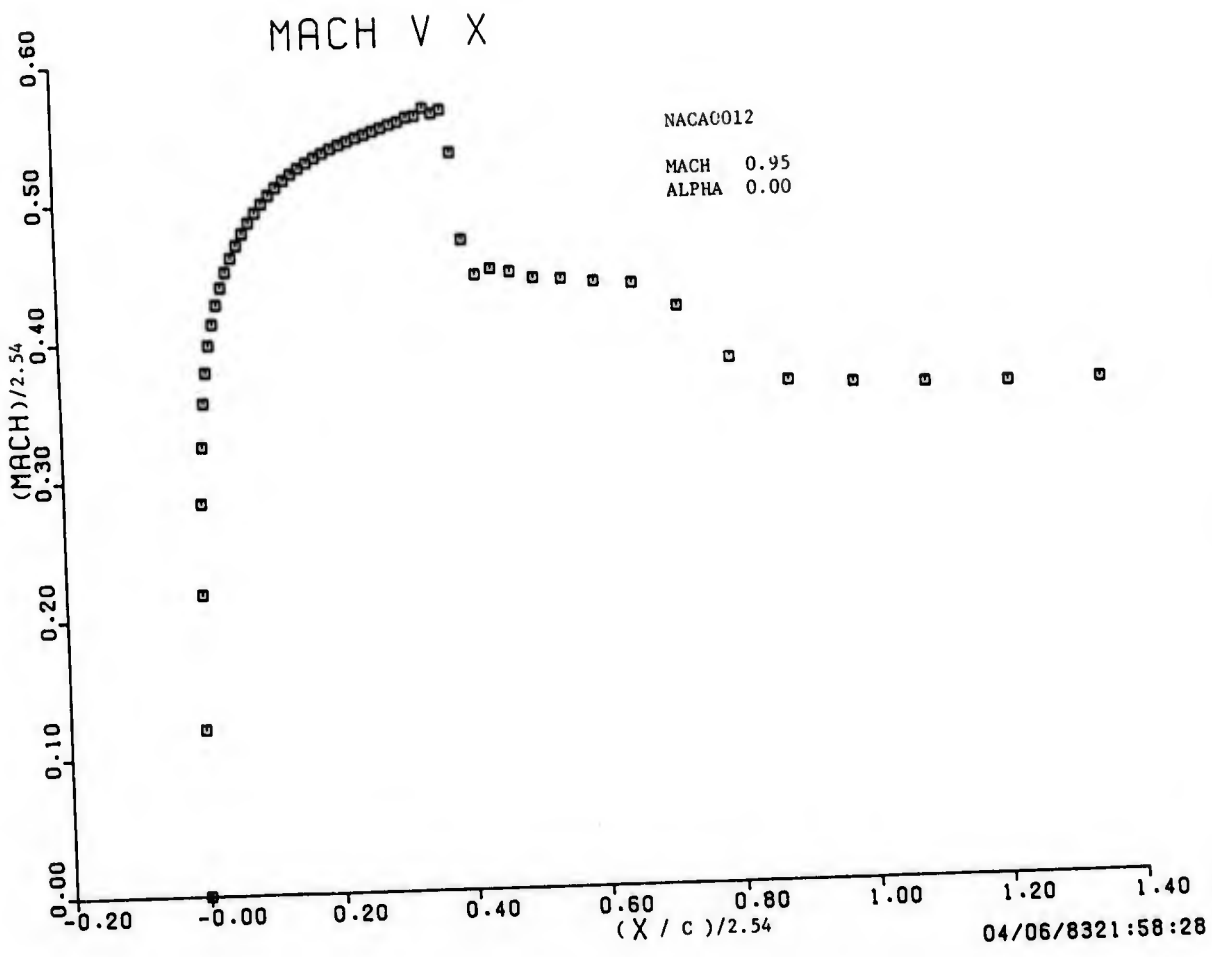
MACH 0.95
A LPHA 0.00

CL 0.00000
CD 0.10780
CM 0.00000

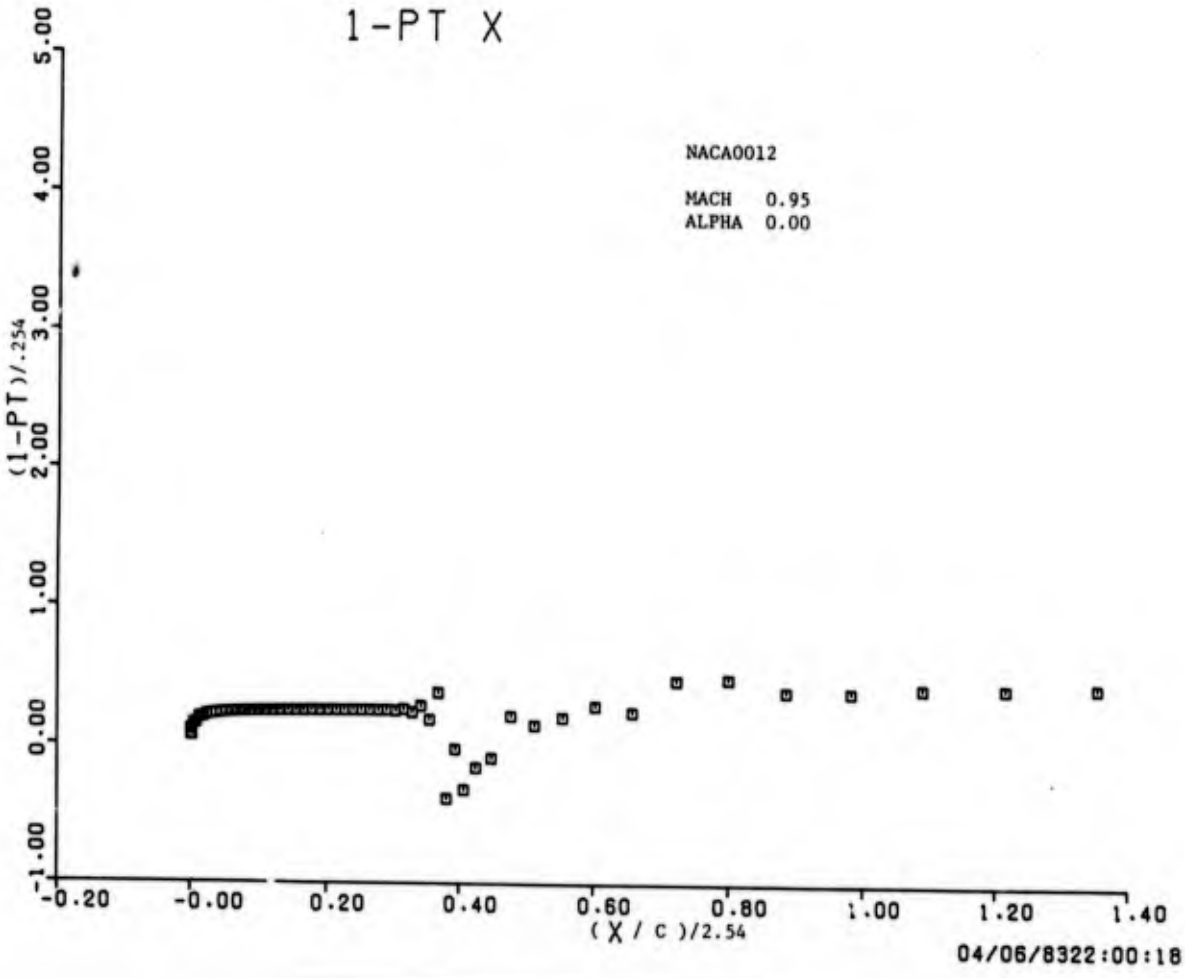
PRATT & WHITNEY	AR 211		R-H.Ni	03-10-5
	NACA 0012: MACH = 0.95, ALPHA = 0			



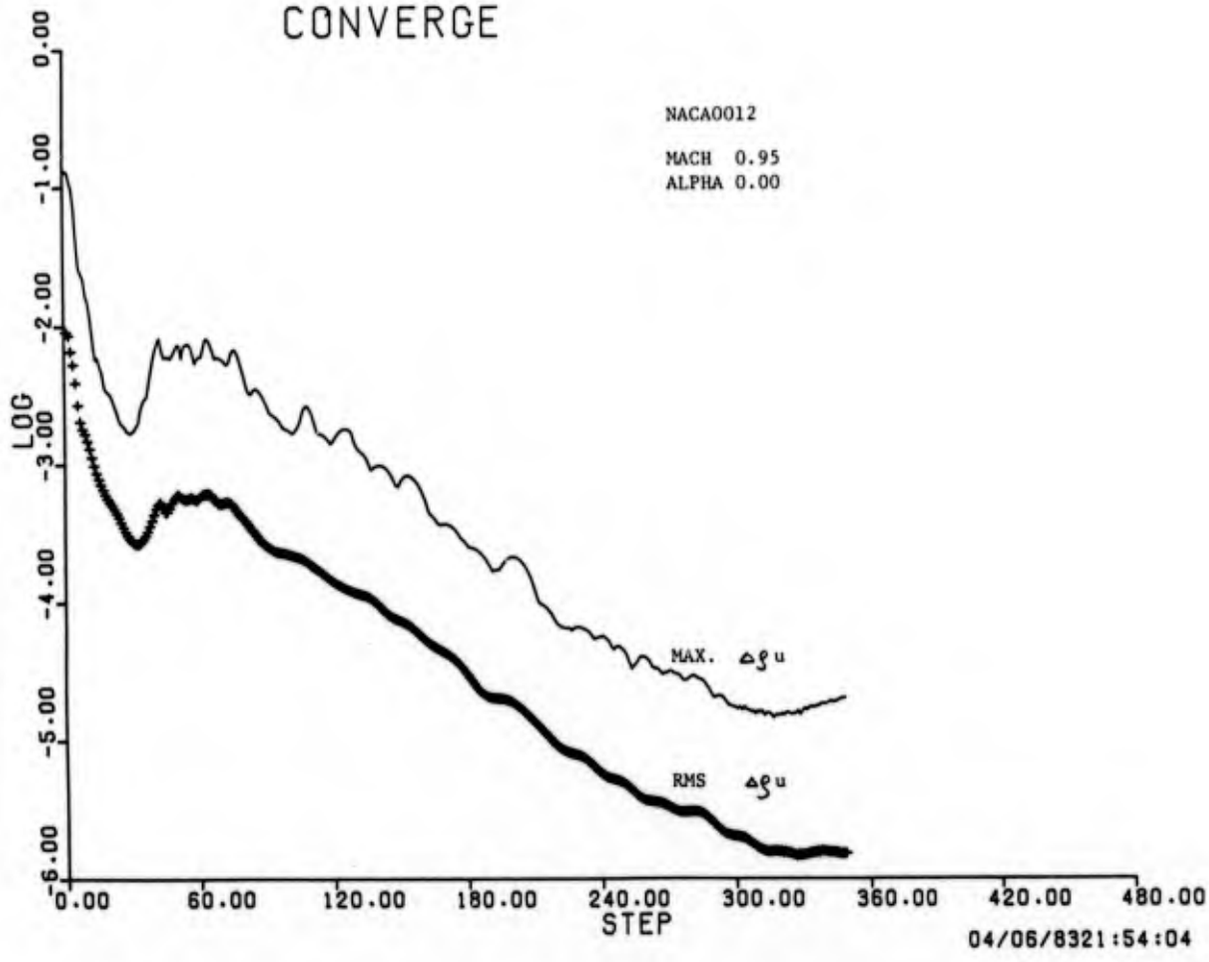
PRATT & WHITNEY	AR 211		R-H.Ni	03-10-6
	NACA 0012: MACH = 0.95, ALPHA = 0			



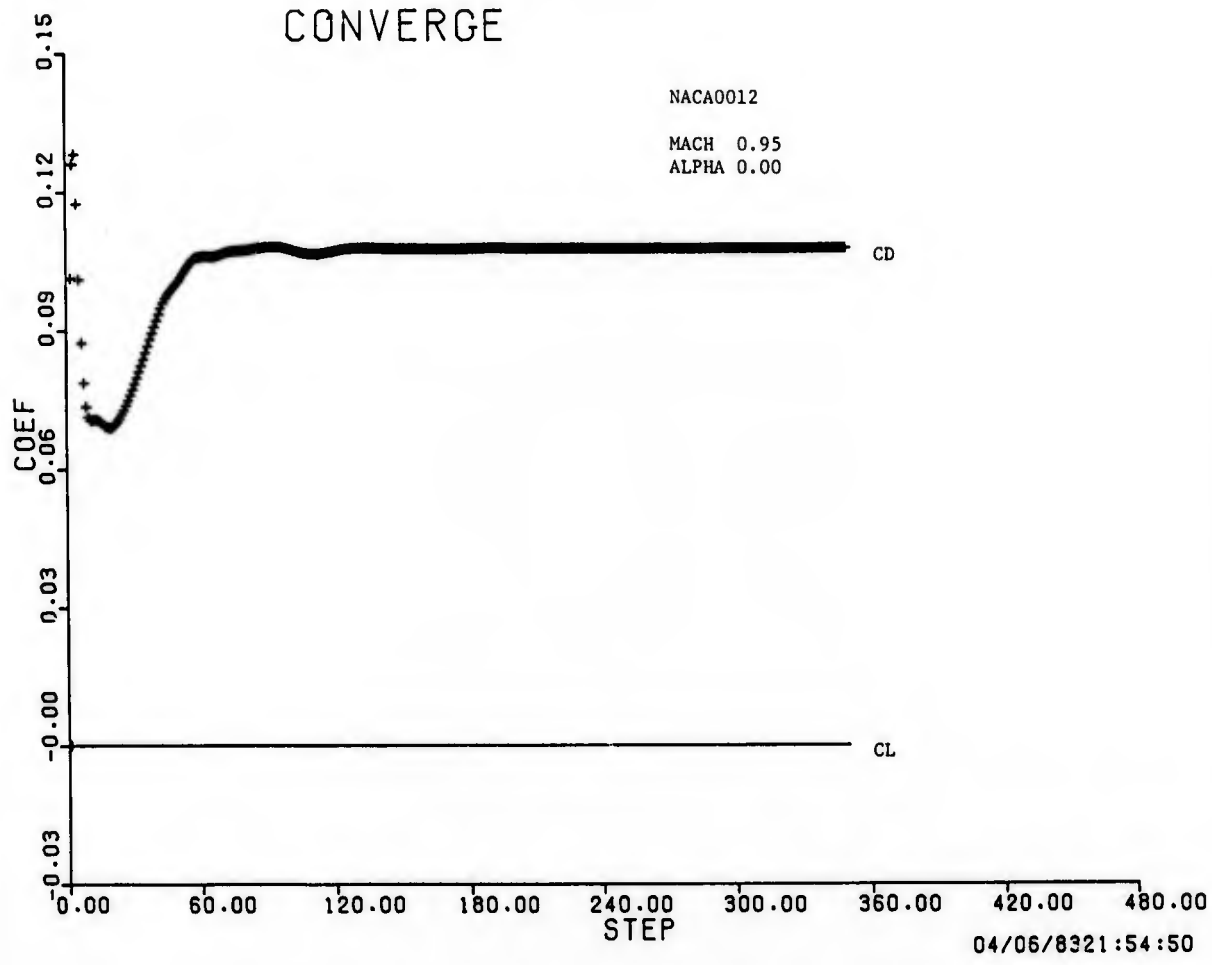
PRATT & WHITNEY	AR 211		R-H.Ni	03-10-7
	NACA 0012: MACH = 0.95, ALPHA = 0			



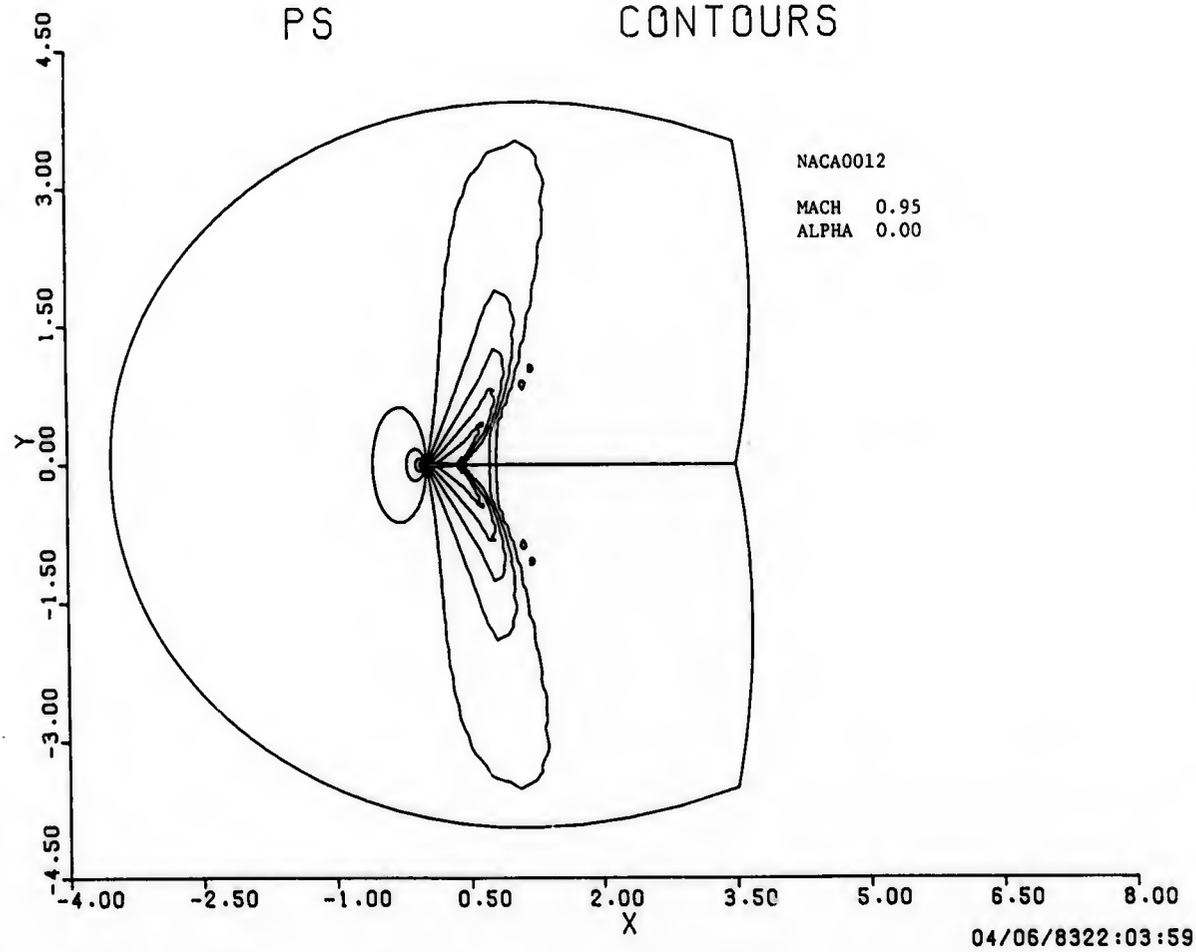
PRATT & WHITNEY	AR 211		R-H.Ni	03-10-8
	NACA 0012: MACH = 0.95, ALPHA = 0			



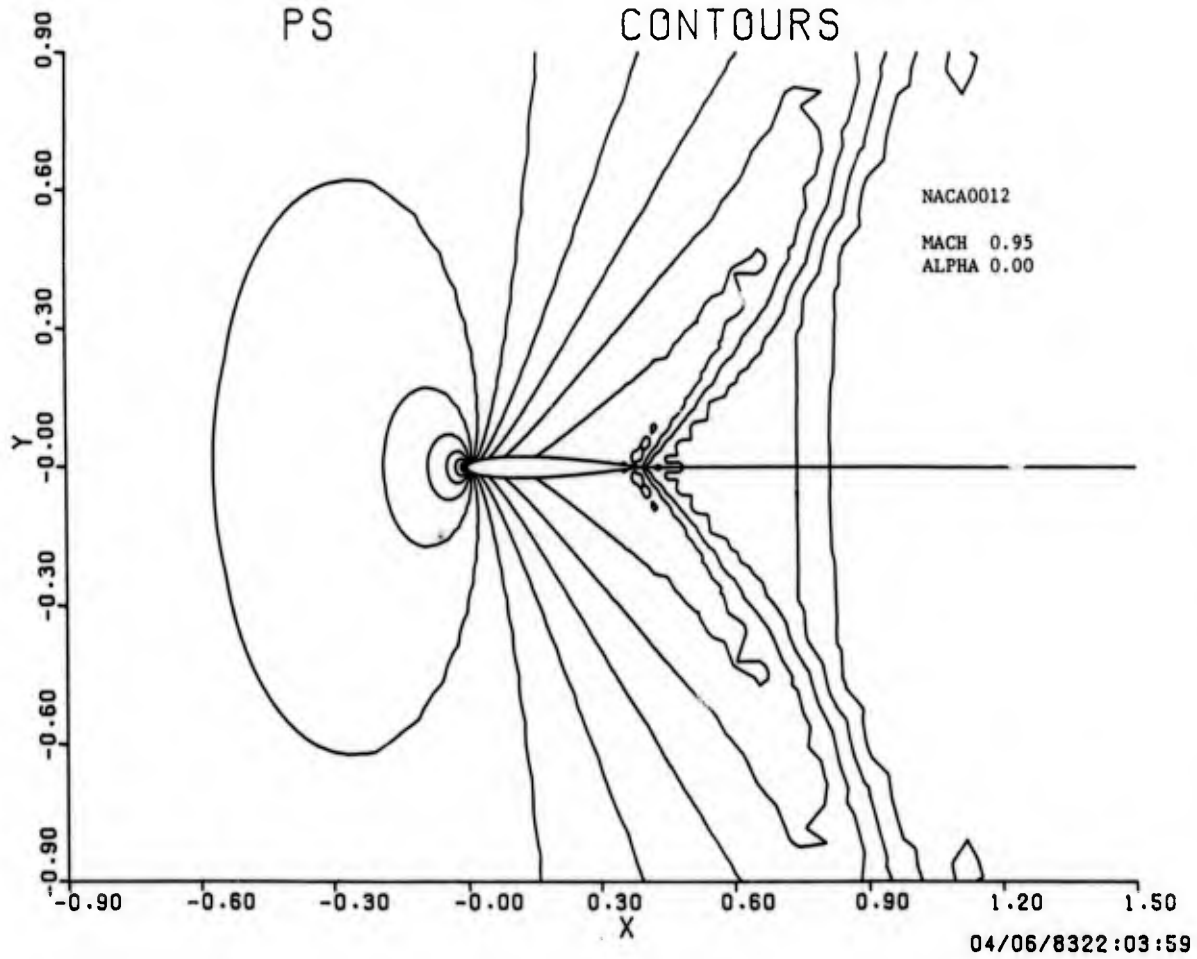
PRATT & WHITNEY	AR 211		R-H.Ni	03-10-9
	NACA 0012: MACH = 0.95, ALPHA = 0			



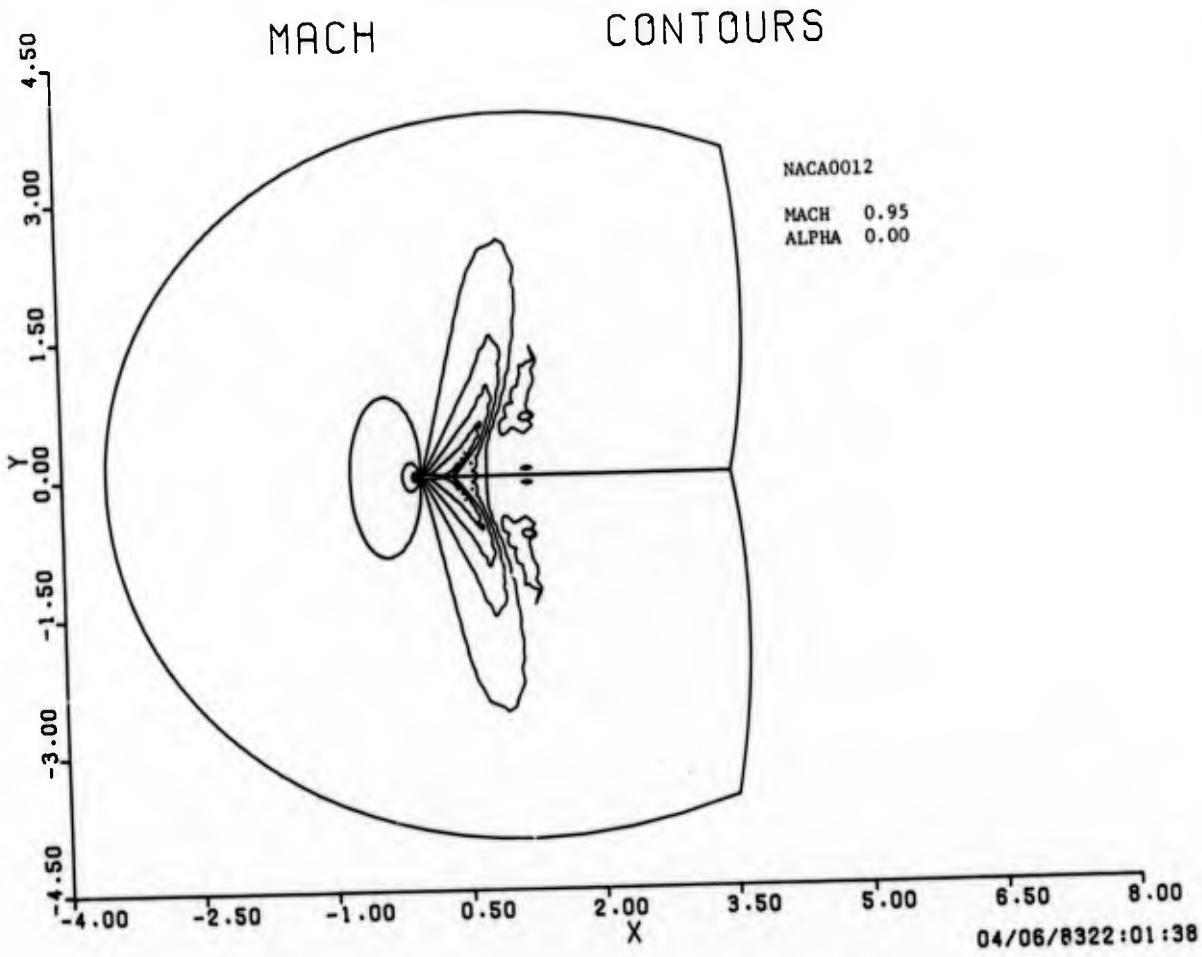
PRATT & WHITNEY	AR 211		R-H.Ni	03-10-10
	NACA 0012: MACH = 0.95, ALPHA = 0			



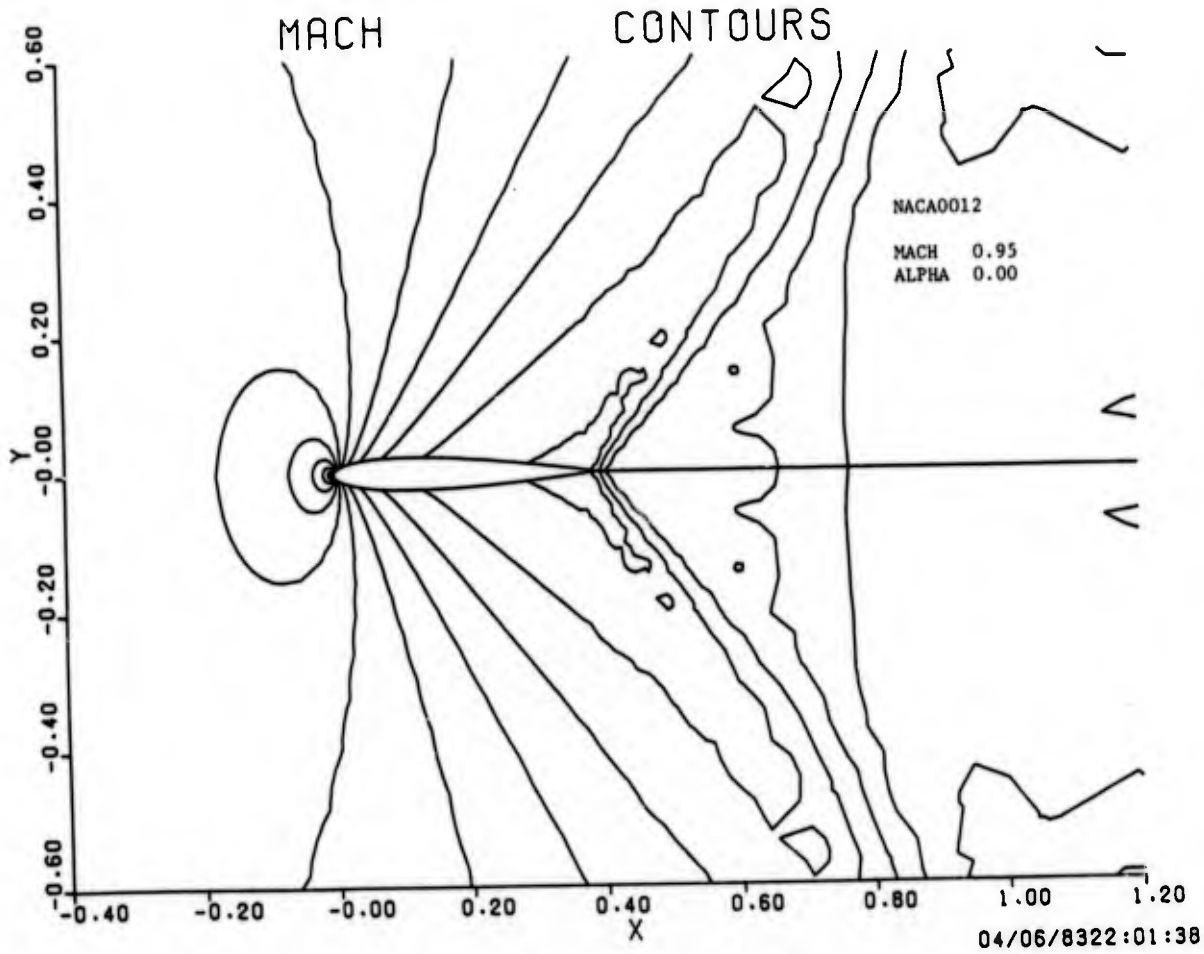
PRATT & WHITNEY	AR 211		R-H.Ni	03-10-11
	NACA 0012: MACH = 0.95, ALPHA = 0			



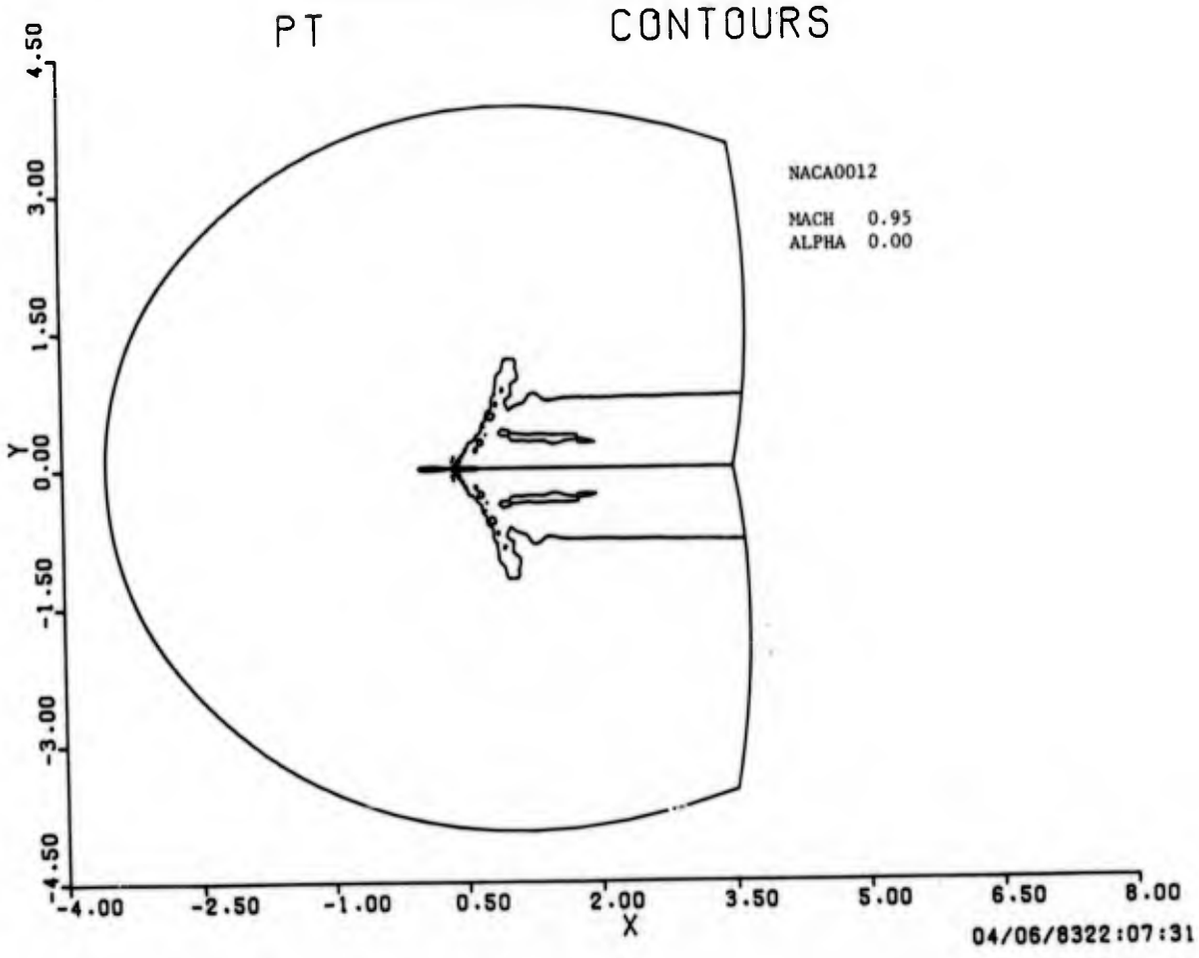
PRATT & WHITNEY	AR 211		R-H.Ni	03-10-12
	NACA 0012: MACH = 0.95, ALPHA = 0			



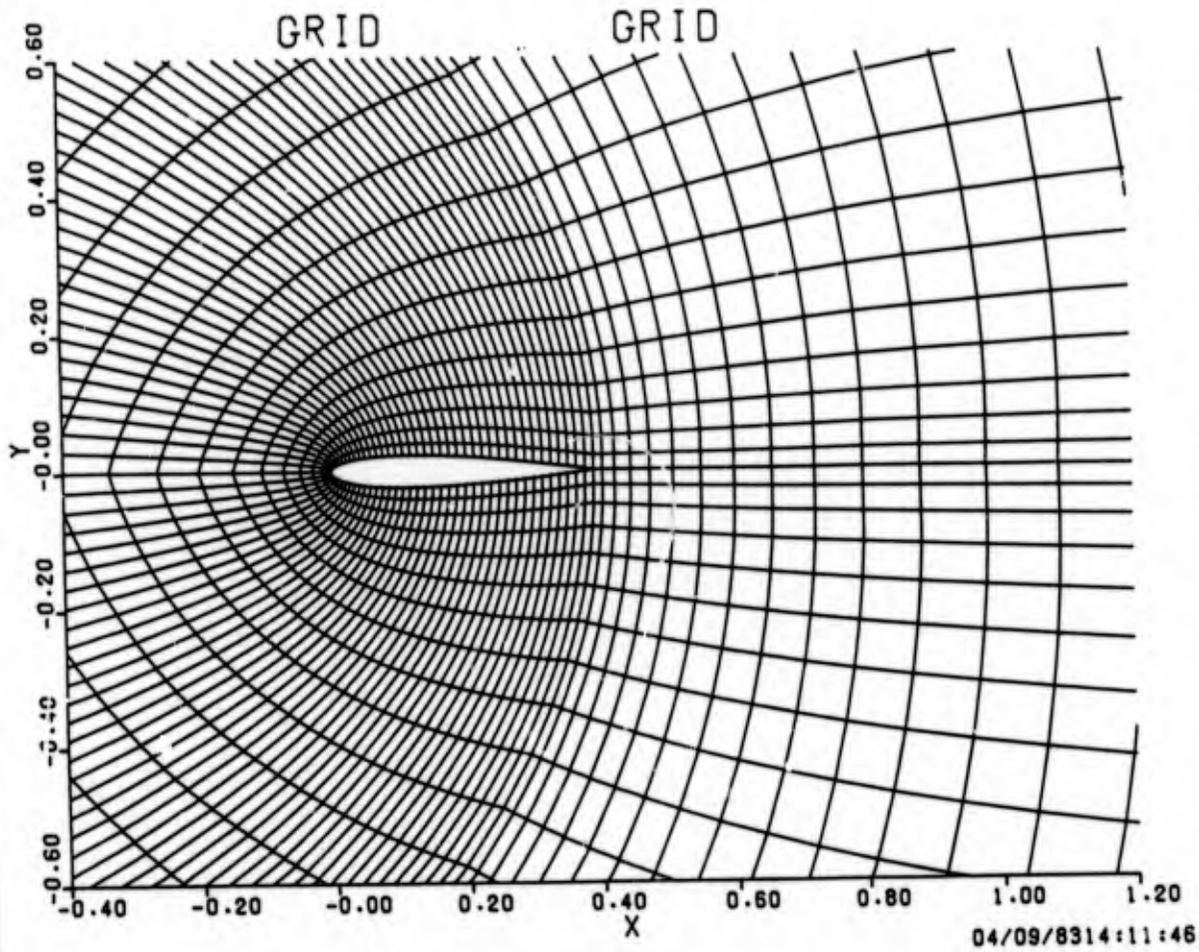
PRATT & WHITNEY	AR 211		R-H.Ni	03-10-13
	NACA 0012: MACH = 0.95, ALPHA = 0			



PRATT & WHITNEY	AR 211		R-H.Ni	03-10-14
	NACA 0012: MACH = 0.95, ALPHA = 0			



PRATT & WHITNEY	AR 211		R-H.Ni	03-10-15
	NACA 0012: MACH = 0.95, ALPHA = 0			



COMPUTIONAL MESH FOR NACA0012

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 04

NACA 0012: MACH = 1.2, ALPHA = 0

Contributor No 1

J.P.Veuillot and A.M.Vuillot

(O.N.E.R.A., France)

COMMENTS ON CALCULATION FOR TEST CASE 04

* The computational domain is inscribed in the rectangle

  - $2.97 \leq x/c \leq 1.98$, $-14.87 \leq z/c \leq 14.87$

* Number of mesh points : 201 x 55 = 11 055 (169 mesh points on the profile)

* Artificial viscosity ;

  D_1 term : $Q_{1i} = Q_{1j} = 0.5\ 10^{-2}$

  D_2 term : $Q_{2i} = 0.2$, $Q_{2j} = 0.2$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-2
	NACA 0012: MACH = 1.2, ALPHA = 0			

WALL VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	0.007335	1.396011	0.000005	0.007335
2	0.000060	0.001410	0.012426	1.383762	0.072036	0.008834
3	0.000260	0.002850	0.024721	1.354184	0.143091	0.010671
4	0.000610	0.004340	0.042156	1.312240	0.213591	0.011217
5	0.001140	0.005900	0.066553	1.253549	0.286127	0.011955
6	0.001880	0.007550	0.096205	1.182214	0.359371	0.011826
7	0.002890	0.009310	0.131107	1.098249	0.433208	0.011506
8	0.004220	0.011190	0.168190	1.009039	0.504929	0.010034
9	0.005920	0.013190	0.207709	0.913967	0.575411	0.008374
10	0.008070	0.015310	0.246826	0.819861	0.641112	0.006934
11	0.010730	0.017540	0.284032	0.730355	0.701762	0.005315
12	0.013970	0.019870	0.318828	0.646646	0.756629	0.004517
13	0.017860	0.022280	0.349715	0.572340	0.804864	0.003934
14	0.022450	0.024770	0.378274	0.503635	0.849610	0.003268
15	0.027780	0.027300	0.405110	0.439076	0.891285	0.003290
16	0.033880	0.029850	0.429067	0.381442	0.929013	0.003156
17	0.040770	0.032390	0.450468	0.329957	0.962721	0.003499
18	0.048450	0.034890	0.468794	0.285869	0.992014	0.003766
19	0.056900	0.037340	0.485331	0.246086	1.019274	0.003470
20	0.066090	0.039720	0.501877	0.206281	1.046738	0.003415
21	0.075990	0.041990	0.517144	0.169553	1.071976	0.003973
22	0.086540	0.044140	0.530074	0.138447	1.094097	0.003949
23	0.097700	0.046170	0.541927	0.109932	1.114567	0.004053
24	0.109420	0.048060	0.553130	0.082981	1.134354	0.003952
25	0.121640	0.049810	0.563839	0.057218	1.153323	0.004132
26	0.134330	0.051400	0.573525	0.033915	1.170769	0.004243
27	0.147420	0.052850	0.582413	0.012535	1.187064	0.004258
28	0.160880	0.054140	0.590723	-0.007458	1.202345	0.004475
29	0.174670	0.055290	0.598448	-0.026043	1.216997	0.004336
30	0.188760	0.056290	0.606109	-0.044472	1.231500	0.004474
31	0.203100	0.057140	0.613120	-0.061338	1.244943	0.004597
32	0.217680	0.057850	0.619338	-0.076298	1.257051	0.004650
33	0.232470	0.058430	0.625175	-0.090340	1.268576	0.004653
34	0.247440	0.058880	0.630928	-0.104179	1.280028	0.004698
35	0.262570	0.059200	0.636344	-0.117209	1.290941	0.004721
36	0.277860	0.059400	0.641356	-0.129267	1.301019	0.004911
37	0.293280	0.059480	0.645867	-0.140119	1.310360	0.004836
38	0.308810	0.059460	0.650338	-0.150876	1.319627	0.004865
39	0.324460	0.059320	0.654468	-0.160811	1.328124	0.005085
40	0.340200	0.059090	0.658220	-0.169836	1.336190	0.004900
41	0.356030	0.058760	0.662168	-0.179334	1.344533	0.005001
42	0.371930	0.058330	0.665554	-0.187481	1.351707	0.005145
43	0.387900	0.057820	0.668486	-0.194533	1.358038	0.005163
44	0.403930	0.057230	0.671480	-0.201736	1.364584	0.005135
45	0.420010	0.056560	0.674481	-0.208956	1.371148	0.005164
46	0.436140	0.055810	0.677238	-0.215590	1.377175	0.005255
47	0.452310	0.054990	0.679800	-0.221751	1.382889	0.005227
48	0.468530	0.054100	0.682355	-0.227900	1.388580	0.005264
49	0.484790	0.053140	0.684673	-0.233476	1.393787	0.005277
50	0.501090	0.052120	0.686738	-0.238444	1.398355	0.005422
51	0.517420	0.051040	0.688682	-0.243120	1.402855	0.005310
52	0.533780	0.049910	0.690844	-0.248320	1.407802	0.005300
53	0.550170	0.048710	0.692689	-0.252759	1.411860	0.005553
54	0.566590	0.047470	0.694225	-0.256455	1.415538	0.005366
55	0.583030	0.046180	0.696227	-0.261272	1.420165	0.005384
56	0.599490	0.044830	0.697958	-0.265435	1.424089	0.005535
57	0.615960	0.043440	0.699304	-0.268673	1.427306	0.005435
58	0.632450	0.042010	0.700851	-0.272394	1.430835	0.005579
59	0.648950	0.040530	0.702266	-0.275799	1.434194	0.005546
60	0.665440	0.039020	0.703727	-0.279315	1.437670	0.005519
61	0.681930	0.037460	0.705203	-0.282865	1.441120	0.005597
62	0.698400	0.035870	0.706554	-0.286114	1.444363	0.005564
63	0.714840	0.034240	0.707941	-0.289451	1.447613	0.005662
64	0.731240	0.032580	0.709279	-0.292670	1.450866	0.005606
65	0.747560	0.030890	0.710748	-0.296205	1.454416	0.005597
66	0.763790	0.029170	0.712070	-0.299384	1.457540	0.005703
67	0.779900	0.027430	0.713237	-0.302191	1.460382	0.005692
68	0.795830	0.025680	0.714673	-0.305646	1.463927	0.005630
69	0.811560	0.023910	0.716097	-0.309072	1.467352	0.005717
70	0.827020	0.022140	0.717193	-0.311708	1.470029	0.005739
71	0.842170	0.020380	0.718500	-0.314853	1.473278	0.005700
72	0.856930	0.018630	0.719948	-0.318336	1.476851	0.005716
73	0.871260	0.016900	0.721043	-0.320971	1.479494	0.005828
74	0.885090	0.015210	0.722196	-0.323745	1.482434	0.005733
75	0.898370	0.013560	0.723749	-0.327481	1.486279	0.005794

AL-VEUILLOT

WALL VALUES - UPPER SIDE (Cont.)

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
76	0.911050	0.011950	0.724848	-0.330125	1.489081	0.005735
77	0.923110	0.010410	0.725978	-0.332842	1.491897	0.005779
78	0.934530	0.008920	0.727260	-0.335928	1.495094	0.005848
79	0.945320	0.007500	0.728254	-0.338319	1.497723	0.005695
80	0.955500	0.006140	0.729391	-0.341054	1.500711	0.005562
81	0.965140	0.004840	0.730162	-0.342909	1.501692	0.006985
82	0.974300	0.003590	0.730424	-0.343539	1.500616	0.009495
83	0.983080	0.002380	0.736514	-0.358191	1.526361	-0.005031
84	0.991610	0.001180	0.738686	-0.363416	1.568142	-0.059652
85	1.000000	0.000000	0.668509	-0.194590	1.379432	-0.024877

SLIP LINE VALUES

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
86	1.008410	0.000000	0.593297	-0.013649	1.174554	0.045767
87	1.017140	0.000000	0.602619	-0.036076	1.195326	0.042215
88	1.026940	0.000000	0.605849	-0.043846	1.241132	-0.008985
89	1.038920	0.000000	0.602375	-0.035490	1.228948	-0.001578
90	1.054360	0.000000	0.601298	-0.032897	1.217722	0.010459
91	1.074560	0.000000	0.601021	-0.032232	1.216553	0.011293
92	1.101040	0.000000	0.600520	-0.031027	1.216108	0.010631
93	1.135670	0.000000	0.599908	-0.029554	1.214862	0.010735
94	1.180590	0.000000	0.599172	-0.027783	1.213310	0.010930
95	1.238220	0.000000	0.598227	-0.025511	1.211387	0.011099
96	1.311150	0.000000	0.597065	-0.022715	1.209053	0.011266
97	1.402160	0.000000	0.595788	-0.019644	1.206553	0.011375
98	1.514230	0.000000	0.594563	-0.016695	1.204190	0.011435
99	1.650140	0.000000	0.593519	-0.014185	1.202184	0.011485
100	1.809280	0.000000	0.592672	-0.012147	1.200452	0.011661
101	1.984130	0.000000	0.591885	-0.010254	1.198756	0.011940

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-4
	NACA 0012: MACH = 1.2, ALPHA = 0			

UPSTREAM X-AXIS VALUES

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	.007335	1.396010	.000006	.007335
2	-.003210	0.000000	.022016	1.360692	.119525	.012201
3	-.006300	0.000000	.035676	1.327830	.200545	.008254
4	-.009500	0.000000	.054419	1.282739	.256134	.010278
5	-.012820	0.000000	.070717	1.243531	.302124	.009973
6	-.016240	0.000000	.086272	1.206110	.340224	.010068
7	-.019780	0.000000	.100628	1.171573	.372843	.010028
8	-.023430	0.000000	.113956	1.139510	.401169	.010057
9	-.027200	0.000000	.126304	1.109804	.426233	.010056
10	-.031090	0.000000	.137777	1.082203	.448646	.010054
11	-.035110	0.000000	.148490	1.056431	.468932	.010054
12	-.039270	0.000000	.158531	1.032275	.487465	.010051
13	-.043590	0.000000	.168012	1.009466	.504579	.010055
14	-.048090	0.000000	.177002	.987839	.520524	.010049
15	-.052780	0.000000	.185570	.967227	.535475	.010047
16	-.057710	0.000000	.193809	.947406	.549650	.010046
17	-.062910	0.000000	.201774	.928244	.563184	.010047
18	-.068430	0.000000	.209525	.909598	.576216	.010044
19	-.074330	0.000000	.217129	.891305	.588873	.010044
20	-.080680	0.000000	.224638	.873240	.601262	.010043
21	-.087550	0.000000	.232080	.855337	.613454	.010034
22	-.095050	0.000000	.239523	.837431	.625544	.010035
23	-.103280	0.000000	.246987	.819475	.637595	.010030
24	-.112380	0.000000	.254519	.801355	.649672	.010033
25	-.122480	0.000000	.262128	.783050	.661810	.010032
26	-.133770	0.000000	.269845	.764485	.674061	.010028
27	-.146410	0.000000	.277676	.745645	.686432	.010028
28	-.160640	0.000000	.285622	.726530	.698940	.010022
29	-.176680	0.000000	.293710	.707072	.711619	.010022
30	-.194820	0.000000	.301938	.687278	.724466	.010032
31	-.215330	0.000000	.310227	.667337	.737409	.010012
32	-.238560	0.000000	.318506	.647420	.750356	.009948
33	-.264870	0.000000	.327265	.626348	.763898	.010006
34	-.294660	0.000000	.337145	.602580	.778848	.010369
35	-.328370	0.000000	.346325	.580495	.793035	.010421
36	-.366480	0.000000	.350107	.571397	.800640	.008712
37	-.409530	0.000000	.351592	.567824	.805309	.006368
38	-.458100	0.000000	.374234	.513354	.836286	.010508
39	-.512790	0.000000	.441302	.352007	.930543	.022862
40	-.574300	0.000000	.531221	.135687	1.082361	.020641
41	-.643360	0.000000	.592411	-.011519	1.212135	-.004202
42	-.720760	0.000000	.605511	-.043034	1.243083	-.012472
43	-.807350	0.000000	.594958	-.017646	1.216958	-.004267
44	-.904060	0.000000	.586496	.002711	1.197043	.001125
45	-1.011870	0.000000	.585193	.005846	1.194027	.001903
46	-1.131840	0.000000	.586798	.001985	1.197980	.000635
47	-1.265110	0.000000	.587934	-.000748	1.200761	-.000238
48	-1.412890	0.000000	.588011	-.000934	1.200975	-.000331
49	-1.576470	0.000000	.587709	-.000207	1.200226	-.000086
50	-1.757230	0.000000	.587539	.000202	1.199790	.000070
51	-1.956640	0.000000	.587544	.000190	1.199793	.000079
52	-2.176260	0.000000	.587601	.000053	1.199938	.000028
53	-2.417740	0.000000	.587634	-.000027	1.200028	-.000010
54	-2.682850	0.000000	.587627	-.000010	1.200009	-.000002
55	-2.973450	0.000000	.587627	-.000010	1.200009	-.000002

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-5
	NACA 0012: MACH = 1.2, ALPHA = 0			

UPPER SURFACE

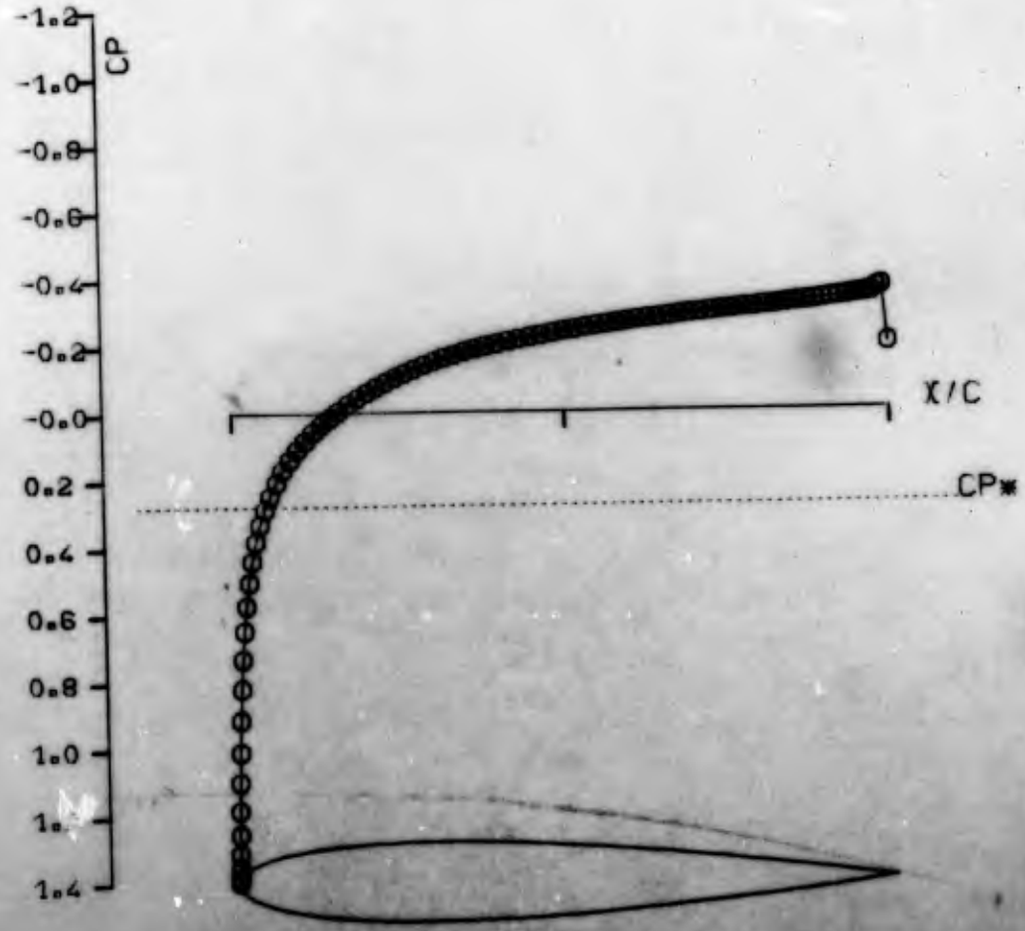
LOWER SURFACE

CL= 0.0000

CD= 0.0946

CM= -0.0000

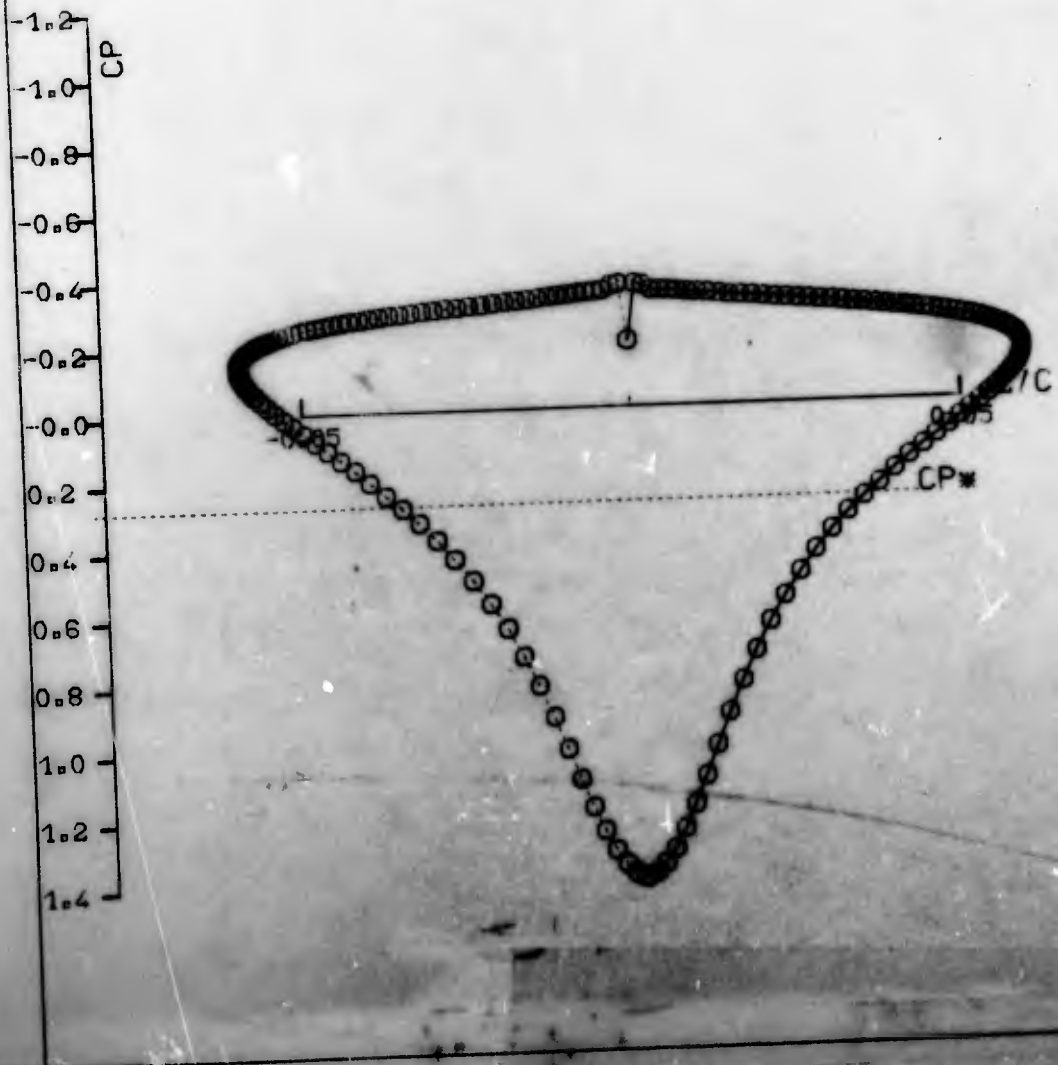
Γ = 0.0000



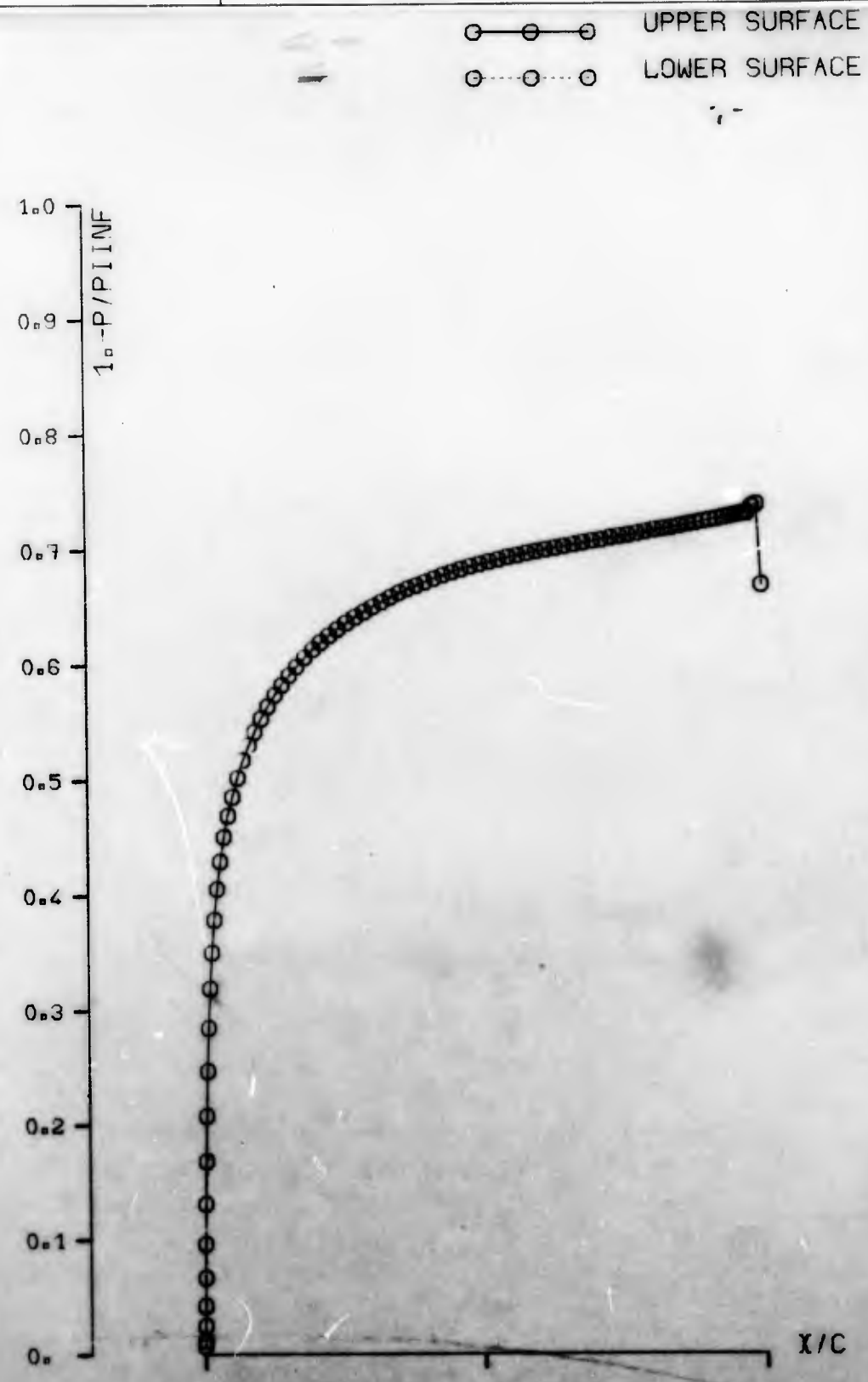
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-6
	NACA 0012: MACH = 1.2. ALPHA = 0			

UPPER SURFACE

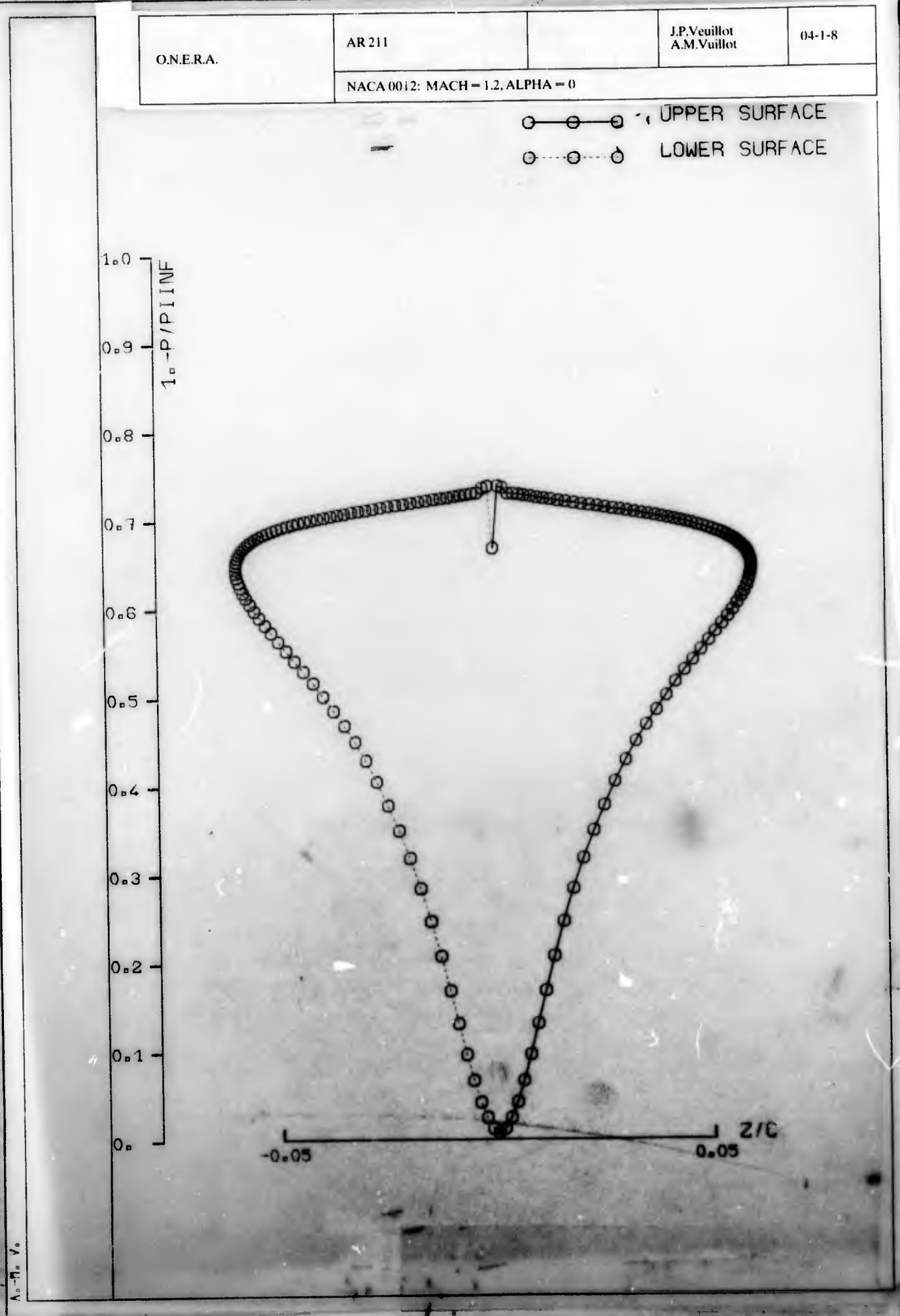
LOWER SURFACE.



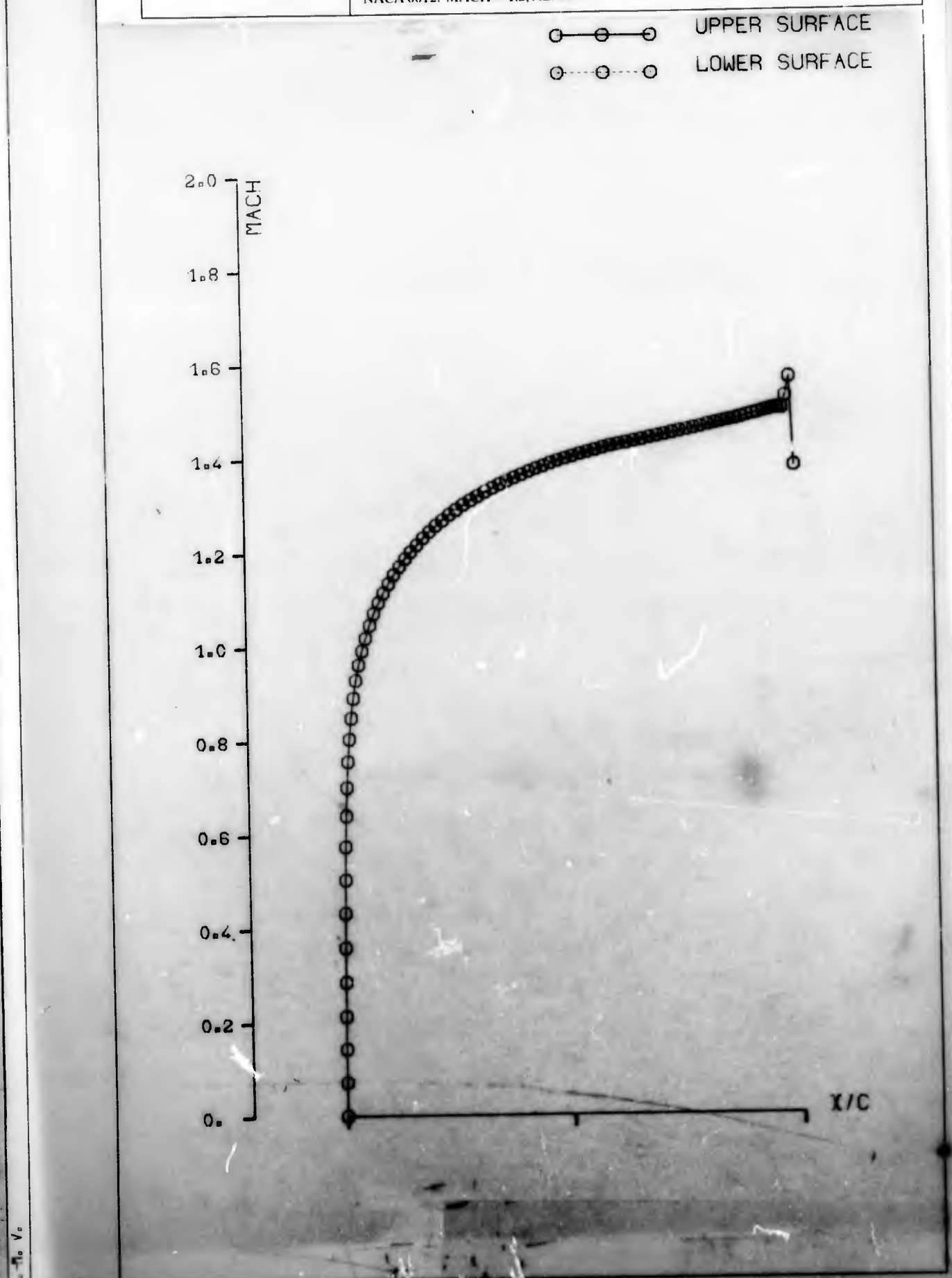
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vujllot	04-1-7
	NACA 0012: MACH = 1.2, ALPHA = 0			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-8
	NACA 0012: MACH = 1.2, ALPHA = 0			

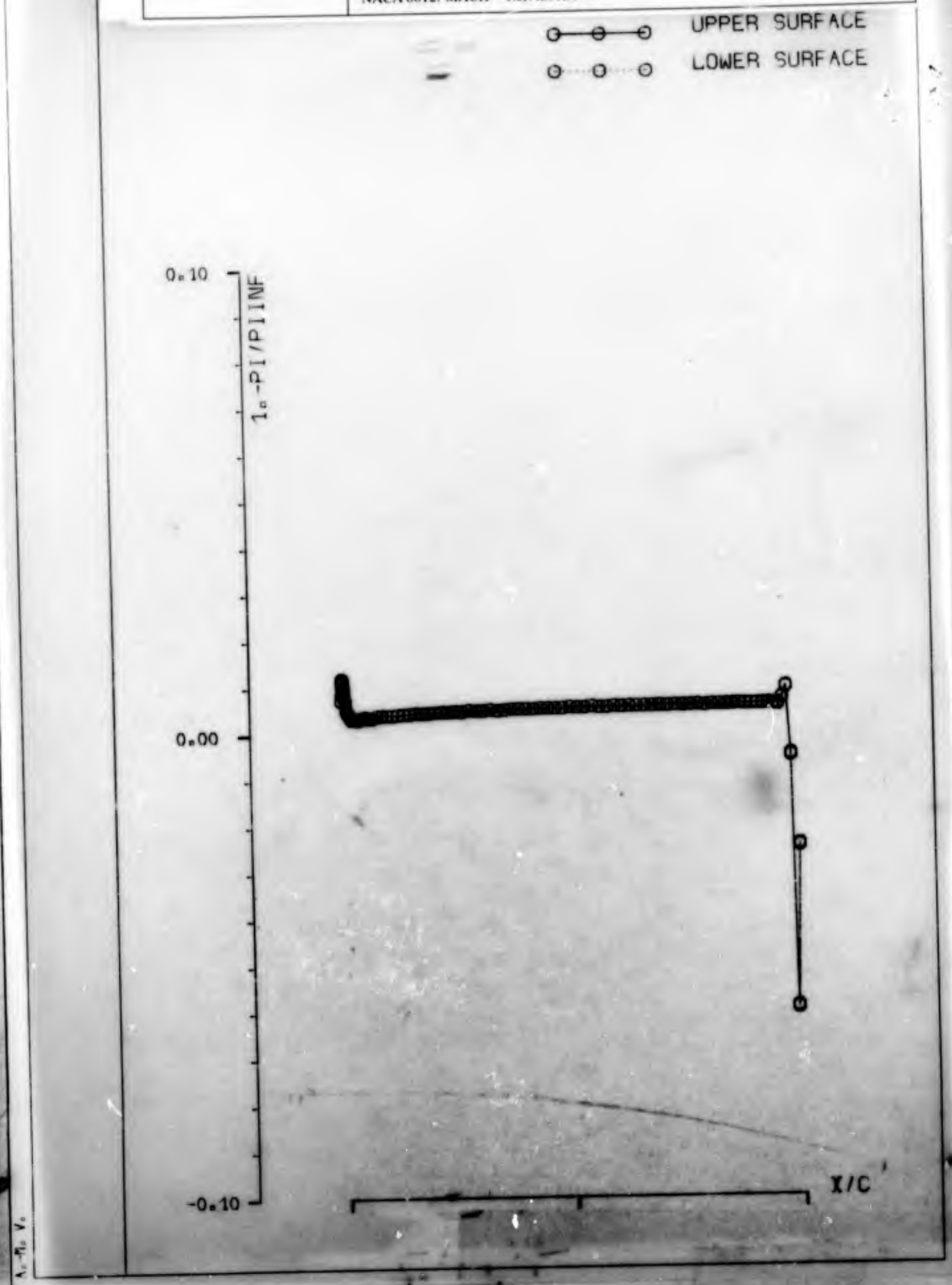


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-9
	NACA 0012: MACH = 1.2, ALPHA = 0			

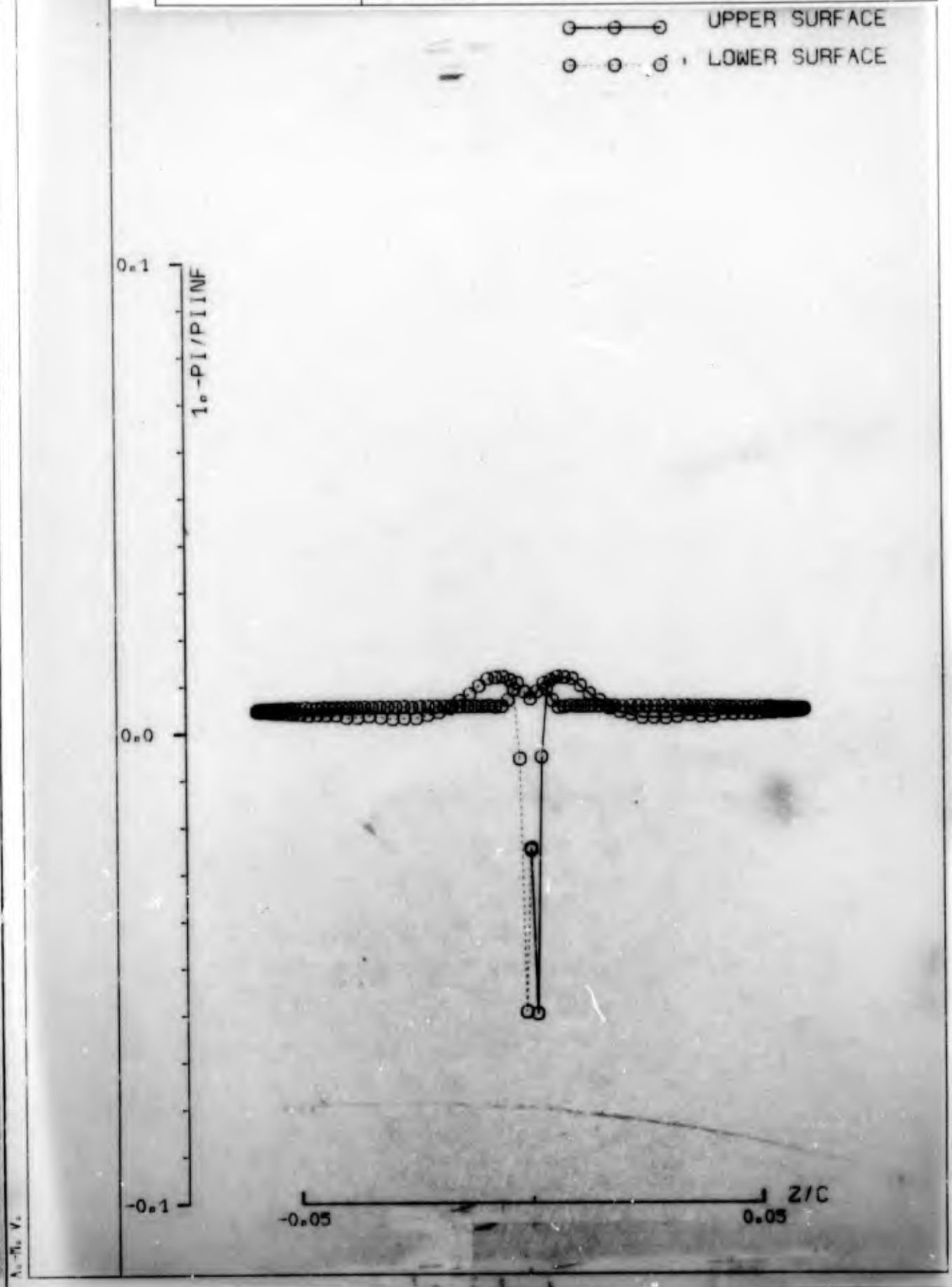


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-10
	NACA 0012: MACH = 1.2, ALPHA = 0			

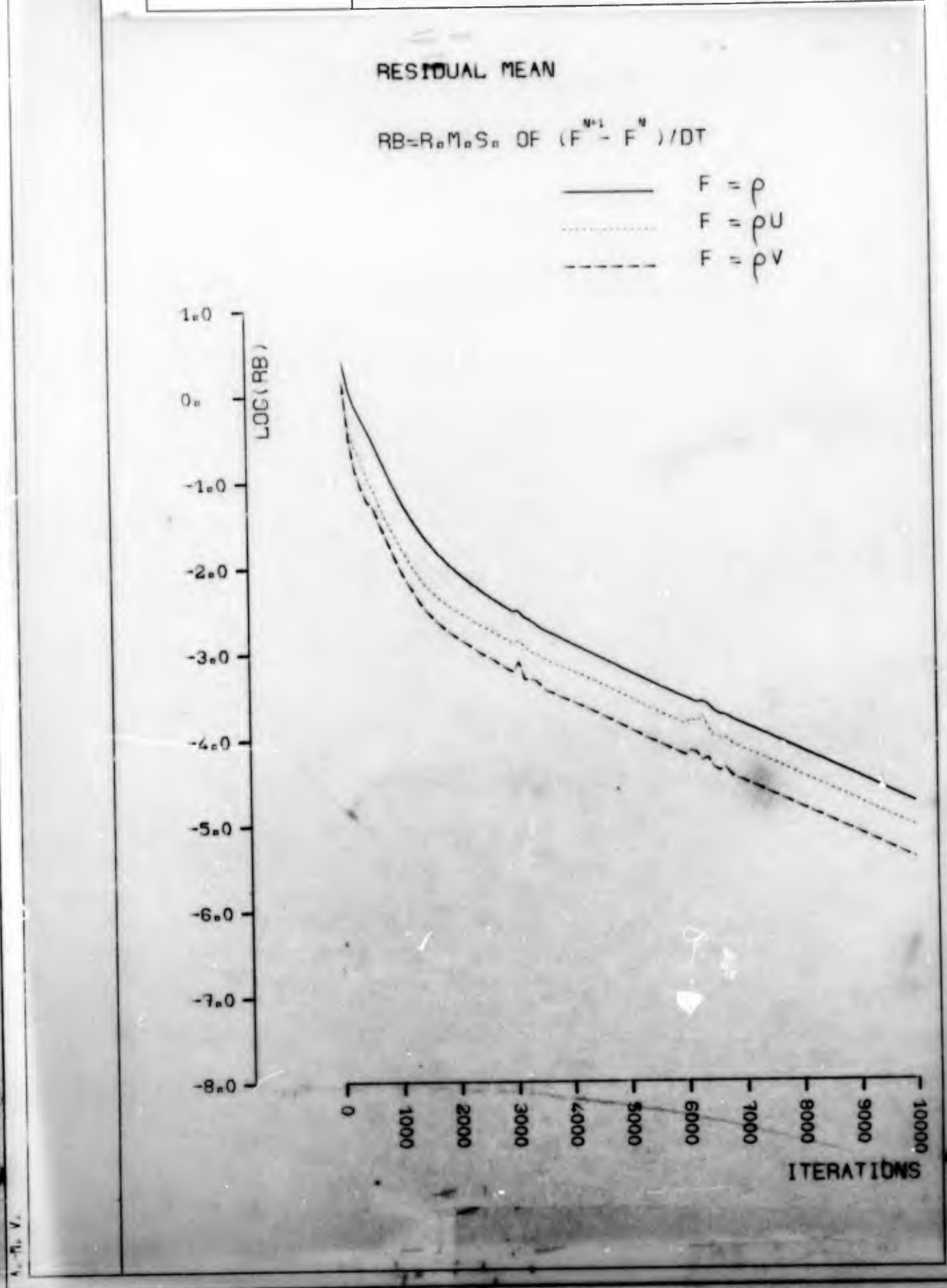
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-11
	NACA 0012: MACH = 1.2, ALPHA = 0			



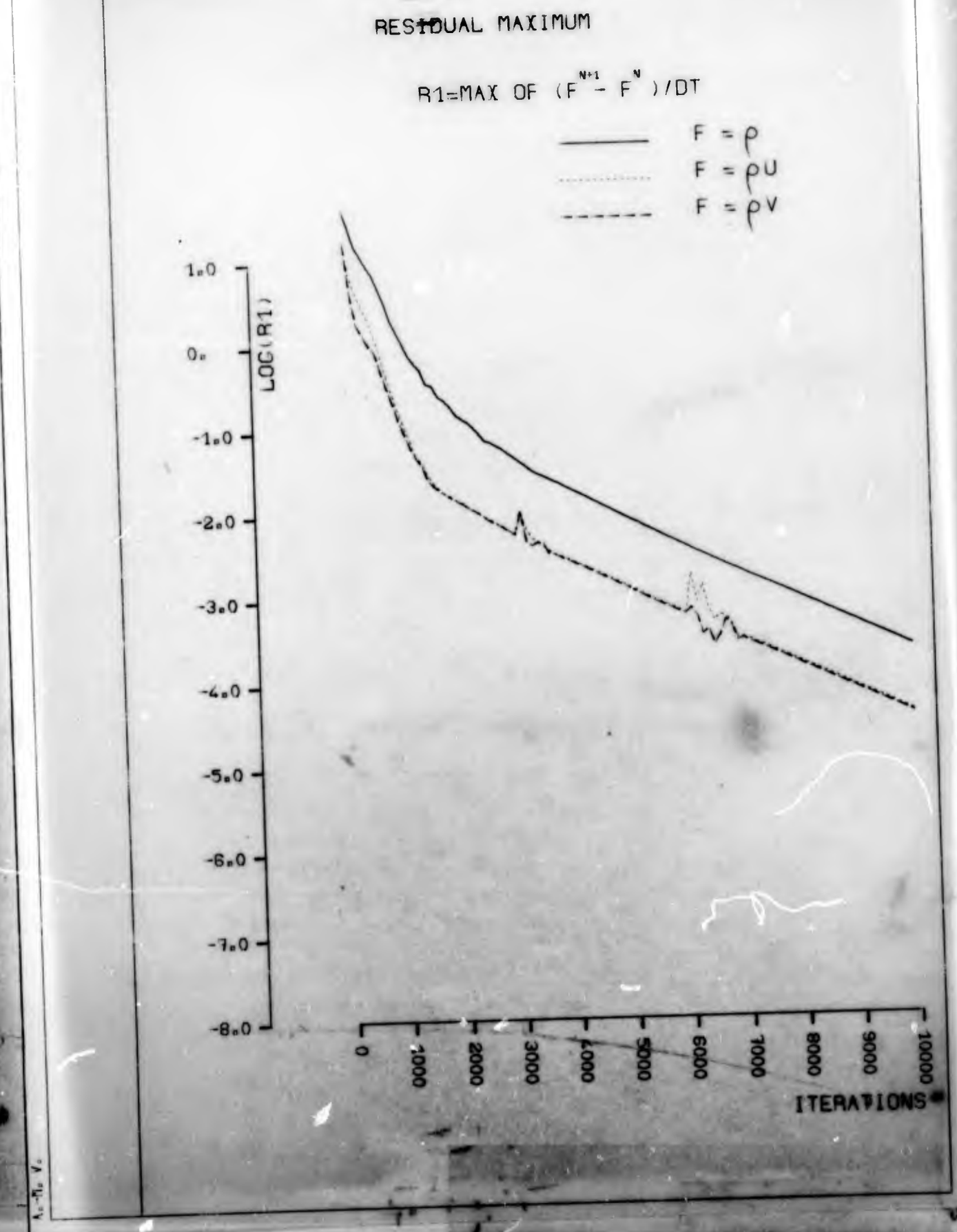
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-12
	NACA 0012: MACH = 1.2, ALPHA = 0			



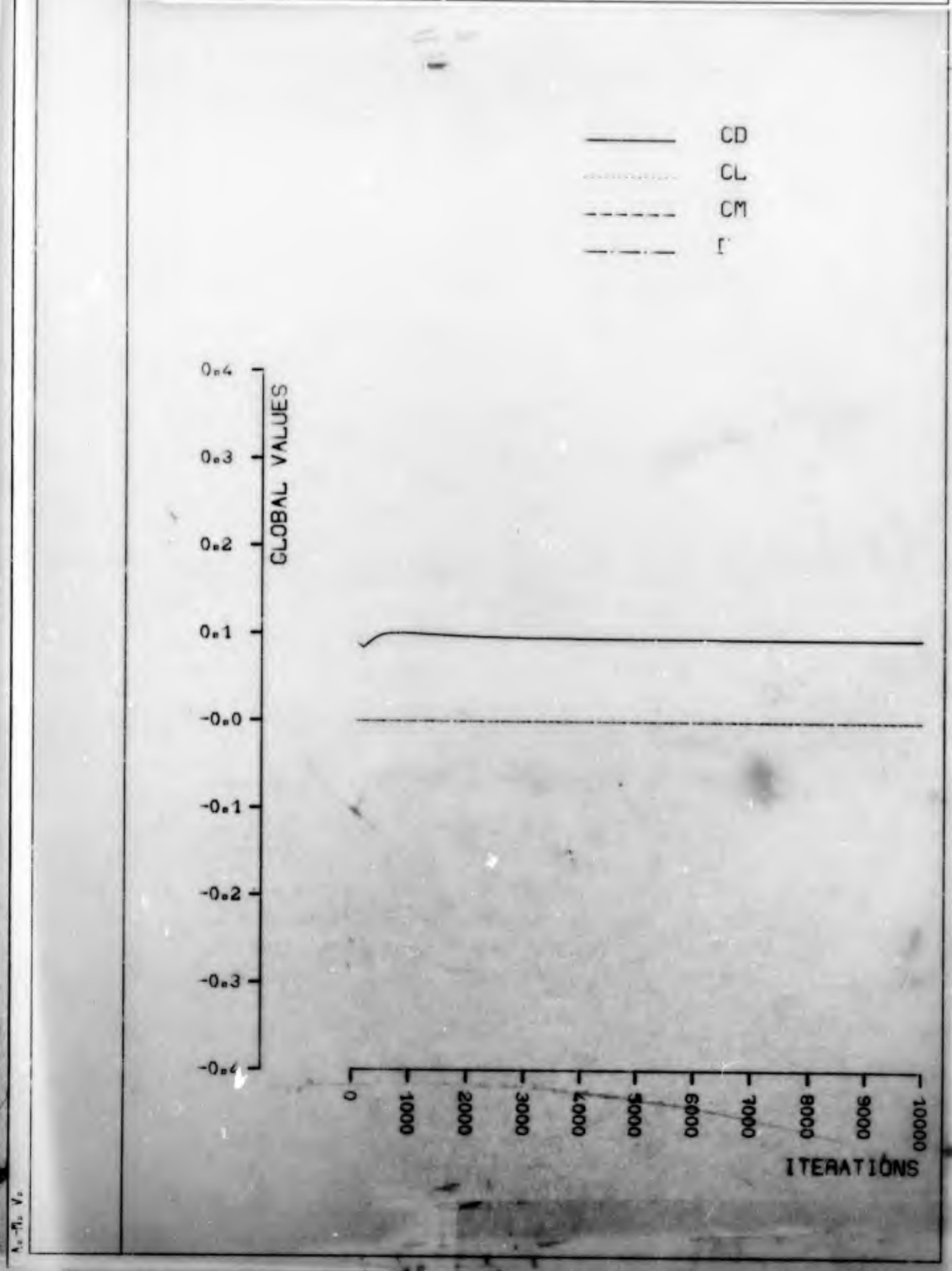
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-13
	NACA 0012: MACH = 1.2, ALPHA = 0			



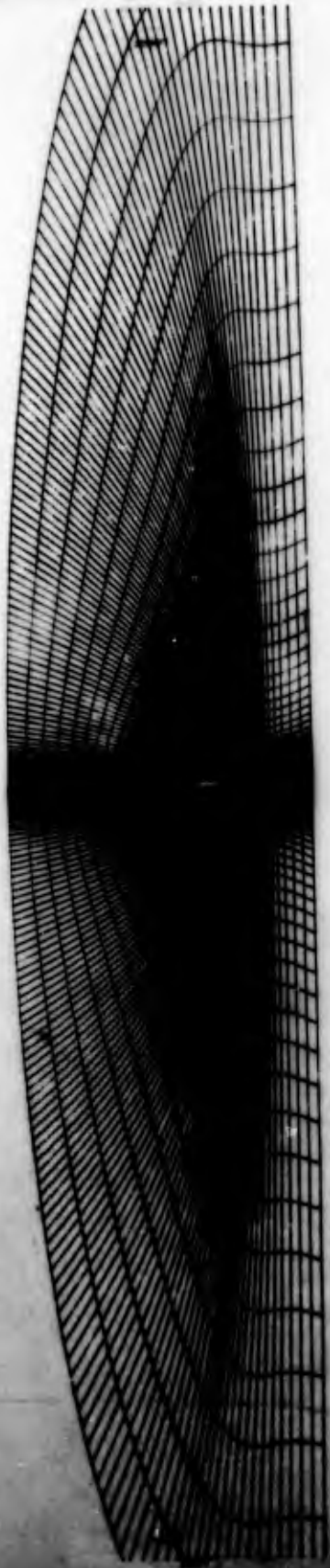
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-14
	NACA 0012: MACH = 1.2, ALPHA = 0			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-15
	NACA 0012: MACH = 1.2, ALPHA = 0			

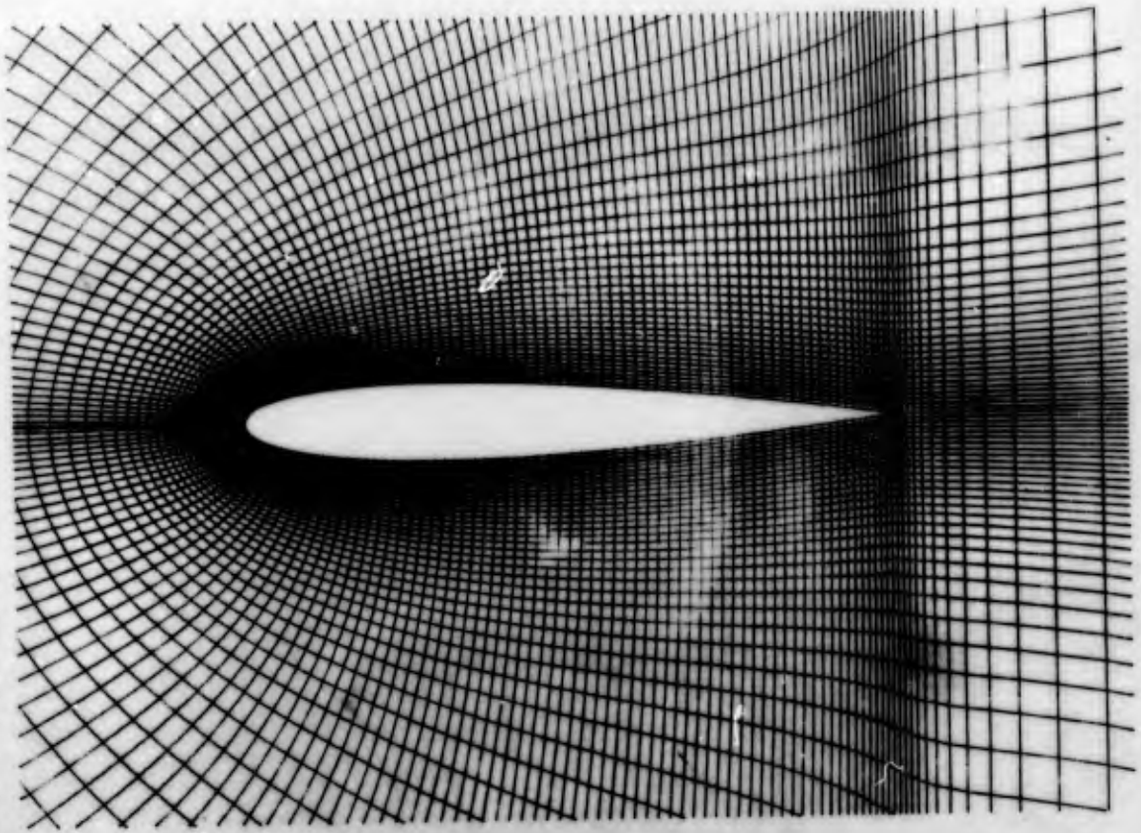


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-16
	NACA 0012: MACH = 1.2, ALPHA = 0			



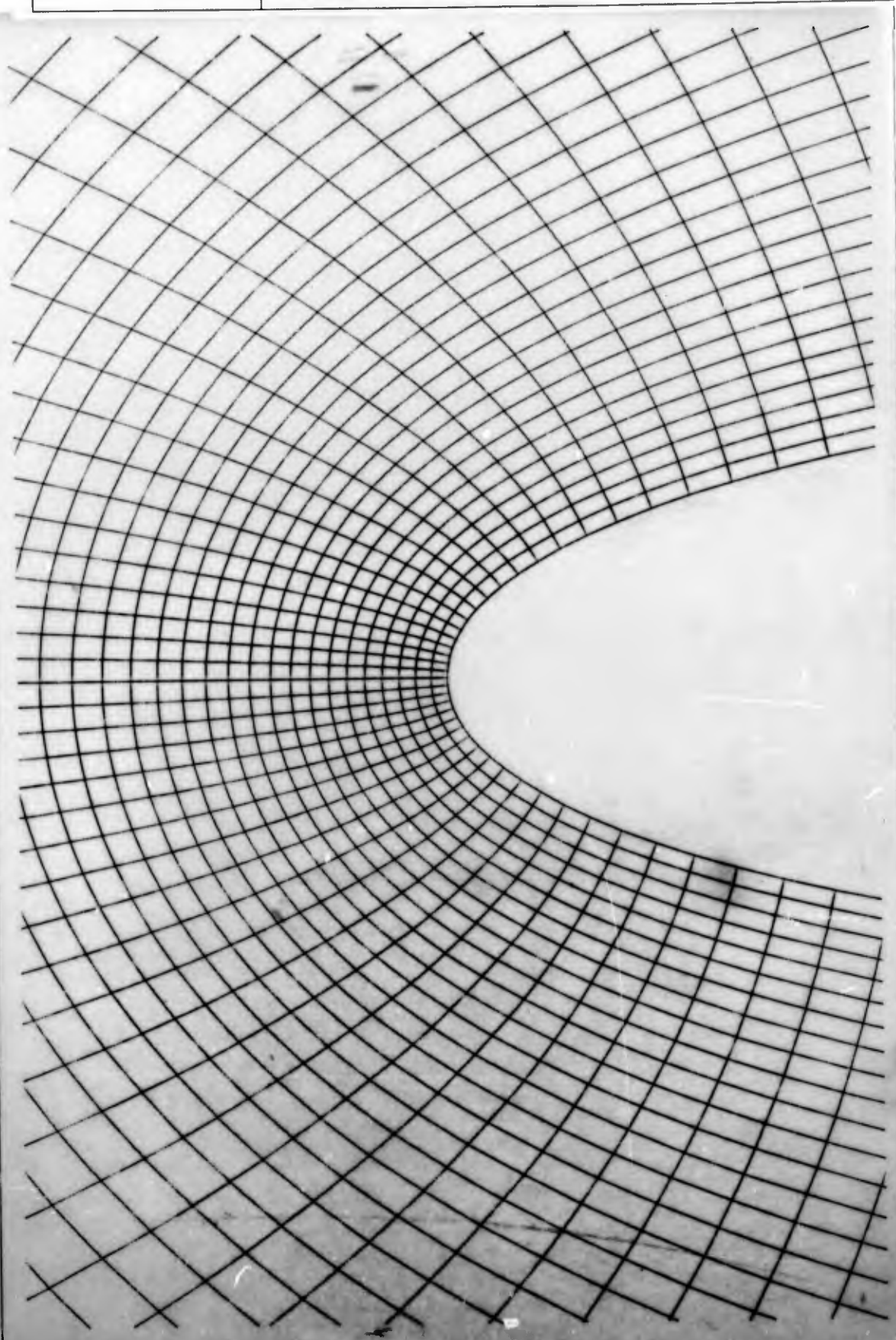
201X55 MESH (1 CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-17
	NACA 0012: MACH = 1.2, ALPHA = 0			



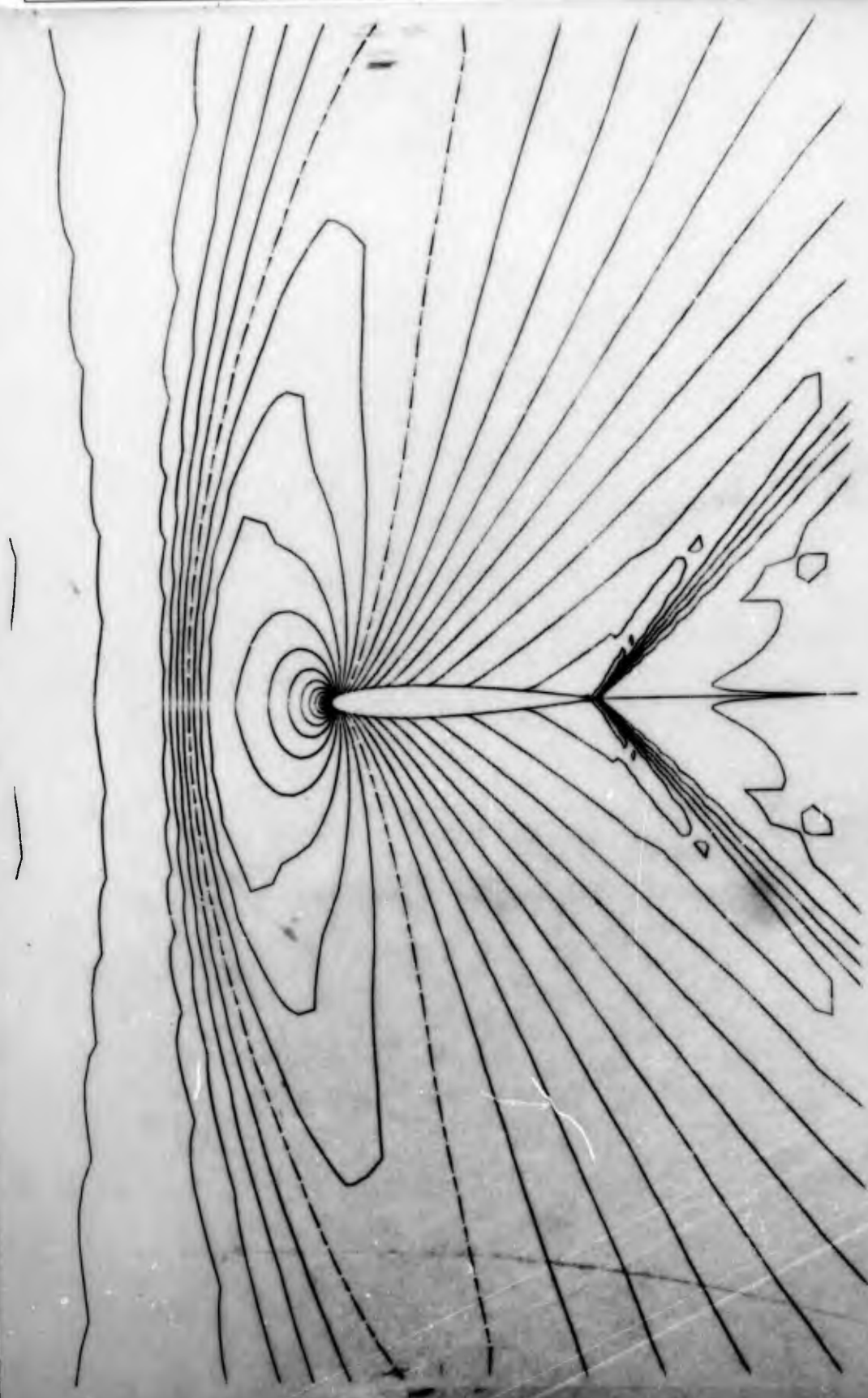
201X55 MESH PARTIAL VIEW (10CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-18
	NACA 0012: MACH = 1.2, ALPHA = 0			



201X55 MESH PARTIAL VIEW (100CM CHORD)

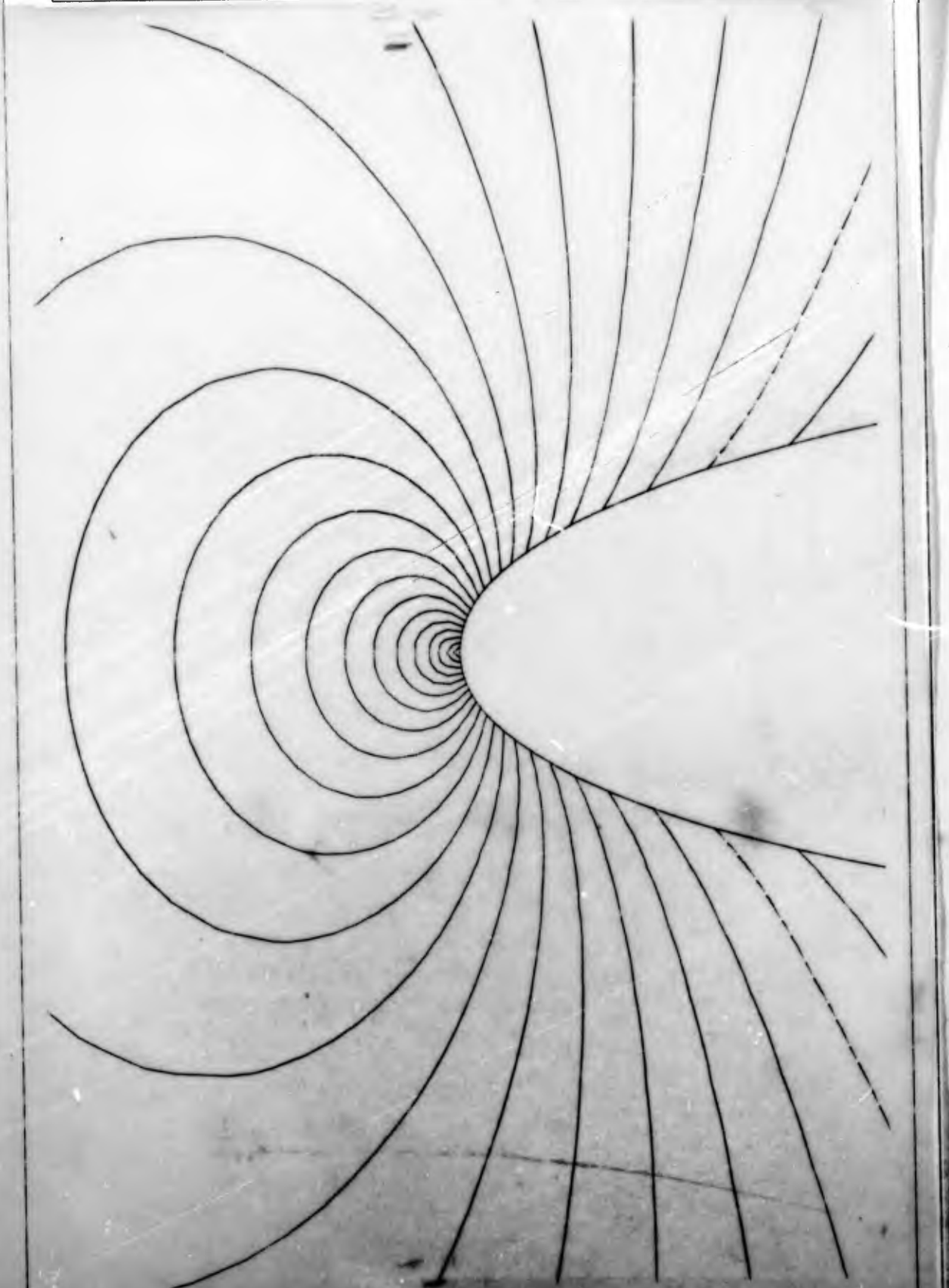
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-19
	NACA 0012: MACH = 1.2, ALPHA = 0			



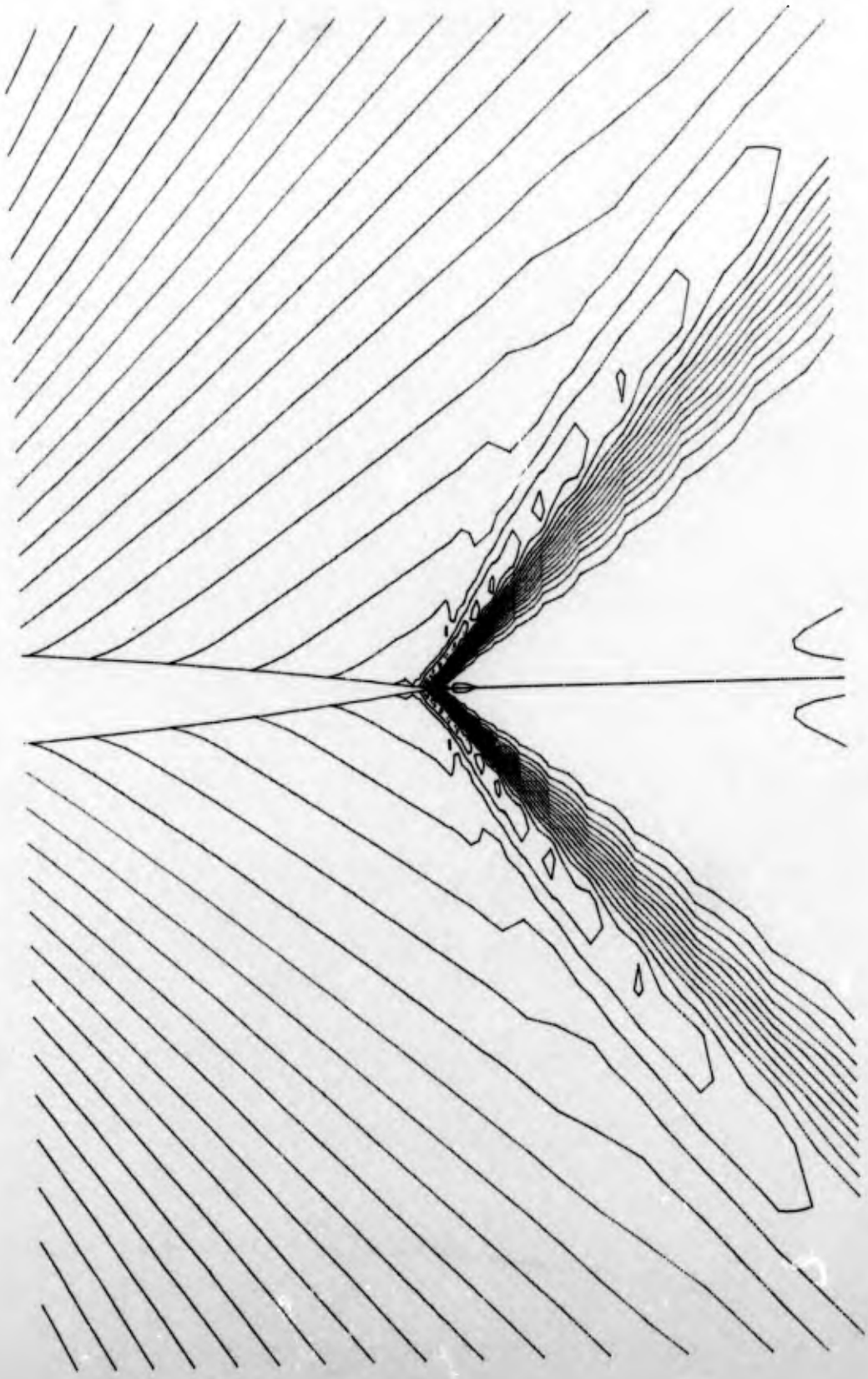
ISO-MACH LINES

$A_\infty \cdot M_\infty \cdot V_\infty$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-20
	NACA 0012: MACH = 1.2, ALPHA = 0			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-21
	NACA 0012: MACH = 1.2, ALPHA = 0			

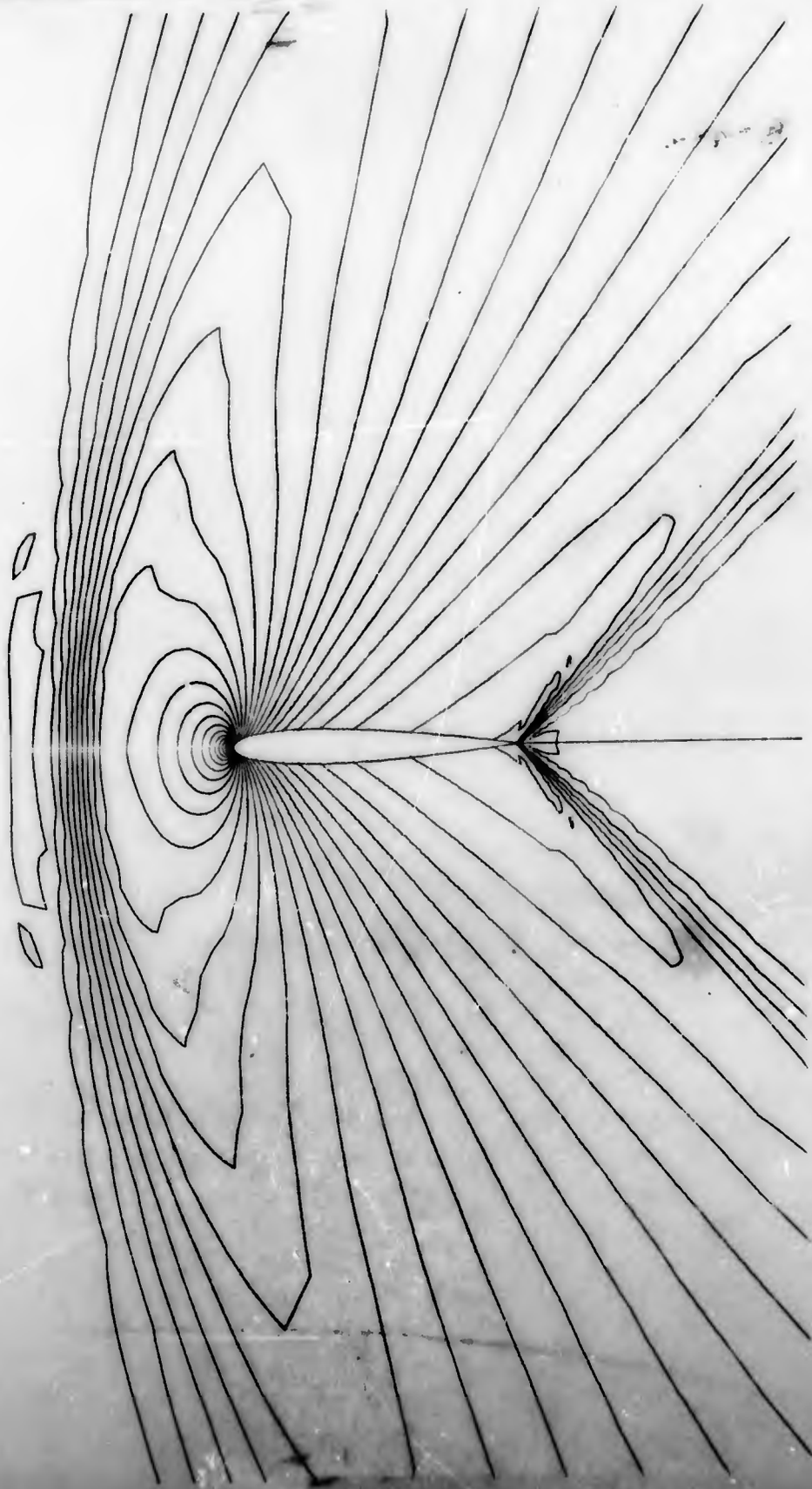


ISO-MACH LINES (DM=.02 15CM CHORD)

A.-M. V.

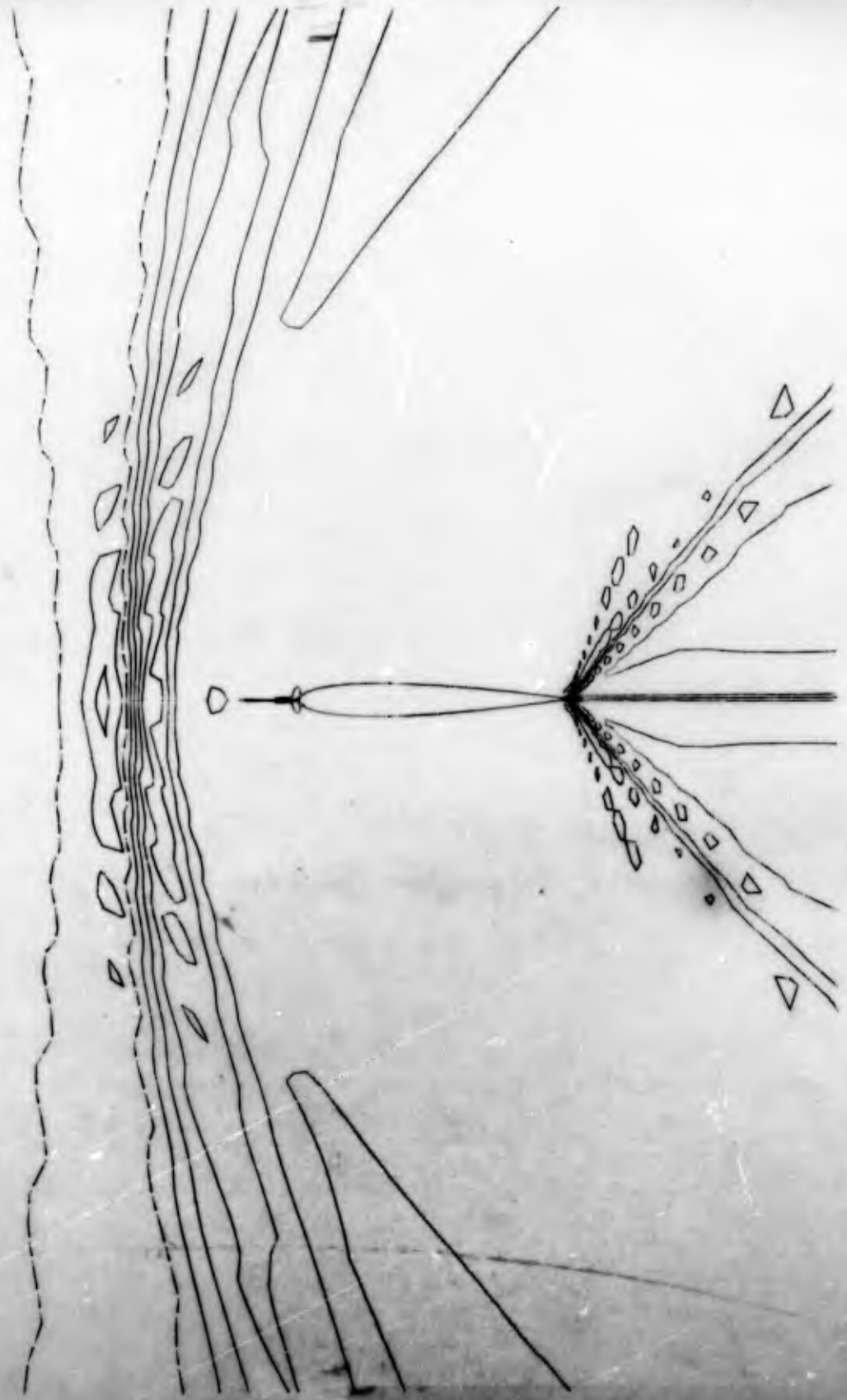
| | | |

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-22
	NACA 0012: MACH = 1.2, ALPHA = 0			



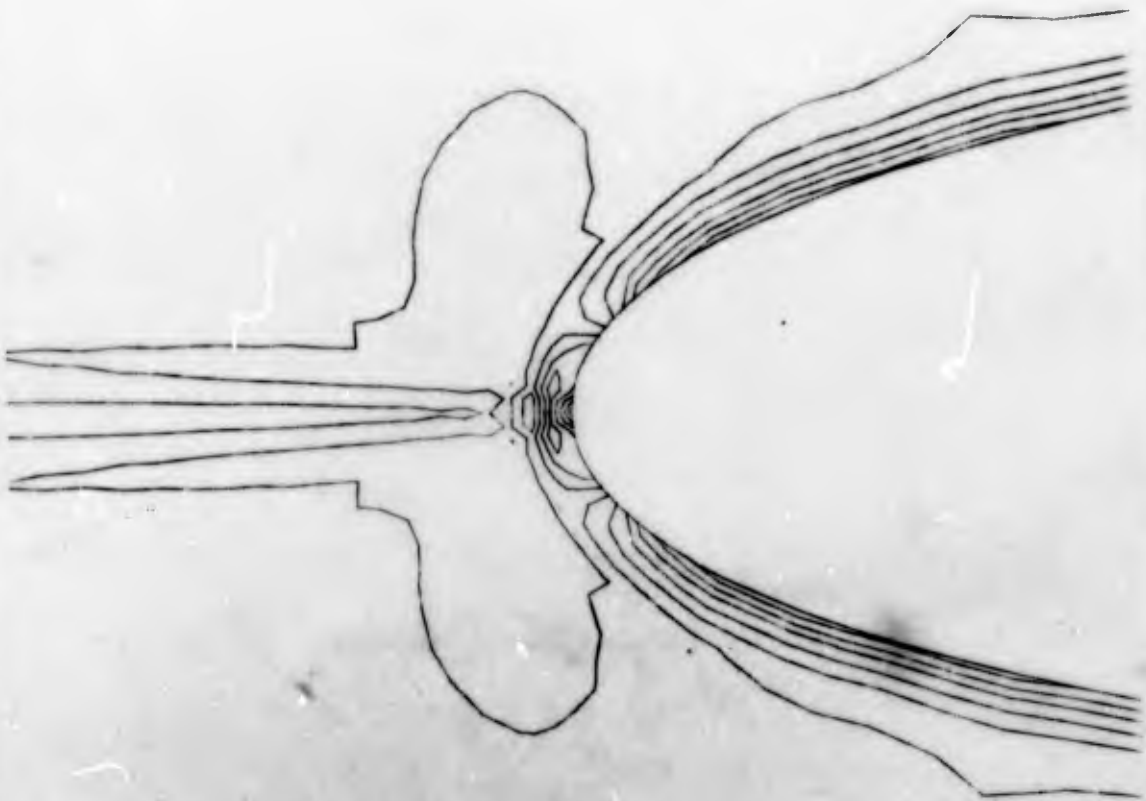
ISO-P/PIINF LINES

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-23
	NACA 0012: MACH = 1.2, ALPHA = 0			



ISO-PI/PIINF LINES (DPI/PIINF=.005)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	04-1-24
	NACA 0012: MACH = 1.2, ALPHA = 0			



ISO-PI/PIINF LINES (DPI/PIINF=.001)

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 04

NACA 0012: MACH = 1.2, ALPHA = 0

Contributor No 3

C.C.Lytton

(R.A.E., G.B.)

R.A.E.	AR 211		C.C.Lytton	04-3-1
	NACA 0012: MACH = 1.2, ALPHA = 0			

NACA0012	MACH	ALPHA	BY FORMULA	0<X<1:
	1.200	0.000		

VERSION 87: KEEPS WALL CELLS ROUGHLY SAME ASPECT RATIO

AFTER K=1, CELL DEPTHS INCREASE IN GEOMETRIC PROGRESSION

TOTAL CELL DEPTH =16.0*CHORD

FULL MESH: TWO TRIANGULAR CELLS AT T.E.

ANGLE RATIO CHANGED SMOOTHLY FROM L.E. TO T.E.

MESH KINKS SWEPT OUT AND FIDDLED TOGETHER AS NEEDED

SMALL MESH ASPECT RATIO FR= 0.5306

JL	KL	NEND	NPRNT
160	24	0	0

CP*	P(CR)	CPS	P(ST)
0.2697	0.6309	1.3963	1.1942

J	X/C	Z/C	1-P/H	CP	M	1-PI/H
81	0.000	0.0018	-0.0002	1.4142	0.1131	-0.0092
82	0.001	0.0052	0.0434	1.3092	0.2659	-0.0048
83	0.003	0.0086	0.1162	1.1340	0.4223	0.0009
84	0.005	0.0120	0.1850	0.9687	0.5459	0.0019
85	0.008	0.0153	0.2462	0.8214	0.6457	0.0023
86	0.012	0.0184	0.2990	0.6944	0.7291	0.0016
87	0.017	0.0216	0.3425	0.5898	0.7970	0.0007
88	0.022	0.0246	0.3786	0.5030	0.8524	0.0008
89	0.028	0.0275	0.4078	0.4326	0.8983	0.0002
90	0.035	0.0304	0.4342	0.3692	0.9401	-0.0002
91	0.043	0.0331	0.4561	0.3164	0.9763	-0.0016
92	0.052	0.0358	0.4751	0.2706	1.0052	0.0003
93	0.061	0.0383	0.4952	0.2223	1.0395	-0.0011
94	0.070	0.0407	0.5086	0.1901	1.0604	0.0005
95	0.081	0.0430	0.5237	0.1539	1.0859	0.0005
96	0.092	0.0452	0.5381	0.1192	1.1110	0.0001
97	0.104	0.0472	0.5486	0.0938	1.1288	0.0008
98	0.116	0.0491	0.5610	0.0641	1.1503	0.0014
99	0.129	0.0508	0.5715	0.0388	1.1692	0.0015
100	0.143	0.0524	0.5802	0.0180	1.1846	0.0020
101	0.157	0.0538	0.5895	-0.0046	1.2014	0.0028
102	0.172	0.0551	0.5978	-0.0244	1.2169	0.0028
103	0.187	0.0562	0.6057	-0.0436	1.2314	0.0036
104	0.203	0.0571	0.6135	-0.0621	1.2462	0.0038
105	0.219	0.0579	0.6204	-0.0789	1.2596	0.0040

106	0.236	0.0585	0.6271	-0.0950	1.2726	0.0044
107	0.253	0.0590	0.6334	-0.1101	1.2851	0.0046
108	0.270	0.0593	0.6392	-0.1241	1.2968	0.0047
109	0.288	0.0594	0.6447	-0.1373	1.3079	0.0049
110	0.306	0.0594	0.6499	-0.1498	1.3184	0.0052
111	0.325	0.0593	0.6548	-0.1615	1.3286	0.0053
112	0.344	0.0590	0.6594	-0.1726	1.3382	0.0055
113	0.363	0.0586	0.6636	-0.1829	1.3472	0.0056
114	0.382	0.0580	0.6676	-0.1925	1.3557	0.0058
115	0.401	0.0573	0.6714	-0.2015	1.3637	0.0060
116	0.421	0.0565	0.6749	-0.2100	1.3713	0.0063
117	0.441	0.0556	0.6783	-0.2181	1.3786	0.0065
118	0.460	0.0545	0.6815	-0.2258	1.3856	0.0066
119	0.480	0.0534	0.6845	-0.2330	1.3923	0.0067
120	0.500	0.0522	0.6872	-0.2397	1.3985	0.0068
121	0.520	0.0509	0.6898	-0.2458	1.4043	0.0068
122	0.540	0.0495	0.6922	-0.2515	1.4097	0.0069
123	0.559	0.0480	0.6944	-0.2569	1.4148	0.0069
124	0.579	0.0465	0.6965	-0.2620	1.4198	0.0070
125	0.599	0.0449	0.6986	-0.2669	1.4245	0.0070
126	0.618	0.0433	0.7005	-0.2716	1.4291	0.0070
127	0.637	0.0416	0.7024	-0.2761	1.4334	0.0071
128	0.656	0.0399	0.7041	-0.2802	1.4374	0.0071
129	0.675	0.0381	0.7057	-0.2840	1.4411	0.0072
130	0.694	0.0363	0.7072	-0.2876	1.4446	0.0073
131	0.712	0.0345	0.7086	-0.2911	1.4480	0.0075
132	0.730	0.0327	0.7100	-0.2944	1.4512	0.0076
133	0.747	0.0309	0.7113	-0.2976	1.4543	0.0077
134	0.764	0.0291	0.7126	-0.3007	1.4575	0.0078
135	0.781	0.0273	0.7139	-0.3039	1.4605	0.0079
136	0.797	0.0255	0.7152	-0.3070	1.4636	0.0080
137	0.813	0.0238	0.7165	-0.3101	1.4667	0.0081
138	0.828	0.0220	0.7178	-0.3132	1.4698	0.0082
139	0.843	0.0203	0.7191	-0.3162	1.4728	0.0083
140	0.857	0.0186	0.7203	-0.3192	1.4758	0.0084
141	0.871	0.0170	0.7215	-0.3221	1.4788	0.0085
142	0.884	0.0154	0.7227	-0.3250	1.4817	0.0086
143	0.896	0.0138	0.7239	-0.3279	1.4846	0.0087
144	0.908	0.0124	0.7250	-0.3306	1.4874	0.0088
145	0.919	0.0109	0.7262	-0.3333	1.4902	0.0089
146	0.930	0.0096	0.7272	-0.3359	1.4929	0.0089
147	0.939	0.0083	0.7283	-0.3384	1.4955	0.0090
148	0.948	0.0071	0.7293	-0.3407	1.4980	0.0090
149	0.957	0.0060	0.7302	-0.3430	1.5004	0.0089
150	0.965	0.0049	0.7310	-0.3450	1.5027	0.0089
151	0.972	0.0040	0.7318	-0.3469	1.5047	0.0088
152	0.978	0.0031	0.7325	-0.3486	1.5066	0.0087
153	0.983	0.0024	0.7331	-0.3501	1.5082	0.0087
154	0.988	0.0017	0.7337	-0.3514	1.5097	0.0086
155	0.992	0.0011	0.7342	-0.3525	1.5111	0.0083
156	0.995	0.0007	0.7346	-0.3536	1.5123	0.0082
157	0.997	0.0004	0.7349	-0.3544	1.5132	0.0080
158	0.999	0.0001	0.7353	-0.3553	1.5149	0.0072
159	1.000	0.0000	0.7215	-0.3221	1.4939	-0.0134

R.A.E.	AR 211		C.C.Lytton	04-3-3
	NACA 0012: MACH = 1.2, ALPHA = 0			

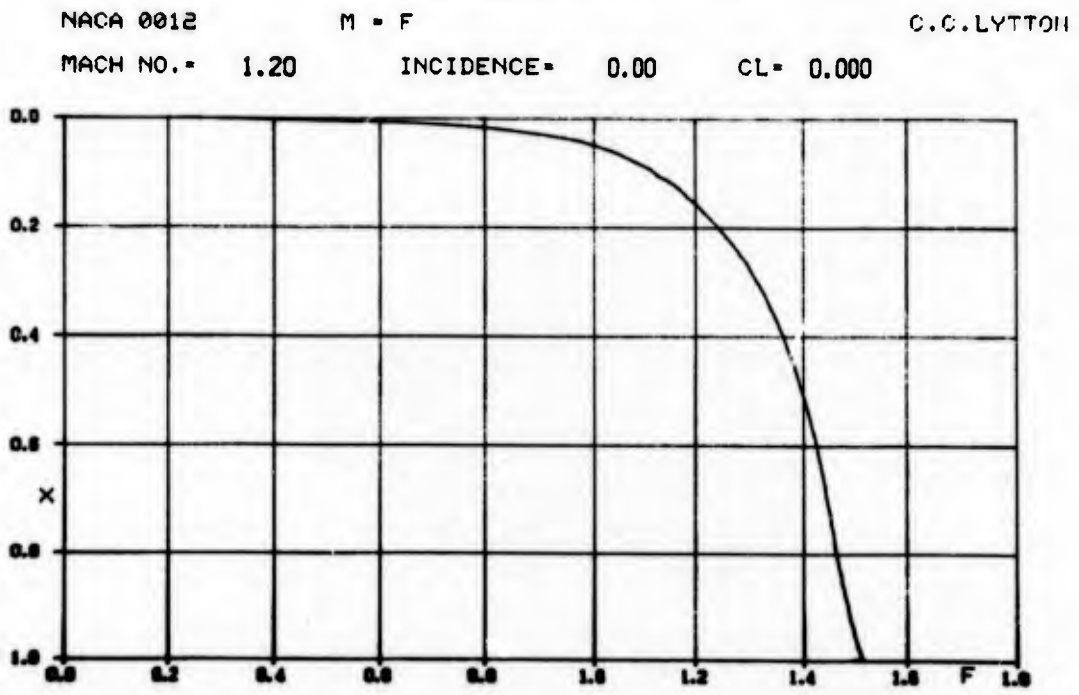
CL= 0.00000 CD= 0.09511 CM= -0.00000

GAMMA AROUND PROFILE = -0.00000

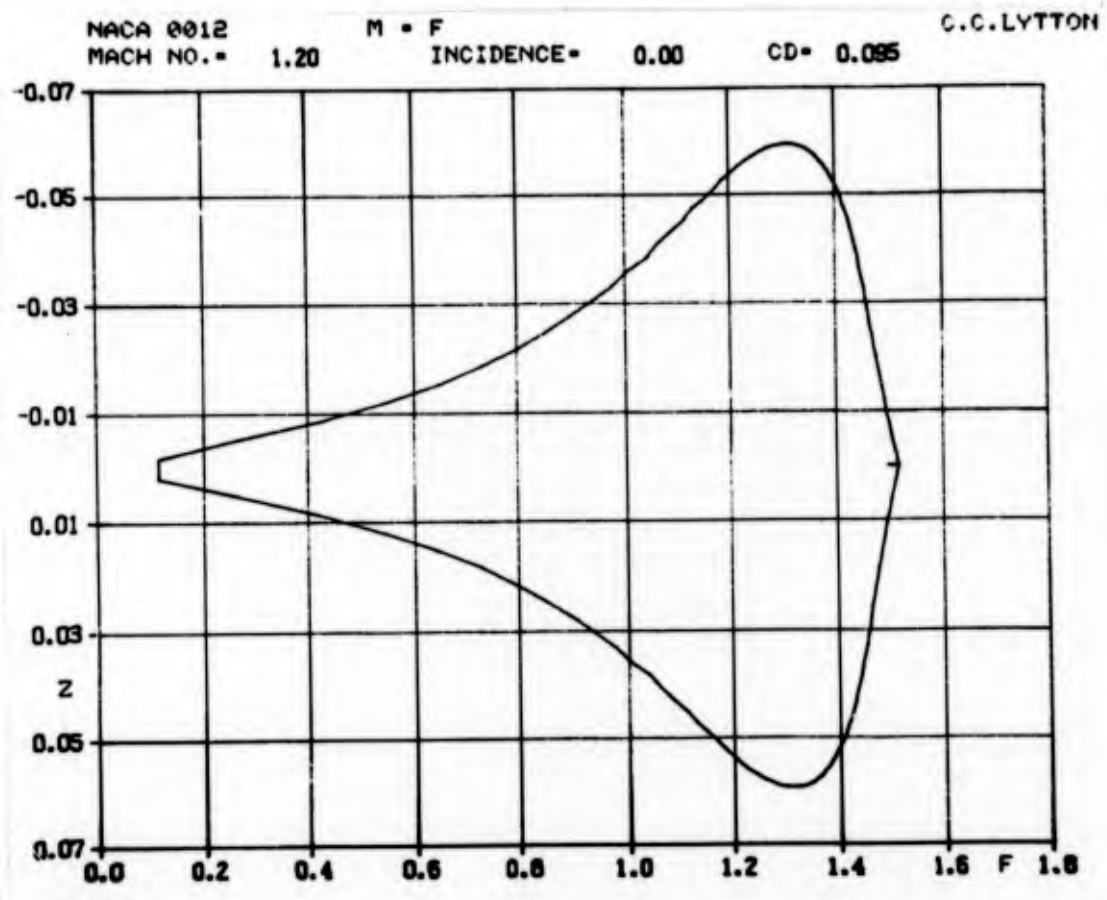
K	X/C	Z/C	1-P/H	CP	M	1-PI/H
1	1.000	-0.0002	0.5996	-0.0288	1.2147	0.0102
2	1.001	-0.0004	0.6172	-0.0713	1.2612	-0.0064
3	1.002	-0.0005	0.6161	-0.0684	1.2627	-0.0115
4	1.006	-0.0007	0.6072	-0.0472	1.2396	-0.0034
5	1.014	-0.0010	0.6060	-0.0443	1.2323	0.0033
6	1.030	-0.0014	0.6035	-0.0381	1.2235	0.0083
7	1.058	-0.0020	0.6032	-0.0375	1.2210	0.0110
8	1.103	-0.0029	0.6023	-0.0354	1.2159	0.0153
9	1.171	-0.0043	0.6013	-0.0330	1.2134	0.0162
10	1.274	-0.0063	0.5989	-0.0271	1.2098	0.0148
11	1.415	-0.0091	0.5975	-0.0239	1.2066	0.0155
12	1.595	-0.0126	0.5954	-0.0186	1.2015	0.0168
13	1.823	-0.0171	0.5931	-0.0132	1.1968	0.0174
14	2.111	-0.0227	0.5918	-0.0101	1.1949	0.0168
15	2.474	-0.0298	0.5910	-0.0082	1.1939	0.0161
16	2.932	-0.0388	0.5906	-0.0071	1.1932	0.0159
17	3.508	-0.0501	0.5898	-0.0053	1.1920	0.0156
18	4.234	-0.0644	0.5892	-0.0039	1.1913	0.0152
19	5.148	-0.0824	0.5884	-0.0019	1.1904	0.0143
20	6.299	-0.1050	0.5876	-0.0000	1.1897	0.0133
21	7.749	-0.1334	0.5868	0.0021	1.1895	0.0115
22	9.578	-0.1694	0.5880	-0.0008	1.1922	0.0110
23	11.907	-0.2151	0.5920	-0.0106	1.2001	0.0105
24	15.163	-0.2789	0.5962	-0.0206	1.2084	0.0100

K	X/C	Z/C	1-P/H	CP	M	1-PI/H
1	-0.002	0.0020	-0.0015	1.4174	0.1084	-0.0098
2	-0.005	0.0024	0.0049	1.4019	0.1887	-0.0202
3	-0.011	0.0029	0.0451	1.3053	0.2767	-0.0071
4	-0.020	0.0037	0.0891	1.1993	0.3725	-0.0025
5	-0.034	0.0048	0.1373	1.0834	0.4635	0.0004
6	-0.056	0.0064	0.1850	0.9685	0.5456	0.0022
7	-0.088	0.0085	0.2294	0.8619	0.6174	0.0034
8	-0.135	0.0113	0.2685	0.7676	0.6790	0.0040
9	-0.201	0.0150	0.3050	0.6800	0.7346	0.0051
10	-0.291	0.0196	0.3330	0.6126	0.7790	0.0040
11	-0.411	0.0253	0.4509	0.3288	0.9501	0.0184
12	-0.569	0.0324	0.5866	0.0024	1.1984	-0.0003
13	-0.775	0.0410	0.5876	0.0000	1.2000	0.0000
14	-1.039	0.0515	0.5876	-0.0000	1.2000	-0.0000
15	-1.377	0.0643	0.5876	-0.0000	1.2000	0.0000
16	-1.807	0.0798	0.5876	-0.0000	1.2000	0.0000
17	-2.353	0.0988	0.5876	-0.0000	1.2000	0.0000
18	-3.045	0.1219	0.5876	0.0000	1.2000	-0.0000
19	-3.920	0.1501	0.5876	0.0000	1.2000	-0.0000
20	-5.028	0.1848	0.5876	0.0000	1.2000	0.0000
21	-6.431	0.2276	0.5876	0.0000	1.2000	-0.0000
22	-8.214	0.2805	0.5876	-0.0000	1.2000	0.0000
23	-10.530	0.3476	0.5876	0.0000	1.2000	0.0000
24	-13.982	0.4440	0.5876	0.0000	1.2000	-0.0000

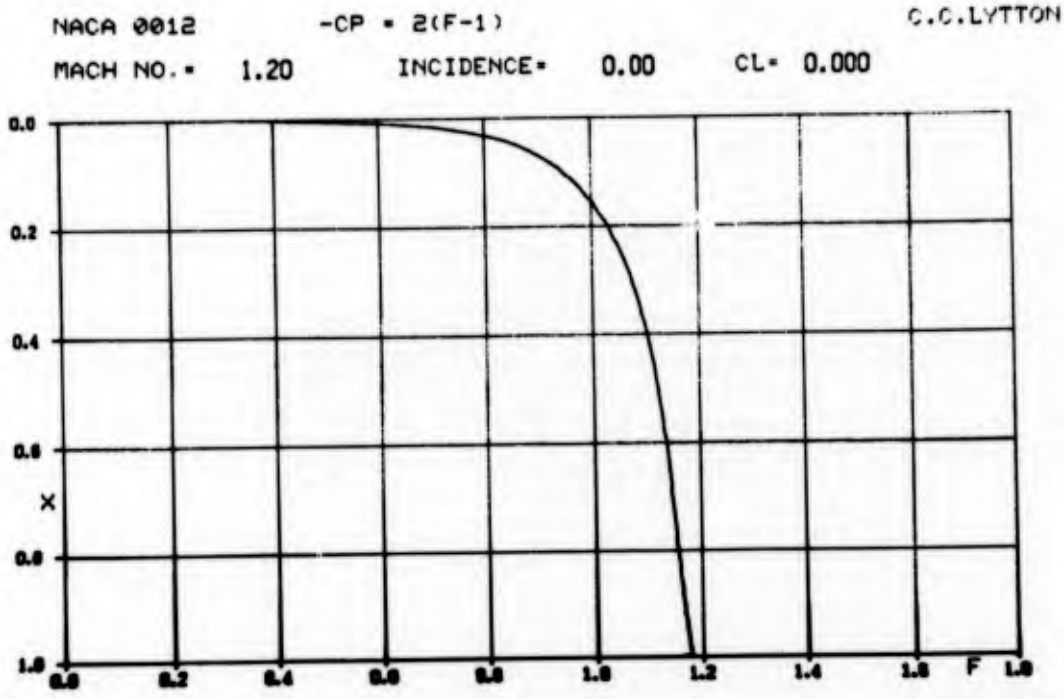
R.A.E.	AR 211		C.C.Lytton	04-3-4
	NACA 0012: MACH = 1.2, ALPHA = 0			



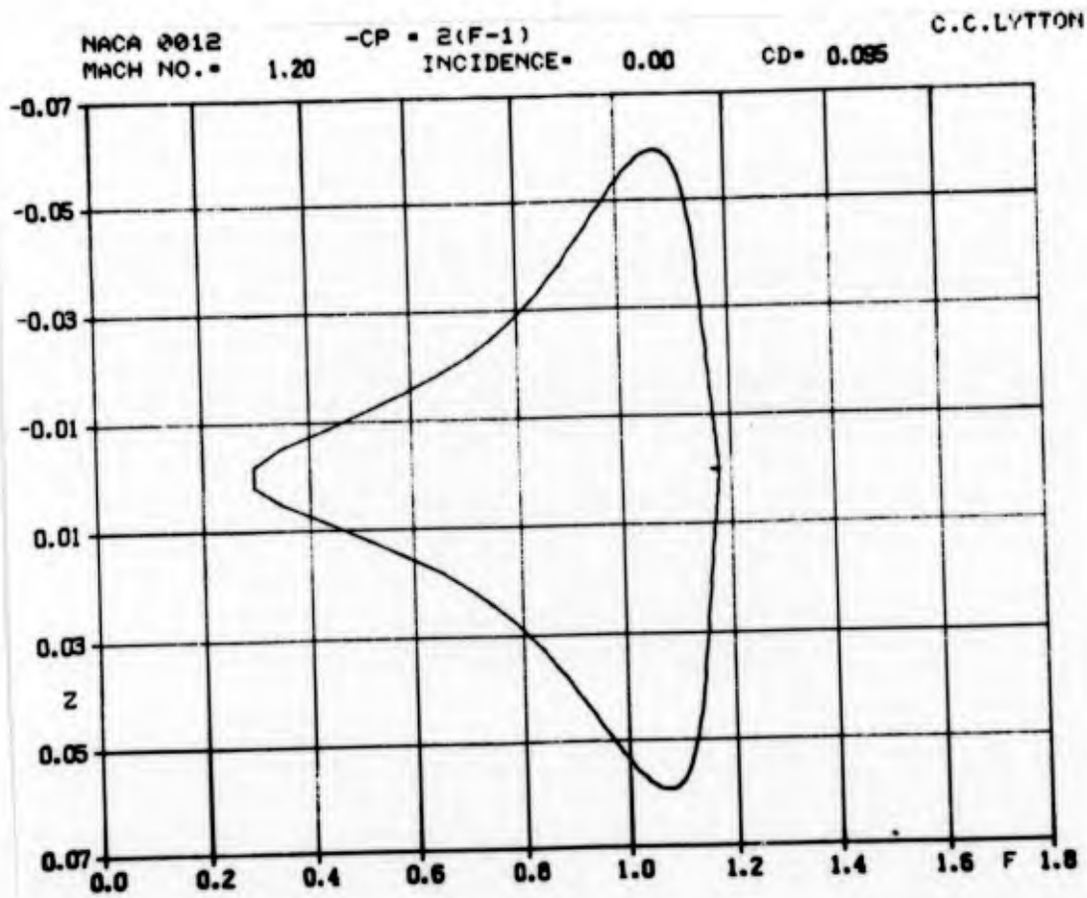
R.A.E.	AR 211		C.C.Lytton	04-3-5
	NACA 0012: MACH = 1.2, ALPHA = 0			



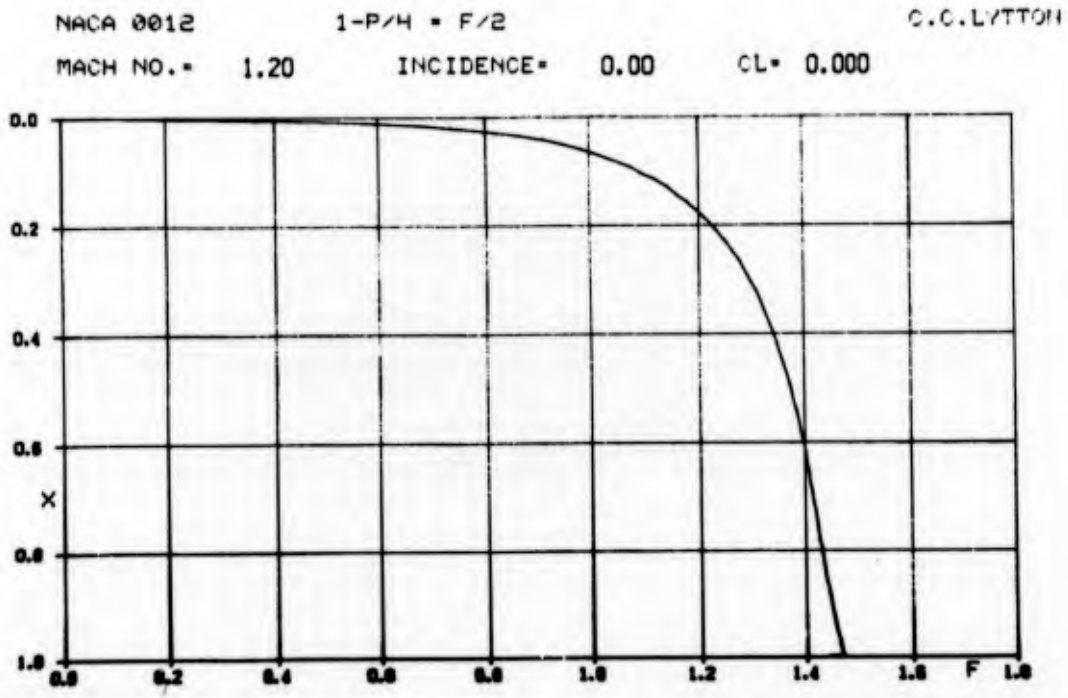
R.A.E.	AR 211		C.C.Lytton	04-3-6
	NACA 0012: MACH = 1.2, ALPHA = 0			



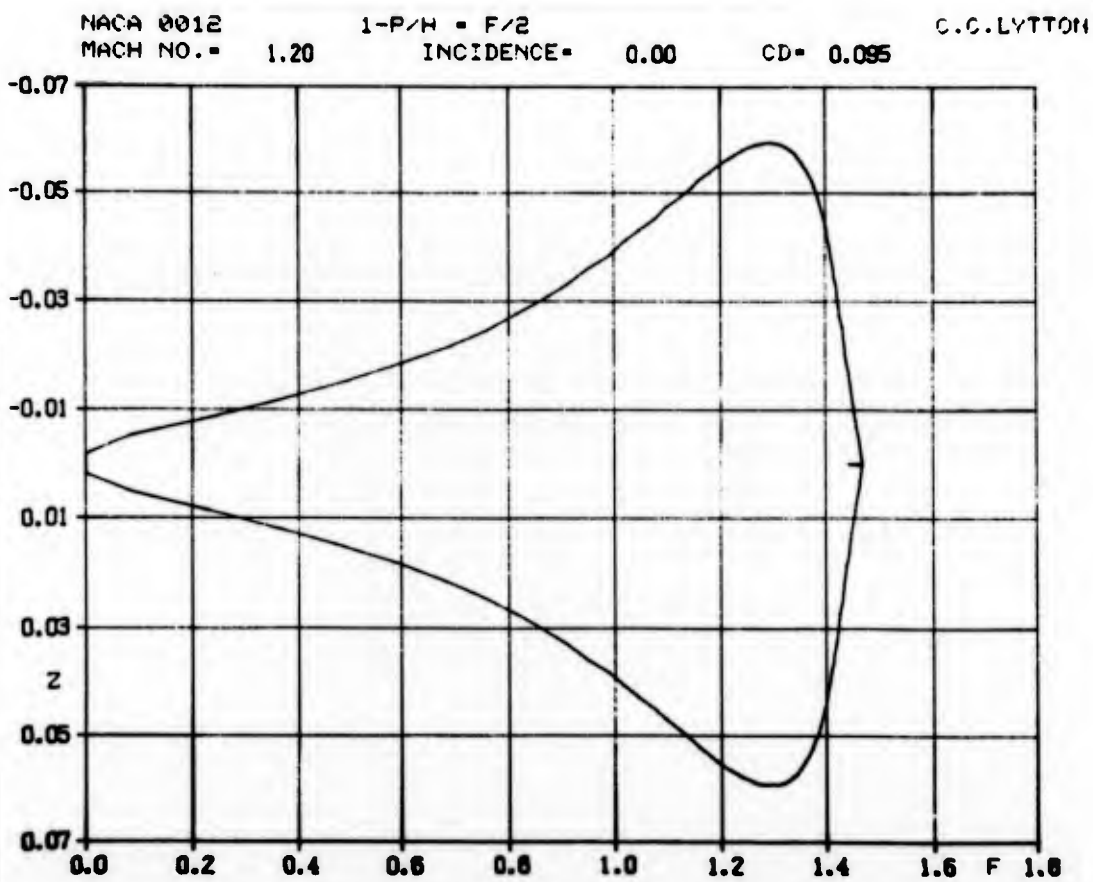
R.A.E.	AR 211		C.C.Lytton	04-3-7
	NACA 0012: MACH = 1.2, ALPHA = 0			



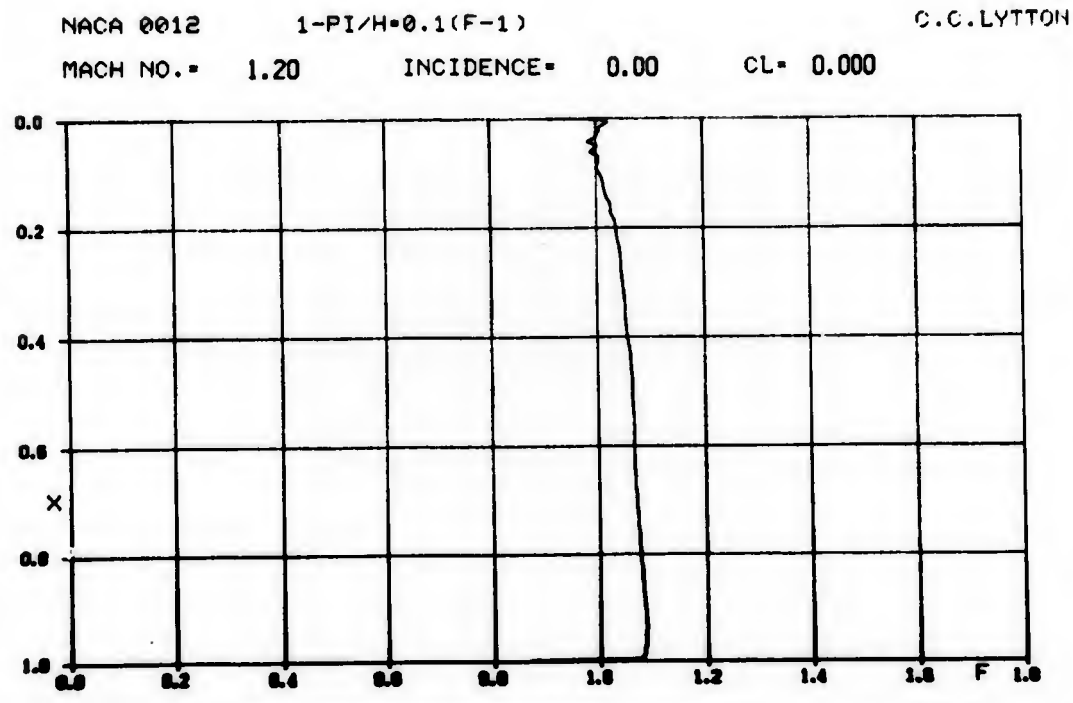
R.A.E.	AR 211		C.C.Lytton	04-3-8
	NACA 0012: MACH = 1.2, ALPHA = 0			



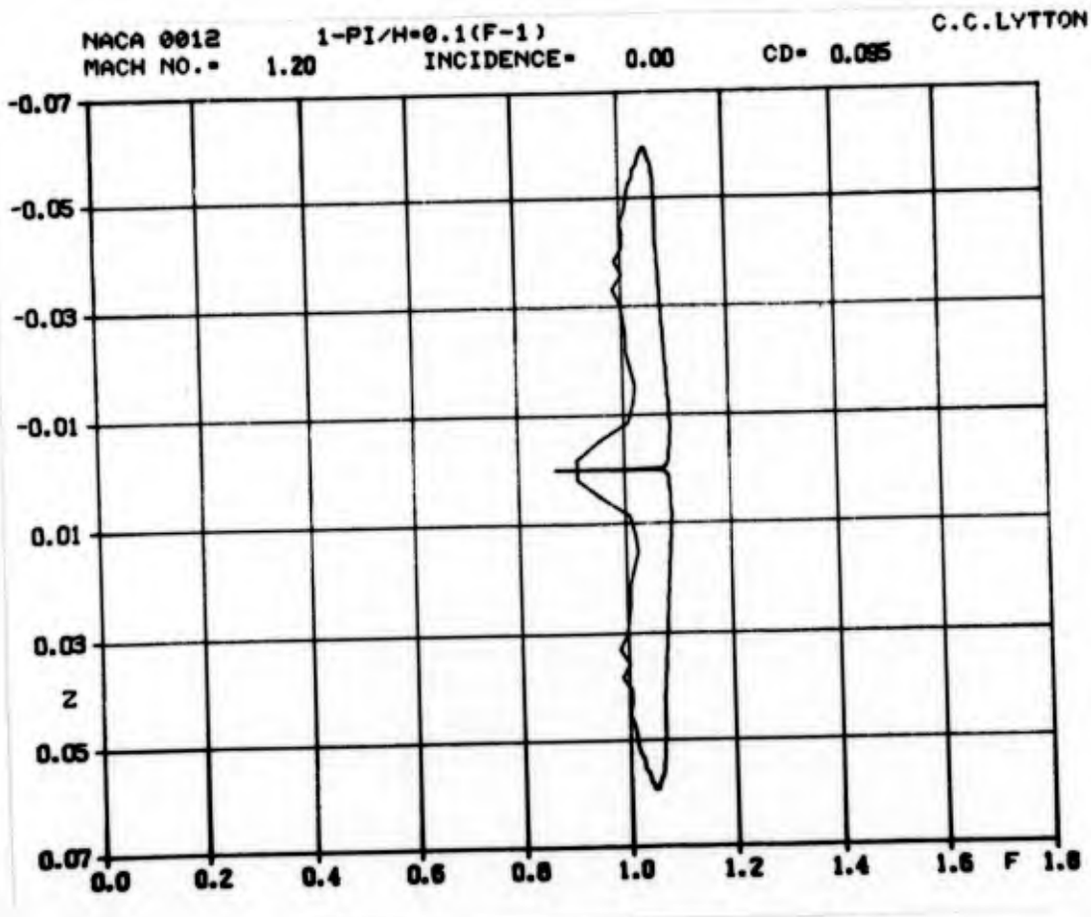
R.A.E.	AR 211		C.C.Lytton	04-3-9
	NACA 0012: MACH = 1.2, ALPHA = 0			



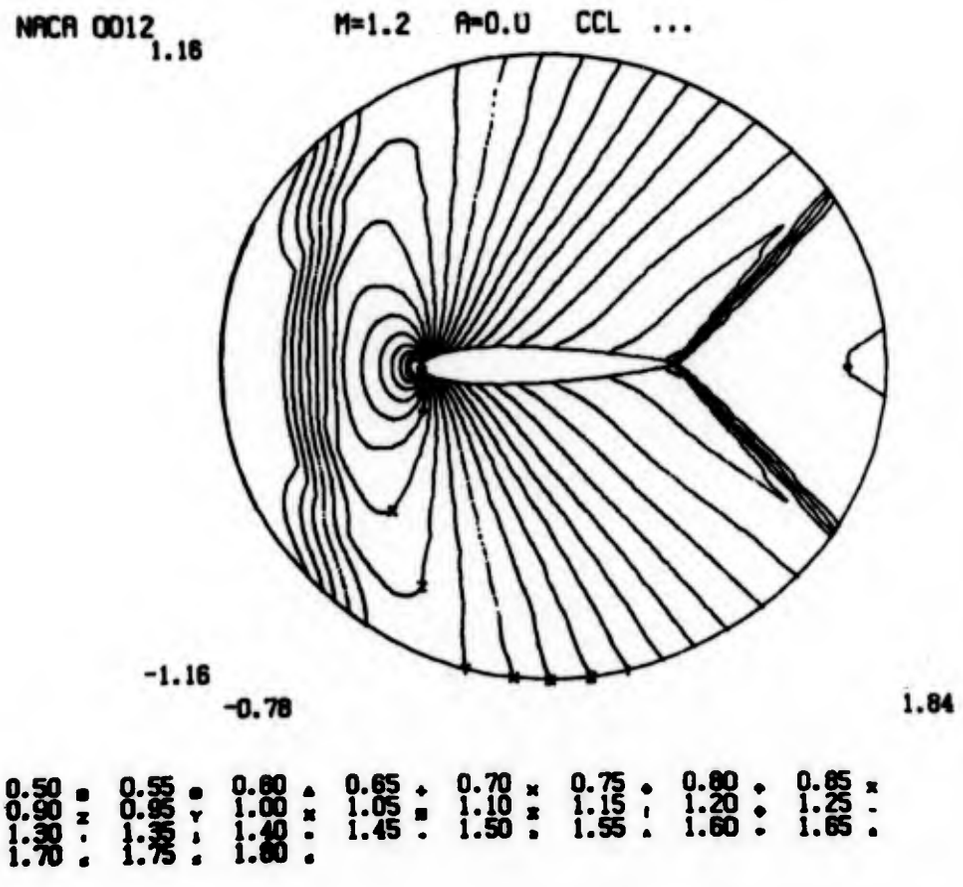
R.A.E.	AR 211		C.C.Lytton	04-3-10
	NACA 0012: MACH = 1.2, ALPHA = 0			



R.A.E.	AR 211		C.C.Lytton	04-3-11
	NACA 0012: MACH = 1.2, ALPHA = 0			

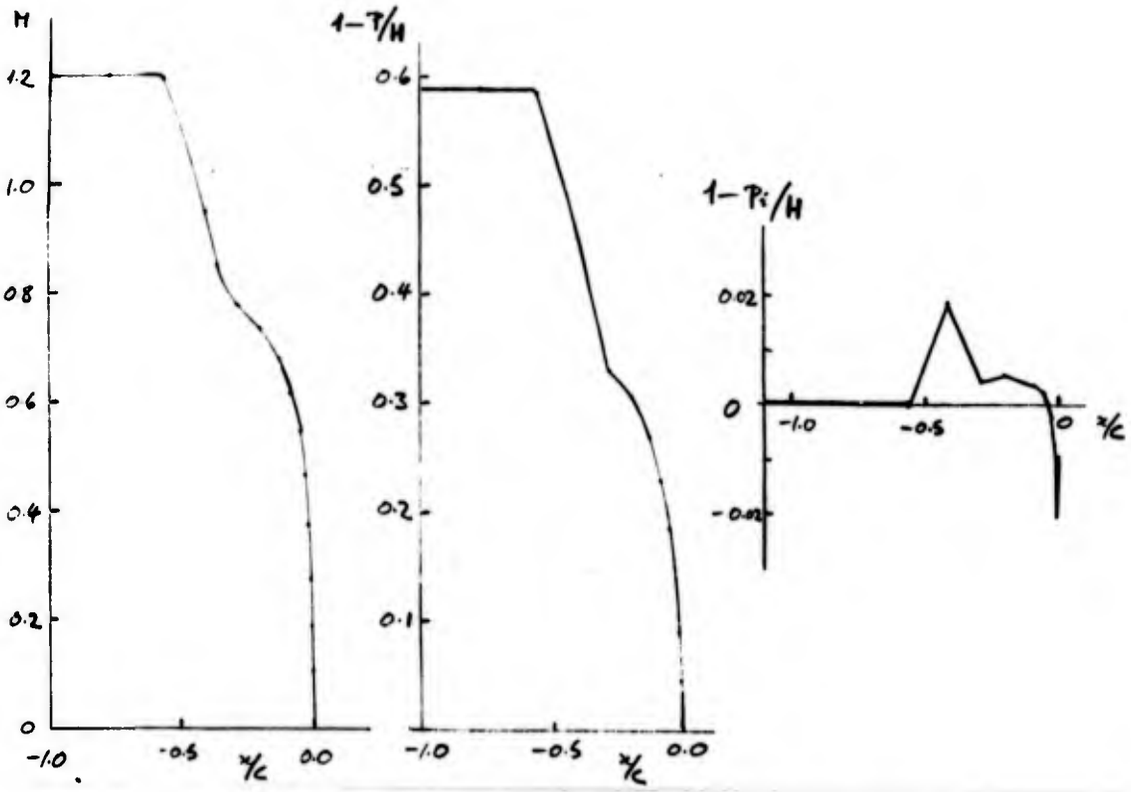


R.A.E.	AR 211		C.C.Lytton	04-3-12
	NACA 0012: MACH = 1.2, ALPHA = 0			



R.A.E.	AR 211		C.C.Lytton	04-3-13
	NACA 0012: MACH = 1.2, ALPHA = 0			

CCL



NACA 0012: M_∞ 1.2, $\alpha = 0$ (Case 40). Upstream plots

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 04

NACA 0012: MACH = 1.2, ALPHA = 0

Contributor No 6

M.D.Salas and J.C.South, Jr

(N.A.S.A. – Langley, U.S.A.)

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-1
	NACA 0012: MACH = 1.2, ALPHA = 0			

NACA Langley Research Center - AGARD case 04
NACA 0012 Mach=1.200 alpha=0.000 (deg)
Cl=0.0000 Cd=0.0957 Cm=0.0000

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-2
	NACA 0012: MACH = 1.2, ALPHA = 0			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
1	.000115	.001330	.011850	1.385149	.062302	.009162
2	.000575	.003980	.035011	1.329429	.187466	.011063
3	.001500	.006610	.073146	1.237688	.303614	.011947
4	.002890	.009215	.122932	1.117917	.415295	.012399
5	.004755	.011790	.174362	.994191	.512641	.012234
6	.007100	.014330	.222335	.878780	.595257	.011753
7	.009915	.016830	.266288	.773042	.666075	.012020
8	.013200	.019290	.305140	.679576	.729281	.010196
9	.016960	.021710	.339414	.597121	.782545	.010199
10	.021195	.024085	.369174	.525526	.830322	.008583
11	.025895	.026405	.394689	.464145	.869481	.009155
12	.031055	.028670	.416520	.411625	.905199	.007568
13	.036675	.030880	.437135	.362032	.937152	.008305
14	.042750	.033030	.454737	.319686	.966497	.006982
15	.049270	.035115	.470924	.280745	.991915	.007874
16	.056235	.037135	.485357	.246024	1.016735	.006502
17	.063640	.039085	.499298	.212485	1.039153	.007326
18	.071470	.040960	.510731	.184981	1.059257	.006230
19	.079725	.042760	.522911	.155678	1.079478	.006799
20	.088400	.044480	.534083	.128803	1.099554	.005753
21	.097480	.046115	.544354	.104092	1.116932	.006397
22	.106960	.047665	.553544	.081984	1.133989	.005334
23	.116830	.049125	.563083	.059036	1.150662	.005784
24	.127085	.050495	.570527	.041129	1.164612	.005141
25	.137720	.051775	.578986	.020777	1.180018	.005202
26	.148720	.052960	.585945	.004036	1.193067	.004956
27	.160080	.054050	.593689	-.014593	1.207830	.004576
28	.171785	.055040	.600323	-.030553	1.220334	.004625
29	.183825	.055935	.606110	-.044474	1.231577	.004374
30	.196190	.056730	.613014	-.061084	1.245144	.004059
31	.208870	.057420	.618938	-.075335	1.256711	.004056
32	.221860	.058010	.624419	-.088521	1.267812	.003669
33	.235140	.058500	.629668	-.101149	1.278161	.003815
34	.248700	.058890	.634750	-.113374	1.288758	.003310
35	.262530	.059180	.639584	-.125005	1.298399	.003553
36	.276620	.059370	.644403	-.136597	1.308766	.002894
37	.290955	.059460	.648828	-.147241	1.317618	.003312
38	.305520	.059455	.652664	-.156470	1.326100	.002667
39	.320305	.059355	.656890	-.166637	1.334729	.003038
40	.335290	.059160	.660677	-.175748	1.343224	.002417
41	.350465	.058870	.664837	-.185756	1.351967	.002652
42	.365820	.058490	.667662	-.192552	1.358256	.002390
43	.381335	.058030	.670518	-.199422	1.364353	.002542
44	.396995	.057485	.674223	-.208335	1.372895	.001945
45	.412785	.056855	.677112	-.215285	1.378854	.002526
46	.428690	.056150	.679532	-.221108	1.384729	.001827
47	.444695	.055370	.682303	-.227773	1.390526	.002378
48	.460780	.054520	.684491	-.233038	1.395908	.001729
49	.476930	.053600	.687608	-.240535	1.402722	.002064
50	.493130	.052615	.689023	-.243940	1.406046	.001918

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-3
	NACA 0012: MACH = 1.2, ALPHA = 0			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
51	.509365	.051575	.691069	-.248863	1.410736	.001900
52	.525615	.050475	.693391	-.254449	1.416202	.001715
53	.541860	.049320	.695371	-.259211	1.420624	.001931
54	.558085	.048115	.697193	-.263596	1.425055	.001650
55	.574270	.046865	.698598	-.266975	1.428079	.002005
56	.590400	.045575	.700130	-.270660	1.432022	.001499
57	.606460	.044245	.701955	-.275051	1.436012	.001927
58	.622430	.042880	.703417	-.278569	1.439772	.001492
59	.638285	.041485	.704970	-.282304	1.443126	.001959
60	.654015	.040065	.705568	-.283743	1.444795	.001608
61	.669600	.038625	.707112	-.287457	1.448395	.001726
62	.685020	.037160	.709109	-.292260	1.453372	.001452
63	.700265	.035680	.709565	-.293359	1.453961	.002179
64	.715310	.034190	.710995	-.296797	1.458156	.001109
65	.730140	.032685	.712474	-.300356	1.460961	.002219
66	.744740	.031175	.713360	-.302488	1.463853	.001160
67	.759090	.029665	.714437	-.305079	1.465680	.002302
68	.773175	.028155	.715586	-.307844	1.469479	.000881
69	.786975	.026650	.716583	-.310241	1.470767	.002538
70	.800475	.025155	.717601	-.312692	1.474619	.000602
71	.813665	.023670	.718705	-.315346	1.475811	.002798
72	.826525	.022200	.719370	-.316947	1.479197	.000295
73	.839040	.020745	.721344	-.321695	1.482330	.002833
74	.851195	.019310	.721753	-.322679	1.485056	.000375
75	.862975	.017905	.722323	-.324052	1.484615	.003059
76	.874365	.016525	.723944	-.327950	1.491136	-.000498
77	.885350	.015175	.724739	-.329863	1.490081	.003903
78	.895915	.013865	.725303	-.331221	1.494993	-.001137
79	.906050	.012590	.726827	-.334886	1.495089	.004276
80	.915740	.011355	.727197	-.335777	1.500237	-.001811
81	.924970	.010165	.729348	-.340950	1.501056	.004907
82	.933735	.009025	.728169	-.338114	1.502927	-.002140
83	.942015	.007940	.730344	-.343348	1.503504	.005047
84	.949795	.006905	.730294	-.343226	1.509011	-.003121
85	.957065	.005930	.732981	-.349691	1.509420	.006285
86	.963815	.005020	.730711	-.344230	1.510583	-.003856
87	.970035	.004175	.733918	-.351946	1.511560	.006690
88	.975710	.003395	.732653	-.348902	1.516522	-.005256
89	.980825	.002685	.736038	-.357046	1.515946	.008304
90	.985370	.002055	.732713	-.349045	1.517713	-.006775
91	.989335	.001505	.736766	-.358795	1.515867	.011150
92	.992700	.001035	.730954	-.344814	1.516540	-.011672
93	.995450	.000645	.741377	-.369890	1.525910	.014165
94	.997570	.000345	.727203	-.335791	1.510355	-.016598
95	.999035	.000140	.754515	-.401496	1.570523	.001041
96	.999800	.000030	.749461	-.389338	1.545958	.016595
97	.999800	-.000030	.749321	-.389000	1.544485	.018165
98	.999035	-.000140	.754414	-.401251	1.570249	.001029
99	.997570	-.000345	.727163	-.335695	1.510066	-.016320
100	.995450	-.000645	.741344	-.369809	1.525821	.014165

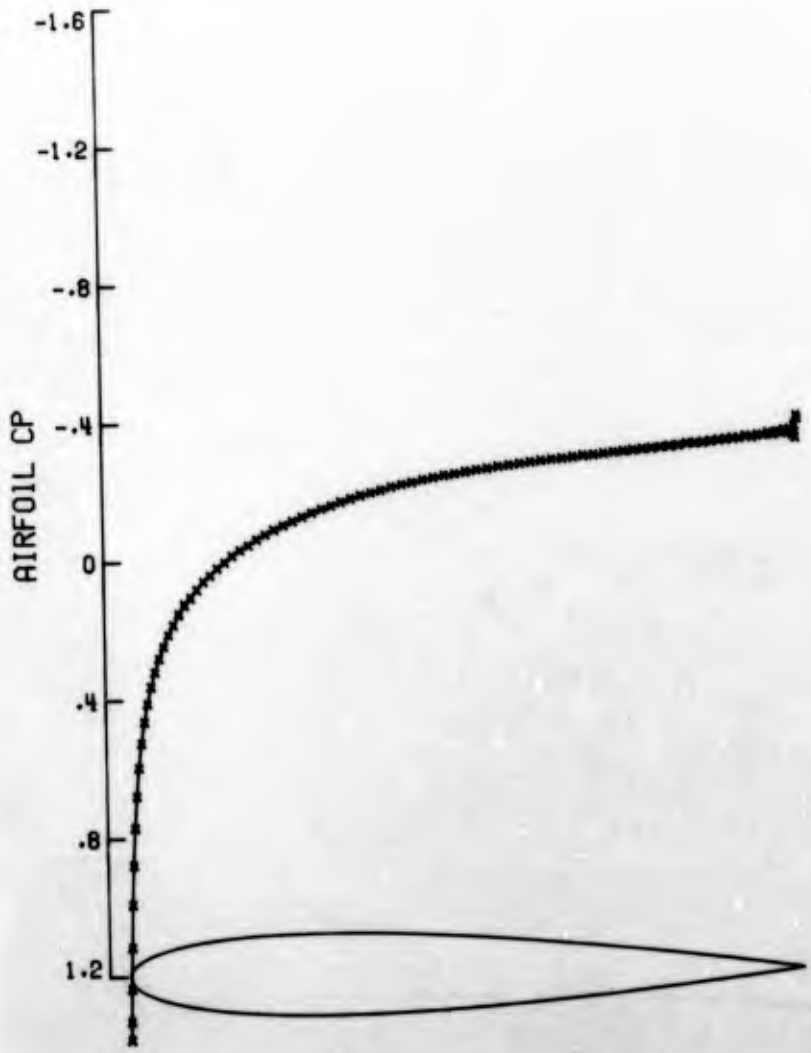
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-4
	NACA 0012: MACH = 1.2, ALPHA = 0			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
101	.992700	-.001035	.730999	-.344922	1.516508	-.011456
102	.989335	-.001505	.736716	-.358676	1.515782	.011085
103	.985370	-.002055	.732761	-.349162	1.517724	-.006606
104	.980825	-.002685	.736095	-.357183	1.516092	.008308
105	.975710	-.003395	.732678	-.348961	1.516507	-.005141
106	.970035	-.004175	.733892	-.351883	1.511537	.006627
107	.963815	-.005020	.730621	-.344013	1.510355	-.003860
108	.957065	-.005930	.732907	-.349514	1.509273	.006223
109	.949795	-.006905	.730347	-.343355	1.509115	-.003073
110	.942015	-.007940	.730495	-.343710	1.503882	.005059
111	.933735	-.009025	.728316	-.338467	1.503258	-.002080
112	.924970	-.010165	.729207	-.340612	1.500755	.004823
113	.915740	-.011355	.726893	-.335043	1.499563	-.001952
114	.906050	-.012585	.726205	-.333389	1.493476	.004333
115	.895915	-.013860	.726261	-.333523	1.497105	-.000703
116	.885350	-.015175	.724741	-.329867	1.490451	.003377
117	.874365	-.016525	.723700	-.327362	1.490258	-.000115
118	.862975	-.017905	.722475	-.324417	1.485146	.002841
119	.851195	-.019310	.721700	-.322551	1.484780	.000582
120	.839040	-.020745	.721342	-.321691	1.482431	.002682
121	.826525	-.022200	.719432	-.317095	1.479220	.000481
122	.813665	-.023670	.718757	-.315472	1.476021	.002682
123	.800475	-.025155	.717537	-.312536	1.474388	.000705
124	.786975	-.026650	.716503	-.310048	1.470620	.002466
125	.773175	-.028155	.715570	-.307804	1.469364	.000988
126	.759090	-.029665	.714539	-.305324	1.465944	.002280
127	.744740	-.031175	.713446	-.302695	1.464000	.001250
128	.730140	-.032685	.712410	-.300202	1.460890	.002099
129	.715310	-.034185	.710453	-.295495	1.456833	.001133
130	.700265	-.035675	.709965	-.294321	1.454811	.002340
131	.685020	-.037155	.708624	-.291095	1.452403	.001175
132	.669600	-.038620	.707636	-.288718	1.449282	.002248
133	.654015	-.040065	.705846	-.284411	1.445802	.001115
134	.638285	-.041485	.704767	-.281817	1.442398	.002310
135	.622430	-.042880	.703335	-.278371	1.439774	.001212
136	.606460	-.044245	.701878	-.274866	1.435642	.002197
137	.590400	-.045575	.700325	-.271130	1.432570	.001372
138	.574270	-.046865	.698756	-.267354	1.428326	.002179
139	.558085	-.048115	.697025	-.263192	1.424817	.001434
140	.541860	-.049315	.694577	-.257301	1.418741	.001995
141	.525615	-.050465	.693533	-.254789	1.416419	.001870
142	.509365	-.051570	.691901	-.250863	1.412633	.001913
143	.493130	-.052615	.688887	-.243612	1.405900	.001687
144	.476930	-.053595	.686901	-.238835	1.401009	.002217
145	.460780	-.054515	.685095	-.234490	1.397159	.001884
146	.444695	-.055370	.682468	-.228172	1.391089	.002110
147	.428690	-.056150	.679363	-.220702	1.384218	.002016
148	.412785	-.056855	.677102	-.215262	1.378896	.002438
149	.396995	-.057485	.674248	-.208396	1.372866	.002064
150	.381335	-.058030	.670602	-.199625	1.364580	.002483

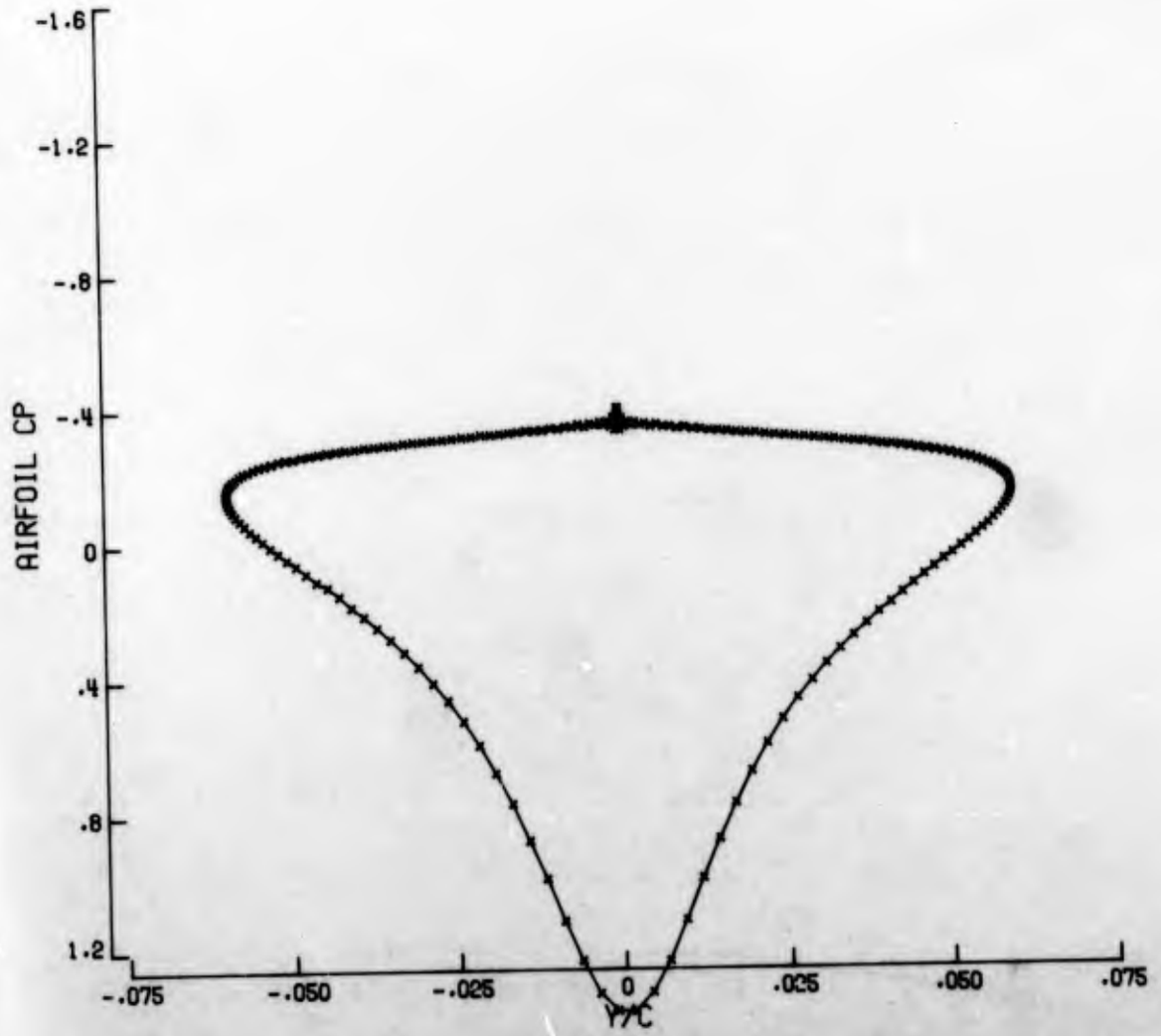
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-5
	NACA 0012: MACH = 1.2, ALPHA = 0			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
151	.365820	-.058490	.667554	-.192291	1.357980	.002447
152	.350465	-.058865	.664184	-.184185	1.350614	.002582
153	.335290	-.059155	.661231	-.177081	1.344199	.002702
154	.320305	-.059355	.657064	-.167056	1.335389	.002637
155	.305520	-.059455	.652516	-.156116	1.325537	.003014
156	.290955	-.059460	.648841	-.147274	1.317832	.003059
157	.276620	-.059370	.644344	-.136455	1.308495	.003097
158	.262530	-.059180	.639568	-.124964	1.298489	.003384
159	.248700	-.058890	.634686	-.113221	1.288521	.003457
160	.235140	-.058500	.629607	-.101001	1.278133	.003686
161	.221860	-.058010	.624332	-.088312	1.267557	.003781
162	.208870	-.057420	.618831	-.075077	1.256564	.003971
163	.196190	-.056730	.612887	-.060778	1.244838	.004137
164	.183825	-.055935	.605942	-.044071	1.231317	.004293
165	.171785	-.055040	.600121	-.030066	1.219899	.004691
166	.160080	-.054050	.593428	-.013964	1.207385	.004516
167	.148720	-.052960	.585622	.004814	1.192433	.005000
168	.137720	-.051775	.578560	.021802	1.179279	.005146
169	.127085	-.050495	.570006	.042381	1.163653	.005160
170	.116830	-.049125	.562512	.060411	1.149712	.005687
171	.106960	-.047665	.552941	.083434	1.132842	.005432
172	.097480	-.046110	.542784	.107870	1.114404	.006119
173	.088400	-.044475	.535807	.124655	1.102264	.006097
174	.079725	-.042760	.524786	.151168	1.083285	.006071
175	.071470	-.040960	.511021	.184283	1.059455	.006581
176	.063640	-.039085	.499464	.212085	1.039750	.006947
177	.056235	-.037135	.485452	.245794	1.016725	.006698
178	.049270	-.035115	.471003	.280554	.992308	.007570
179	.042750	-.033030	.454838	.319443	.966545	.007111
180	.036675	-.030880	.437194	.361890	.937503	.008020
181	.031055	-.028670	.416607	.411417	.905292	.007615
182	.025895	-.026405	.394797	.463886	.869931	.008860
183	.021195	-.024085	.369221	.525413	.830432	.008546
184	.016960	-.021710	.339593	.596690	.783171	.009862
185	.013200	-.019290	.305009	.679891	.729271	.010019
186	.009915	-.016830	.266979	.771379	.667587	.011671
187	.007100	-.014325	.221389	.881057	.594827	.010881
188	.004755	-.011785	.174599	.993620	.512455	.012643
189	.002890	-.009215	.122558	1.118815	.416252	.011447
190	.001500	-.006610	.073993	1.235649	.303847	.012755
191	.000575	-.003975	.033669	1.332657	.188360	.009456
192	.000115	-.001325	.012741	1.383005	.058742	.010354

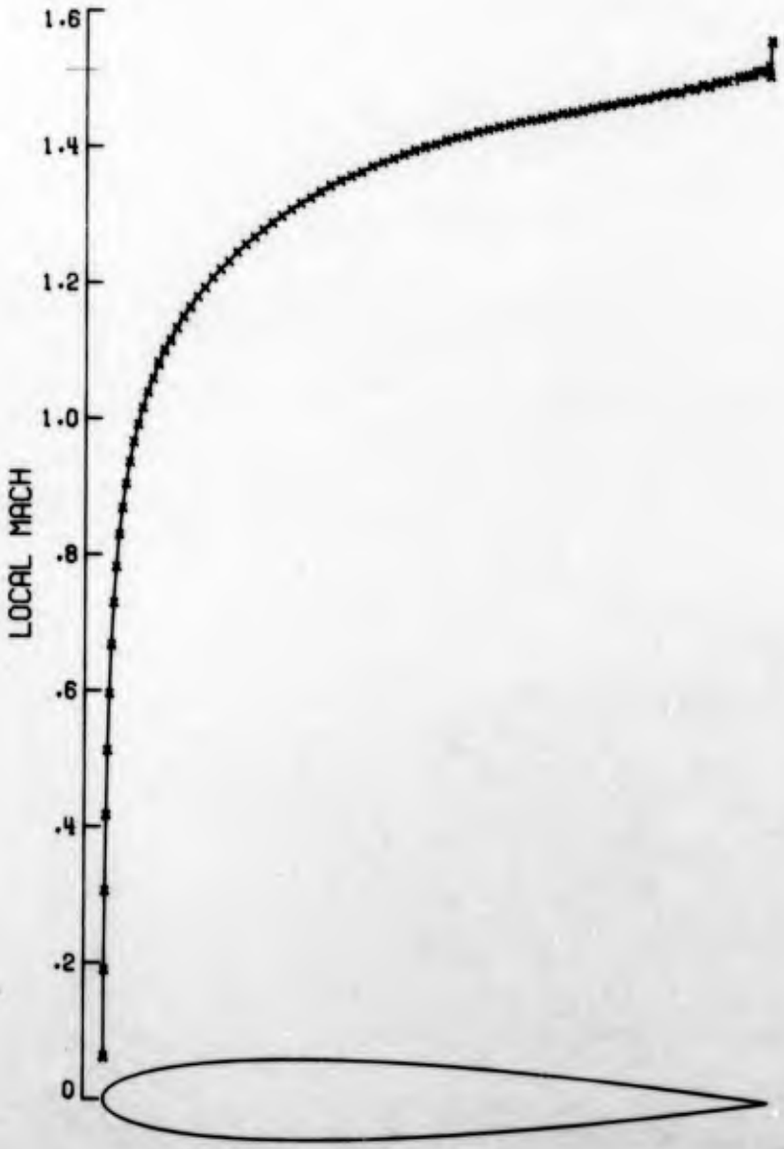
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-6
	NACA 0012: MACH = 1.2, ALPHA = 0			



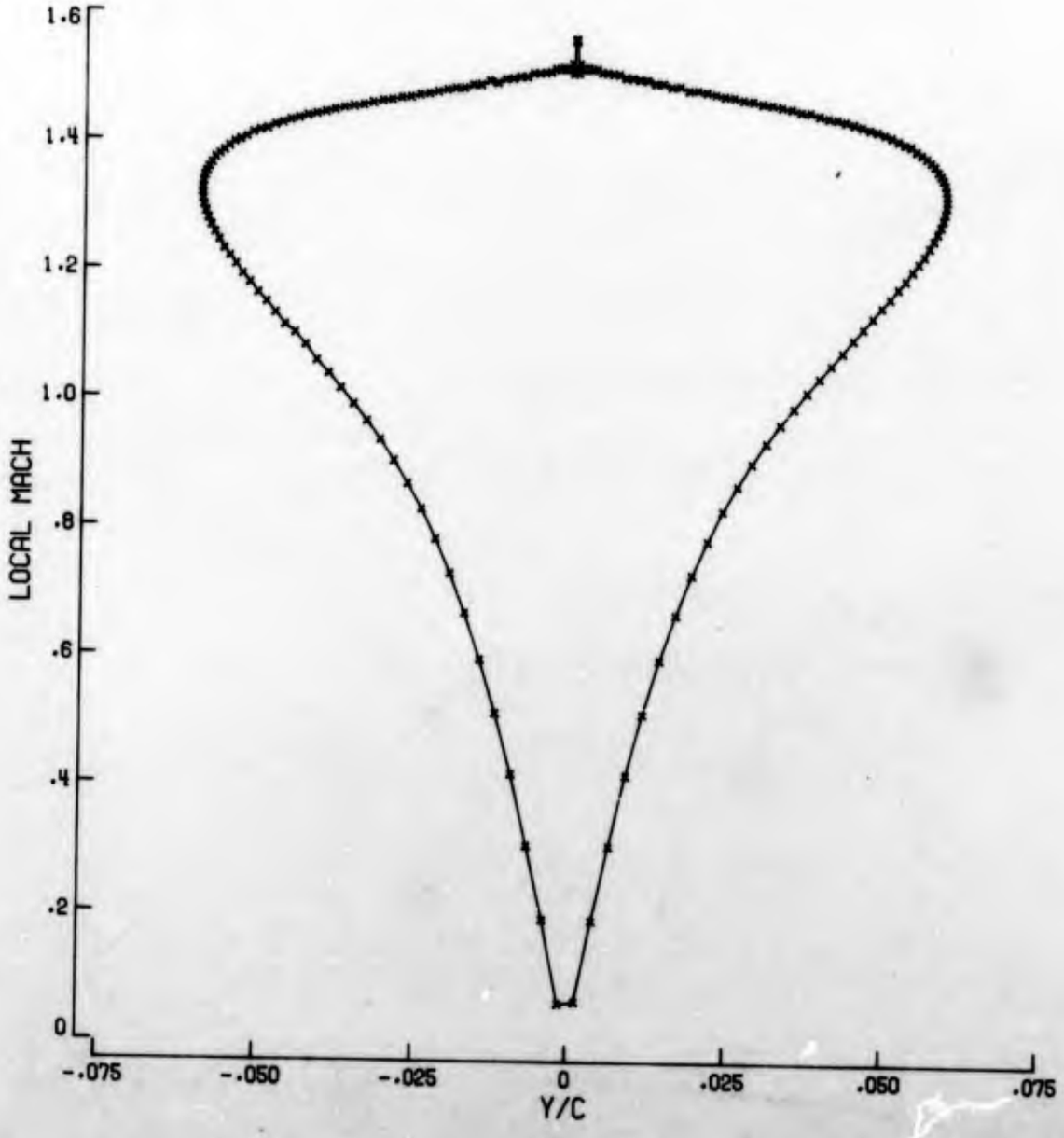
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-7
	NACA 0012: MACH = 1.2, ALPHA = 0			



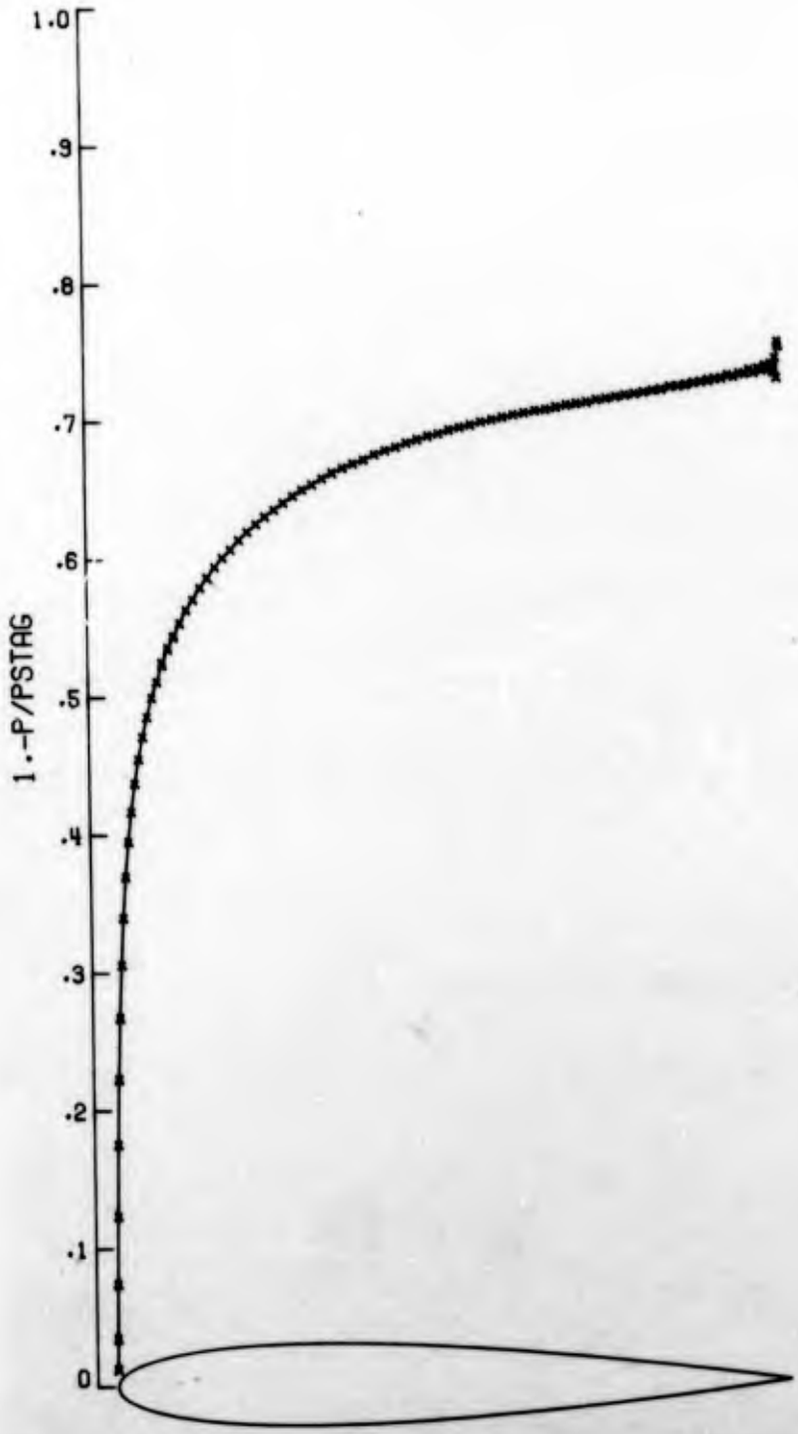
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-8
	NACA 0012: MACH = 1.2, ALPHA = 0			



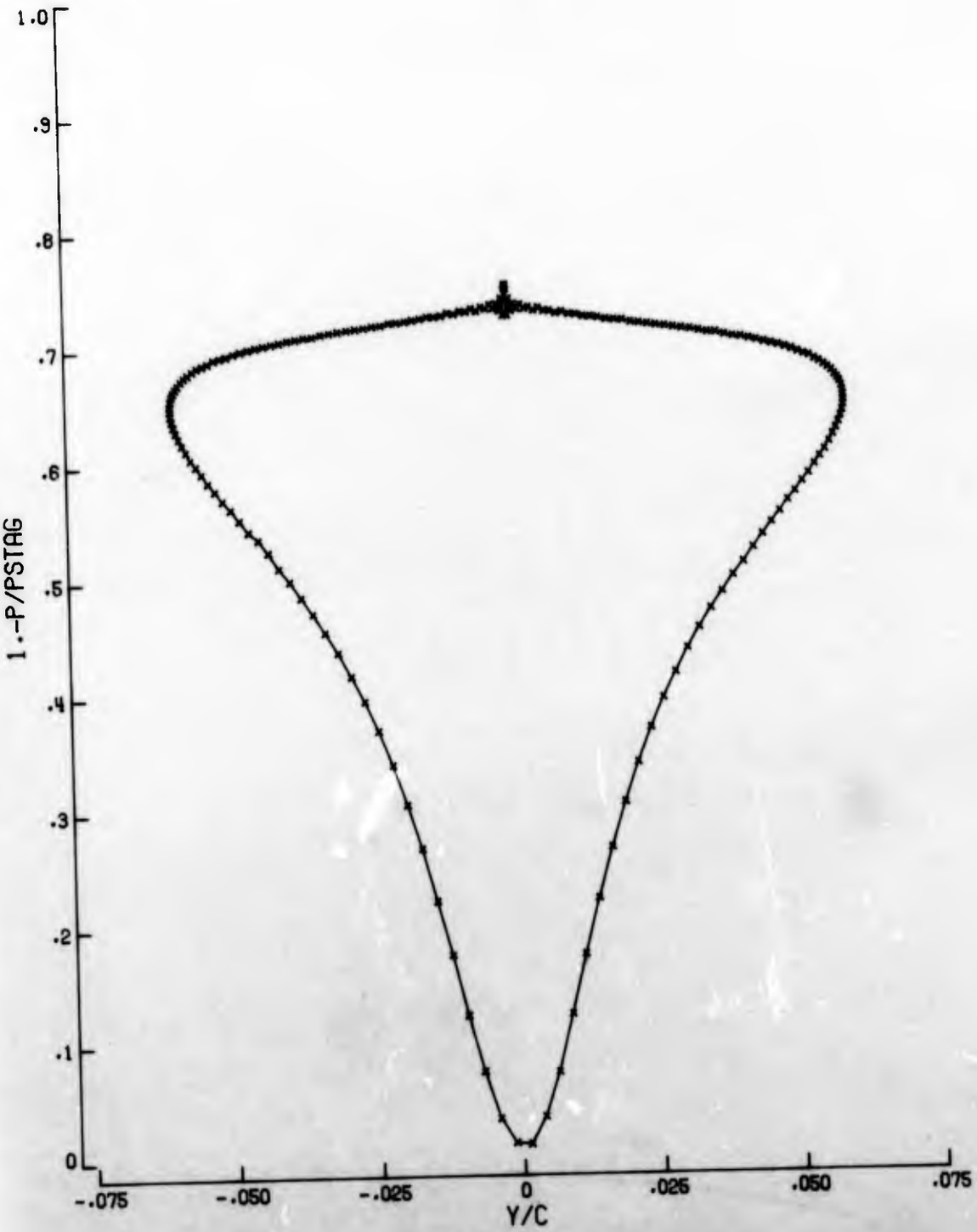
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-9
	NACA 0012: MACH = 1.2, ALPHA = 0			



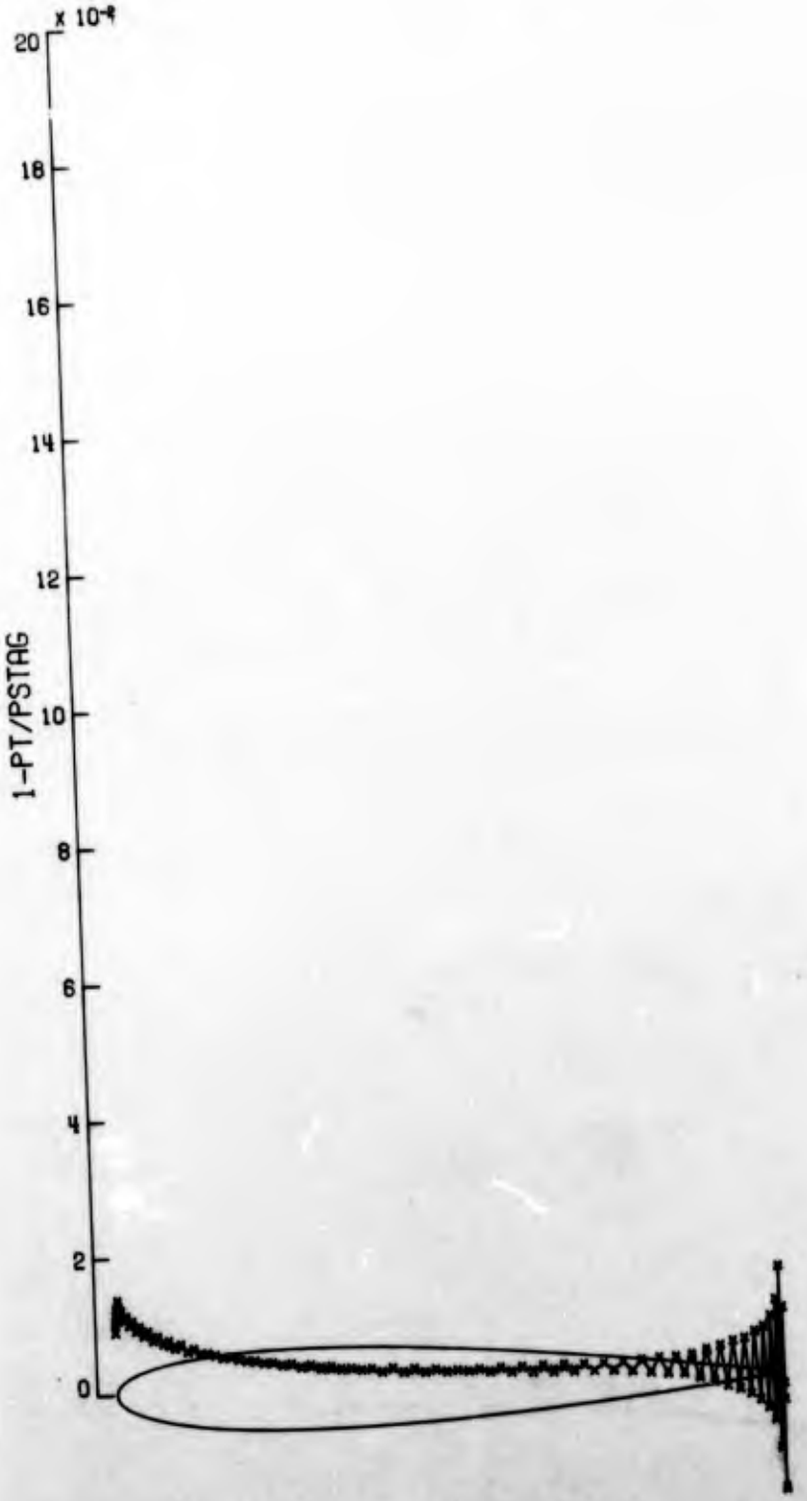
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-10
	NACA 0012: MACH = 1.2, ALPHA = 0			



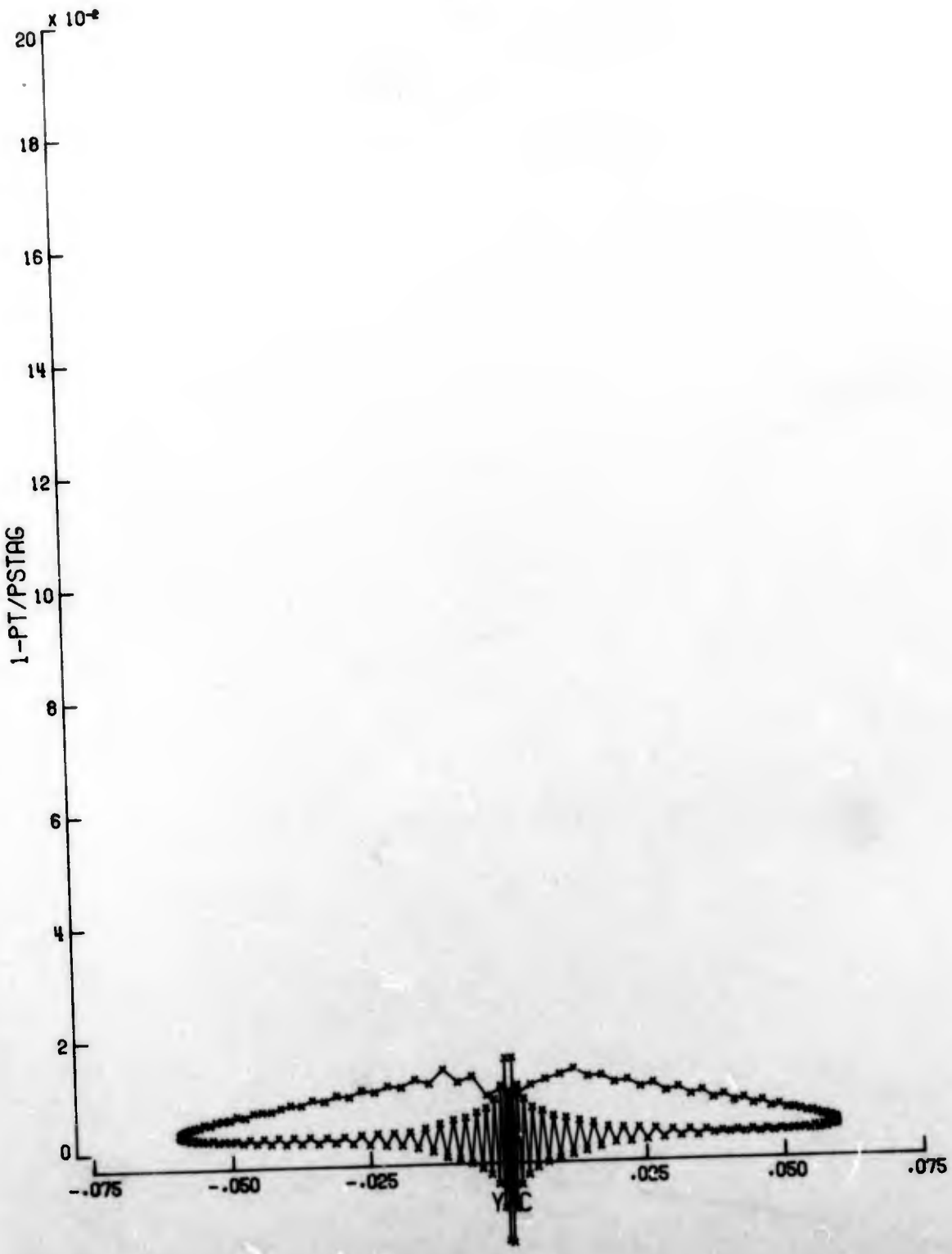
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-11
	NACA 0012: MACH = 1.2, ALPHA = 0			



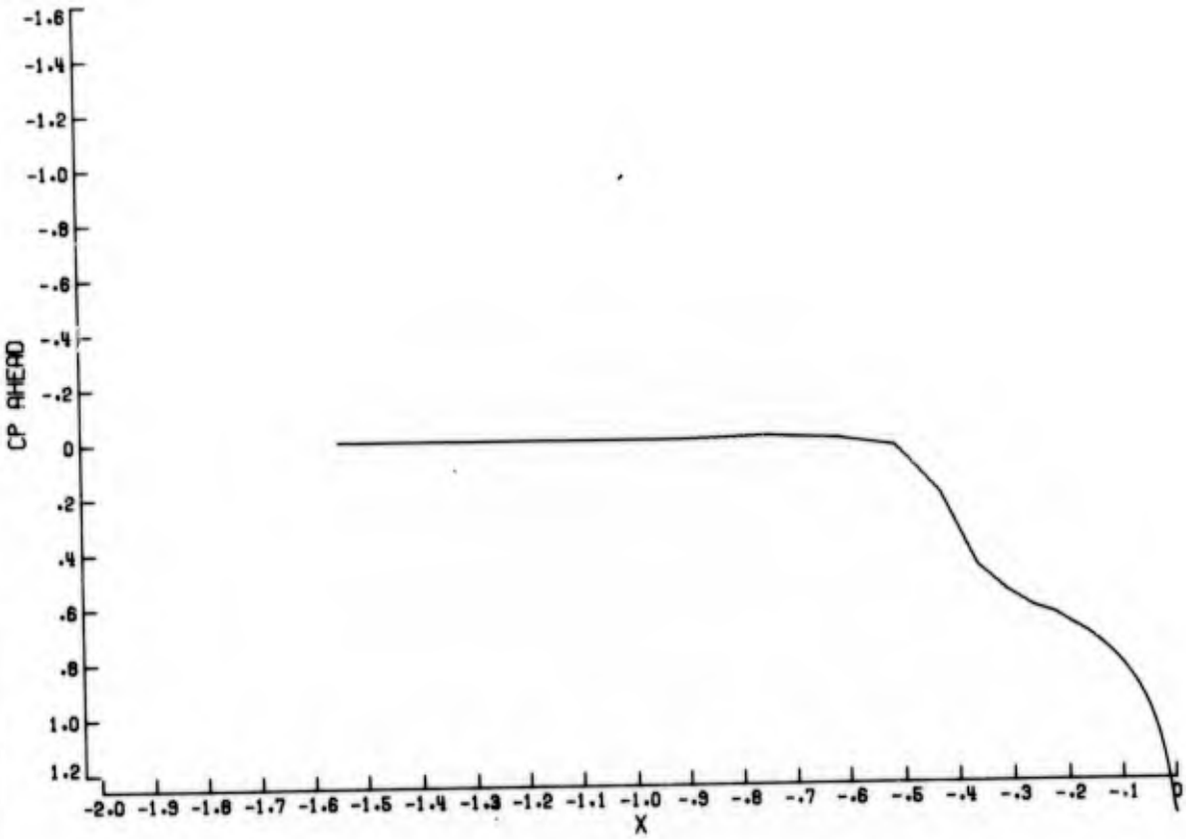
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-12
	NACA 0012: MACH = 1.2, ALPHA = 0			



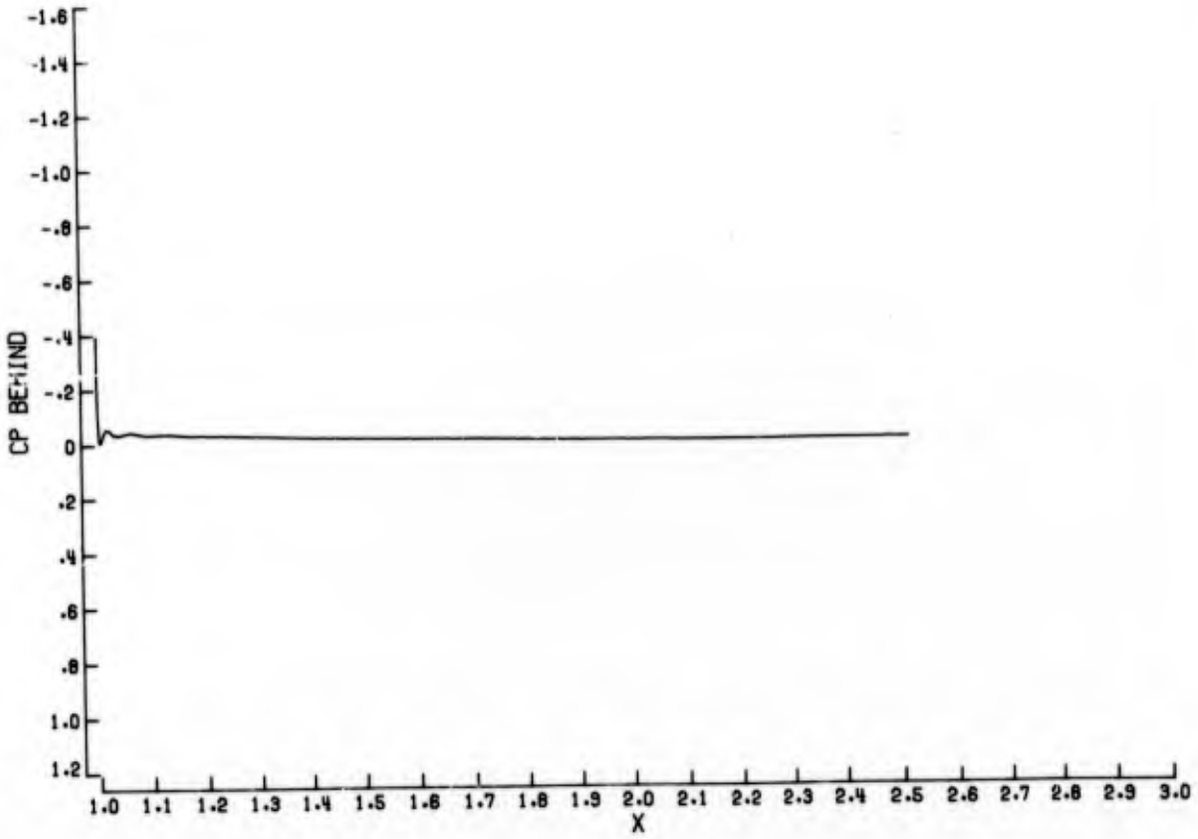
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-13
	NACA 0012: MACH = 1.2, ALPHA = 0			



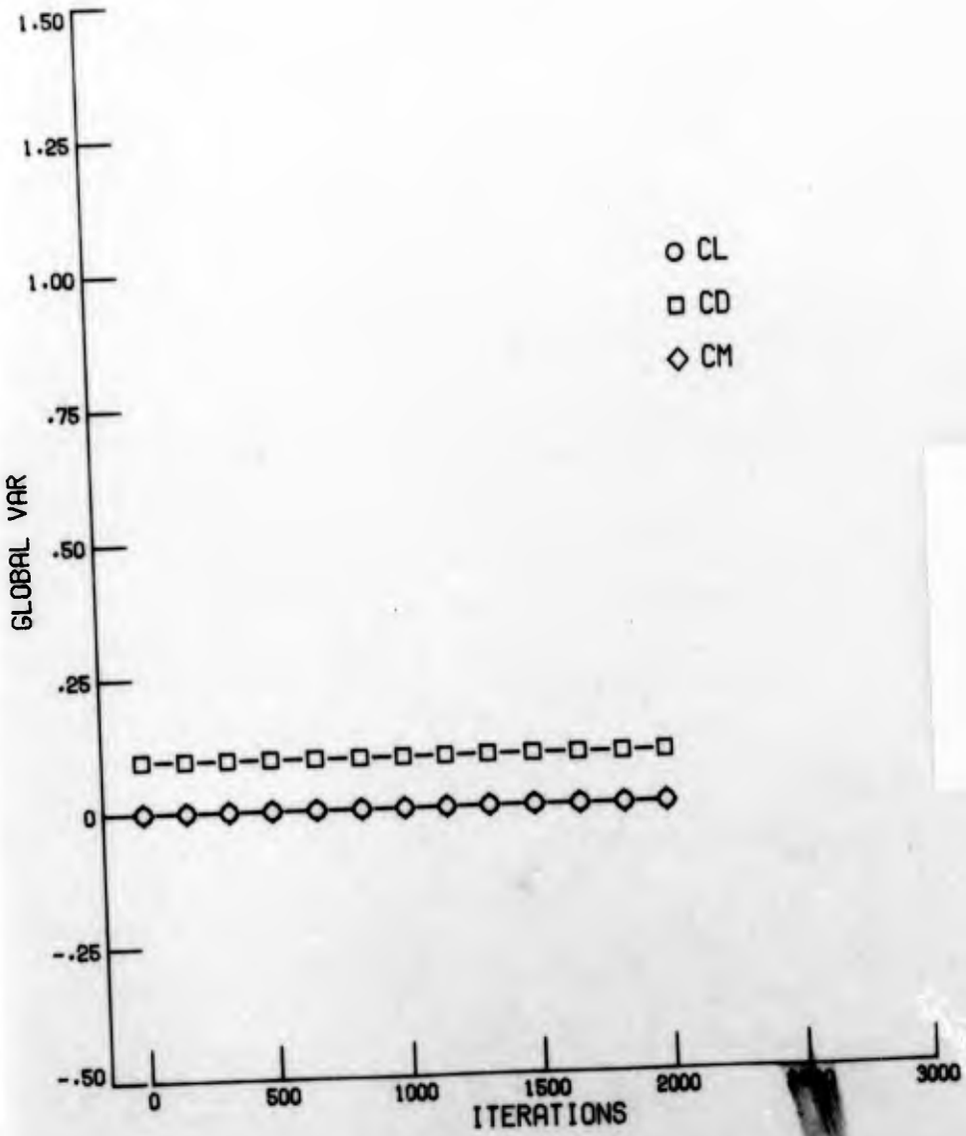
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-14
	NACA 0012: MACH = 1.2, ALPHA = 0			



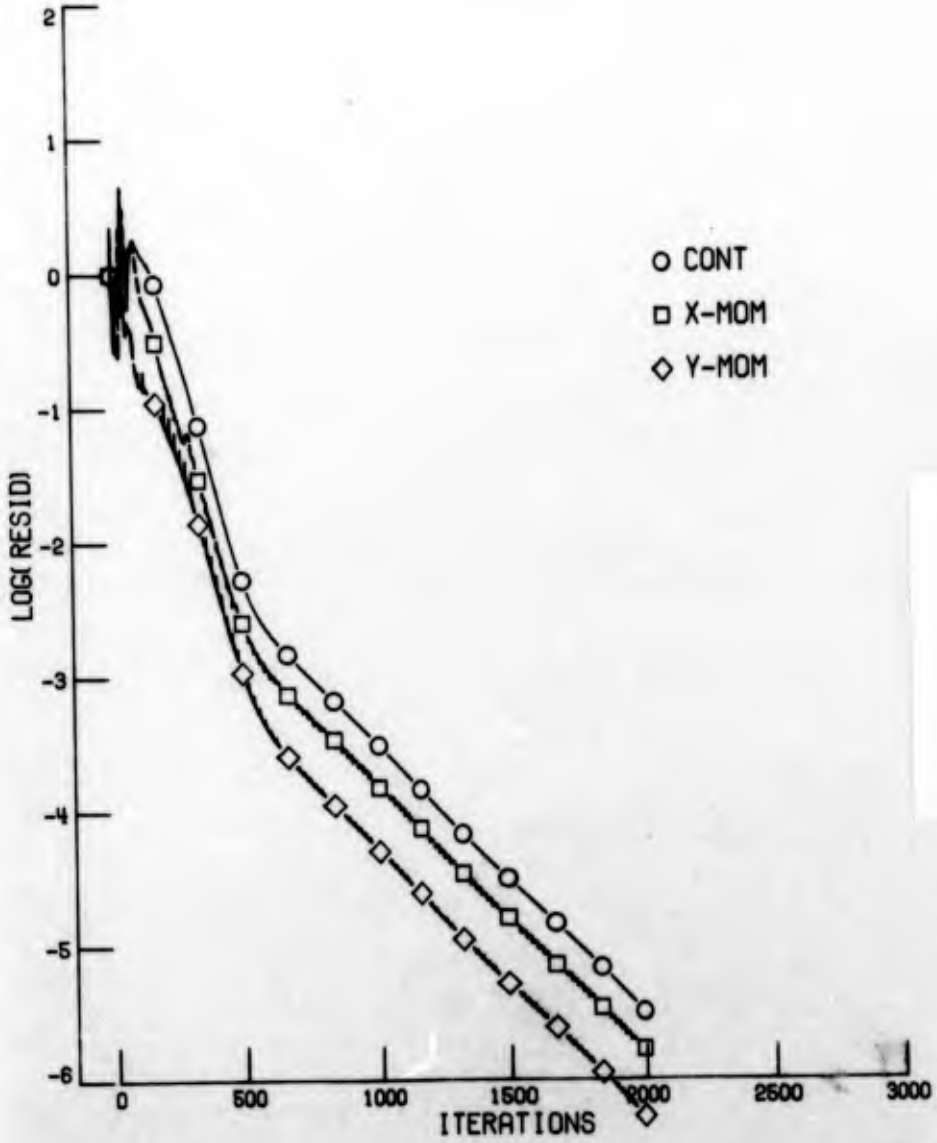
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-15
	NACA 0012: MACH = 1.2, ALPHA = 0			



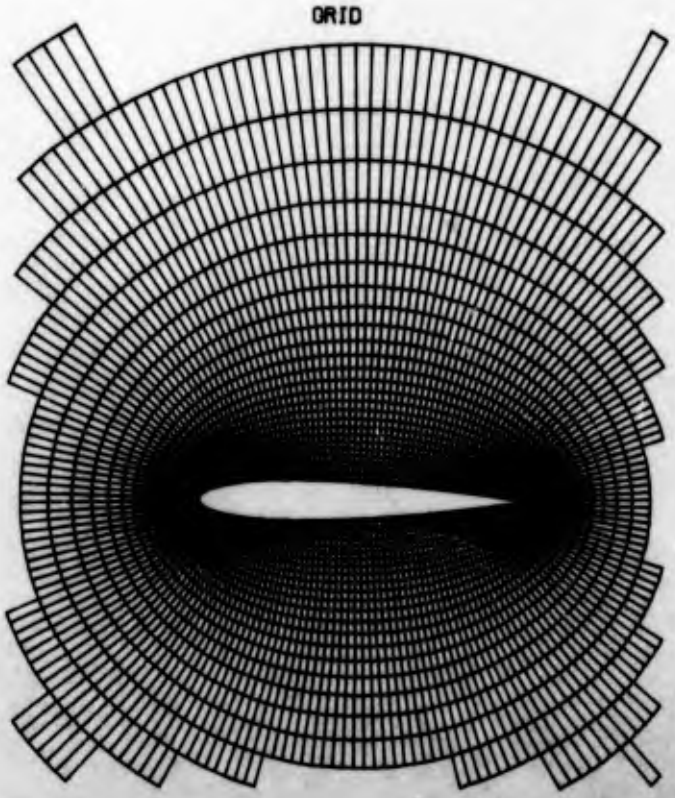
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-16
	NACA 0012: MACH = 1.2, ALPHA = 0			



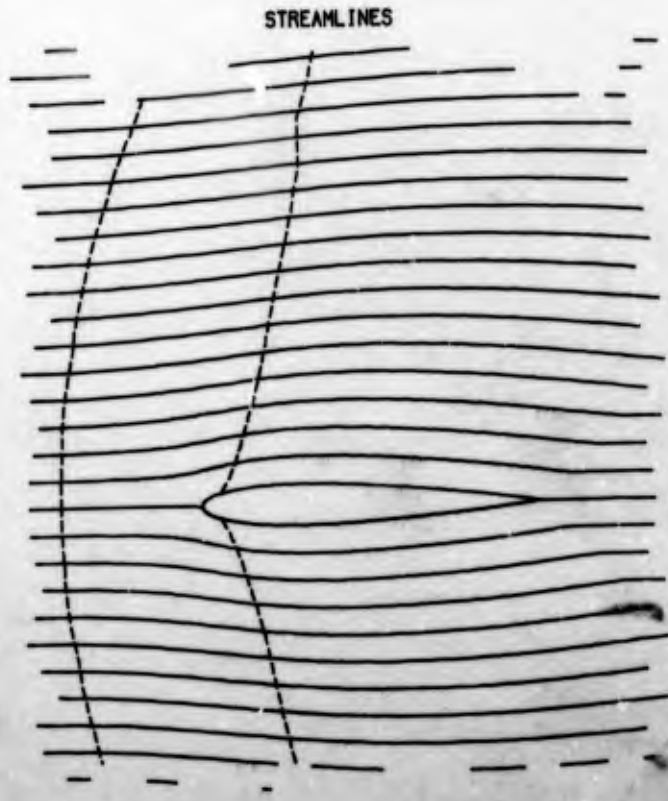
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-17
	NACA 0012: MACH = 1.2, ALPHA = 0			



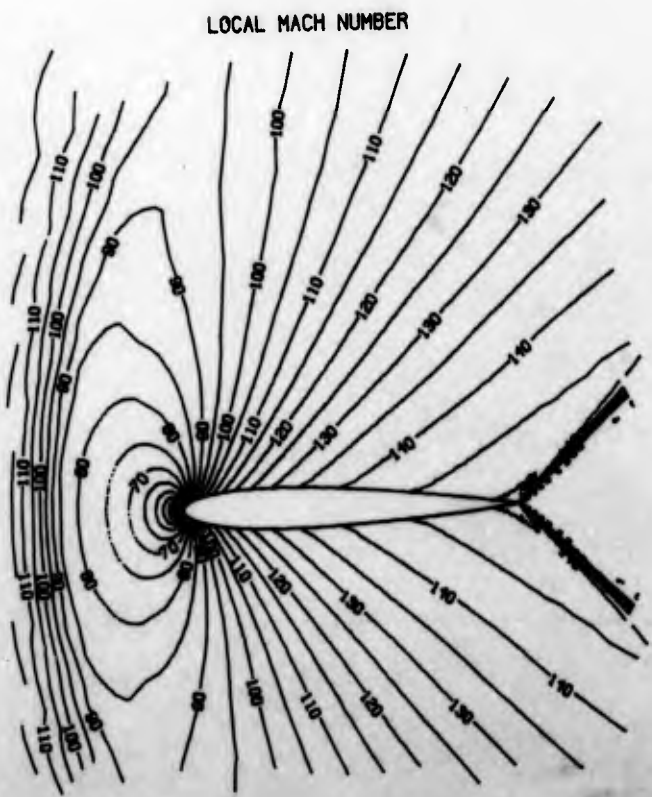
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-18
	NACA 0012: MACH = 1.2, ALPHA = 0			



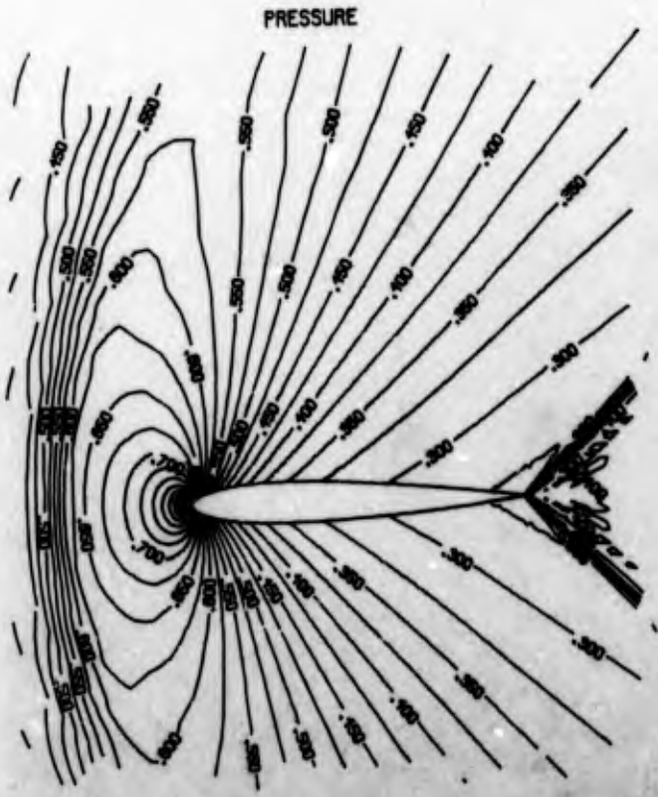
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-19
	NACA 0012: MACH = 1.2, ALPHA = 0			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-20
	NACA 0012: MACH = 1.2, ALPHA = 0			

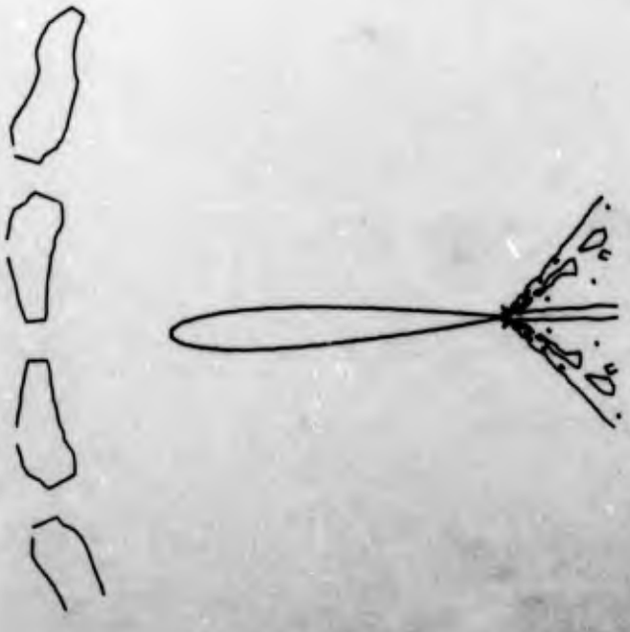


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-21
	NACA 0012: MACH = 1.2, ALPHA = 0			



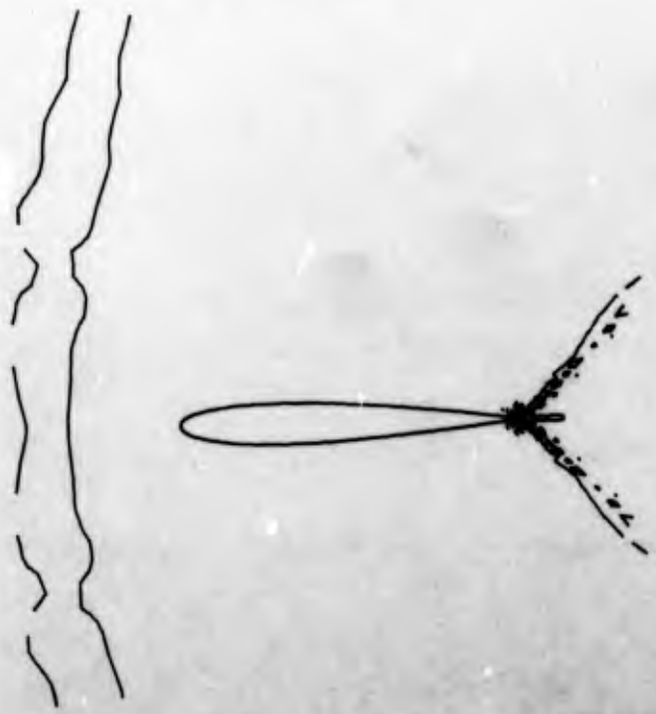
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-22
	NACA 0012: MACH = 1.2, ALPHA = 0			

ENTROPY



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	04-6-23
	NACA 0012: MACH = 1.2, ALPHA = 0			

TOTAL PRESSURE



AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 04

NACA 0012: MACH = 1.2, ALPHA = 0

Contributor No 9

W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-1
	NACA 0012: MACH = 1.2, ALPHA = 0			

N	X/C(%)	Z/C(%)	1-P/PIINF	CP	MACH	1-PI/PIINF
2	99.992828	-0.001020	0.574604	0.031319	1.151928	0.030439
3	99.965897	-0.004846	0.717141	-0.311585	1.433684	0.055915
4	99.914658	-0.012110	0.732111	-0.347599	1.505971	0.008026
5	99.840439	-0.022620	0.736860	-0.359023	1.516755	0.010228
6	99.744003	-0.036276	0.737537	-0.360652	1.523432	0.003135
7	99.625946	-0.052983	0.737382	-0.360279	1.520443	0.006878
8	99.486725	-0.072632	0.736502	-0.358163	1.519408	0.005050
9	99.326721	-0.095145	0.736629	-0.358468	1.518799	0.006408
10	99.146286	-0.120481	0.736341	-0.357776	1.518752	0.005392
11	98.945786	-0.148593	0.736229	-0.357507	1.518021	0.006029
12	98.725494	-0.179389	0.735880	-0.356666	1.517410	0.005596
13	98.485703	-0.212798	0.735646	-0.356104	1.516552	0.005958
14	98.226700	-0.248813	0.735435	-0.355595	1.516151	0.005740
15	97.948761	-0.287339	0.735031	-0.354623	1.515112	0.005725
16	97.652130	-0.328249	0.734599	-0.353585	1.513923	0.005828
17	97.337082	-0.371551	0.734380	-0.353058	1.513327	0.005868
18	97.003891	-0.417216	0.734065	-0.352301	1.512605	0.005733
19	96.652786	-0.465119	0.733620	-0.351230	1.511400	0.005810
20	96.284027	-0.515193	0.733199	-0.350218	1.510305	0.005822
21	95.897858	-0.567390	0.732770	-0.349185	1.509219	0.005792
22	95.494553	-0.621635	0.732298	-0.348049	1.508004	0.005790
23	95.074341	-0.677854	0.731836	-0.346938	1.506805	0.005804
24	94.637466	-0.735998	0.731425	-0.345948	1.505732	0.005830
25	94.184219	-0.796038	0.731031	-0.345000	1.504722	0.005827
26	93.714828	-0.857903	0.730549	-0.343841	1.503510	0.005796
27	93.229553	-0.921482	0.729985	-0.342485	1.502064	0.005803
28	92.728638	-0.986685	0.729413	-0.341108	1.500599	0.005808
29	92.212341	-1.053459	0.728895	-0.339862	1.499263	0.005828
30	91.680923	-1.121780	0.728421	-0.338723	1.498058	0.005828
31	91.134644	-1.191594	0.727925	-0.337528	1.496801	0.005819
32	90.573761	-1.262822	0.727387	-0.336234	1.495429	0.005830
33	89.998535	-1.335393	0.726815	-0.334859	1.493990	0.005817
34	89.409225	-1.409214	0.726201	-0.333382	1.492449	0.005802
35	88.806091	-1.484191	0.725601	-0.331937	1.490909	0.005834
36	88.189407	-1.560317	0.725086	-0.330698	1.489593	0.005862
37	87.559418	-1.637572	0.724547	-0.329402	1.488273	0.005809
38	86.916428	-1.715837	0.723918	-0.327889	1.486690	0.005815
39	86.260666	-1.795019	0.723299	-0.326399	1.485114	0.005848
40	85.592407	-1.875083	0.722713	-0.324989	1.483654	0.005838
41	84.911942	-1.955977	0.722112	-0.323545	1.482159	0.005831
42	84.219528	-2.037631	0.721487	-0.322040	1.480599	0.005830
43	83.515427	-2.119970	0.720855	-0.320521	1.479026	0.005831
44	82.799927	-2.202941	0.720244	-0.319051	1.477501	0.005842
45	82.073288	-2.286501	0.719647	-0.317615	1.476019	0.005844
46	81.335815	-2.370600	0.719039	-0.316151	1.474513	0.005843
47	80.587753	-2.455165	0.718399	-0.314613	1.472938	0.005834
48	79.829376	-2.540112	0.717737	-0.313021	1.471303	0.005839
49	79.060974	-2.625375	0.717087	-0.311455	1.469692	0.005850
50	78.282837	-2.710910	0.716447	-0.309916	1.468120	0.005850
51	77.495209	-2.796670	0.715795	-0.308349	1.466524	0.005846
52	76.698410	-2.882581	0.715109	-0.306697	1.464854	0.005832
53	75.892685	-2.968552	0.714408	-0.305011	1.463135	0.005838
54	75.078339	-3.054547	0.713758	-0.303446	1.461530	0.005867
55	74.255630	-3.140560	0.713126	-0.301925	1.460004	0.005849
56	73.424866	-3.226509	0.712439	-0.300274	1.458344	0.005837
57	72.586319	-3.312301	0.711728	-0.298564	1.456605	0.005858
58	71.740265	-3.397891	0.711020	-0.296861	1.454897	0.005851
59	70.887009	-3.483205	0.710284	-0.295090	1.453129	0.005836
60	70.026794	-3.568157	0.709550	-0.293323	1.451341	0.005860
61	69.159943	-3.652738	0.708860	-0.291664	1.449671	0.005876
62	68.286728	-3.736912	0.708122	-0.289888	1.447928	0.005833
63	67.407440	-3.820540	0.707295	-0.287898	1.445949	0.005829
64	66.522354	-3.903537	0.706499	-0.285983	1.444018	0.005867
65	65.631760	-3.985905	0.705762	-0.284211	1.442262	0.005867
66	64.735947	-4.067623	0.705012	-0.282407	1.440479	0.005863
67	63.835220	-4.148601	0.704181	-0.280407	1.438520	0.005841
68	62.929840	-4.228698	0.703274	-0.278225	1.436371	0.005839
69	62.020111	-4.307839	0.702398	-0.276117	1.434275	0.005875
70	61.106308	-4.386030	0.701564	-0.274112	1.432314	0.005865
71	60.188751	-4.463216	0.700692	-0.272013	1.430269	0.005853
72	59.267700	-4.539302	0.699765	-0.269784	1.428089	0.005860
73	58.343460	-4.614206	0.698805	-0.267475	1.425840	0.005859
74	57.416321	-4.687847	0.697812	-0.265086	1.423524	0.005853
75	56.486572	-4.760140	0.696803	-0.262658	1.421165	0.005864
76	55.554504	-4.831051	0.695807	-0.260262	1.418839	0.005881
77	54.620422	-4.900533	0.694765	-0.257756	1.416444	0.005852
78	53.684616	-4.968453	0.693627	-0.255017	1.413819	0.005840
79	52.747375	-5.034718	0.692491	-0.252284	1.411174	0.005879
80	51.808990	-5.099324	0.691391	-0.249639	1.408648	0.005877

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-2
	NACA 0012: MACH = 1.2, ALPHA = 0			

81	50.869781	-5.162216	0.690232	-0.246851	1.406006	0.005858
82	49.930008	-5.223271	0.688994	-0.243872	1.403168	0.005869
83	48.990005	-5.282402	0.687713	-0.240791	1.400249	0.005873
84	48.050049	-5.339531	0.686388	-0.237602	1.397246	0.005862
85	47.110458	-5.394568	0.685019	-0.234310	1.394147	0.005868
86	46.171509	-5.447458	0.683645	-0.231003	1.391035	0.005885
87	45.233521	-5.498161	0.682240	-0.227623	1.387884	0.005876
88	44.296783	-5.546580	0.680751	-0.224042	1.384557	0.005865
89	43.361603	-5.592612	0.679204	-0.220320	1.381093	0.005881
90	42.428284	-5.636191	0.677626	-0.216523	1.377582	0.005886
91	41.497131	-5.677249	0.675986	-0.212578	1.373956	0.005877
92	40.568451	-5.715693	0.674274	-0.208459	1.370180	0.005876
93	39.642548	-5.751444	0.672512	-0.204220	1.366306	0.005880
94	38.719727	-5.784445	0.670728	-0.199929	1.362394	0.005894
95	37.800293	-5.814661	0.668912	-0.195561	1.358435	0.005899
96	36.884567	-5.842010	0.666990	-0.190936	1.354280	0.005877
97	35.972839	-5.866369	0.664963	-0.186060	1.349895	0.005888
98	35.065430	-5.887674	0.662899	-0.181094	1.345444	0.005906
99	34.162659	-5.905882	0.660783	-0.176005	1.340924	0.005895
100	33.264816	-5.920918	0.658584	-0.170715	1.336240	0.005896
101	32.372223	-5.932717	0.656325	-0.165280	1.331440	0.005911
102	31.485199	-5.941235	0.654001	-0.159689	1.326542	0.005906
103	30.604050	-5.946396	0.651575	-0.153852	1.321457	0.005896
104	29.729080	-5.948131	0.649072	-0.147832	1.316222	0.005911
105	28.860626	-5.946407	0.646528	-0.141710	1.310930	0.005920
106	27.998978	-5.941193	0.643909	-0.135410	1.305524	0.005916
107	27.144455	-5.932426	0.641186	-0.128860	1.299928	0.005920
108	26.297394	-5.920048	0.638359	-0.122057	1.294149	0.005920
109	25.458069	-5.904007	0.635439	-0.115034	1.288214	0.005928
110	24.626831	-5.884267	0.632437	-0.107813	1.282146	0.005931
111	23.803986	-5.860794	0.629345	-0.100374	1.275934	0.005937
112	22.989822	-5.833555	0.626145	-0.092674	1.269546	0.005935
113	22.184692	-5.802505	0.622822	-0.084681	1.262957	0.005933
114	21.388901	-5.767619	0.619413	-0.076481	1.256226	0.005947
115	20.602753	-5.728903	0.615947	-0.068141	1.249426	0.005957
116	19.826538	-5.686358	0.612390	-0.059584	1.242497	0.005960
117	19.060628	-5.639968	0.608694	-0.050693	1.235346	0.005961
118	18.305237	-5.589691	0.604826	-0.041387	1.227912	0.005958
119	17.560776	-5.535499	0.600806	-0.031717	1.220232	0.005964
120	16.827515	-5.477386	0.596675	-0.021778	1.212390	0.005973
121	16.105759	-5.415383	0.592466	-0.011653	1.204450	0.005987
122	15.395823	-5.349519	0.588148	-0.001266	1.196369	0.005992
123	14.697994	-5.279799	0.583662	0.009527	1.188031	0.005993
124	14.012589	-5.206223	0.578990	0.020767	1.179403	0.006003
125	13.339911	-5.128796	0.574134	0.032450	1.170505	0.006004
126	12.680262	-5.047531	0.569102	0.044555	1.161348	0.006009
127	12.033938	-4.962469	0.563941	0.056970	1.152011	0.006032
128	11.401228	-4.873669	0.558642	0.069718	1.142501	0.006045
129	10.782431	-4.781145	0.553051	0.083169	1.132573	0.006014
130	10.177848	-4.684890	0.547181	0.097290	1.122186	0.006039
131	9.587761	-4.584977	0.541179	0.111730	1.111625	0.006089
132	9.012450	-4.481469	0.534914	0.126800	1.100745	0.006062
133	8.452214	-4.374364	0.528256	0.142818	1.089249	0.006065
134	7.907336	-4.263697	0.521298	0.159558	1.077296	0.006101
135	7.378089	-4.149546	0.514073	0.176940	1.065003	0.006114
136	6.864746	-4.031963	0.506505	0.195146	1.052231	0.006124
137	6.367586	-3.910989	0.498513	0.214373	1.038854	0.006128
138	5.886880	-3.786671	0.490120	0.234563	1.024895	0.006155
139	5.422886	-3.659085	0.481325	0.255721	1.010363	0.006205
140	4.975878	-3.528265	0.471837	0.278548	0.994889	0.006160
141	4.546138	-3.394206	0.461559	0.303272	0.979208	0.006172
142	4.133910	-3.257002	0.450794	0.329171	0.960791	0.006276
143	3.739435	-3.116738	0.439308	0.356802	0.942462	0.006254
144	3.363000	-2.973392	0.426712	0.387104	0.922506	0.006227
145	3.004866	-2.826992	0.413101	0.419848	0.901000	0.006302
146	2.665271	-2.677608	0.398376	0.455274	0.877946	0.006307
147	2.344483	-2.525252	0.382214	0.494153	0.852807	0.006287
148	2.042769	-2.369932	0.364481	0.536815	0.825310	0.006299
149	1.760388	-2.211676	0.345037	0.583592	0.795266	0.006288
150	1.497621	-2.050488	0.323618	0.635120	0.762185	0.006272
151	1.254779	-1.886312	0.299825	0.692359	0.725381	0.006202
152	1.032200	-1.719143	0.273421	0.755881	0.684207	0.006140
153	0.830213	-1.548982	0.244399	0.825698	0.638251	0.006092
154	0.649191	-1.375844	0.212723	0.901903	0.586866	0.006010
155	0.489575	-1.199747	0.178650	0.983872	0.529284	0.005989
156	0.351844	-1.020777	0.142677	1.070414	0.464726	0.005918
157	0.236489	-0.839120	0.106229	1.158096	0.393221	0.005696
158	0.143964	-0.655104	0.071645	1.241297	0.314823	0.005626
159	0.074616	-0.469198	0.041770	1.313166	0.230484	0.005664
160	0.028571	-0.281985	0.019794	1.366035	0.142216	0.005848

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-3
	NACA 0012: MACH = 1.2, ALPHA = 0			

161	0.005686	-0.094065	0.008199	1.393930	0.055963	0.006025
162	0.005686	0.094065	0.008199	1.393930	0.055963	0.006025
163	0.028571	0.281985	0.019794	1.366035	0.142216	0.005848
164	0.074616	0.469198	0.041770	1.313166	0.230484	0.005664
165	0.143964	0.555104	0.071645	1.241297	0.314823	0.005626
166	0.236489	0.339120	0.106229	1.158096	0.393221	0.005696
167	0.351844	1.020777	0.142677	1.070414	0.464726	0.005918
168	0.489575	1.199747	0.178650	0.983872	0.529284	0.005989
169	0.649191	1.375844	0.212723	0.901903	0.586866	0.006010
170	0.830213	1.548982	0.244399	0.825698	0.638251	0.006092
171	1.032200	1.719143	0.273421	0.755081	0.684207	0.006140
172	1.254779	1.886312	0.299825	0.692359	0.725381	0.006202
173	1.497621	2.050480	0.323618	0.635120	0.762185	0.006272
174	1.760388	2.211676	0.345037	0.583592	0.795266	0.006288
175	2.042769	2.369932	0.364481	0.536815	0.825310	0.006299
176	2.344483	2.525252	0.382214	0.494153	0.852807	0.006287
177	2.665271	2.677608	0.398376	0.455274	0.877946	0.006307
178	3.004866	2.826992	0.413101	0.419848	0.901000	0.006302
179	3.363000	2.973392	0.426712	0.387104	0.922506	0.006227
180	3.739435	3.116738	0.439308	0.356802	0.942462	0.006254
181	4.133910	3.257002	0.450754	0.329171	0.960791	0.006276
182	4.546138	3.394206	0.461559	0.303272	0.978208	0.006172
183	4.975878	3.528265	0.471837	0.278548	0.994889	0.006160
184	5.422886	3.659085	0.481325	0.255721	1.010363	0.006205
185	5.886880	3.786671	0.490120	0.234563	1.024895	0.006155
186	6.367586	3.910989	0.498513	0.214373	1.038854	0.006128
187	6.864746	4.031963	0.506505	0.195146	1.052231	0.006124
188	7.378089	4.149546	0.514073	0.176940	1.065003	0.006114
189	7.907336	4.263697	0.521298	0.159558	1.077296	0.006101
190	8.452214	4.374364	0.528256	0.142818	1.089249	0.006065
191	9.012450	4.481469	0.534914	0.126800	1.100745	0.006062
192	9.587761	4.584977	0.541179	0.111730	1.111625	0.006089
193	10.177848	4.684890	0.547181	0.097290	1.122186	0.006039
194	10.782431	4.781145	0.553051	0.083169	1.132573	0.006014
195	11.401228	4.873669	0.558642	0.069718	1.142501	0.006045
196	12.033938	4.962469	0.563941	0.056970	1.152011	0.006032
197	12.680262	5.047531	0.569102	0.044555	1.161348	0.006009
198	13.339911	5.128796	0.574134	0.032450	1.170505	0.006004
199	14.012589	5.206223	0.578990	0.020767	1.179403	0.006003
200	14.697994	5.279799	0.583662	0.009527	1.188031	0.005993
201	15.395823	5.349519	0.588148	-0.001266	1.196369	0.005992
202	16.105759	5.415383	0.592466	-0.011653	1.204450	0.005987
203	16.827515	5.477386	0.596675	-0.021778	1.212390	0.005973
204	17.560776	5.535495	0.600806	-0.031717	1.220232	0.005964
205	18.305237	5.589691	0.604826	-0.041387	1.227912	0.005958
206	19.060658	5.639968	0.608694	-0.050693	1.235346	0.005961
207	19.826538	5.686358	0.612390	-0.059584	1.242497	0.005960
208	20.602753	5.728903	0.615947	-0.068141	1.249425	0.005957
209	21.388901	5.767619	0.619413	-0.076481	1.256226	0.005947
210	22.184692	5.802505	0.622822	-0.084681	1.262957	0.005933
211	22.989822	5.833555	0.626145	-0.092674	1.269546	0.005935
212	23.803986	5.860794	0.629345	-0.100374	1.275934	0.005937
213	24.626831	5.884267	0.632437	-0.107813	1.282146	0.005931
214	25.458069	5.904007	0.635439	-0.115034	1.288214	0.005928
215	26.297394	5.920048	0.638359	-0.122057	1.294149	0.005920
216	27.144455	5.932426	0.641186	-0.128860	1.299928	0.005920
217	27.998978	5.941193	0.643909	-0.135410	1.305524	0.005916
218	28.860626	5.946407	0.646528	-0.141710	1.310930	0.005920
219	29.729080	5.948131	0.649072	-0.147832	1.316222	0.005911
220	30.604050	5.946396	0.651575	-0.153852	1.321457	0.005896
221	31.485199	5.941235	0.654001	-0.159689	1.326542	0.005906
222	32.372223	5.932717	0.656325	-0.165280	1.331440	0.005911
223	33.264816	5.920918	0.658584	-0.170715	1.336240	0.005896
224	34.162659	5.905882	0.660783	-0.176005	1.340924	0.005895
225	35.065430	5.887674	0.662899	-0.181094	1.345444	0.005906
226	35.972839	5.866369	0.664963	-0.186060	1.349895	0.005888
227	36.884567	5.842010	0.666990	-0.190936	1.354280	0.005877
228	37.800293	5.814661	0.668912	-0.195561	1.358435	0.005898
229	38.719727	5.784445	0.670728	-0.199929	1.362394	0.005894
230	39.642548	5.751444	0.672512	-0.204220	1.366306	0.005880
231	40.568451	5.715693	0.674274	-0.208455	1.370180	0.005876
232	41.497131	5.677249	0.675986	-0.212578	1.373956	0.005877
233	42.428284	5.636191	0.677626	-0.216523	1.377582	0.005886
234	43.361603	5.592612	0.679204	-0.220320	1.381093	0.005881
235	44.296783	5.546580	0.680751	-0.224042	1.384557	0.005865
236	45.233521	5.498161	0.682240	-0.227623	1.387884	0.005876
237	46.171509	5.447458	0.683645	-0.231003	1.391035	0.005885
238	47.110458	5.394568	0.685019	-0.234310	1.394147	0.005868
239	48.050049	5.339531	0.686388	-0.237602	1.397246	0.005862
240	48.990005	5.282402	0.687713	-0.240791	1.400249	0.005873

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-4
	NACA 0012: MACH = 1.2, ALPHA = 0			

241	49.930008	5.223271	0.688994	-0.243872	1.403168	0.005869
242	50.869781	5.162216	0.690232	-0.246851	1.406006	0.005858
243	51.808990	5.099324	0.691391	-0.249639	1.408648	0.005877
244	52.747375	5.034718	0.692491	-0.252284	1.411174	0.005879
245	53.684616	4.968453	0.693627	-0.255017	1.413819	0.005840
246	54.620422	4.900533	0.694765	-0.257756	1.416444	0.005852
247	55.554504	4.831051	0.695807	-0.260262	1.418839	0.005881
248	56.486572	4.760140	0.696803	-0.262658	1.421165	0.005864
249	57.416321	4.687847	0.697812	-0.265086	1.423524	0.005853
250	58.343460	4.614206	0.698805	-0.267475	1.425840	0.005859
251	59.267700	4.539302	0.699765	-0.269784	1.428089	0.005860
252	60.188751	4.463216	0.700692	-0.272013	1.430269	0.005853
253	61.106308	4.386030	0.701564	-0.274112	1.432314	0.005865
254	62.020111	4.307839	0.702398	-0.276117	1.434275	0.005875
255	62.929840	4.228698	0.703274	-0.278225	1.436371	0.005839
256	63.835220	4.148601	0.704181	-0.280407	1.438520	0.005841
257	64.735947	4.067623	0.705012	-0.282407	1.440479	0.005863
258	65.631760	3.985905	0.705762	-0.284211	1.442262	0.005867
259	66.522354	3.903537	0.706499	-0.285983	1.444018	0.005867
260	67.407440	3.820540	0.707295	-0.287898	1.445949	0.005829
261	68.286728	3.736912	0.708122	-0.289888	1.447928	0.005833
262	69.159943	3.652738	0.708860	-0.291664	1.449671	0.005876
263	70.026794	3.568157	0.709550	-0.293323	1.451341	0.005860
264	70.887009	3.483205	0.710284	-0.295090	1.453129	0.005836
265	71.740265	3.397891	0.711020	-0.296861	1.454897	0.005851
266	72.586319	3.312301	0.711728	-0.298564	1.456605	0.005858
267	73.424866	3.226509	0.712439	-0.300274	1.458344	0.005837
268	74.255630	3.140560	0.713126	-0.301925	1.460004	0.005849
269	75.078339	3.054547	0.713758	-0.303446	1.461530	0.005867
270	75.892685	2.968552	0.714408	-0.305011	1.463135	0.005838
271	76.698410	2.882581	0.715109	-0.306697	1.464854	0.005832
272	77.495209	2.796670	0.715795	-0.308349	1.466524	0.005846
273	78.282837	2.710910	0.716447	-0.309916	1.468120	0.005850
274	79.060974	2.625375	0.717087	-0.311455	1.469692	0.005850
275	79.829376	2.540112	0.717737	-0.313021	1.471303	0.005839
276	80.587753	2.455165	0.718359	-0.314613	1.472938	0.005834
277	81.335815	2.370600	0.719039	-0.316151	1.474513	0.005843
278	82.073288	2.286501	0.719647	-0.317615	1.476019	0.005844
279	82.799927	2.202941	0.720244	-0.319051	1.477501	0.005842
280	83.515427	2.119970	0.720855	-0.320521	1.479026	0.005831
281	84.219528	2.037631	0.721487	-0.322040	1.480599	0.005830
282	84.911942	1.955977	0.722112	-0.323545	1.482159	0.005831
283	85.592407	1.875083	0.722713	-0.324989	1.483654	0.005838
284	86.260666	1.795019	0.723299	-0.326399	1.485114	0.005848
285	86.916428	1.715837	0.723918	-0.327889	1.486690	0.005815
286	87.559418	1.637572	0.724547	-0.329402	1.488273	0.005809
287	88.189407	1.560317	0.725086	-0.330698	1.489593	0.005862
288	88.806091	1.484191	0.725601	-0.331937	1.490909	0.005834
289	89.409225	1.409214	0.726201	-0.333382	1.492449	0.005802
290	89.998535	1.335393	0.726815	-0.334859	1.493990	0.005817
291	90.573761	1.262822	0.727387	-0.336234	1.495429	0.005830
292	91.134644	1.191594	0.727925	-0.337528	1.496801	0.005819
293	91.680923	1.121780	0.728421	-0.338723	1.498058	0.005828
294	92.212341	1.053459	0.728895	-0.339862	1.499263	0.005828
295	92.728638	0.986685	0.729413	-0.341108	1.500599	0.005808
296	93.229553	0.921482	0.729985	-0.342485	1.502064	0.005803
297	93.714828	0.857903	0.730549	-0.343841	1.503510	0.005796
298	94.184219	0.796038	0.731031	-0.345000	1.504722	0.005827
299	94.637466	0.735998	0.731425	-0.345948	1.505732	0.005830
300	95.074341	0.677854	0.731836	-0.346938	1.506805	0.005804
301	95.494553	0.621635	0.732298	-0.348049	1.508004	0.005790
302	95.897858	0.567390	0.732770	-0.349185	1.509219	0.005792
303	96.284027	0.515193	0.733199	-0.350218	1.510305	0.005822
304	96.652786	0.465119	0.733620	-0.351230	1.511400	0.005810
305	97.003891	0.417216	0.734065	-0.352301	1.512605	0.005733
306	97.337082	0.371551	0.734380	-0.353058	1.513327	0.005868
307	97.652130	0.328249	0.734599	-0.353585	1.513923	0.005828
308	97.948761	0 287339	0.735031	-0.354623	1.515112	0.005725
309	98.226700	0.248813	0.735435	-0.355595	1.516151	0.005740
310	98.485703	0.212798	0.735646	-0.356104	1.516552	0.005958
311	98.725494	0.179389	0.735880	-0.356666	1.517410	0.005596
312	98.945786	0.148593	0.736229	-0.357507	1.518021	0.006029
313	99.146286	0.120481	0.736341	-0.357776	1.518752	0.005392
314	99.326721	0.095145	0.736629	-0.358468	1.518799	0.006408
315	99.486725	0.072632	0.736502	-0.358163	1.519408	0.005050
316	99.625946	0.052983	0.737382	-0.360273	1.520443	0.006878
317	99.744003	0.036276	0.737537	-0.360652	1.523432	0.003135
318	99.840439	0.022620	0.736860	-0.359023	1.516755	0.010228
319	99.914658	0.012110	0.732111	-0.347599	1.505971	0.008026
320	99.965897	0.004846	0.717141	-0.311585	1.433684	0.055915
321	99.992828	0.001020	0.574604	0.031319	1.151928	0.030439

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-5
	NACA 0012: MACH = 1.2, ALPHA = 0			

NACA 0012 M=1.20, ALPHA=0.0
VALUES ON X-AXIS UPSTREAM OF LEADING EDGE

J	X/C(%)	Z/C(%)	1-P/PINF	CP	MACH	1-PI/PINF
2	-0.066177	0.000000	0.008071	1.394238	0.054231	0.006030
3	-0.204744	0.000000	0.012585	1.383377	0.093981	0.006468
4	-0.356041	0.000000	0.018869	1.368261	0.137970	0.005733
5	-0.520694	0.000000	0.027994	1.346309	0.178299	0.006194
6	-0.699376	0.000000	0.037634	1.323117	0.215733	0.005916
7	-0.892805	0.000000	0.048279	1.297507	0.249905	0.006020
8	-1.101754	0.000000	0.059164	1.271322	0.281451	0.005954
9	-1.327055	0.000000	0.070282	1.244576	0.310597	0.005971
10	-1.569596	0.000000	0.081400	1.217828	0.337689	0.005962
11	-1.830337	0.000000	0.092449	1.191248	0.362960	0.005967
12	-2.110308	0.000000	0.103348	1.165028	0.386635	0.005965
13	-2.410620	0.000000	0.114055	1.139268	0.408891	0.005966
14	-2.732471	0.000000	0.124542	1.114040	0.429886	0.005964
15	-3.077155	0.000000	0.134792	1.089382	0.449752	0.005964
16	-3.446071	0.000000	0.144795	1.065317	0.468605	0.005965
17	-3.840734	0.000000	0.154550	1.041850	0.486546	0.005963
18	-4.262787	0.000000	0.164057	1.018977	0.503662	0.005965
19	-4.714013	0.000000	0.173323	0.996689	0.520030	0.005964
20	-5.196353	0.000000	0.182353	0.974965	0.535720	0.005964
21	-5.711921	0.000000	0.191155	0.953789	0.550791	0.005965
22	-6.263024	0.000000	0.199740	0.933137	0.565299	0.005965
23	-6.852186	0.000000	0.208117	0.912983	0.579293	0.005966
24	-7.482173	0.000000	0.216298	0.893302	0.592819	0.005966
25	-8.156018	0.000000	0.224294	0.874067	0.605917	0.005969
26	-8.877065	0.000000	0.232116	0.855249	0.618626	0.005969
27	-9.648993	0.000000	0.239775	0.836822	0.630981	0.005969
28	-10.475878	0.000000	0.247285	0.818756	0.643016	0.005970
29	-11.362229	0.000000	0.254657	0.801020	0.654761	0.005970
30	-12.313064	0.000000	0.261904	0.783586	0.666249	0.005973
31	-13.333968	0.000000	0.269039	0.766421	0.677507	0.005973
32	-14.431187	0.000000	0.276077	0.749491	0.688567	0.005972
33	-15.611721	0.000000	0.283033	0.732757	0.699459	0.005976
34	-16.883438	0.000000	0.289918	0.716192	0.710209	0.005977
35	-18.255249	0.000000	0.296742	0.699776	0.720840	0.005975
36	-19.737213	0.000000	0.303545	0.683410	0.731409	0.005976
37	-21.340790	0.000000	0.310398	0.666924	0.742015	0.005994
38	-23.079071	0.000000	0.317292	0.650339	0.752660	0.006025
39	-24.967102	0.000000	0.323936	0.634355	0.762995	0.005969
40	-27.022202	0.000000	0.330478	0.618617	0.773228	0.005851
41	-29.264465	0.000000	0.338408	0.599540	0.785240	0.006078
42	-31.717346	0.000000	0.348613	0.574989	0.800186	0.006882
43	-34.408340	0.000000	0.356552	0.555890	0.812144	0.007200
44	-37.369934	0.000000	0.369462	0.524833	0.831197	0.008151
45	-40.640778	0.000000	0.427220	0.385884	0.914977	0.015301
46	-44.267197	0.000000	0.509149	0.188785	1.048935	0.015368
47	-48.305267	0.000000	0.566941	0.049753	1.156981	0.006589
48	-52.823441	0.000000	0.583245	0.010530	1.190951	0.001219
49	-57.906250	0.000000	0.586377	0.002996	1.197394	0.000381
50	-63.659195	0.000000	0.587569	0.000128	1.200059	-0.000206
51	-70.215820	0.000000	0.587418	0.000491	1.199773	-0.000199
52	-77.747650	0.000000	0.587007	0.001480	1.198887	-0.000038
53	-86.478714	0.000000	0.586822	0.001924	1.198504	0.000012
54	-96.707367	0.000000	0.586868	0.001814	1.198582	0.000022
55	-108.839966	0.000000	0.586982	0.001541	1.198809	0.000000
56	-123.444702	0.000000	0.587065	0.001341	1.198975	-0.000012
57	-141.341370	0.000000	0.587102	0.001251	1.199046	-0.000015
58	-163.758469	0.000000	0.587113	0.001224	1.199065	-0.000014
59	-192.625519	0.000000	0.587117	0.001215	1.199071	-0.000012
60	-231.159912	0.000000	0.587124	0.001198	1.199083	-0.000010
61	-285.167480	0.000000	0.587138	0.001166	1.199107	-0.000010
62	-366.344727	0.000000	0.587157	0.001118	1.199144	-0.000011
63	-502.499512	0.000000	0.587185	0.001053	1.199196	-0.000013
64	-781.729248	0.000000	0.587222	0.000963	1.199265	-0.000010
65	-1762.49097	0.000000	0.587271	0.000845	1.199351	-0.000006

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-6
	NACA 0012: MACH = 1.2, ALPHA = 0			

NACA 0012 M=1.20, ALPHA=0.0
VALUES ON X-AXIS DOWNSTREAM OF TRAILING EDGE

J	X/C(%)	Z/C(%)	1-P/PINF	CP	MACH	1-PI/PINF
2	100.004654	0.0	0.577604	0.024102	1.157489	0.030418
3	100.022430	0.0	0.525920	0.148438	1.051915	0.045588
4	100.056946	0.0	0.535147	0.126241	1.057587	0.057733
5	100.108124	0.0	0.571943	0.037720	1.123578	0.058748
6	100.176270	0.0	0.586743	0.002115	1.151154	0.059036
7	100.261856	0.0	0.606181	-0.044647	1.188363	0.059352
8	100.365479	0.0	0.620036	-0.077978	1.216063	0.059020
9	100.487854	0.0	0.623458	-0.086211	1.224380	0.057233
10	100.629761	0.0	0.618633	-0.074602	1.216308	0.055242
11	100.792053	0.0	0.611861	-0.058311	1.205653	0.051802
12	100.975723	0.0	0.607373	-0.047514	1.200749	0.046964
13	101.181778	0.0	0.605574	-0.043188	1.199582	0.044054
14	101.411392	0.0	0.606378	-0.045122	1.202895	0.041870
15	101.665817	0.0	0.607281	-0.047294	1.206164	0.039973
16	101.946396	0.0	0.607705	-0.048314	1.208289	0.038339
17	102.254608	0.0	0.607834	-0.048624	1.209571	0.037040
18	102.592087	0.0	0.607758	-0.048441	1.210326	0.035899
19	102.960571	0.0	0.607608	-0.048081	1.210860	0.034857
20	103.361984	0.0	0.607384	-0.047541	1.211231	0.033836
21	103.798431	0.0	0.607138	-0.046949	1.211588	0.032779
22	104.272171	0.0	0.606957	-0.046515	1.212008	0.031800
23	104.785736	0.0	0.606850	-0.046258	1.212499	0.030911
24	105.341873	0.0	0.606776	-0.046080	1.212981	0.030117
25	105.943604	0.0	0.606686	-0.045863	1.213378	0.029389
26	106.594238	0.0	0.606559	-0.045556	1.213657	0.028718
27	107.297485	0.0	0.606397	-0.045166	1.213844	0.028081
28	108.057373	0.0	0.606215	-0.044728	1.213981	0.027456
29	108.878433	0.0	0.606025	-0.044272	1.214091	0.026847
30	109.765671	0.0	0.605835	-0.043816	1.214186	0.026258
31	110.724655	0.0	0.605643	-0.043352	1.214252	0.025696
32	111.761627	0.0	0.605433	-0.042848	1.214264	0.025164
33	112.883591	0.0	0.605199	-0.042285	1.214211	0.024653
34	114.098419	0.0	0.604946	-0.041675	1.214108	0.024160
35	115.414993	0.0	0.604689	-0.041057	1.213986	0.023679
36	116.843399	0.0	0.604440	-0.040459	1.213871	0.023214
37	118.395096	0.0	0.604191	-0.039859	1.213739	0.022766
38	120.083160	0.0	0.603915	-0.039196	1.213545	0.022336
39	121.922623	0.0	0.603600	-0.038437	1.213262	0.021921
40	123.930847	0.0	0.603253	-0.037604	1.212914	0.021513
41	126.127914	0.0	0.602898	-0.036748	1.212543	0.021113
42	128.537262	0.0	0.602540	-0.035889	1.212159	0.020725
43	131.186401	0.0	0.602172	-0.035003	1.211747	0.020346
44	134.107819	0.0	0.601780	-0.034058	1.211284	0.019976
45	137.340179	0.0	0.601353	-0.033032	1.210748	0.019614
46	140.929810	0.0	0.600889	-0.031915	1.210134	0.019263
47	144.932770	0.0	0.600404	-0.030748	1.209479	0.018913
48	149.417572	0.0	0.599928	-0.029604	1.208844	0.018561
49	154.468674	0.0	0.599472	-0.028506	1.208246	0.018210
50	160.191650	0.0	0.598990	-0.027348	1.207592	0.017873
51	166.720047	0.0	0.598400	-0.025928	1.206716	0.017553
52	174.225357	0.0	0.597649	-0.024122	1.205526	0.017247
53	182.931641	0.0	0.596784	-0.022042	1.204126	0.016935
54	193.137253	0.0	0.595945	-0.020023	1.202787	0.016612
55	205.248581	0.0	0.595292	-0.018450	1.201819	0.016267
56	219.833817	0.0	0.594911	-0.017533	1.201400	0.015878
57	237.712753	0.0	0.594708	-0.017047	1.201343	0.015461
58	260.113770	0.0	0.594325	-0.016126	1.200914	0.015080
59	288.966797	0.0	0.593248	-0.013534	1.199023	0.014897
60	327.488770	0.0	0.591175	-0.008547	1.195127	0.014891
61	381.486084	0.0	0.588401	-0.001872	1.190110	0.014651
62	462.654297	0.0	0.585878	0.004197	1.185483	0.014545
63	598.802246	0.0	0.584380	0.007801	1.182818	0.014385
64	878.027344	0.0	0.583614	0.009642	1.183614	0.011552
65	1858.78564	0.0	0.583287	0.010430	1.185865	0.007886

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-7
	NACA 0012: MACH = 1.2, ALPHA = 0			

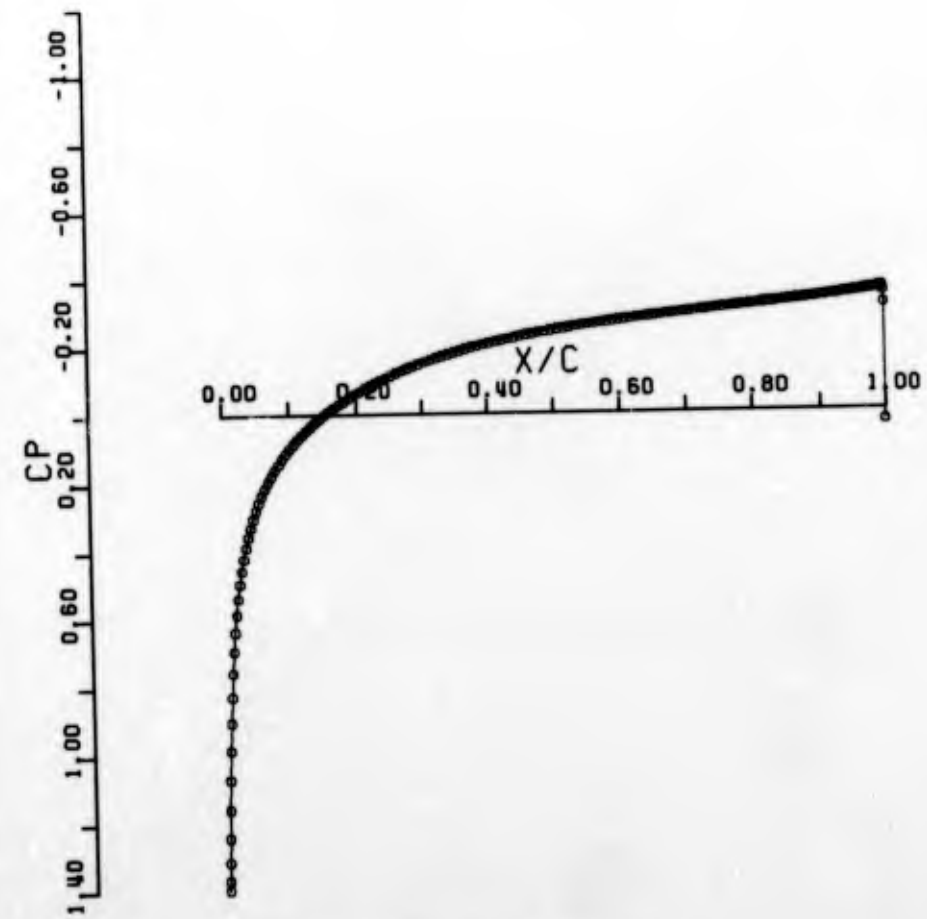


FIG. : CP(X/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-8
	NACA 0012: MACH = 1.2, ALPHA = 0			

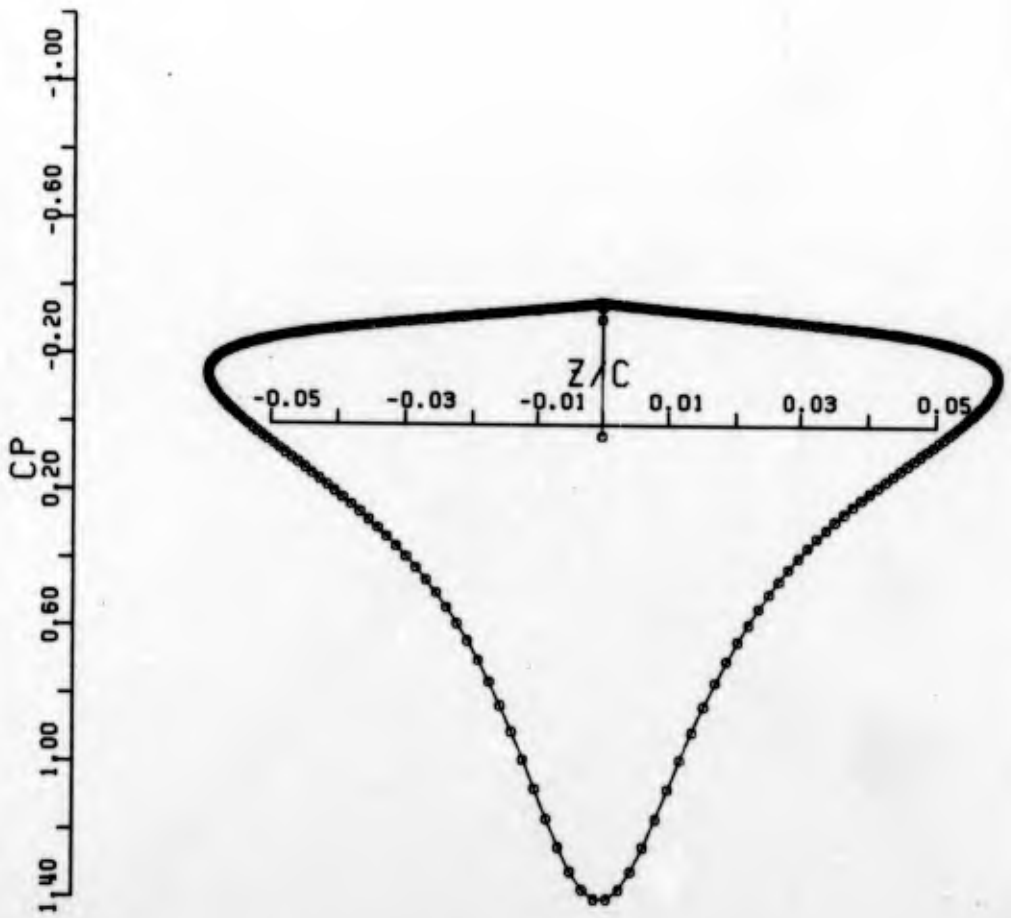


FIG. : CP(Z/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-9
	NACA 0012: MACH = 1.2, ALPHA = 0			

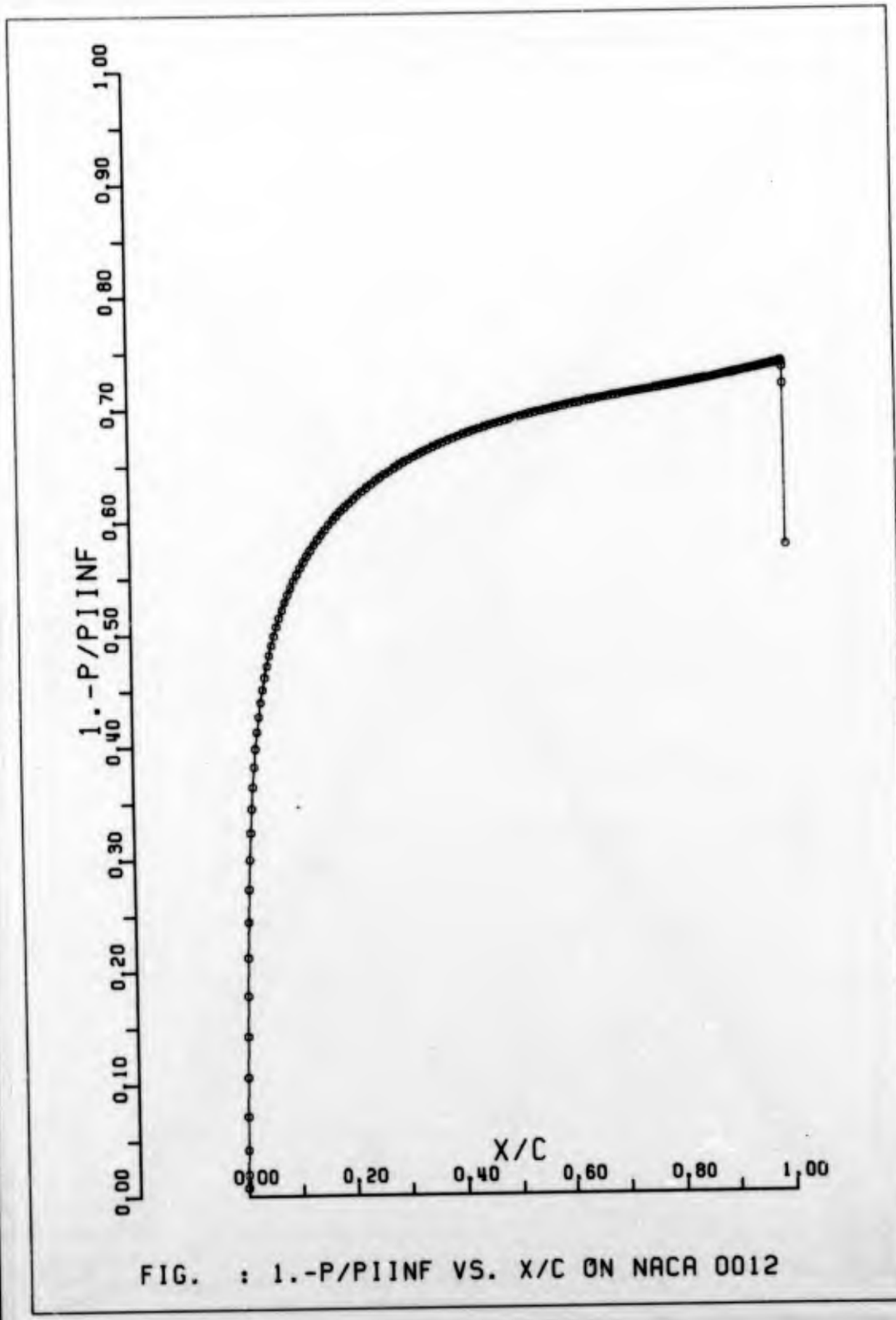


FIG. : 1.-P/PIINF VS. X/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-10
	NACA 0012: MACH = 1.2, ALPHA = 0			

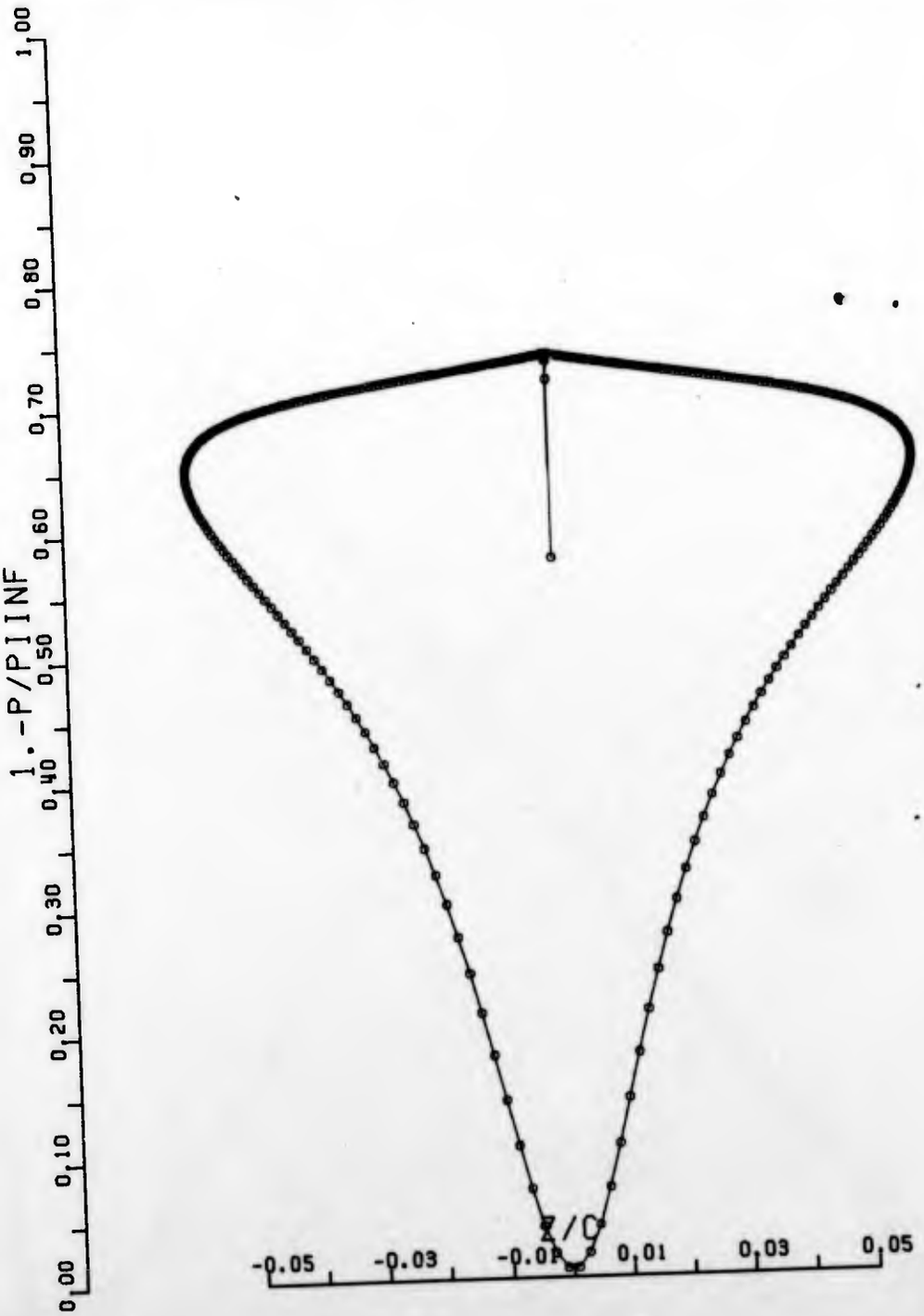


FIG. : 1.-P/PIINF VS. Z/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-11
	NACA 0012: MACH = 1.2, ALPHA = 0			

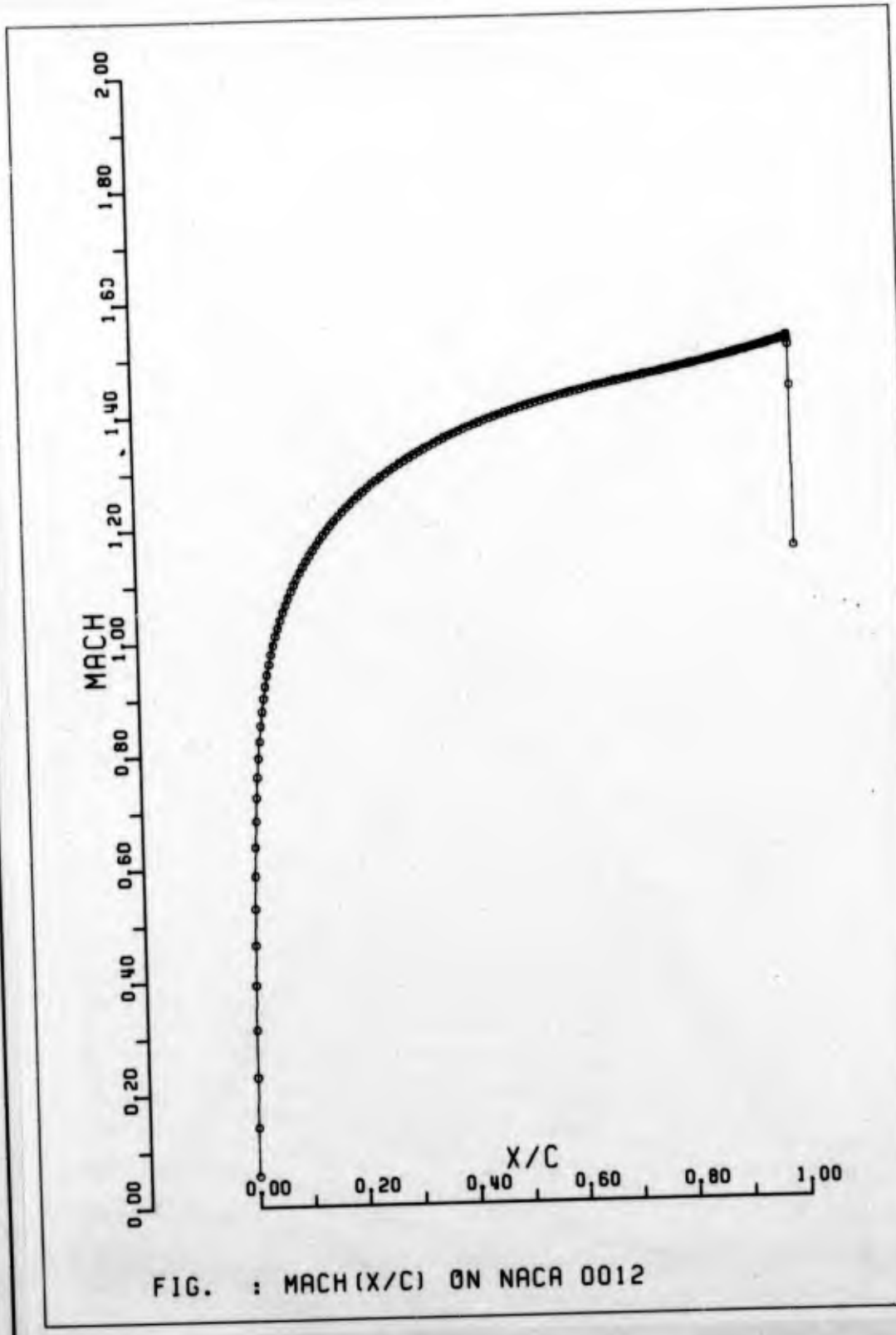


FIG. : MACH(X/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-12
	NACA 0012: MACH = 1.2, ALPHA = 0			

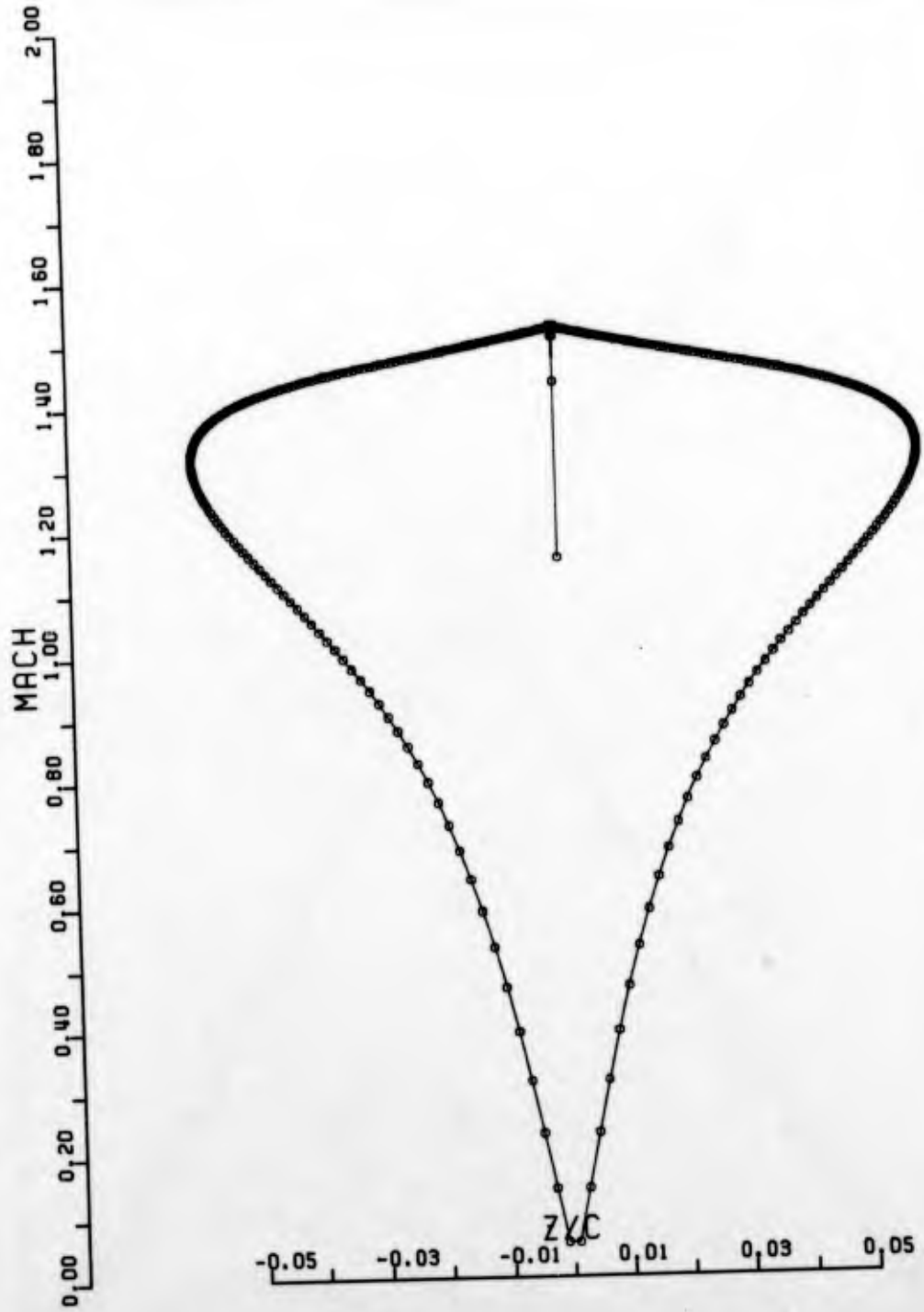


FIG. : MACH(Z/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-13
	NACA 0012: MACH = 1.2, ALPHA = 0			

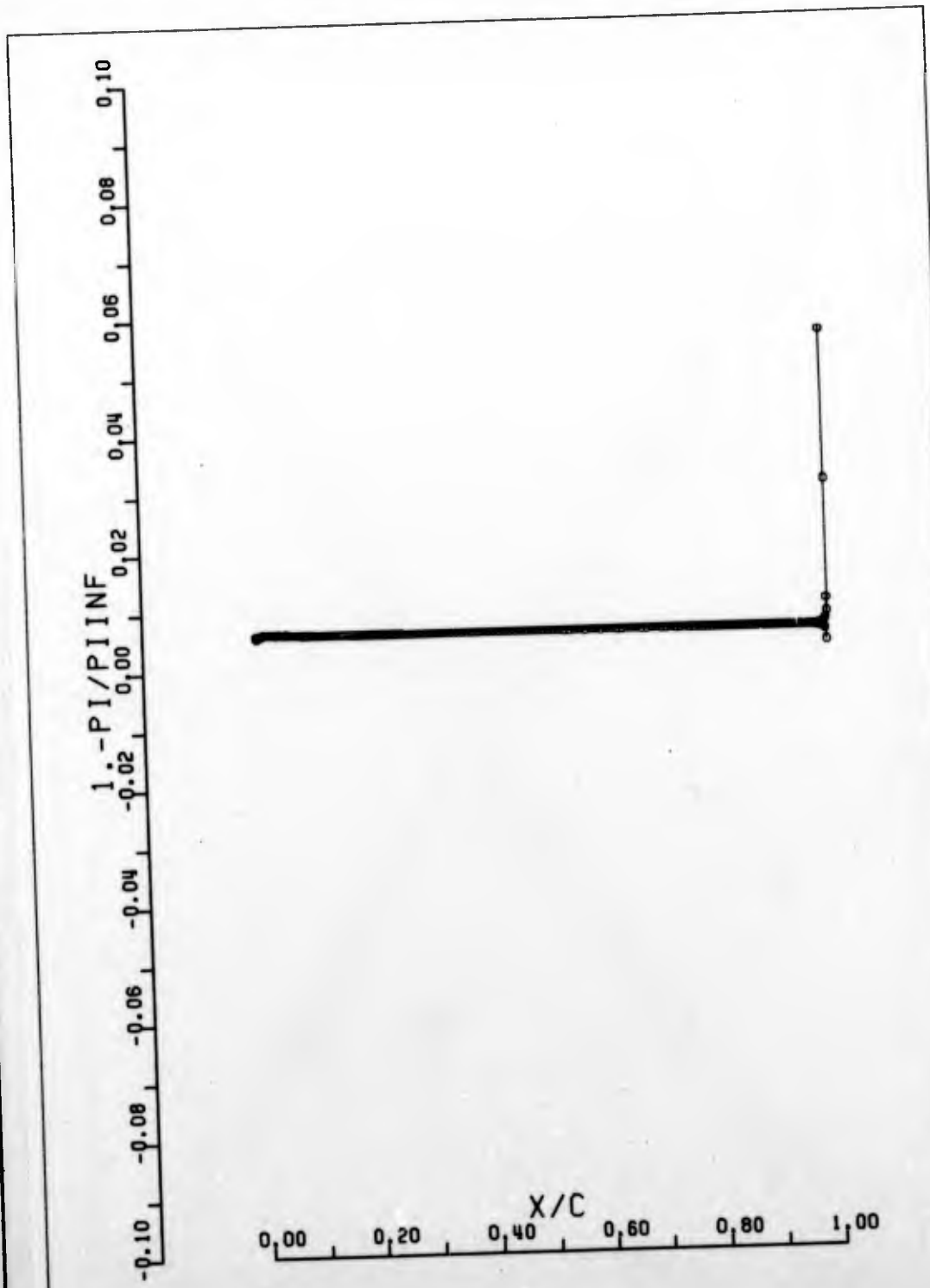


FIG. : 1.-PI/PIINF VS. X/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-14
	NACA 0012: MACH = 1.2, ALPHA = 0			

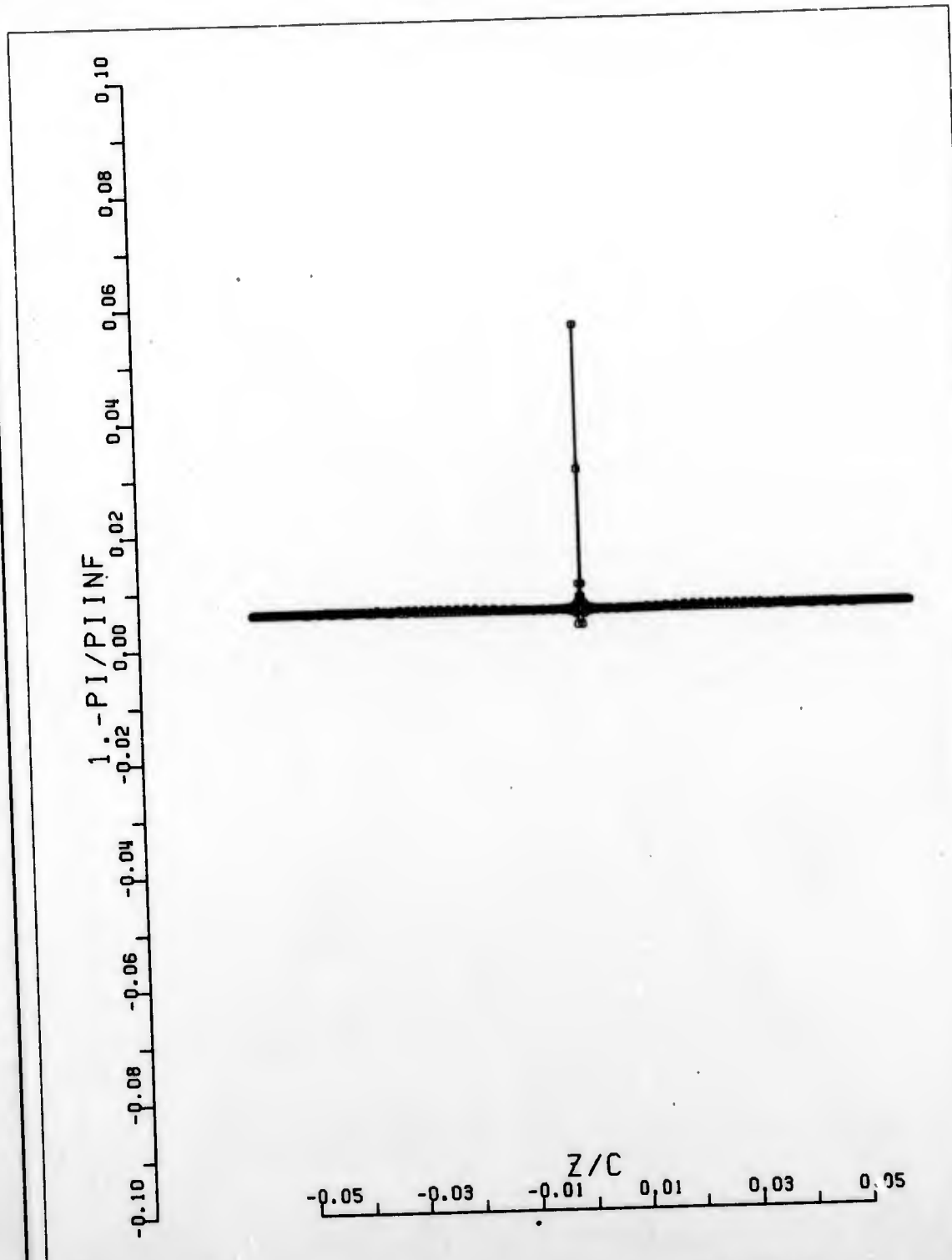
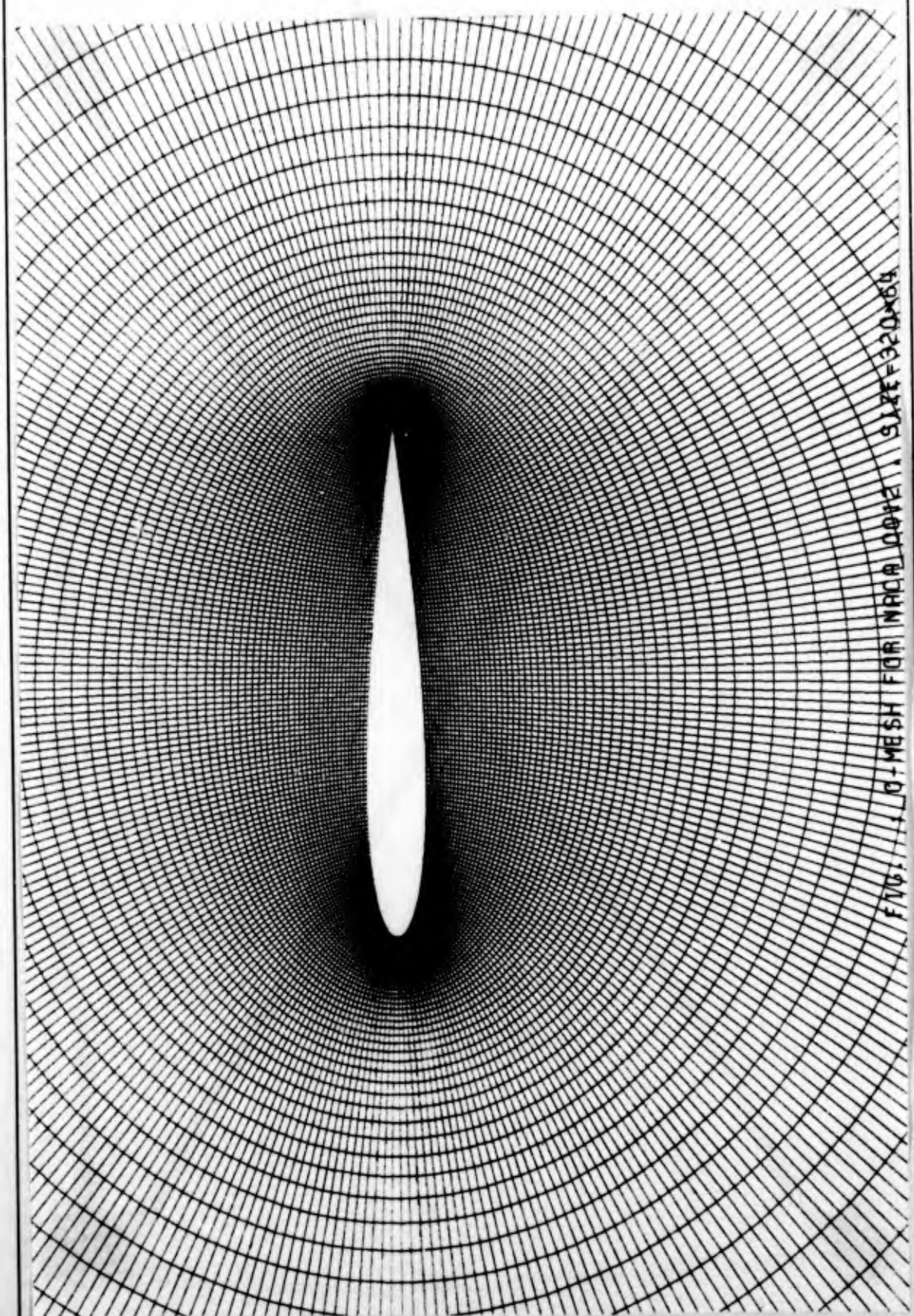
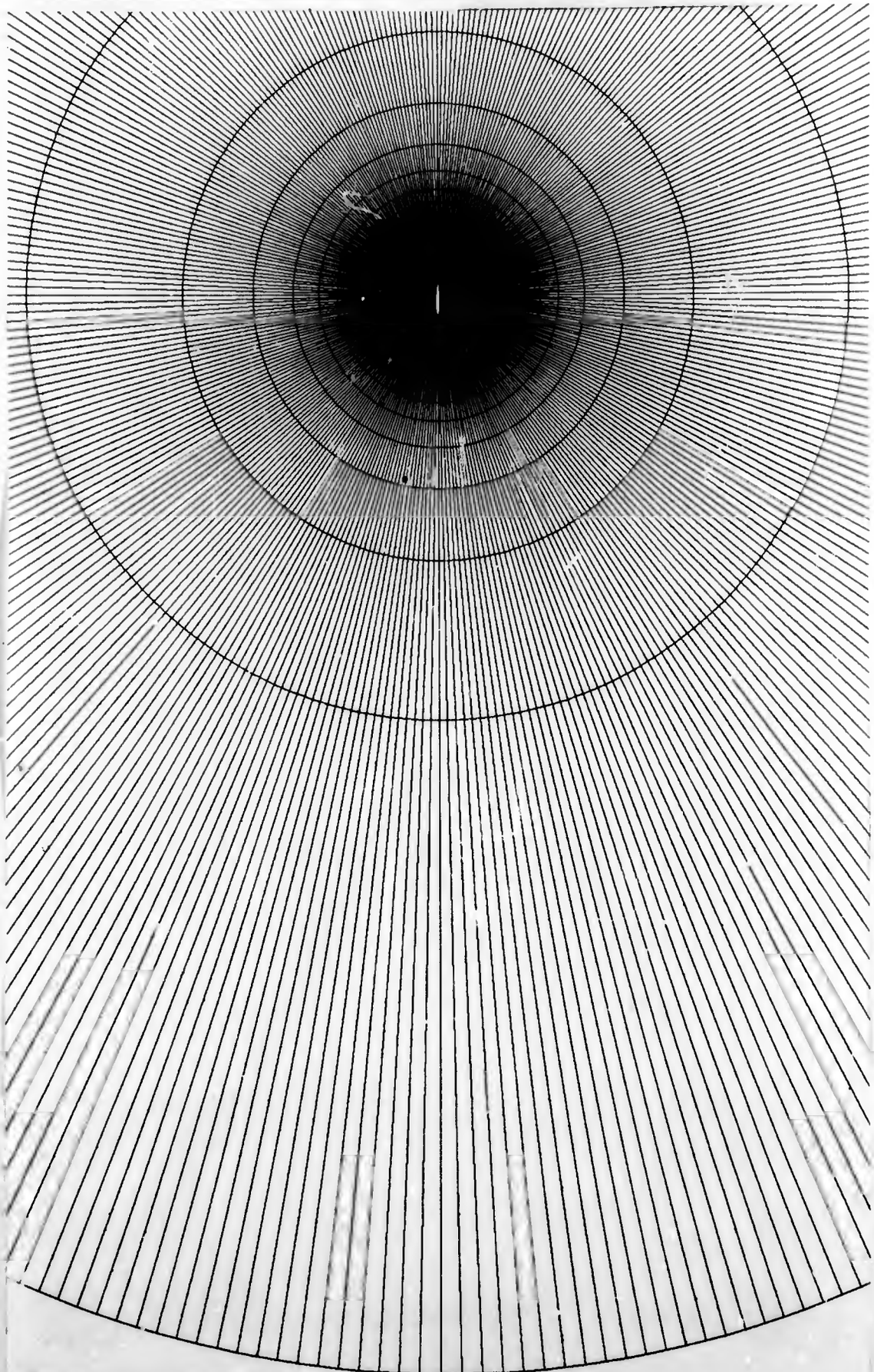


FIG. : 1.-PI/PIINF VS. Z/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-15
	NACA 0012: MACH = 1.2, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-16
	NACA 0012: MACH = 1.2, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-17
	NACA 0012: MACH = 1.2, ALPHA = 0			

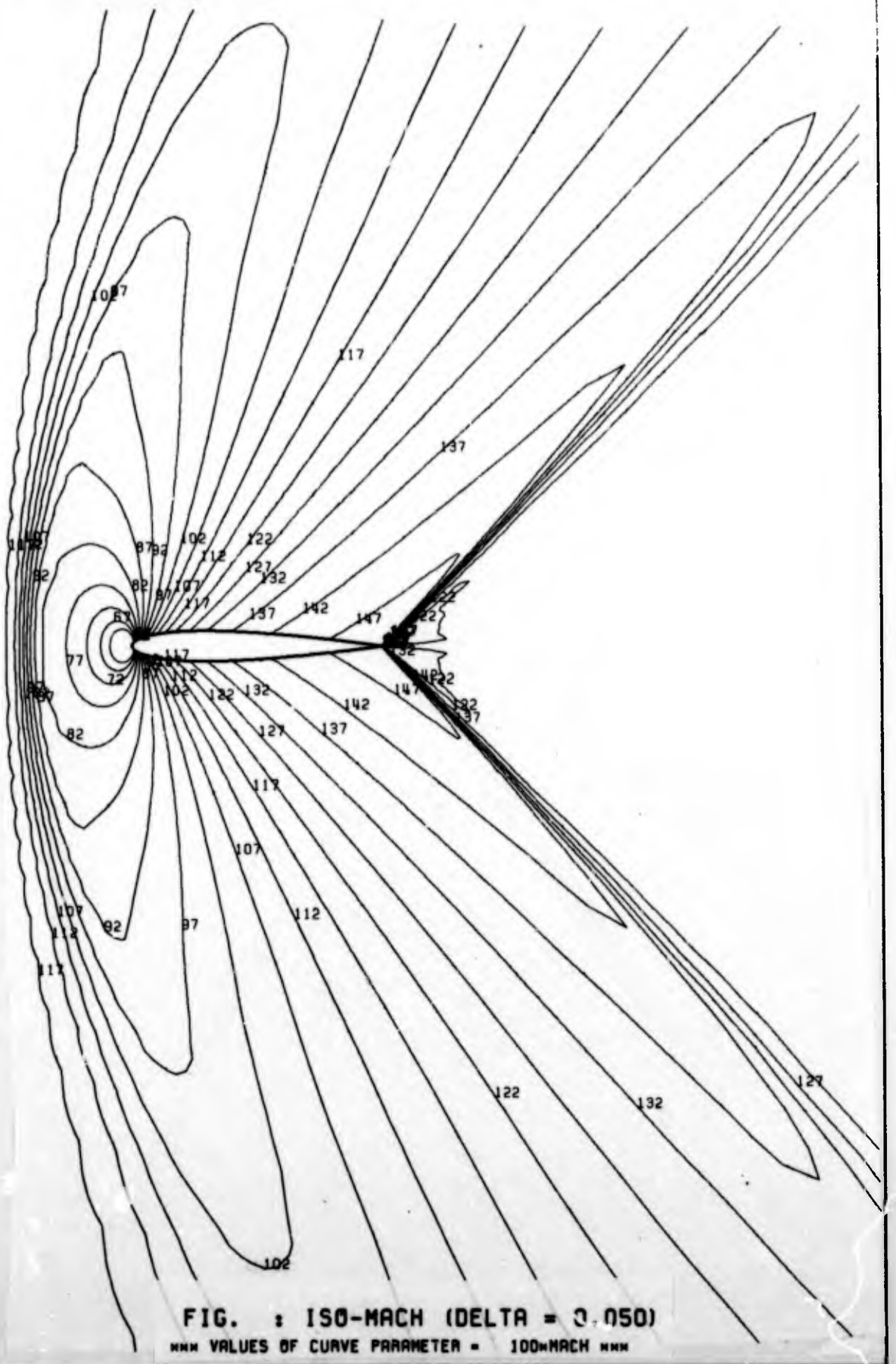
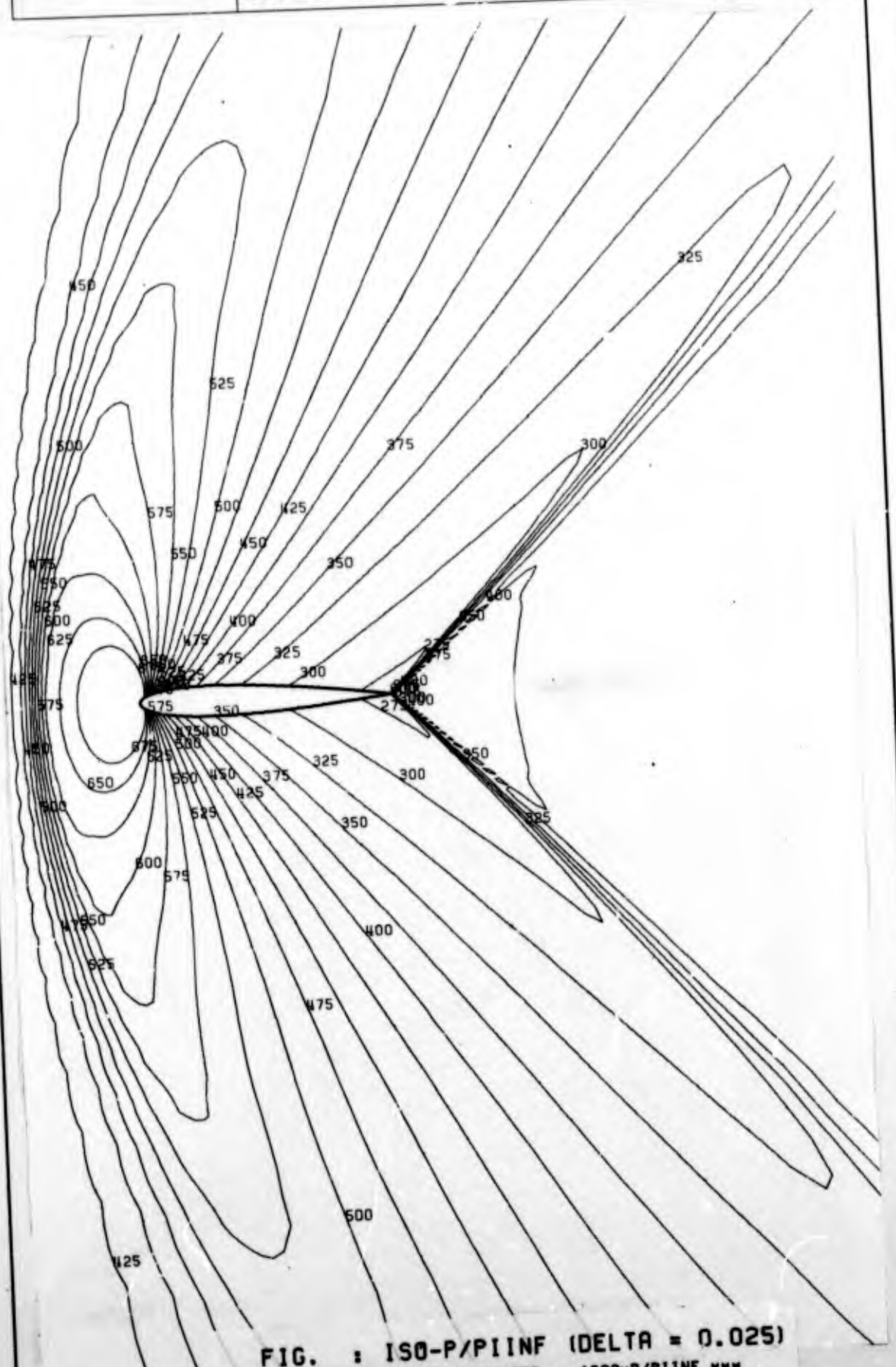


FIG. : ISO-MACH (DELTA = 0.050)

nnn VALUES OF CURVE PARAMETER = 100*MACH nnn

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-18
	NACA 0012: MACH = 1.2, ALPHA = 0			


450
625
600
575
650
625
600
625
575
650
600
575
650
625
600
575
650
625
600
575
650
625

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-19
	NACA 0012: MACH = 1.2, ALPHA = 0			

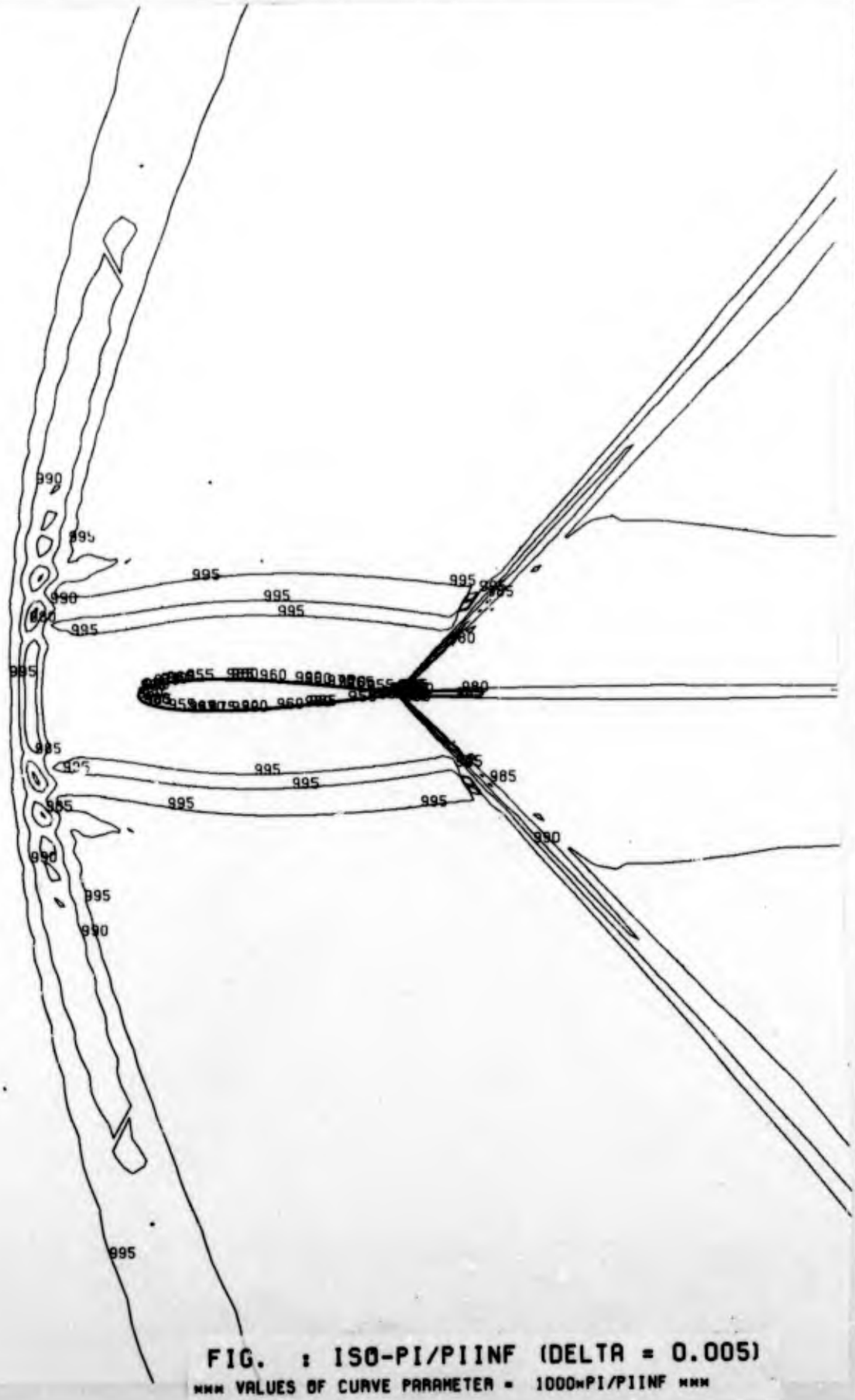


FIG. : ISO-PI/PIINF (DELTA = 0.005)

**** VALUES OF CURVE PARAMETER = 1000*PI/PIINF ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-20
	NACA 0012: MACH = 1.2, ALPHA = 0			

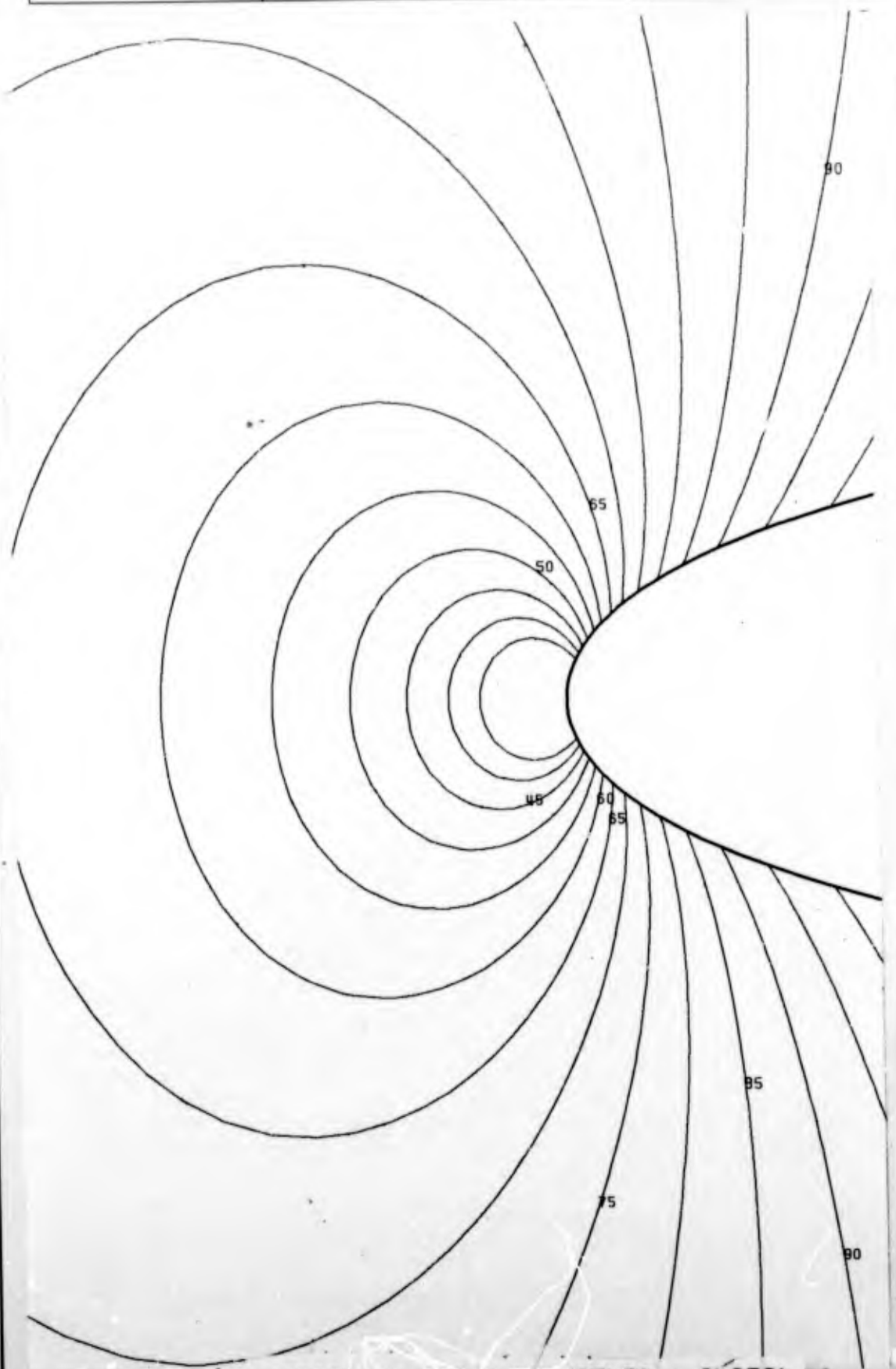


FIG. : ISO-MACH (DELTA = 0.050)

*** VALUES OF CURVE PARAMETER = ISO-MACH ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-21
	NACA 0012: MACH = 1.2, ALPHA = 0			

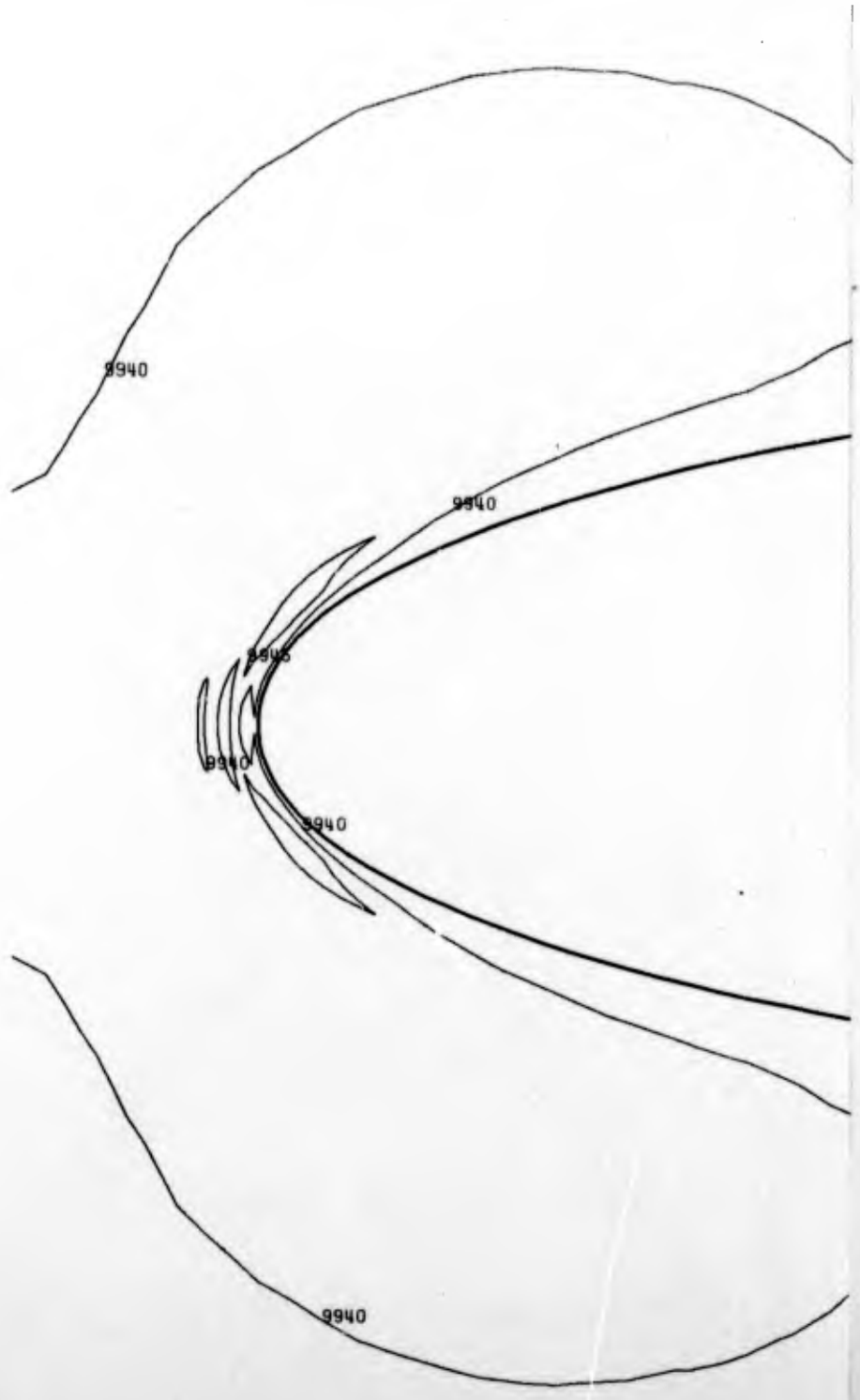


FIG. : ISO-PI/PIINF (DELTA = 0.0005)

××× VALUES OF CURVE PARAMETER = 10000×PI/PIINF ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-22
	NACA 0012: MACH = 1.2, ALPHA = 0			

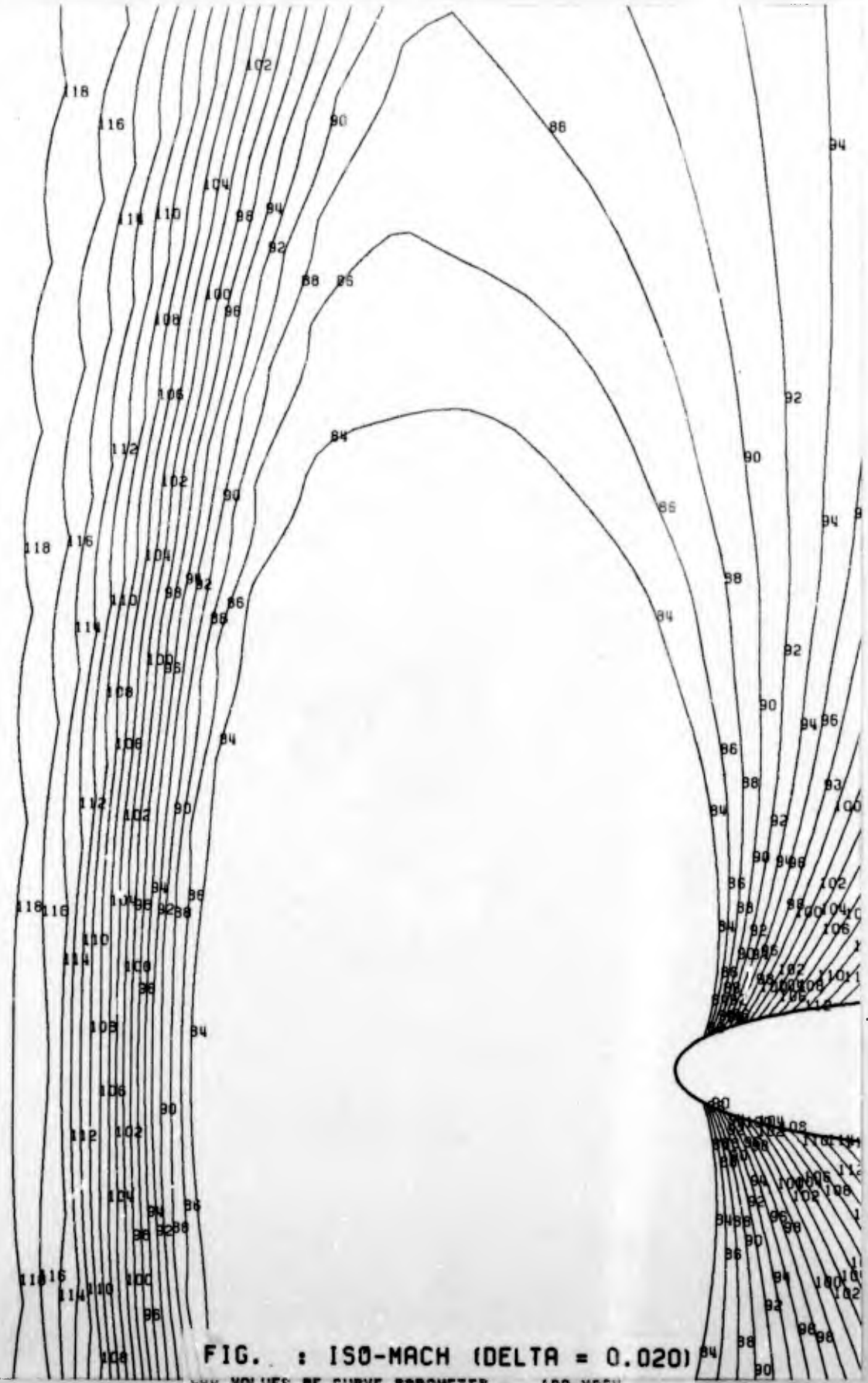


FIG. : ISO-MACH (DELTA = 0.020)

*** VALUES OF CURVE PARAMETER = 100*MACH ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-23
	NACA 0012: MACH = 1.2, ALPHA = 0			

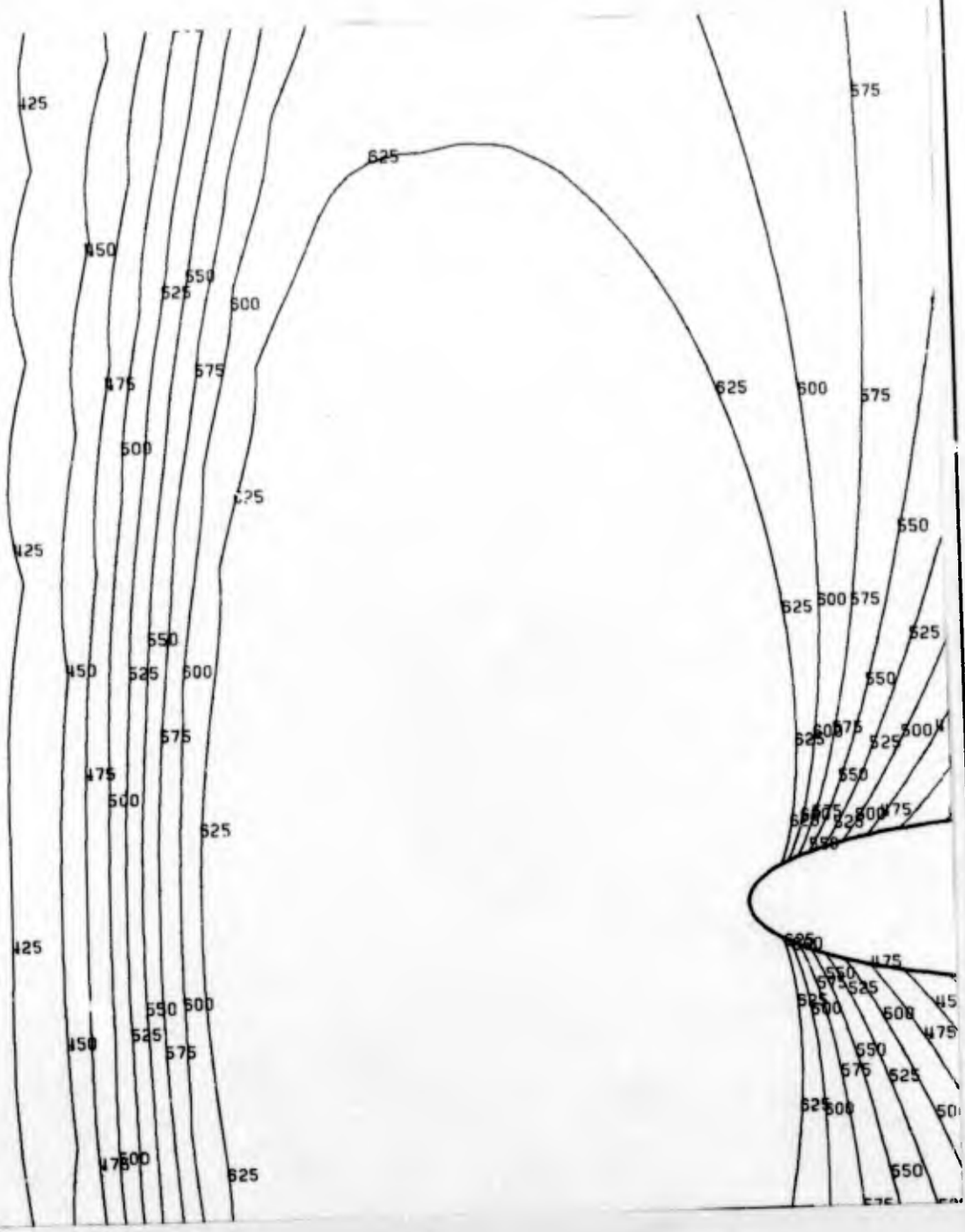
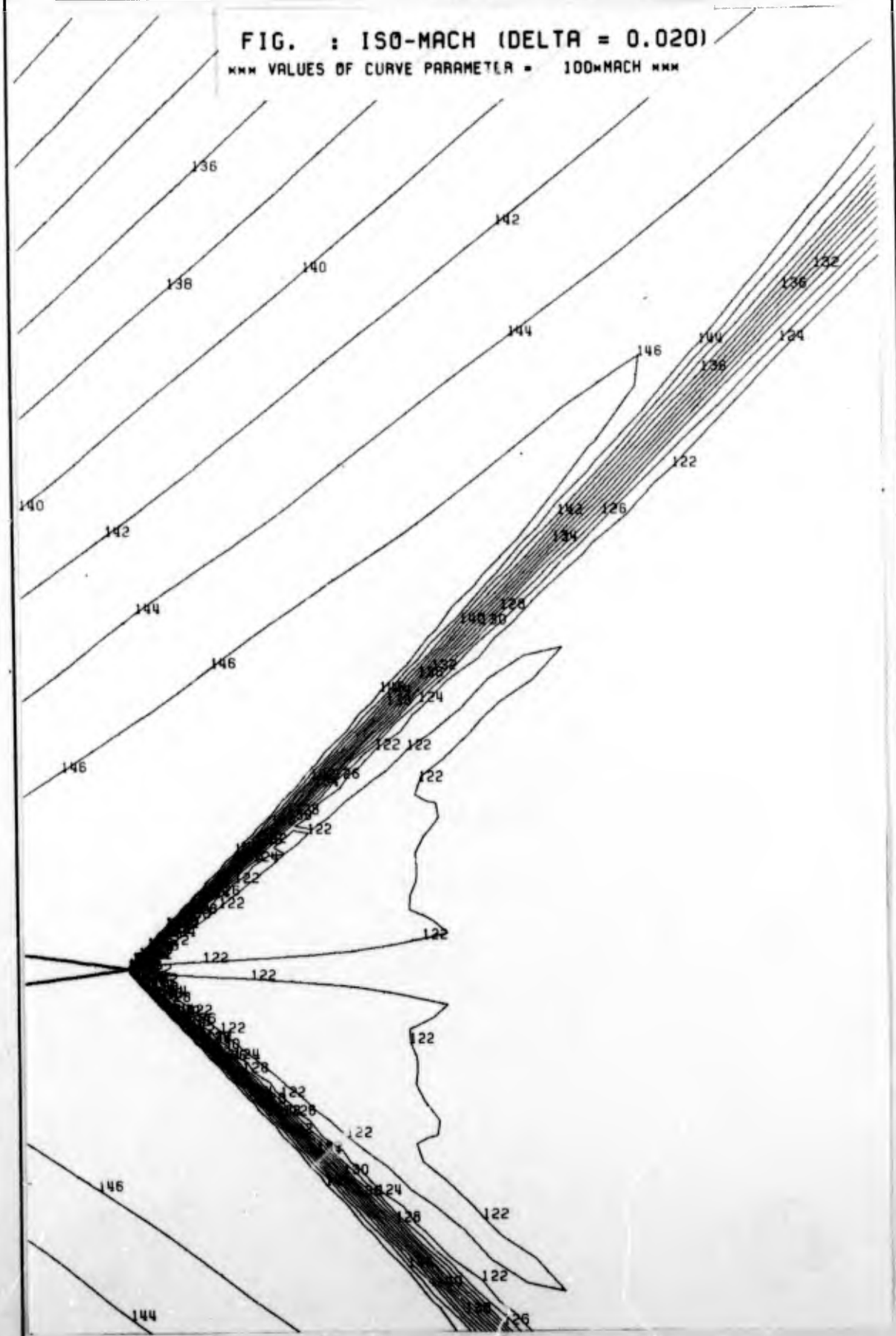


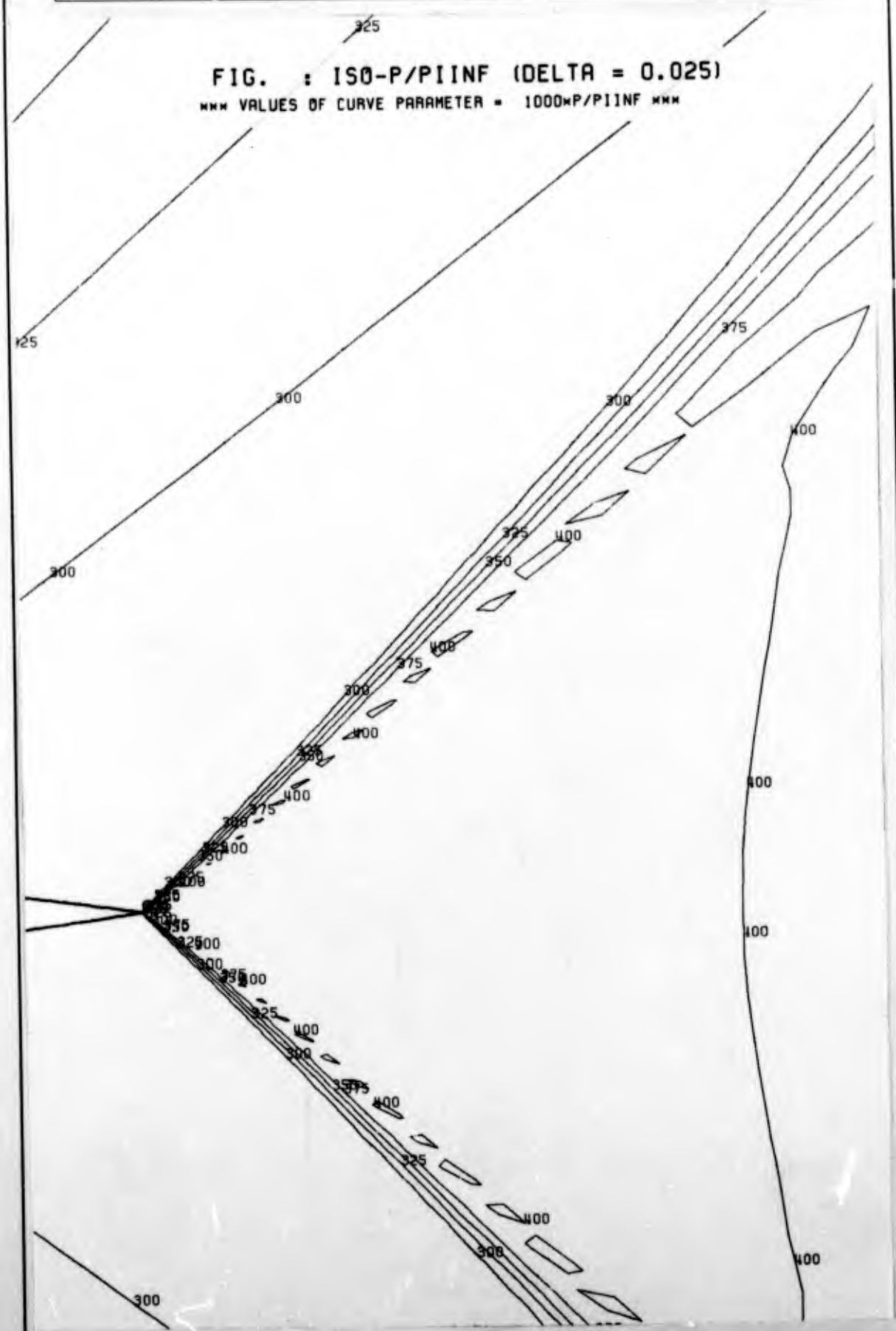
FIG. : ISO-P/PIINF (DELTA = 0.025)

**** VALUES OF CURVE PARAMETER = 1000*P/PIINF ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-24
	NACA 0012: MACH = 1.2, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-25
	NACA 0012: MACH = 1.2, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	04-9-26
	NACA 0012: MACH = 1.2, ALPHA = 0			

MESH	C_L	C_D	C_M	n-1	$(\Delta\rho/\Delta t)_{local}$ n = CYCLE	CYCLE
80 x 16	0.0	0.0995	0.0	0.45	$0.48 \cdot 10^{-4}$	500
160 x 32	0.0	0.0967	0.0	0.62	$0.11 \cdot 10^{-3}$	750
320 x 64	0.0	0.0960	0.0	1.14	$0.19 \cdot 10^{-3}$	1000

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 05

NACA 0012: MACH = 1.2, ALPHA = 7

Contributor No 1

J.P.Veuillot and A.M.Vuillot

(O.N.E.R.A., France)

COMMENTS ON CALCULATION FOR TEST CASE 05

* The computational domain is inscribed in the rectangle

  - $2.97 \leq x/c \leq 1.98$, $-14.87 \leq z/c \leq 14.87$

* Number of mesh points : 201 x 55 = 11 055 (169 mesh points on the profile)

* Artificial viscosity ;

  D_1 term : $Q_{xi} = Q_{1j} = 0.5\ 10^{-2}$

  D_2 term : $Q_{xi} = 0.2$, $Q_{ij} = 0.2$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-2
	NACA 0012: MACH = 1.2, ALPHA = 7			

WALL VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	0.056751	1.277130	0.276630	0.005250
2	0.000064	0.001410	0.089809	1.197602	0.350099	0.009293
3	0.000262	0.002846	0.124982	1.112984	0.423628	0.010040
4	0.000611	0.004335	0.165519	1.015464	0.499623	0.010377
5	0.001139	0.005897	0.210217	0.907933	0.577374	0.010044
6	0.001883	0.007552	0.257893	0.793238	0.656398	0.008915
7	0.002891	0.009314	0.306632	0.675987	0.735085	0.007000
8	0.004216	0.011192	0.354549	0.560711	0.811736	0.004516
9	0.005920	0.013190	0.400061	0.451222	0.884520	0.002107
10	0.008069	0.015307	0.441671	0.351120	0.951607	0.000212
11	0.010731	0.017536	0.478748	0.261923	1.012141	-0.000826
12	0.013974	0.019868	0.511361	0.183464	1.066232	-0.000926
13	0.017862	0.022285	0.539523	0.115715	1.113977	-0.000435
14	0.022449	0.024770	0.563779	0.057362	1.156235	0.000286
15	0.027779	0.027298	0.584825	0.006730	1.194067	0.000967
16	0.033883	0.029846	0.602995	-0.036981	1.227812	0.001483
17	0.040774	0.032387	0.618948	-0.075360	1.258395	0.001837
18	0.048452	0.034895	0.633015	-0.109200	1.286149	0.002105
19	0.056901	0.037345	0.645399	-0.138993	1.311255	0.002302
20	0.066091	0.039716	0.656453	-0.165587	1.334242	0.002439
21	0.075985	0.041988	0.666493	-0.189738	1.355612	0.002548
22	0.086538	0.044144	0.675580	-0.211601	1.375359	0.002678
23	0.097699	0.046172	0.683837	-0.231465	1.393700	0.002761
24	0.109418	0.048063	0.691494	-0.249885	1.411047	0.002833
25	0.121644	0.049808	0.698588	-0.266951	1.427404	0.002930
26	0.134328	0.051404	0.705099	-0.282613	1.442700	0.003000
27	0.147422	0.052850	0.711180	-0.297243	1.457222	0.003083
28	0.160884	0.054144	0.716857	-0.310901	1.471012	0.003152
29	0.174674	0.055289	0.722161	-0.323662	1.484111	0.003203
30	0.188757	0.056286	0.727143	-0.335647	1.496580	0.003282
31	0.203102	0.057139	0.731774	-0.346787	1.508353	0.003337
32	0.217679	0.057853	0.736156	-0.357329	1.519650	0.003391
33	0.232465	0.058430	0.740270	-0.367227	1.530391	0.003455
34	0.247436	0.058877	0.744107	-0.376457	1.540542	0.003507
35	0.262573	0.059198	0.747736	-0.385188	1.550264	0.003558
36	0.277859	0.059398	0.751145	-0.393389	1.559497	0.003615
37	0.293278	0.059482	0.754334	-0.401060	1.568236	0.003663
38	0.308815	0.059456	0.757377	-0.408381	1.576670	0.003704
39	0.324459	0.059322	0.760231	-0.415246	1.584652	0.003757
40	0.340199	0.059088	0.762889	-0.421641	1.592170	0.003794
41	0.356025	0.058757	0.765414	-0.427715	1.599366	0.003847
42	0.371928	0.058334	0.767770	-0.433384	1.606149	0.003888
43	0.387898	0.057824	0.770008	-0.438766	1.612649	0.003922
44	0.403926	0.057230	0.772140	-0.443896	1.618892	0.003959
45	0.420007	0.056556	0.774127	-0.448676	1.624754	0.003994
46	0.436138	0.055807	0.776008	-0.453203	1.630345	0.004032
47	0.452314	0.054985	0.777781	-0.457468	1.635648	0.004072
48	0.468534	0.054095	0.779449	-0.461481	1.640676	0.004102
49	0.484793	0.053139	0.781051	-0.465334	1.645536	0.004131
50	0.501089	0.052120	0.782564	-0.468972	1.650155	0.004157
51	0.517419	0.051041	0.783988	-0.472399	1.654523	0.004194
52	0.533780	0.049905	0.785344	-0.475661	1.658709	0.004223
53	0.550171	0.048714	0.786649	-0.478800	1.662759	0.004251
54	0.566588	0.047470	0.787887	-0.481780	1.666626	0.004275
55	0.583028	0.046176	0.789078	-0.484644	1.670363	0.004297
56	0.599488	0.044833	0.790219	-0.487389	1.673952	0.004331
57	0.615964	0.043444	0.791299	-0.489988	1.677373	0.004356
58	0.632451	0.042011	0.792374	-0.492573	1.680791	0.004379
59	0.648945	0.040534	0.793405	-0.495055	1.684091	0.004398
60	0.665440	0.039017	0.794404	-0.497457	1.687295	0.004422
61	0.681928	0.037460	0.795393	-0.499837	1.690484	0.004444
62	0.698400	0.035866	0.796350	-0.502139	1.693581	0.004465
63	0.714841	0.034237	0.797290	-0.504399	1.696630	0.004494
64	0.731235	0.032576	0.798229	-0.506658	1.699698	0.004511
65	0.747561	0.030885	0.799171	-0.508925	1.702797	0.004519
66	0.763792	0.029168	0.800087	-0.511130	1.705810	0.004544
67	0.779896	0.027430	0.800995	-0.513312	1.708801	0.004576
68	0.795833	0.025676	0.801928	-0.515557	1.711905	0.004588
69	0.811558	0.023911	0.802858	-0.517795	1.715019	0.004588
70	0.827022	0.022143	0.803768	-0.519985	1.718065	0.004611
71	0.842166	0.020380	0.804675	-0.522166	1.721105	0.004642
72	0.856932	0.018631	0.805593	-0.524374	1.724209	0.004655
73	0.871260	0.016904	0.806499	-0.526555	1.727292	0.004660
74	0.885090	0.015210	0.807391	-0.528699	1.730332	0.004671
75	0.898369	0.013557	0.808273	-0.530822	1.733347	0.004694

JC-VEUILLOT

WALL VALUES - UPPER SIDE (Cont.)

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
76	0.911054	0.011954	0.809123	-0.532868	1.736257	0.004727
77	0.923112	0.010408	0.809999	-0.534974	1.739301	0.004709
78	0.934532	0.008922	0.810820	-0.536950	1.742164	0.004695
79	0.945319	0.007501	0.811574	-0.538763	1.744832	0.004637
80	0.955503	0.006142	0.812256	-0.540404	1.747012	0.004952
81	0.965138	0.004840	0.813208	-0.542694	1.750889	0.004150
82	0.974299	0.003588	0.813831	-0.544194	1.747615	0.012397
83	0.983085	0.002375	0.815382	-0.547925	1.762926	-0.002443
84	0.991610	0.001184	0.825723	-0.572802	1.884708	-0.140522
85	1.000000	0.000000	0.746828	-0.383003	1.731069	-0.309753

SLIP LINE VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
86	1.008407	0.000876	0.584586	0.007305	1.162548	0.040253
87	1.017144	0.001886	0.603196	-0.037465	1.156062	0.090822
88	1.026938	0.003112	0.613952	-0.063340	1.301382	-0.071654
89	1.038925	0.004561	0.607187	-0.047066	1.275178	-0.052418
90	1.054362	0.006406	0.605041	-0.041902	1.238485	-0.007507
91	1.074558	0.008826	0.605083	-0.042003	1.237922	-0.006648
92	1.101042	0.012003	0.604462	-0.040511	1.237775	-0.008033
93	1.135669	0.016157	0.603545	-0.038304	1.234925	-0.006561
94	1.180595	0.021548	0.602473	-0.035725	1.231575	-0.004816
95	1.238223	0.028471	0.601166	-0.032580	1.227698	-0.002968
96	1.311152	0.037245	0.599554	-0.028703	1.223076	-0.000898
97	1.402163	0.048213	0.597757	-0.024381	1.217971	0.001345
98	1.514235	0.061740	0.596084	-0.020355	1.212948	0.003785
99	1.650141	0.078177	0.594842	-0.017367	1.208368	0.006703
100	1.809283	0.097515	0.593988	-0.015312	1.203874	0.010442
101	1.984134	0.118729	0.593297	-0.012230	1.198331	0.014475

AL-VEUILLOT

O.N.E.R.A	AK 211		J.P.Veuillot A.M.Vuillot	05-1-4
	NACA 0012: MACH = 1.2, ALPHA = 7			

WALL VALUES - LOWER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	0.056751	1.277130	0.276630	0.005250
2	0.000064	-0.001410	0.035350	1.328615	0.210883	0.004984
3	0.000262	-0.002846	0.016932	1.372922	0.140205	0.003338
4	0.000611	-0.004335	0.008862	1.392336	0.066403	0.005800
5	0.001139	-0.005897	0.006825	1.397238	0.006278	0.006797
6	0.001883	-0.007552	0.013626	1.380876	0.090105	0.009188
7	0.002891	-0.009314	0.027417	1.347699	0.154199	0.011133
8	0.004216	-0.011192	0.047176	1.300164	0.227235	0.012289
9	0.005920	-0.013190	0.071524	1.241589	0.297807	0.012593
10	0.008069	-0.015307	0.098904	1.175721	0.364696	0.012183
11	0.010731	-0.017536	0.127858	1.106066	0.427062	0.011344
12	0.013974	-0.019868	0.157239	1.035382	0.484579	0.010389
13	0.017862	-0.022285	0.186089	0.965977	0.537157	0.009496
14	0.022449	-0.024770	0.213839	0.899218	0.585102	0.008762
15	0.027779	-0.027298	0.240201	0.835799	0.628853	0.008250
16	0.033883	-0.029846	0.264892	0.776400	0.668760	0.007858
17	0.040774	-0.032387	0.287996	0.720819	0.705352	0.007634
18	0.048452	-0.034894	0.309353	0.669438	0.738799	0.007473
19	0.056901	-0.037345	0.329173	0 621758	0.769636	0.007357
20	0.066091	-0.039716	0.347610	0.577404	0.798204	0.007306
21	0.075985	-0.041988	0.364663	0.536378	0.824624	0.007274
22	0.086538	-0.044144	0.380432	0.498443	0.849083	0.007272
23	0.097699	-0.046172	0.395066	0.463237	0.871882	0.007253
24	0.109418	-0.048063	0.408748	0.430322	0.893274	0.007261
25	0.121644	-0.049808	0.421442	0.399784	0.913203	0.007299
26	0.134328	-0.051404	0.433183	0.371540	0.931778	0.007300
27	0.147422	-0.052850	0.444193	0.345053	0.949288	0.007325
28	0.160884	-0.054144	0.454483	0.320297	0.965761	0.007352
29	0.174674	-0.055289	0.464087	0.297192	0.981255	0.007363
30	0.188757	-0.056286	0.473068	0.275588	0.995817	0.007404
31	0.203102	-0.057139	0.481427	0.255478	1.009490	0.007414
32	0.217679	-0.057853	0.489310	0.236513	1.022464	0.007437
33	0.232465	-0.058430	0.496677	0.218792	1.034660	0.007471
34	0.247436	-0.058877	0.503539	0.202282	1.046115	0.007485
35	0.262573	-0.059198	0.510012	0.186710	1.056983	0.007505
36	0.277859	-0.059398	0.516085	0.172099	1.067245	0.007528
37	0.293278	-0.059482	0.521781	0.158397	1.076930	0.007549
38	0.308815	-0.059455	0.527117	0.145560	1.086054	0.007573
39	0.324459	-0.059322	0.532122	0.133520	1.094670	0.007588
40	0.340199	-0.059088	0.536843	0.122162	1.102841	0.007605
41	0.356025	-0.058757	0.541288	0.111468	1.110577	0.007621
42	0.371928	-0.058334	0.545460	0.101433	1.117874	0.007638
43	0.387898	-0.057823	0.549360	0.092051	1.124725	0.007660
44	0.403926	-0.057229	0.553010	0.083268	1.131176	0.007674
45	0.420007	-0.056556	0.556490	0.074897	1.137360	0.007678
46	0.436138	-0.055807	0.559804	0.066925	1.143263	0.007699
47	0.452314	-0.054985	0.562886	0.059511	1.148779	0.007716
48	0.468534	-0.054095	0.565791	0.052521	1.154007	0.007724
49	0.484793	-0.053139	0.568578	0.045817	1.159037	0.007736
50	0.501089	-0.052120	0.571203	0.039501	1.163794	0.007750
51	0.517419	-0.051041	0.573676	0.033553	1.168288	0.007764
52	0.533780	-0.049905	0.576033	0.027883	1.172594	0.007770
53	0.550171	-0.048714	0.578299	0.022430	1.176742	0.007784
54	0.566588	-0.047470	0.580454	0.017246	1.180702	0.007793
55	0.583028	-0.046176	0.582527	0.012260	1.184522	0.007804
56	0.599488	-0.044833	0.584520	0.007465	1.188208	0.007811
57	0.615964	-0.043444	0.586436	0.002854	1.191760	0.007824
58	0.632451	-0.042010	0.588287	-0.001599	1.195205	0.007829
59	0.648945	-0.040534	0.590100	-0.005958	1.198584	0.007839
60	0.665440	-0.039016	0.591853	-0.010176	1.201860	0.007852
61	0.681928	-0.037460	0.593573	-0.014315	1.205091	0.007855
62	0.698400	-0.035866	0.595310	-0.018493	1.208359	0.007862
63	0.714841	-0.034237	0.597022	-0.022612	1.211592	0.007866
64	0.731235	-0.032575	0.598689	-0.026623	1.214736	0.007886
65	0.747561	-0.030884	0.600322	-0.030551	1.217839	0.007884
66	0.763792	-0.029168	0.602014	-0.034621	1.221057	0.007892
67	0.779896	-0.027429	0.603692	-0.038658	1.224260	0.007897
68	0.795833	-0.025675	0.605352	-0.042651	1.227435	0.007905
69	0.811558	-0.023910	0.607010	-0.046640	1.230610	0.007920
70	0.827022	-0.022143	0.608694	-0.050692	1.233861	0.007911
71	0.842166	-0.020380	0.610425	-0.054855	1.237196	0.007926
72	0.856932	-0.018630	0.612079	-0.058834	1.240398	0.007930
73	0.871260	-0.016904	0.613763	-0.062885	1.243670	0.007933
74	0.885090	-0.015209	0.615449	-0.066942	1.246954	0.007938
75	0.898369	-0.013556	0.617046	-0.070785	1.250073	0.007945

AL-VEUILLOT

WALL VALUES - LOWER SIDE (Cont.)

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
76	0.911054	-0.011953	0.618626	-0.074585	1.253160	0.007959
77	0.923112	-0.010407	0.620204	-0.078380	1.256264	0.007957
78	0.934532	-0.008922	0.621763	-0.082132	1.259341	0.007956
79	0.945319	-0.007500	0.623241	-0.085686	1.262259	0.007962
80	0.955503	-0.006141	0.624719	-0.089242	1.265197	0.007953
81	0.965138	-0.004839	0.626039	-0.092417	1.267747	0.008053
82	0.974299	-0.003588	0.627022	-0.094782	1.269664	0.008109
83	0.983085	-0.002374	0.630157	-0.102325	1.277608	0.005871
84	0.991610	-0.001183	0.632477	-0.107907	1.285635	0.001340
85	1.000000	0.000000	0.607543	-0.047921	1.231221	0.008463

SLIP LINE VALUES - LOWER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
86	1.008407	0.000876	0.584586	0.007305	1.180564	0.017741
87	1.017144	0.001886	0.603196	-0.037465	1.219426	0.012961
88	1.026938	0.003112	0.613952	-0.063340	1.247330	0.003577
89	1.038925	0.004561	0.607187	-0.047066	1.232144	0.006352
90	1.054362	0.006406	0.605041	-0.041902	1.225161	0.010098
91	1.074558	0.008826	0.605083	-0.042003	1.225600	0.009629
92	1.101042	0.012003	0.604462	-0.040511	1.224721	0.009223
93	1.135669	0.016157	0.603545	-0.038304	1.222942	0.009252
94	1.180595	0.021548	0.602473	-0.035725	1.220887	0.009258
95	1.238223	0.028471	0.601166	-0.032580	1.218372	0.009285
96	1.311152	0.037245	0.599554	-0.028703	1.215250	0.009355
97	1.402163	0.048213	0.597757	-0.024381	1.211790	0.009418
98	1.514235	0.061740	0.596084	-0.020355	1.208698	0.009319
99	1.650141	0.078177	0.594842	-0.017367	1.206572	0.009036
100	1.809283	0.097515	0.593988	-0.015312	1.204960	0.009037
101	1.984134	0.118729	0.592707	-0.012230	1.202520	0.009075

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-6
	NACA 0012: MACH = 1.2, ALPHA = 7			

UPSTREAM X-AXIS VALUES

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	.056752	1.277127	.276627	.005252
2	-.003210	0.000000	.057842	1.274504	.262173	.011726
3	-.006300	0.000000	.062607	1.263041	.281096	.009727
4	-.009500	0.000000	.073909	1.235852	.308111	.010893
5	-.012820	0.000000	.085187	1.208720	.336742	.010490
6	-.016240	0.000000	.096786	1.180816	.363752	.010326
7	-.019780	0.000000	.108041	1.153740	.388569	.010157
8	-.023430	0.000000	.118834	1.127775	.411186	.010064
9	-.027200	0.000000	.129075	1.103138	.431826	.009993
10	-.031090	0.000000	.138786	1.079776	.450760	.009947
11	-.035110	0.000000	.147992	1.057629	.468219	.009919
12	-.039270	0.000000	.156736	1.036593	.484425	.009897
13	-.043590	0.000000	.165078	1.016525	.499573	.009887
14	-.048090	0.000000	.173059	.997325	.513826	.009875
15	-.052780	0.000000	.180740	.978846	.527337	.009866
16	-.057710	0.000000	.188173	.960965	.540238	.009859
17	-.062910	0.000000	.195417	.943538	.552653	.009860
18	-.068430	0.000000	.202503	.926491	.564678	.009854
19	-.074330	0.000000	.209495	.909670	.576422	.009853
20	-.080680	0.000000	.216433	.892979	.587964	.009858
21	-.087550	0.000000	.223348	.876343	.599383	.009856
22	-.095050	0.000000	.230294	.859633	.610762	.009858
23	-.103280	0.000000	.237295	.842791	.622148	.009863
24	-.112380	0.000000	.244377	.825753	.633591	.009868
25	-.122480	0.000000	.251563	.808466	.645135	.009872
26	-.133770	0.000000	.258874	.790878	.656805	.009884
27	-.146410	0.000000	.266312	.772984	.668625	.009889
28	-.160640	0.000000	.273891	.754751	.680607	.009900
29	-.176680	0.000000	.281607	.736189	.692752	.009914
30	-.194820	0.000000	.289453	.717313	.705054	.009930
31	-.215330	0.000000	.297419	.698149	.717501	.009949
32	-.238560	0.000000	.305511	.678682	.730108	.009970
33	-.264870	0.000000	.313726	.658919	.742869	.009999
34	-.294660	0.000000	.321951	.639132	.755650	.010003
35	-.328370	0.000000	.330225	.619227	.768509	.009989
36	-.366480	0.000000	.339354	.597265	.782436	.010214
37	-.409530	0.000000	.349198	.573584	.797296	.010613
38	-.458100	0.000000	.355227	.559079	.807559	.009715
39	-.512790	0.000000	.355913	.557429	.811215	.007139
40	-.574300	0.000000	.373619	.514833	.836056	.009770
41	-.643360	0.000000	.439784	.355659	.928079	.022881
42	-.720760	0.000000	.532871	.131718	1.083998	.022124
43	-.807350	0.000000	.593258	-.013556	1.213545	-.003971
44	-.904060	0.000000	.601845	-.034214	1.234439	-.010226
45	-1.011870	0.000000	.590747	-.007516	1.207216	-.001825
46	-1.131840	0.000000	.585668	.004703	1.194964	.001830
47	-1.265110	0.000000	.586489	.002728	1.197162	.000953
48	-1.412890	0.000000	.587760	-.000330	1.200366	-.000145
49	-1.576470	0.000000	.587904	-.000676	1.200726	-.000265
50	-1.757230	0.000000	.587639	-.000039	1.200057	-.000035
51	-1.956640	0.000000	.587551	.000173	1.199806	.000079
52	-2.176260	0.000000	.587592	.000074	1.199910	.000042
53	-2.417740	0.000000	.587633	-.000024	1.200018	.000001
54	-2.682850	0.000000	.587628	-.000012	1.200015	-.000007
55	-2.973450	0.000000	.587628	-.000012	1.200015	-.000007

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-7
	NACA 0012: MACH = 1.2, ALPHA = 7			

UPPER SURFACE

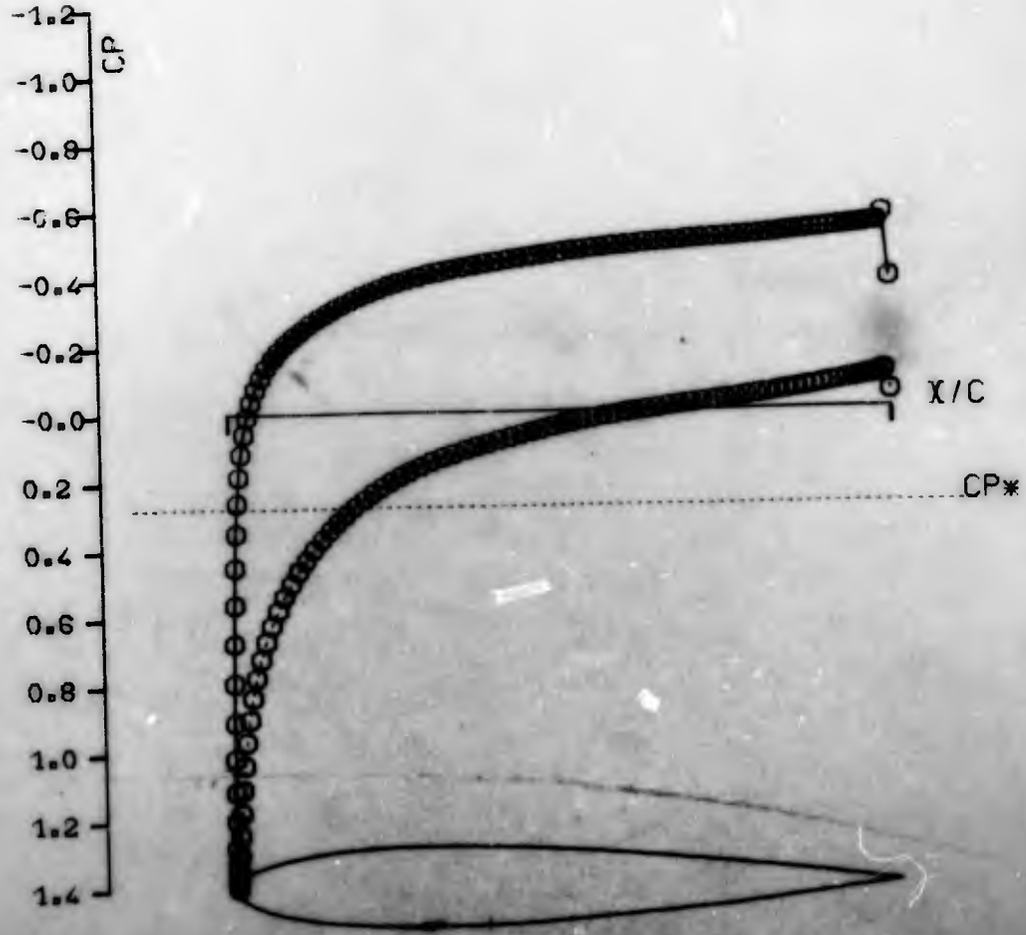
LOWER SURFACE

CL= 0.5280

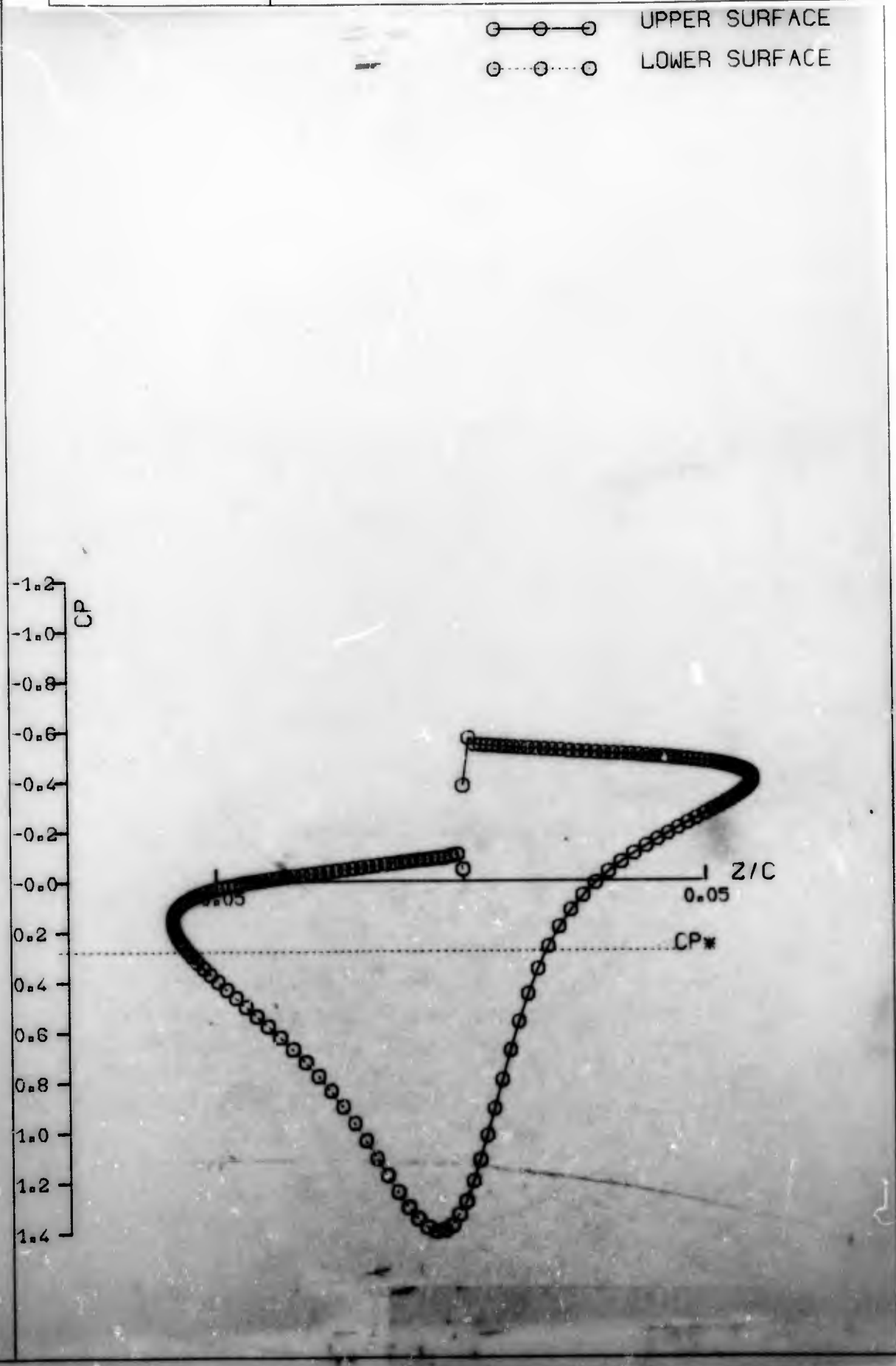
CD= 0.1536

CM= -0.1121

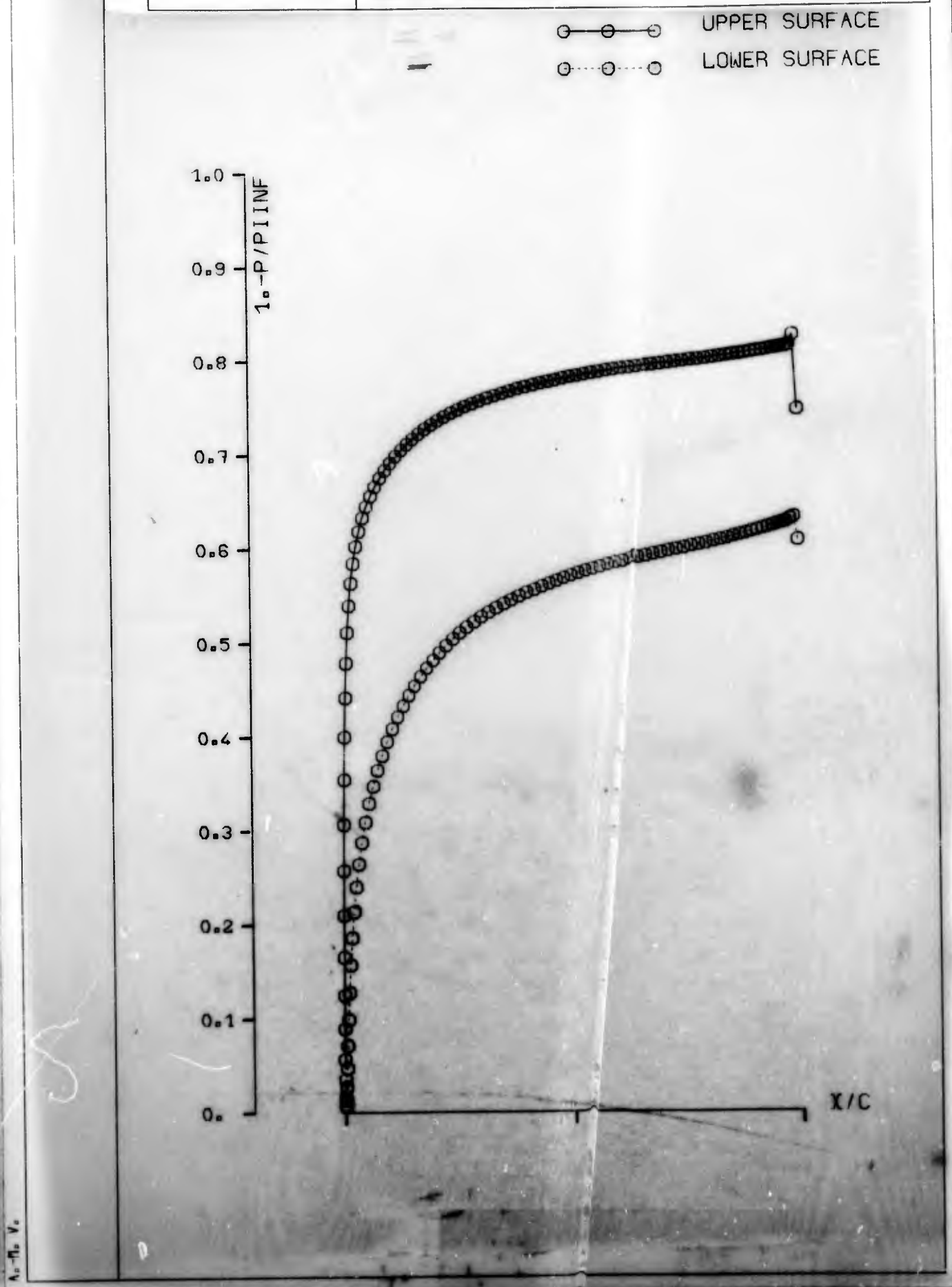
Γ = 0.3046



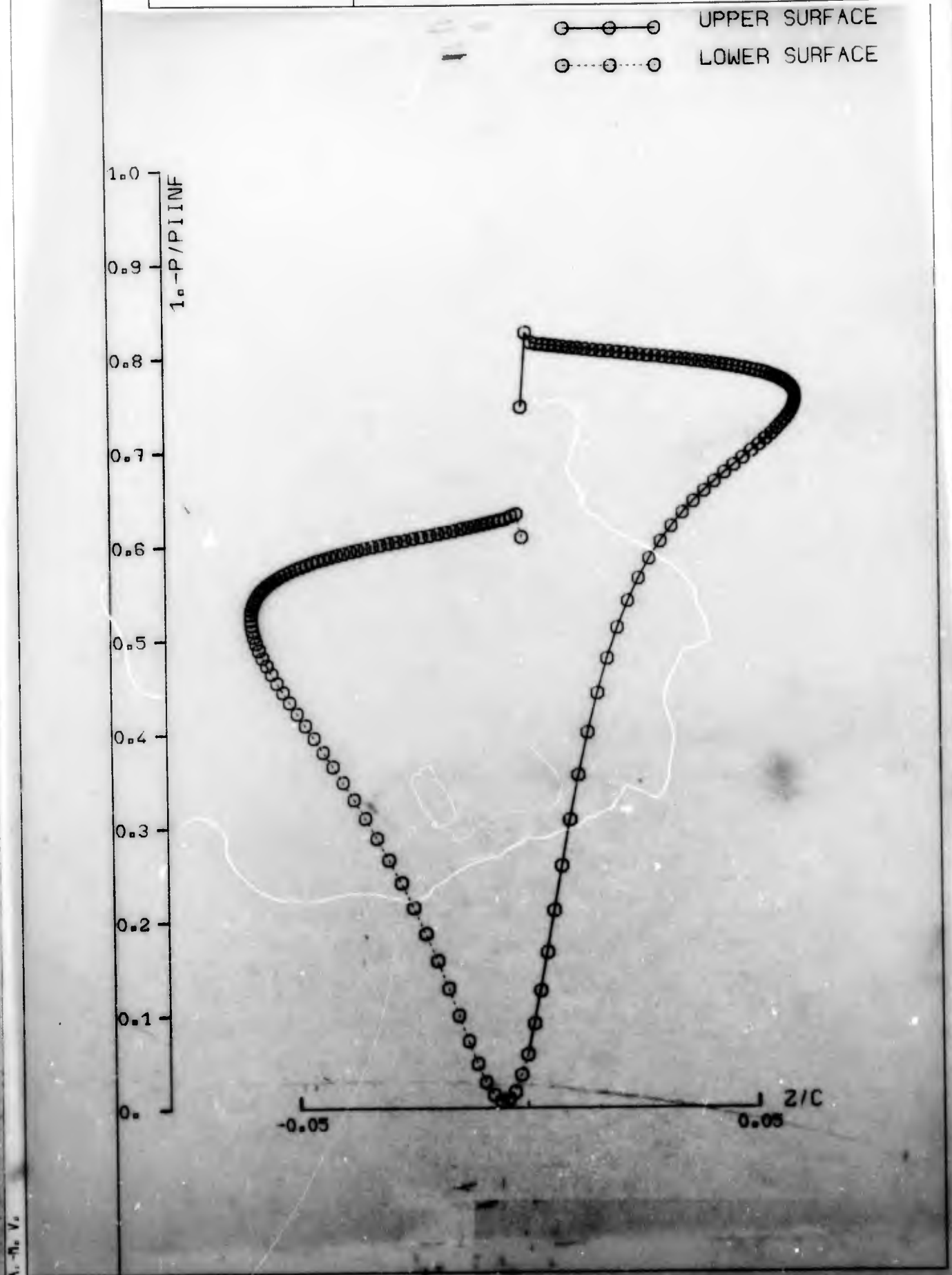
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-8
	NACA 0012: MACH = 1.2, ALPHA = 7			



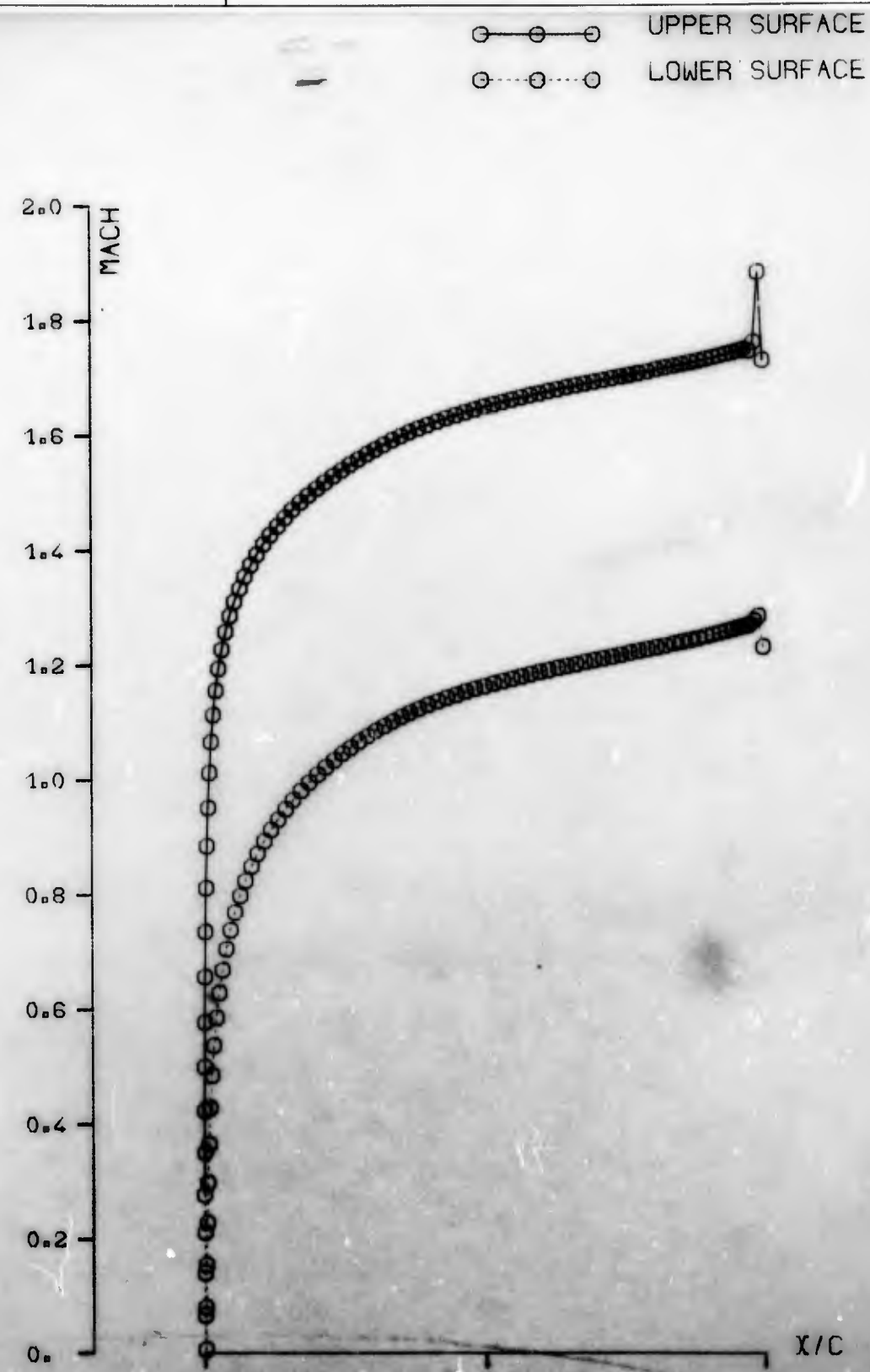
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-9
	NACA 0012: MACH = 1.2, ALPHA = 7			



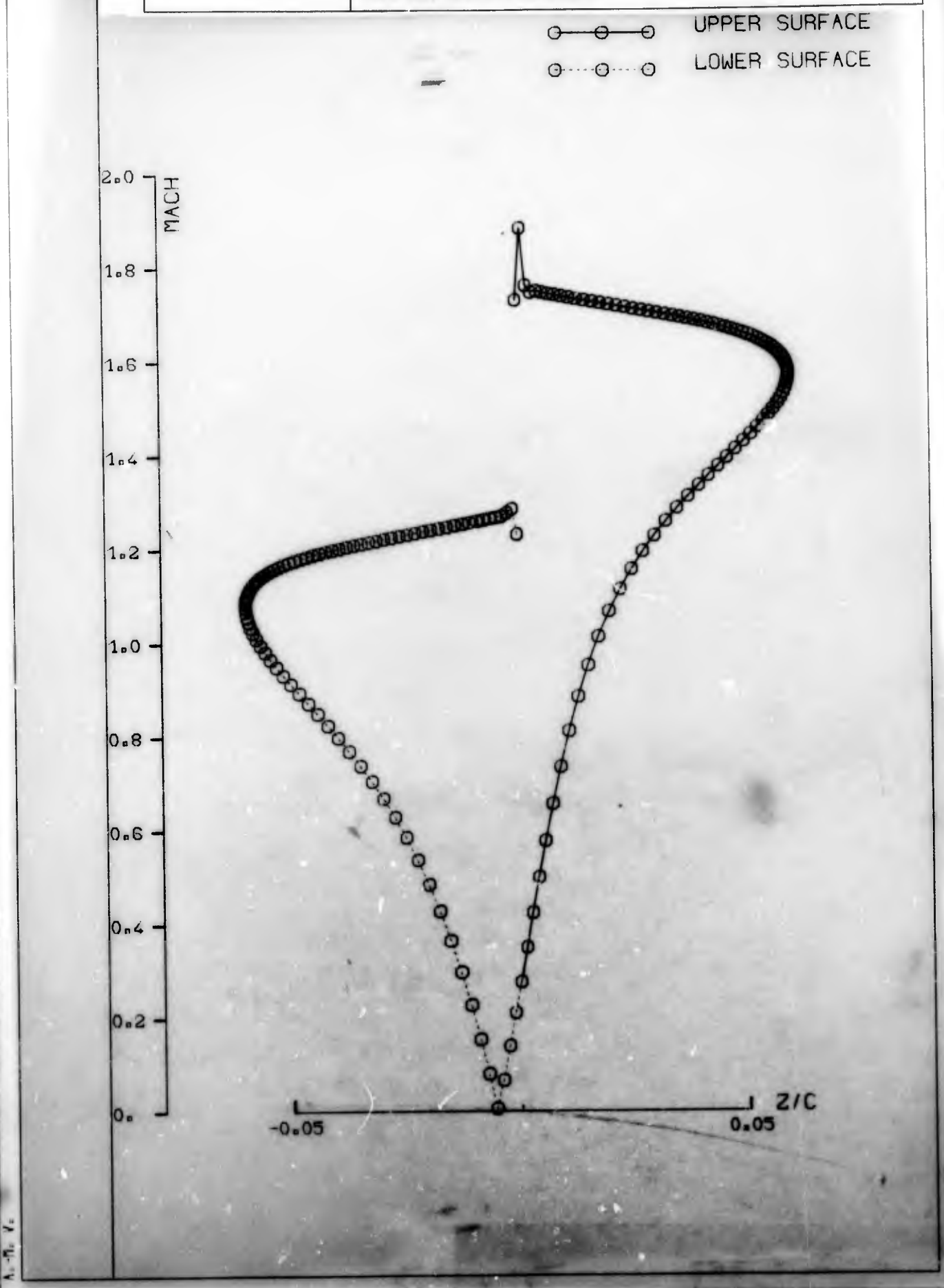
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-10
	NACA 0012: MACH = 1.2, ALPHA = 7			



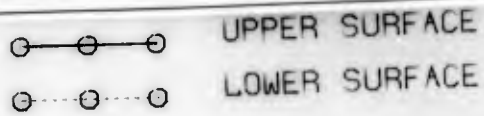
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-11
	NACA 0012: MACH = 1.2, ALPHA = 7			

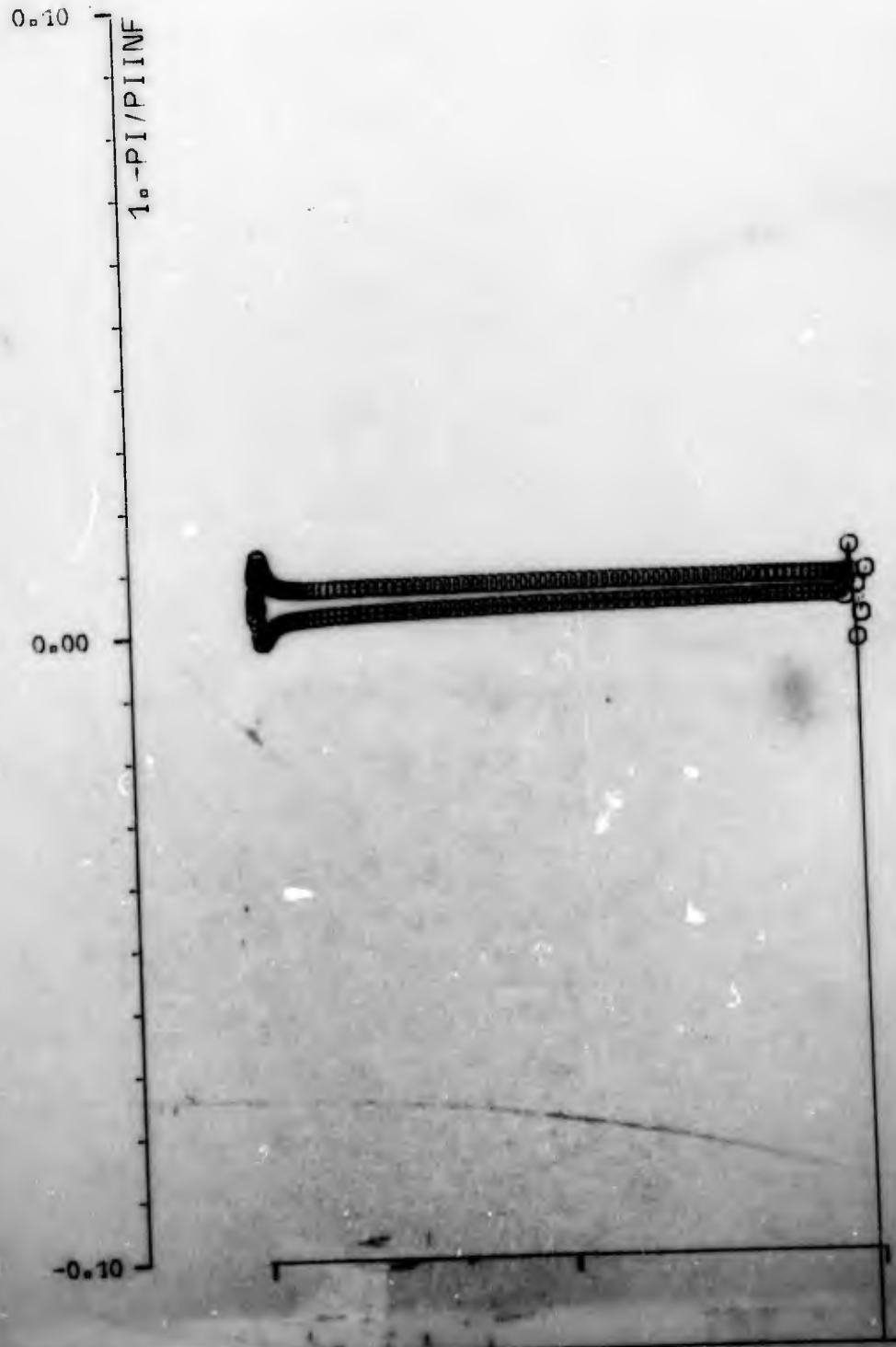


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-12
	NACA 0012: MACH = 1.2, ALPHA = 7			

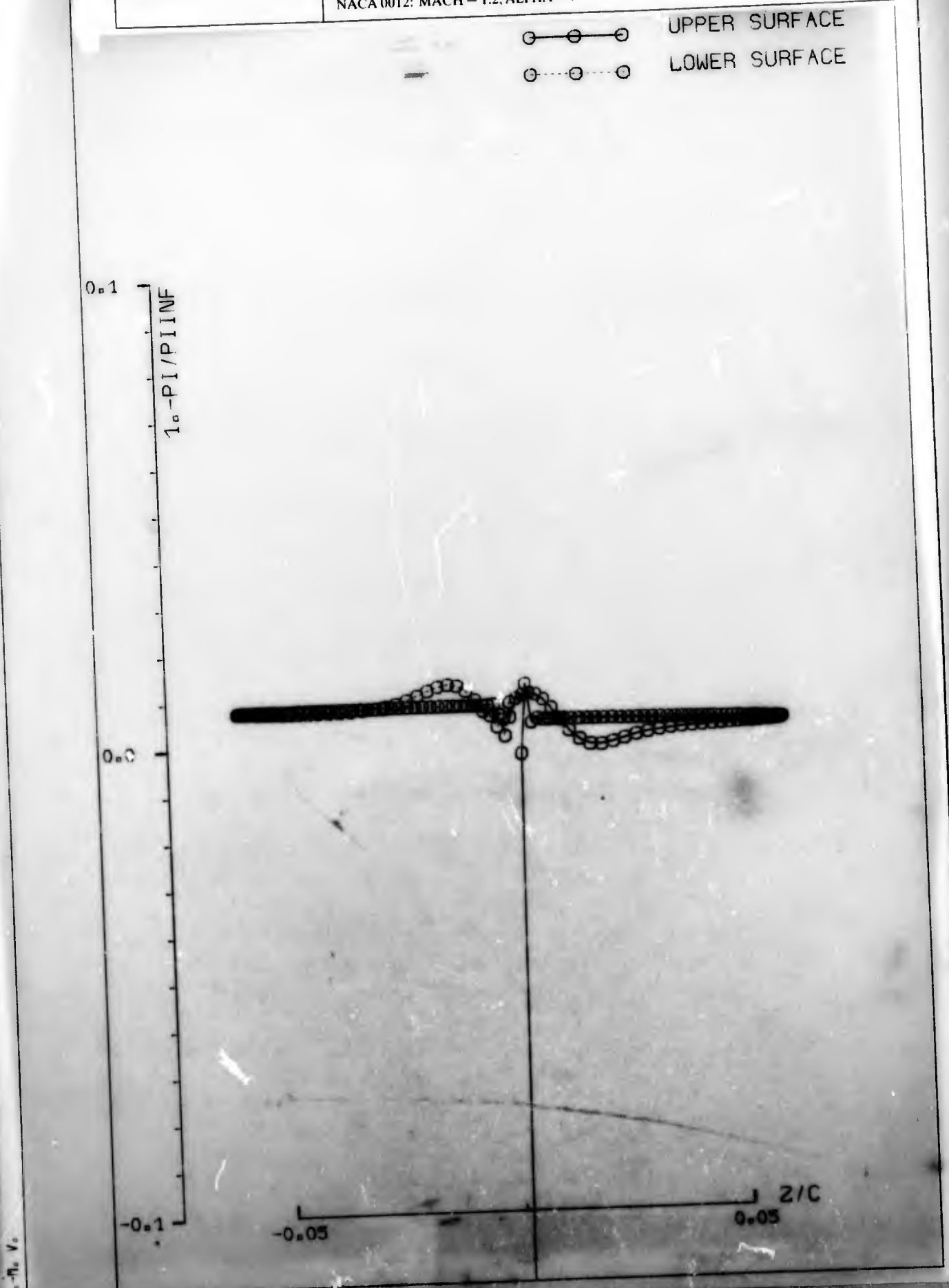


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-13
	NACA 0012: MACH = 1.2, ALPHA = 7			





O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-14
	NACA 0012: MACH = 1.2, ALPHA = 7			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-15
	NACA 0012 MACH = 1.2, ALPHA = 7			

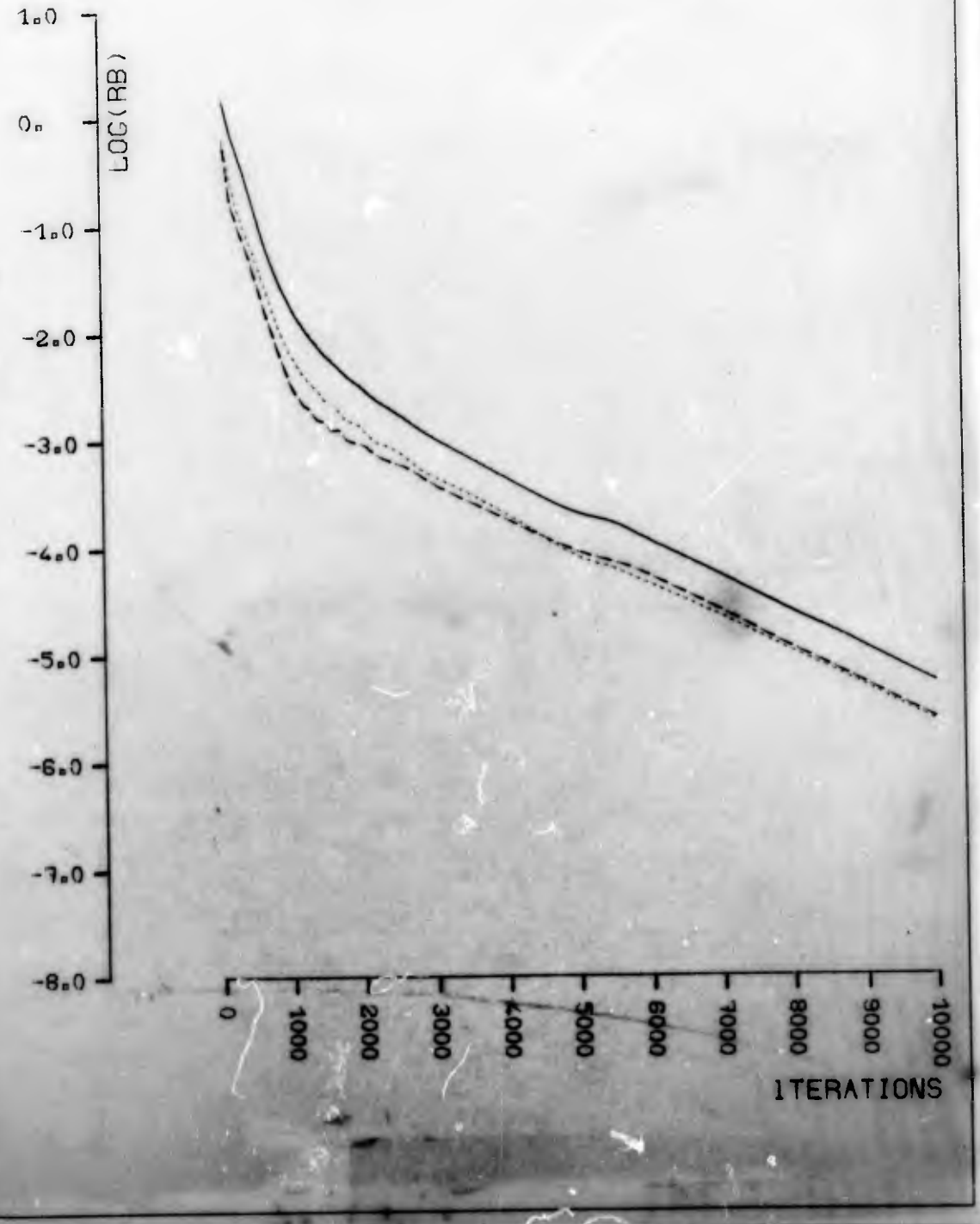
RESIDUAL MEAN

RB=R.M.S. OF $(F^{N+1} - F^{N})/DT$

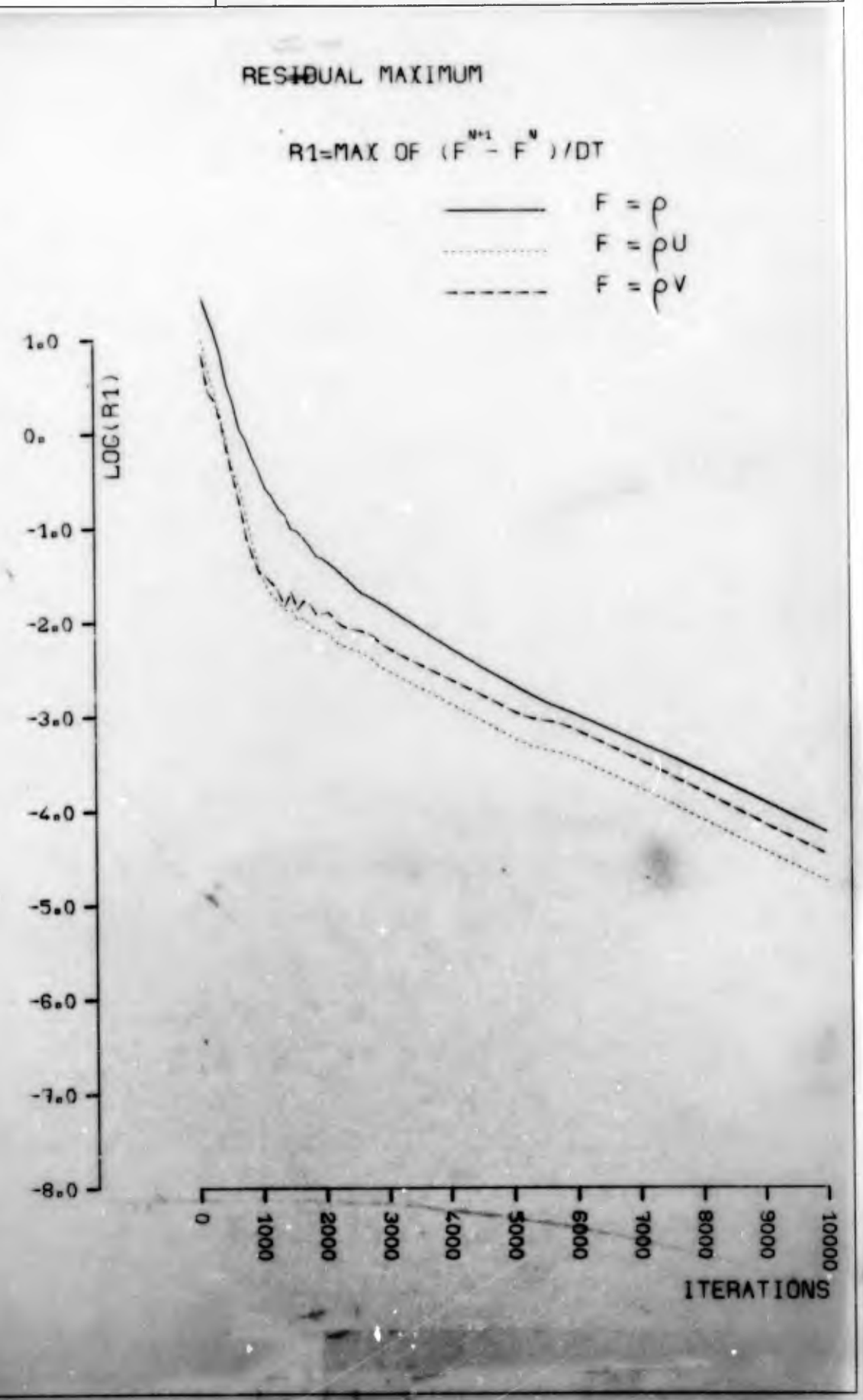
——— $F = \rho$

..... $F = \rho U$

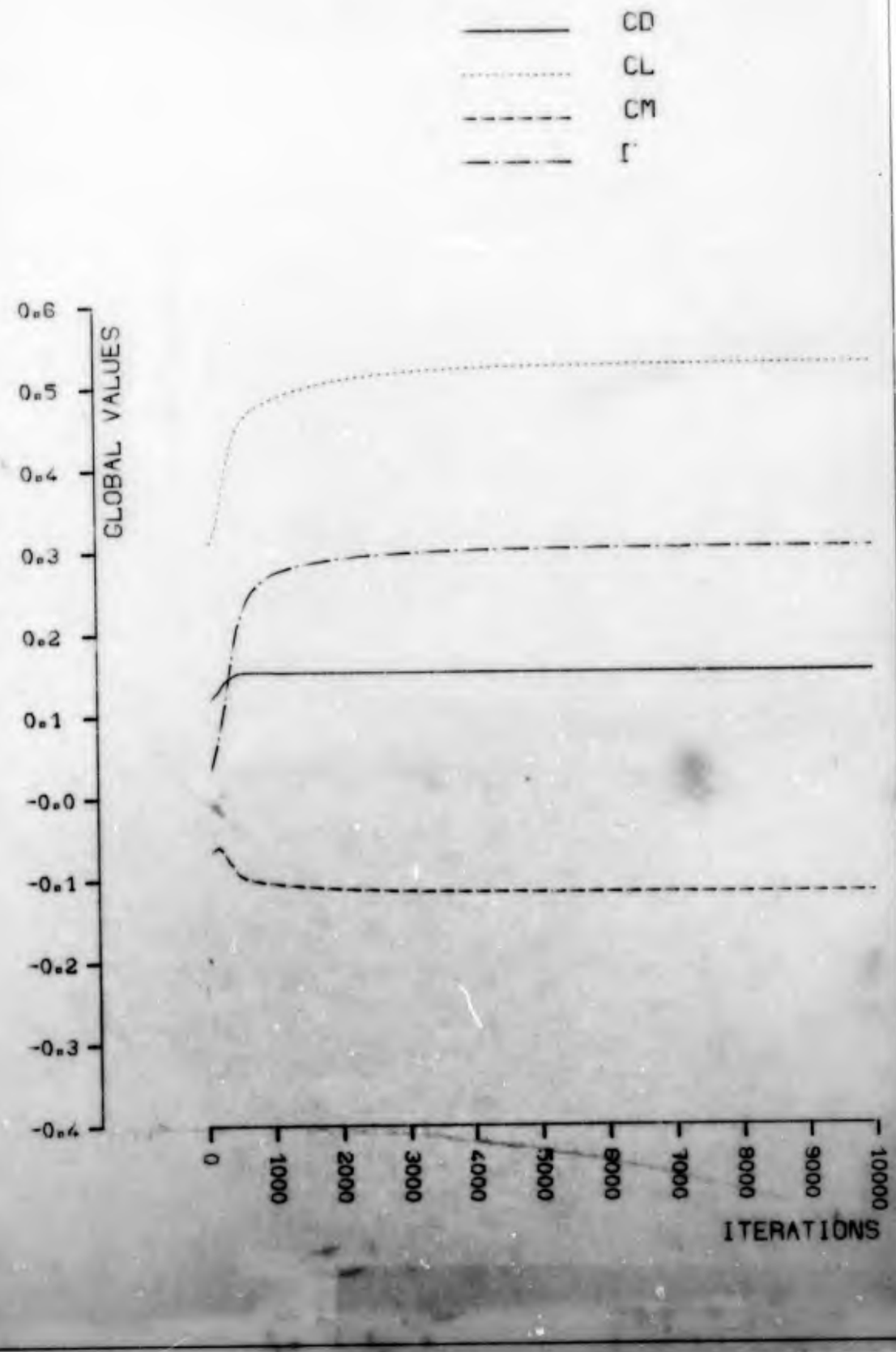
– – – – – $F = \rho V$



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-16
	NACA 0012: MACH = 1.2, ALPHA = 7			



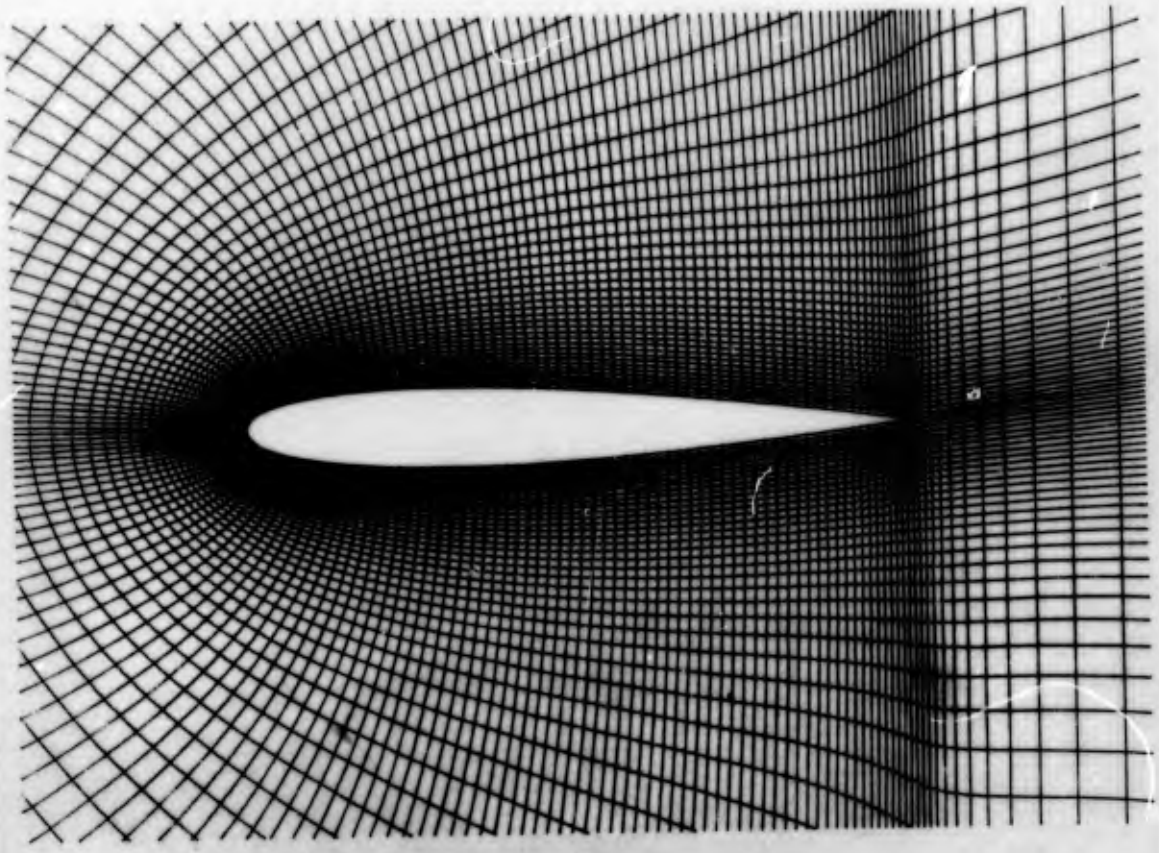
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-17
	NACA 0012: MACH = 1.2, ALPHA = 7			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-18
	NACA 0012: MACH = 1.2, ALPHA = 7			

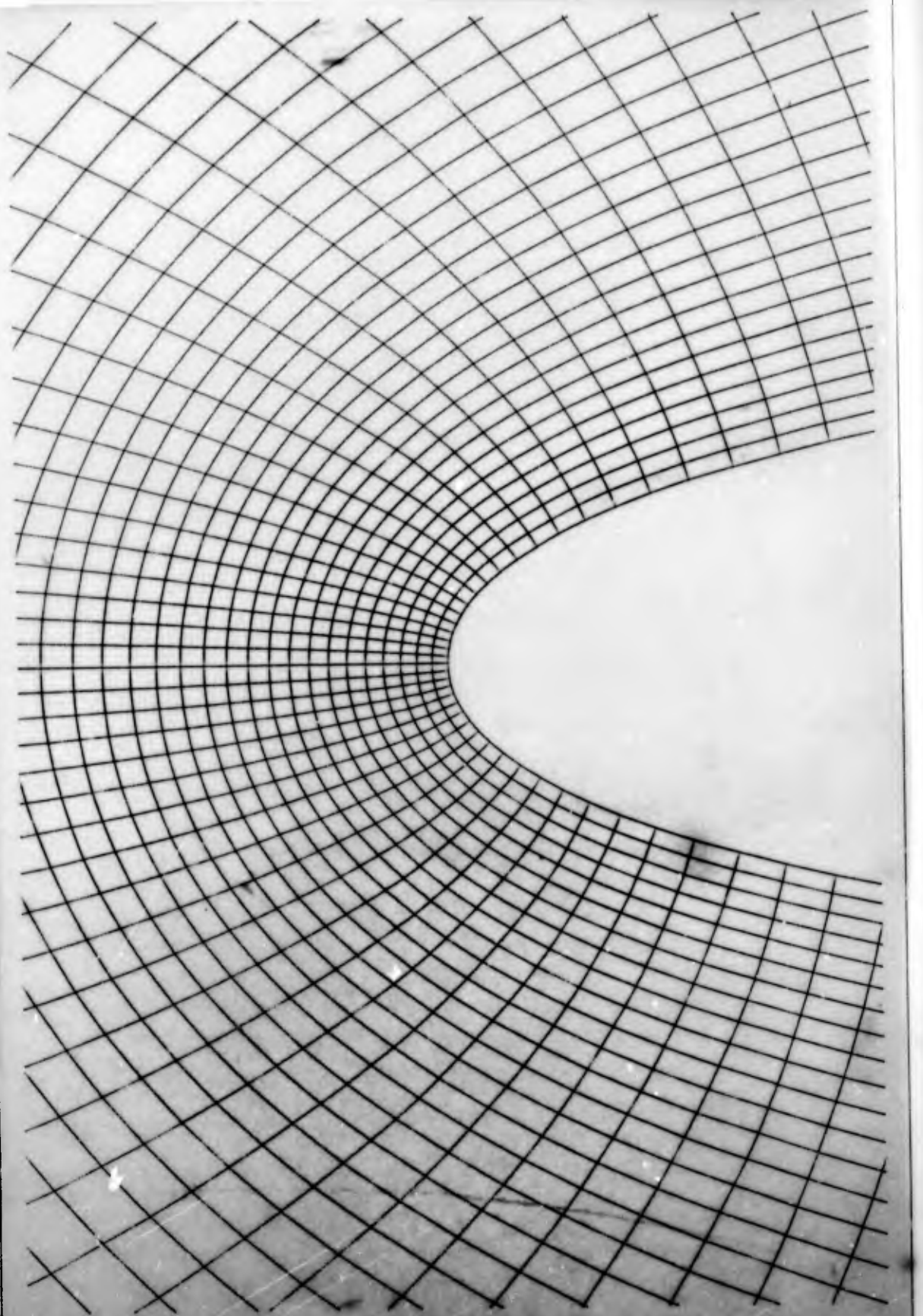
201X55 MESH (1CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-19
	NACA 0012: MACH = 1.2, ALPHA = 7			



201X55 MESH PARTIAL VIEW (10CM CHORD)

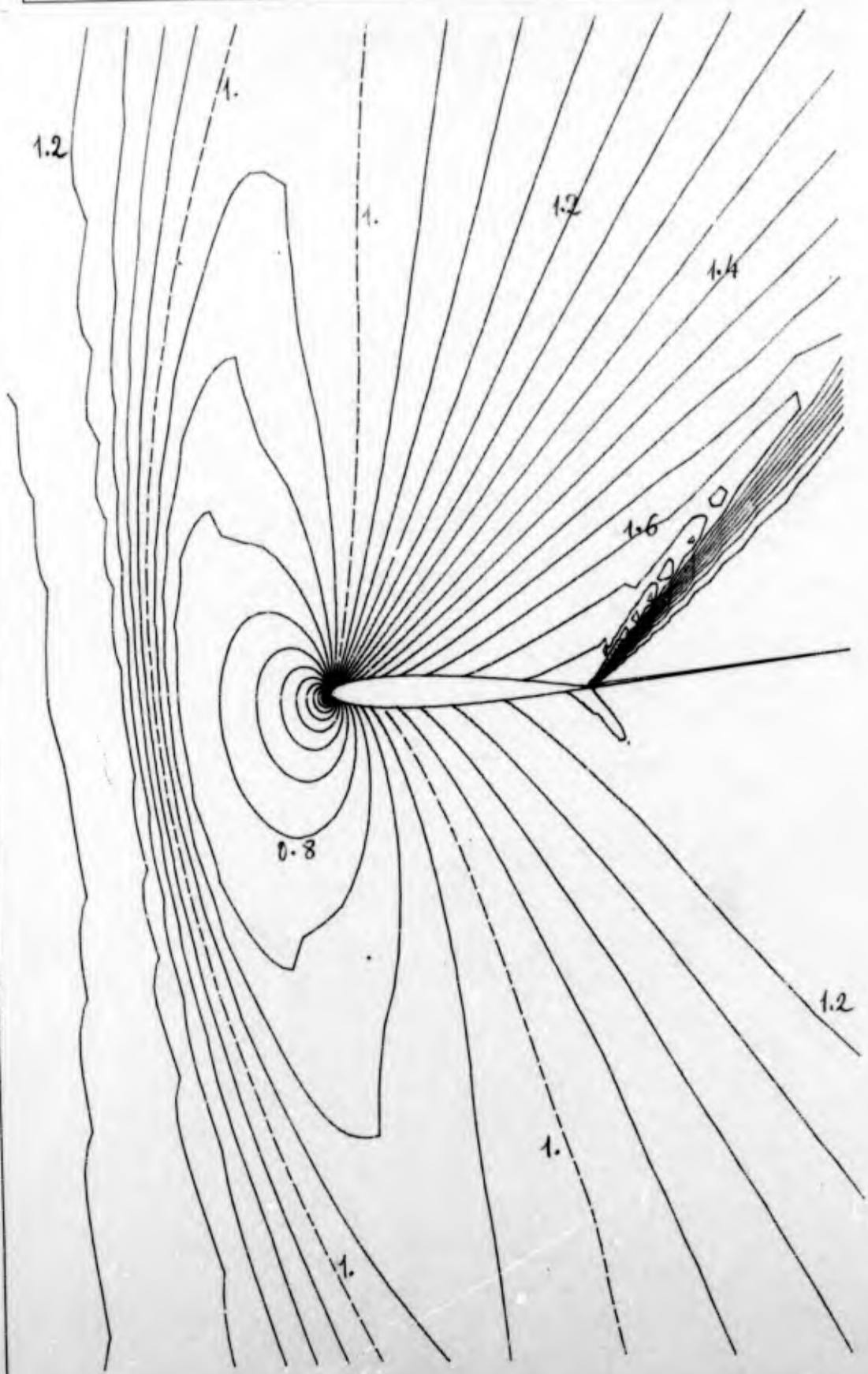
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-20
	NACA 0012: MACH = 1.2, ALPHA = 7			



201X55 MESH PARTIAL VIEW (100CM CHORD)

$A_0 - M_0 V_0$

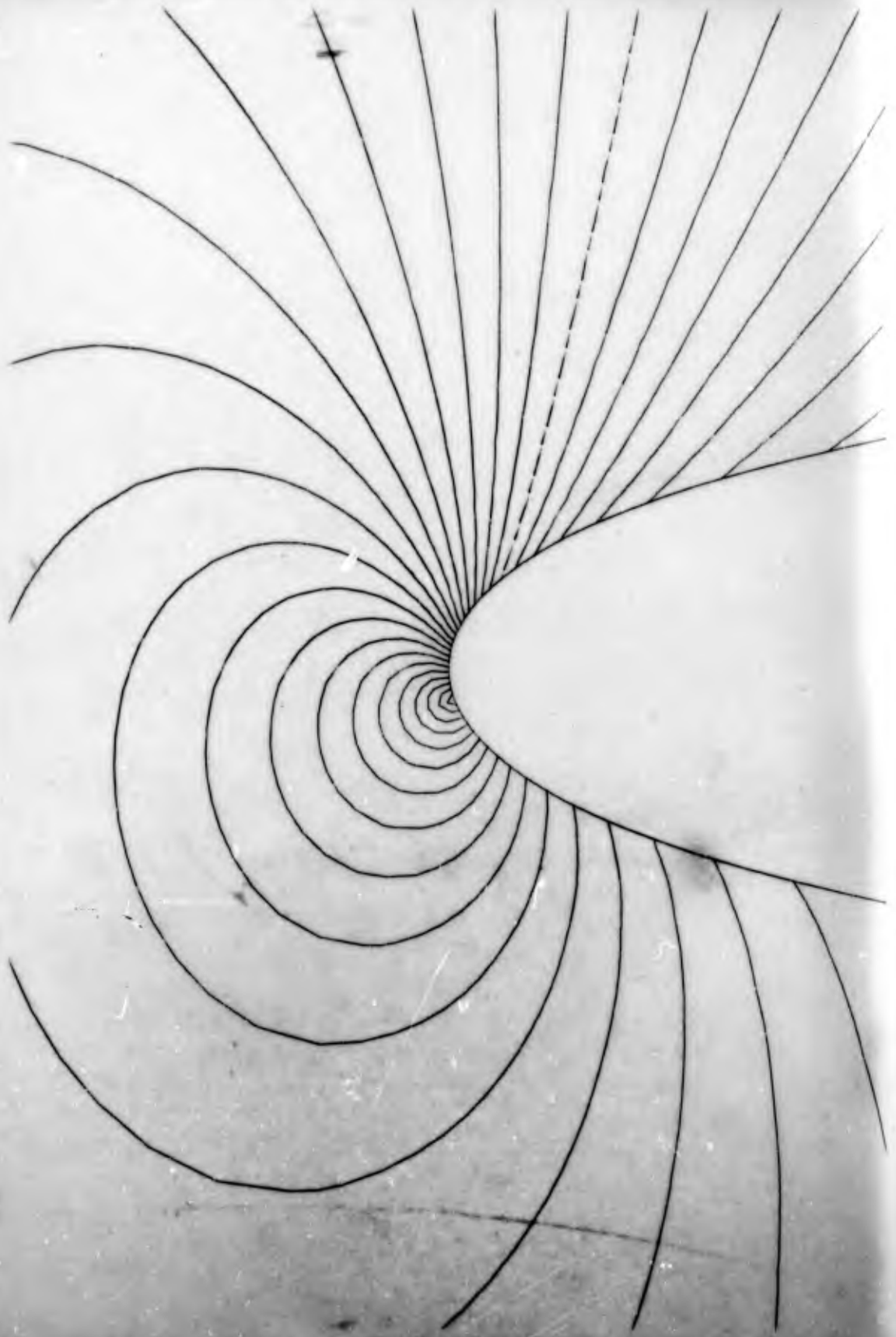
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-21
	NACA 0012: MACH = 1.2, ALPHA = 7			



ISO-MACH LINES (DM=.05 5CM CHORD)

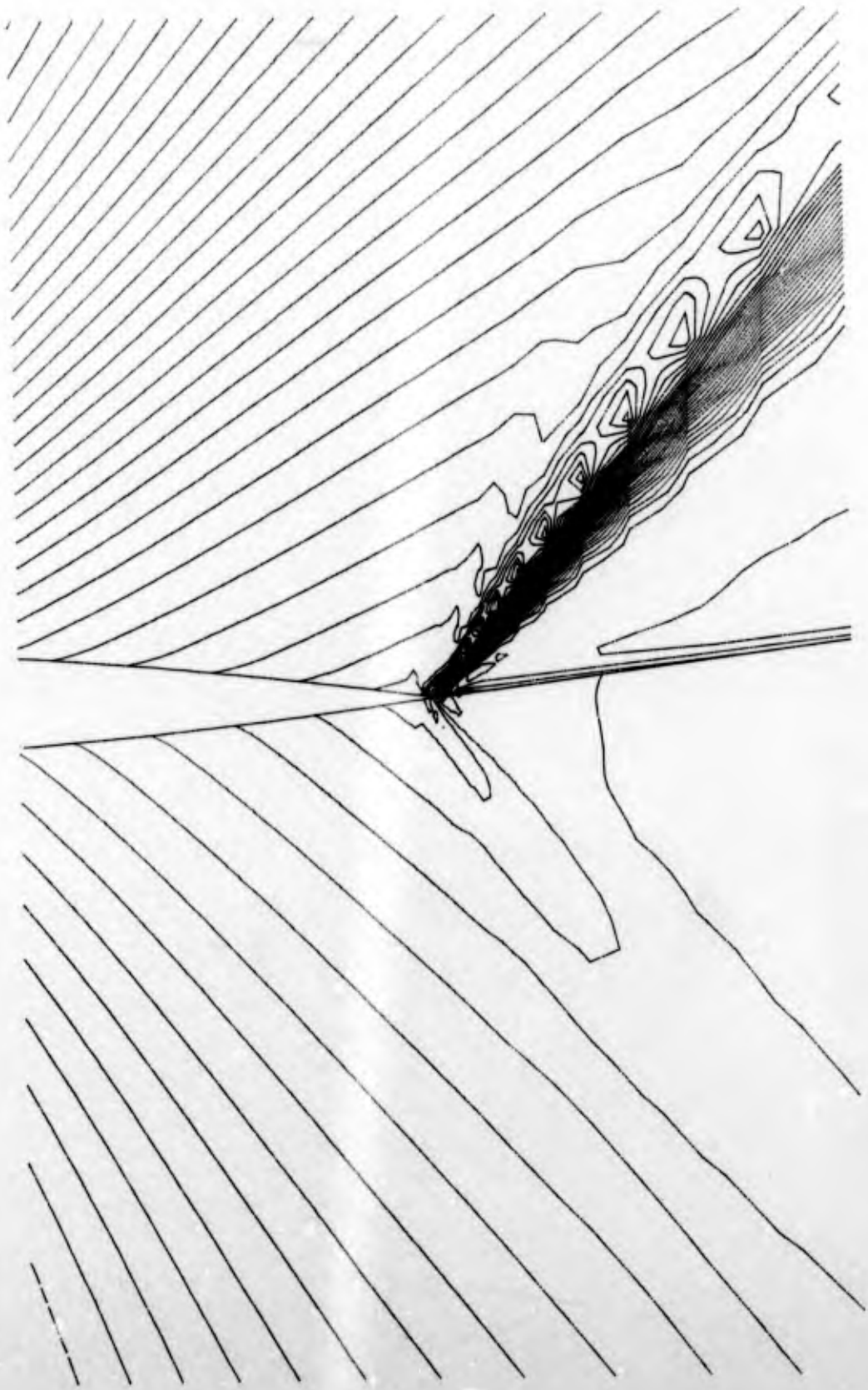
A∞-M∞ V∞

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-22
	NACA 0012: MACH = 1.2, ALPHA = 7			



ISO-MACH LINES (DM=.05 100CM CHORD)

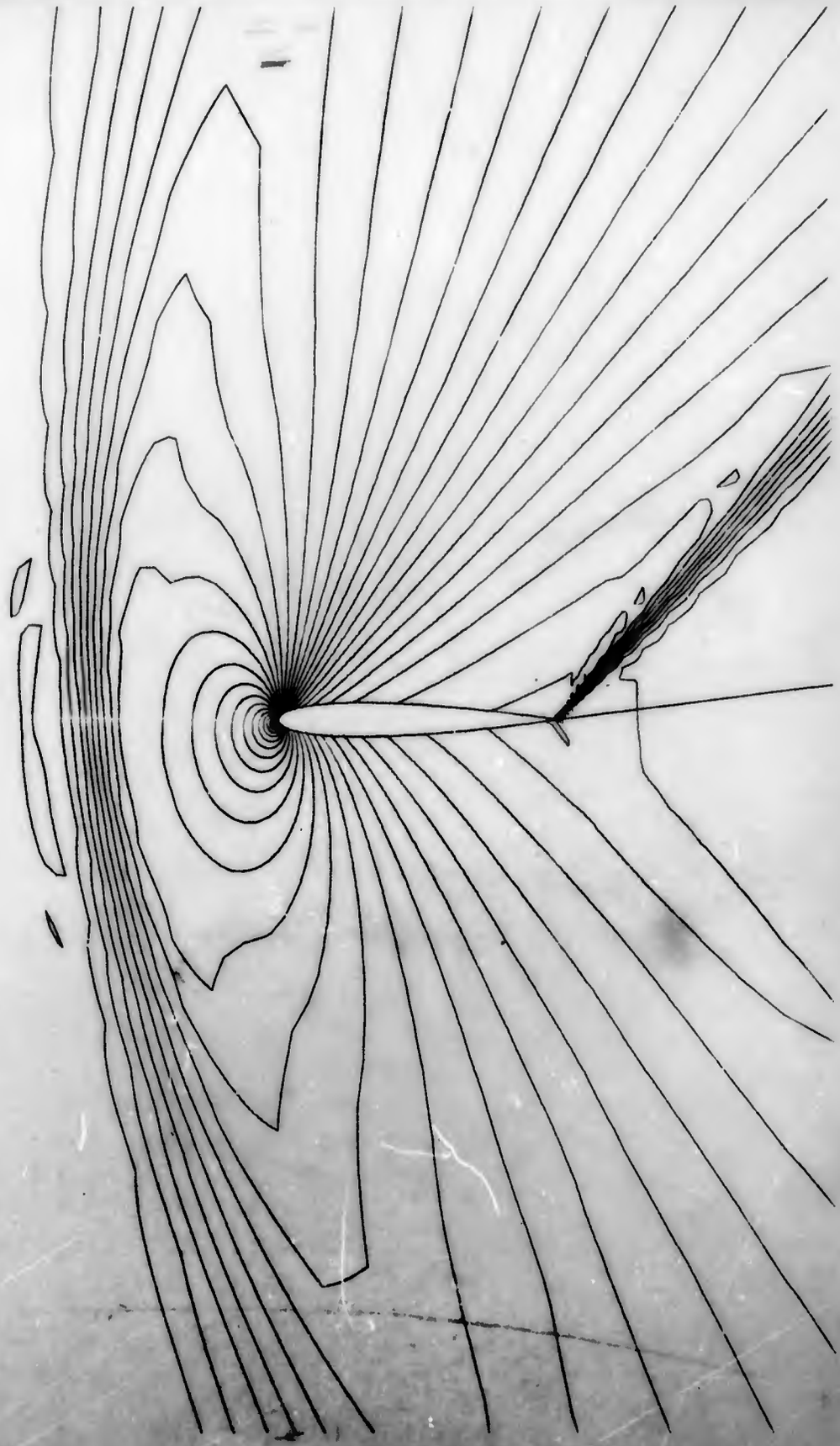
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-23
	NACA 0012: MACH = 1.2. ALPHA = 7			



ISO-MACH LINES (DM=.02 15CM CHORD)

A.-M. V.

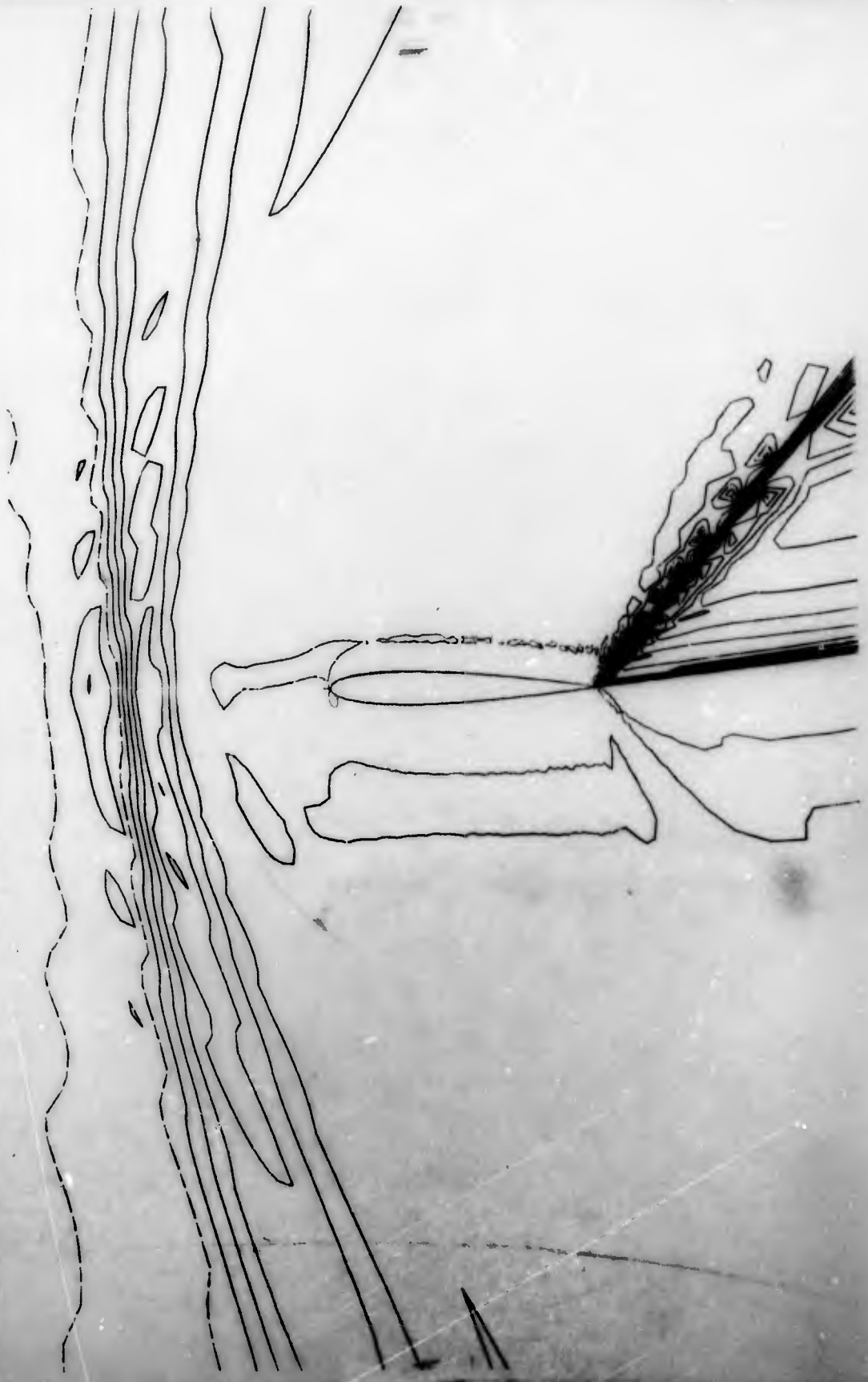
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-24
	NACA 0012: MACH = 1.2, ALPHA = 7			



ISO-P/PINF LINES

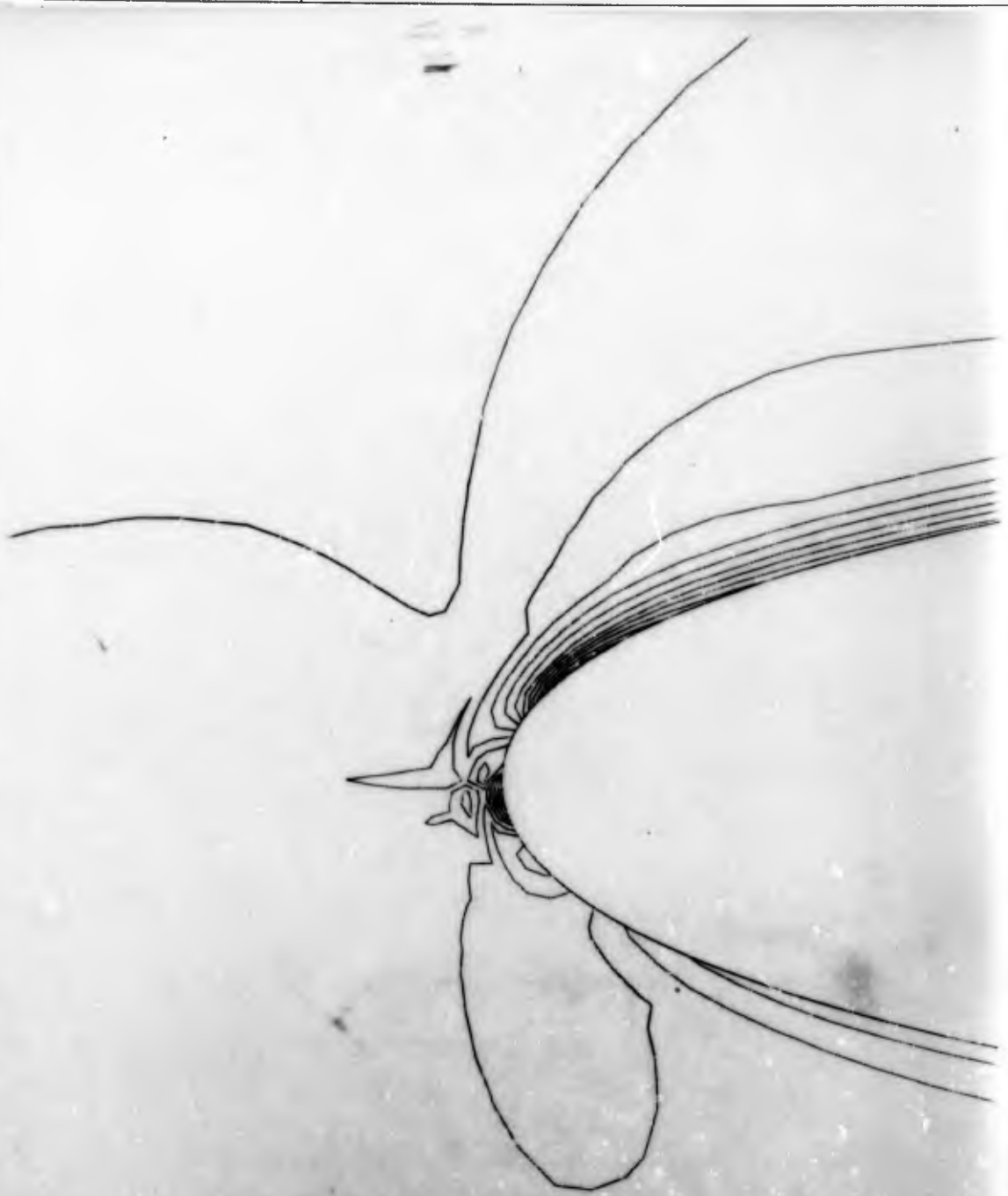
A∞-M∞ V∞

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-25
	NACA 0012: MACH = 1.2, ALPHA = 7			



ISO-PI/PIINF LINES (DPI/PIINF=.005)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	05-1-26
	NACA 0012: MACH = 1.2, ALPHA = 7			



ISO-PI/PIINF LINES (DPI/PIINF=.001)

													FICHE Nº 7
		04-1-22	04-1-23	04-1-24	TEST CASE 04 CONTRIBUTOR 3	04-3-1	04-3-2	04-3-3	04-3-4	04-3-5	04-3-6	04-3-7	04-3-8	
04-3-9	04-3-10	04-3-11	04-3-12	04-3-13	TEST CASE 04 CONTRIBUTOR 6	04-6-1	04-6-2	04-6-3	04-6-4	04-6-5	04-6-6	04-6-7	04-6-8	
04-6-9	04-6-10	04-6-11	04-6-12	04-6-13	04-6-14	04-6-15	04-6-16	04-6-17	04-6-18	04-6-19	04-6-20	04-6-21	04-6-22	
04-6-23	TEST CASE 04 CONTRIBUTOR 9	04-9-1	04-9-2	04-9-3	04-9-4	04-9-5	04-9-6	04-9-7	04-9-8	04-9-9	04-9-10	04-9-11	04-9-12	
04-9-13	04-9-14	04-9-15	04-9-16	04-9-17	04-9-18	04-9-19	04-9-20	04-9-21	04-9-22	04-9-23	04-9-24	04-9-25	04-9-26	
TEST CASE 05 Contributor 1	05-1-1	05-1-2	05-1-3	05-1-4	05-1-5	05-1-6	05-1-7	05-1-8	05-1-9	05-1-10	05-1-11	05-1-12	05-1-13	
05-1-14	05-1-15	05-1-16	05-1-17	05-1-18	05-1-19	05-1-20	05-1-21	05-1-22	05-1-23	05-1-24	05-1-25	05-1-26	CONTINUED	

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 05

NACA 0012: MACH = 1.2, ALPHA = 7

Contributor No 3

C.C.Lytton

(R.A.E., G.B.)

R.A.E.	AR 211		C.C.Lytton	05-3-1
	NACA 0012: MACH = 1.2, ALPHA = 7			

NACA0012 MACH 1.200 | ALPHA 7.000 BY FORMULA 0<X<1:

VERSION 87: KEEPS WALL CELLS ROUGHLY SAME ASPECT RATIO

AFTER K=1, CELL DEPTHS INCREASE IN GEOMETRIC PROGRESSION

TOTAL CELL DEPTH =16.0*CHORD

JL	KL	NEND	NPRNT
160	24	0	0

CP*	P(CR)	CPS	P(ST)
0.2697	0.6309	1.3963	1.1942

J	X/C	Z/C	1-P/H	CP	M	1-PI/H
2	1.000	-0.0000	0.6306	-0.1034	1.2815	0.0018
3	0.999	-0.0001	0.6344	-0.1125	1.2881	0.0031
4	0.997	-0.0004	0.6340	-0.1115	1.2870	0.0036
5	0.995	-0.0007	0.6335	-0.1105	1.2860	0.0037
6	0.992	-0.0011	0.6330	-0.1092	1.2849	0.0038
7	0.988	-0.0017	0.6324	-0.1077	1.2836	0.0038
8	0.983	-0.0024	0.6316	-0.1059	1.2822	0.0038
9	0.978	-0.0031	0.6308	-0.1040	1.2806	0.0037
10	0.972	-0.0040	0.6300	-0.1019	1.2789	0.0037
11	0.965	-0.0049	0.6290	-0.0995	1.2769	0.0036
12	0.957	-0.0060	0.6279	-0.0970	1.2748	0.0036
13	0.948	-0.0071	0.6267	-0.0941	1.2725	0.0036
14	0.939	-0.0083	0.6255	-0.0911	1.2701	0.0035
15	0.930	-0.0096	0.6242	-0.0880	1.2676	0.0033
16	0.919	-0.0109	0.6228	-0.0847	1.2650	0.0032
17	0.908	-0.0124	0.6214	-0.0813	1.2623	0.0030
18	0.896	-0.0138	0.6199	-0.0777	1.2596	0.0028
19	0.884	-0.0154	0.6184	-0.0741	1.2568	0.0026
20	0.871	-0.0170	0.6169	-0.0704	1.2539	0.0024
21	0.857	-0.0186	0.6153	-0.0665	1.2509	0.0022
22	0.843	-0.0203	0.6136	-0.0626	1.2479	0.0020
23	0.828	-0.0220	0.6120	-0.0586	1.2448	0.0018
24	0.813	-0.0238	0.6103	-0.0545	1.2417	0.0016
25	0.797	-0.0255	0.6086	-0.0504	1.2385	0.0014
26	0.781	-0.0273	0.6068	-0.0462	1.2353	0.0012
27	0.764	-0.0291	0.6050	-0.0419	1.2320	0.0010
28	0.747	-0.0309	0.6032	-0.0375	1.2287	0.0009
29	0.730	-0.0327	0.6014	-0.0332	1.2254	0.0007
30	0.712	-0.0345	0.5995	-0.0287	1.2219	0.0006
31	0.694	-0.0363	0.5976	-0.0241	1.2184	0.0004
32	0.675	-0.0381	0.5957	-0.0194	1.2148	0.0003
33	0.656	-0.0399	0.5936	-0.0145	1.2111	0.0001
34	0.637	-0.0416	0.5915	-0.0094	1.2073	-0.0000
35	0.618	-0.0433	0.5893	-0.0041	1.2033	-0.0001
36	0.599	-0.0449	0.5870	0.0016	1.1989	-0.0002
37	0.579	-0.0465	0.5845	0.0076	1.1944	-0.0003
38	0.559	-0.0480	0.5818	0.0139	1.1896	-0.0004
39	0.540	-0.0495	0.5792	0.0204	1.1847	-0.0005
40	0.520	-0.0509	0.5764	0.0270	1.1798	-0.0006
41	0.500	-0.0522	0.5735	0.0341	1.1745	-0.0007
42	0.480	-0.0534	0.5702	0.0419	1.1686	-0.0007
43	0.460	-0.0545	0.5667	0.0504	1.1622	-0.0008
44	0.441	-0.0556	0.5629	0.0594	1.1556	-0.0009
45	0.421	-0.0565	0.5590	0.0688	1.1488	-0.0010

R.A.E.	AR 211		C.C.Lytton	05-3-2
	NACA 0012: MACH = 1.2, ALPHA = 7			

46	0.401	-0.0573	0.5549	0.0788	1.1415	-0.0011
47	0.382	-0.0580	0.5503	0.0898	1.1335	-0.0012
48	0.363	-0.0586	0.5454	0.1016	1.1250	-0.0014
49	0.344	-0.0590	0.5403	0.1139	1.1161	-0.0014
50	0.325	-0.0593	0.5344	0.1281	1.1060	-0.0016
51	0.306	-0.0594	0.5288	0.1415	1.0965	-0.0016
52	0.288	-0.0594	0.5224	0.1568	1.0857	-0.0018
53	0.270	-0.0593	0.5154	0.1736	1.0739	-0.0019
54	0.253	-0.0590	0.5090	0.1891	1.0632	-0.0021
55	0.236	-0.0585	0.5003	0.2100	1.0487	-0.0021
56	0.219	-0.0579	0.4924	0.2290	1.0358	-0.0023
57	0.203	-0.0571	0.4839	0.2494	1.0221	-0.0026
58	0.187	-0.0562	0.4748	0.2713	1.0073	-0.0026
59	0.172	-0.0551	0.4647	0.2958	0.9913	-0.0031
60	0.157	-0.0538	0.4546	0.3201	0.9751	-0.0032
61	0.143	-0.0524	0.4432	0.3476	0.9571	-0.0034
62	0.129	-0.0508	0.4311	0.3767	0.9382	-0.0036
63	0.116	-0.0491	0.4185	0.4068	0.9189	-0.0039
64	0.104	-0.0472	0.4045	0.4404	0.8974	-0.0043
65	0.092	-0.0452	0.3901	0.4752	0.8753	-0.0046
66	0.081	-0.0430	0.3743	0.5133	0.8513	-0.0050
67	0.070	-0.0407	0.3572	0.5544	0.8255	-0.0053
68	0.061	-0.0383	0.3387	0.5988	0.7975	-0.0055
69	0.052	-0.0358	0.3185	0.6474	0.7669	-0.0058
70	0.043	-0.0331	0.2963	0.7008	0.7332	-0.0060
71	0.035	-0.0304	0.2718	0.7598	0.6955	-0.0060
72	0.028	-0.0275	0.2447	0.8251	0.6532	-0.0061
73	0.022	-0.0246	0.2136	0.8997	0.6047	-0.0067
74	0.017	-0.0216	0.1793	0.9824	0.5484	-0.0069
75	0.012	-0.0184	0.1398	1.0775	0.4810	-0.0078
76	0.008	-0.0153	0.0973	1.1795	0.4014	-0.0086
77	0.005	-0.0120	0.0508	1.2915	0.2980	-0.0095
78	0.003	-0.0086	0.0087	1.3927	0.1693	-0.0113
79	0.001	-0.0052	-0.0061	1.4284	0.0675	-0.0094
80	0.000	-0.0018	0.0146	1.3786	0.1873	-0.0098
81	0.000	0.0018	0.0836	1.2126	0.3559	-0.0003
82	0.001	0.0052	0.1854	0.9677	0.5329	0.0116
83	0.003	0.0086	0.2780	0.7448	0.6814	0.0149
84	0.005	0.0120	0.3617	0.5436	0.8105	0.0167
85	0.008	0.0153	0.4309	0.3771	0.9200	0.0162
86	0.012	0.0184	0.4809	0.2567	0.9981	0.0195
87	0.017	0.0216	0.5256	0.1491	1.0765	0.0160
88	0.022	0.0246	0.5526	0.0843	1.1206	0.0199
89	0.028	0.0275	0.5789	0.0210	1.1693	0.0186
90	0.035	0.0304	0.6029	-0.0368	1.2130	0.0206
91	0.043	0.0331	0.6192	-0.0759	1.2444	0.0209
92	0.052	0.0358	0.6348	-0.1135	1.2732	0.0241
93	0.061	0.0383	0.6473	-0.1435	1.2988	0.0243
94	0.070	0.0407	0.6589	-0.1714	1.3218	0.0263
95	0.081	0.0430	0.6695	-0.1970	1.3443	0.0271
96	0.092	0.0452	0.6788	-0.2194	1.3647	0.0273
97	0.104	0.0472	0.6872	-0.2396	1.3826	0.0286
98	0.116	0.0491	0.6952	-0.2588	1.4010	0.0287
99	0.129	0.0508	0.7027	-0.2767	1.4194	0.0275
100	0.143	0.0524	0.7095	-0.2931	1.4356	0.0276
101	0.157	0.0538	0.7157	-0.3082	1.4500	0.0288
102	0.172	0.0551	0.7215	-0.3220	1.4636	0.0297
103	0.187	0.0562	0.7267	-0.3346	1.4764	0.0304
104	0.203	0.0571	0.7317	-0.3466	1.4886	0.0312
105	0.219	0.0579	0.7365	-0.3582	1.5008	0.0316

R.A.E.	AR 211		C.C.Lytton	05-3-3
	NACA 0012: MACH = 1.2, ALPHA = 7			

106	0.236	0.0585	0.7411	-0.3693	1.5128	0.0319
107	0.253	0.0590	0.7455	-0.3797	1.5243	0.0319
108	0.270	0.0593	0.7494	-0.3893	1.5352	0.0318
109	0.288	0.0594	0.7532	-0.3982	1.5458	0.0313
110	0.306	0.0594	0.7567	-0.4066	1.5558	0.0309
111	0.325	0.0593	0.7600	-0.4148	1.5657	0.0304
112	0.344	0.0590	0.7633	-0.4226	1.5751	0.0302
113	0.363	0.0586	0.7664	-0.4302	1.5844	0.0299
114	0.382	0.0580	0.7694	-0.4373	1.5932	0.0298
115	0.401	0.0573	0.7722	-0.4440	1.6015	0.0297
116	0.421	0.0565	0.7747	-0.4502	1.6090	0.0297
117	0.441	0.0556	0.7770	-0.4556	1.6157	0.0299
118	0.460	0.0545	0.7791	-0.4606	1.6217	0.0302
119	0.480	0.0534	0.7810	-0.4651	1.6273	0.0304
120	0.500	0.0522	0.7828	-0.4695	1.6329	0.0305
121	0.520	0.0509	0.7845	-0.4736	1.6382	0.0304
122	0.540	0.0495	0.7861	-0.4774	1.6434	0.0301
123	0.559	0.0480	0.7876	-0.4811	1.6484	0.0297
124	0.579	0.0465	0.7890	-0.4845	1.6532	0.0293
125	0.599	0.0449	0.7904	-0.4877	1.6577	0.0290
126	0.618	0.0433	0.7916	-0.4908	1.6619	0.0288
127	0.637	0.0416	0.7929	-0.4938	1.6660	0.0286
128	0.656	0.0399	0.7941	-0.4966	1.6699	0.0285
129	0.675	0.0381	0.7952	-0.4994	1.6736	0.0285
130	0.694	0.0363	0.7963	-0.5021	1.6772	0.0285
131	0.712	0.0345	0.7974	-0.5046	1.6807	0.0285
132	0.730	0.0327	0.7984	-0.5071	1.6841	0.0285
133	0.747	0.0309	0.7994	-0.5095	1.6874	0.0285
134	0.764	0.0291	0.8004	-0.5119	1.6908	0.0284
135	0.781	0.0273	0.8014	-0.5142	1.6941	0.0282
136	0.797	0.0255	0.8023	-0.5165	1.6975	0.0280
137	0.813	0.0238	0.8032	-0.5187	1.7008	0.0277
138	0.828	0.0220	0.8041	-0.5209	1.7040	0.0274
139	0.843	0.0203	0.8050	-0.5230	1.7071	0.0271
140	0.857	0.0186	0.8059	-0.5250	1.7102	0.0268
141	0.871	0.0170	0.8067	-0.5270	1.7133	0.0265
142	0.884	0.0154	0.8075	-0.5290	1.7162	0.0262
143	0.896	0.0138	0.8083	-0.5309	1.7192	0.0259
144	0.908	0.0124	0.8091	-0.5327	1.7221	0.0256
145	0.919	0.0109	0.8098	-0.5345	1.7249	0.0252
146	0.930	0.0096	0.8105	-0.5362	1.7277	0.0248
147	0.939	0.0083	0.8112	-0.5379	1.7304	0.0243
148	0.948	0.0071	0.8119	-0.5395	1.7331	0.0238
149	0.957	0.0060	0.8125	-0.5410	1.7356	0.0233
150	0.965	0.0049	0.8131	-0.5424	1.7381	0.0227
151	0.972	0.0040	0.8136	-0.5437	1.7403	0.0221
152	0.978	0.0031	0.8141	-0.5448	1.7424	0.0216
153	0.983	0.0024	0.8145	-0.5459	1.7443	0.0211
154	0.988	0.0017	0.8149	-0.5468	1.7461	0.0205
155	0.992	0.0011	0.8153	-0.5477	1.7477	0.0200
156	0.995	0.0007	0.8156	-0.5484	1.7490	0.0196
157	0.997	0.0004	0.8158	-0.5489	1.7502	0.0190
158	0.999	0.0001	0.8161	-0.5496	1.7514	0.0187
159	1.000	0.0000	0.7952	-0.4993	1.7110	-0.0280

R.A.E.	AR 211		C.C.Lytton	05-3-4
	NACA 0012: MACH = 1.2, ALPHA = 7			

K	X/C	Z/C	1-P/H	CP	M	1-PI/H
1	1.000	-0.0002	0.6082	-0.0495	1.2371	0.0023
2	1.001	-0.0004	0.6165	-0.0694	1.2558	-0.0012
3	1.002	-0.0005	0.6202	-0.0785	1.2643	-0.0026
4	1.006	-0.0007	0.6078	-0.0485	1.2380	0.0001
5	1.014	-0.0010	0.6124	-0.0595	1.2460	0.0012
6	1.030	-0.0014	0.6109	-0.0560	1.2430	0.0015
7	1.058	-0.0020	0.6086	-0.0506	1.2382	0.0021
8	1.103	-0.0029	0.6070	-0.0466	1.2338	0.0036
9	1.171	-0.0043	0.6034	-0.0380	1.2261	0.0048
10	1.274	-0.0063	0.6003	-0.0304	1.2198	0.0052
11	1.415	-0.0091	0.5987	-0.0266	1.2158	0.0065
12	1.595	-0.0126	0.5978	-0.0244	1.2123	0.0088
13	1.823	-0.0171	0.5956	-0.0191	1.2072	0.0100
14	2.111	-0.0227	0.5938	-0.0149	1.2038	0.0101
15	2.474	-0.0298	0.5923	-0.0113	1.2027	0.0079
16	2.932	-0.0388	0.5911	-0.0083	1.2027	0.0048
17	3.508	-0.0501	0.5904	-0.0066	1.2027	0.0032
18	4.234	-0.0644	0.5895	-0.0046	1.2011	0.0031
19	5.148	-0.0824	0.5885	-0.0022	1.1989	0.0037
20	6.299	-0.1050	0.5879	-0.0006	1.1969	0.0046
21	7.749	-0.1334	0.5872	0.0010	1.1949	0.0056
22	9.578	-0.1694	0.5886	-0.0023	1.1971	0.0061
23	11.907	-0.2151	0.5952	-0.0182	1.2082	0.0077
24	15.163	-0.2789	0.6020	-0.0345	1.2226	0.0058

K	X/C	Z/C	1-P/H	CP	M	1-PI/H
1	-0.002	0.0020	0.0646	1.2583	0.3288	-0.0081
2	-0.005	0.0024	0.0535	1.2851	0.3210	-0.0166
3	-0.011	0.0029	0.0764	1.2299	0.3500	-0.0053
4	-0.020	0.0037	0.1052	1.1606	0.4061	-0.0024
5	-0.034	0.0048	0.1424	1.0710	0.4737	-0.0000
6	-0.056	0.0064	0.1826	0.9743	0.5423	0.0017
7	-0.088	0.0085	0.2214	0.8810	0.6056	0.0025
8	-0.135	0.0113	0.2578	0.7934	0.6630	0.0033
9	-0.201	0.0150	0.2917	0.7120	0.7153	0.0038
10	-0.291	0.0196	0.3229	0.6369	0.7636	0.0038
11	-0.411	0.0253	0.3542	0.5615	0.8121	0.0036
12	-0.569	0.0324	0.5248	0.1510	1.0792	0.0111
13	-0.775	0.0410	0.5876	0.0001	1.1999	-0.0000
14	-1.039	0.0515	0.5876	0.0000	1.2000	0.0000
15	-1.377	0.0643	0.5876	0.0000	1.2000	0.0000
16	-1.807	0.0798	0.5876	0.0000	1.2000	0.0000
17	-2.353	0.0988	0.5876	0.0000	1.2000	-0.0000
18	-3.045	0.1219	0.5876	0.0000	1.2000	-0.0000
19	-3.920	0.1501	0.5876	0.0000	1.2000	-0.0000
20	-5.028	0.1848	0.5876	0.0000	1.2000	0.0000
21	-6.431	0.2276	0.5876	0.0000	1.2000	0.0000
22	-8.214	0.2805	0.5876	0.0000	1.2000	0.0000
23	-10.530	0.3476	0.5876	0.0000	1.2000	-0.0000
24	-13.982	0.4440	0.5876	0.0000	1.2000	0.0000

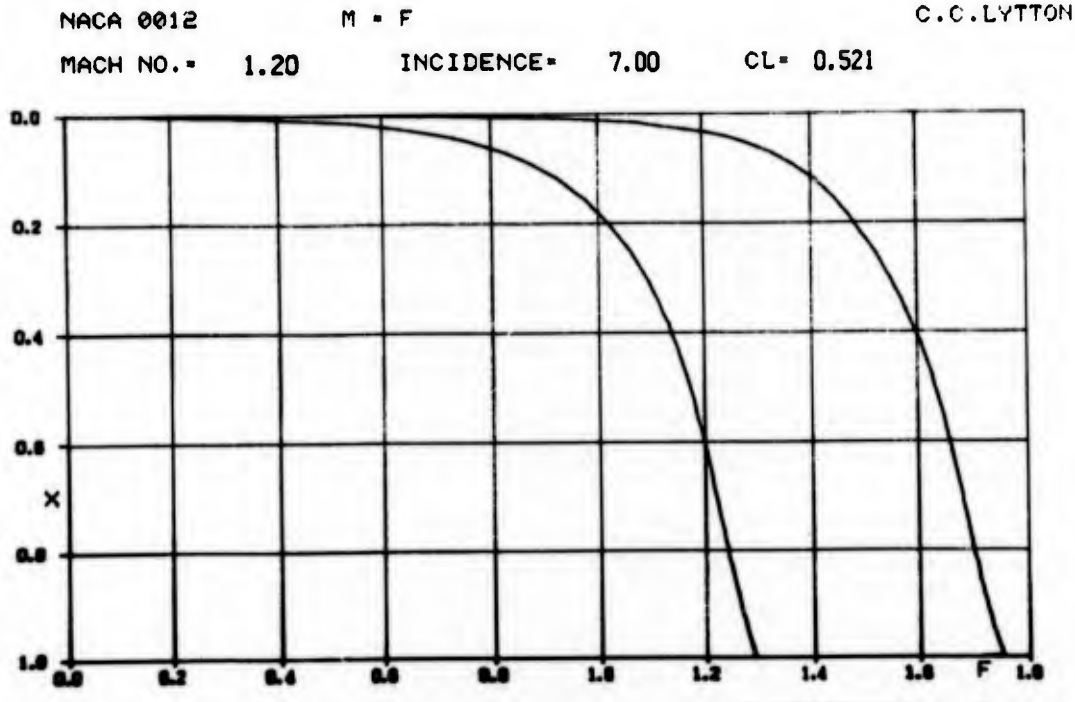
R.A.E.	AR 211		C.C.Lytton	05-3-5
	NACA 0012: MACH = 1.2, ALPHA = 7			

CL= 0.52138 CD= 0.15422 CM= -0.11086

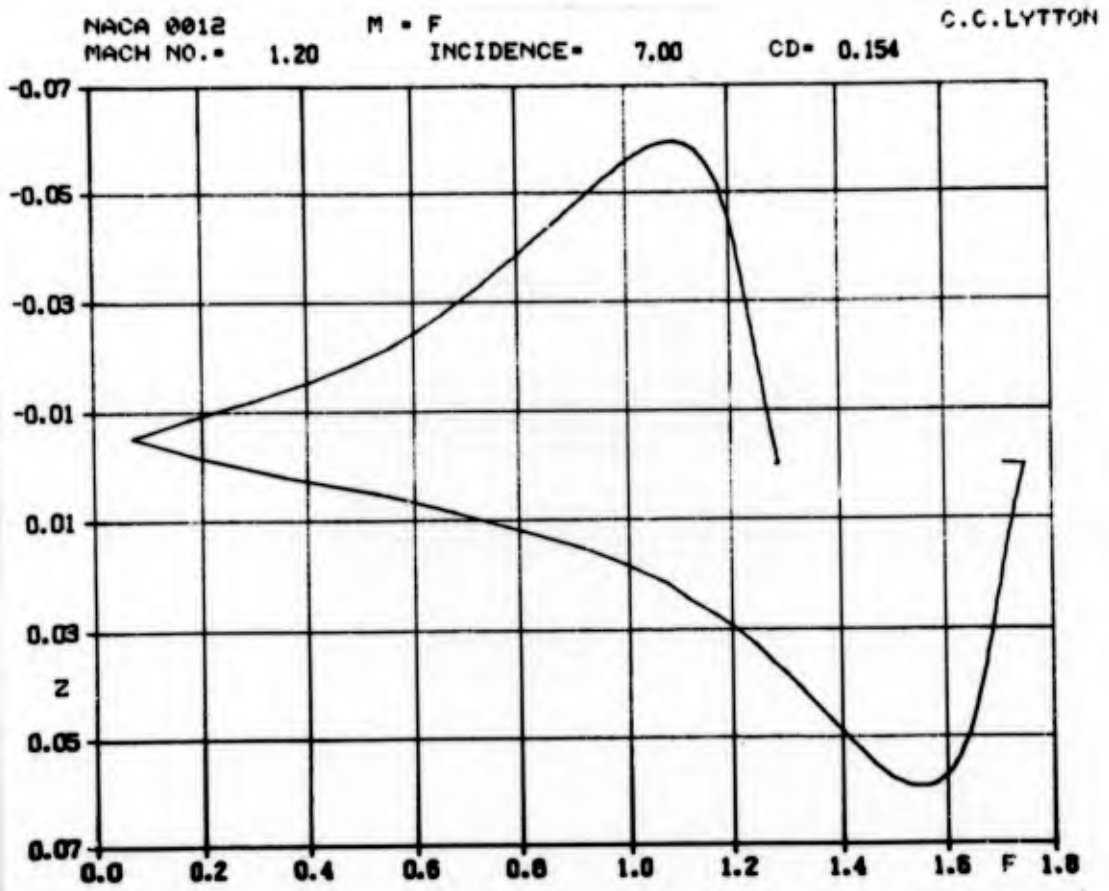
GAMMA AROUND PROFILE = 0.28627

K	GAMMA
1	0.29126
2	0.30175
3	0.29830
4	0.29836
5	0.29800
6	0.29757
7	0.29715
8	0.29566
9	0.29324
10	0.28962
11	0.28775
12	0.28468
13	0.28477
14	0.28022
15	0.27655
16	0.27621
17	0.27327
18	0.26940
19	0.26679
20	0.26521
21	0.26085
22	0.26133
23	0.26119

R.A.E.	AR 211		C.C.Lytton	05-3-6
	NACA 0012: MACH = 1.2, ALPHA = 7			



R.A.E.	AR 211		C.C.Lytton	05-3-7
	NACA 0012: MACH = 1.2, ALPHA = 7			

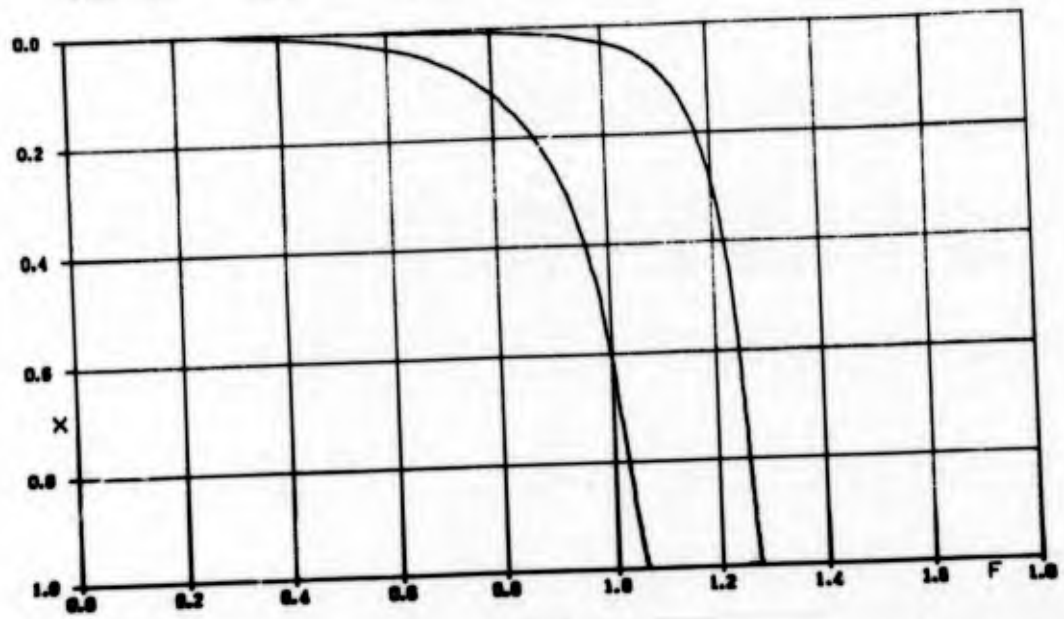


R.A.E.	AR 211		C.C.Lytton	05-3-8
	NACA 0012: MACH = 1.2, ALPHA = 7			

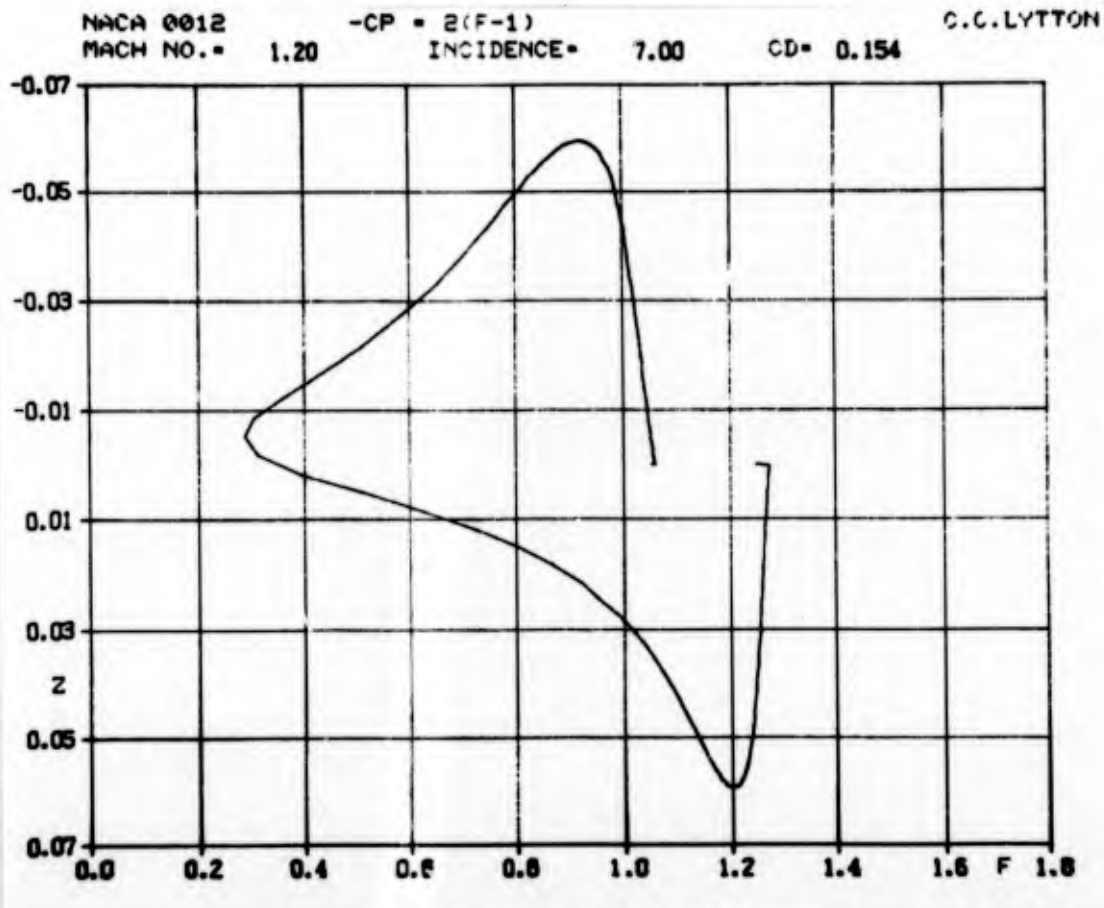
C.C.LYTTON

NACA 0012 -CP = 2(F-1)

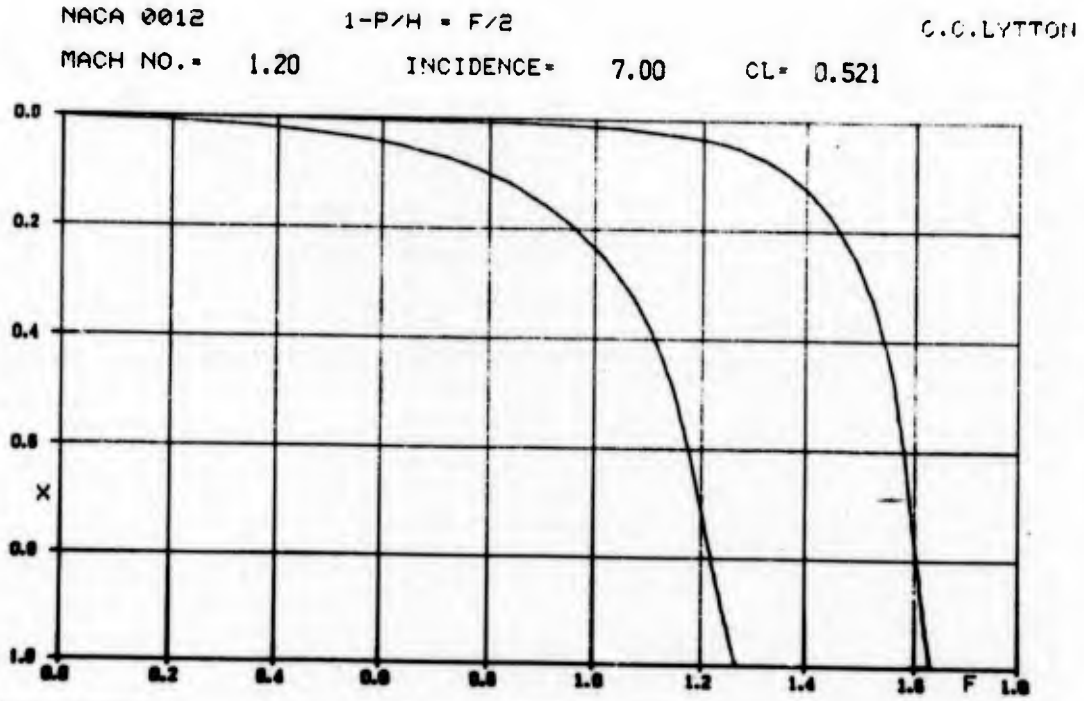
MACH NO.= 1.20 INCIDENCE= 7.00 CL= 0.521



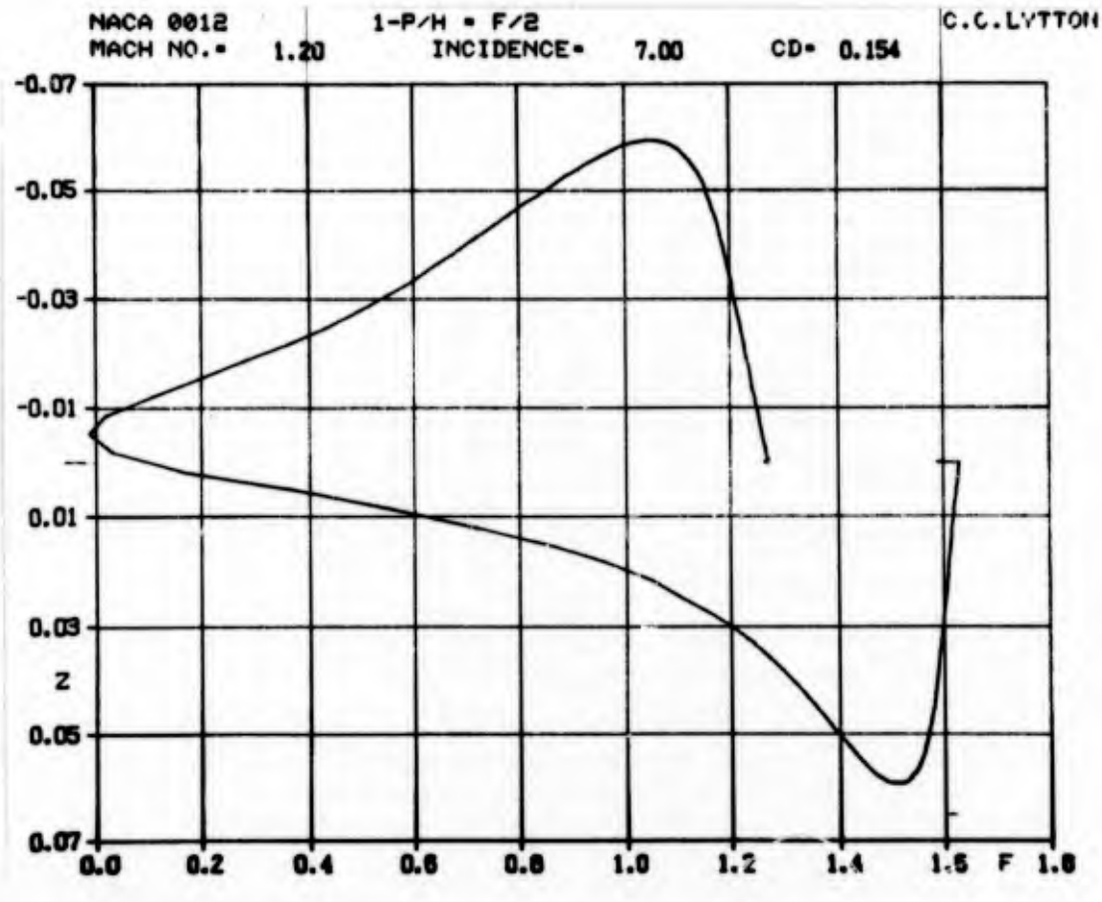
R.A.E.	AR 211		C.C.Lytton	05-3-9
	NACA 0012: MACH = 1.2, ALPHA = 7			



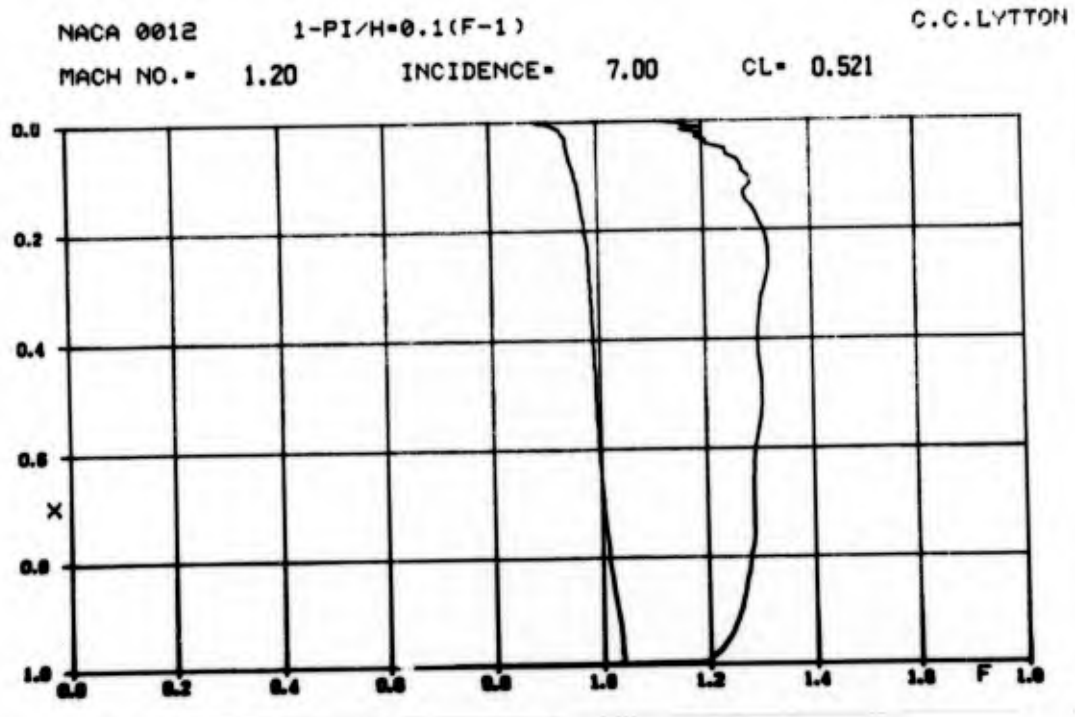
R.A.E.	AR 211		C.C.Lytton	05-3-10
	NACA 0012: MACH = 1.2, ALPHA = 7			



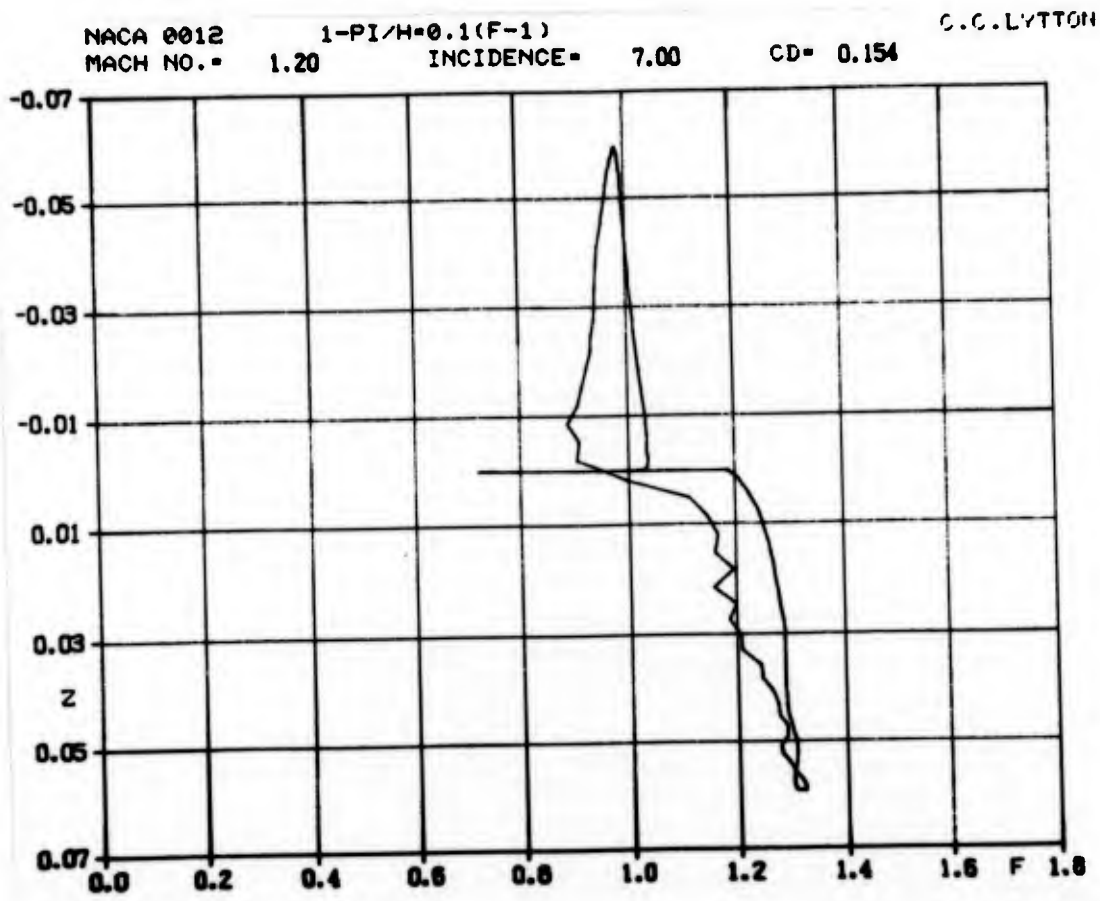
R.A.E.	AR 211		C.C.Lytton	05-3-11
	NACA 0012: MACH = 1.2, ALPHA = 7			



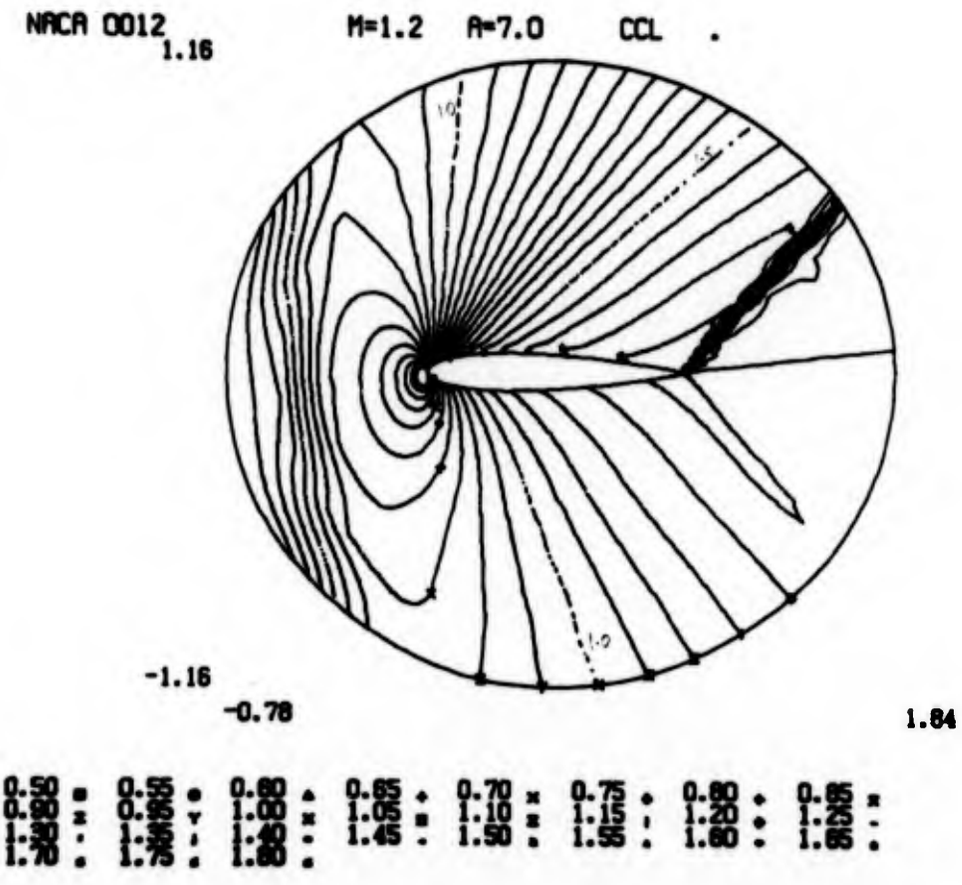
R.A.E.	AR 211		C.C.Lytton	05-3-12
	NACA 0012: MACH = 1.2, ALPHA = 7			



R.A.E.	AR 211		C.C.Lytton	05-3-13
	NACA 0012: MACH = 1.2, ALPHA = 7			



R.A.E.	AR 211		C.C.Lytton	05-3-14
	NACA 0012: MACH = 1.2, ALPHA = 7			



AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 05

NACA 0012: MACH = 1.2, ALPHA = 7

Contributor No 5

T.H.Pulliam and J.T.Barton

(N.A.S.A. — Ames, U.S.A.)

§6e AGARD05 NACA0012 $M = 1.2 \quad \alpha = 7$.

Grid

The grid for AGARD05 is the same as for AGARD04.

The grid for AGARD04 is presented in Figures 4a – 4e, with the full extent given in Fig. 4a and closeups in Figs. 4b – 4e. There are 34 points in the wake from the trailing edge to the far field right boundary. A total of 181 points are distributed on the body (91 on the upper and 90 on the lower surface) with clustering at the leading edge (minimum $\Delta x = 0.001$) and clustering at the trailing edge (minimum $\Delta x = 0.005$). The minimum spacing in the normal direction is $dy = 0.005$ and exponential stretching is used to the outer boundary. The physical extent of the domain is $-2.0 \leq x \leq 8.0$ and $-12.0 \leq y \leq 12.0$.

Convergence Histories

The residual and ΔQ histories are given in Figs. 5a – 5d. In this case, we converge about 10 orders of magnitude in 1600 iterations. Convergence histories for C_L, C_D, and C_{pm} are shown in Figs. 5e – 5g. The jump in the residuals, see Fig. 5a, is due to a change in the boundary condition similar to what occurred in AGARD01. For AGARD05 the solution was sensitive to the stagnation enthalpy boundary condition at least in the initialization phase. The run was therefore started with the old density extrapolation boundary condition and then after 200 steps the new enthalpy condition was turned on for the remainder of the iterations. Convergence rates were not affected.

Surface Plots

Surface values are plotted versus x and y in Figs. 5h – 5q. This case also has an oblique shock at the trailing edge and, as seen in the contour plots, a bow shock in front of the airfoil. The same strategy for the upwind operators that was used for AGARD04 was used for this case.

Tabulated data for the surface values are presented in Table 5. The converged values for lift, drag, and moment are

$$C_L = 0.51965, \quad C_D = 0.15431, \quad C_{pm} = -0.11020,$$

with computed circulation $\Gamma = 0.2995$.

Flowfield Contours

Flowfield contours for this case are presented in Figs. 5r – 5w. Mach contours in Fig. 5r show the bow shock and trailing edge shock system. In Fig. 5u, a farfield view is shown, demonstrating how far away the farfield boundaries are from any large gradients in the solution. Again, good stagnation values are obtained, see Fig. 5w.

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-2
	NACA 0012: MACH = 1.2, ALPHA = 7			

NACA##12 Mach = 1.2## Alpha = 7.### Results on the airfoil surface

N	X/C	Y/C	1-P/Pinf	Cp	Mach	1-Pt/Ptinf	1-Tt/Tinf
1	0.######	#.######	#.587858	-#.###565	1.195829	#.##5986	-#.#####7#
2	6.948697	#.######	#.587858	-#.###565	1.195829	#.##5987	-#.#####7#
3	6.#54345	#.######	#.58784#	-#.###523	1.195618	#.##6218	-#.#####3
4	5.293813	#.######	#.588###	-#.##1#99	1.195736	#.##6642	-#.####49
5	4.647###	#.######	#.588666	-#.##25#9	1.196585	#.##7#62	#.####12
6	4.#97118	#.######	#.589455	-#.###4##	1.197824	#.##7263	#.####38
7	3.629445	#.######	#.59#226	-#.##6263	1.199288	#.##7234	#.#####9
8	3.23175#	#.######	#.59#86#	-#.##7789	1.2##548	#.##7142	-#.####34
9	2.893563	#.######	#.591#89	-#.##91##	1.2#1588	#.##7126	-#.####52
1#	2.6#5970	#.######	#.592#27	-#.#1#596	1.2#2684	#.##72#0	-#.####37
11	2.361425	#.######	#.592854	-#.#12583	1.2#4143	#.##7329	-#.#####1#
12	2.153463	#.######	#.593924	-#.#15159	1.2#6#81	#.##7420	#.#####16
13	1.976619	#.######	#.595166	-#.#18146	1.2#8368	#.##7497	#.#####32
14	1.826236	#.######	#.596459	-#.#21257	1.21#768	#.##755#	#.#####29
15	1.698365	#.######	#.597716	-#.#24281	1.213225	#.##7449	-#.######5
16	1.589#89	#.######	#.598#87	-#.#27146	1.21577#	#.##7#75	-#.#####21
17	1.497134	#.######	#.6###45	-#.#29884	1.217879	#.##7145	#.#####37
18	1.418496	#.######	#.6#1139	-#.#32515	1.219#14	#.##73##	#.#####27
19	1.351625	#.######	#.6#2188	-#.#35#2#	1.22#491	#.##9#44	-#.####2#5
2#	1.294768	#.######	#.6#3176	-#.#37417	1.224#19	#.##6922	-#.####3#2
21	1.24b4##	#.######	#.6#4#75	-#.#39578	1.228#73	#.##3854	-#.#####1##
22	1.2#5282	#.######	#.6#4881	-#.#41517	1.23#4#3	#.##2817	#.####235
23	1.17#314	#.######	#.6#5585	-#.#43211	1.231372	#.##3317	#.####589
24	1.14#578	#.######	#.6#6#42	-#.#44312	1.231317	#.##4545	#.####44
25	1.115292	#.######	#.6#6748	-#.#46#1#	1.23121#	#.##6469	#.##1#46
26	1.#93789	#.######	#.6#7#79	-#.#48##5	1.23#747	#.##7912	#.##1#26
27	1.#756#3	#.######	#.6#8179	-#.#49453	1.231362	#.##9899	#.##1124
28	1.#59954	#.######	#.6#9#83	-#.#51626	1.232332	#.#1####	#.####953
29	1.#46731	#.######	#.6##824	-#.#51##3	1.23#872	#.#12155	#.####82
3#	1.#35487	#.######	#.614584	-#.#64669	1.24#729	#.#13699	#.####956
31	1.#25925	#.######	#.61#451	-#.#54918	1.2344#7	#.#11651	-#.####87
32	1.#17794	#.######	#.63#939	-#.1#42#7	1.269377	#.#1#9#5	#.##1343
33	1.#1####	#.######	#.598654	-#.#26297	1.216659	#.##5#41	-#.##2217
34	1.##5###	#.######	#.66#831	-#.195363	1.322#6#	#.#54345	-#.##189#
35	1.######	#.######	#.587#91	#.##1279	1.245629	-#.#63342	#.######
36	#.995##1	-#.###713	#.6#329#	-#.#37691	1.326#87	-#.14#336	#.######
37	#.99###1	-#.##1422	#.633284	-#.1#9847	1.29#333	-#.##2#27	#.######
38	#.985##1	-#.##2127	#.633493	-#.11#35#	1.28#727	-#.####7#	#.######
39	#.98####	-#.##2#27	#.6329##	-#.1#0924	1.28754#	-#.####87	#.######
4#	#.974873	-#.##3541	#.632225	-#.1#73#1	1.286462	-#.####5#	#.######
41	#.969372	-#.##43#2	#.631416	-#.1#5354	1.285#77	-#.###789	#.######
42	#.963457	-#.##5114	#.63#453	-#.1#3#36	1.283289	-#.###983	#.######
43	#.957#84	-#.##5982	#.629384	-#.1##466	1.281171	-#.##1#7	#.######
44	#.95#2##	-#.##6913	#.628#45	-#.#97869	1.278879	-#.###822	#.######
45	#.942748	-#.##7911	#.627281	-#.#954#6	1.27663#	-#.####54#	#.######
46	#.934659	-#.###985	#.626275	-#.#92985	1.274489	-#.###351	#.######
47	#.925858	-#.#1#142	#.625149	-#.##9276	1.27232#	-#.####41	#.######
48	#.916258	-#.#11398	#.623823	-#.#87###8	1.269996	-#.####44	#.######
49	#.9#5757	-#.#12739	#.622383	-#.##3622	1.267263	-#.###995	#.######

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-3
	NACA 0012: MACH = 1.2, ALPHA = 7			

NACA##12 Mach = 1.2## Alpha = 7.### Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-P1/P1inf	1-T1/T1inf
50	#.894243	-#.#14199	#.62#946	-#.###166	1.263937	-#.###327	#.######
51	#.881584	-#.#15782	#.619447	-#.#76559	1.26#736	#.####14	#.######
52	#.867636	-#.#17499	#.617731	-#.#72433	1.2582#2	-#.##1#91	#.######
53	#.852234	-#.#19362	#.615788	-#.#67739	1.254767	-#.##1577	#.######
54	#.835199	-#.#21385	#.613768	-#.#62898	1.24961#	#.####69	#.######
55	#.816336	-#.#23577	#.611856	-#.#58297	1.24591#	#.#####58	#.######
56	#.795446	-#.#25948	#.6#9623	-#.#52925	1.242954	-#.##1748	#.######
57	#.772331	-#.#28583	#.6#6#85	-#.#46147	1.236715	-#.###655	#.######
58	#.746817	-#.#31239	#.6#4189	-#.#39854	1.231285	#.####11	#.######
59	#.718778	-#.#34144	#.6#1528	-#.#3345#	1.223149	-#.##1332	#.######
6#	#.688173	-#.#3719#	#.598##9	-#.#24985	1.22##15	-#.###719	#.######
61	#.655#81	-#.#4#332	#.594362	-#.#16213	1.213123	-#.###691	#.######
62	#.619747	-#.#435#4	#.59#667	-#.##7324	1.2#6412	-#.###967	#.######
63	#.582597	-#.#46623	#.586171	#.##3493	1.19797#	-#.###868	#.######
64	#.54424#	-#.#4959#	#.58#925	#.#16115	1.188487	-#.##1137	#.######
65	#.5#5413	-#.#5238#	#.575593	#.#28942	1.178597	-#.###978	#.######
66	#.466913	-#.#64671	#.569414	#.#438#5	1.167677	-#.##1367	#.######
67	#.429494	-#.#56625	#.562255	#.#61#27	1.154421	-#.####85	#.######
68	#.393791	-#.#58129	#.554674	#.#79267	1.141705	-#.##1883	#.######
69	#.36#264	-#.#59177	#.544238	#.1#4373	1.123#49	-#.##15#9	#.######
7#	#.329188	-#.#59792	#.535848	#.124575	1.1#7737	-#.###619	#.######
71	#.3##671	-#.#6##14	#.528543	#.142129	1.#96823	-#.##267#	#.######
72	#.274693	-#.#59897	#.517513	#.168664	1.#78356	-#.###358	#.######
73	#.251142	-#.#59495	#.5#7679	#.192323	1.#61556	-#.##2758	#.######
74	#.229853	-#.#5886#	#.498#63	#.215456	1.#45976	-#.##3296	#.######
75	#.21#632	-#.#58#41	#.488152	#.239298	1.#296#2	-#.##3275	#.######
76	#.193281	-#.#57#78	#.478228	#.263193	1.#1332#	-#.##323#	#.######
77	#.1776#4	-#.#56##6	#.468361	#.287#56	#.997#86	-#.###415	#.######
78	#.16342#	-#.#54854	#.458427	#.31#888	#.981783	-#.##3731	#.######
79	#.15#563	-#.#53644	#.448629	#.33438#	#.966592	-#.##425#	#.######
8#	#.138884	-#.#52394	#.438912	#.357758	#.951#79	-#.###132	#.######
81	#.128249	-#.#51118	#.429265	#.38#965	#.936211	-#.###45#	#.######
82	#.118543	-#.#49827	#.419689	#.4#4##1	#.921137	-#.###429	#.######
83	#.1#9663	-#.#4853#	#.41#154	#.426941	#.9#6552	-#.###474#	#.######
84	#.1#152#	-#.#47232	#.4##681	#.449729	#.891783	-#.###467	#.######
85	#.#94#34	-#.#45939	#.39122#	#.472489	#.877345	-#.###471	#.######
86	#.#87137	-#.#44655	#.38179#	#.495177	#.862746	-#.###48#	#.######
87	#.#8#768	-#.#43381	#.37234#	#.517911	#.848338	-#.###49#	#.######
88	#.#74875	-#.#42119	#.362892	#.54#64#	#.833784	-#.###476	#.######
89	#.#69412	-#.#4#87#	#.353389	#.563##	#.819144	-#.###474	#.######
9#	#.#64337	-#.#39636	#.343856	#.586434	#.8#4323	-#.###449	#.######
91	#.#59615	-#.#38415	#.334224	#.6#96#8	#.789434	-#.###433	#.######
92	#.#55214	-#.#372#8	#.324535	#.632916	#.774215	-#.###393	#.######
93	#.#511#7	-#.#36#15	#.3147#5	#.656563	#.758796	-#.###357	#.######
94	#.#47267	-#.#34835	#.3#4791	#.68#415	#.742955	-#.###297	#.######
95	#.#43673	-#.#33667	#.294685	#.7#4726	#.726768	-#.###237	#.######
96	#.#4#3#6	-#.#32511	#.284476	#.729286	#.71#868	-#.###151	#.######
97	#.#37147	-#.#31366	#.274#26	#.754427	#.692843	-#.###615	#.######
98	#.#34182	-#.#3#231	#.263448	#.779874	#.674997	#.###546	#.######
99	#.#31397	-#.#291#4	#.252581	#.8#6#16	#.656439	#.##1786	#.######

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-4
	NACA 0012: MACH = 1.2, ALPHA = 7			

NACA####12 Mach = 1.2## Alpha = 7.### Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-P1/P1inf	1-T1/Tinf
1##	#.#28778	-#.#27986	#.241584	#.832473	#.637149	#.##3293	#.######
1#1	#.#26315	-#.#26874	#.23#241	#.859761	#.616942	#.##4#67	#.######
1#2	#.#23998	-#.#25768	#.218766	#.887366	#.595878	#.##6737	#.######
1#3	#.#21819	-#.#24666	#.2#6919	#.915866	#.573691	#.##8673	#.######
1#4	#.#19769	-#.#23568	#.19496#	#.944636	#.551541	#.#1#82#	#.######
1#5	#.#17841	-#.#22472	#.182596	#.974382	#.526#48	#.#12998	#.######
1#6	#.#16#3#	-#.#21378	#.17#148	1.##4328	#.5##5#9	#.#15284	#.######
1#7	#.#1433#	-#.#2#283	#.157311	1.#3621#	#.473427	#.#17524	#.######
1#8	#.#12738	-#.#19189	#.14446#	1.#66125	#.445253	#.#19731	#.######
1#9	#.#11248	-#.#18#92	#.131262	1.#97#78	#.415349	#.#21749	#.######
11#	#.##9857	-#.#16993	#.118165	1.129385	#.384373	#.#23547	#.######
111	#.##8564	-#.#15898	#.1#4847	1.161423	#.351618	#.#24999	#.######
112	#.##7366	-#.#14784	#.#91841	1.192713	#.317713	#.#26#35	#.######
113	#.##6262	-#.#13673	#.#78863	1.223934	#.281938	#.#26582	#.######
114	#.##525#	-#.#12559	#.#66589	1.253461	#.245469	#.#26623	#.######
115	#.##4331	-#.#11441	#.#54828	1.281755	#.207#62	#.#26156	#.######
116	#.##3583	-#.#1#32#	#.#44398	1.3#6047	#.168274	#.#25322	#.######
117	#.##2766	-#.##9198	#.#353##	1.328735	#.127779	#.#24229	#.######
118	#.##2121	-#.###877	#.#28391	1.345355	#.##7945	#.#23121	#.######
119	#.##1568	-#.##6965	#.#23849	1.356282	#.#46#66	#.#22399	#.######
12#	#.##1182	-#.##5854	#.#22551	1.359485	#.##4622	#.#22536	#.######
121	#.###713	-#.##4724	#.#24452	1.354832	#.#39493	#.#23386	#.######
122	#.###485	-#.##3569	#.#3#665	1.339886	#.##3187	#.#25961	#.######
123	#.###181	-#.##2393	#.#41#37	1.314933	#.12###8	#.#29839	#.######
124	#.####45	-#.##12#2	#.#559#3	1.279169	#.173628	#.#35783	#.######
125	#.######	#.######	#.#74781	1.233755	#.221#38	#.#42749	#.######
126	#.####45	#.##12#2	#.#97861	1.178231	#.269#85	#.#51#13	#.######
127	#.###181	#.##2393	#.124347	1.114513	#.319356	#.#6#222	#.######
128	#.###485	#.##3569	#.152689	1.#46522	#.367499	#.#69756	#.######
129	#.###713	#.##4724	#.181432	#.977181	#.412646	#.#7964#	#.######
13#	#.##1182	#.##5854	#.21#428	#.9#7425	#.457841	#.###373	#.######
131	#.##1568	#.##6965	#.239487	#.837517	#.5#7261	#.#93464	#.######
132	#.##2121	#.###877	#.268#13	#.769891	#.56#264	#.#94155	#.######
133	#.##2766	#.##9198	#.295432	#.7#2931	#.6#6583	#.#9665#	#.######
134	#.##3583	#.#1#32#	#.321##2	#.639492	#.654626	#.#95619	#.######
135	#.##4331	#.#11441	#.346#82	#.579188	#.7#167#	#.#92734	#.######
136	#.##525#	#.#12559	#.37#599	#.522#99	#.748995	#.#86#81	#.######
137	#.##6262	#.#13673	#.392#67	#.468672	#.792728	#.#81#68	#.######
138	#.##7366	#.#14784	#.413663	#.418498	#.837148	#.#72#42	#.######
139	#.##8564	#.#1589#	#.433185	#.371726	#.87721#	#.#644##	#.######
14#	#.##9857	#.#16993	#.451231	#.327881	#.917733	#.#53889	#.######
141	#.#11247	#.#18#92	#.468313	#.287#26	#.953626	#.#45748	#.######
142	#.#12738	#.#19189	#.484179	#.248857	#.9897#2	#.#352#8	#.######
143	#.#1433#	#.#2#283	#.498979	#.213254	1.#21369	#.#27489	#.######
144	#.#16#3#	#.#21378	#.512###	#.181735	1.#51#66	#.#1873#	#.######
145	#.#178-1	#.#22472	#.523895	#.153312	1.#75528	#.#13628	#.######
146	#.#19769	#.#23568	#.538194	#.118913	1.1#7437	#.##4827	#.######
147	#.#21819	#.#24666	#.549918	#.09#7#7	1.133138	-#.##1668	#.######
148	#.#23998	#.#25767	#.56#526	#.#65187	1.155117	-#.##5731	#.######
149	#.#26315	#.#26874	#.57#53#	#.#4112#	1.176647	-#.#1#241	#.######

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-5
	NACA 0012: MACH = 1.2, ALPHA = 7			

NACA##12 Mach = 1.2## Alpha = 7.### Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-P1/P1inf	1-T1/Tinf
15#	#.#28778	#.#27986	#.579754	#.#10931	1.1956#2	-#.#13259	#.######
151	#.#31397	#.#291#4	#.588348	-#.##1724	1.212759	-#.#15#64	#.######
152	#.#34182	#.#3#231	#.5964#5	-#.#21127	1.228889	-#.#16537	#.######
153	#.#37147	#.#31366	#.6##454	-#.#39527	1.244423	-#.#18#26	#.######
154	#.#4#386	#.#32611	#.611374	-#.#5714#	1.259483	-#.#19485	#.######
155	#.#43673	#.#33667	#.618428	-#.#74#89	1.274#31	-#.#2#747	#.######
156	#.#47267	#.#34835	#.625237	-#.#9#488	1.287977	-#.#21568	#.######
157	#.#51186	#.#36#15	#.631793	-#.1#6261	1.3#1232	-#.#21919	#.######
158	#.#55214	#.#372#8	#.638116	-#.121473	1.313844	-#.#21799	#.######
159	#.#59615	#.#38415	#.644222	-#.136162	1.326#46	-#.#21497	#.######
16#	#.#64337	#.#39635	#.65#147	-#.15#416	1.338124	-#.#21324	#.######
161	#.#69412	#.#4#87#	#.655938	-#.164346	1.35#247	-#.#21394	#.######
162	#.#74875	#.#42119	#.661625	-#.178#29	1.362373	-#.#2166#	#.######
163	#.###768	#.#43381	#.667221	-#.19149#	1.3743##	-#.#216#8	#.######
164	#.#87137	#.#44655	#.672732	-#.2#4748	1.385872	-#.#2#988	#.######
165	#.#94#34	#.#45939	#.678186	-#.21787#	1.3972##	-#.#2##72	#.######
166	#.1#152#	#.#47232	#.683635	-#.23#978	1.4#8769	-#.#19284	#.######
167	#.1#9663	#.#4853#	#.689129	-#.244194	1.42#983	-#.#19#39	#.######
168	#.118543	#.#49827	#.694682	-#.257554	1.433788	-#.#19197	#.######
169	#.128249	#.#51118	#.7##233	-#.27#9#8	1.446713	-#.#1927#	#.######
17#	#.138884	#.#52394	#.7#571#	-#.284#84	1.459222	-#.#1871#	#.######
171	#.158563	#.#53644	#.711133	-#.297131	1.471486	-#.#17693	#.######
172	#.163428	#.#54854	#.716616	-#.31#322	1.484432	-#.#17163	#.######
173	#.1776#4	#.#56##6	#.722229	-#.323#24	1.498417	-#.#17372	#.######
174	#.193281	#.#57#78	#.727898	-#.337463	1.512591	-#.#173#5	#.######
175	#.21#632	#.#58#41	#.7335#9	-#.35#962	1.526344	-#.#16469	#.######
176	#.229853	#.#588#8	#.739#99	-#.364#89	1.54#486	-#.#1591#	#.######
177	#.251143	#.#59495	#.744758	-#.378##3	1.555588	-#.#16133	#.######
178	#.274693	#.#59897	#.75#384	-#.391567	1.57#556	-#.#15821	#.######
179	#.3##671	#.#6##14	#.756#55	-#.4#52#1	1.586191	-#.#144##	#.######
18#	#.329188	#.#59792	#.761237	-#.417666	1.598764	-#.#12986	#.######
181	#.36#264	#.#59177	#.765937	-#.428974	1.612#23	-#.#12765	#.######
182	#.393791	#.#58129	#.77#687	-#.44#4#1	1.625956	-#.#12985	#.######
183	#.429494	#.#56625	#.775266	-#.451417	1.639273	-#.#12665	#.######
184	#.466913	#.#54671	#.779564	-#.461757	1.652252	-#.#12751	#.######
185	#.5#5413	#.#523#3	#.783293	-#.47#728	1.663#2	-#.#12536	#.######
186	#.544248	#.#4959#	#.786#4	-#.478212	1.672827	-#.#12#61	#.######
187	#.582598	#.#46623	#.789339	-#.485272	1.682344	-#.#12534	#.######
188	#.619747	#.#435#4	#.792#22	-#.491728	1.69#725	-#.#12326	#.######
189	#.655#82	#.#4#332	#.794198	-#.496961	1.6972#8	-#.#1157#	#.######
19#	#.688173	#.#37189	#.796169	-#.5#17#3	1.7#4#36	-#.#12253	#.######
191	#.718779	#.#34144	#.798#87	-#.5#6317	1.71#54#	-#.#12625	#.######
192	#.746818	#.#31239	#.799742	-#.51#299	1.715316	-#.#11598	#.######
193	#.772332	#.#28#83	#.8#1161	-#.513712	1.719859	-#.#11358	#.######
194	#.795447	#.#26948	#.8#2526	-#.516996	1.72497#	-#.#12214	#.######
195	#.816337	#.#23577	#.8#3831	-#.52#136	1.729479	-#.#12413	#.######
196	#.835199	#.#21385	#.8#4996	-#.522938	1.732942	-#.#11697	#.######
197	#.852236	#.#19362	#.8#6#29	-#.525423	1.7362#4	-#.#11326	#.######
198	#.867637	#.#17499	#.8#6998	-#.527756	1.739798	-#.#11772	#.######
199	#.881585	#.#16782	#.8#7937	-#.53##13	1.743397	-#.#12368	#.######

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-6
	NACA 0012: MACH = 1.2, ALPHA = 7			

NACA##12 Mach = 1.2## Alpha = 7.### Results on the airfoil surface

N	X/C	Y/C	1-P/P1inf	Cp	Mach	1-P1/P1inf	1-T1/T1inf
2##	#.894243	#.#14199	#.###829	-#.53216#	1.7465#8	-#.#12436	#.######
2#1	#.9#5758	#.#12739	#.#9965#	-#.534143	1.749#2#	-#.#11922	#.######
2#2	#.916259	#.#11398	#.81#394	-#.535923	1.751221	-#.#11365	#.######
2#3	#.925859	#.#18142	#.811#61	-#.537529	1.753382	-#.#1#997	#.######
2#4	#.934668	#.##0985	#.#11671	-#.538997	1.755483	-#.#11#81	#.######
2#5	#.942748	#.##7911	#.812244	-#.540374	1.75776#	-#.#115#2	#.######
2#6	#.95#2#1	#.##6913	#.812793	-#.541696	1.759946	-#.#119#3	#.######
2#7	#.957##4	#.##5982	#.813322	-#.542969	1.7621#8	-#.#12367	#.######
2#8	#.963458	#.##5113	#.813833	-#.544199	1.764114	-#.#12682	#.######
2#9	#.969372	#.##43#1	#.814327	-#.545387	1.765814	-#.#12612	#.######
21#	#.974873	#.##3541	#.814##2	-#.54653#	1.767378	-#.#12429	#.######
211	#.98####	#.##2827	#.81525#	-#.547#86	1.768862	-#.#12269	#.######
212	#.985##1	#.##2127	#.815647	-#.548563	1.77#2#4	-#.#12157	#.######
213	#.99####	#.##1422	#.814995	-#.546993	1.771#83	-#.#18218	#.######
214	#.995##1	#.###713	#.777749	-#.457389	1.814385	-#.3#5437	#.######
215	1.######	#.######	#.666434	-#.189598	1.79362#	-#.897999	#.######
216	1.##5###	#.######	#.668831	-#.195363	1.322#68	#.#54345	-#.##189#
217	1.#1####	#.######	#.598554	-#.#26297	1.216669	#.##5#41	-#.##2217
218	1.#17794	#.######	#.63#939	-#.1#42#7	1.269377	#.#189#5	#.##1343
219	1.#25925	#.######	#.61#451	-#.#54918	1.234#87	#.#11651	-#.###887
22#	1.#35487	#.######	#.614584	-#.#64669	1.24#729	#.#13699	#.###956
221	1.#46731	#.######	#.6##824	-#.#51##3	1.23#872	#.#12155	#.###8#2
222	1.#59954	#.######	#.6#9#93	-#.#51626	1.232332	#.#1####	#.###953
223	1.#75583	#.######	#.6##179	-#.#49453	1.231362	#.###899	#.##1124
224	1.#93789	#.######	#.687#79	-#.#46##5	1.23#747	#.##7912	#.##1#26
225	1.115292	#.######	#.6#6748	-#.#46#1#	1.23121#	#.##6469	#.##1#46
226	1.14#578	#.######	#.6#6#42	-#.#44312	1.231317	#.##4545	#.###844
227	1.17#314	#.######	#.6#5585	-#.#43211	1.231372	#.##3317	#.###589
228	1.2#5282	#.######	#.6#4881	-#.#41517	1.23#4#3	#.##2817	#.###235
229	1.246#83	#.######	#.6#4#75	-#.#39578	1.228#73	#.##3854	-#.###18#
23#	1.294768	#.######	#.6#3176	-#.#37417	1.224#19	#.##6922	-#.##9382
231	1.351625	#.######	#.6#218#	-#.#35#2#	1.22#491	#.##9#44	-#.###2#5
232	1.418496	#.######	#.6#1139	-#.#32515	1.219#14	#.###38#	#.###827
233	1.497134	#.######	#.6###45	-#.#29884	1.217879	#.##7145	#.###837
234	1.589689	#.######	#.598987	-#.#27146	1.21577#	#.##7#75	-#.###821
235	1.698355	#.######	#.597716	-#.#24281	1.213225	#.##7449	-#.###8#5
236	1.826236	#.######	#.596459	-#.#21257	1.21#768	#.##755#	#.###829
237	1.976619	#.######	#.595166	-#.#18146	1.2#8368	#.##7497	#.###832
238	2.153463	#.######	#.593924	-#.#15159	1.2#6#81	#.##7428	#.###816
239	2.361425	#.######	#.592854	-#.#12583	1.2#4143	#.##7329	-#.###81#
24#	2.6#5978	#.######	#.592#27	-#.#1#596	1.2#2684	#.##7#8#	-#.###837
241	2.893563	#.######	#.591489	-#.##9188	1.2#1588	#.##7126	-#.###852
242	3.231758	#.######	#.59#86#	-#.##7789	1.2##548	#.##7142	-#.###834
243	3.629445	#.######	#.59#226	-#.##6263	1.199288	#.##7234	#.###889
244	4.#97118	#.######	#.589455	-#.##4#88	1.197824	#.##7263	#.###838
245	4.647###	#.######	#.588666	-#.##2589	1.1965#5	#.##7#62	#.###812
246	5.293813	#.######	#.588#8#	-#.##1899	1.195736	#.##6642	-#.###849
247	6.#54345	#.######	#.587#4#	-#.###523	1.195618	#.##6218	-#.###883
248	6.948697	#.######	#.587858	-#.###565	1.195829	#.##5987	-#.###7#
249	8.######	#.######	#.587858	-#.###565	1.195829	#.##5986	-#.###7#

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-7
	NACA 0012: MACH = 1.2, ALPHA = 7			

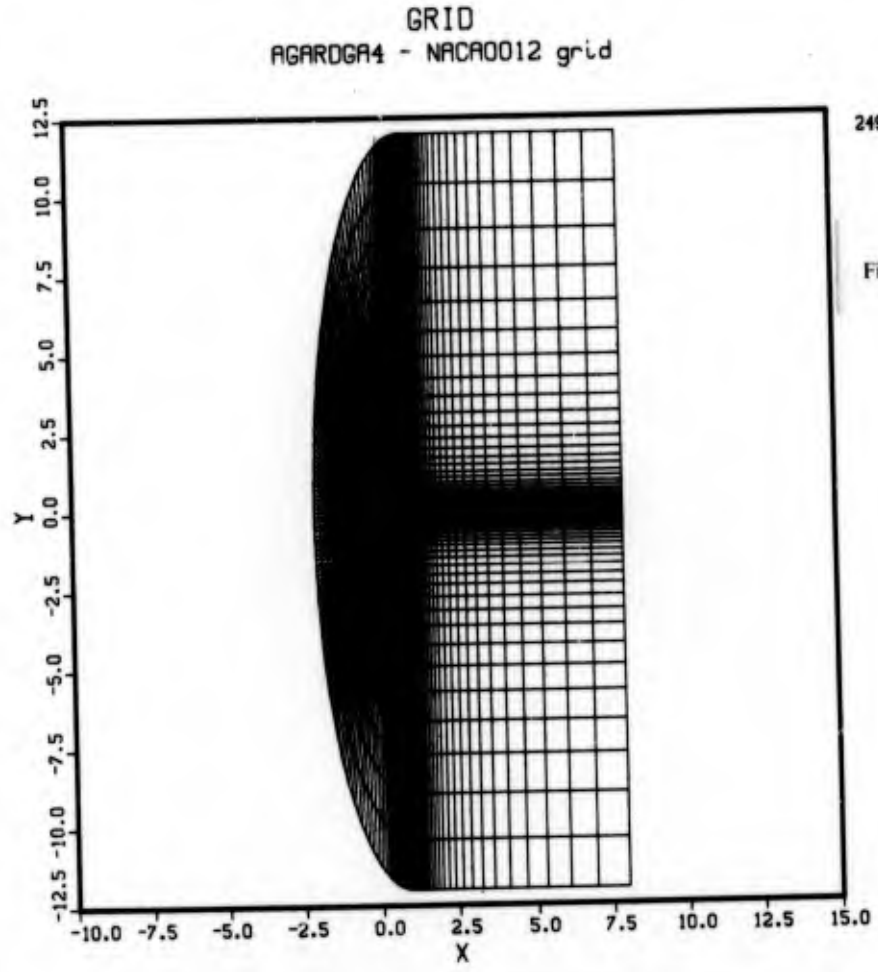


Figure 4a

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-8
	NACA 0012: MACH = 1.2, ALPHA = 7			

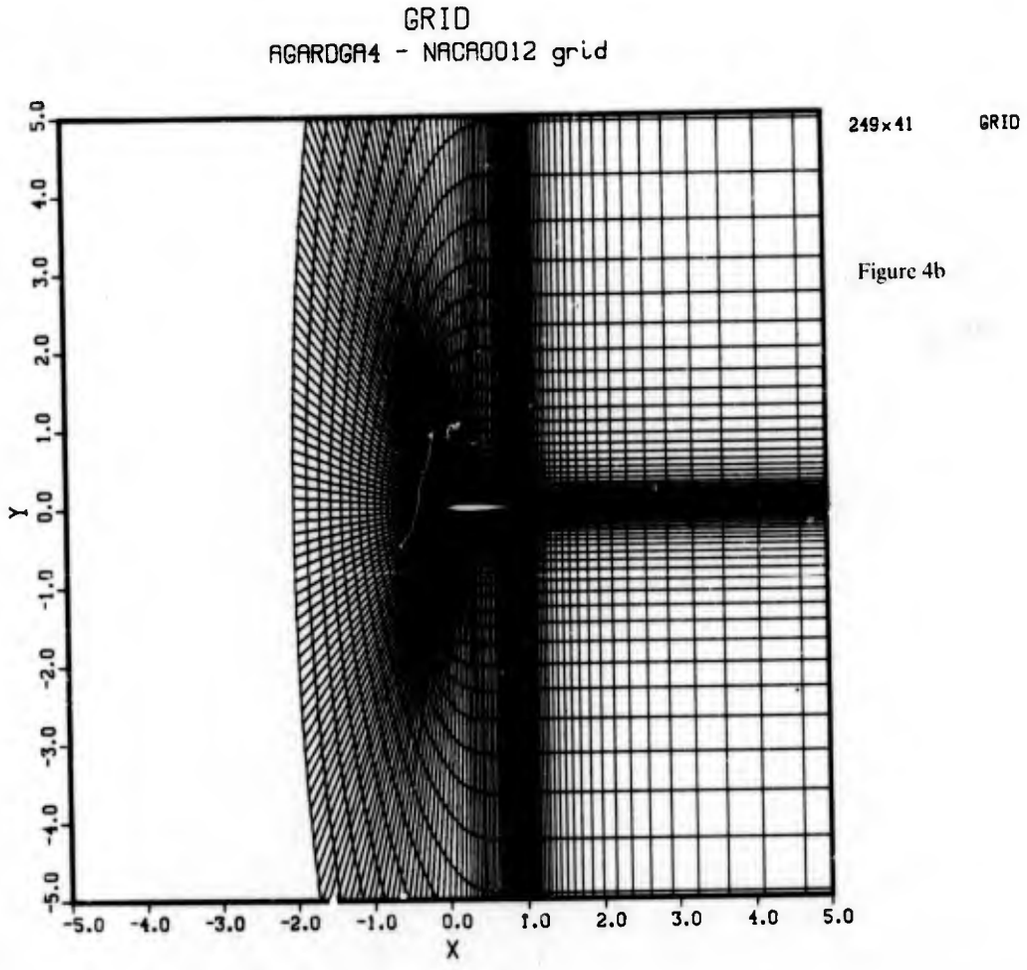


Figure 4b

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-9
	NACA 0012: MACH = 1.2, ALPHA = 7			

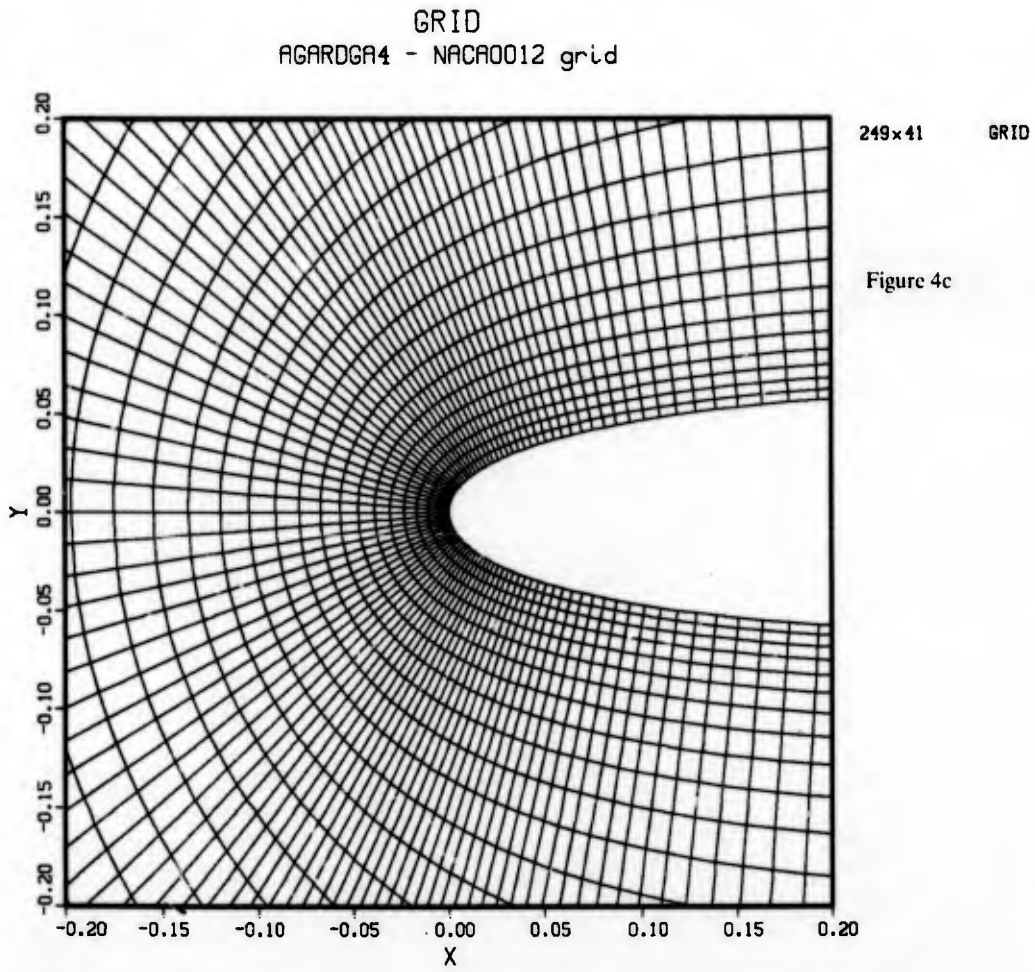


Figure 4c

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-10
	NACA 0012: MACH = 1.2, ALPHA = 7			

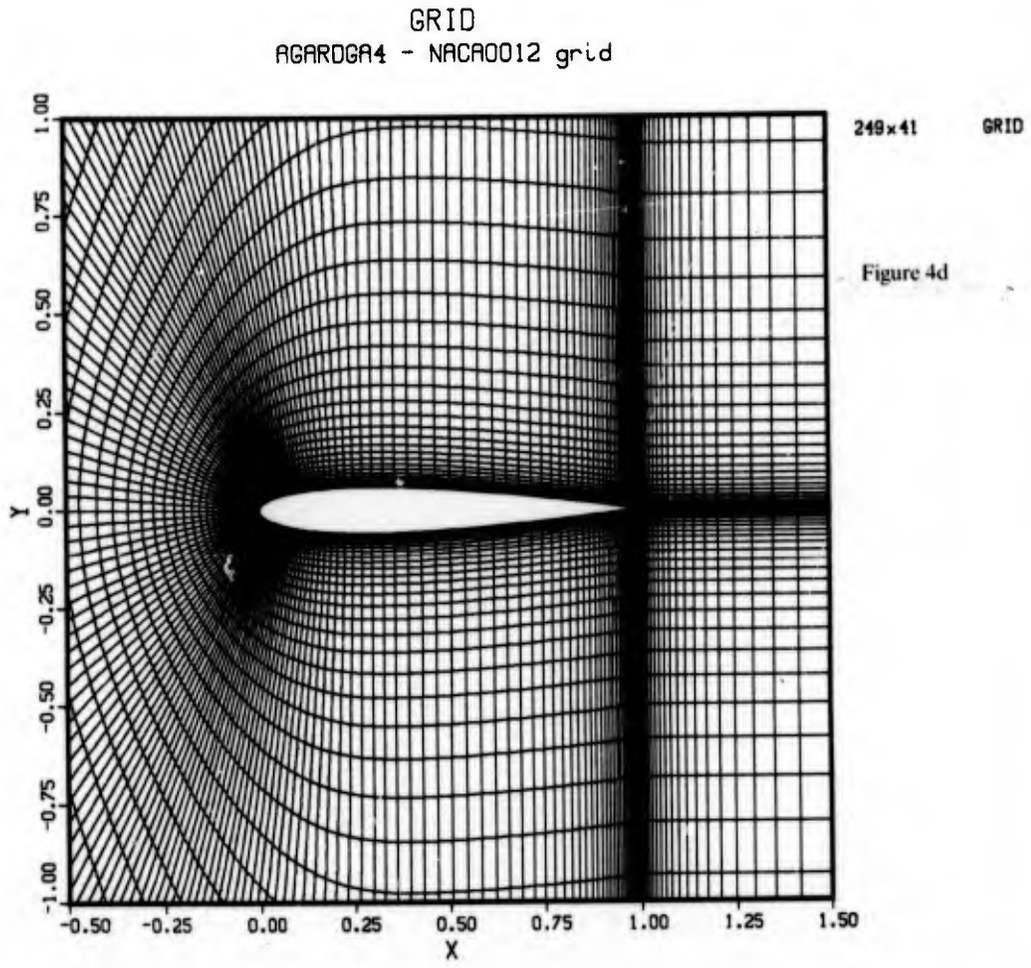


Figure 4d

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-11
	NACA 0012: MACH = 1.2, ALPHA = 7			

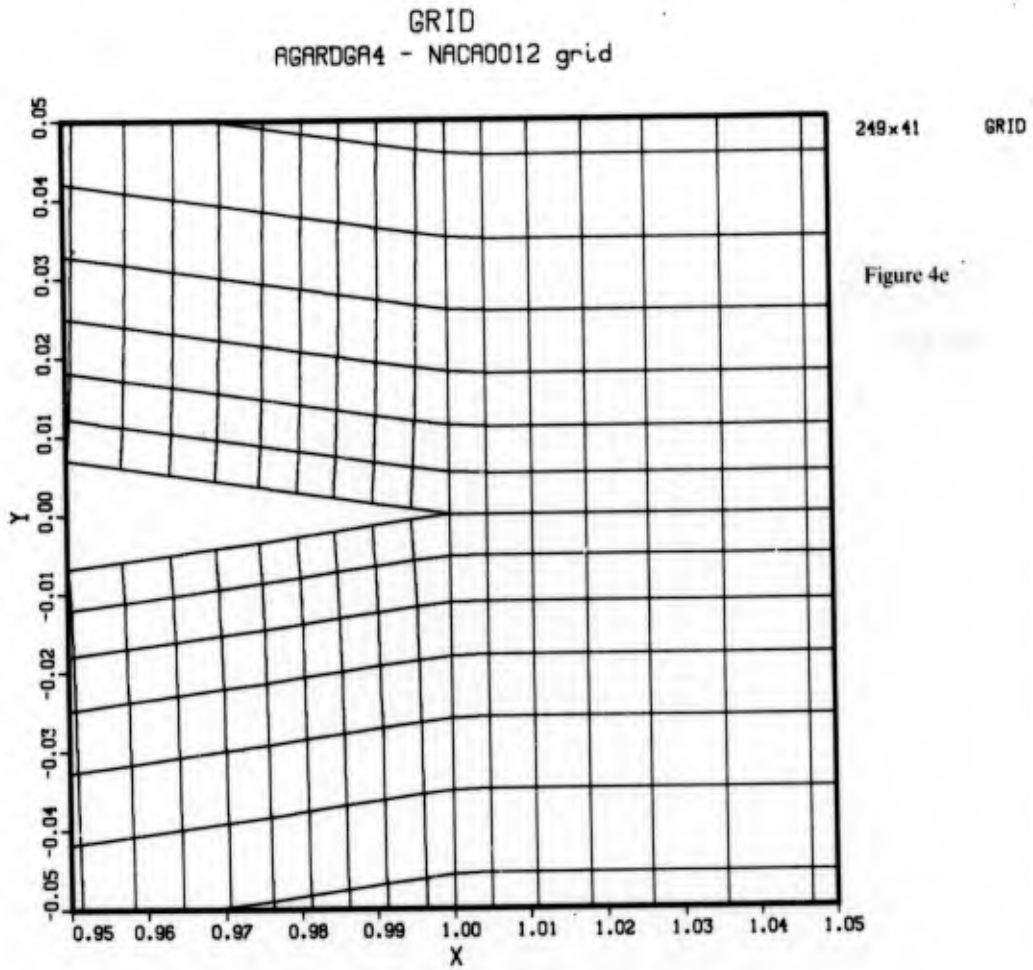


Figure 4c

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-12
	NACA 0012: MACH = 1.2, ALPHA = 7			

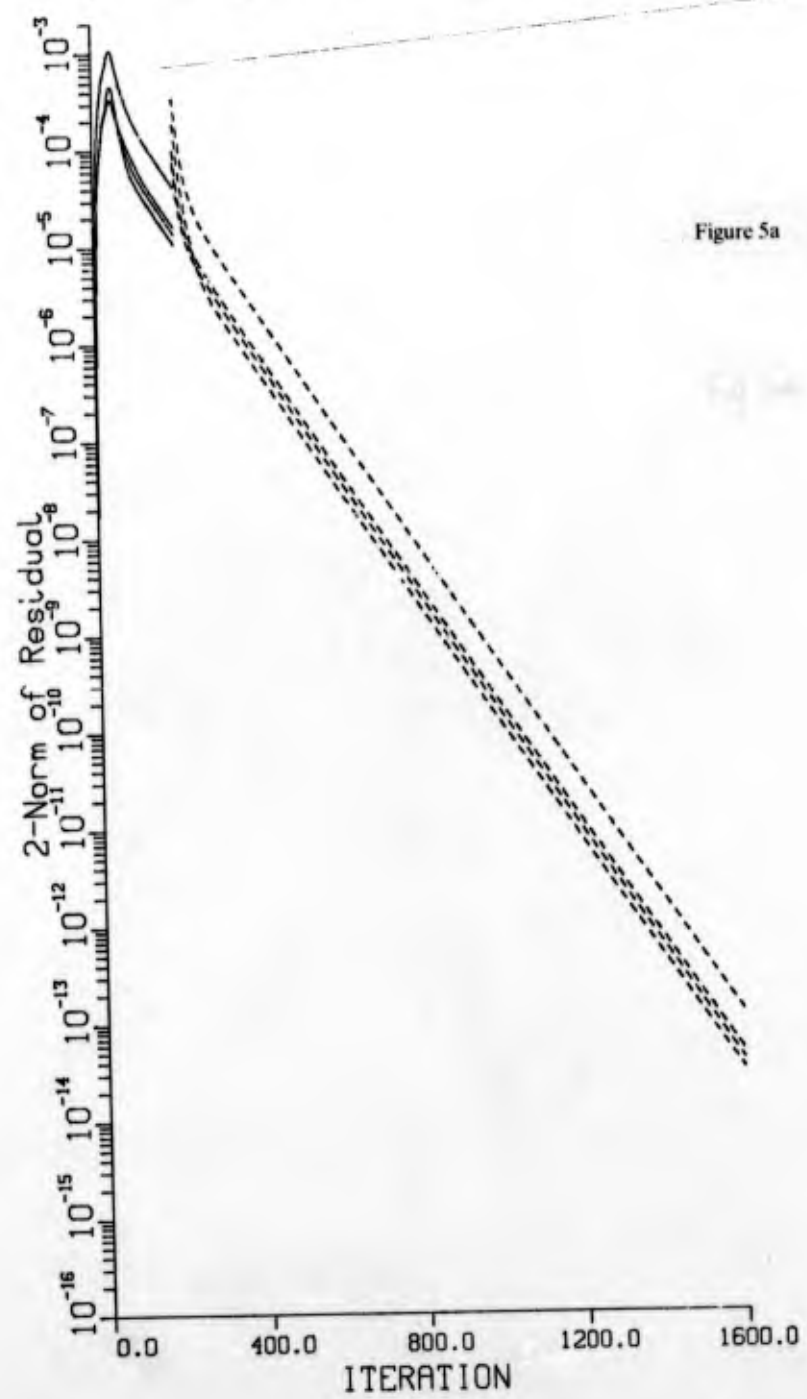


Figure 5a

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-13
	NACA 0012: MACH = 1.2, ALPHA = 7			

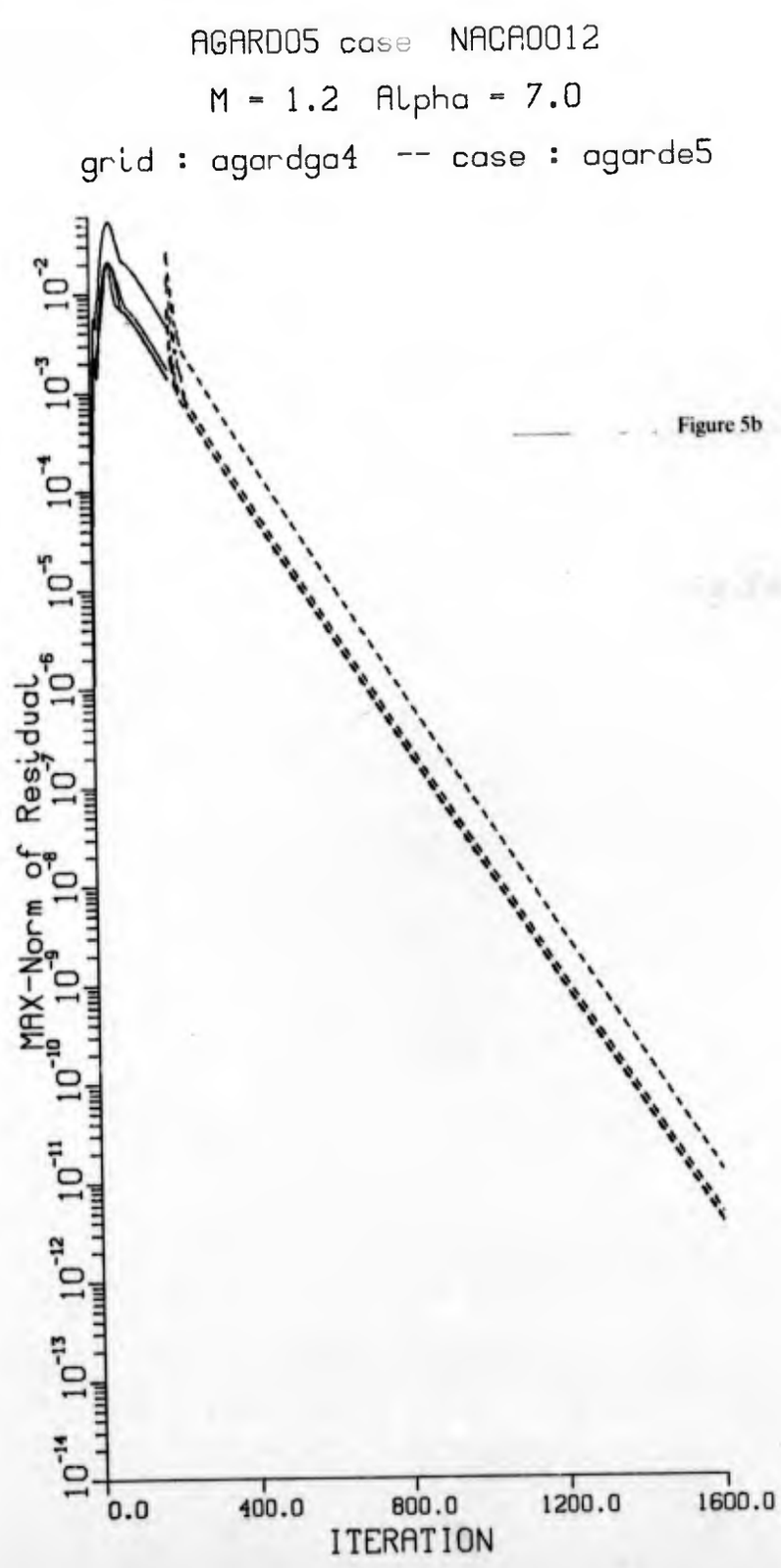


Figure 5b

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-14
	NACA 0012: MACH = 1.2, ALPHA = 7			

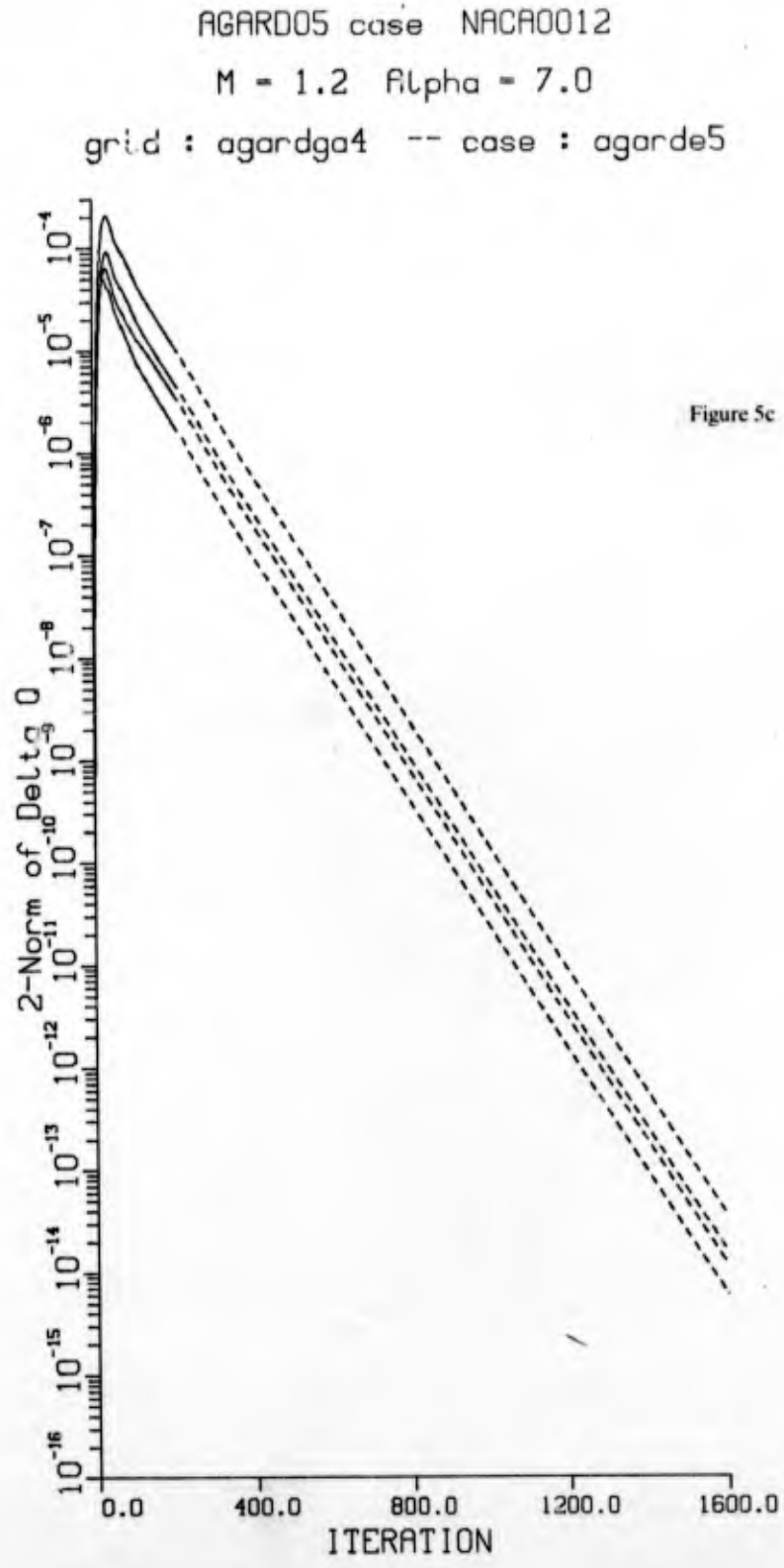


Figure 5c

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-15
	NACA 0012: MACH = 1.2, ALPHA = 7			

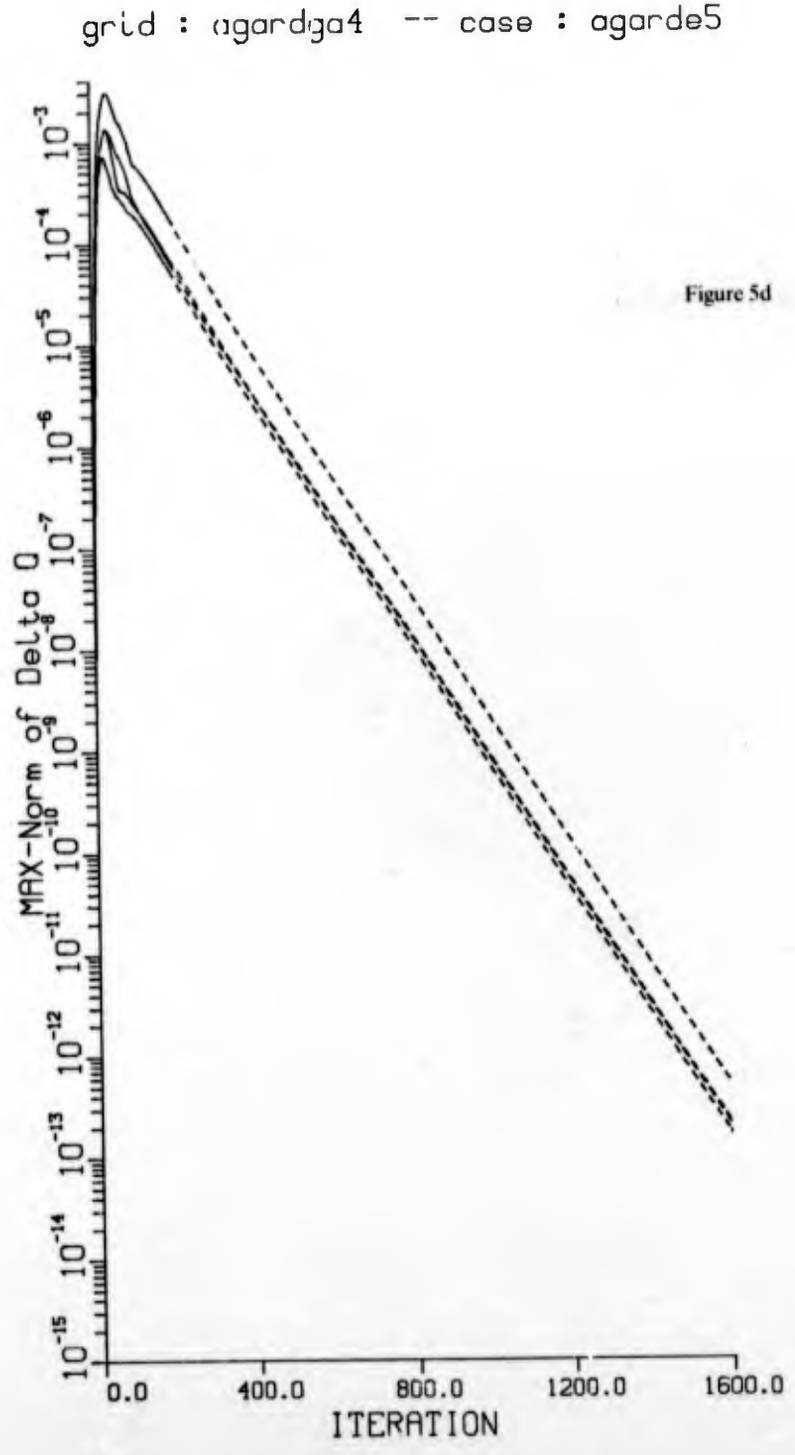


Figure 5d

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-16
	NACA 0012: MACH = 1.2, ALPHA = 7			

AGARD05 case NACA0012

M = 1.2 Alpha = 7.0

grid : agardga4 -- case : agarde5

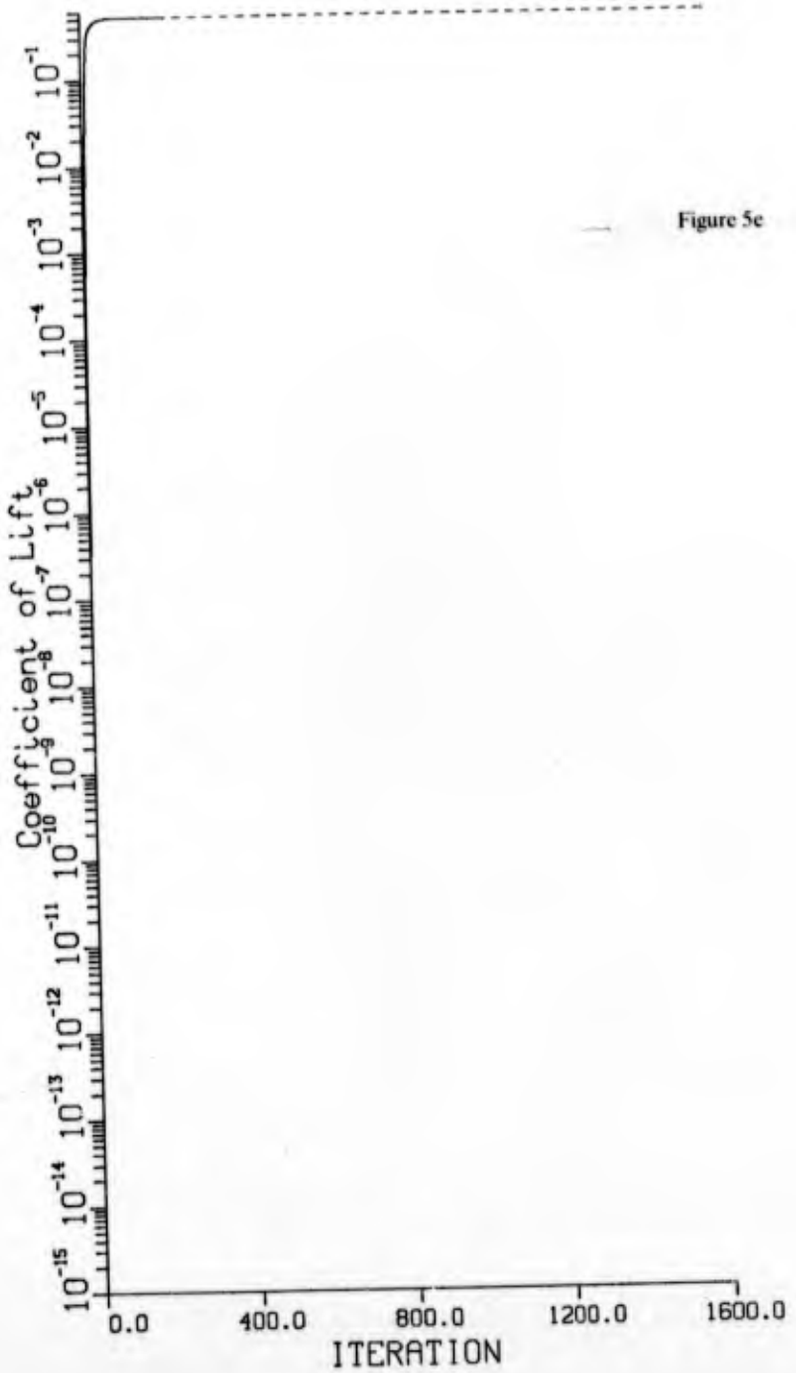


Figure 5e

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-17
	NACA 0012: MACH = 1.2, ALPHA = 7			

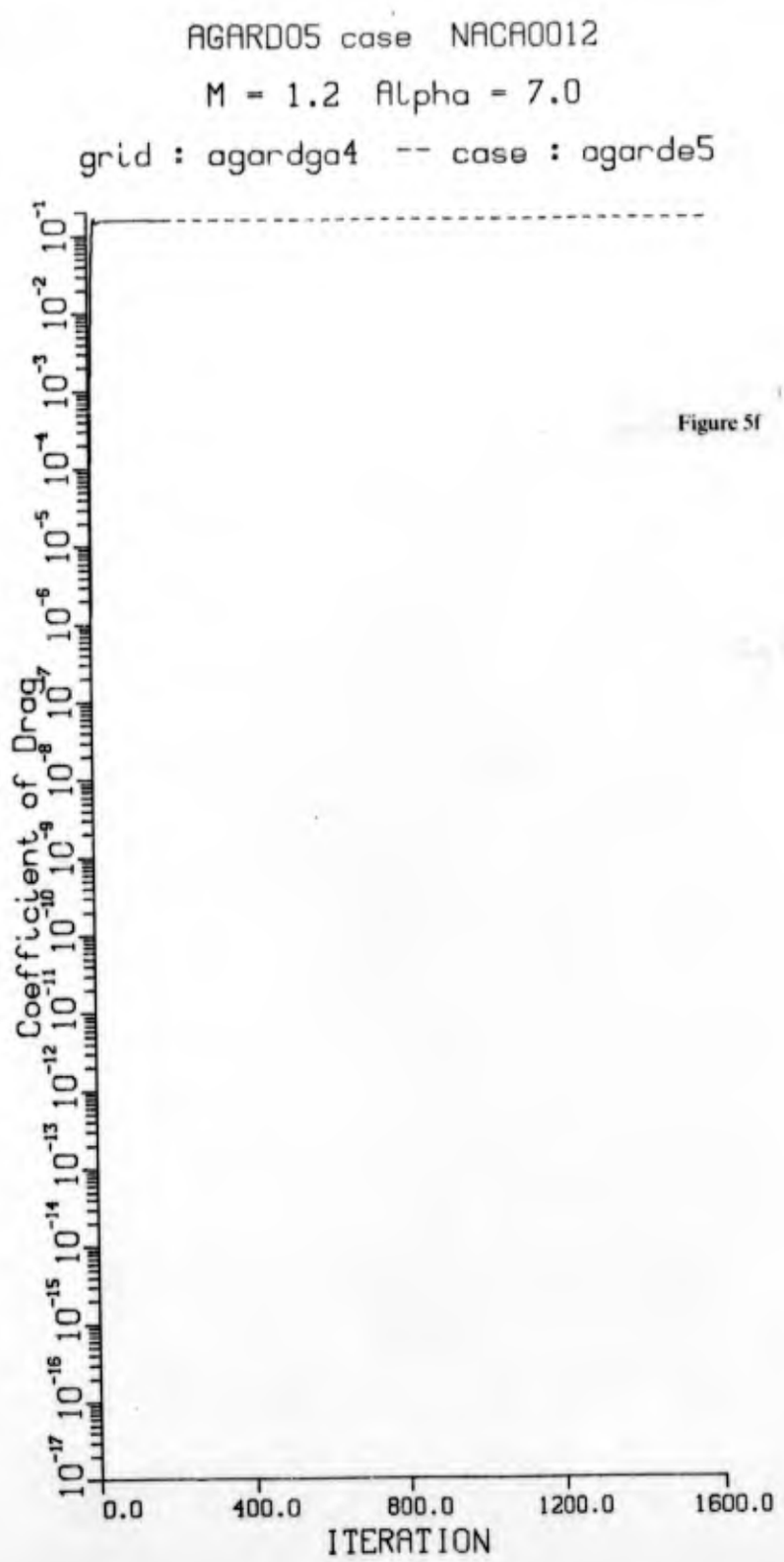


Figure 5f

AGARD05 case NACA0012

M = 1.2 Alpha = 7.0

grid : agardga4 -- case : agarde5

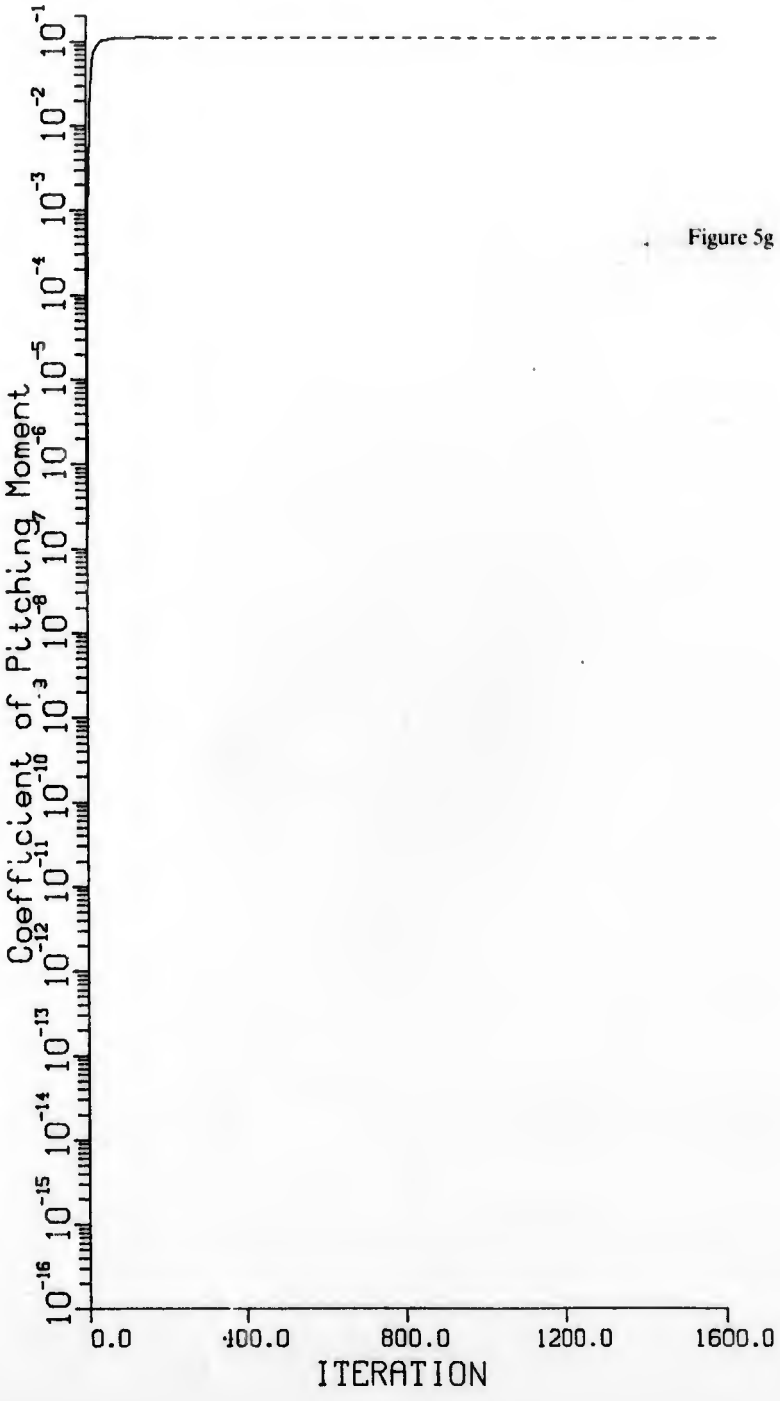
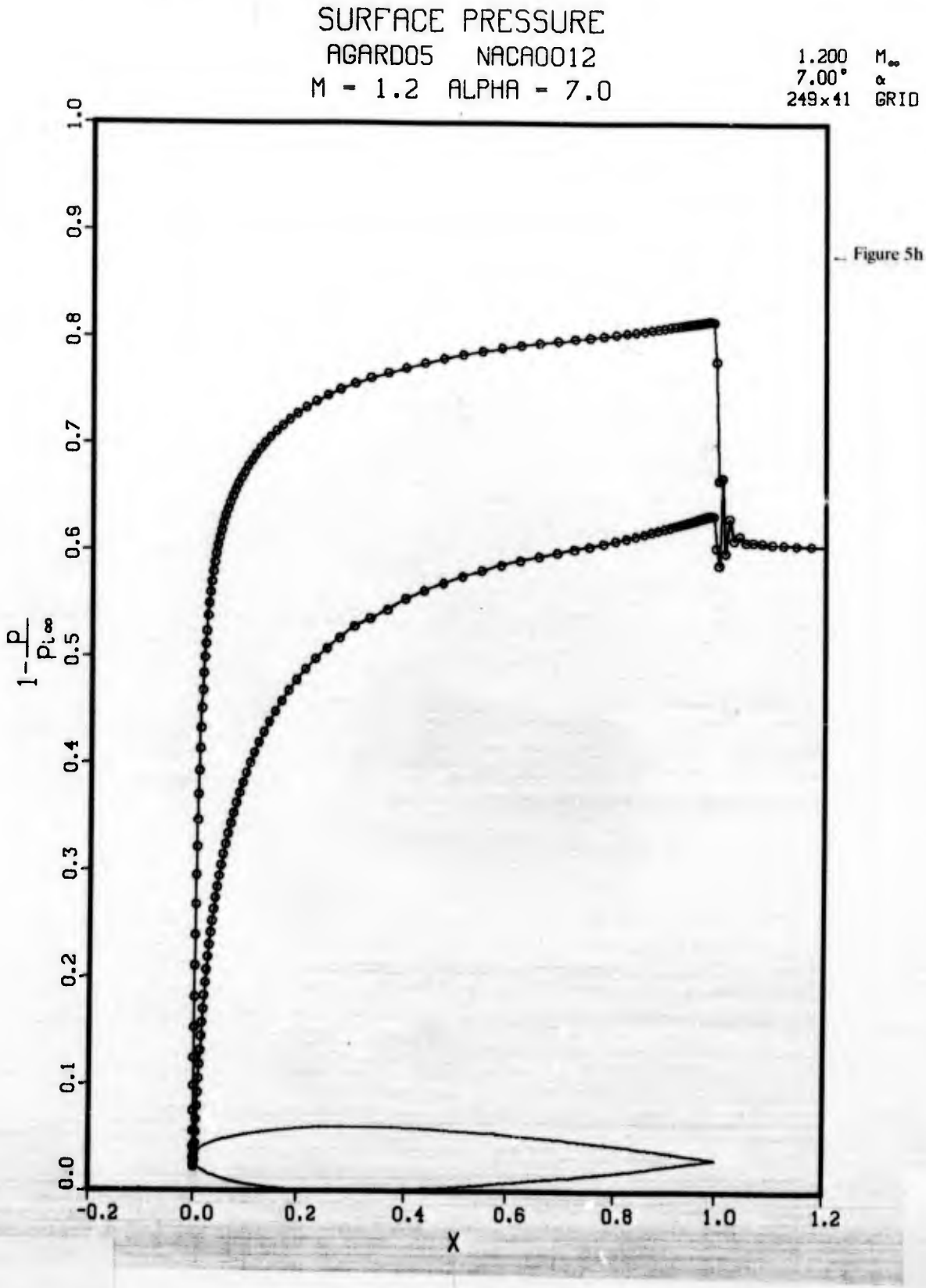


Figure 5g

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-19
	NACA 0012: MACH = 1.2, ALPHA = 7			



... Figure 5h

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-20
	NACA 0012: MACH = 1.2, ALPHA = 7			

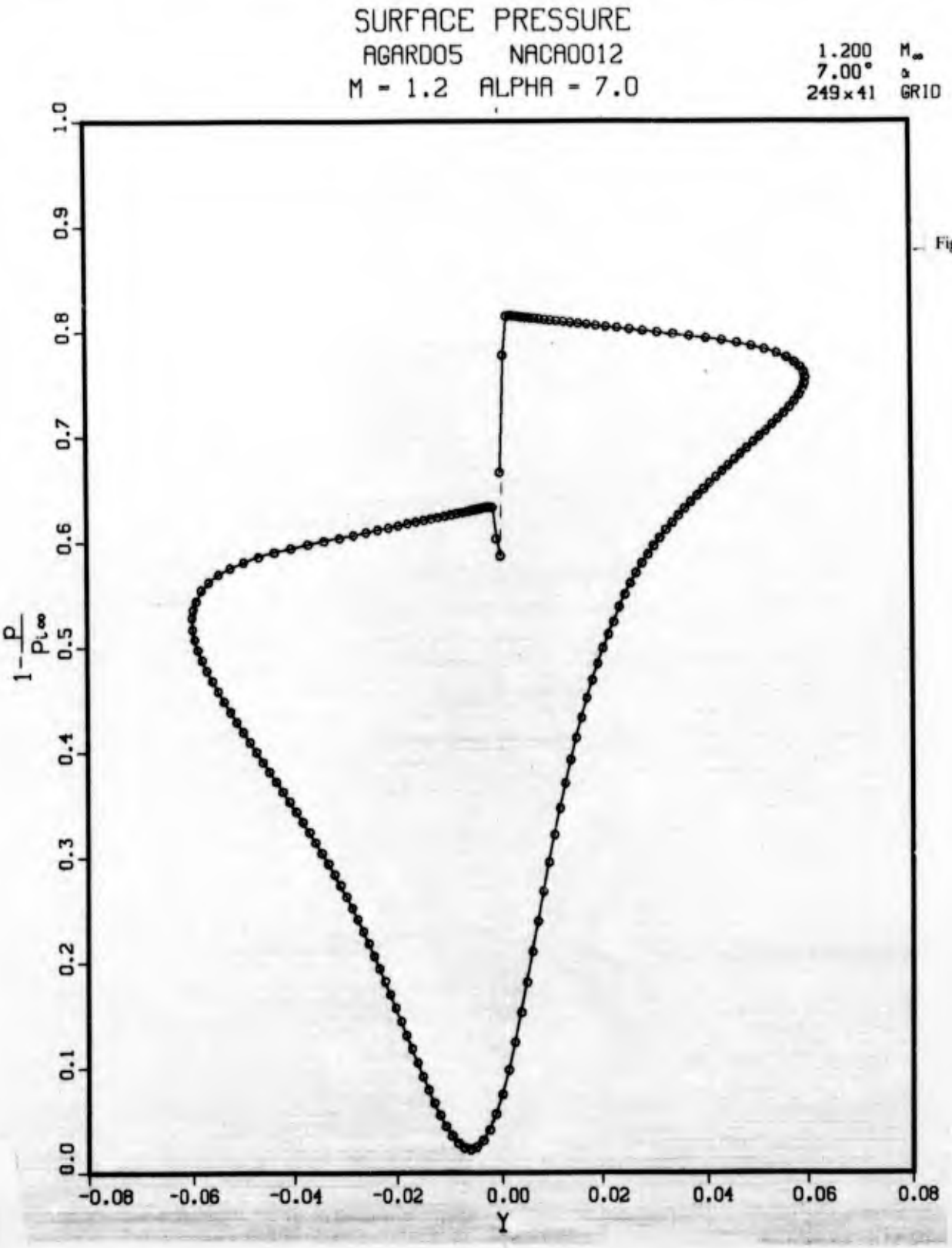


Figure 5i

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-21
	NACA 0012: MACH = 1.2, ALPHA = 7			

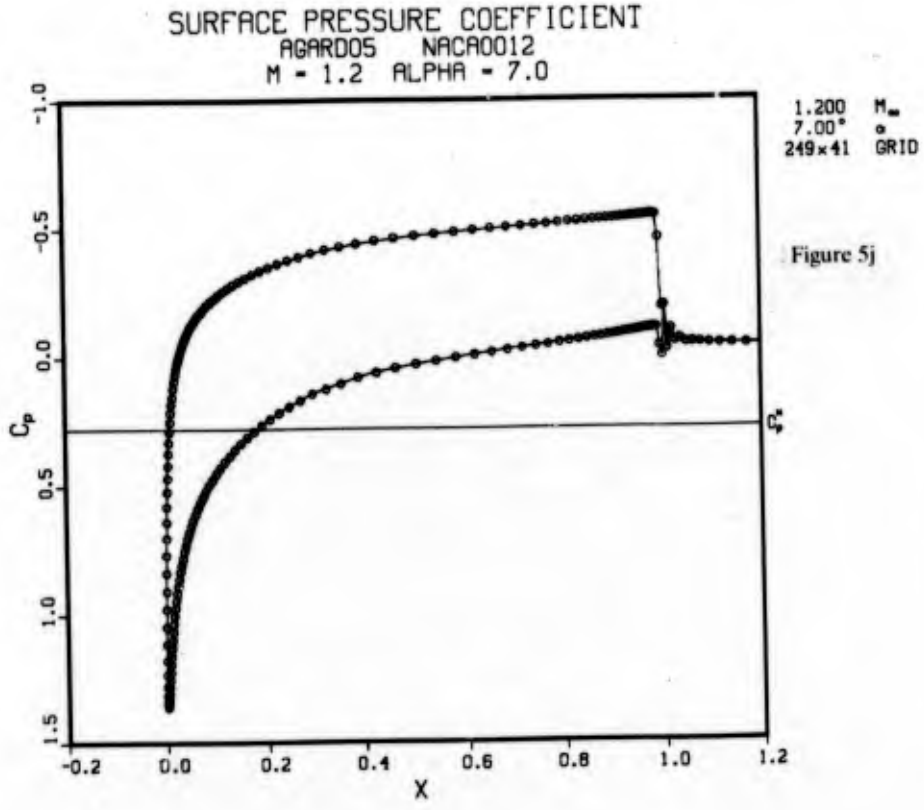


Figure 5j

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-22
	NACA 0012: MACH = 1.2, ALPHA = 7			

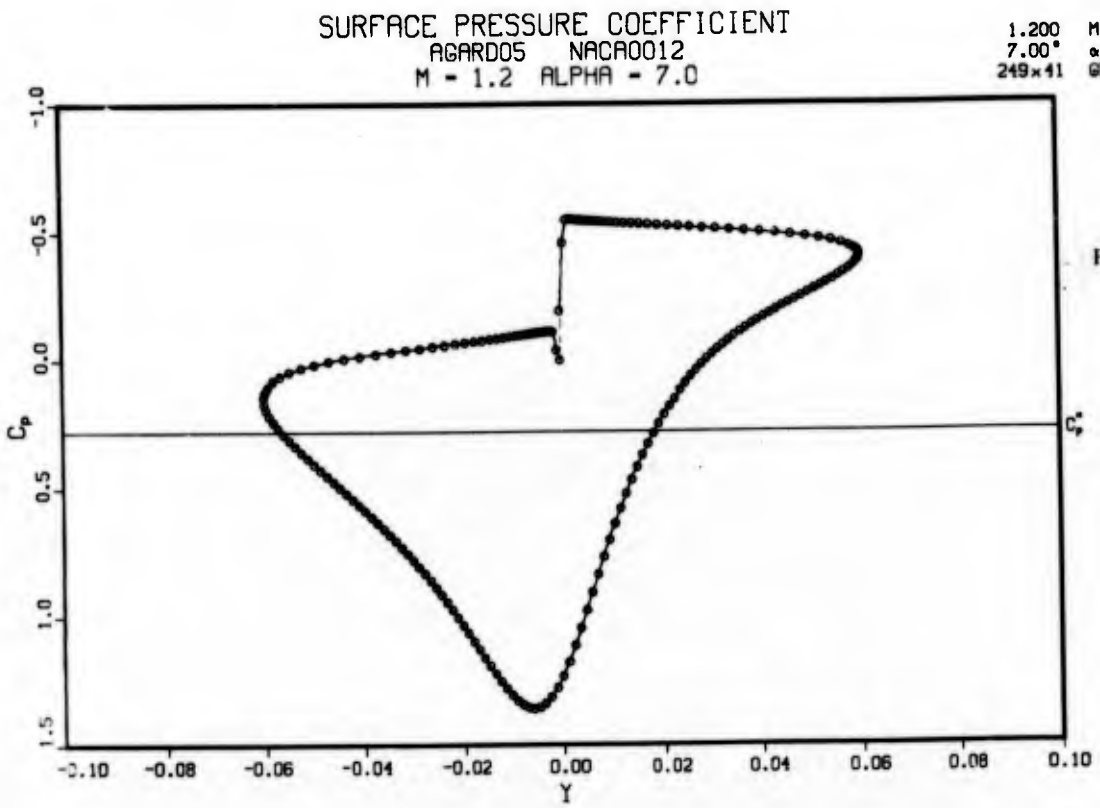


Figure 5k

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-23
	NACA 0012: MACH = 1.2, ALPHA = 7			

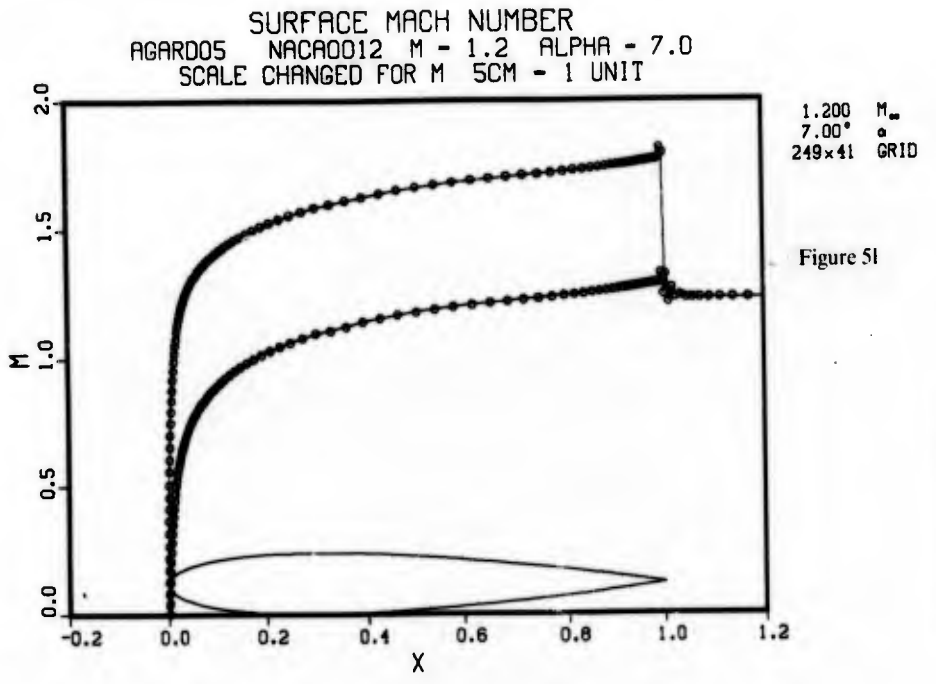


Figure 5l

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-24
	NACA 0012: MACH = 1.2, ALPHA = 7			

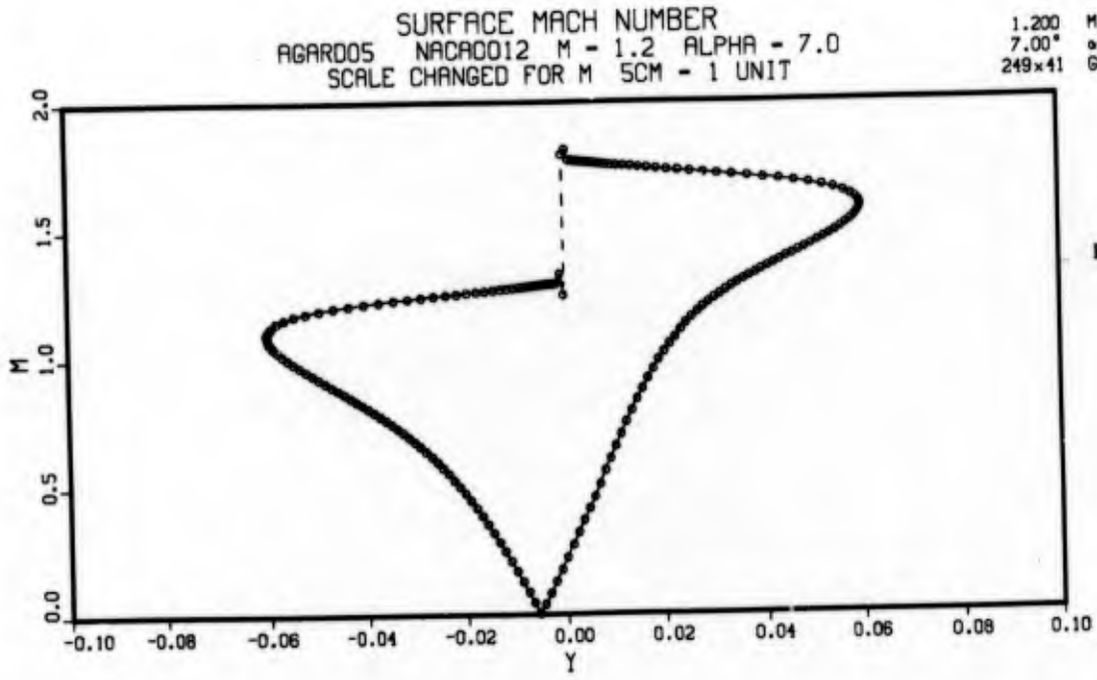


Figure 5m

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-25
	NACA 0012: MACH = 1.2, ALPHA = 7			

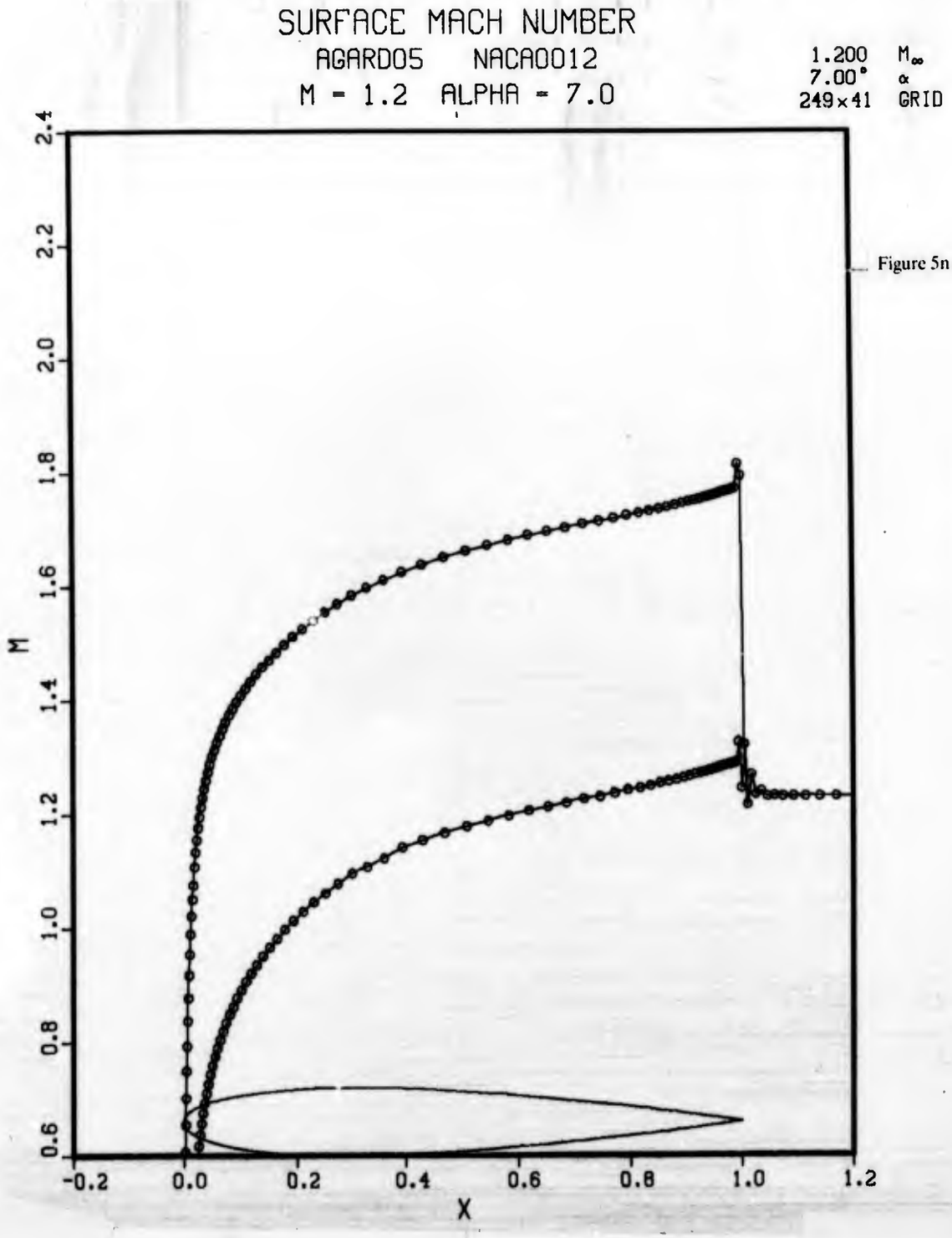


Figure 5n

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-26
	NACA 0012: MACH = 1.2, ALPHA = 7			

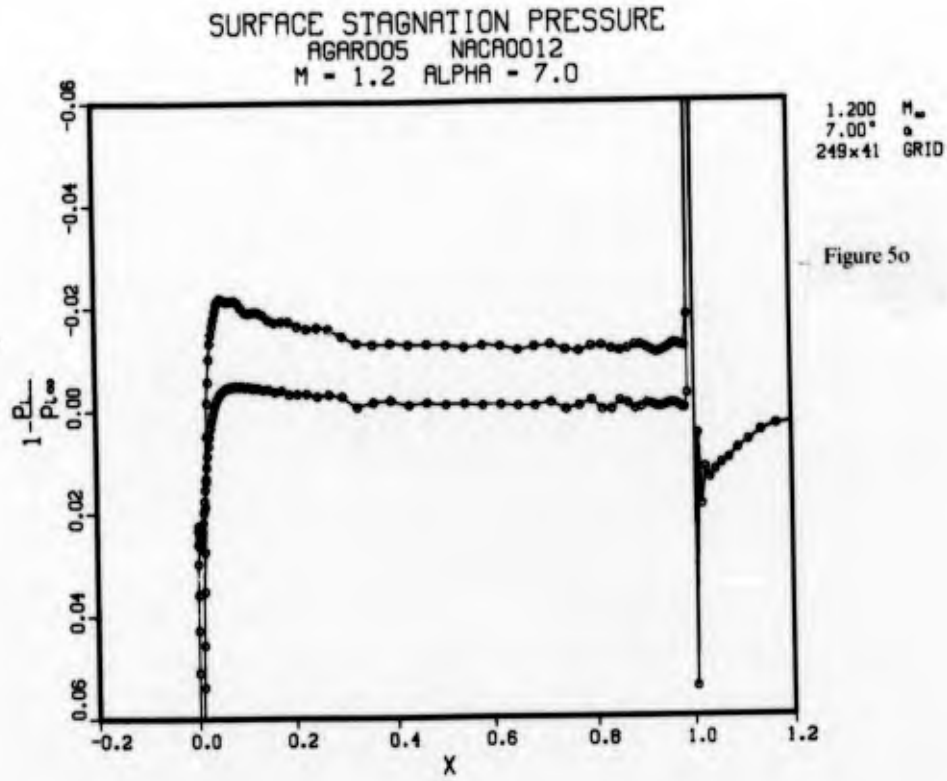


Figure 5o

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Baston	05-5-27
	NACA 0012: MACH = 1.2, ALPHA = 7			

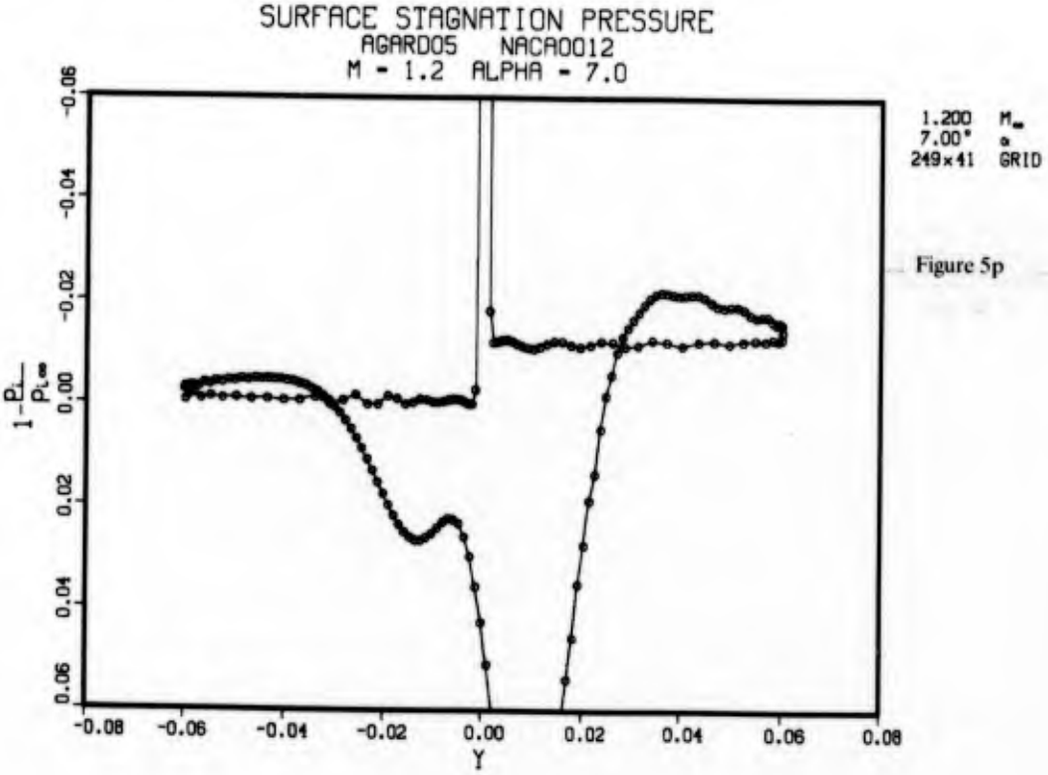


Figure 5p

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-28
	NACA 0012: MACH = 1.2, ALPHA = 7			

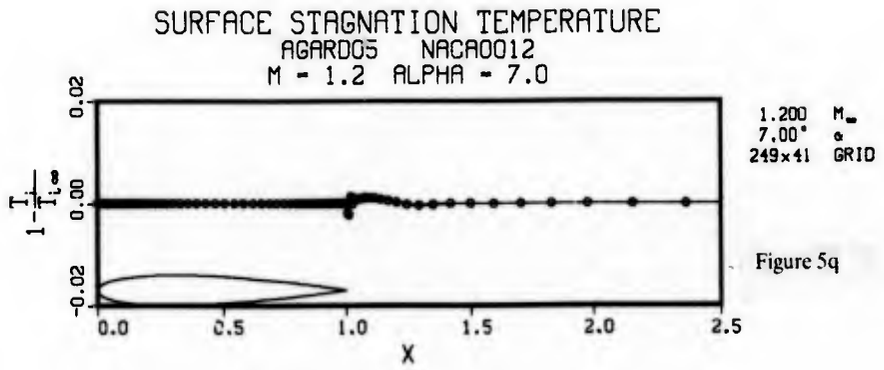


Figure 5q

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-29
	NACA 0012: MACH = 1.2, ALPHA = 7			

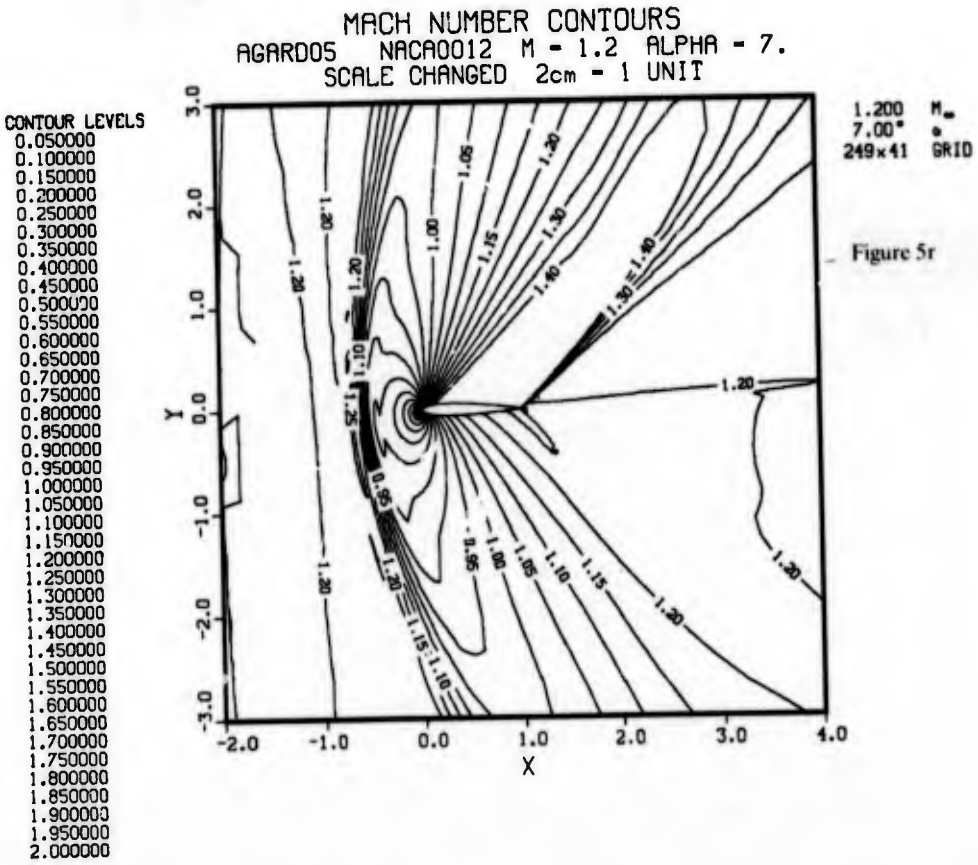


Figure 5r

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-30
	NACA 0012: MACH = 1.2, ALPHA = 7			

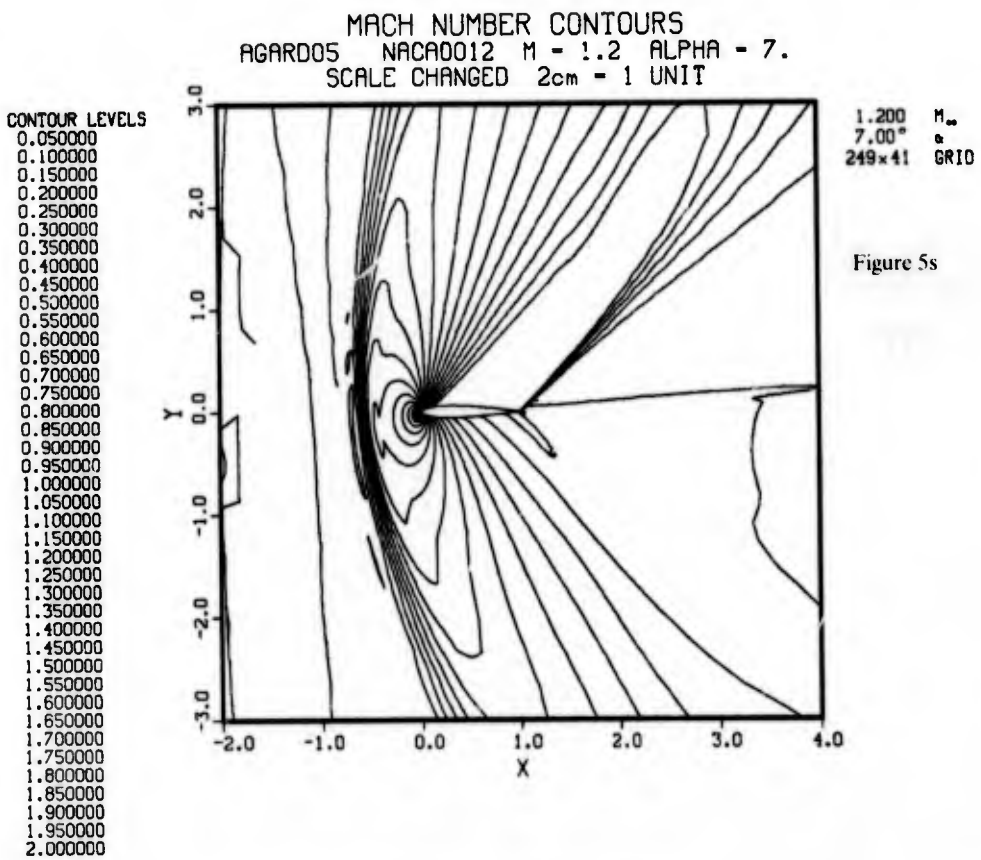


Figure 5s

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-31
	NACA 0012: MACH = 1.2, ALPHA = 7			

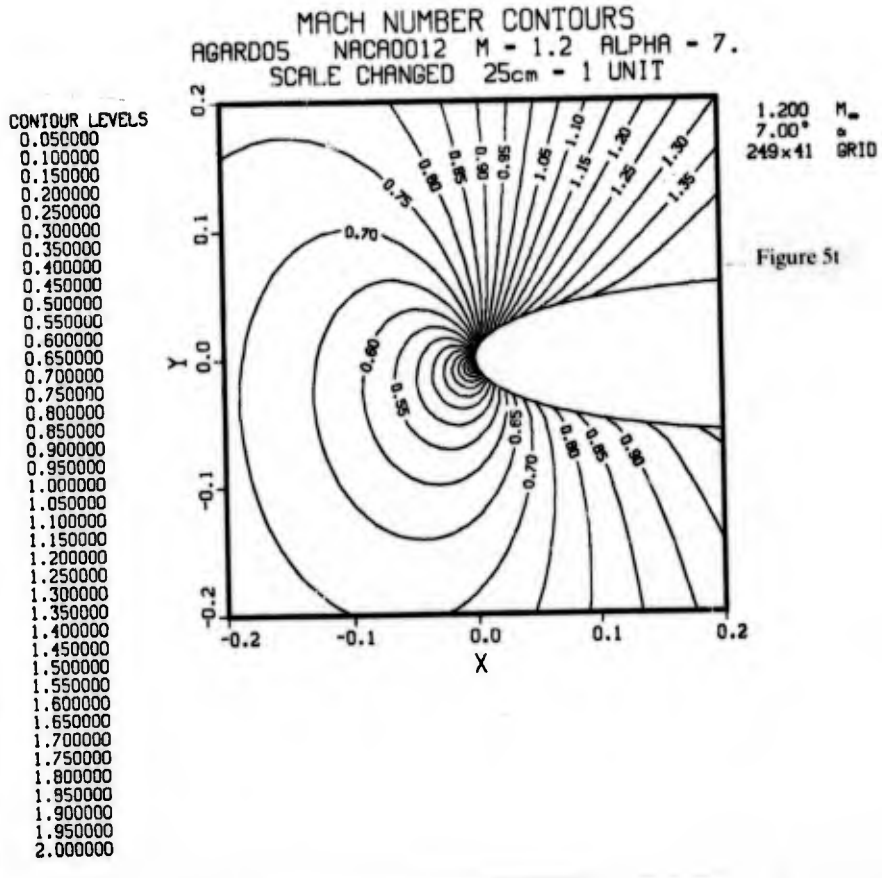
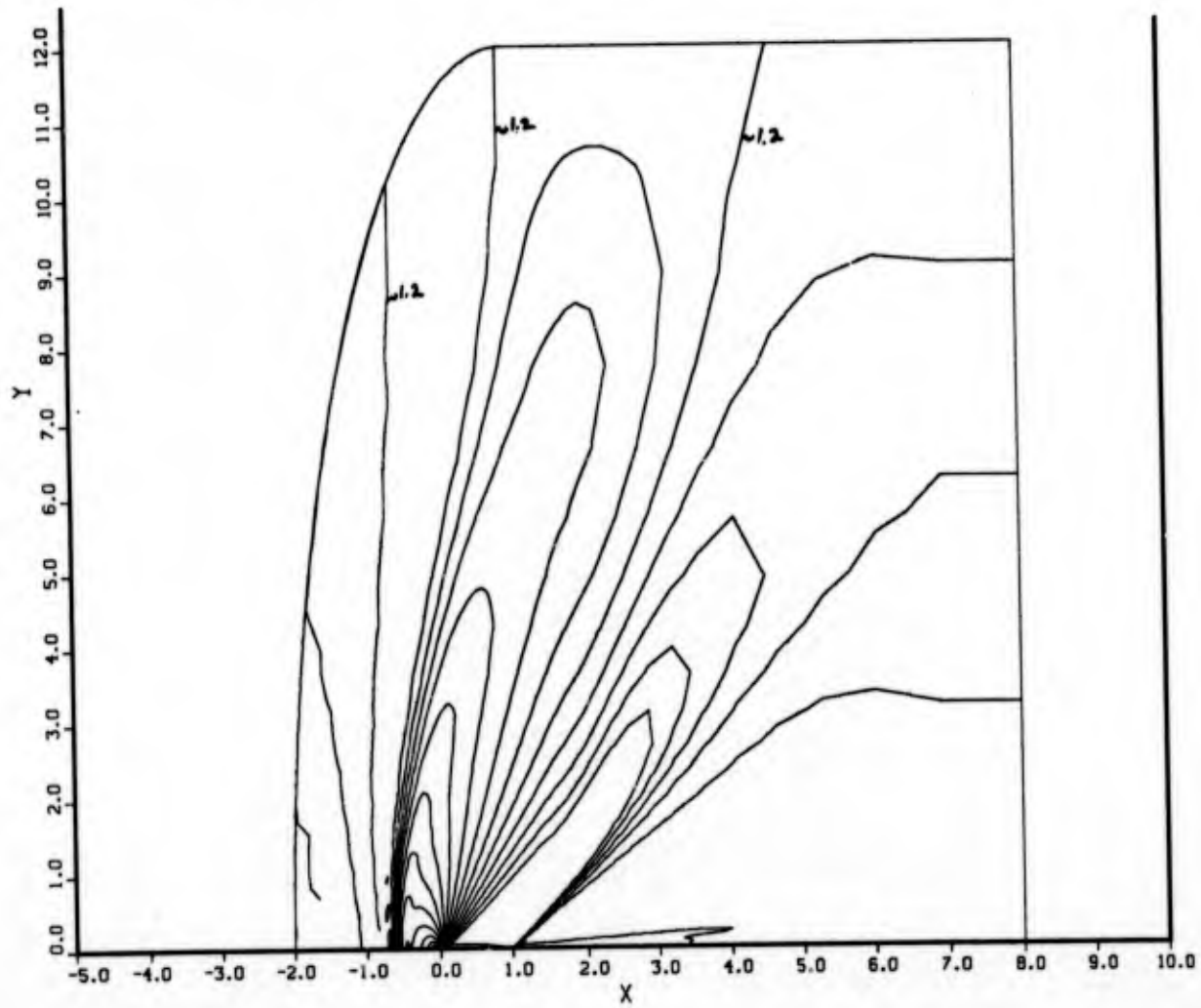


Figure 5t

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-32
	NACA 0012: MACH = 1.2, ALPHA = 7			

Figure 5u Mach Contours. AGARD05 $M_\infty = 1.2$, $\alpha = 7$. Scale changed: 1.5 cm = 1 unit



N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-33
	NACA 0012: MACH = 1.2, ALPHA = 7			

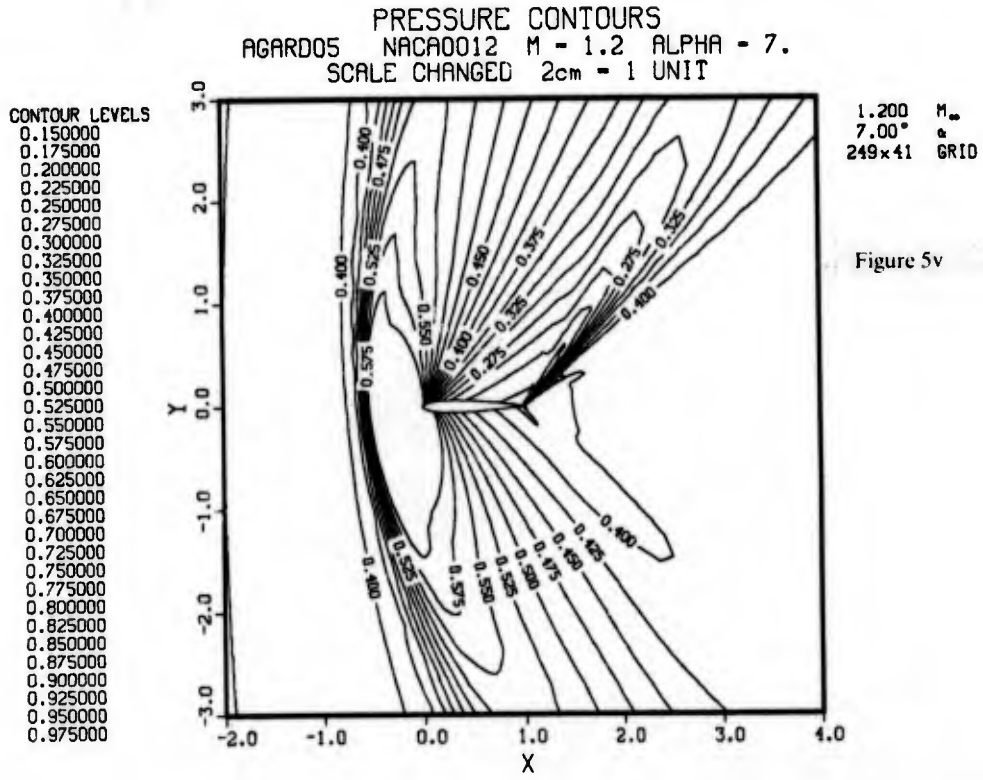


Figure 5v

N.A.S.A. AMES	AR 211		T.H.Pulliam J.T.Barton	05-5-34
	NACA 0012: MACH = 1.2, ALPHA = 7			

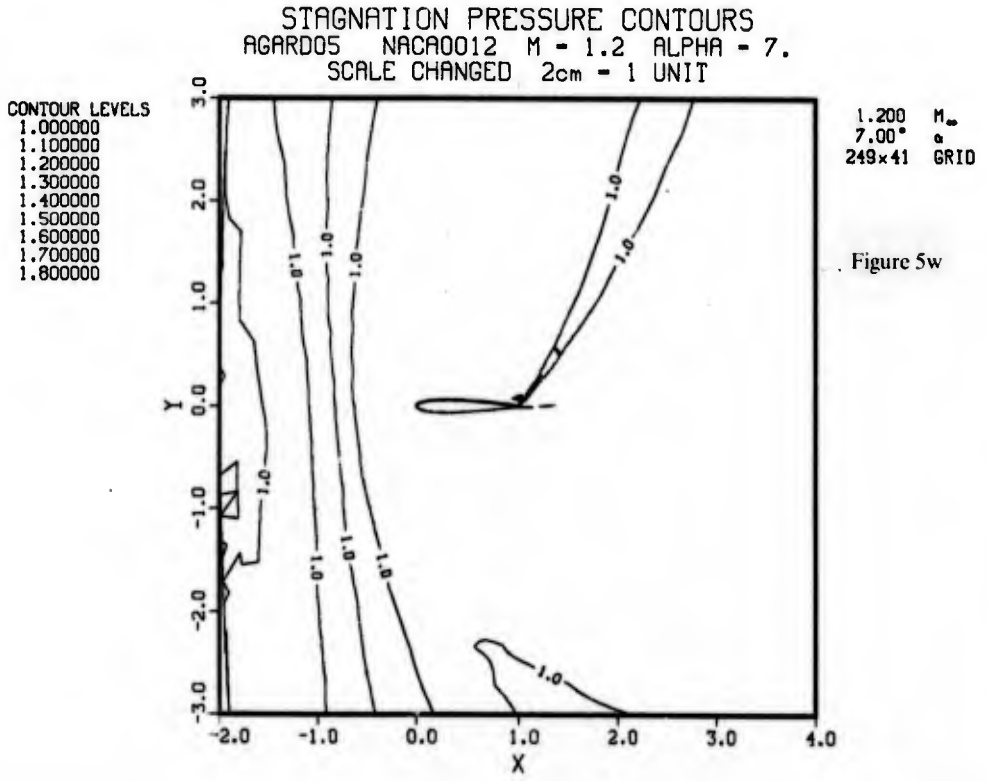


Figure 5w

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 05

NACA 0012: MACH = 1.2, ALPHA = 7

Contributor No 6

M.D.Salas and J.C.South, Jr

(N.A.S.A. — Langley, U.S.A.)

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South. Jr	05-6-1
	NACA 0012: MACH = 1.2, ALPHA = 7			

NASA Langley Research Center - AGARD case 05
NACA 0012 Mach=1.2 alpha=7.000 (deg)
Cl=0.5177 Cd=0.1538 Cm=-0.1103

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-2
	NACA 0012: MACH = 1.2, ALPHA = 7			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
1	.000115	.001330	.084274	1.210917	.331852	.011718
2	.000575	.003980	.148004	1.057600	.465400	.011679
3	.001500	.006610	.219641	.885261	.588642	.013396
4	.002890	.009215	.290818	.714028	.707352	.009790
5	.004755	.011790	.355763	.557791	.810407	.007712
6	.007100	.014330	.409187	.429267	.892510	.008814
7	.009915	.016830	.454500	.320257	.965925	.007198
8	.013200	.019290	.492046	.229931	1.030656	.003108
9	.016960	.021710	.523865	.153384	1.084545	.002600
10	.021195	.024085	.550715	.088790	1.133532	-.000391
11	.025895	.026405	.572486	.036416	1.171385	.001024
12	.031055	.028670	.589186	-.003761	1.203449	-.000705
13	.036675	.030880	.604956	-.041698	1.232158	.000689
14	.042750	.033030	.618452	-.074165	1.259587	-.001060
15	.049270	.035115	.630594	-.103376	1.282484	.000489
16	.056235	.037135	.640759	-.127831	1.304222	-.001101
17	.063640	.039085	.651013	-.152499	1.324582	.000014
18	.071470	.040960	.659210	-.172219	1.342767	-.001263
19	.079725	.042760	.667567	-.192323	1.360035	-.000364
20	.088400	.044480	.675159	-.210587	1.377610	-.001763
21	.097480	.046115	.682402	-.228011	1.393124	-.000957
22	.106960	.047665	.688584	-.242883	1.407940	-.002167
23	.116830	.049125	.695396	-.259271	1.423283	-.001756
24	.127085	.050495	.700477	-.271495	1.435592	-.002422
25	.137720	.051775	.706314	-.285538	1.449409	-.002445
26	.148720	.052960	.711087	-.297020	1.460950	-.002577
27	.160080	.054050	.716569	-.310207	1.474644	-.003089
28	.171785	.055040	.721341	-.321687	1.486471	-.003152
29	.183825	.055935	.725032	-.330568	1.495876	-.003407
30	.196190	.056730	.729750	-.341918	1.508048	-.003739
31	.208870	.057420	.734128	-.352449	1.519204	-.003619
32	.221860	.058010	.738107	-.362021	1.529927	-.004167
33	.235140	.058500	.741621	-.370477	1.539095	-.004044
34	.248700	.058890	.744986	-.378572	1.548447	-.004626
35	.262530	.059180	.748305	-.386556	1.557155	-.004296
36	.276620	.059370	.751776	-.394907	1.567053	-.004959
37	.290955	.059460	.755047	-.402774	1.575719	-.004457
38	.305520	.059455	.757801	-.409400	1.583874	-.005185
39	.320305	.059355	.760604	-.416144	1.591521	-.004841
40	.335290	.059160	.762859	-.421568	1.598355	-.005495
41	.350465	.058870	.765944	-.428991	1.606932	-.005111
42	.365820	.058490	.768370	-.434826	1.614038	-.005244
43	.381335	.058030	.770252	-.439354	1.619501	-.005205
44	.396995	.057485	.772542	-.444864	1.626635	-.005805
45	.412785	.056855	.774510	-.449599	1.631997	-.005101
46	.428690	.056150	.776386	-.454112	1.638051	-.005780
47	.444695	.055370	.778491	-.459175	1.643960	-.005143
48	.460780	.054520	.779739	-.462178	1.648144	-.005748
49	.476930	.053600	.781906	-.467391	1.654528	-.005411
50	.493130	.052615	.783120	-.470312	1.658156	-.005259

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-3
	NACA 0012: MACH = 1.2, ALPHA = 7			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
51	.509365	.051575	.784533	-.473711	1.662706	-.005541
52	.525615	.050475	.785954	-.477128	1.667077	-.005482
53	.541860	.049320	.787250	-.480247	1.671047	-.005363
54	.558085	.048115	.788748	-.483852	1.675702	-.005286
55	.574270	.046865	.789820	-.486429	1.678928	-.005047
56	.590400	.045575	.790910	-.489051	1.682590	-.005356
57	.606460	.044245	.792069	-.491840	1.686078	-.005043
58	.622430	.042880	.792815	-.493635	1.688593	-.005234
59	.638285	.041485	.794140	-.496821	1.692670	-.004959
60	.654015	.040065	.794913	-.498681	1.695061	-.004799
61	.669600	.038625	.795590	-.500311	1.697499	-.005167
62	.685020	.037160	.797008	-.503721	1.701914	-.004865
63	.700265	.035680	.797514	-.504940	1.703263	-.004401
64	.715310	.034190	.798480	-.507263	1.706995	-.005256
65	.730140	.032685	.799465	-.509632	1.709610	-.004302
66	.744740	.031175	.800214	-.511434	1.712410	-.004792
67	.759090	.029665	.800900	-.513084	1.714350	-.004284
68	.773175	.028155	.801806	-.515264	1.717870	-.005049
69	.786975	.026650	.802412	-.516722	1.719159	-.003930
70	.800475	.025155	.803115	-.518414	1.722412	-.005293
71	.813665	.023670	.804136	-.520869	1.724816	-.003726
72	.826525	.022200	.804463	-.521657	1.727026	-.005409
73	.839040	.020745	.805739	-.524727	1.730324	-.003849
74	.851195	.019310	.806296	-.526065	1.732834	-.004790
75	.862975	.017905	.806787	-.527248	1.733885	-.003836
76	.874365	.016525	.807675	-.529384	1.738125	-.005668
77	.885350	.015175	.808222	-.530700	1.738341	-.003137
78	.895915	.013865	.808785	-.532054	1.742210	-.006082
79	.906050	.012590	.809753	-.534383	1.743691	-.003241
80	.915740	.011355	.810060	-.535120	1.746831	-.006412
81	.924970	.010165	.811614	-.538860	1.749554	-.002313
82	.933735	.009025	.810984	-.537345	1.750166	-.006599
83	.942015	.007940	.812533	-.541070	1.753160	-.002904
84	.949795	.006905	.812554	-.541121	1.755966	-.007079
85	.957065	.005930	.812698	-.541466	1.753407	-.002399
86	.963815	.005020	.814884	-.546727	1.763951	-.006715
87	.970035	.004175	.812681	-.541427	1.753791	-.003074
88	.975710	.003395	.815679	-.548638	1.768518	-.009390
89	.980825	.002685	.815418	-.548012	1.759779	.002542
90	.985370	.002055	.814712	-.546312	1.767751	-.013501
91	.989335	.001505	.815537	-.548296	1.759490	.003619
92	.992700	.001035	.815558	-.548347	1.771969	-.015377
93	.995450	.000645	.820440	-.560092	1.772355	.010917
94	.997570	.000345	.808576	-.531551	1.752911	-.023686
95	.999035	.000140	.829443	-.581752	1.835949	-.035481
96	.999800	.000030	.815992	-.549392	1.722900	.059762
97	.999800	-.000030	.670127	-.198482	1.368350	-.004216
98	.999035	-.000140	.652990	-.157254	1.315246	.018317
99	.997570	-.000345	.622102	-.082946	1.273799	-.010582
100	.995450	-.000645	.643029	-.133291	1.294915	.017735

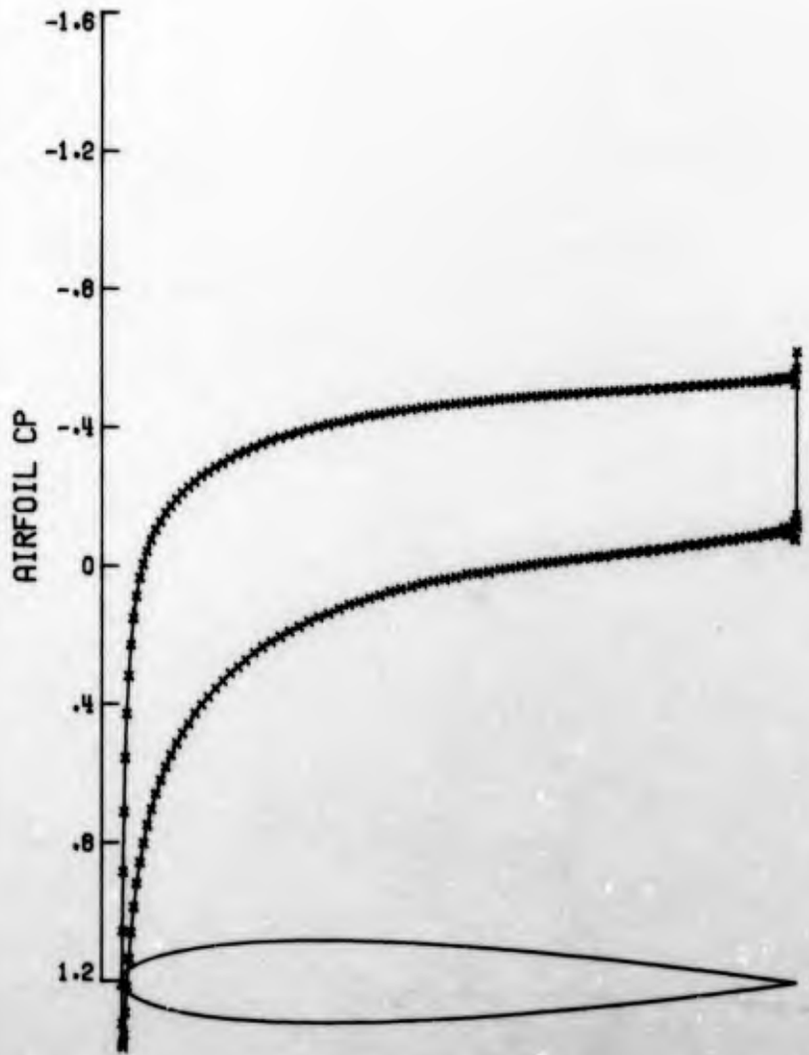
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-4
	NACA 0012: MACH = 1.2, ALPHA = 7			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
101	.992700	-.001035	.629062	-.099692	1.284715	-.006686
102	.989335	-.001505	.636929	-.118617	1.285634	.013438
103	.985370	-.002055	.627835	-.096739	1.279829	-.003372
104	.980825	-.002685	.635925	-.116201	1.285151	.011356
105	.975710	-.003395	.630614	-.103425	1.284357	-.001990
106	.970035	-.004175	.631292	-.105055	1.277059	.009654
107	.963815	-.005020	.629223	-.100078	1.280194	-.000124
108	.957065	-.005930	.628107	-.097393	1.271880	.008043
109	.949795	-.006905	.629574	-.100924	1.279878	.001251
110	.942015	-.007940	.625660	-.091507	1.268004	.006705
111	.933735	-.009025	.625930	-.092156	1.271647	.002548
112	.924970	-.010165	.624549	-.088834	1.266385	.005922
113	.915740	-.011355	.623561	-.086456	1.266489	.003165
114	.906050	-.012585	.621501	-.081500	1.260723	.005429
115	.895915	-.013860	.621284	-.080980	1.261553	.003753
116	.885350	-.015175	.619810	-.077432	1.257686	.005038
117	.874365	-.016525	.618608	-.074540	1.256074	.004041
118	.862975	-.017905	.616886	-.070399	1.252075	.004875
119	.851195	-.019310	.615398	-.066820	1.249635	.004257
120	.839040	-.020745	.615137	-.066191	1.248624	.004922
121	.826525	-.022200	.612782	-.060526	1.244661	.004102
122	.813665	-.023670	.611753	-.058050	1.241930	.005075
123	.800475	-.025155	.610176	-.054257	1.239567	.004164
124	.786975	-.026650	.608913	-.051217	1.236466	.005038
125	.773175	-.028155	.607708	-.048318	1.234698	.004307
126	.759090	-.029665	.606203	-.044699	1.231329	.004937
127	.744740	-.031175	.604724	-.041141	1.228866	.004447
128	.730140	-.032685	.603668	-.038600	1.226465	.004947
129	.715310	-.034185	.601319	-.032949	1.222401	.004400
130	.700265	-.035675	.600448	-.030853	1.220196	.005116
131	.685020	-.037155	.598765	-.026804	1.217568	.004374
132	.669600	-.038620	.597632	-.024078	1.214831	.005147
133	.654015	-.040065	.595548	-.019066	1.211472	.004393
134	.638285	-.041485	.594102	-.015586	1.208117	.005215
135	.622430	-.042880	.592447	-.011605	1.205554	.004504
136	.606460	-.044245	.590685	-.007367	1.201735	.005175
137	.590400	-.045575	.588668	-.002514	1.198381	.004637
138	.574270	-.046865	.586693	.002238	1.194290	.005171
139	.558085	-.048115	.584909	.006529	1.191289	.004769
140	.541860	-.049315	.581927	.013704	1.185523	.005088
141	.525615	-.050465	.580294	.017632	1.182533	.005061
142	.509365	-.051570	.578558	.021809	1.179325	.005080
143	.493130	-.052615	.575138	.030035	1.173116	.005008
144	.476930	-.053595	.572559	.036239	1.168157	.005334
145	.460780	-.054515	.570320	.041627	1.164255	.005117
146	.444695	-.055370	.567311	.048865	1.158636	.005333
147	.428690	-.056150	.563578	.057846	1.151976	.005245
148	.412785	-.056855	.560696	.064779	1.146563	.005552
149	.396995	-.057485	.557289	.072974	1.140661	.005319
150	.381335	-.058030	.552869	.083607	1.132586	.005594

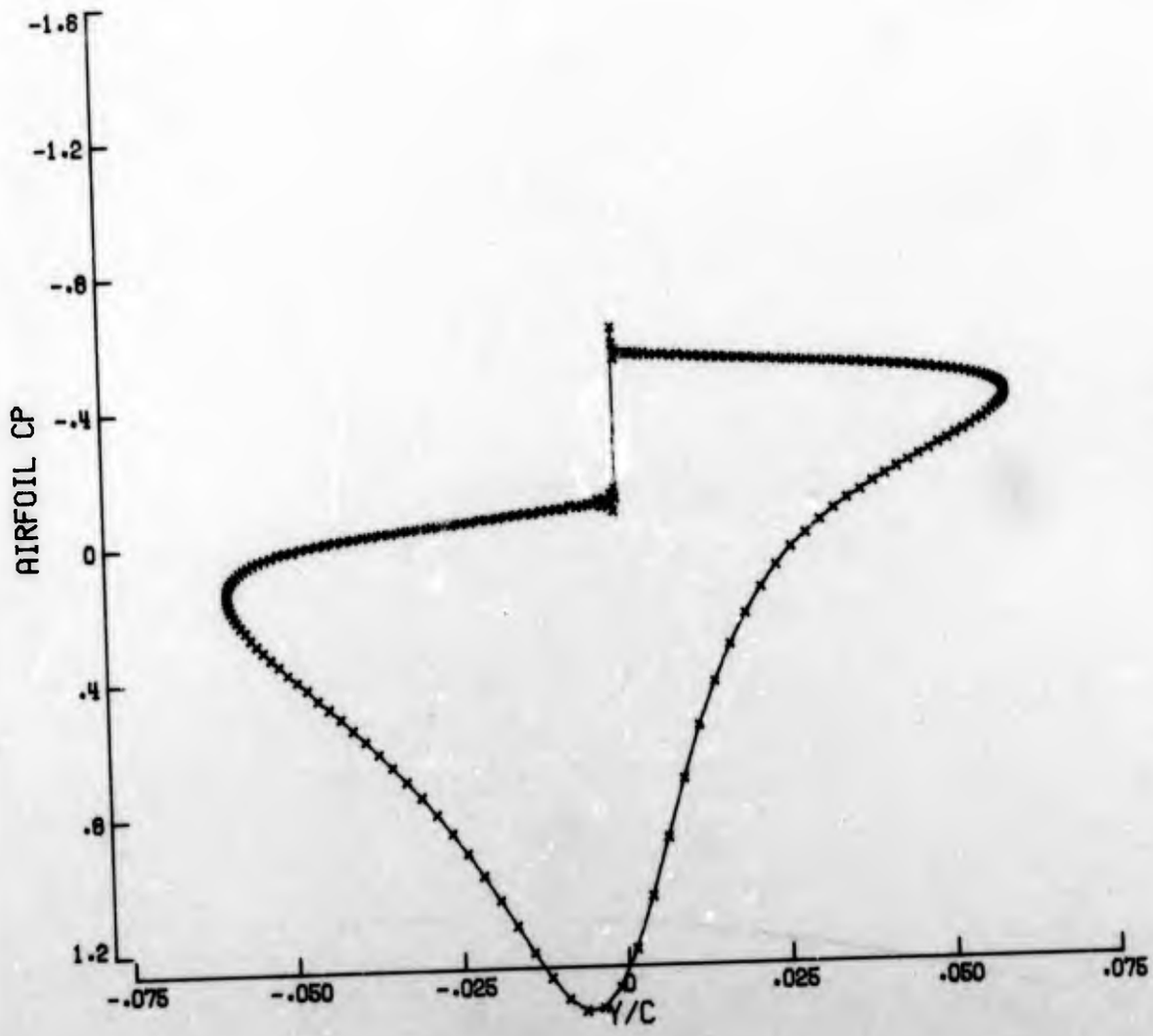
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-5
	NACA 0012: MACH = 1.2, ALPHA = 7			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
151	.365820	-.058490	.549223	.092380	1.126113	.005625
152	.350465	-.058865	.545189	.102085	1.119004	.005639
153	.335290	.059155	.541622	.110666	1.112623	.005807
154	.320305	-.059355	.536714	.122473	1.104153	.005708
155	.305520	-.059455	.530971	.136288	1.093998	.005973
156	.290955	-.059460	.526484	.147083	1.086210	.006053
157	.276620	-.059370	.521094	.160051	1.077001	.006034
158	.262530	-.059180	.515024	.174652	1.066514	.006236
159	.248700	-.058890	.508958	.189246	1.056218	.006291
160	.235140	-.058500	.502868	.203897	1.045874	.006429
161	.221860	-.058010	.496683	.218775	1.035498	.006492
162	.208870	-.057420	.490346	.234021	1.024885	.006605
163	.196190	-.056730	.483451	.250608	1.013429	.006701
164	.183825	-.055935	.474520	.272093	.998807	.006688
165	.171785	-.055040	.466623	.291091	.985623	.007070
166	.160080	-.054050	.458913	.309640	.973265	.006935
167	.148720	-.052960	.449642	.331944	.958164	.007152
168	.137720	-.051775	.440905	.352962	.944048	.007317
169	.127085	-.050495	.430546	.377884	.927685	.007202
170	.116830	-.049125	.421233	.400288	.912491	.007713
171	.106960	-.047665	.410886	.425179	.896477	.007424
172	.097480	-.046110	.397882	.456465	.875869	.007683
173	.088400	-.044475	.386678	.483418	.858182	.007908
174	.079725	-.042760	.374677	.512288	.839532	.007902
175	.071470	-.040960	.360119	.547312	.816871	.007992
176	.063640	-.039085	.346153	.580909	.794940	.008297
177	.056235	-.037135	.330174	.619351	.770403	.008105
178	.049270	-.035115	.313604	.659212	.744142	.008641
179	.042750	-.033030	.295358	.703107	.716046	.008358
180	.036675	-.030880	.275978	.749730	.685009	.008939
181	.031055	-.028670	.254204	.802112	.650857	.008630
182	.025895	-.026405	.231233	.857373	.612919	.009365
183	.021195	-.024085	.205638	.918948	.570986	.009090
184	.016960	-.021710	.177598	.986405	.522078	.009702
185	.013200	-.019290	.146977	1.060072	.467092	.009439
186	.009915	-.016830	.115230	1.136446	.403858	.010028
187	.007100	-.014325	.081652	1.217224	.331841	.008893
188	.004755	-.011785	.050564	1.292013	.243200	.010671
189	.002890	-.009215	.024478	1.354769	.147671	.009506
190	.001500	-.006610	.009920	1.389791	.037092	.008966
191	.000575	-.003975	.012900	1.382623	.077355	.008759
192	.000115	-.001325	.037822	1.322666	.206196	.008881

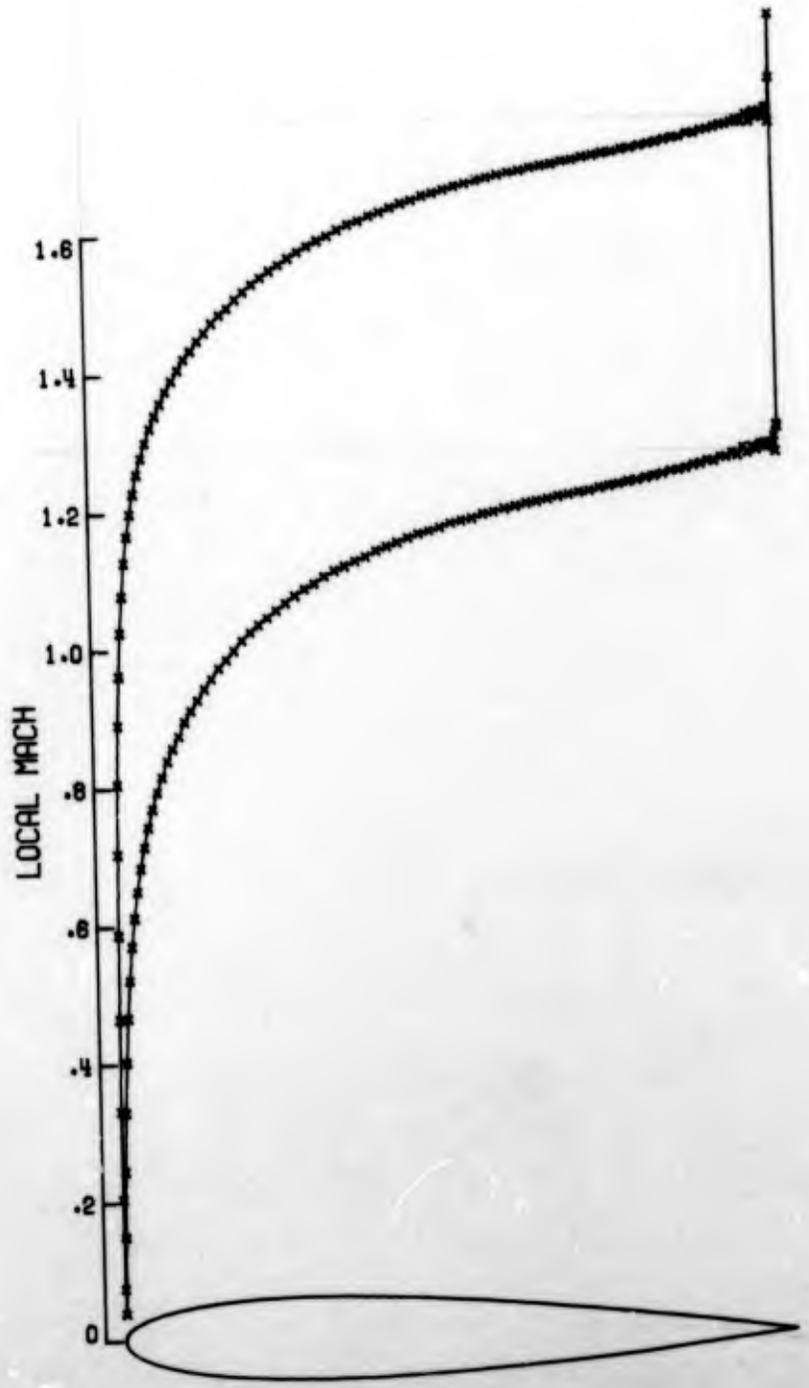
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-6
	NACA 0012: MACH = 1.2, ALPHA = 7			



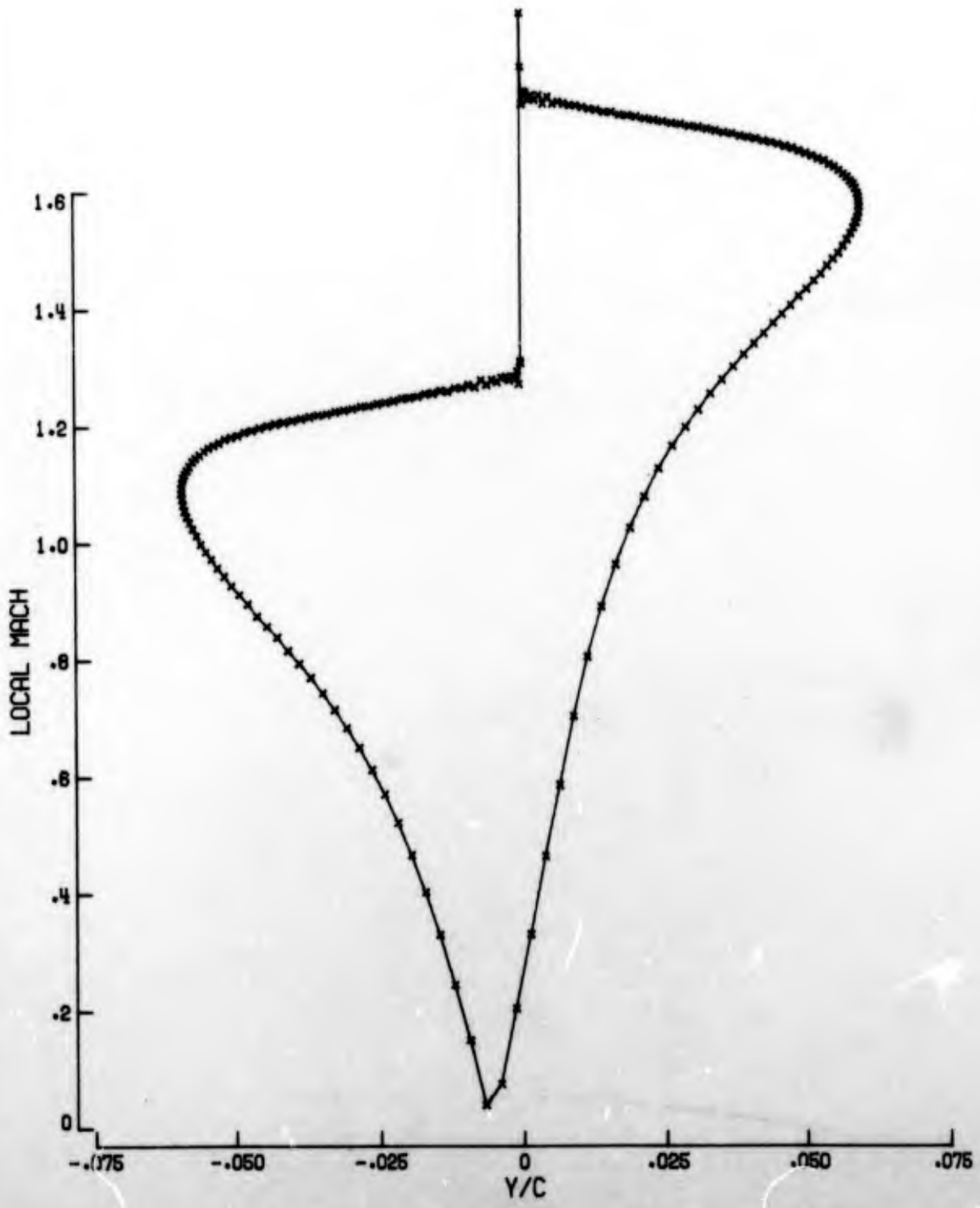
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-7
	NACA 0012: MACH = 1.2, ALPHA = 7			



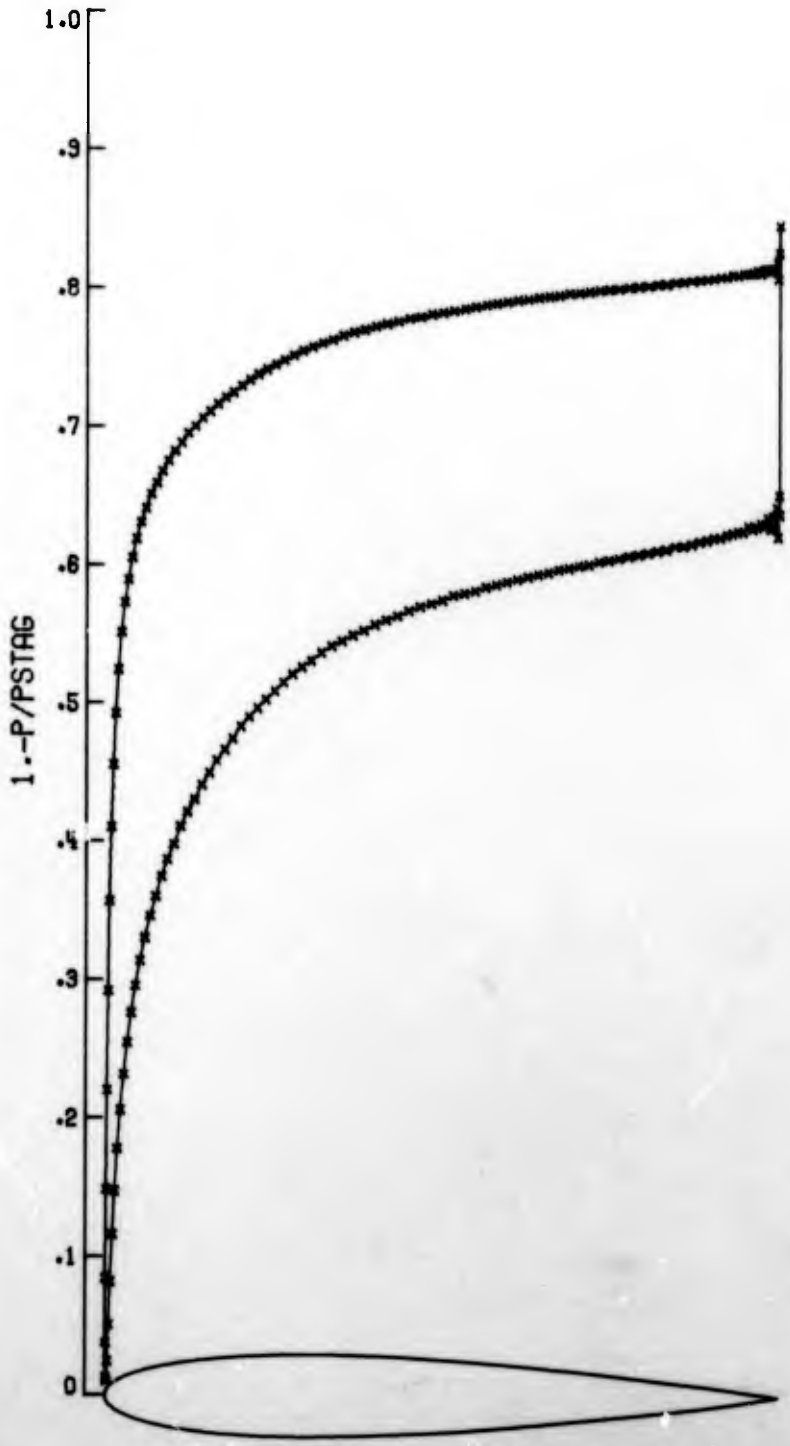
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-8
	NACA 0012: MACH = 1.2, ALPHA = 7			



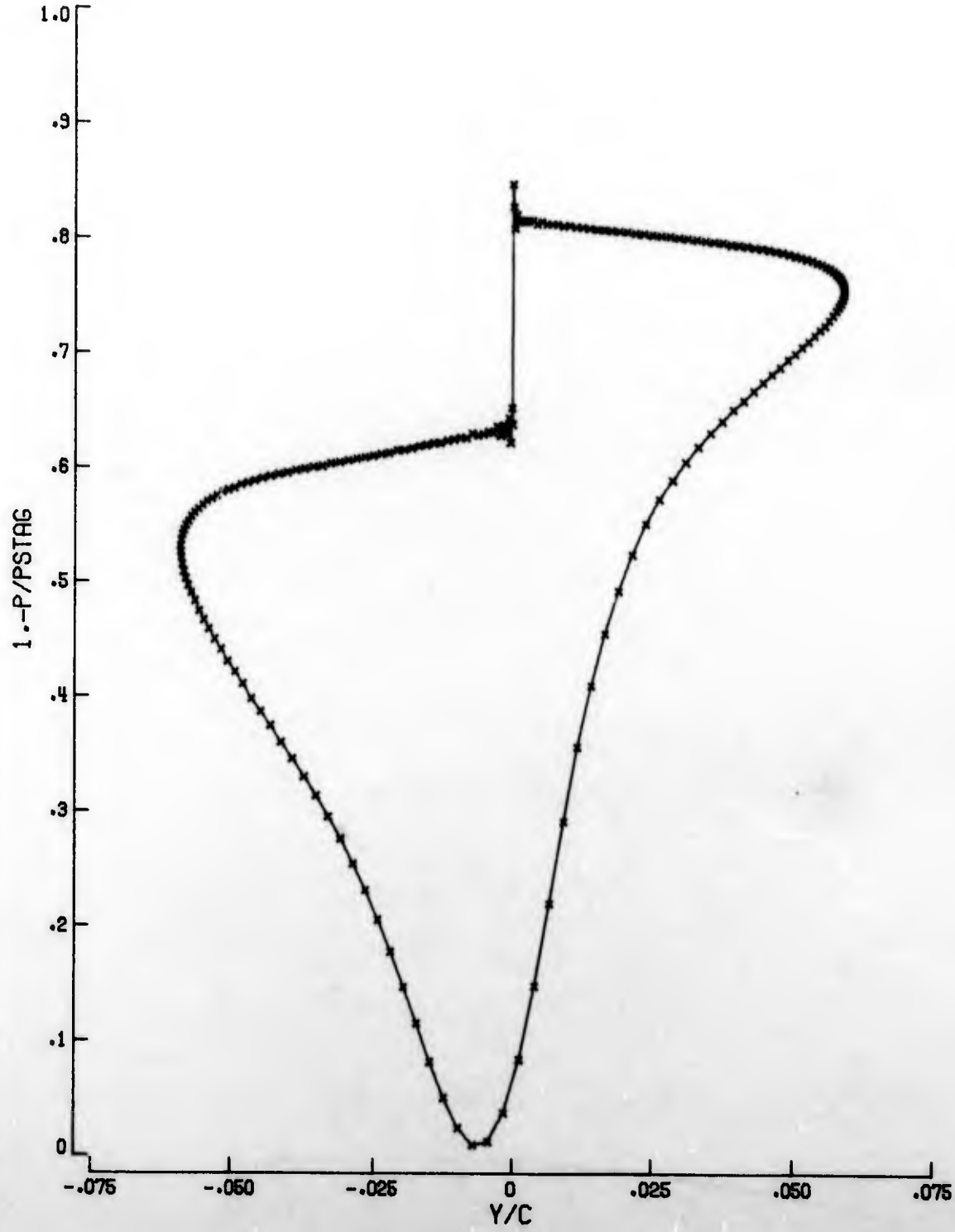
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-9
	NACA 0012: MACH = 1.2, ALPHA = 7			



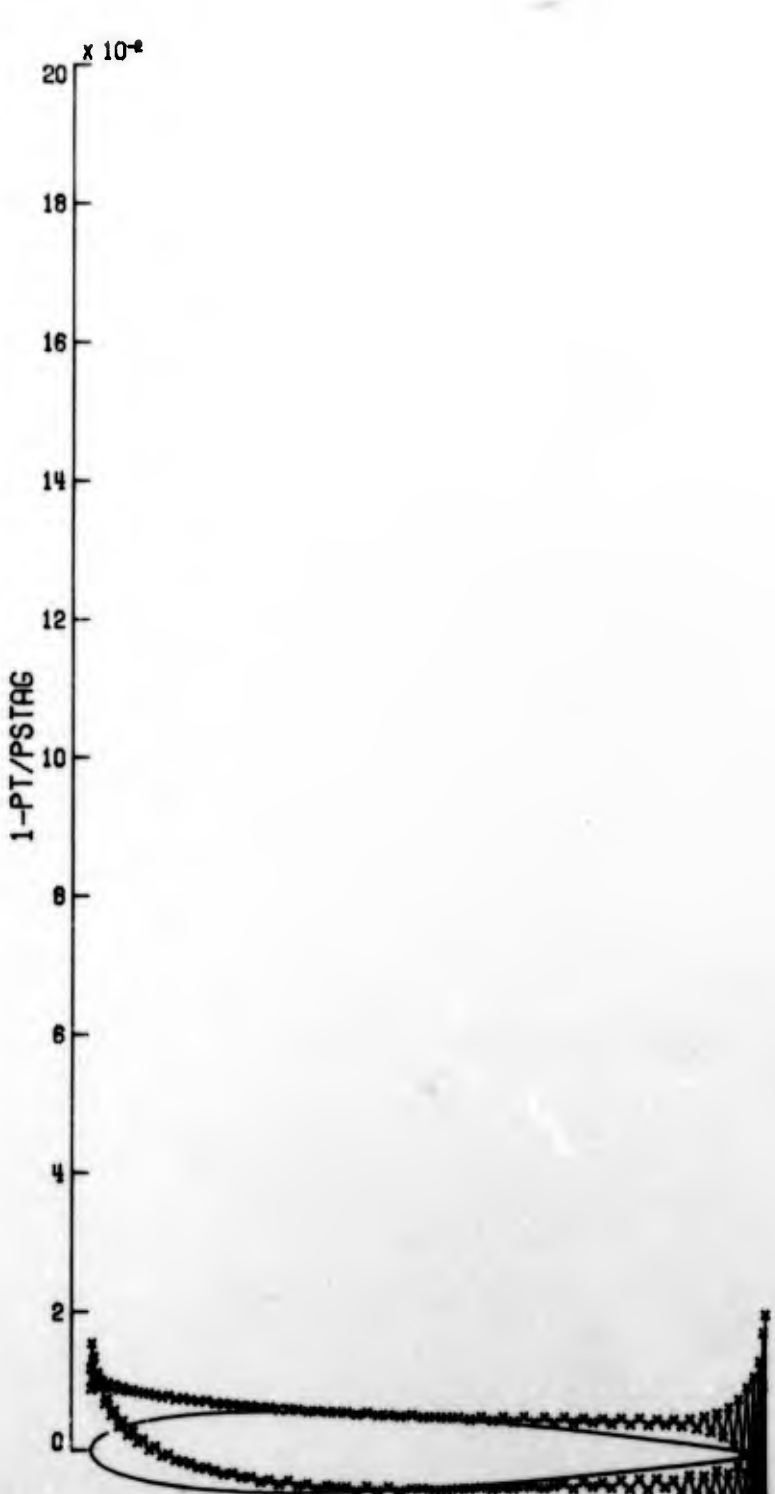
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-10
	NACA 0012: MACH = 1.2, ALPHA = 7			



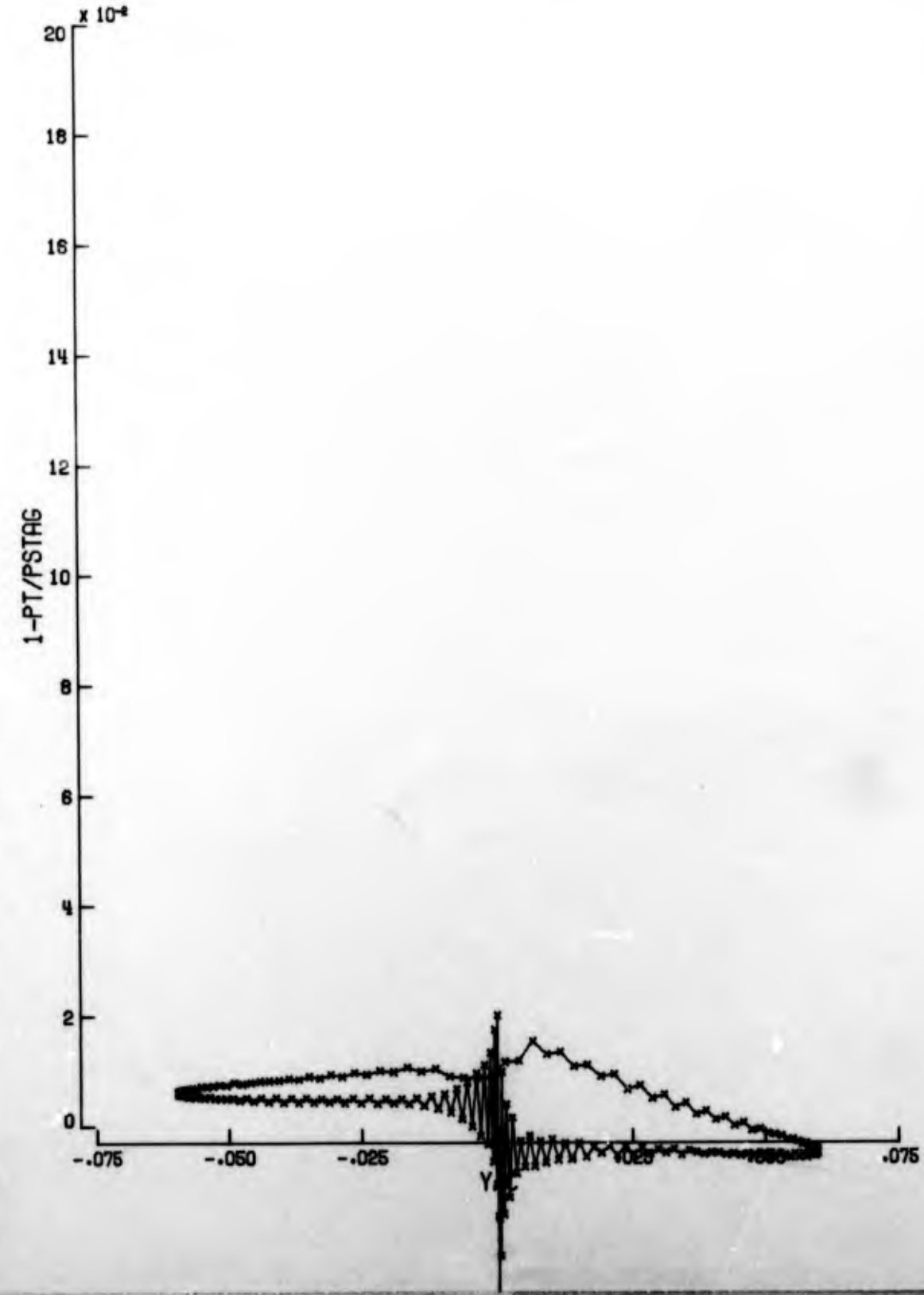
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-11
	NACA 0012: MACH = 1.2, ALPHA = 7			



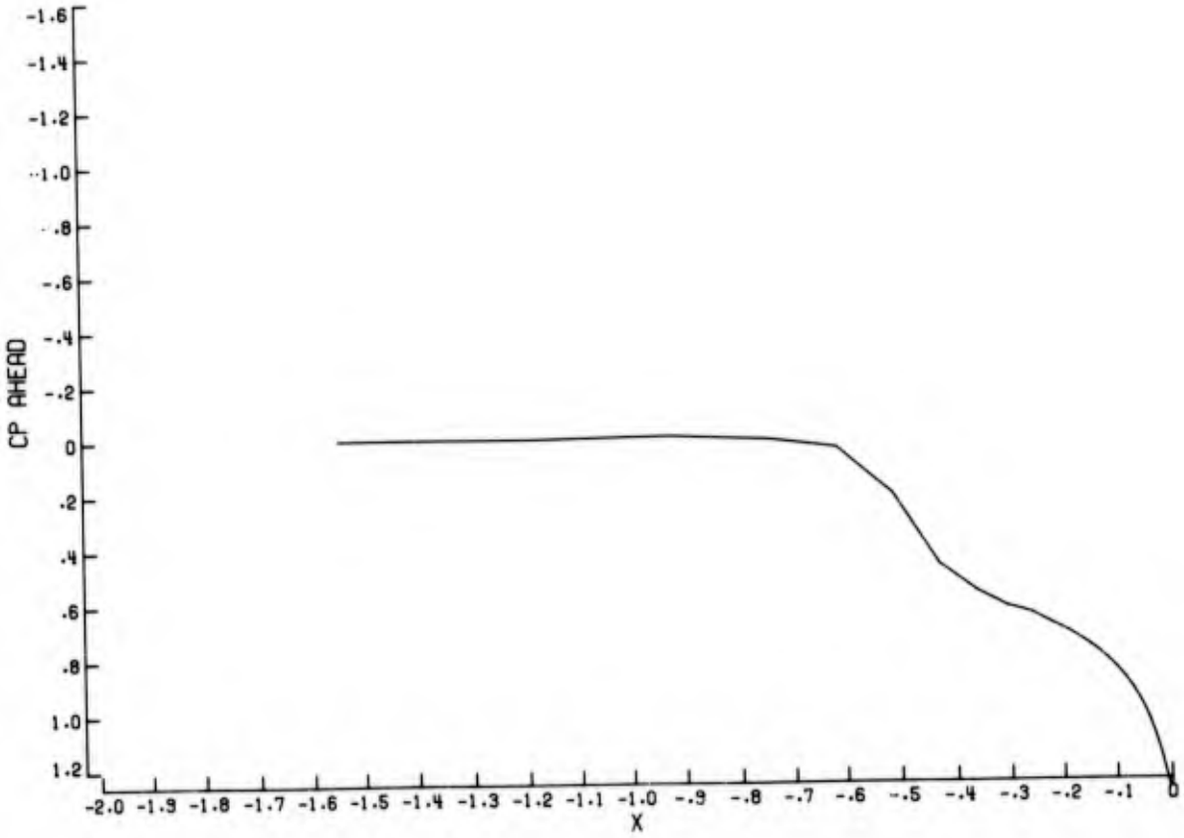
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-12
	NACA 0012: MACH = 1.2, ALPHA = 7			



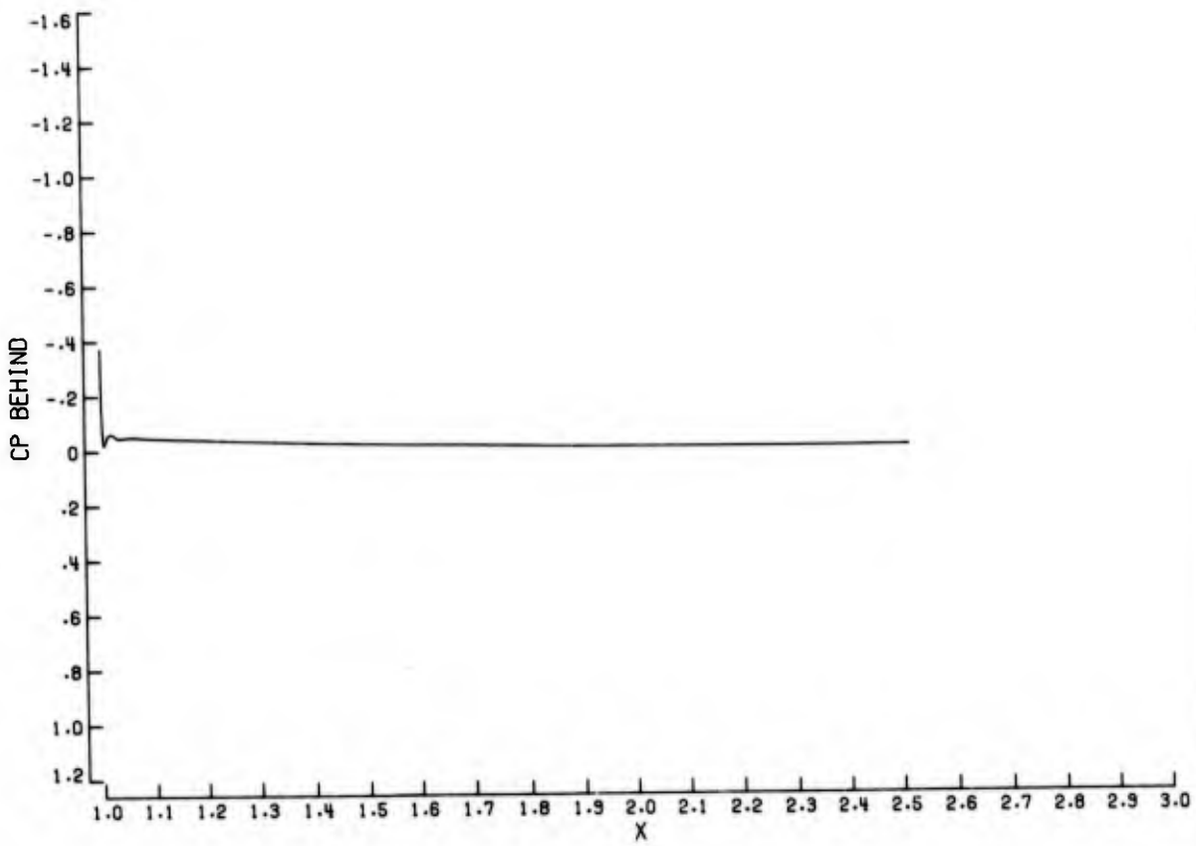
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-13
	NACA 0012: MACH = 1.2, ALPHA = 7			



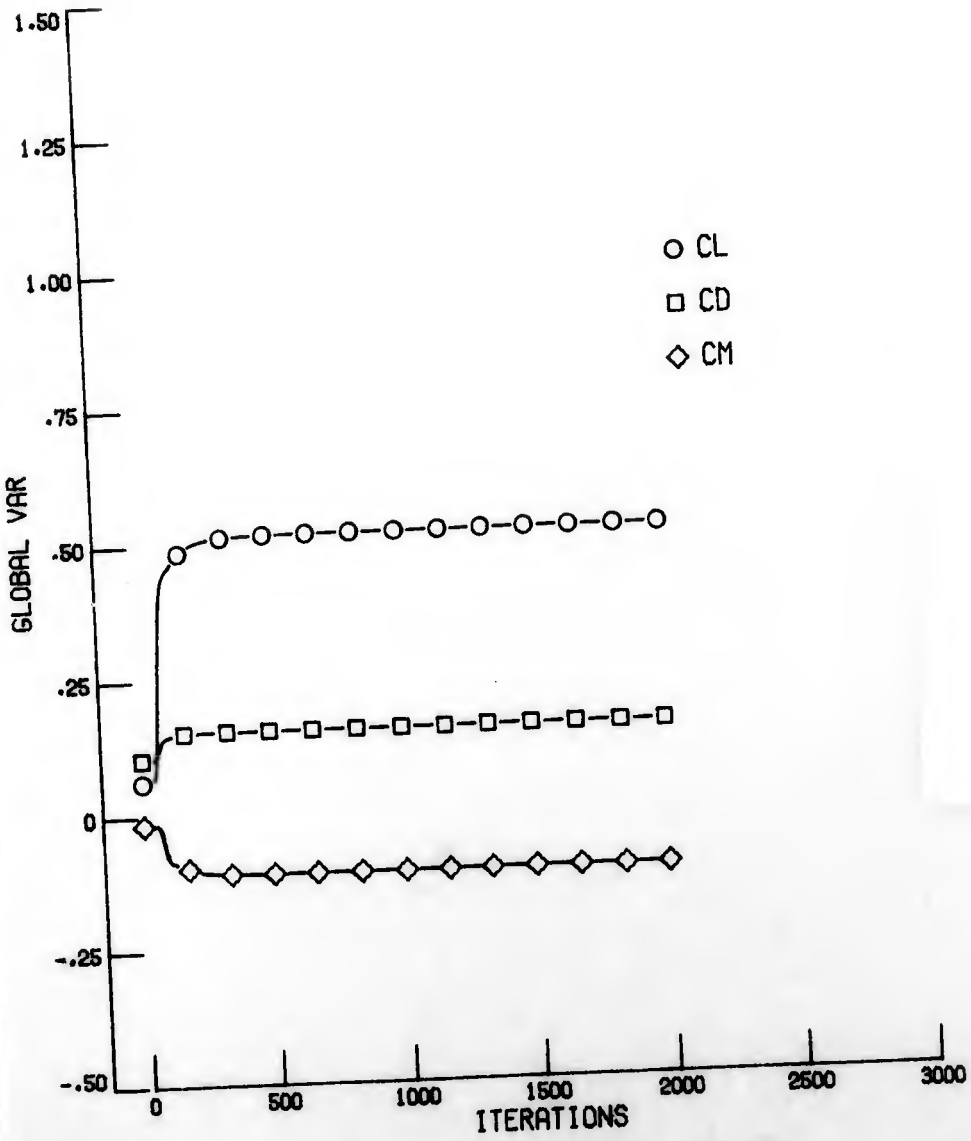
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-14
	NACA 0012: MACH = 1.2, ALPHA = 7			



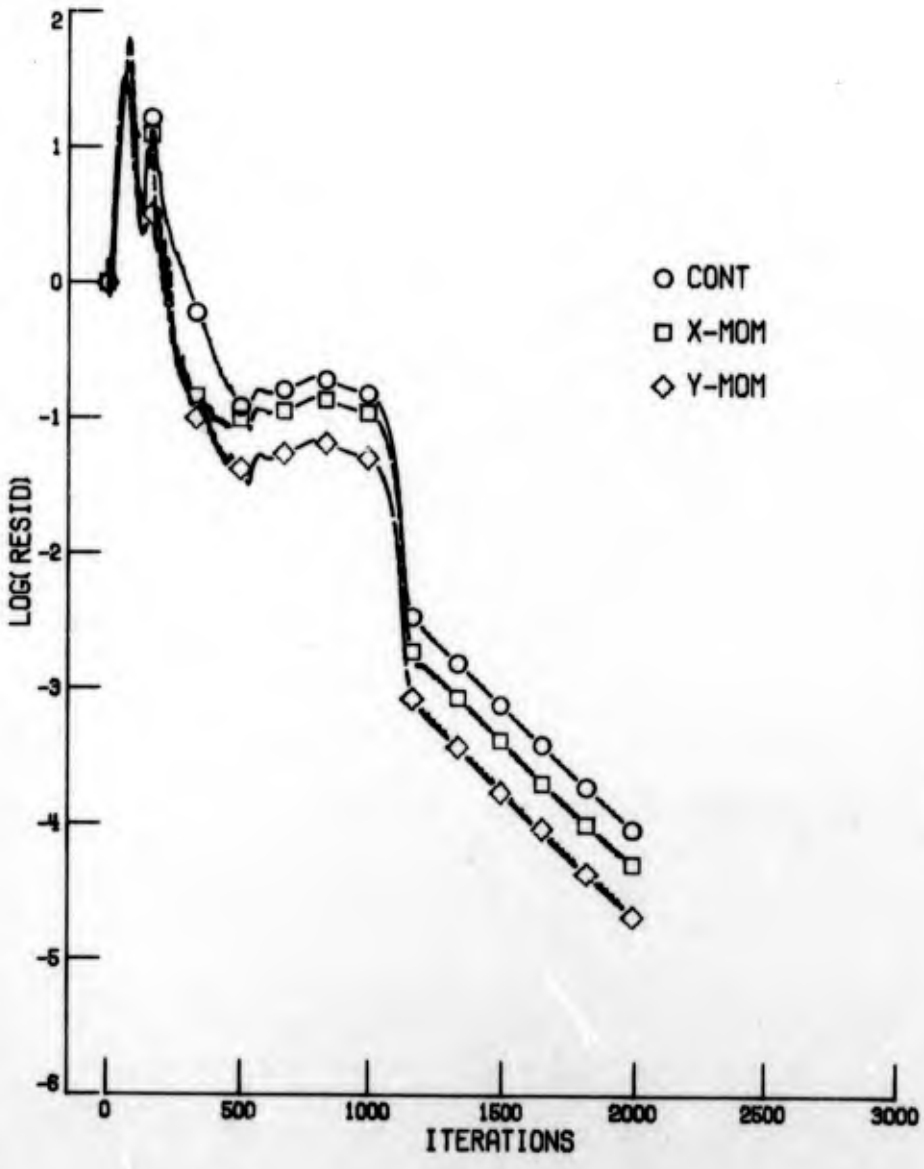
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-15
	NACA 0012: MACH = 1.2, ALPHA = 7			



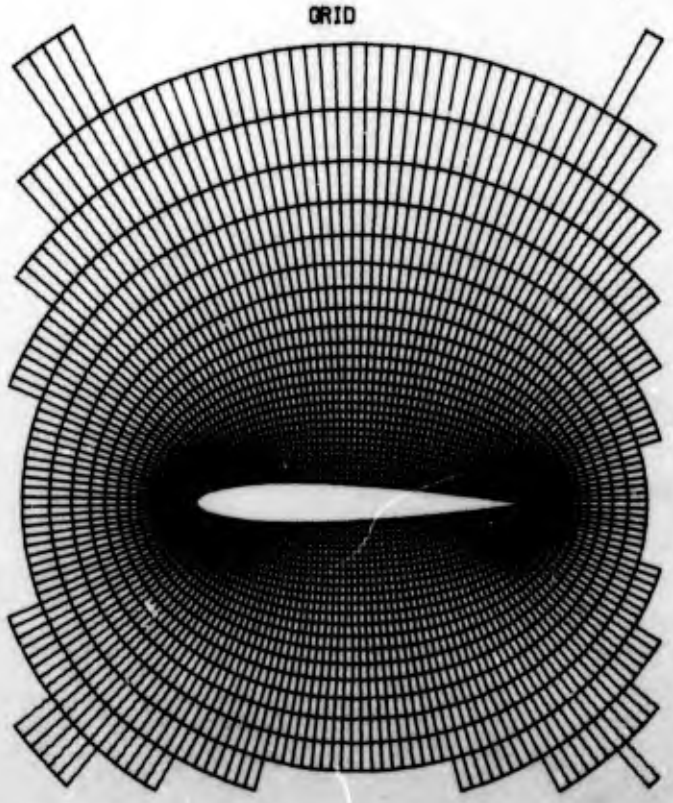
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-16
	NACA 0012: MACH = 1.2, ALPHA = 7			



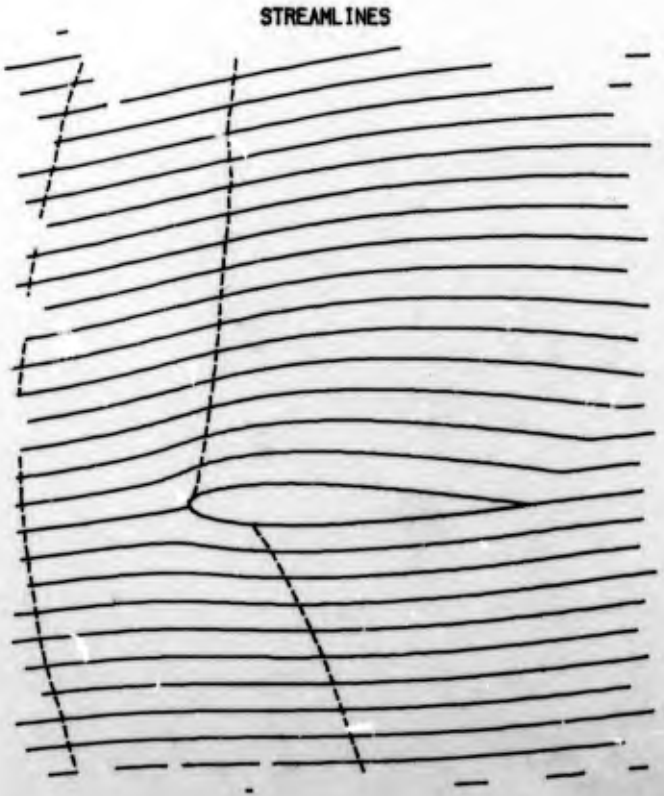
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-17
	NACA 0012: MACH = 1.2, ALPHA = 7			



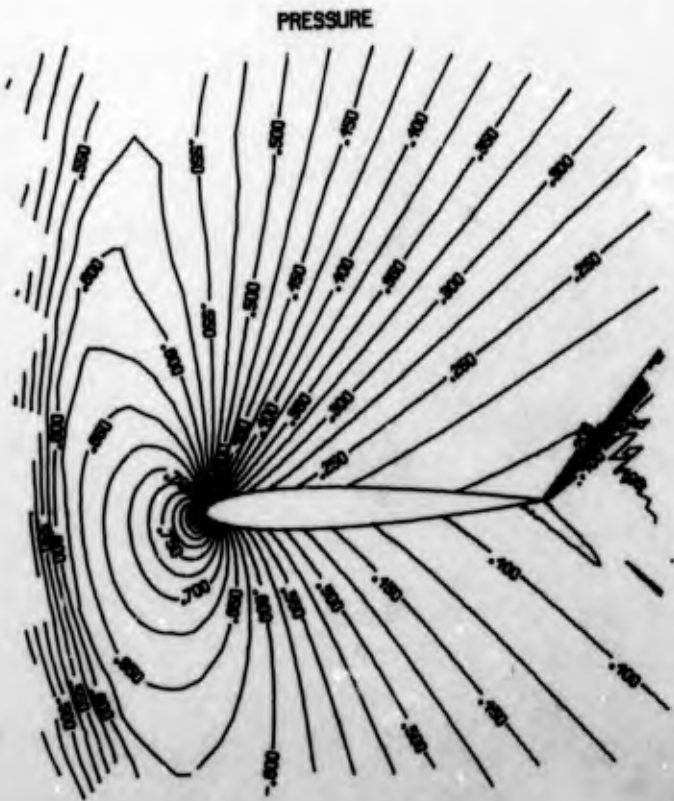
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-18
	NACA 0012: MACH = 1.2, ALPHA = 7			



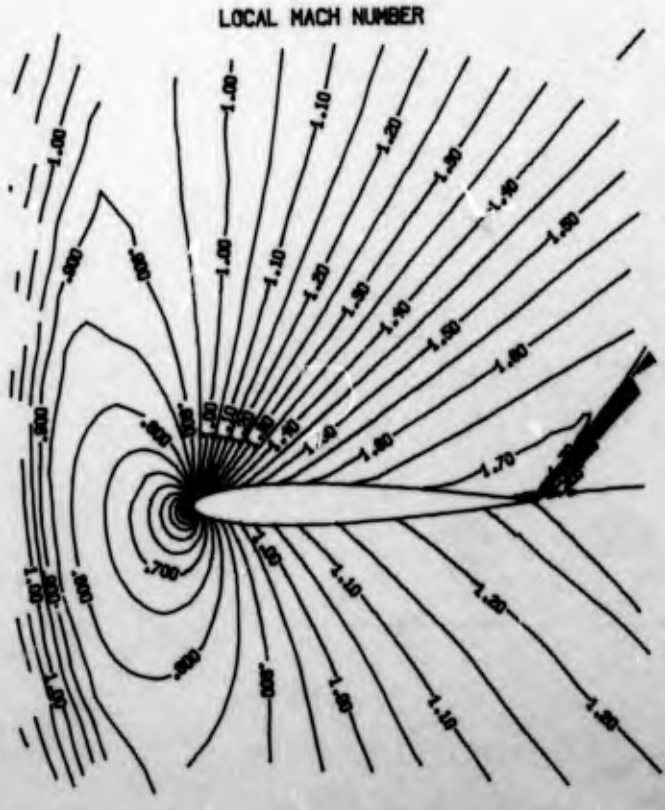
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-19
	NACA 0012: MACH = 1.2, ALPHA = 7			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-20
	NACA 0012: MACH = 1.2, ALPHA = 7			

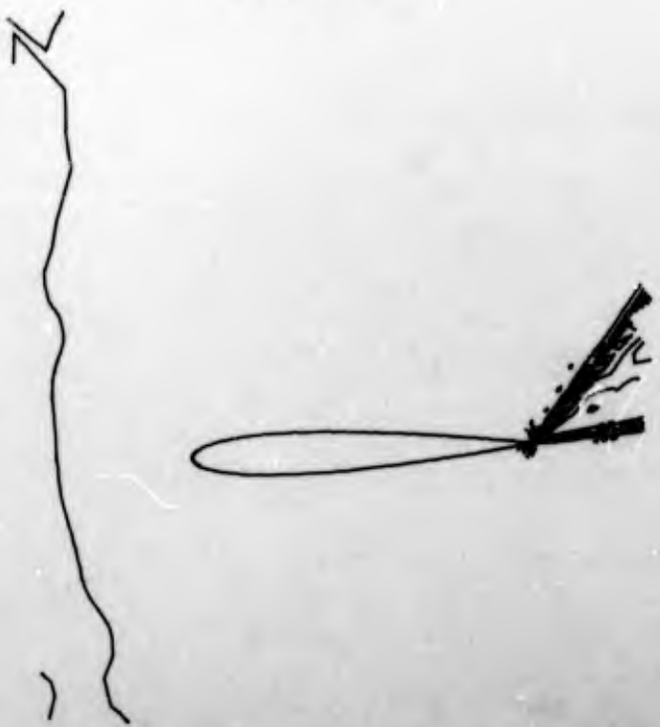


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-21
	NACA 0012: MACH = 1.2, ALPHA = 7			



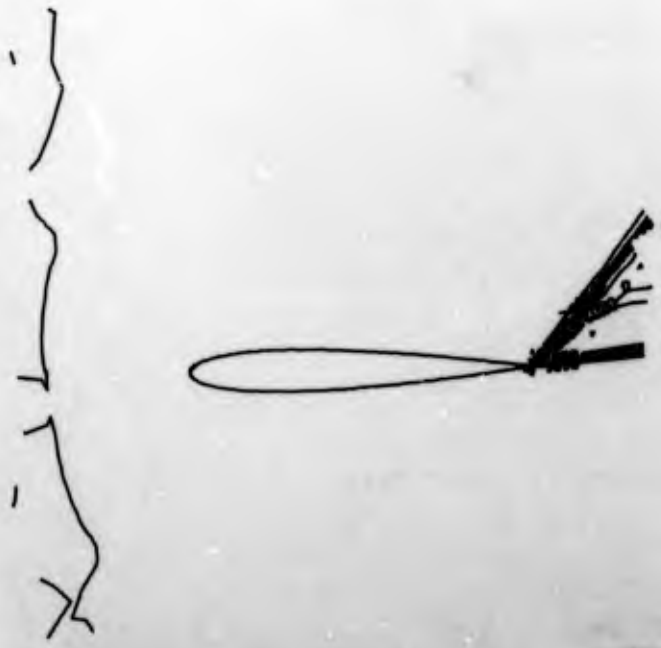
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-22
	NACA 0012: MACH = 1.2, ALPHA = 7			

TOTAL PRESSURE



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	05-6-23
	NACA 0012: MACH = 1.2, ALPHA = 7			

ENTROPY



AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 05

NACA 0012: MACH = 1.2, ALPHA = 7

Contributor No 8

A.Rizzi

(F.F.A., Sweden)

F.F.A.	AR 211		A.Rizzi	05-8-1
	NACA 0012: MACH = 1.2, ALPHA = 7			

SAME MESH AS FOR
TEST CASE 01

UPSTREAM

I	X/C	Y/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	-0.001496	0.000000	0.058296	1.275412	0.263307	0.009562
2	-0.004322	0.000000	0.065386	1.256355	0.272844	0.014555
3	-0.008361	0.000000	0.071087	1.242642	0.307874	0.007463
4	-0.013733	0.000000	0.089904	1.197375	0.346375	0.010929
5	-0.019634	0.000000	0.106754	1.156836	0.390229	0.007760
6	-0.026842	0.000000	0.128037	1.105635	0.430852	0.009331
7	-0.035739	0.000000	0.148256	1.056994	0.471908	0.007901
8	-0.046819	0.000000	0.170041	1.004586	0.510339	0.008609
9	-0.060718	0.000000	0.191211	0.953656	0.548115	0.007956
10	-0.078227	0.000000	0.212727	0.901894	0.583916	0.008259
11	-0.100325	0.000000	0.233636	0.851593	0.618569	0.007980
12	-0.128212	0.000000	0.254157	0.802225	0.651483	0.008045
13	-0.163336	0.000000	0.273970	0.754561	0.683029	0.007911
14	-0.207457	0.000000	0.293413	0.707787	0.713394	0.008012
15	-0.262666	0.000000	0.311829	0.663484	0.742132	0.007946
16	-0.331475	0.000000	0.328495	0.623390	0.768386	0.007549
17	-0.416867	0.000000	0.346324	0.579295	0.796500	0.007786
18	-0.522383	0.000000	0.379931	0.499649	0.844126	0.011562
19	-0.652217	0.000000	0.446754	0.338890	0.943364	0.018455
20	-0.811323	0.000000	0.529369	0.138940	1.084495	0.015238
21	-1.005547	0.000000	0.579579	0.019352	1.192921	0.002366
22	-1.241774	0.000000	0.594190	-0.015799	1.214149	-0.002464
23	-1.528109	0.000000	0.591412	-0.009115	1.208067	-0.001312
24	-1.874077	0.000000	0.587194	0.001033	1.199186	0.000021
25	-2.290869	0.000000	0.586589	0.002246	1.197976	0.000377
26	-2.791620	0.000000	0.587453	0.000409	1.199654	0.000039
27	-3.391740	0.000000	0.587785	-0.000390	1.200334	-0.000043
28	-4.109295	0.000000	0.587697	-0.000179	1.200166	-0.000036
29	-4.965463	0.000000	0.587605	0.000044	1.199959	0.000009
30	-5.935052	0.000000	0.587598	0.000060	1.199950	0.000005
31	-7.197122	0.000000	0.587618	0.000011	1.199990	0.000002
32	-8.635695	0.000000	0.587625	-0.000005	1.200005	-0.000002

F.F.A.	AR 211		A.Rizzi	05-8-2
	NACA 0012: MACH = 1.2, ALPHA = 7			

AIRFOIL

1	0.998814	-0.000168	0.552293	0.064995	1.200461	-0.029076
2	0.994210	-0.000816	0.609177	-0.051654	1.201161	0.031216
3	0.985354	-0.002052	0.631985	-0.106722	1.275173	0.003052
4	0.972671	-0.003802	0.628273	-0.097792	1.272172	0.009023
5	0.956583	-0.005985	0.627291	-0.095429	1.269754	0.008973
6	0.937500	-0.008522	0.626635	-0.079416	1.257646	0.007343
7	0.915823	-0.011335	0.619683	-0.077126	1.253448	0.010370
8	0.891931	-0.014354	0.616010	-0.068290	1.248578	0.007226
9	0.866187	-0.017512	0.613215	-0.061568	1.241254	0.009729
10	0.838931	-0.020752	0.609657	-0.053007	1.235754	0.007821
11	0.810477	-0.024023	0.606593	-0.045877	1.228973	0.009248
12	0.781120	-0.027285	0.603503	-0.038202	1.223647	0.008196
13	0.751125	-0.030499	0.600493	-0.030961	1.217335	0.008945
14	0.720735	-0.033631	0.597314	-0.023313	1.211718	0.008393
15	0.690171	-0.036654	0.594210	-0.015846	1.205547	0.008802
16	0.659627	-0.039542	0.590960	-0.008028	1.199671	0.008498
17	0.629275	-0.042276	0.587677	-0.000131	1.193360	0.008733
18	0.599267	-0.044837	0.584217	0.008194	1.187053	0.008568
19	0.569732	-0.047211	0.580597	0.016904	1.180251	0.008704
20	0.540762	-0.049386	0.576739	0.026183	1.173220	0.008620
21	0.512511	-0.051354	0.572676	0.035959	1.165718	0.008710
22	0.484994	-0.053108	0.568349	0.046363	1.157981	0.008674
23	0.458294	-0.054646	0.563758	0.057413	1.149533	0.008741
24	0.432457	-0.055965	0.558842	0.069238	1.140711	0.008731
25	0.407518	-0.057066	0.553605	0.081839	1.131313	0.008788
26	0.383502	-0.057952	0.548060	0.095173	1.121480	0.008806
27	0.360423	-0.058629	0.542228	0.109208	1.111178	0.008861
28	0.338284	-0.059101	0.536080	0.123997	1.100419	0.008891
29	0.317085	-0.059378	0.529607	0.139569	1.089148	0.008949
30	0.296816	-0.059466	0.522780	0.155993	1.077362	0.008986
31	0.277463	-0.059374	0.515636	0.173181	1.065104	0.009053
32	0.259007	-0.059114	0.508215	0.191033	1.052482	0.009106
33	0.241424	-0.058694	0.500519	0.209547	1.039479	0.009172
34	0.224690	-0.058124	0.492543	0.228736	1.026106	0.009235
35	0.208777	-0.057415	0.484275	0.248627	1.012335	0.009305
36	0.193656	-0.056576	0.475684	0.269293	0.998131	0.009371
37	0.179295	-0.055615	0.466779	0.290717	0.983501	0.009450
38	0.165666	-0.054542	0.457557	0.312903	0.968454	0.009524
39	0.152737	-0.053364	0.447994	0.335909	0.952942	0.009603
40	0.140478	-0.052089	0.438074	0.359773	0.936950	0.009681
41	0.128861	-0.050722	0.427786	0.384523	0.920452	0.009762
42	0.117853	-0.049271	0.417095	0.410243	0.903392	0.009841
43	0.107442	-0.047741	0.405957	0.437033	0.885697	0.009917
44	0.097589	-0.046134	0.394323	0.465025	0.867266	0.009990
45	0.088277	-0.044457	0.382132	0.494353	0.848050	0.010056
46	0.079484	-0.042711	0.369308	0.525205	0.827963	0.010108
47	0.071193	-0.040900	0.355761	0.557794	0.806568	0.010142
48	0.063388	-0.039026	0.341391	0.592365	0.783982	0.010147
49	0.056055	-0.037090	0.326081	0.629198	0.759883	0.010118
50	0.049182	-0.035094	0.309683	0.668645	0.733989	0.010040
51	0.042762	-0.033040	0.292037	0.711097	0.705960	0.009903
52	0.036788	-0.030923	0.272978	0.756946	0.675391	0.009693
53	0.031256	-0.028760	0.252273	0.806753	0.641716	0.009388
54	0.026164	-0.026534	0.229565	0.861147	0.604219	0.008993
55	0.021511	-0.024253	0.204927	0.920659	0.562055	0.008512
56	0.017301	-0.021916	0.177931	0.985603	0.514195	0.007982
57	0.013535	-0.019525	0.148785	1.055722	0.459510	0.007498
58	0.010220	-0.017083	0.117391	1.130044	0.396489	0.007192
59	0.007361	-0.014589	0.083061	1.206617	0.323365	0.006922
60	0.004963	-0.012043	0.055276	1.260679	0.238057	0.006824
61	0.003035	-0.009443	0.029283	1.343209	0.138787	0.006941
62	0.001582	-0.006790	0.014135	1.379652	0.035753	0.007179
63	0.000609	-0.004092	0.010772	1.373308	0.059308	0.007164
64	0.000122	-0.001367	0.042470	1.311483	0.189640	0.007130
65	0.000122	0.001367	0.091482	1.193576	0.327438	0.007002
66	0.000609	0.004092	0.158052	1.033427	0.461229	0.007349
67	0.001582	0.006790	0.231970	0.855602	0.597191	0.008601

F.F.A.	AR 211		A.Rizzi	05-8-3
	NACA 0012: MACH = 1.2, ALPHA = 7			

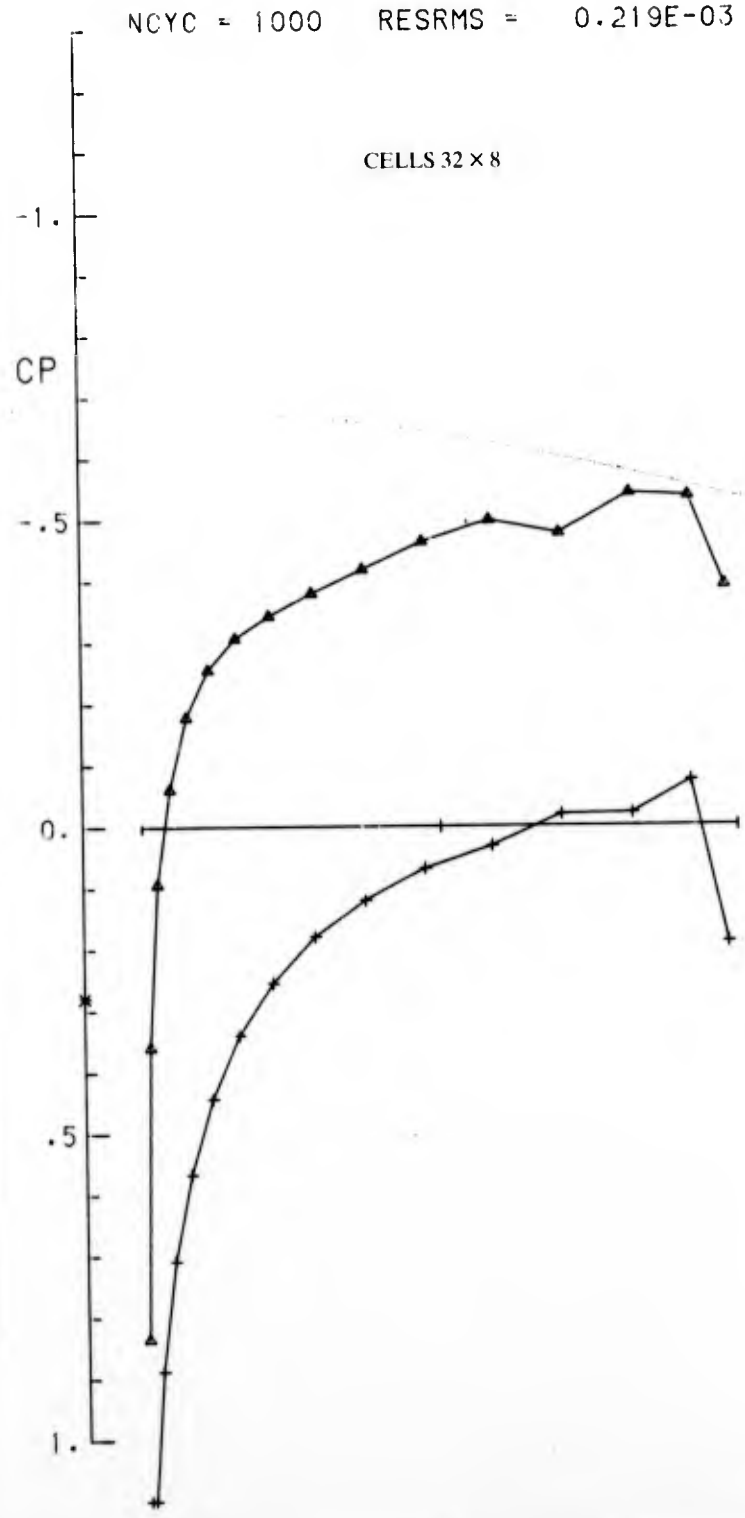
68	0.003035	0.009443	0.302943	0.684860	0.700803	0.008778
69	0.004963	0.012043	0.365725	0.553625	0.800384	0.010290
70	0.007361	0.014589	0.418932	0.405825	0.886809	0.012377
71	0.010220	0.017083	0.462820	0.300241	0.960444	0.014113
72	0.013535	0.019525	0.499054	0.213073	1.023315	0.014890
73	0.017301	0.021916	0.529071	0.140359	1.076995	0.014981
74	0.021511	0.024253	0.553376	0.081186	1.122782	0.014349
75	0.026164	0.026534	0.574465	0.031654	1.161762	0.013516
76	0.031256	0.028760	0.591963	-0.010442	1.195305	0.012650
77	0.036788	0.030923	0.607023	-0.046670	1.225776	0.011845
78	0.042762	0.033040	0.620111	-0.078157	1.252286	0.011097
79	0.049182	0.035094	0.631685	-0.106000	1.276115	0.010406
80	0.056055	0.037090	0.642077	-0.131002	1.297919	0.009785
81	0.063388	0.039026	0.651514	-0.153704	1.318075	0.009232
82	0.071193	0.040900	0.660169	-0.174525	1.336860	0.008743
83	0.079484	0.042711	0.668178	-0.193792	1.354514	0.008318
84	0.088277	0.044457	0.675647	-0.211760	1.371233	0.007941
85	0.097589	0.046134	0.682657	-0.228625	1.387154	0.007614
86	0.107442	0.047741	0.689273	-0.244554	1.402411	0.007323
87	0.117858	0.049271	0.695563	-0.259686	1.417116	0.007066
88	0.128861	0.050722	0.701574	-0.274134	1.431361	0.006837
89	0.140478	0.052089	0.707330	-0.287984	1.445210	0.006636
90	0.152737	0.053364	0.712870	-0.301310	1.458736	0.006453
91	0.165666	0.054542	0.718216	-0.314169	1.471989	0.006289
92	0.179295	0.055615	0.723372	-0.326574	1.484952	0.006146
93	0.193656	0.056576	0.728354	-0.338558	1.497646	0.006012
94	0.208777	0.057415	0.733170	-0.350146	1.510104	0.005891
95	0.224690	0.058124	0.737817	-0.361326	1.522292	0.005785
96	0.241424	0.058694	0.742304	-0.372120	1.534214	0.005683
97	0.259007	0.059114	0.746636	-0.382540	1.545887	0.005592
98	0.277463	0.059374	0.750809	-0.392580	1.557281	0.005516
99	0.296816	0.059466	0.754833	-0.402260	1.568433	0.005439
100	0.317085	0.059378	0.758697	-0.411555	1.579300	0.005383
101	0.338284	0.059101	0.762378	-0.420411	1.589769	0.005333
102	0.360423	0.058629	0.765879	-0.428833	1.599825	0.005286
103	0.383502	0.057952	0.769203	-0.436831	1.609479	0.005251
104	0.407518	0.057066	0.772365	-0.444438	1.618792	0.005212
105	0.432457	0.055965	0.775364	-0.451653	1.627739	0.005196
106	0.458294	0.054646	0.778183	-0.458433	1.636232	0.005182
107	0.484994	0.053103	0.780818	-0.464773	1.644213	0.005189
108	0.512511	0.051354	0.783294	-0.470730	1.651800	0.005166
109	0.540782	0.049386	0.785623	-0.476332	1.658984	0.005195
110	0.569732	0.047211	0.787823	-0.481626	1.665884	0.005161
111	0.599267	0.044837	0.789892	-0.486602	1.672352	0.005236
112	0.629275	0.042276	0.791849	-0.491311	1.678611	0.005160
113	0.659627	0.039542	0.793712	-0.495792	1.684463	0.005305
114	0.690171	0.036654	0.795514	-0.500128	1.690394	0.005130
115	0.720735	0.033631	0.797275	-0.504364	1.695941	0.005408
116	0.751125	0.030499	0.798973	-0.508450	1.701724	0.005075
117	0.781120	0.027285	0.800713	-0.512634	1.707184	0.005530
118	0.810477	0.024023	0.802345	-0.516560	1.712995	0.004938
119	0.838931	0.020752	0.804005	-0.520555	1.717833	0.005995
120	0.866187	0.017512	0.806129	-0.525565	1.726800	0.003538
121	0.891931	0.014354	0.806683	-0.526997	1.724541	0.009454
122	0.915823	0.011335	0.810331	-0.535773	1.745718	-0.003126
123	0.937500	0.008522	0.810991	-0.537362	1.734766	0.017320
124	0.956583	0.005985	0.805338	-0.524965	1.728645	-0.003171
125	0.972671	0.003802	0.824384	-0.570784	1.801413	0.004151
126	0.985354	0.002052	0.842915	-0.614161	1.873218	-0.053786
127	0.994210	0.000815	0.776416	-0.454183	1.443475	0.105744
128	0.998814	0.000163	0.673729	-0.207147	1.213940	0.075065

F.F.A.	AR 211		A.Rizzi	05-8-4
	NACA 0012: MACH = 1.2, ALPHA = 7			

DOWNSTREAM

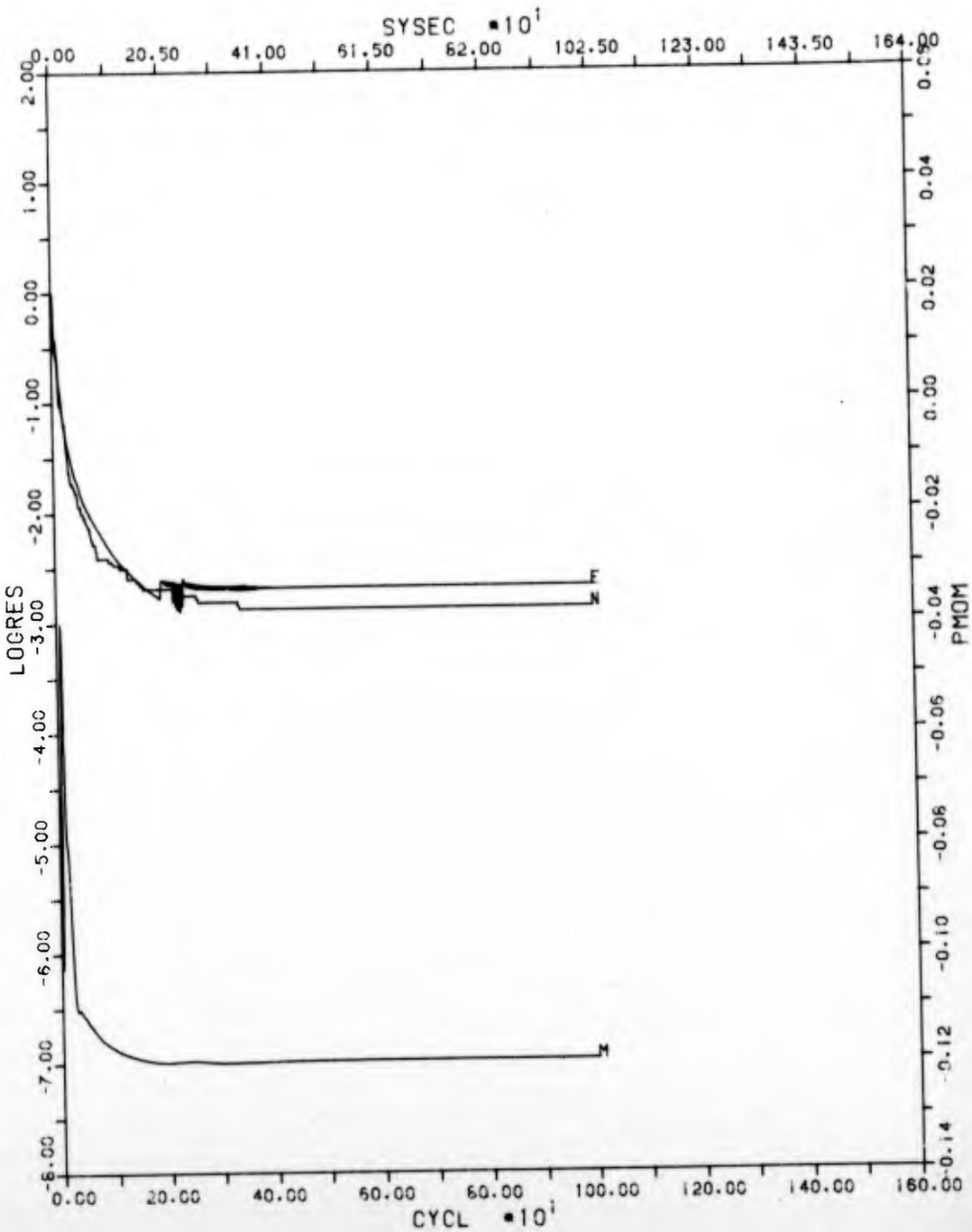
1	1.003723	0.000000	0.601454	-0.033274	1.209169	0.021760
2	1.011506	0.000000	0.602444	-0.035656	1.213107	0.019318
3	1.020008	0.000000	0.599649	-0.028931	1.207762	0.019627
4	1.029354	0.000000	0.600440	-0.030835	1.208944	0.022536
5	1.039740	0.000000	0.602363	-0.035459	1.208678	0.024706
6	1.051447	0.000000	0.603745	-0.038785	1.210380	0.025867
7	1.064851	0.000000	0.604398	-0.040357	1.211651	0.025330
8	1.080446	0.000000	0.604199	-0.039876	1.211941	0.024940
9	1.098357	0.000000	0.602986	-0.036958	1.211224	0.022833
10	1.120366	0.000000	0.600935	-0.032026	1.209074	0.020509
11	1.147440	0.000000	0.599229	-0.027920	1.207802	0.017984
12	1.179757	0.000000	0.598370	-0.025854	1.207716	0.016068
13	1.219246	0.000000	0.598235	-0.025529	1.208494	0.014785
14	1.267629	0.000000	0.598044	-0.025070	1.208576	0.014226
15	1.326963	0.000000	0.596990	-0.022535	1.207296	0.013297
16	1.399727	0.000000	0.595440	-0.018805	1.205770	0.011475
17	1.488833	0.000000	0.594059	-0.015483	1.204320	0.010005
18	1.597764	0.000000	0.592992	-0.012915	1.203168	0.008909
19	1.730633	0.000000	0.592069	-0.010696	1.202170	0.007963
20	1.892299	0.000000	0.591228	-0.008672	1.201268	0.007093
21	2.088495	0.000000	0.590344	-0.006547	1.200001	0.006595
22	2.325974	0.000000	0.589476	-0.004458	1.198626	0.006276
23	2.612679	0.000000	0.588938	-0.003163	1.197656	0.006230
24	2.957951	0.000000	0.588732	-0.002669	1.197203	0.006319
25	3.372759	0.000000	0.588584	-0.002552	1.196823	0.006692
26	3.869976	0.000000	0.588597	-0.002342	1.196513	0.006881
27	4.464706	0.000000	0.588330	-0.001701	1.195709	0.007278
28	5.174656	0.000000	0.587202	0.001013	1.193441	0.007490
29	6.020579	0.000000	0.584454	0.007624	1.187977	0.007947
30	7.026787	-0.000001	0.579817	0.018779	1.179087	0.008354
31	8.221754	-0.000001	0.574847	0.030734	1.169756	0.008619
32	9.638821	-0.000001	0.572453	0.036496	1.165384	0.007983

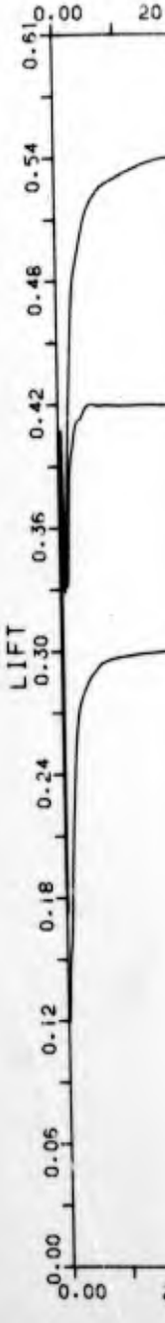
F.F.A.	AR 211		A.Rizzi	05-8-5
	NACA 0012: MACH = 1.2, ALPHA = 7			



15 JUN AFVTOQO INVOR OUTTOQO MSHX NO5 BAS BAS4 .05

PITCH	-0.120	GCIRC	0.322	CELLS	32X 8
MACH	1.200	ALPHA	7.000	RESAE	0.219E-
RATE	0.994	RESAS	0.105E+00	DRAG	0.151E+
NSUP	164	LIFT	0.543E+00	RESMX	-0.291E-
CYCL	1000	SYSEC	0.102E+04		

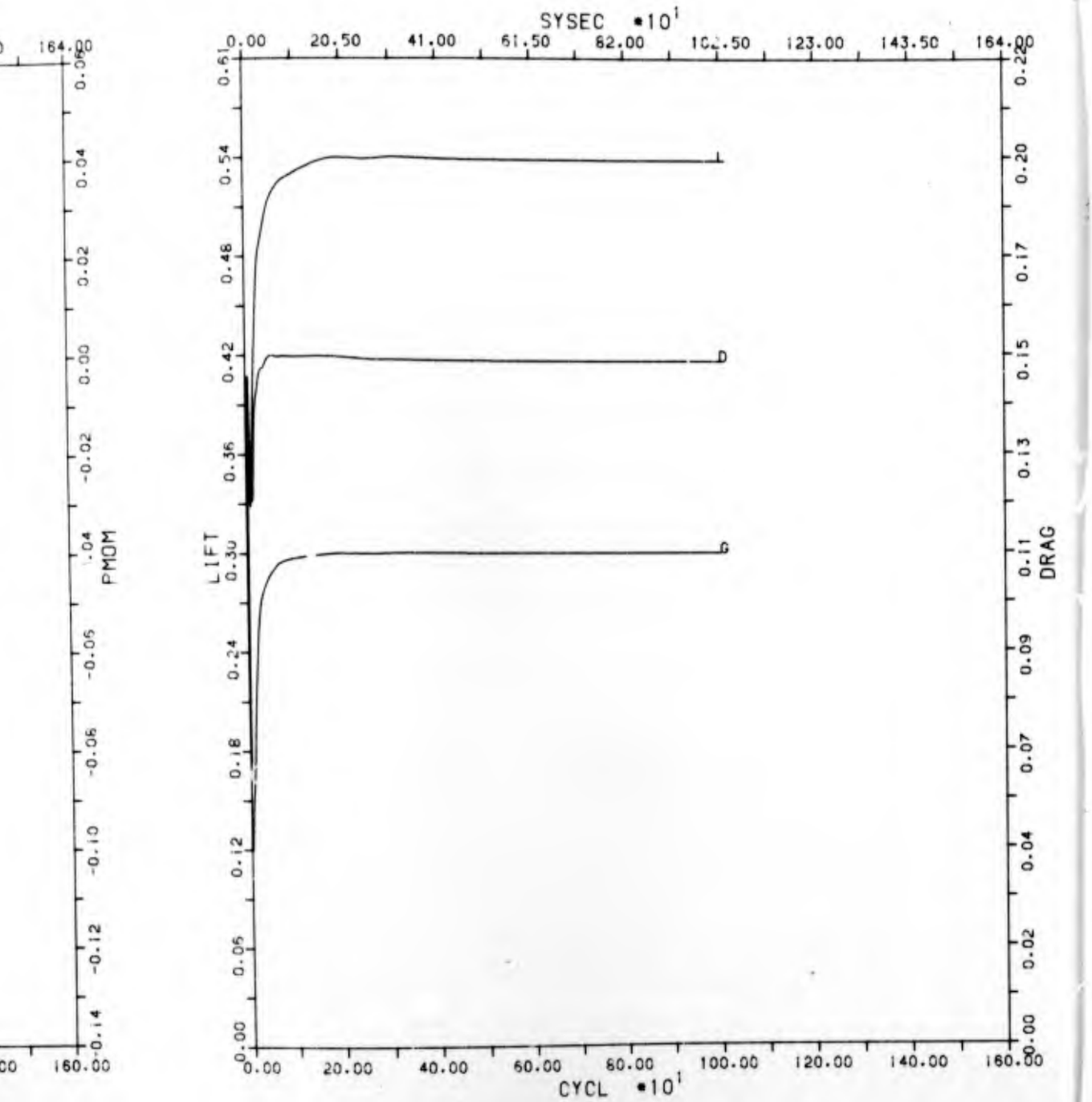




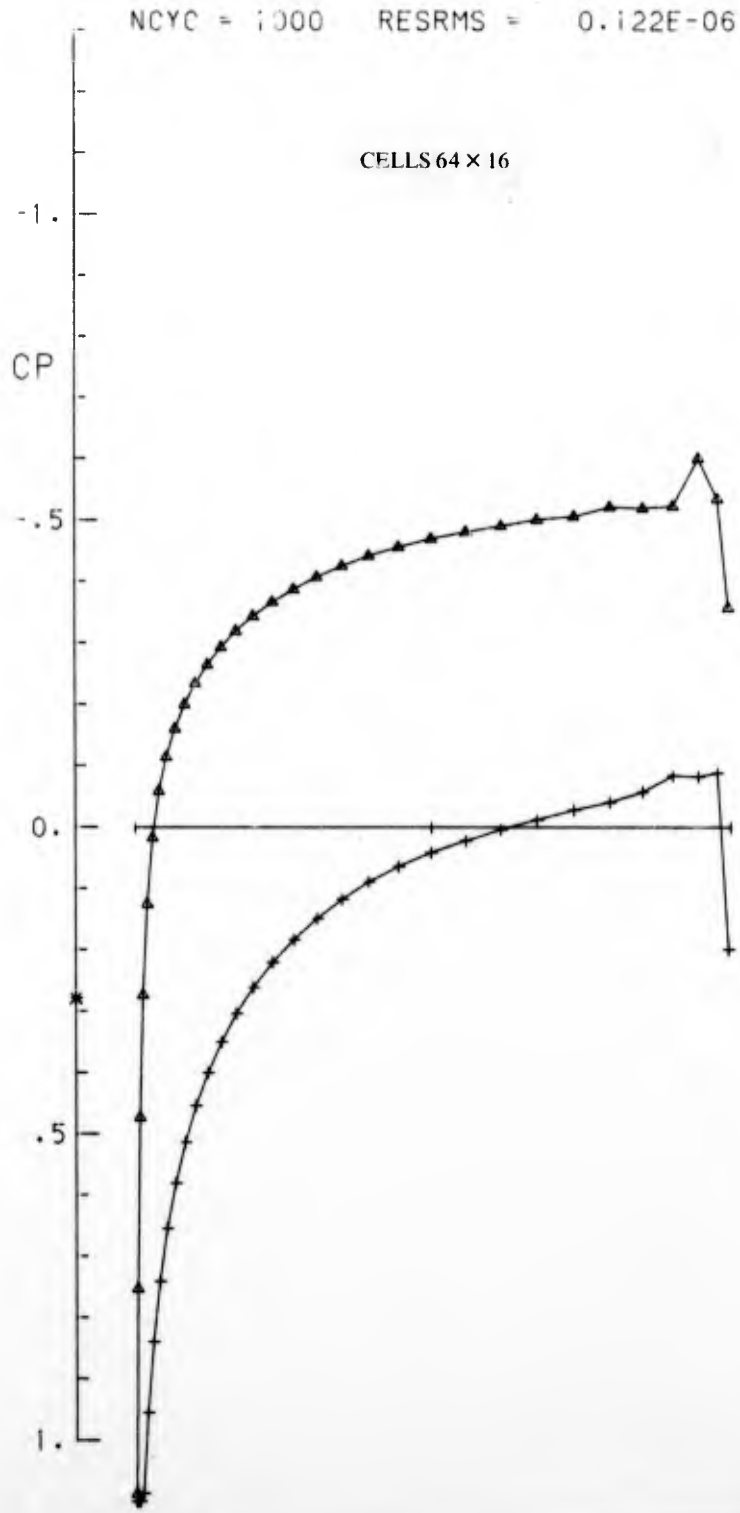
F.F.A.	AR 211		A.Rizzi	05-8-6
	NACA 0012: MACH = 1.2, ALPHA = 7			

X NO5 BAS BAS4 .05 0. .01

CELLS 32X 8
RESAE 0.219E-03
DRAG 0.151E+00
RESMX -0.291E-02 8 7

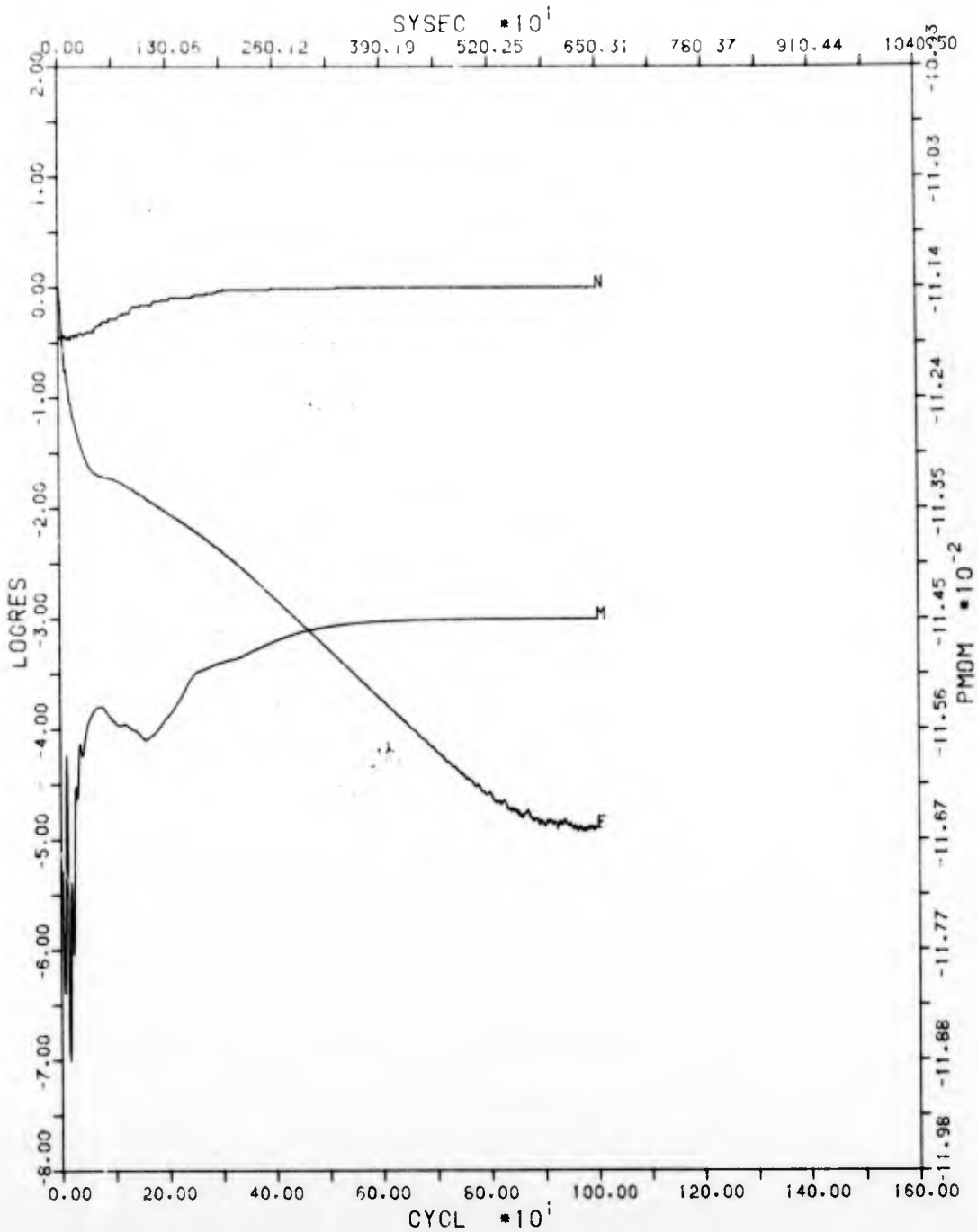


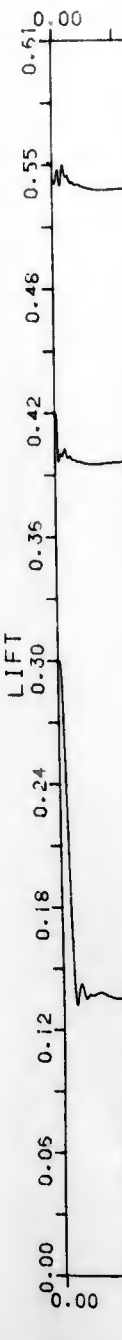
F.F.A.	AR 211		A.Rizzi	05-8-7
	NACA 0012: MACH = 1.2, ALPHA = 7			



15 JUN AFVTOQO INVOR OUTTOQO MSHX N05 BAS BAS4 .0

PITCH	-0.115	GCIRC	0.306	CELLS	64X1
MACH	1.200	ALPHA	7.000	RESAE	0.122
RATE	0.989	RESAS	0.950E-02	DRAG	0.154
NSUP	699	LIFT	0.531E+00	RESMX	-0.477
CYCL	1000	SYSEC	0.650E+04		

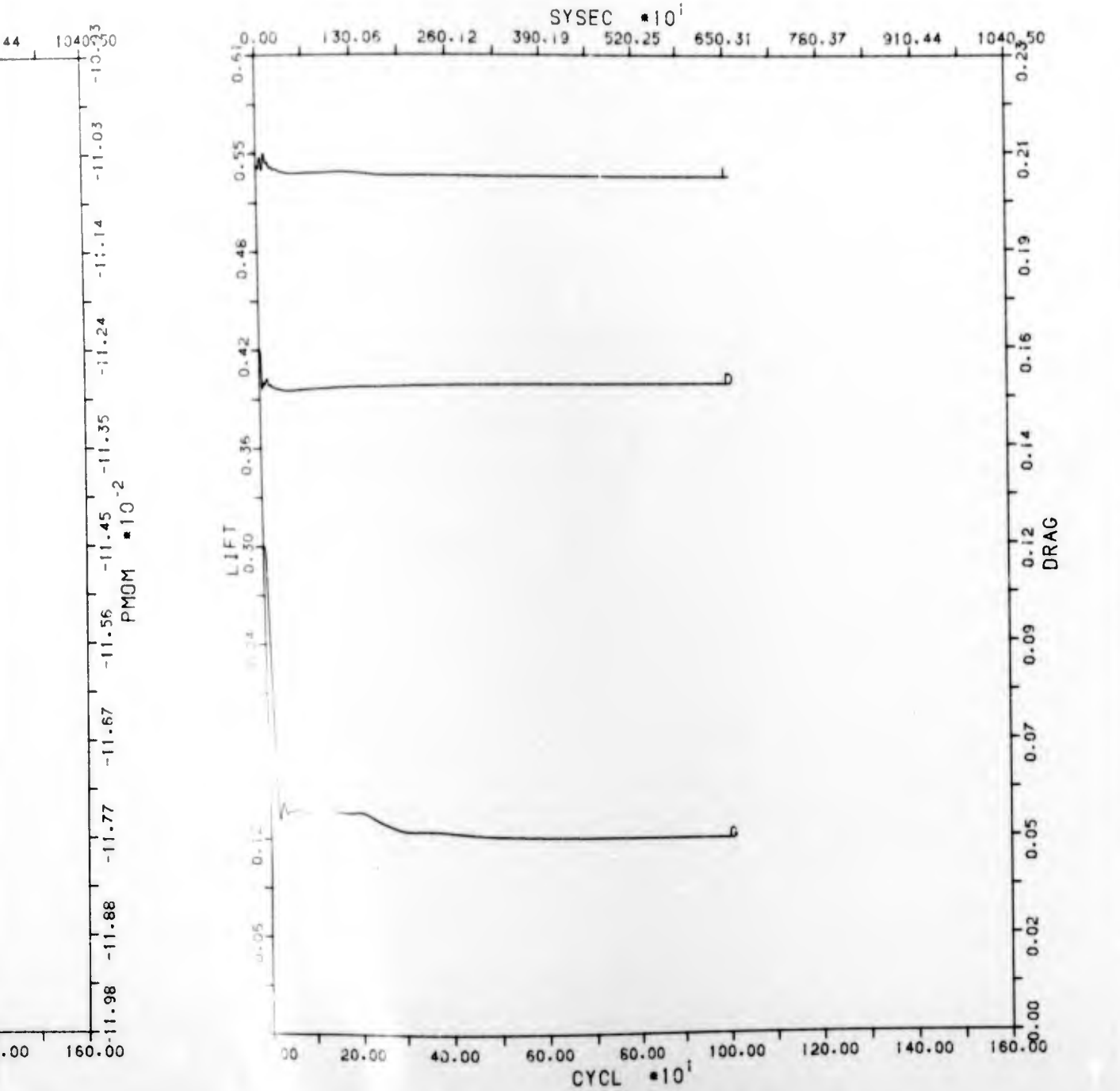




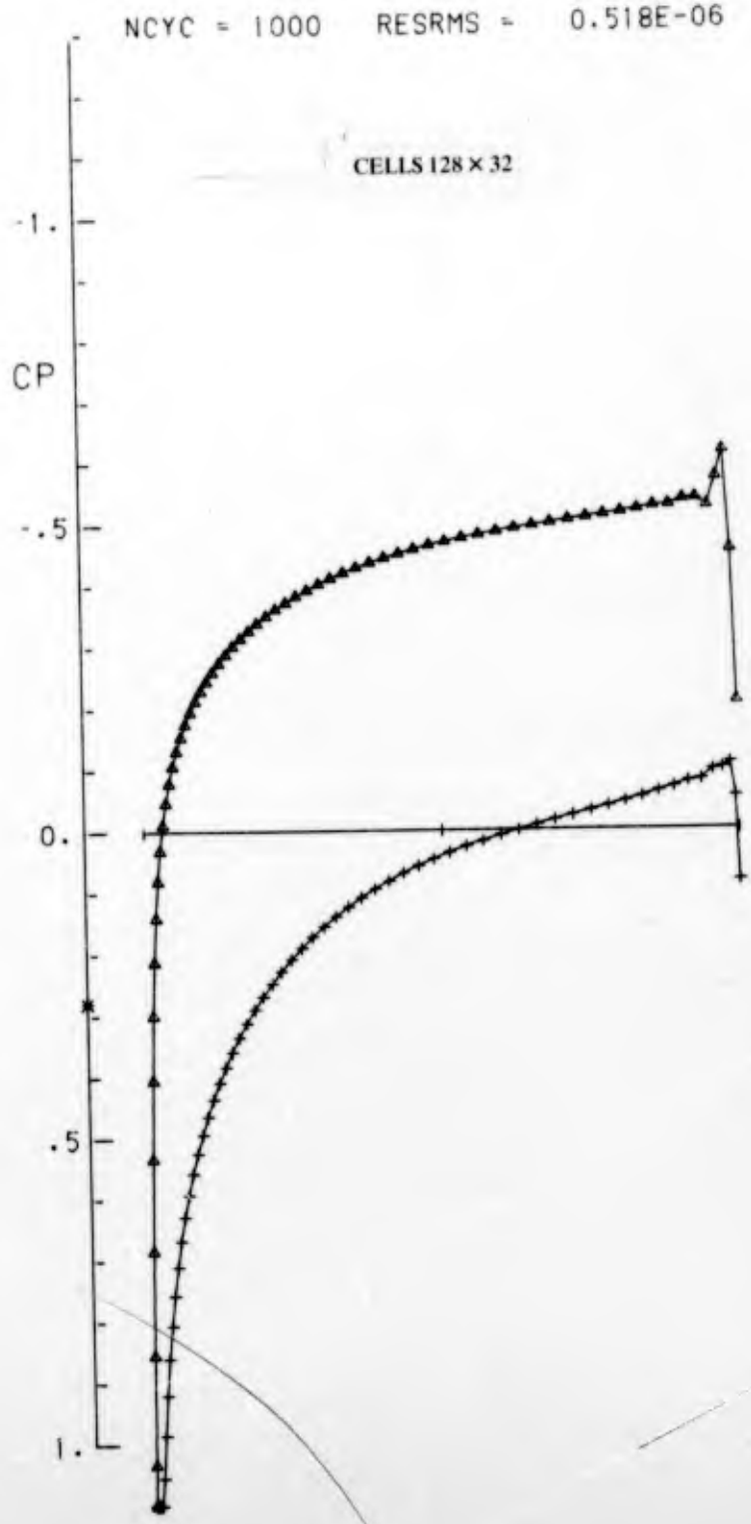
F.F.A.	AR 211		A.Rizzi	05-8-8
	NACA 0012: MACH = 1.2, ALPHA = 7			

HX NO5 BAS BAS4 .05 0. .01

CELLS 64X16
RESAE 0.122E-06
DRAG 0.154E+00
RESMX -0.477E-06 35 10



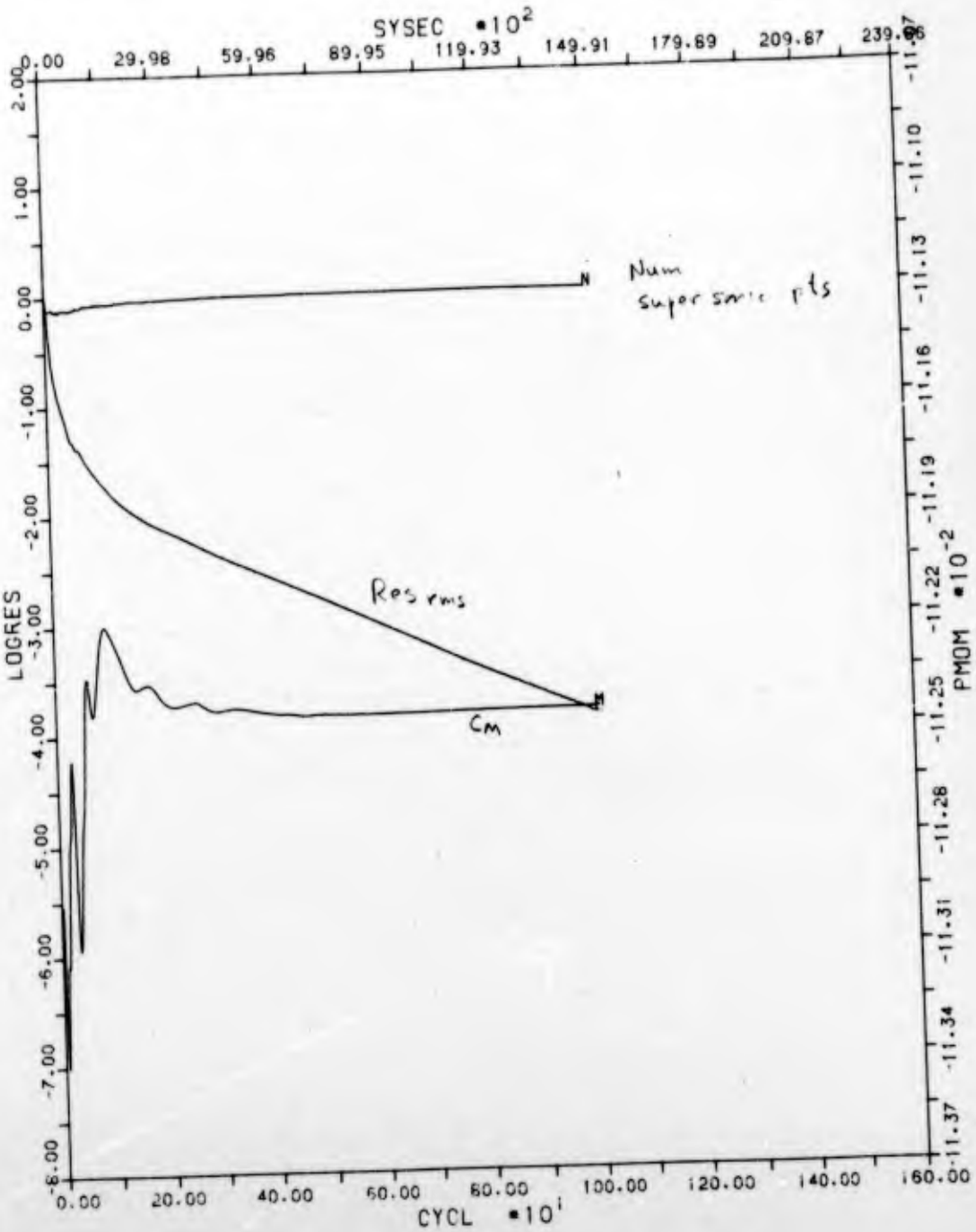
F.F.A.	AR 211		A.Rizzi	
	NACA 0012: MACH = 1.2, ALPHA = 7			



15 JUN AFVTOQO INVOR OUTTOQO MSHX N05 BAS BAS4 .05

C_m	PITCH	-0.112	T GCIRC	0.303	
	MACH	1.200	ALPHA	7.000	
	RATE	0.991	start RESAS	0.374E-02	
Num super pt	NSUP	2841	C_L LIFT	0.528E+00	
	CYCL	1000	SYSEC	0.150E+05	

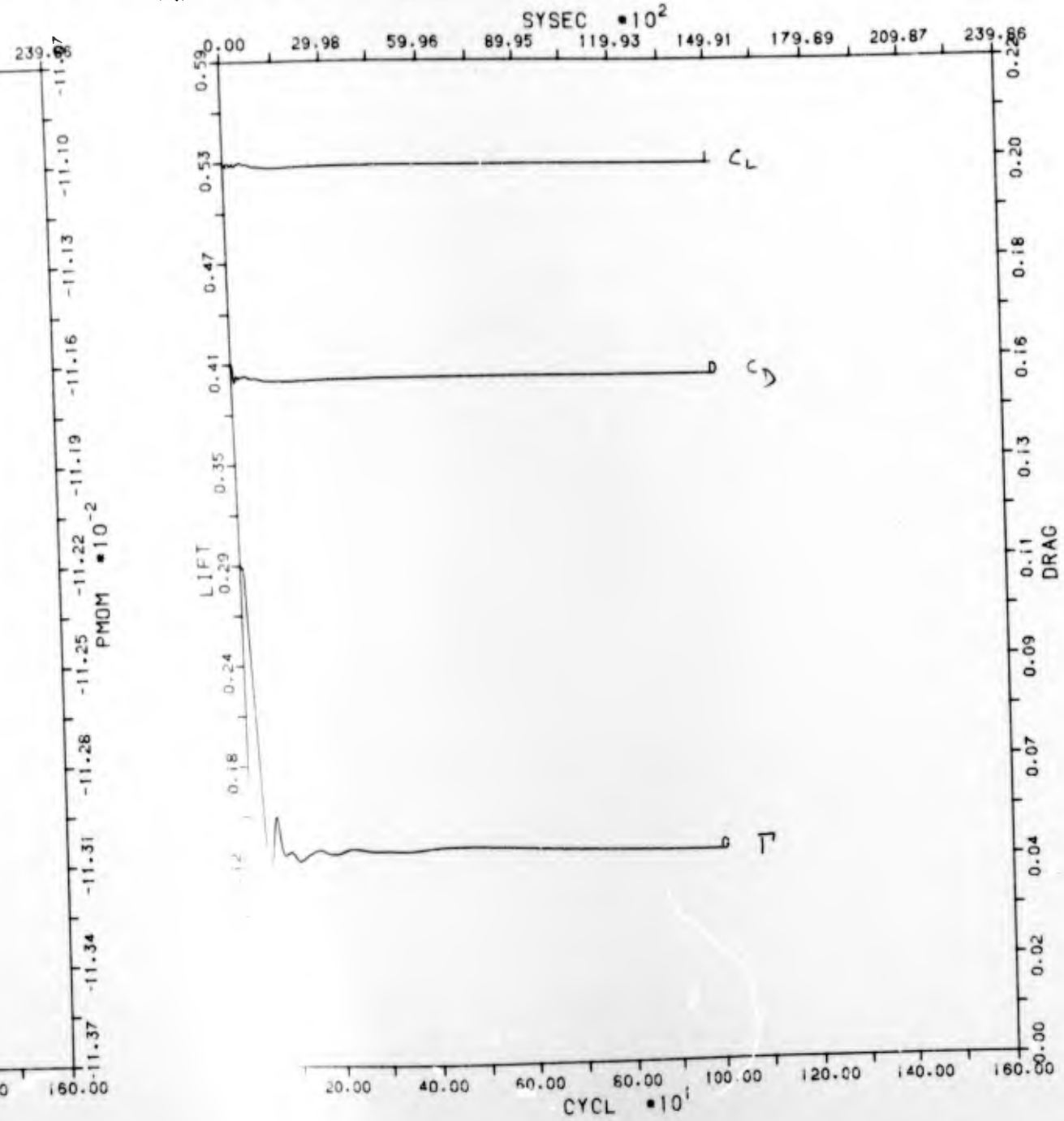
	CELLS	128X32
END	RESAE	0.518E
C_D	DRAG	0.154E
	RESMX	-0.322E
	max	



F.F.A.	AR 211		A.Rizzi	05-8-10
	NACA 0012: MACH = 1.2, ALPHA = 7			

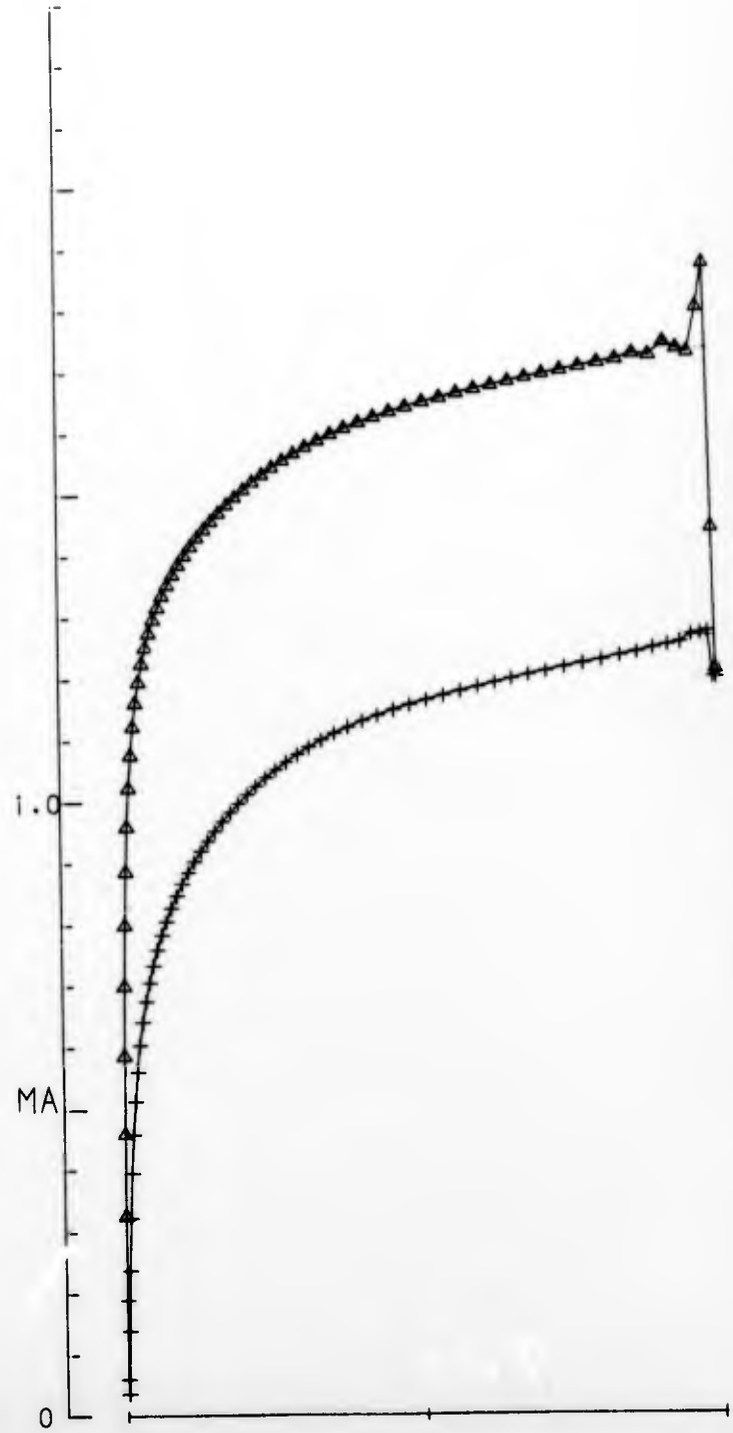
NO5 BAS BAS4 .05 0. .01

CELLS 128X32
END RESAE 0.518E-06
C_D DRAG 0.154E+00
RESMX -0.322E-05 73 20
max I J



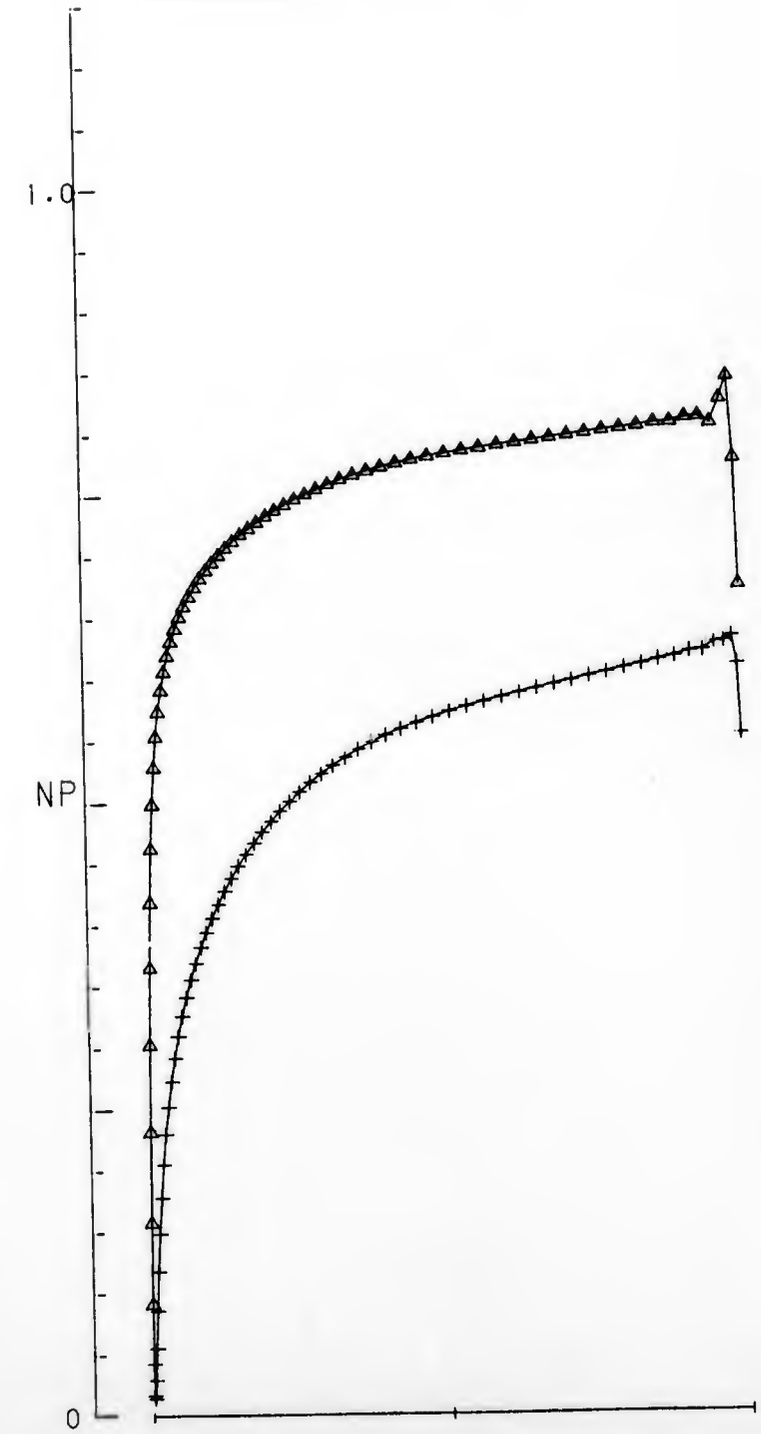
F.F.A.

P 2 MACH

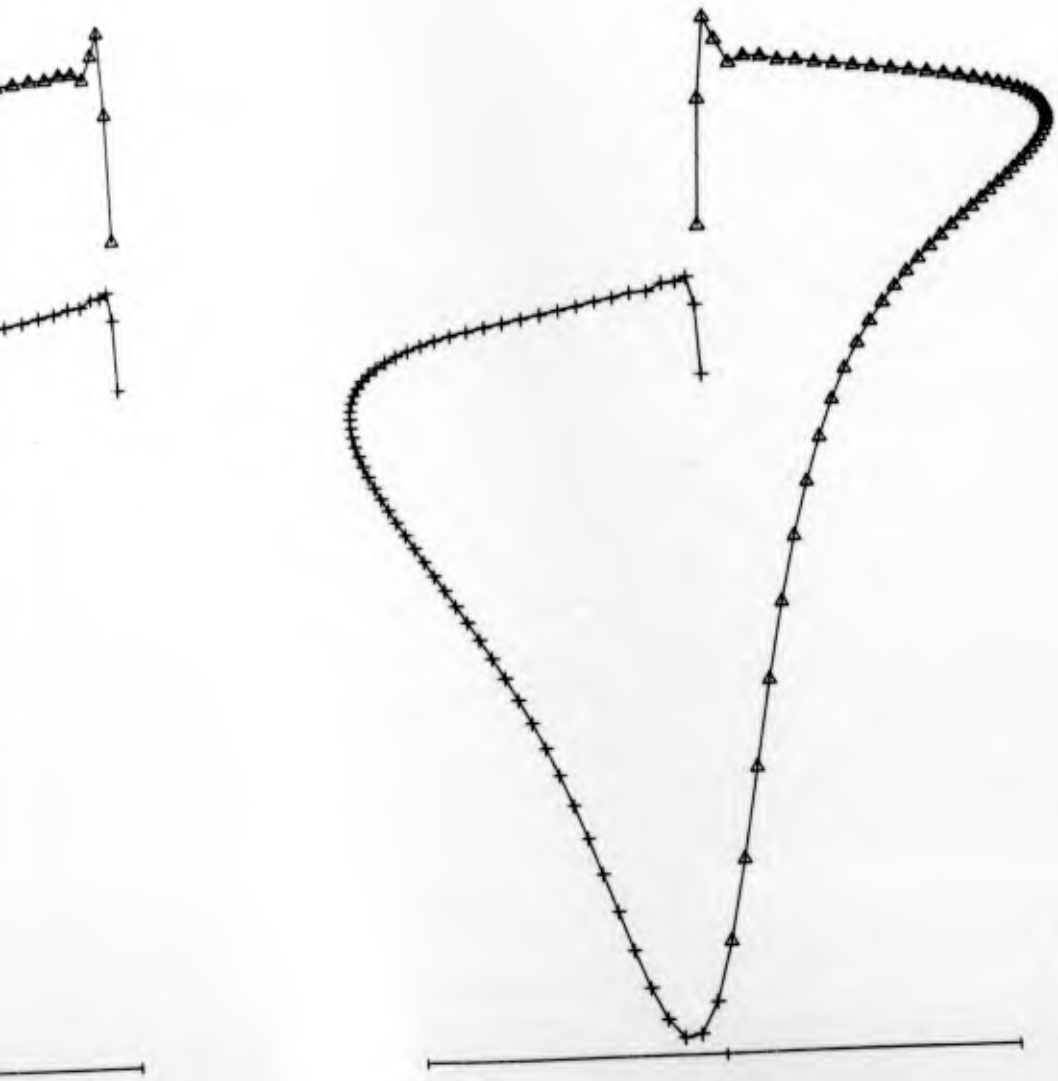


F.F.A.	AR 211		A.Rizzi	05-8-11
	NACA 0012: MACH = 1.2, ALPHA = 7			

F.F.A.

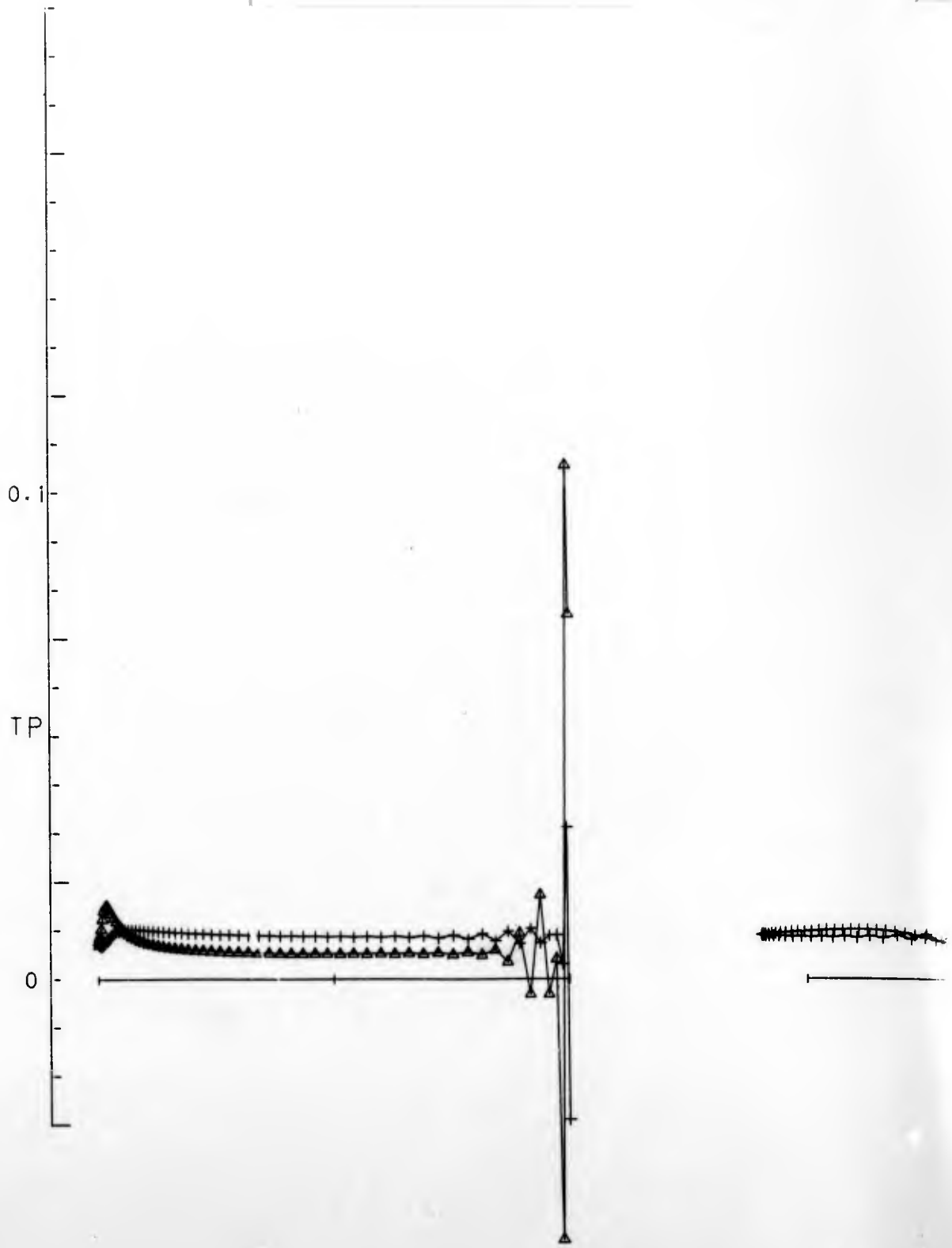


F.F.A.	AR 211		A.Rizzi	05-8-12
	NACA 0012: MACH = 1.2, ALPHA = 7			

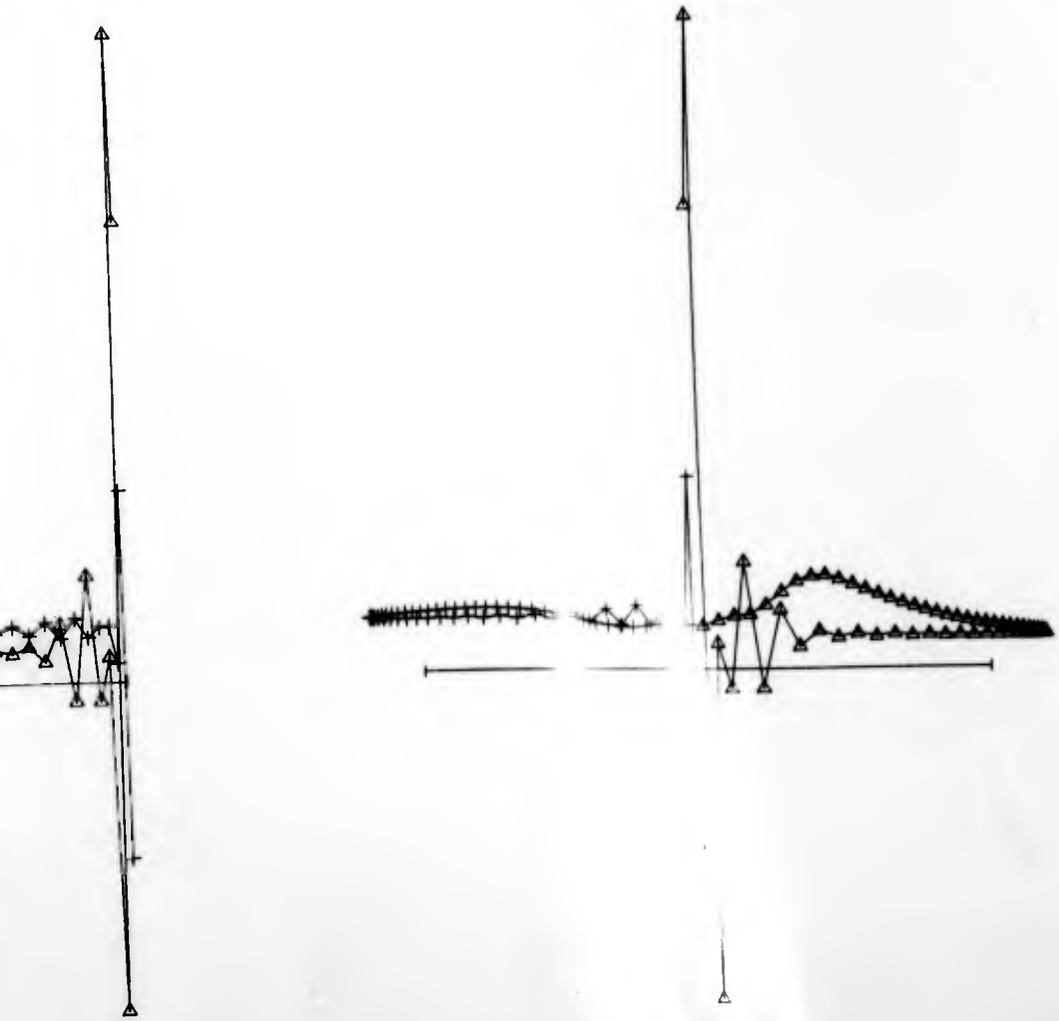


F.F.A.

P 3 TOTP 1-PI/PIINF

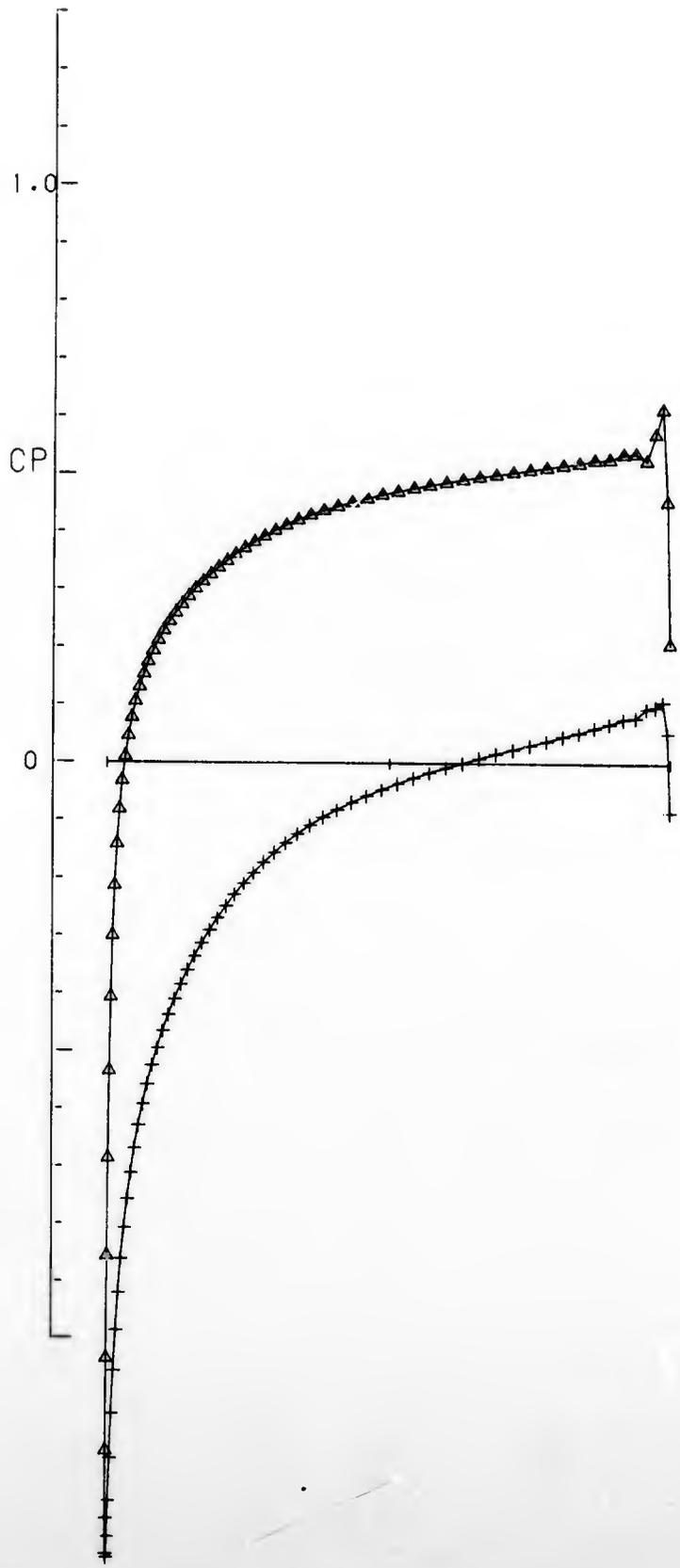


F.F.A.	AR 211		A.Rizzi	05-8-13
	NACA 0012: MACH = 1.2, ALPHA = 7			

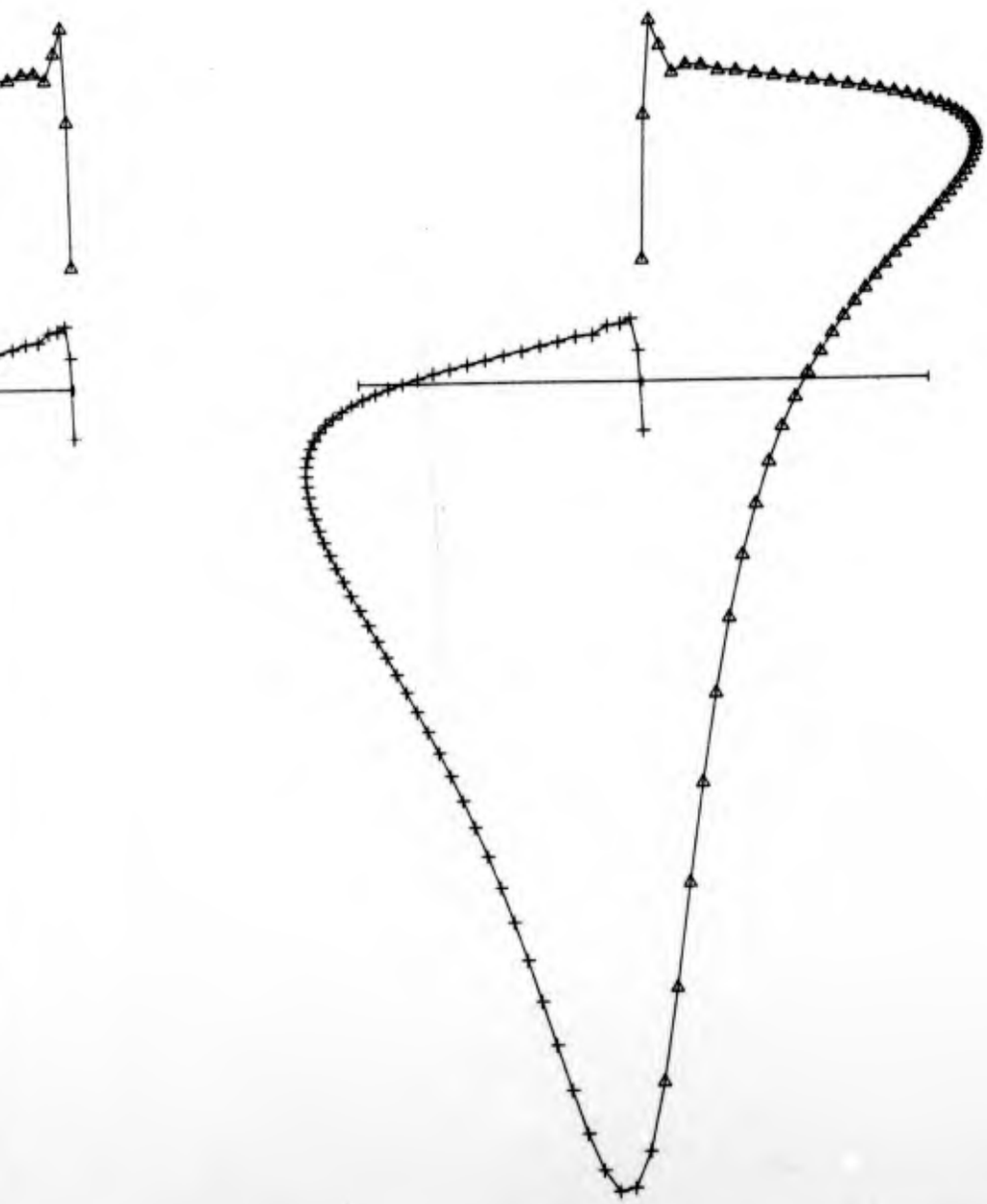


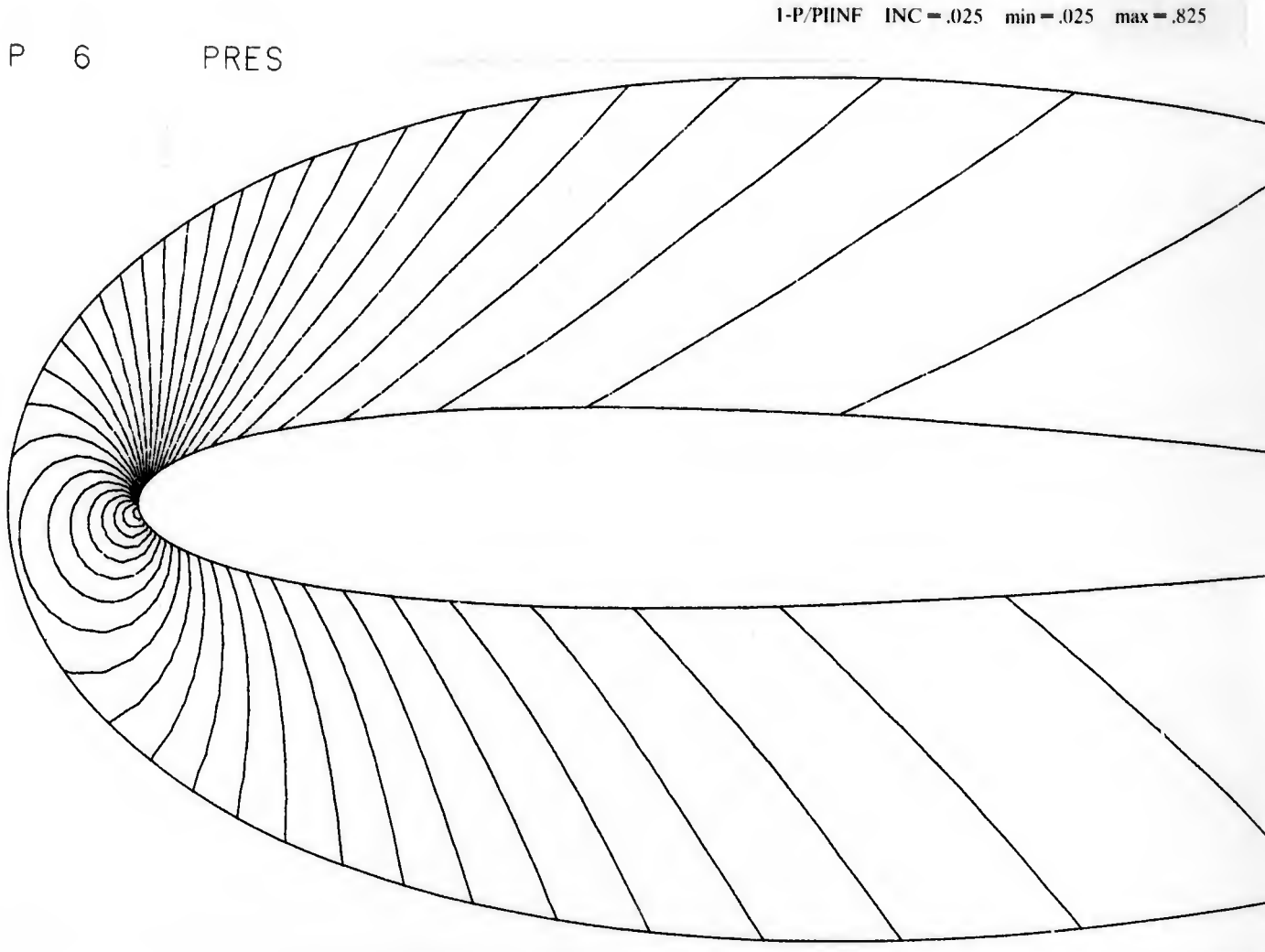
F.F.A.

P 4 COEP



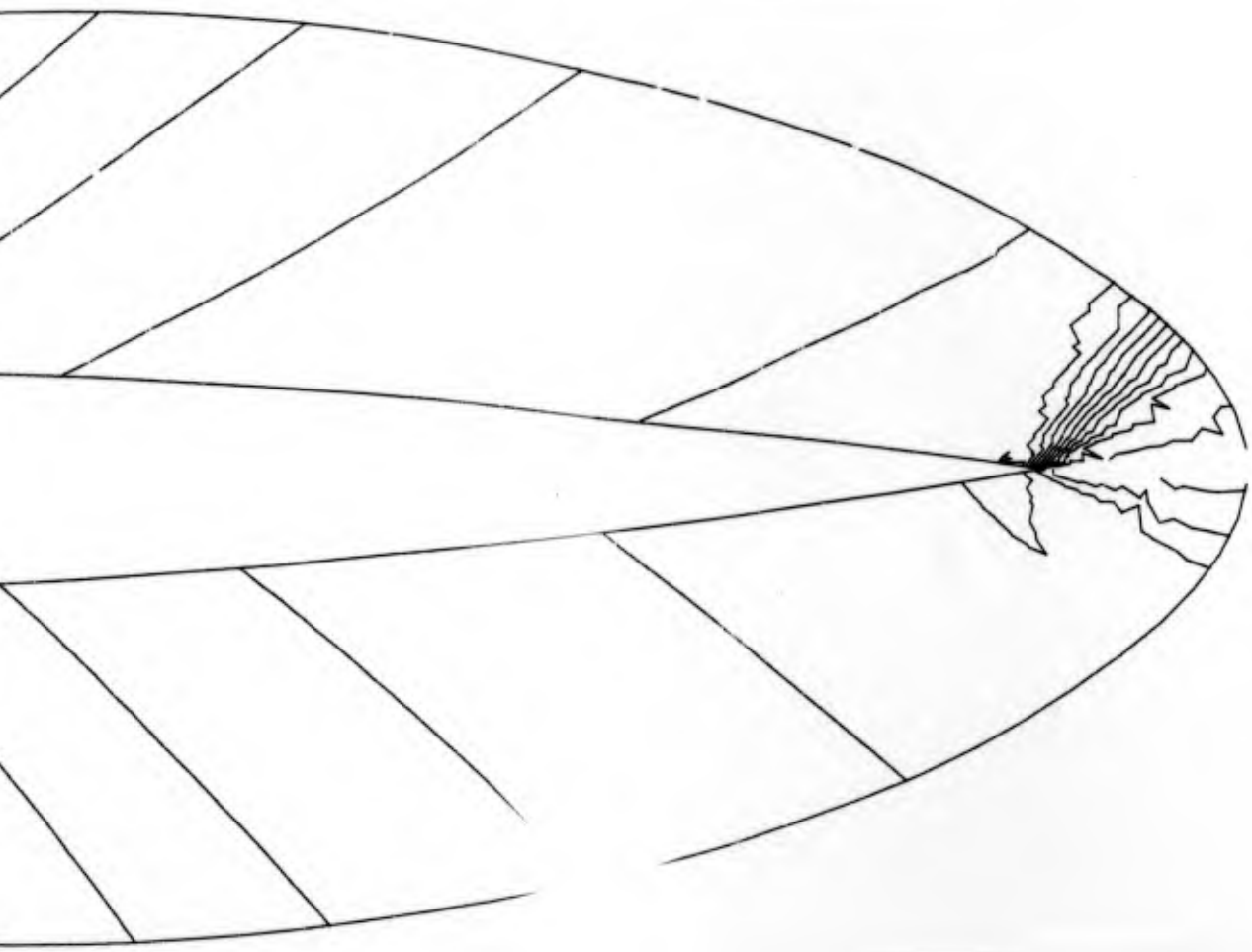
F.F.A.	AR 211		A.Rizzi	05-8-14
	NACA 0012: MACH = 1.2, ALPHA = 7			




1-P/PIINF INC = .025 min = .025 max = .825
P 6 PRES

F.F.A.	AR 211		A.Rizzi	05-8 5
	NACA 0012: MACH = 1.2, ALPHA = 7			

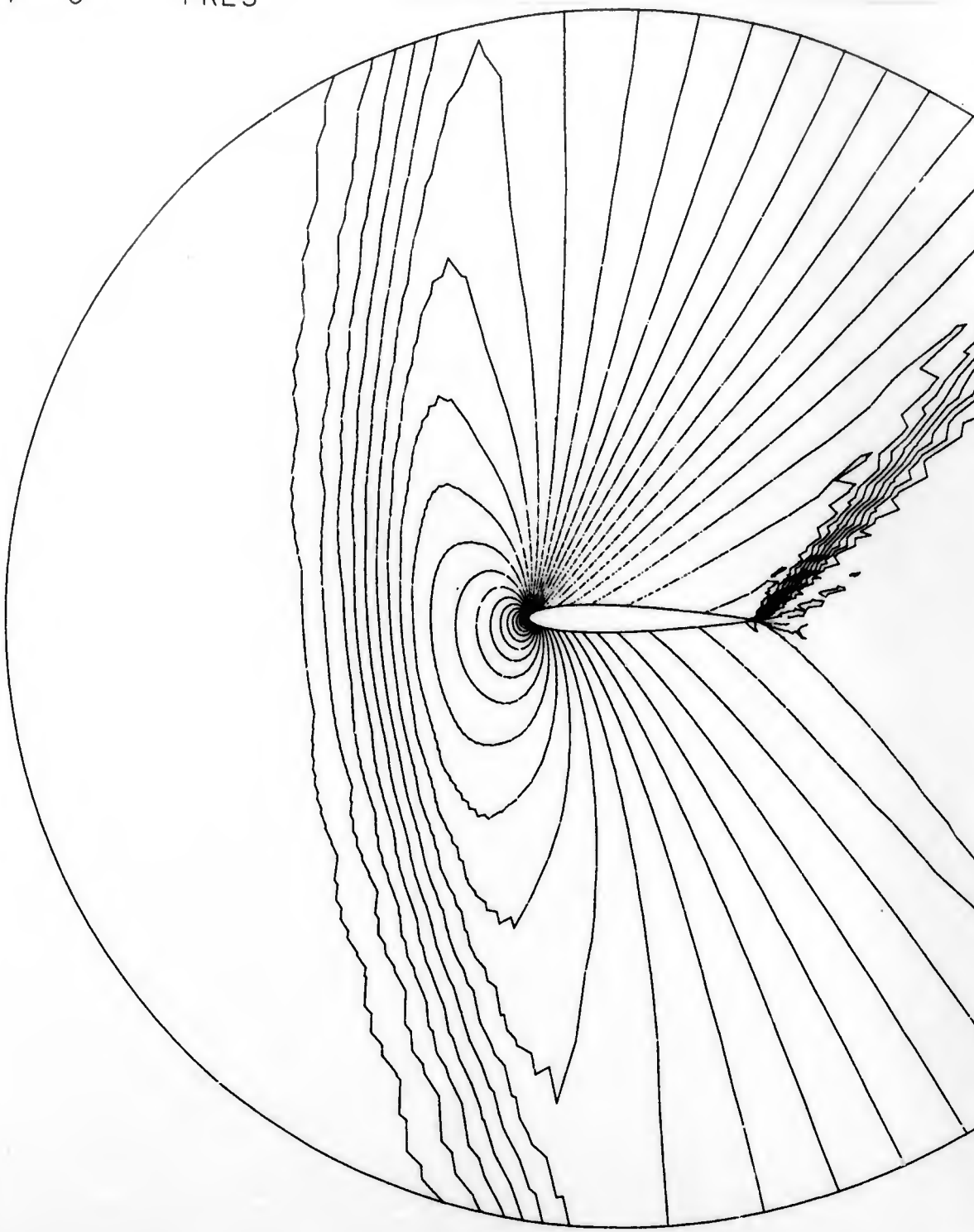
P/PIINF INC = .025 min = .025 max = .825



F.F.A.

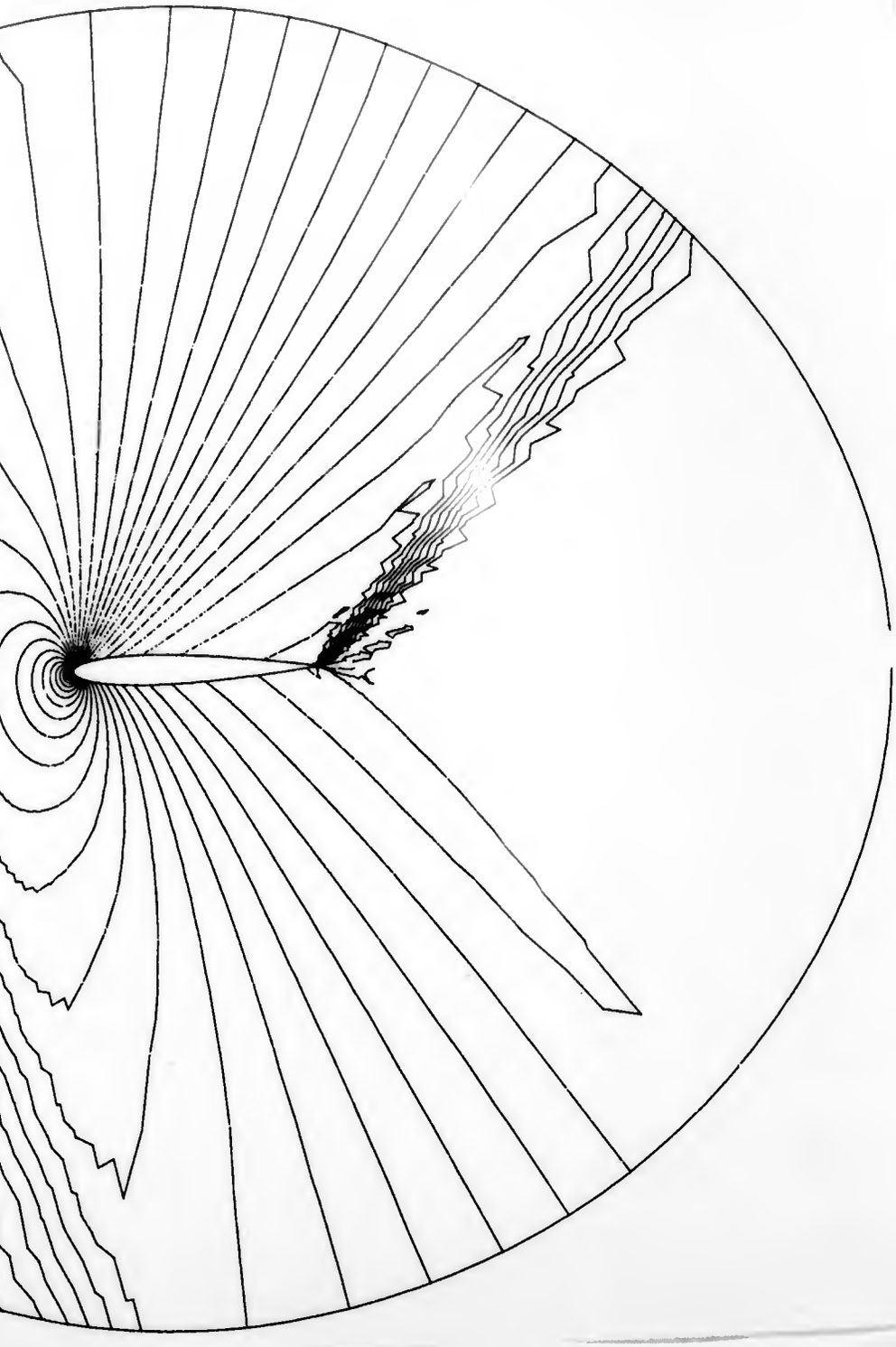
1-P/PIINF INC = .025 min = .025 max = .825

P 5 PRES



F.F.A.	AR 211		A.Rizzi	05-8-16
	NACA 0012: MACH = 1.2, ALPHA = 7			

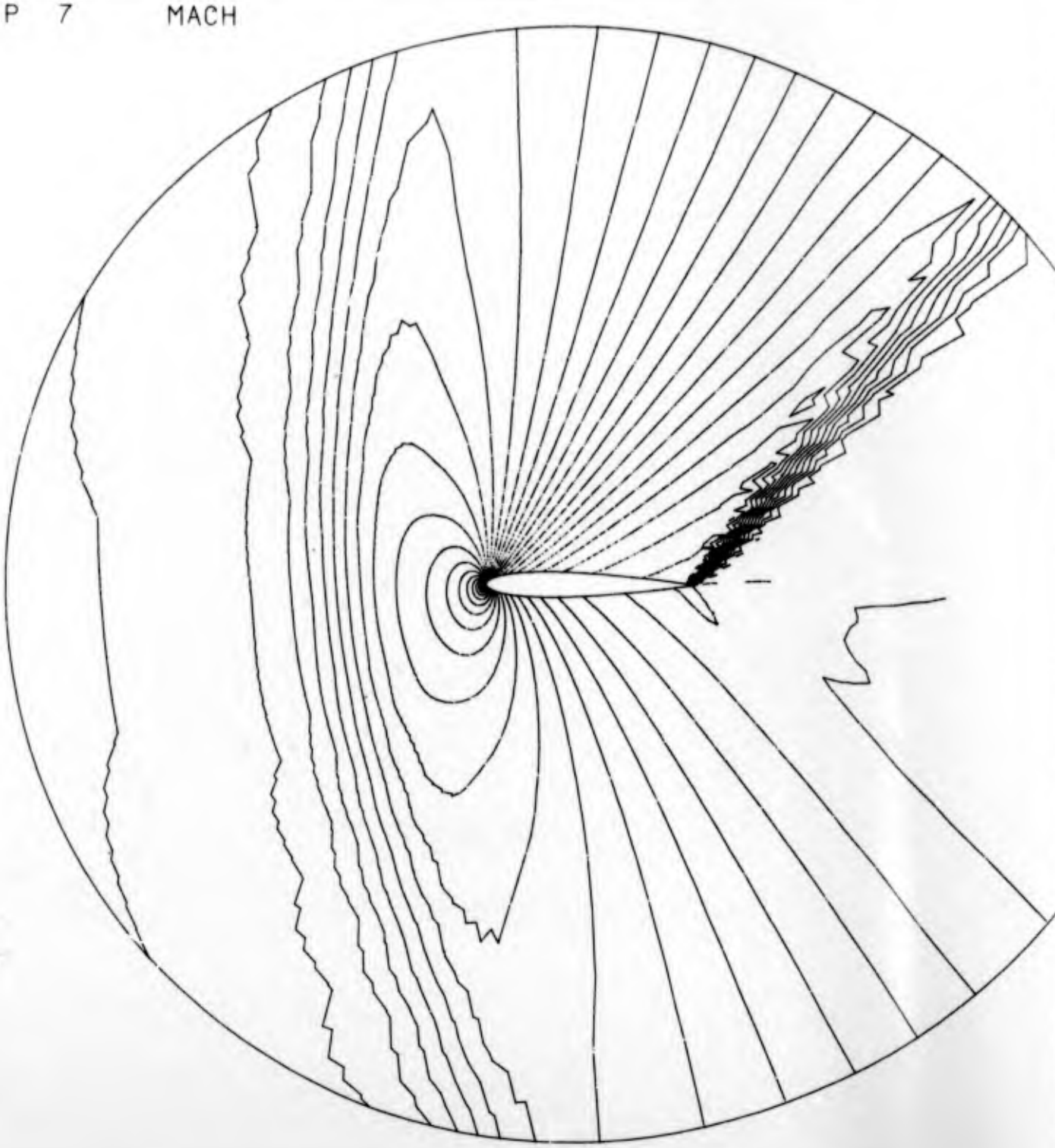
/PIINF INC = .025 min = .025 max = .825



F.F.A.

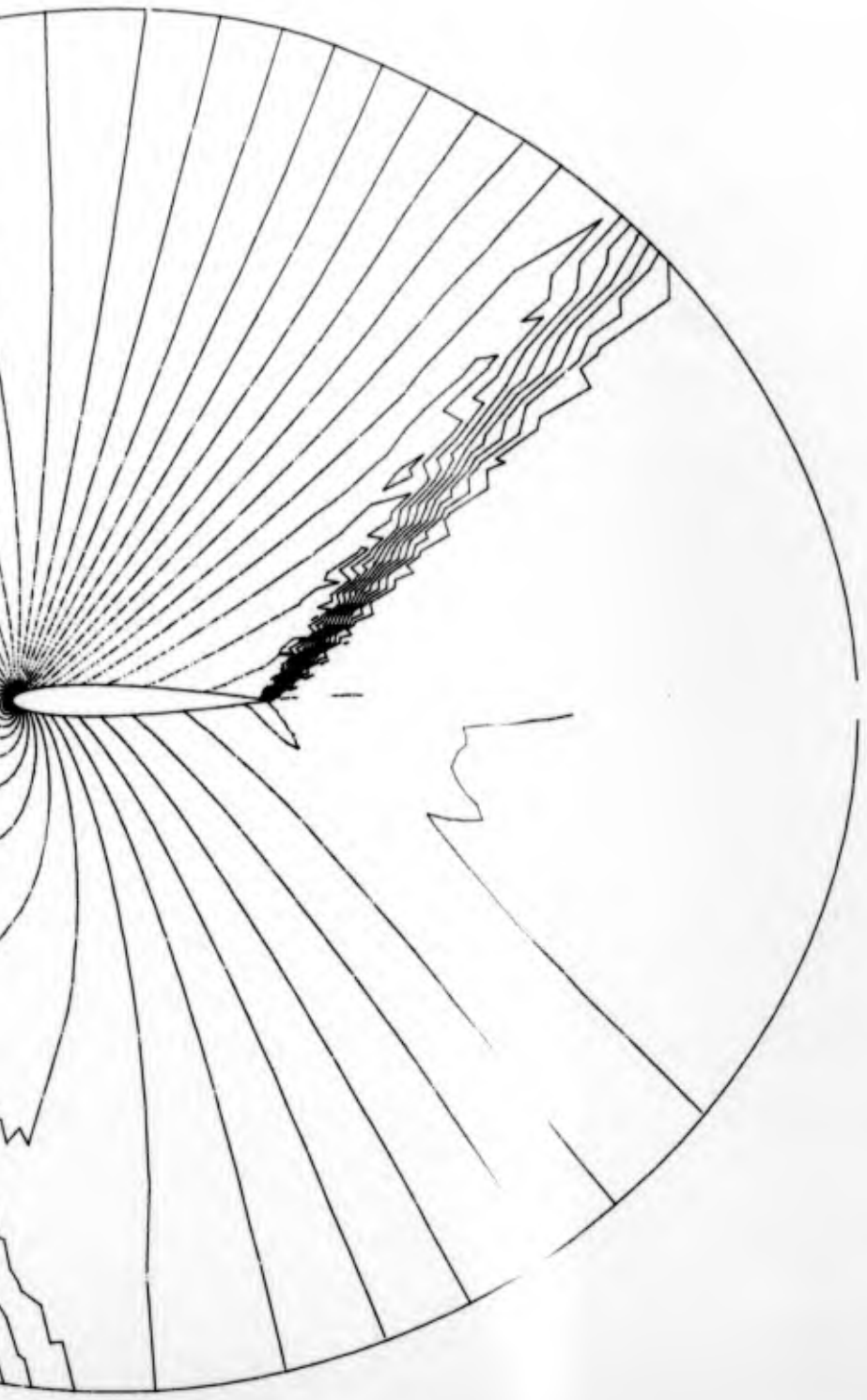
INC = .05 min = .05 max = 1.85

P 7 MACH



F.F.A.	AR 211		A.Rizzi	05-8-17
	NACA 0012 MACH = 1.2, ALPHA = 7			

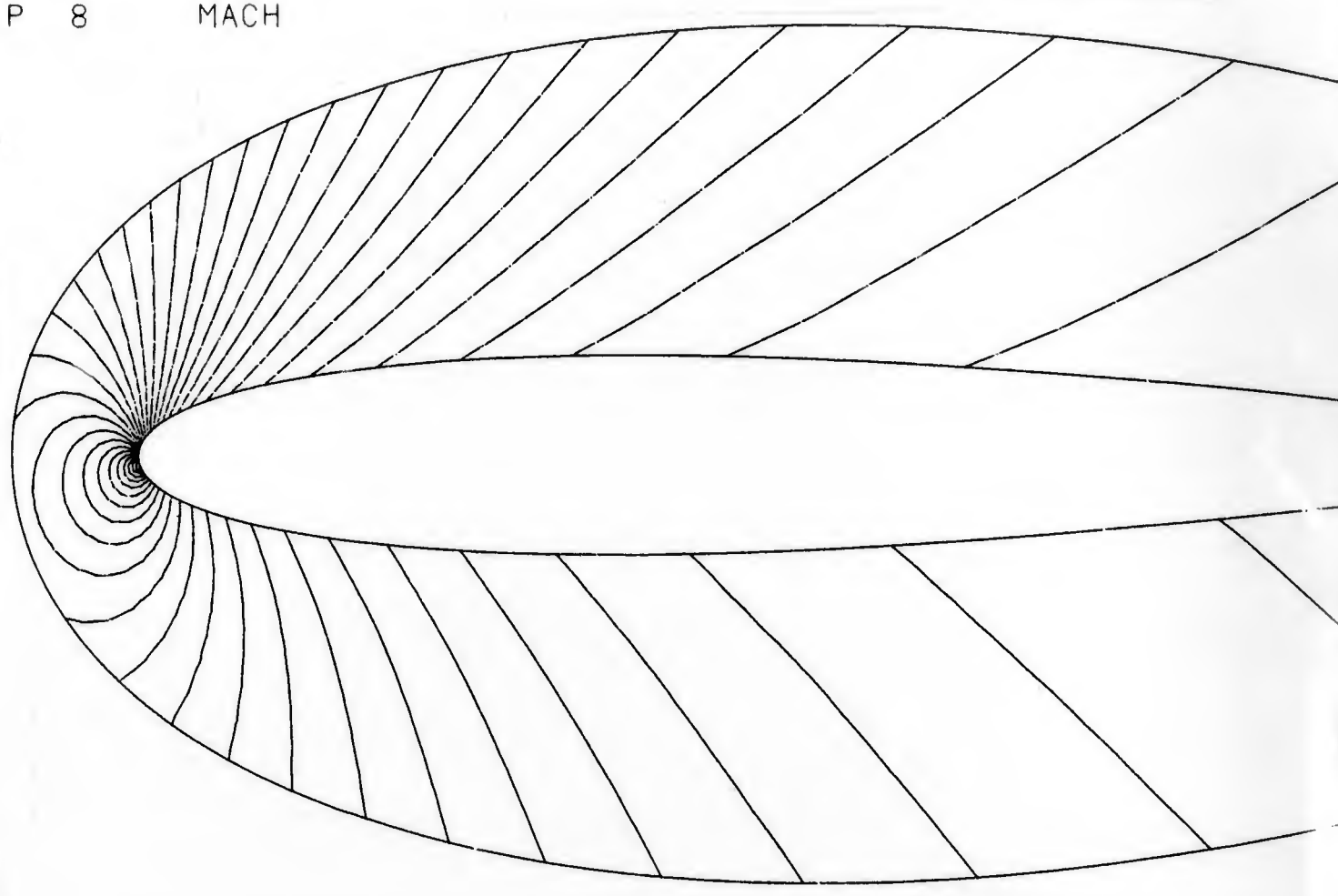
NC = .05 min = .05 max = 1.85



F.F.A.

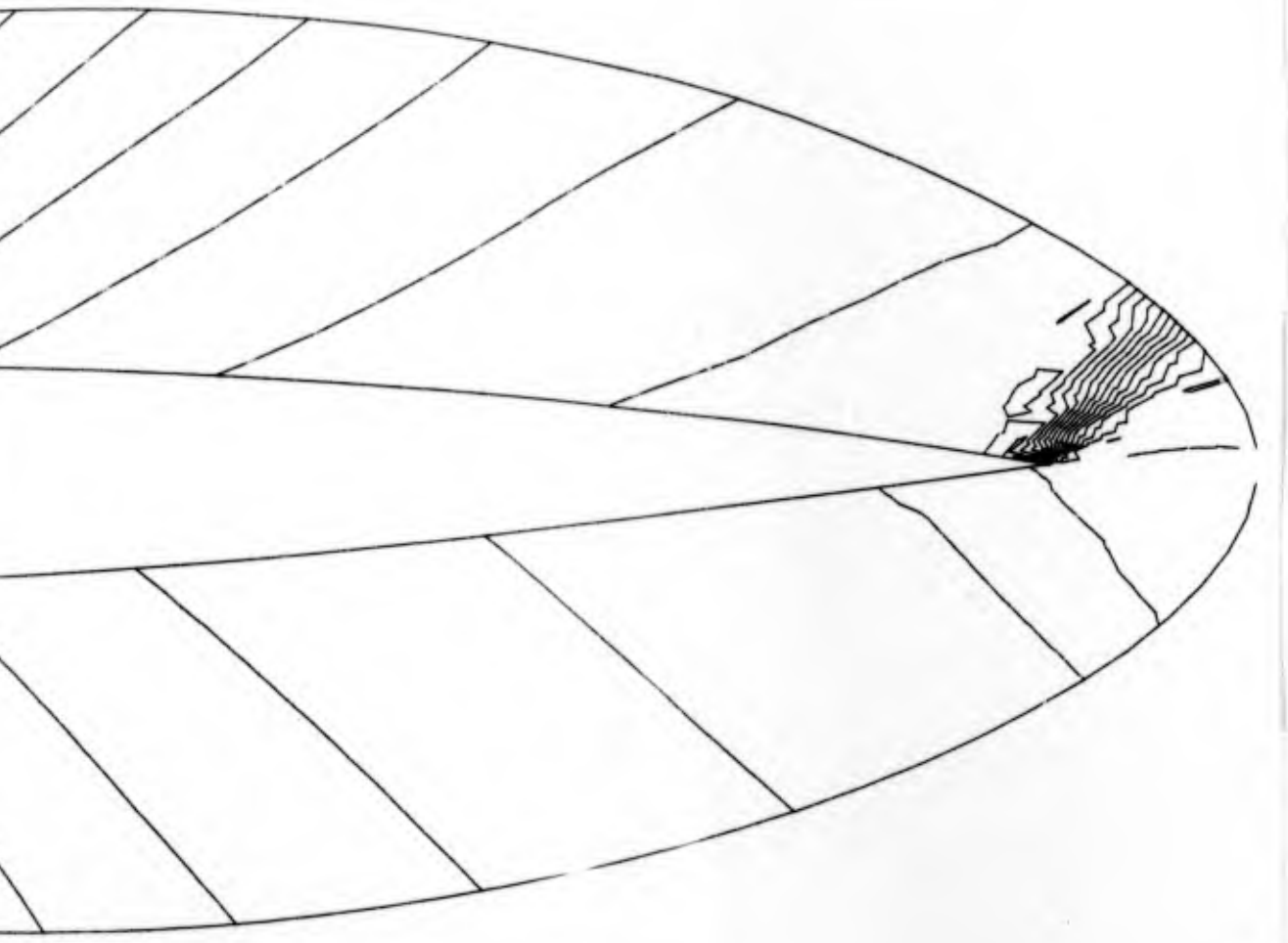
INC = .05 min = .05 max = 1.85

P 8 MACH



F.F.A.	AR 211		A.Rizzi	05-8-18
	NACA 0012: MACH = 1.2, ALPHA = 7			

INC = .05 min = .05 max = 1.85



F.F.A.

1-PI/PIINF INC = .005 min = −.05 max = .15

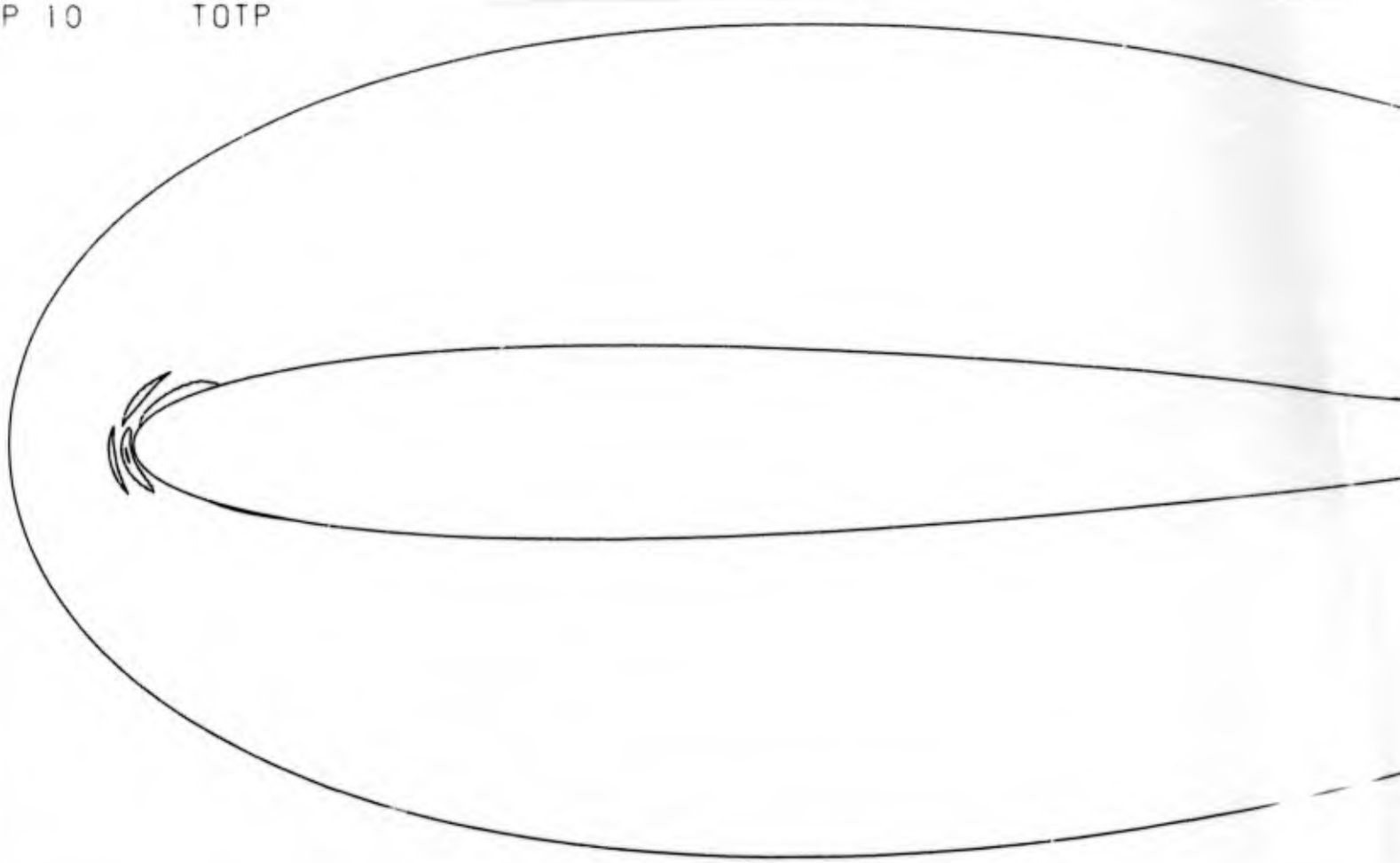
F.F.A.	AR 211		A.Rizzi	05-8-19
	NACA 0012: MACH = 1.2, ALPHA = 7			

NF INC = .005 min = −.05 max = .15

F.F.A.

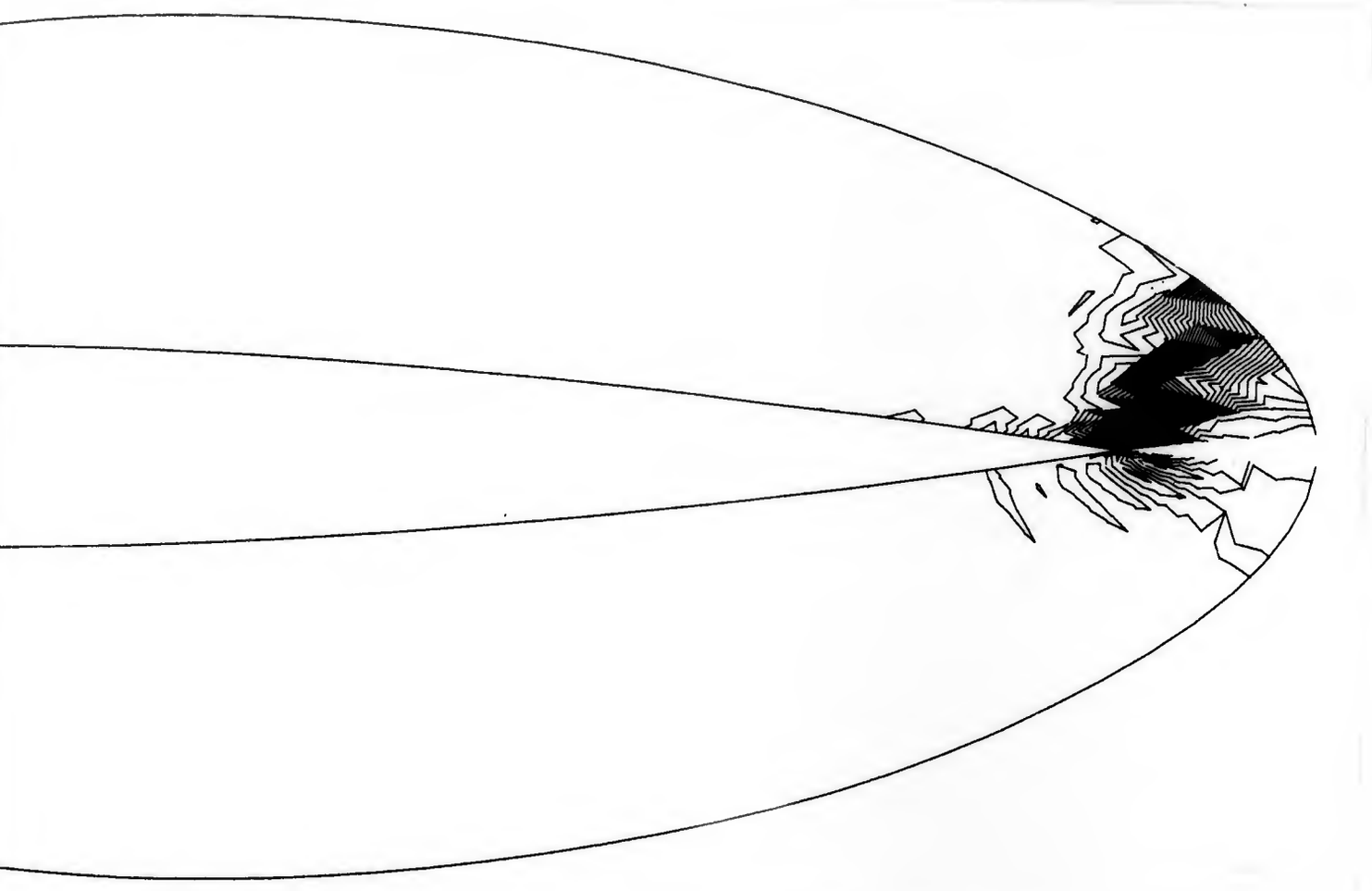
1-PI/PIINF INC = .005 min = −.05 max = .15

P 10 TOTP



F.F.A.	AR 211		A.Rizzi	05-8-20
	NACA 0012: MACH = 1.2, ALPHA = 7			

1-PI/PIINF INC = .005 min = −.05 max = .15



AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 05

NACA 0012: MACH = 1.2, ALPHA = 7

Contributor No 9

W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-1
	NACA 0012: MACH = 1.2, ALPHA = 7			

N	X/C(%)	Z/C(%)	1-P/PIINF	CP	MACH	1-PI/PIINF
2	99.992828	-Ø.ØØ1ØØØ	Ø.35Ø145	Ø.571303	Ø.78Ø297	Ø.Ø28413
3	99.965897	-Ø.ØØ4846	Ø.584395	Ø.ØØ7764	1.148386	Ø.Ø57Ø16
4	99.914658	-Ø.Ø12110	Ø.617343	-Ø.Ø71499	1.248738	Ø.Ø10476
5	99.840439	-Ø.Ø22620	Ø.635068	-Ø.114140	1.281499	Ø.Ø13ØØ7
6	99.744003	-Ø.Ø36276	Ø.637913	-Ø.12Ø985	1.298296	-Ø.ØØØ926
7	99.625946	-Ø.Ø52983	Ø.642525	-Ø.132Ø81	1.3ØØ531	Ø.ØØ8814
8	99.486725	-Ø.Ø72632	Ø.637922	-Ø.121ØØ7	1.297182	Ø.ØØØ614
9	99.326721	-Ø.Ø95145	Ø.639199	-Ø.124Ø8Ø	1.294510	Ø.ØØ7745
10	99.146286	-Ø.12Ø481	Ø.638081	-Ø.121390	1.296046	Ø.ØØ2593
11	98.945786	-Ø.148593	Ø.638379	-Ø.122105	1.294154	Ø.ØØ597Ø
12	98.725494	-Ø.179389	Ø.637607	-Ø.12Ø249	1.294155	Ø.ØØ3846
13	98.485703	-Ø.212798	Ø.637395	-Ø.119739	1.292698	Ø.ØØ5233
14	98.226700	-Ø.248813	Ø.637050	-Ø.118910	1.292548	Ø.ØØ449Ø
15	97.948761	-Ø.287339	Ø.636540	-Ø.117683	1.291290	Ø.ØØ4789
16	97.652130	-Ø.328249	Ø.635876	-Ø.116Ø85	1.29ØØ17	Ø.ØØ4691
17	97.337082	-Ø.371551	Ø.635554	-Ø.115311	1.289216	Ø.ØØ4892
18	97.ØØ3891	-Ø.417216	Ø.635127	-Ø.114283	1.288485	Ø.ØØ47Ø9
19	96.652786	-Ø.465119	Ø.634519	-Ø.112820	1.287183	Ø.ØØ4805
20	96.284027	-Ø.515193	Ø.633924	-Ø.111388	1.285965	Ø.ØØ4829
21	95.897858	-Ø.567350	Ø.633347	-Ø.11ØØØØ	1.284798	Ø.ØØ4832
22	95.494553	-Ø.621635	Ø.632709	-Ø.1Ø8465	1.283514	Ø.ØØ4827
23	95.Ø74341	-Ø.677854	Ø.632Ø55	-Ø.1Ø6892	1.282181	Ø.ØØ4852
24	94.637466	-Ø.735998	Ø.631464	-Ø.1Ø5471	1.28Ø967	Ø.ØØ4885
25	94.184219	-Ø.796Ø38	Ø.63Ø926	-Ø.1ø 176	1.279869	Ø.ØØ49Ø9
26	93.714828	-Ø.857Ø03	Ø.63Ø293	-Ø.1Ø2Ø55	1.278616	Ø.ØØ4887
27	93.229553	-Ø.921482	Ø.629541	-Ø.1ØØ844	1.277Ø98	Ø.ØØ49Ø1
28	92.728638	-Ø.986685	Ø.628755	-Ø.Ø98953	1.275514	Ø.ØØ4916
29	92.212341	-1.Ø53459	Ø.628Ø35	-Ø.Ø97222	1.274Ø53	Ø.ØØ4948
30	91.680923	-1.121780	Ø.627383	-Ø.Ø95654	1.272742	Ø.ØØ496Ø
31	91.134644	-1.191594	Ø.626712	-Ø.Ø94Ø4Ø	1.271405	Ø.ØØ496Ø
32	9Ø.573761	-1.262822	Ø.626ØØØ	-Ø.Ø92325	1.269970	Ø.ØØ4982
33	89.998535	-1.335393	Ø.625246	-Ø.Ø9Ø511	1.268467	Ø.ØØ4988
34	89.4Ø9225	-1.4Ø9214	Ø.624416	-Ø.Ø88516	1.266830	Ø.ØØ4975
35	88.8Ø6Ø91	-1.484191	Ø.623588	-Ø.Ø86524	1.265163	Ø.ØØ5Ø12
36	88.189407	-1.56Ø317	Ø.622892	-Ø.Ø84849	1.263750	Ø.ØØ5Ø58
37	87.559418	-1.637572	Ø.622191	-Ø.Ø83163	1.262390	Ø.ØØ5Ø26
38	86.916428	-1.715837	Ø.621362	-Ø.Ø81169	1.26Ø754	Ø.ØØ5Ø27
39	86.26Ø666	-1.795Ø19	Ø.62Ø523	-Ø.Ø79150	1.259070	Ø.ØØ5Ø65
40	85.592407	-1.875Ø83	Ø.619735	-Ø.Ø77255	1.257514	Ø.ØØ5Ø75
41	84.911942	-1.955977	Ø.618948	-Ø.Ø75361	1.255963	Ø.ØØ5Ø79
42	84.219528	-2.Ø37631	Ø.618129	-Ø.Ø73390	1.254353	Ø.ØØ5Ø84
43	83.515427	-2.119970	Ø.617292	-Ø.Ø71378	1.252707	Ø.ØØ5Ø93
44	82.799927	-2.2Ø2941	Ø.616479	-Ø.Ø69422	1.251101	Ø.ØØ5113
45	82.Ø73288	-2.286501	Ø.615693	-Ø.Ø67530	1.249557	Ø.ØØ5124
46	81.335815	-2.37Ø6ØØ	Ø.614904	-Ø.Ø65633	1.248013	Ø.ØØ5133
47	8Ø.587753	-2.455165	Ø.614077	-Ø.Ø63643	1.246401	Ø.ØØ5133
48	79.829376	-2.54Ø112	Ø.613211	-Ø.Ø61559	1.244711	Ø.ØØ5141
49	79.Ø6Ø974	-2.625375	Ø.612353	-Ø.Ø59495	1.243030	Ø.ØØ516Ø
50	78.282837	-2.71Ø91Ø	Ø.611520	-Ø.Ø57491	1.241405	Ø.ØØ5171
51	77.495209	-2.796670	Ø.61Ø688	-Ø.Ø55490	1.239789	Ø.ØØ5179
52	76.698410	-2.882581	Ø.6Ø9810	-Ø.Ø53378	1.238098	Ø.ØØ5171
53	75.892685	-2.968552	Ø.6Ø8900	-Ø.Ø51188	1.236333	Ø.ØØ5182
54	75.Ø78339	-3.Ø54547	Ø.6Ø8Ø57	-Ø.Ø49159	1.234680	Ø.ØØ5219
55	74.255630	-3.14Ø560	Ø.6Ø7253	-Ø.Ø47225	1.233136	Ø.ØØ5214
56	73.424866	-3.226509	Ø.6Ø6385	-Ø.Ø45138	1.231475	Ø.ØØ52Ø5
57	72.586319	-3.312301	Ø.6Ø5485	-Ø.Ø42972	1.229727	Ø.ØØ5234
58	71.740265	-3.397891	Ø.6Ø4591	-Ø.Ø4Ø823	1.228009	Ø.ØØ524Ø
59	7Ø.887009	-3.483205	Ø.6Ø3655	-Ø.Ø38571	1.226229	Ø.Ø15226
60	7Ø.Ø26794	-3.568157	Ø.6Ø2713	-Ø.Ø363Ø3	1.224409	Ø.ØØ525Ø
61	69.159943	-3.652738	Ø.6Ø1847	-Ø.Ø3422Ø	1.222733	Ø.ØØ5285
62	68.286728	-3.736912	Ø.6ØØ944	-Ø.Ø32Ø49	1.221Ø35	Ø.ØØ5256
63	67.4Ø7440	-3.82Ø54Ø	Ø.599915	-Ø.Ø29573	1.219Ø83	Ø.ØØ525Ø
64	66.522354	-3.9Ø3537	Ø.598898	-Ø.Ø27125	1.217124	Ø.ØØ5287
65	65.631760	-3.985905	Ø.597967	-Ø.Ø24888	1.215350	Ø.ØØ53Ø2
66	64.735947	-4.Ø67623	Ø.597Ø54	-Ø.Ø22689	1.213616	Ø.ØØ53Ø7
67	63.835220	-4.148601	Ø.596Ø44	-Ø.Ø2Ø261	1.211720	Ø.ØØ5291
68	62.929840	-4.228698	Ø.594916	-Ø.Ø17547	1.2Ø9595	Ø.ØØ5288
69	62.Ø2Ø111	-4.3Ø7839	Ø.593814	-Ø.Ø14895	1.2Ø7489	Ø.ØØ5329
70	61.1Ø63Ø8	-4.386Ø3Ø	Ø.592782	-Ø.Ø12412	1.2Ø5544	Ø.ØØ5335
71	6Ø.188751	-4.463216	Ø.591719	-Ø.ØØ9856	1.2Ø3557	Ø.ØØ5327
72	59.267700	-4.539302	Ø.59Ø59Ø	-Ø.ØØ7139	1.2Ø1433	Ø.ØØ5338
73	58.343460	-4.614206	Ø.589413	-Ø.ØØ43Ø9	1.199228	Ø.ØØ5344
74	57.416321	-4.687847	Ø.588189	-Ø.ØØ1362	1.196943	Ø.ØØ5343
75	56.486572	-4.76Ø140	Ø.586940	Ø.ØØ1641	1.194608	Ø.ØØ5358
76	55.554504	-4.831051	Ø.585722	Ø.ØØ4573	1.192321	Ø.ØØ5386
77	54.62Ø422	-4.9ØØ533	Ø.5844[illegible]	Ø.ØØ7598	1.19ØØØØ	Ø.ØØ5369
78	53.684616	-4.968453	Ø.583Ø76	Ø.Ø1Ø938	1.187440	Ø.ØØ5357
79	52.747375	-5.Ø34718	Ø.581673	Ø.Ø14312	1.184818	Ø.ØØ5395
80	51.8Ø8990	-5.Ø99324	Ø.58Ø329	Ø.Ø17546	1.182327	Ø.ØØ54Ø9

980767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-2
	NACA 0012: MACH = 1.2, ALPHA = 7			

81	50.869781	-5.162216	Ø.578929	Ø.020915	1.179763	Ø.005396
82	49.930008	-5.223271	Ø.577425	Ø.024531	1.176996	Ø.005403
83	48.990005	-5.282402	Ø.575861	Ø.028294	1.174120	Ø.005416
84	48.050049	-5.339531	Ø.574240	Ø.032195	1.171159	Ø.005415
85	47.110458	-5.394568	Ø.572564	Ø.036226	1.168099	Ø.005420
86	46.171509	-5.447458	Ø.570885	Ø.040264	1.165029	Ø.005442
87	45.233521	-5.498161	Ø.569182	Ø.044361	1.161938	Ø.005443
88	44.296783	-5.546580	Ø.567377	Ø.048706	1.158575	Ø.005435
89	43.361603	-5.592612	Ø.565486	Ø.053254	1.155250	Ø.005454
90	42.428284	-5.636191	Ø.563555	Ø.057900	1.151764	Ø.005463
91	41.497131	-5.677249	Ø.561557	Ø.062705	1.148177	Ø.005464
92	40.568451	-5.715693	Ø.559472	Ø.067721	1.144443	Ø.005467
93	39.642548	-5.751444	Ø.557317	Ø.072906	1.140589	Ø.005472
94	38.719727	-5.784445	Ø.555137	Ø.078150	1.136696	Ø.005490
95	37.800293	-5.814661	Ø.552932	Ø.083454	1.132771	Ø.005502
96	36.884567	-5.842010	Ø.550602	Ø.089060	1.128660	Ø.005487
97	35.972839	-5.866369	Ø.548127	Ø.095015	1.124288	Ø.005494
98	35.065430	-5.887674	Ø.545594	Ø.101109	1.119814	Ø.005516
99	34.162659	-5.905882	Ø.543005	Ø.107336	1.115276	Ø.005518
100	33.264816	-5.920918	Ø.540321	Ø.113794	1.110586	Ø.005519
101	32.372223	-5.932717	Ø.537561	Ø.120434	1.105765	Ø.005535
102	31.485199	-5.941235	Ø.534724	Ø.127259	1.100838	Ø.005542
103	30.604050	-5.946396	Ø.531761	Ø.134386	1.095718	Ø.005536
104	29.729080	-5.948131	Ø.528696	Ø.141760	1.090425	Ø.005549
105	28.860626	-5.946407	Ø.525579	Ø.149260	1.085058	Ø.005564
106	27.998978	-5.941193	Ø.522381	Ø.156952	1.079584	Ø.005568
107	27.144455	-5.932426	Ø.519058	Ø.164945	1.073914	Ø.005574
108	26.297394	-5.920048	Ø.515593	Ø.173283	1.068024	Ø.005577
109	25.458069	-5.904007	Ø.511996	Ø.181935	1.061928	Ø.005588
110	24.626831	-5.884267	Ø.508286	Ø.190860	1.055666	Ø.005597
111	23.803986	-5.860794	Ø.504464	Ø.200056	1.049239	Ø.005606
112	22.989822	-5.833555	Ø.500506	Ø.209577	1.042615	Ø.005609
113	22.184692	-5.802505	Ø.496393	Ø.219471	1.035760	Ø.005611
114	21.388901	-5.767619	Ø.492172	Ø.229627	1.028742	Ø.005623
115	20.602753	-5.728903	Ø.487901	Ø.239901	1.021667	Ø.005641
116	19.826538	-5.686358	Ø.483569	Ø.250323	1.014523	Ø.005649
117	19.060608	-5.639968	Ø.479105	Ø.261063	1.007189	Ø.005661
118	18.305237	-5.589691	Ø.474423	Ø.272326	Ø.999538	Ø.005657
119	17.560776	-5.535499	Ø.469506	Ø.284156	Ø.991527	Ø.005662
120	16.827515	-5.477386	Ø.464395	Ø.296449	Ø.983235	Ø.005668
121	16.105759	-5.415383	Ø.459167	Ø.309028	Ø.974768	Ø.005691
122	15.395823	-5.349519	Ø.453834	Ø.321857	Ø.966175	Ø.005705
123	14.697994	-5.279799	Ø.448347	Ø.335057	Ø.957374	Ø.005708
124	14.012589	-5.206223	Ø.442662	Ø.348733	Ø.948281	Ø.005721
125	13.339911	-5.128796	Ø.436746	Ø.362965	Ø.938860	Ø.005725
126	12.680262	-5.047531	Ø.430585	Ø.377788	Ø.929087	Ø.005728
127	12.033938	-4.962469	Ø.424245	Ø.393040	Ø.919043	Ø.005754
128	11.401228	-4.873669	Ø.417770	Ø.408616	Ø.908817	Ø.005783
129	10.782431	-4.781145	Ø.411006	Ø.424890	Ø.898213	Ø.005760
130	10.177848	-4.684890	Ø.403913	Ø.441952	Ø.887097	Ø.005773
131	9.587761	-4.584977	Ø.396646	Ø.459436	Ø.875706	Ø.005820
132	9.012450	-4.481469	Ø.389128	Ø.477522	Ø.864001	Ø.005819
133	8.452214	-4.374364	Ø.381221	Ø.496543	Ø.851718	Ø.005816
134	7.907336	-4.263697	Ø.372966	Ø.516403	Ø.838889	Ø.005848
135	7.378089	-4.149546	Ø.364392	Ø.537029	Ø.825601	Ø.005865
136	6.864746	-4.031963	Ø.355451	Ø.558538	Ø.811764	Ø.005883
137	6.367586	-3.910989	Ø.346056	Ø.581141	Ø.797249	Ø.005885
138	5.886880	-3.786671	Ø.336211	Ø.604825	Ø.782025	Ø.005907
139	5.422886	-3.659085	Ø.325990	Ø.629415	Ø.766184	Ø.005955
140	4.975878	-3.528265	Ø.315182	Ø.655416	Ø.749481	Ø.005941
141	4.546138	-3.394206	Ø.303634	Ø.683197	Ø.731589	Ø.005934
142	4.133910	-3.257002	Ø.291569	Ø.712220	Ø.712744	Ø.006010
143	3.739435	-3.116738	Ø.278871	Ø.742770	Ø.692900	Ø.006014
144	3.363000	-2.973392	Ø.265263	Ø.775507	Ø.671524	Ø.005998
145	3.004866	-2.826992	Ø.250814	Ø.810267	Ø.648551	Ø.006047
146	2.665271	-2.677608	Ø.235476	Ø.847164	Ø.623938	Ø.006066
147	2.344483	-2.525252	Ø.219081	Ø.886607	Ø.597267	Ø.006062
148	2.042769	-2.369932	Ø.201590	Ø.928685	Ø.568238	Ø.006090
149	1.760388	-2.211676	Ø.182974	Ø.973470	Ø.536594	Ø.006106
150	1.497621	-2.050480	Ø.163204	1.021029	Ø.501909	Ø.006119
151	1.254779	-1.886312	Ø.142246	1.071449	Ø.463601	Ø.006116
152	1.032200	-1.719143	Ø.120254	1.124357	Ø.421077	Ø.006141
153	Ø.830213	-1.548982	Ø.097546	1.178985	Ø.373788	Ø.006161
154	Ø.649191	-1.375844	Ø.074651	1.234064	Ø.321208	Ø.006080
155	Ø.489575	-1.199747	Ø.052531	1.287278	Ø.262591	Ø.006008
156	Ø.351844	-1.020777	Ø.032598	1.335233	Ø.197519	Ø.005922
157	Ø.236489	-Ø.839120	Ø.016851	1.373116	Ø.126137	Ø.005859
158	Ø.143964	-Ø.655104	Ø.007694	1.395144	Ø.051980	Ø.005819
159	Ø.074616	-Ø.469198	Ø.007580	1.395410	Ø.051107	Ø.005766
160	Ø.028571	-Ø.281985	Ø.018325	1.369569	Ø.135790	Ø.005599

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-3
	NACA 0012: MACH = 1.2, ALPHA = 7			

161	0.005686	-0.094065	0.040674	1.315803	0.227839	0.005362
162	0.005686	0.094065	0.073970	1.235703	0.322203	0.00491
163	0.028571	0.281985	0.116848	1.132551	0.417126	0.004523
164	0.074616	0.469198	0.166260	1.013680	0.510004	0.004331
165	0.143964	0.655104	0.218518	0.887962	0.598305	0.004539
166	0.236489	0.839120	0.269808	0.764573	0.680273	0.004623
167	0.351844	1.020777	0.317658	0.649459	0.754556	0.004769
168	0.489575	1.199747	0.361068	0.545025	0.821218	0.005103
169	0.649191	1.375844	0.399551	0.452447	0.880581	0.005458
170	0.830213	1.548982	0.433173	0.371563	0.933146	0.005774
171	1.032200	1.719143	0.462432	0.301172	0.979831	0.005931
172	1.254779	1.886312	0.487949	0.239786	1.021383	0.006066
173	1.497621	2.050480	0.510061	0.186591	1.058152	0.006202
174	1.760388	2.211676	0.529189	0.140574	1.090716	0.006233
175	2.042769	2.369932	0.545970	0.100203	1.119900	0.006235
176	2.344483	2.525252	0.560899	0.064289	1.146419	0.006194
177	2.665271	2.677608	0.574210	0.032267	1.170485	0.006207
178	3.004866	2.826992	0.586044	0.003797	1.192288	0.006202
179	3.363000	2.973392	0.596783	-0.022038	1.212505	0.006088
180	3.739435	3.116738	0.606604	-0.045665	1.231227	0.006084
181	4.133910	3.257002	0.615362	-0.066735	1.248139	0.006149
182	4.546138	3.394206	0.623380	-0.086023	1.263984	0.006034
183	4.975878	3.528265	0.630983	-0.104312	1.279175	0.005992
184	5.422886	3.659085	0.637974	-0.121131	1.293269	0.006058
185	5.886880	3.786671	0.644374	-0.136530	1.306407	0.006019
186	6.367586	3.910989	0.650413	-0.151056	1.318961	0.005986
187	6.864746	4.031963	0.656119	-0.164785	1.330951	0.005984
188	7.378089	4.149546	0.661479	-0.177679	1.342343	0.005987
189	7.907336	4.263697	0.666543	-0.189860	1.353230	0.005990
190	8.452214	4.374364	0.671398	-0.201540	1.363813	0.005954
191	9.012450	4.481469	0.676056	-0.212746	1.374059	0.005949
192	9.587761	4.584977	0.680424	-0.223254	1.383731	0.005997
193	10.177848	4.684890	0.684578	-0.233249	1.393082	0.005965
194	10.782431	4.781145	0.688647	-0.243038	1.402334	0.005929
195	11.401228	4.873669	0.692536	-0.252393	1.411214	0.005969
196	12.033938	4.962469	0.696210	-0.261231	1.419708	0.005972
197	12.680262	5.047531	0.699774	-0.269806	1.428041	0.005955
198	13.339911	5.128796	0.703249	-0.278165	1.436230	0.005956
199	14.012589	5.206223	0.706607	-0.286244	1.444210	0.005963
200	14.697994	5.279799	0.709841	-0.294024	1.451971	0.005962
201	15.395823	5.349519	0.712947	-0.301497	1.459487	0.005966
202	16.105759	5.415383	0.715932	-0.308678	1.466771	0.005973
203	16.827515	5.477386	0.718838	-0.315668	1.473932	0.005964
204	17.560776	5.535499	0.721693	-0.322536	1.481020	0.005961
205	18.305237	5.589691	0.724476	-0.329230	1.487988	0.005961
206	19.060609	5.639968	0.727160	-0.335588	1.494754	0.005974
207	19.826538	5.686358	0.729724	-0.341857	1.501274	0.005978
208	20.602753	5.728903	0.732188	-0.347784	1.507588	0.005981
209	21.388901	5.767619	0.734586	-0.353553	1.513786	0.005974
210	22.184692	5.802505	0.736948	-0.359236	1.519941	0.005963
211	22.989822	5.833555	0.739259	-0.364795	1.525992	0.005972
212	23.803986	5.860794	0.741487	-0.370156	1.531871	0.005981
213	24.626831	5.884267	0.743637	-0.375328	1.537586	0.005984
214	25.458069	5.904007	0.745721	-0.380341	1.543168	0.005984
215	26.297394	5.920048	0.747749	-0.385220	1.548639	0.005980
216	27.144455	5.932426	0.749719	-0.389959	1.553985	0.005982
217	27.998978	5.941193	0.751619	-0.394531	1.559176	0.005983
218	28.860626	5.946407	0.753446	-0.398926	1.564193	0.005994
219	29.729080	5.948131	0.755216	-0.403184	1.569092	0.005992
220	30.604050	5.946396	0.756958	-0.407375	1.573952	0.005979
221	31.485199	5.941235	0.758655	-0.411456	1.578695	0.005987
222	32.372223	5.932717	0.760281	-0.415367	1.583267	0.006001
223	33.264816	5.920918	0.761858	-0.419163	1.587743	0.005993
224	34.162659	5.905882	0.763394	-0.422857	1.592120	0.005990
225	35.065430	5.887674	0.764871	-0.426412	1.596342	0.006007
226	35.972839	5.866369	0.766312	-0.429877	1.600498	0.005999
227	36.884567	5.842010	0.767730	-0.433289	1.604612	0.005985
228	37.800293	5.814661	0.769081	-0.436538	1.608528	0.006011
229	38.719727	5.784445	0.770355	-0.439603	1.612250	0.006018
230	39.642548	5.751444	0.771598	-0.442594	1.615911	0.006005
231	40.568451	5.715693	0.772824	-0.445544	1.619535	0.006001
232	41.497131	5.677249	0.774024	-0.448431	1.623096	0.006001
233	42.428284	5.636191	0.775180	-0.451211	1.626530	0.006016
234	43.361603	5.592612	0.776288	-0.453876	1.629841	0.006024
235	44.296783	5.546580	0.777368	-0.456475	1.633098	0.006010
236	45.233521	5.498161	0.778411	-0.458983	1.636239	0.006017
237	46.171509	5.447458	0.779396	-0.461355	1.639215	0.006036
238	47.110458	5.394568	0.780358	-0.463668	1.642148	0.006025
239	48.050049	5.339531	0.781313	-0.465966	1.645070	0.006018
240	48.990005	5.282402	0.782242	-0.468200	1.647909	0.006031

960767

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	95-9-4
	NACA 0012: MACH = 1.2, ALPHA = 7			

241	49.930000	5.223271	0.783142	-0.470365	1.650675	0.000634
242	50.869781	5.162216	0.784014	-0.472462	1.653374	0.000625
243	51.808990	5.099324	0.784830	-0.474427	1.655890	0.000647
244	52.747375	5.034718	0.785597	-0.476271	1.658263	0.000663
245	53.684616	4.968453	0.786301	-0.478158	1.660735	0.000625
246	54.620422	4.900533	0.787175	-0.480069	1.663218	0.000627
247	55.554504	4.831051	0.787916	-0.481850	1.665519	0.000662
248	56.486572	4.760140	0.788623	-0.483550	1.667747	0.000658
249	57.416321	4.687847	0.789325	-0.485241	1.669971	0.000652
250	58.343460	4.614206	0.790013	-0.486894	1.672143	0.000657
251	59.267700	4.539302	0.790683	-0.488507	1.674269	0.000665
252	60.188751	4.463216	0.791337	-0.490080	1.676355	0.000658
253	61.106308	4.386030	0.791956	-0.491569	1.678324	0.000672
254	62.020111	4.307839	0.792540	-0.492974	1.680180	0.000691
255	62.929840	4.228698	0.793143	-0.494424	1.682134	0.000665
256	63.835220	4.148601	0.793770	-0.495933	1.684155	0.000659
257	64.735947	4.067623	0.794361	-0.497356	1.686049	0.000682
258	65.631760	3.985905	0.794904	-0.498662	1.687797	0.000695
259	66.522354	3.903537	0.795421	-0.499905	1.689462	0.000112
260	67.407440	3.820540	0.795960	-0.501203	1.691236	0.000679
261	68.286728	3.736912	0.796530	-0.502573	1.693099	0.000668
262	69.159943	3.652738	0.797059	-0.503847	1.694798	0.000112
263	70.026794	3.568157	0.797558	-0.505048	1.696431	0.000114
264	70.887009	3.483205	0.798073	-0.506286	1.698133	0.000693
265	71.740265	3.397891	0.798580	-0.507506	1.699793	0.000108
266	72.586319	3.312301	0.799074	-0.508693	1.701410	0.000120
267	73.424866	3.226509	0.799576	-0.509900	1.703077	0.000106
268	74.255630	3.140560	0.800065	-0.511076	1.704691	0.000113
269	75.078339	3.054547	0.800516	-0.512162	1.706169	0.000139
270	75.892685	2.968552	0.800971	-0.513257	1.707692	0.000125
271	76.698410	2.882581	0.801455	-0.514421	1.709311	0.000114
272	77.495209	2.796670	0.801936	-0.515578	1.710907	0.000128
273	78.282837	2.710910	0.802405	-0.516707	1.712471	0.000137
274	79.060974	2.625375	0.802865	-0.517815	1.714008	0.000147
275	79.829376	2.540112	0.803323	-0.518916	1.715550	0.000142
276	80.587753	2.455165	0.803785	-0.520027	1.717105	0.000142
277	81.335815	2.370600	0.804236	-0.521112	1.718621	0.000149
278	82.073288	2.286501	0.804672	-0.522161	1.720092	0.000152
279	82.799927	2.202941	0.805099	-0.523188	1.721535	0.000159
280	83.515427	2.119970	0.805529	-0.524223	1.723000	0.000153
281	84.219528	2.037631	0.805972	-0.525287	1.724504	0.000152
282	84.911942	1.955977	0.806416	-0.526355	1.726014	0.000156
283	85.592407	1.875083	0.806850	-0.527400	1.727492	0.000165
284	86.260666	1.795019	0.807272	-0.528415	1.728921	0.000186
285	86.916428	1.715837	0.807706	-0.529460	1.730427	0.000168
286	87.559418	1.637572	0.808149	-0.530526	1.731957	0.000149
287	88.189407	1.560317	0.808542	-0.531470	1.733273	0.000204
288	88.806091	1.484191	0.808917	-0.532373	1.734573	0.000194
289	89.409225	1.409214	0.809336	-0.533381	1.736042	0.000163
290	89.998535	1.335393	0.809761	-0.534403	1.737505	0.000174
291	90.573761	1.262822	0.810172	-0.535391	1.738920	0.000189
292	91.134644	1.191594	0.810569	-0.536348	1.740305	0.000187
293	91.680923	1.121780	0.810935	-0.537227	1.741570	0.000197
294	92.212341	1.053459	0.811274	-0.538043	1.742744	0.000209
295	92.728638	0.986685	0.811632	-0.538905	1.744008	0.000192
296	93.229553	0.921482	0.812024	-0.539848	1.745381	0.000189
297	93.714828	0.857903	0.812423	-0.540808	1.746790	0.000177
298	94.184219	0.796038	0.812787	-0.541683	1.748044	0.000212
299	94.637466	0.735998	0.813092	-0.542418	1.749106	0.000230
300	95.074341	0.677854	0.813388	-0.543129	1.750158	0.000217
301	95.494553	0.621635	0.813697	-0.543872	1.751253	0.000207
302	95.897858	0.567390	0.814018	-0.544643	1.752396	0.000196
303	96.284027	0.515193	0.814329	-0.545392	1.753474	0.000231
304	96.652786	0.465119	0.814637	-0.546135	1.754564	0.000237
305	97.003891	0.417216	0.814961	-0.546914	1.755764	0.000163
306	97.337082	0.371551	0.815201	-0.547491	1.756548	0.000266
307	97.652130	0.328249	0.815371	-0.547899	1.757127	0.000305
308	97.948761	0.287339	0.815652	-0.548575	1.758228	0.000153
309	98.226700	0.248813	0.815919	-0.549217	1.759140	0.000215
310	98.485703	0.212798	0.816071	-0.549584	1.759609	0.000330
311	98.725494	0.179389	0.816283	-0.550093	1.760478	0.000158
312	98.945786	0.148593	0.816489	-0.550590	1.761088	0.000354
313	99.146286	0.120481	0.816611	-0.550882	1.761749	0.000810
314	99.326721	0.095145	0.816736	-0.551184	1.761651	0.000843
315	99.486725	0.072632	0.816914	-0.551611	1.763481	0.000535
316	99.625946	0.052983	0.817074	-0.551997	1.761640	0.000691
317	99.744003	0.036276	0.817052	-0.551944	1.766059	0.001879
318	99.840439	0.022620	0.817691	-0.553480	1.760504	0.013736
319	99.914658	0.012110	0.817220	-0.552348	1.771003	-0.004742
320	99.965897	0.004846	0.814129	-0.544912	1.748100	0.025166
321	99.992828	0.001020	0.874160	-0.689328	2.078408	-0.112612

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-5
	NACA 0012: MACH = 1.2, ALPHA = 7			

NACA 0012 M=1.20, ALPHA=7.0
VALUES ON X-AXIS UPSTREAM OF LEADING EDGE

J	X/C(%)	Z/C(%)	1-P/PINF	CP	MACH	1-PI/PINF
2	-0.066177	0.000000	0.053353	1.285302	0.267786	0.004978
3	-0.204744	0.000000	0.051056	1.290828	0.259788	0.005465
4	-0.356041	0.000000	0.051536	1.289673	0.262316	0.005061
5	-0.520694	0.000000	0.055489	1.280163	0.272161	0.005605
6	-0.699376	0.000000	0.060716	1.267589	0.286981	0.005444
7	-0.892805	0.000000	0.067448	1.251391	0.304332	0.005577
8	-1.101754	0.000000	0.074948	1.233349	0.323100	0.005570
9	-1.327055	0.000000	0.083064	1.213824	0.342365	0.005601
10	-1.569596	0.000000	0.091541	1.193431	0.361657	0.005613
11	-1.830337	0.000000	0.100244	1.172495	0.380671	0.005623
12	-2.110308	0.000000	0.109059	1.151288	0.399241	0.005629
13	-2.410620	0.000000	0.117908	1.130001	0.417276	0.005635
14	-2.732471	0.000000	0.126731	1.108775	0.434736	0.005639
15	-3.077155	0.000000	0.135487	1.087709	0.451612	0.005641
16	-3.446071	0.000000	0.144147	1.066876	0.467911	0.005644
17	-3.840734	0.000000	0.152690	1.046324	0.483651	0.005646
18	-4.262787	0.000000	0.161103	1.026085	0.498857	0.005649
19	-4.714013	0.000000	0.169377	1.006180	0.513559	0.005651
20	-5.196353	0.000000	0.177508	0.986619	0.527784	0.005651
21	-5.711921	0.000000	0.185494	0.967407	0.541563	0.005652
22	-6.263024	0.000000	0.193338	0.948538	0.554926	0.005653
23	-6.852186	0.000000	0.201040	0.930009	0.567901	0.005655
24	-7.482173	0.000000	0.208606	0.911808	0.580516	0.005656
25	-8.156018	0.000000	0.216040	0.893923	0.592797	0.005657
26	-8.877065	0.000000	0.223349	0.876339	0.604772	0.005658
27	-9.648993	0.000000	0.230540	0.859039	0.616463	0.005658
28	-10.475878	0.000000	0.237621	0.842006	0.627896	0.005661
29	-11.362229	0.000000	0.244598	0.825219	0.639095	0.005660
30	-12.313064	0.000000	0.251483	0.808657	0.650081	0.005662
31	-13.333968	0.000000	0.258282	0.792299	0.660879	0.005663
32	-14.431187	0.000000	0.265008	0.776120	0.671510	0.005666
33	-15.611721	0.000000	0.271669	0.760094	0.681998	0.005664
34	-16.883438	0.000000	0.278279	0.744193	0.692368	0.005669
35	-18.255249	0.000000	0.284852	0.728379	0.702646	0.005671
36	-19.737213	0.000000	0.291399	0.712629	0.712855	0.005672
37	-21.340790	0.000000	0.297924	0.696934	0.723010	0.005669
38	-23.079071	0.000000	0.304472	0.681181	0.733175	0.005672
39	-24.967102	0.000000	0.311120	0.665187	0.743453	0.005696
40	-27.022202	0.000000	0.317832	0.649039	0.753812	0.005728
41	-29.264465	0.000000	0.324297	0.633486	0.763884	0.005654
42	-31.717346	0.000000	0.330768	0.617920	0.774002	0.005537
43	-34.408340	0.000000	0.338796	0.598606	0.786107	0.005818
44	-37.369934	0.000000	0.349071	0.573888	0.801093	0.006687
45	-40.640778	0.000000	0.357279	0.554140	0.813405	0.007064
46	-44.267197	0.000000	0.372639	0.517189	0.835690	0.008595
47	-48.305267	0.000000	0.431820	0.374816	0.921703	0.015955
48	-52.823441	0.000000	0.512637	0.180392	1.054651	0.015604
49	-57.906250	0.000000	0.567132	0.049295	1.157099	0.006876
50	-63.659195	0.000000	0.582807	0.011585	1.190096	0.001277
51	-70.215820	0.000000	0.586141	0.003564	1.196800	0.000584
52	-77.747650	0.000000	0.587404	0.000526	1.199802	-0.000273
53	-86.478714	0.000000	0.587308	0.000755	1.199557	-0.000182
54	-96.707367	0.000000	0.586833	0.001899	1.198586	-0.000069
55	-108.839966	0.000000	0.586569	0.002535	1.198025	0.000023
56	-123.444702	0.000000	0.586560	0.002555	1.197996	0.000041
57	-141.341370	0.000000	0.586668	0.002296	1.198209	0.000024
58	-163.758469	0.000000	0.586780	0.002027	1.198431	0.000005
59	-192.625519	0.000000	0.586859	0.001837	1.198584	-0.000004
60	-231.159912	0.000000	0.586909	0.001715	1.198680	-0.000006
61	-285.167480	0.000000	0.586949	0.001621	1.198752	-0.000004
62	-366.344727	0.000000	0.586990	0.001522	1.198828	-0.000003
63	-502.499512	0.000000	0.587039	0.001403	1.198920	-0.000005
64	-781.729248	0.000000	0.587103	0.001250	1.199037	-0.000004
65	-1762.49097	0.000000	0.587183	0.001058	1.199179	0.000005

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-6
	NACA 0012: MACH = 1.2, ALPHA = 7			

NACA 0012 M=1.20, ALPHA=7.0
VALUES ON X-AXIS DOWNSTREAM OF TRAILING EDGE

J	X/C(%)	Z/C(%)	1-P/PINF	CP	MACH	1-PI/PINF
2	100.004654	0.0	0.406944	0.434662	0.870432	0.028238
3	100.022430	0.0	0.440355	0.354285	0.955014	-0.006005
4	100.056946	0.0	0.528079	0.143244	1.087781	0.007487
5	100.108124	0.0	0.581841	0.013908	1.173473	0.020258
6	100.176270	0.0	0.617347	-0.071509	1.241040	0.020571
7	100.261856	0.0	0.640867	-0.128092	1.288515	0.020328
8	100.365479	0.0	0.644063	-0.135780	1.297826	0.016704
9	100.487854	0.0	0.628613	-0.098612	1.267863	0.014727
10	100.629761	0.0	0.611467	-0.057364	1.239887	0.007041
11	100.792053	0.0	0.606488	-0.045386	1.235262	0.000466
12	100.975723	0.0	0.609404	-0.052401	1.244033	-0.003744
13	101.181778	0.0	0.613647	-0.062608	1.254494	-0.006782
14	101.411392	0.0	0.616161	-0.068656	1.260715	-0.008589
15	101.665817	0.0	0.616044	-0.068374	1.261426	-0.009858
16	101.946396	0.0	0.614651	-0.065024	1.259577	-0.011013
17	102.254608	0.0	0.613393	-0.061996	1.257907	-0.012053
18	102.592087	0.0	0.612813	-0.060602	1.257380	-0.012856
19	102.960571	0.0	0.612770	-0.060498	1.257714	-0.013421
20	103.361984	0.0	0.612950	-0.060931	1.258301	-0.013743
21	103.798431	0.0	0.613077	-0.061236	1.258620	-0.013845
22	104.272171	0.0	0.613014	-0.061085	1.258435	-0.013762
23	104.785736	0.0	0.612782	-0.060528	1.257812	-0.013521
24	105.341873	0.0	0.612483	-0.059808	1.256955	-0.013144
25	105.943604	0.0	0.612208	-0.059146	1.256042	-0.012624
26	106.594238	0.0	0.611991	-0.058624	1.255120	-0.011945
27	107.297485	0.0	0.611810	-0.058189	1.254150	-0.011106
28	108.057373	0.0	0.611634	-0.057765	1.253071	-0.010106
29	108.878433	0.0	0.611446	-0.057312	1.251868	-0.008975
30	109.765671	0.0	0.611248	-0.056836	1.250561	-0.007730
31	110.724655	0.0	0.611033	-0.056320	1.249147	-0.006388
32	111.761627	0.0	0.610775	-0.055698	1.247583	-0.004959
33	112.883591	0.0	0.610449	-0.054915	1.245833	-0.003460
34	114.098419	0.0	0.610069	-0.053999	1.243937	-0.001909
35	115.414993	0.0	0.609690	-0.053089	1.242026	-0.000338
36	116.843399	0.0	0.609374	-0.052329	1.240230	0.001237
37	118.395096	0.0	0.609119	-0.051716	1.238560	0.002799
38	120.083160	0.0	0.608856	-0.051082	1.236895	0.004329
39	121.922623	0.0	0.608507	-0.050242	1.235114	0.005790
40	123.930847	0.0	0.608067	-0.049183	1.233236	0.007144
41	126.127914	0.0	0.607592	-0.048041	1.231393	0.008363
42	128.537262	0.0	0.607122	-0.046912	1.229672	0.009434
43	131.186401	0.0	0.606643	-0.045758	1.228056	0.010341
44	134.107819	0.0	0.606120	-0.044500	1.226501	0.011059
45	137.340179	0.0	0.605545	-0.043118	1.225013	0.011559
46	140.929810	0.0	0.604936	-0.041653	1.223639	0.011823
47	144.932770	0.0	0.604318	-0.040166	1.222444	0.011834
48	149.417572	0.0	0.603708	-0.038698	1.221460	0.011593
49	154.468674	0.0	0.603093	-0.037218	1.220648	0.011117
50	160.191650	0.0	0.602420	-0.035600	1.219881	0.010441
51	166.720047	0.0	0.601634	-0.033707	1.219023	0.009603
52	174.225357	0.0	0.600717	-0.031503	1.218016	0.008637
53	182.931641	0.0	0.599717	-0.029097	1.216910	0.007598
54	193.137253	0.0	0.598740	-0.026745	1.215855	0.006552
55	205.248581	0.0	0.597930	-0.024798	1.215052	0.005599
56	219.833817	0.0	0.597383	-0.023481	1.214603	0.004830
57	237.712753	0.0	0.596961	-0.022465	1.214197	0.004318
58	260.113770	0.0	0.596178	-0.020582	1.212954	0.004011
59	288.966797	0.0	0.594421	-0.016355	1.209793	0.003815
60	327.488770	0.0	0.591451	-0.009211	1.204153	0.003899
61	381.486084	0.0	0.587764	-0.000341	1.196987	0.004261
62	462.654297	0.0	0.584565	0.007354	1.190890	0.004460
63	598.802246	0.0	0.582817	0.011560	1.188458	0.003423
64	878.027344	0.0	0.582080	0.013333	1.190285	-0.000707
65	1858.78564	0.0	0.581890	0.013790	1.193385	-0.005203

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-7
	NACA 0012: MACH = 1.2, ALPHA = 7			

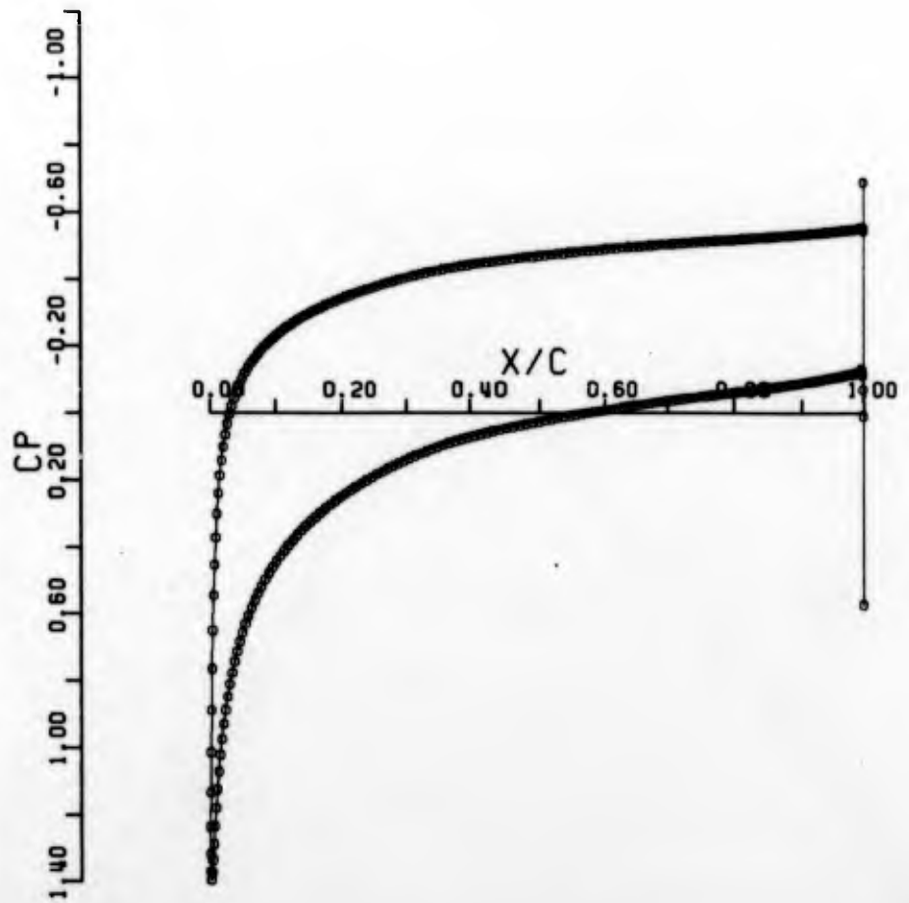


FIG. : CP(X/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-8
	NACA 0012: MACH = 1.2, ALPHA = 7			

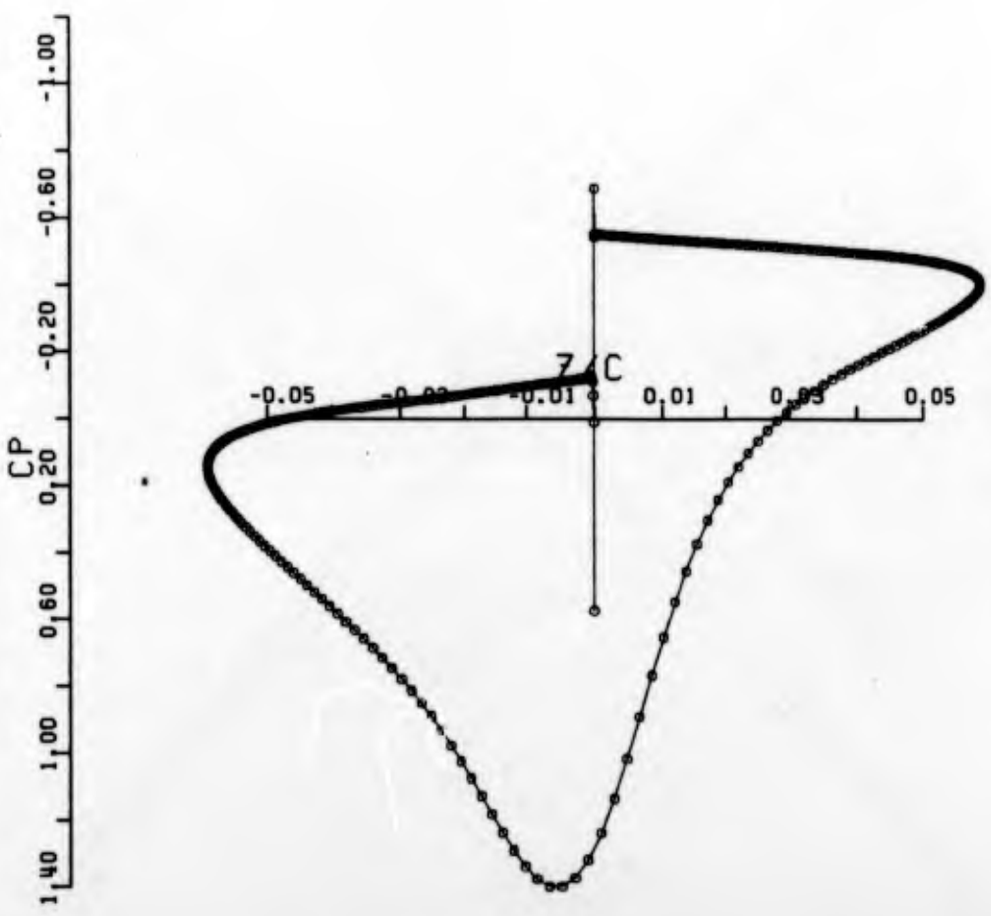


FIG. : CP(Z/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-9
	NACA 0012: MACH = 1.2, ALPHA = 7			

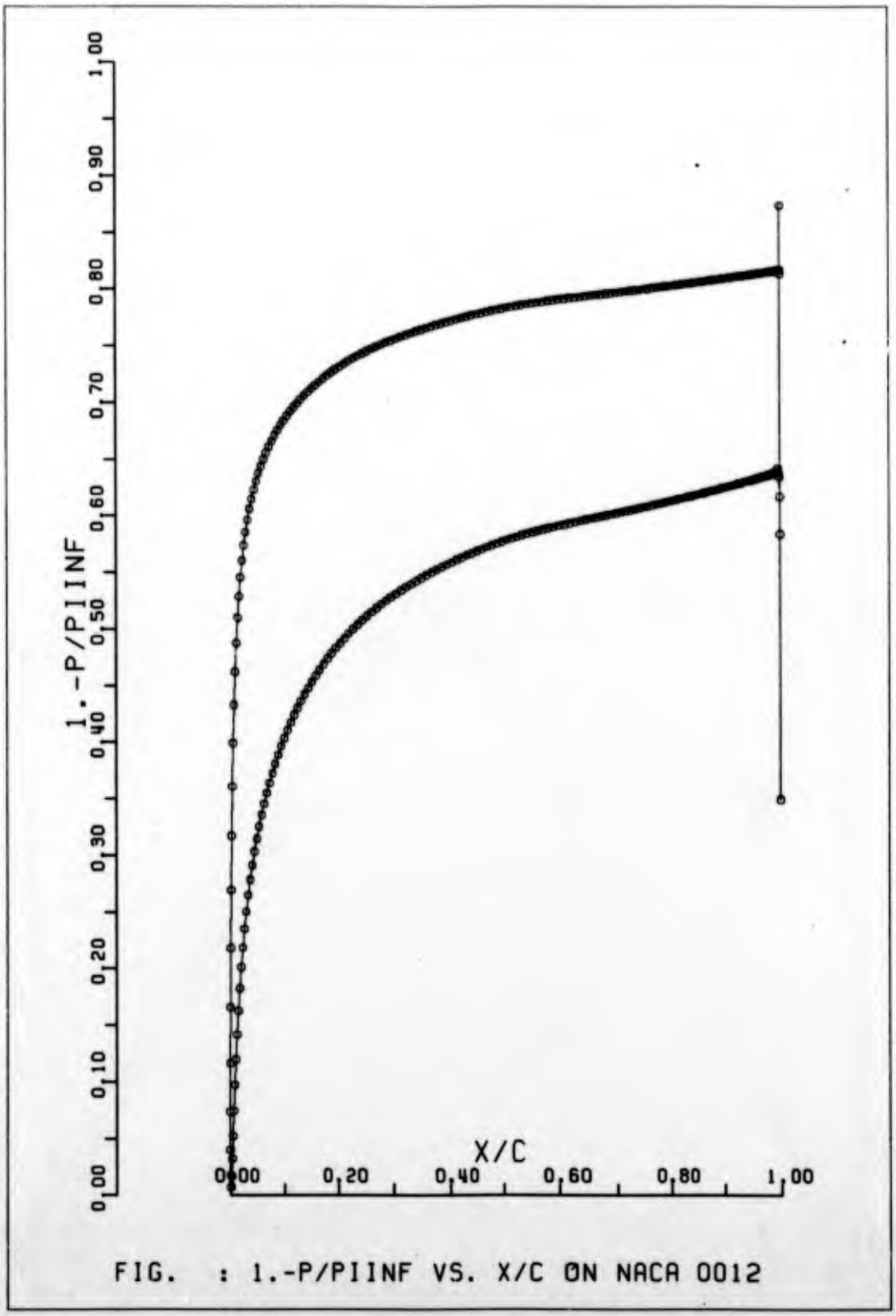


FIG. : 1.-P/PIINF VS. X/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-10
	NACA 0012: MACH = 1.2, ALPHA = 7			

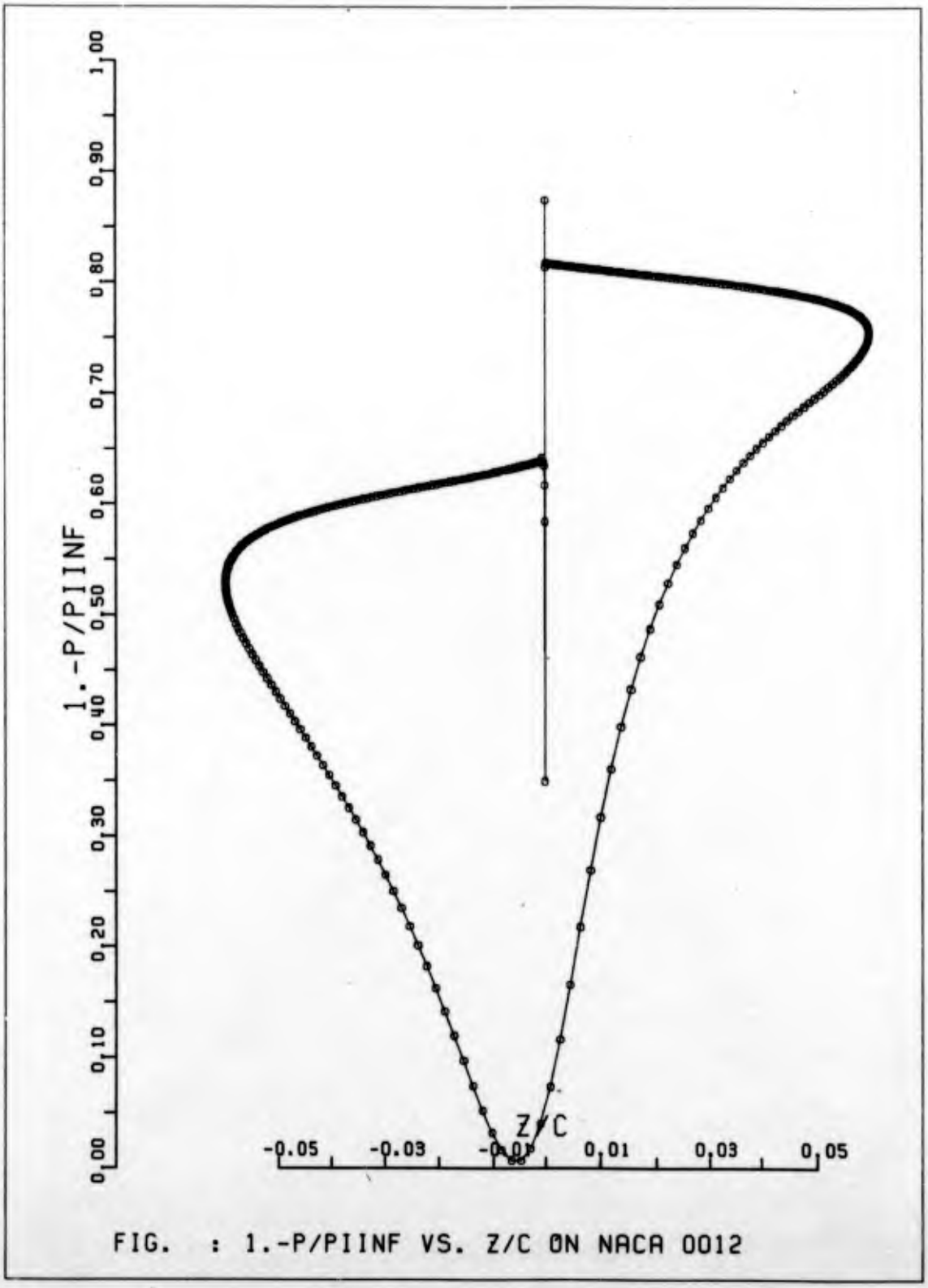


FIG. : 1.-P/PIINF VS. Z/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-11
	NACA 0012: MACH = 1.2, ALPHA = 7			

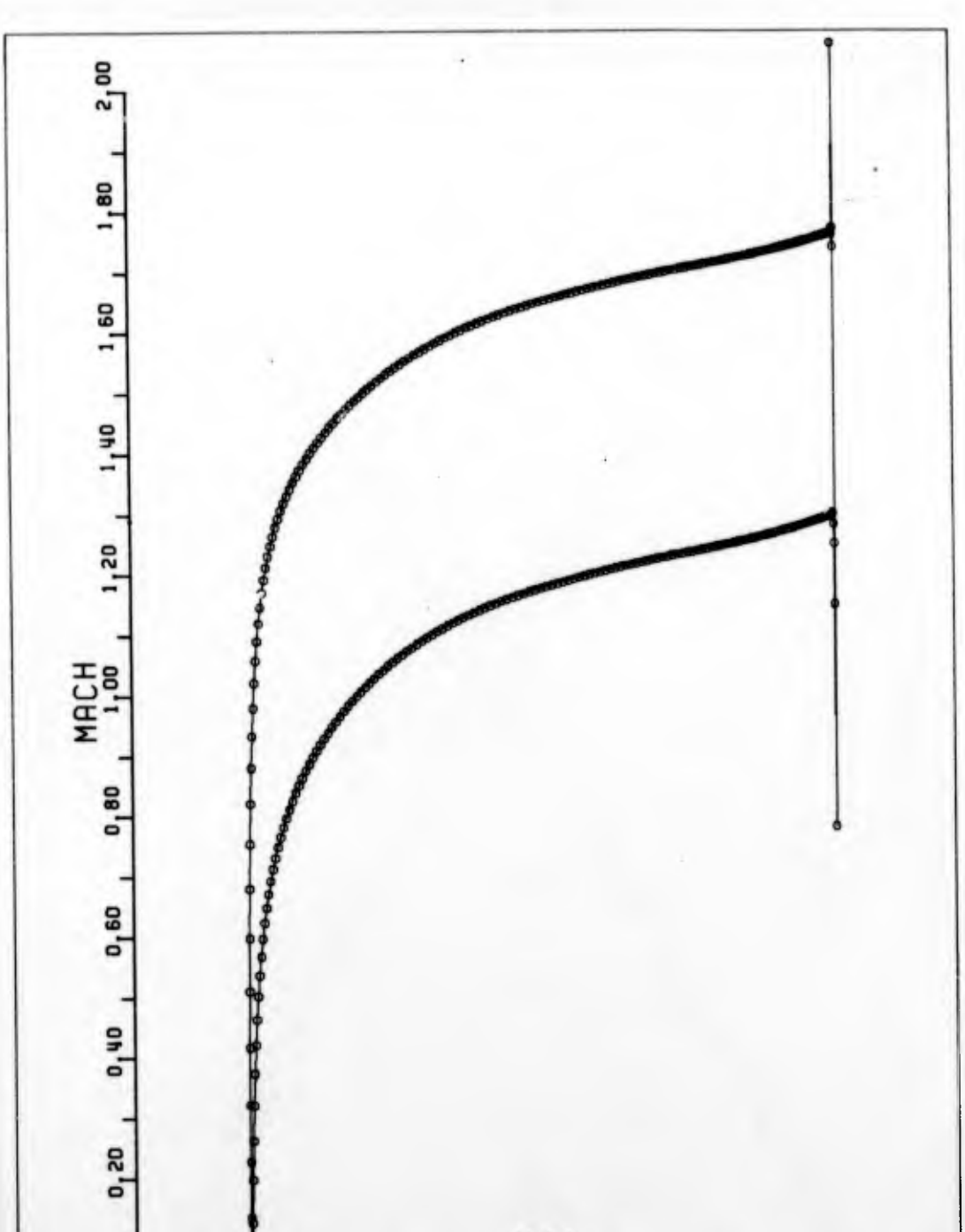


FIG. : MACH(X/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-12
	NACA 0012: MACH = 1.2, ALPHA = 7			

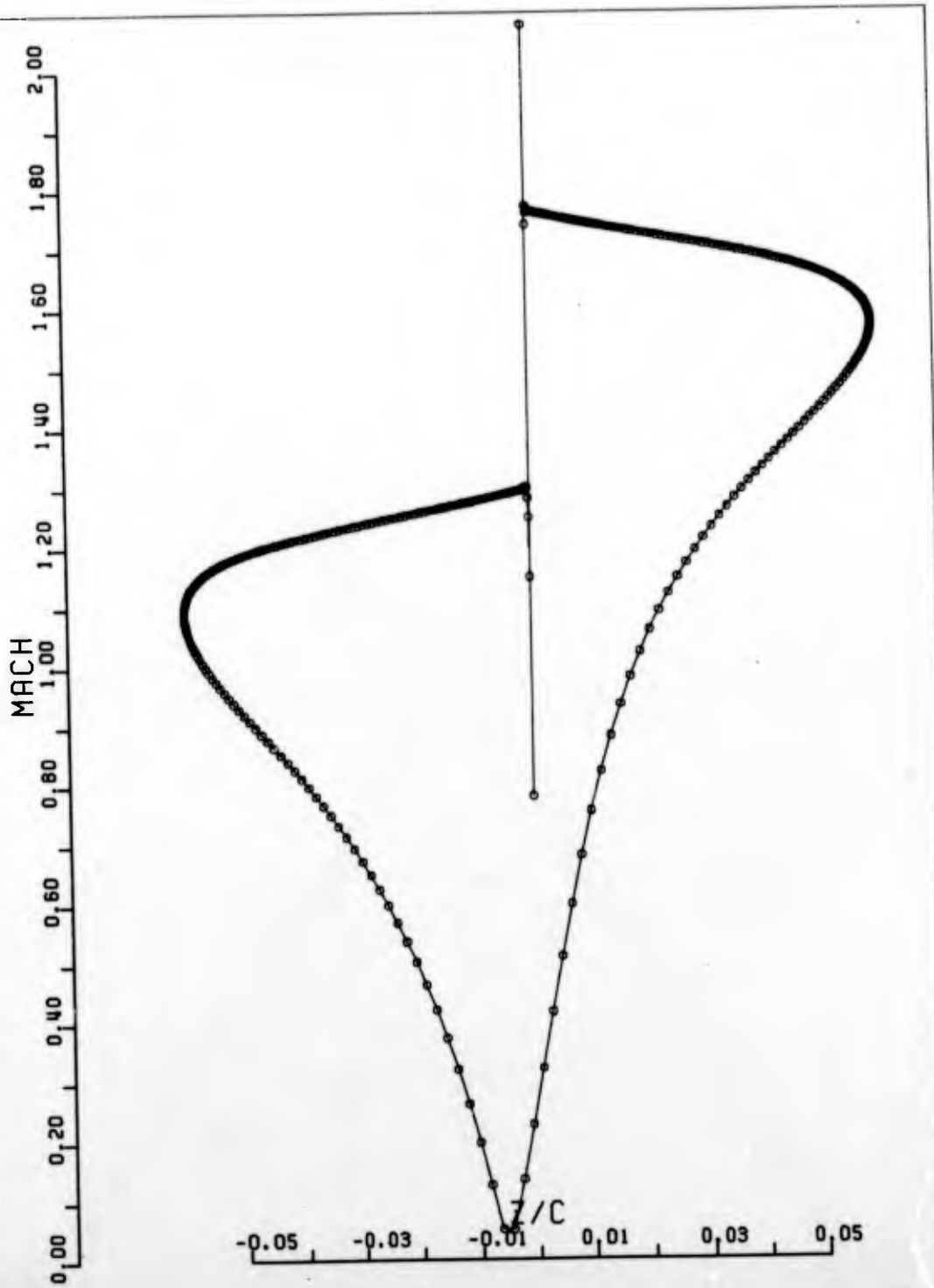


FIG. : MACH (Z/C) ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-13
	NACA 0012: MACH = 1.2, ALPHA = 7			

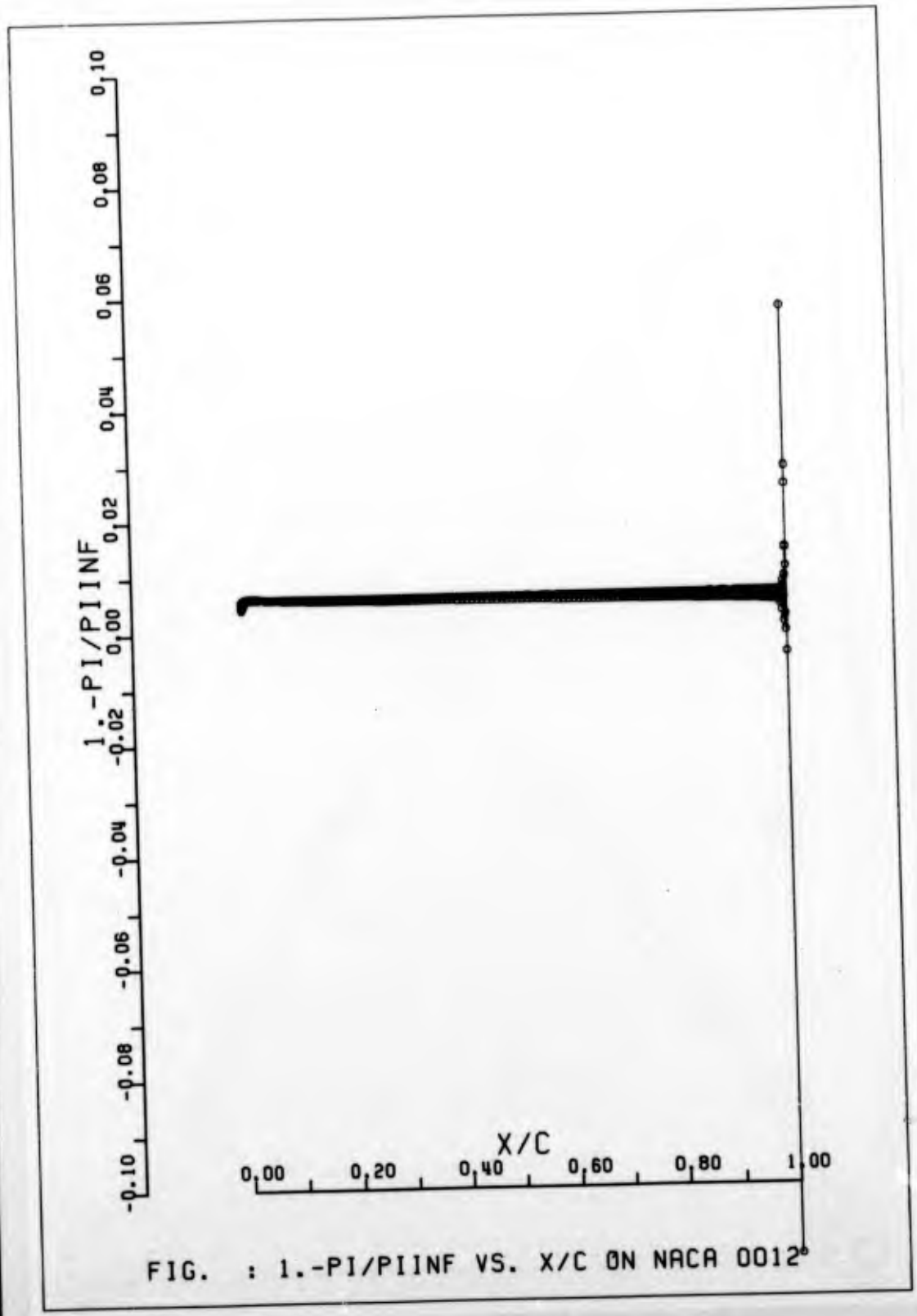


FIG. : 1.-PI/PIINF VS. X/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-14
	NACA 0012: MACH = 1.2, ALPHA = 7			

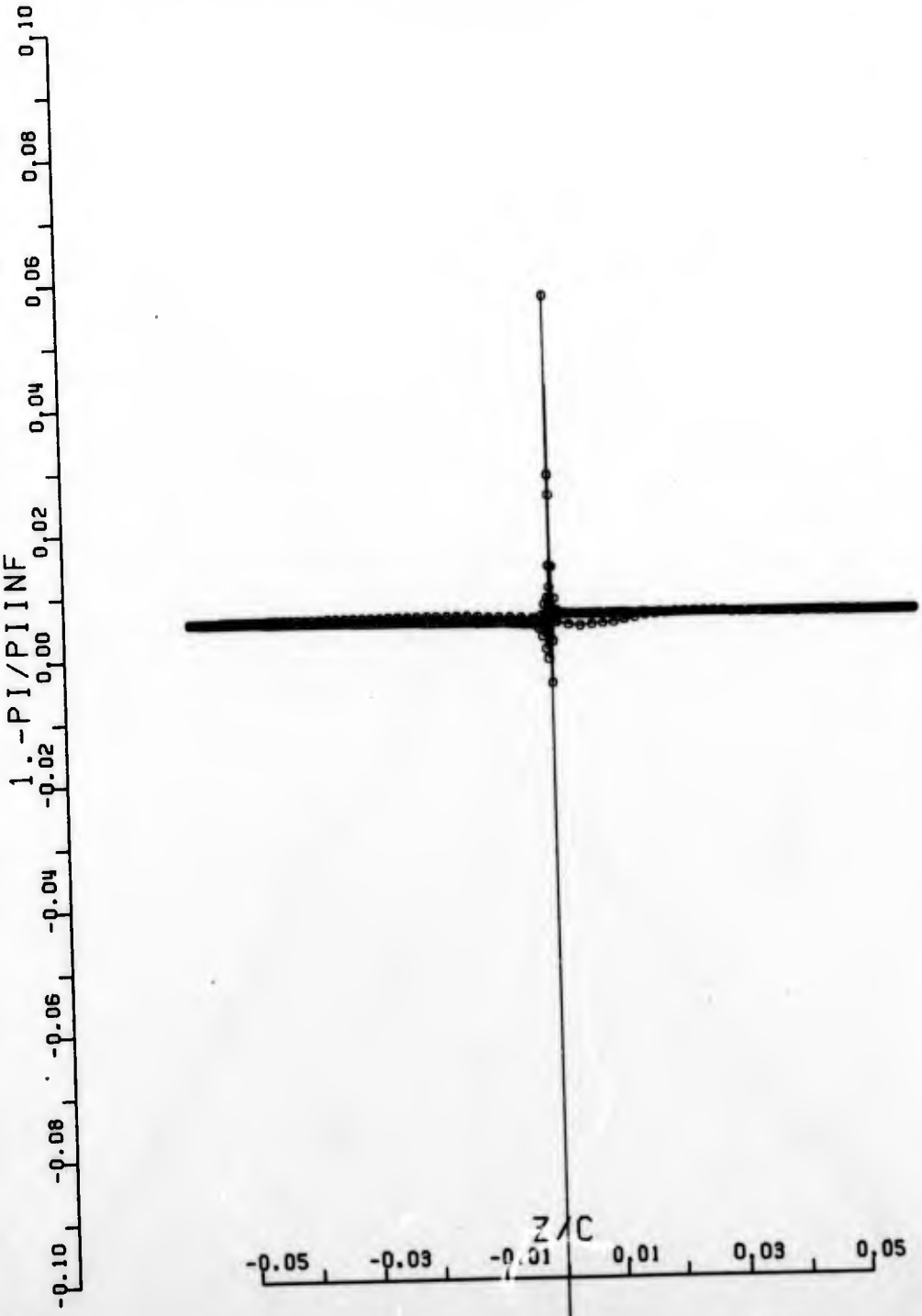
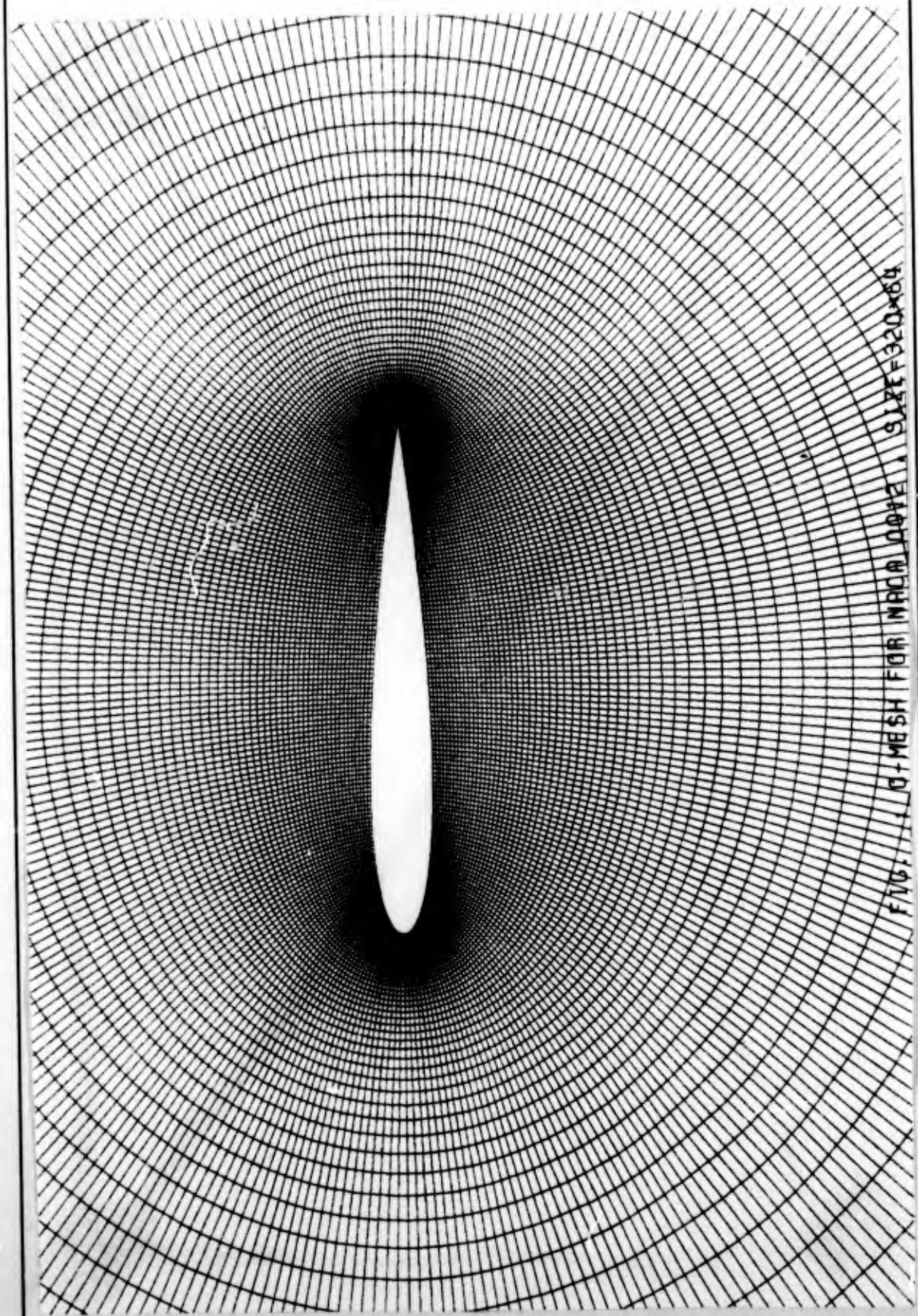
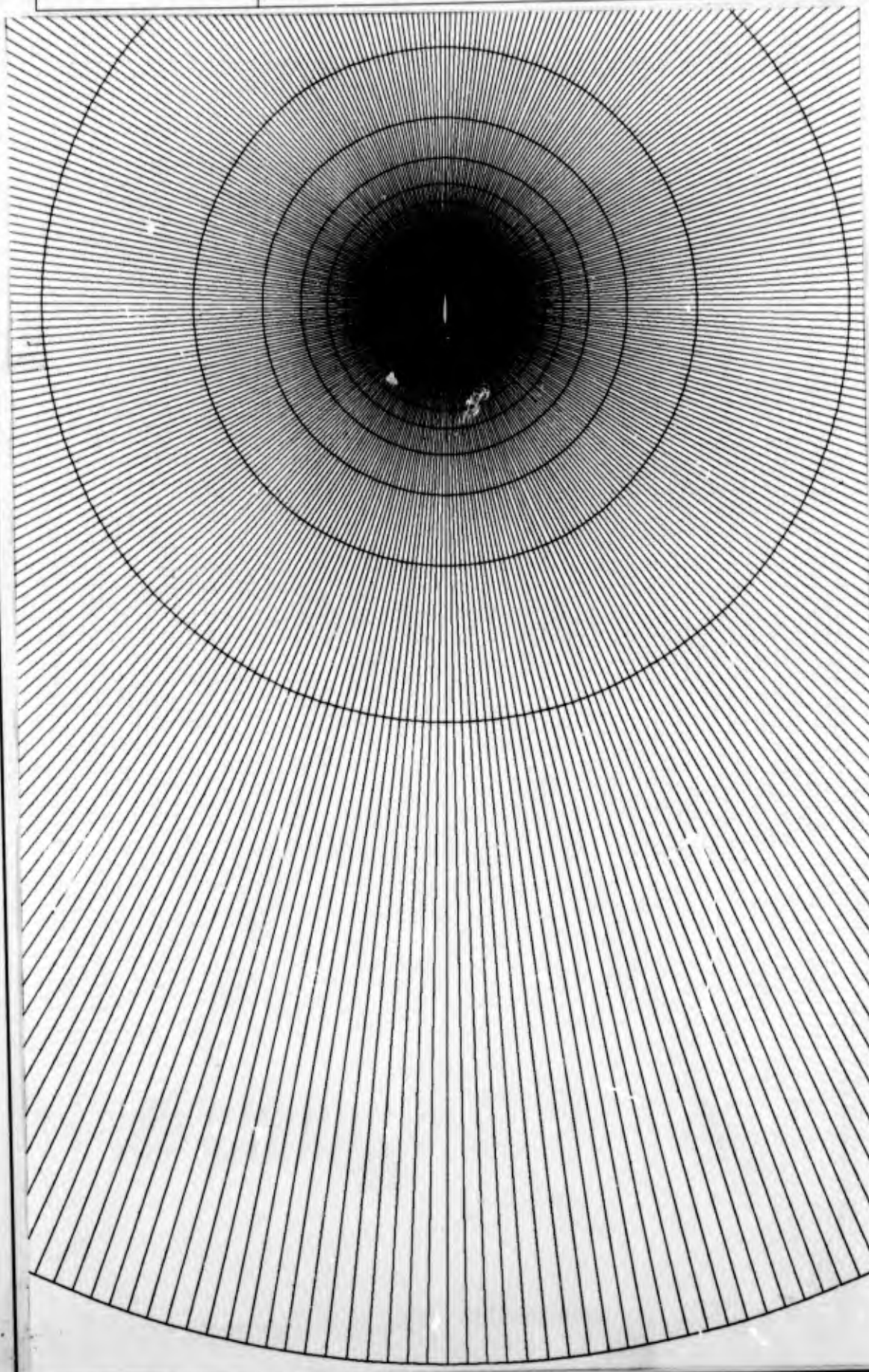


FIG. : 1.-PI/PIINF VS. Z/C ON NACA 0012

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-15
	NACA 0012: MACH = 1.2, ALPHA = 7			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-16
	NACA 0012: MACH = 1.2, ALPHA = 7			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-17
	NACA 0012: MACH = 1.2, ALPHA = 7			

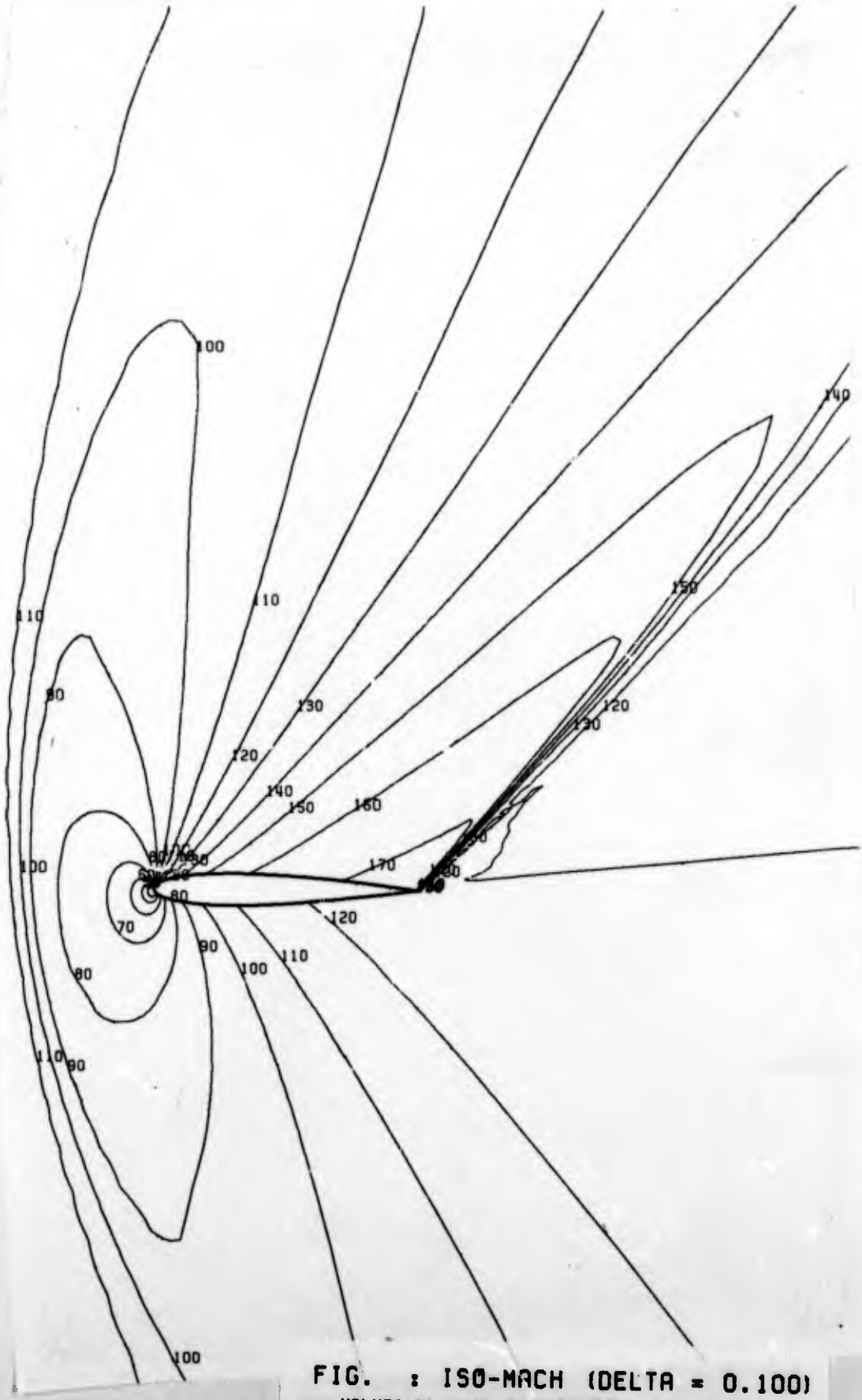


FIG. : ISO-MACH (DELTA = 0.100)

**** VALUES OF CURVE PARAMETER = 100*MACH ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-18
	NACA 0012: MACH = 1.2, ALPHA = 7			

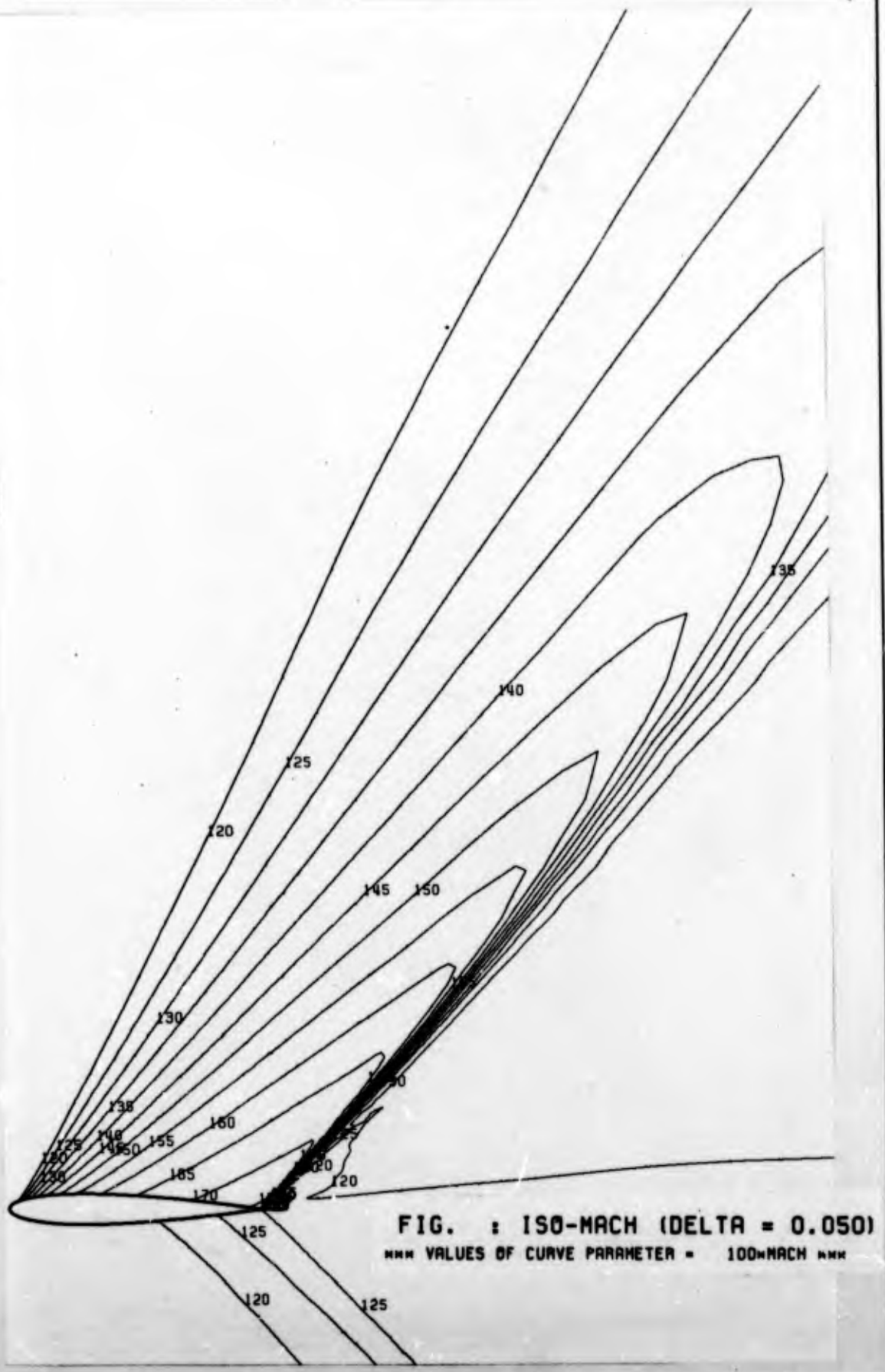


FIG. : ISO-MACH (DELTA = 0.050)

**** VALUES OF CURVE PARAMETER = 100*MACH ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-19
	NACA 0012: MACH = 1.2, ALPHA = 7			

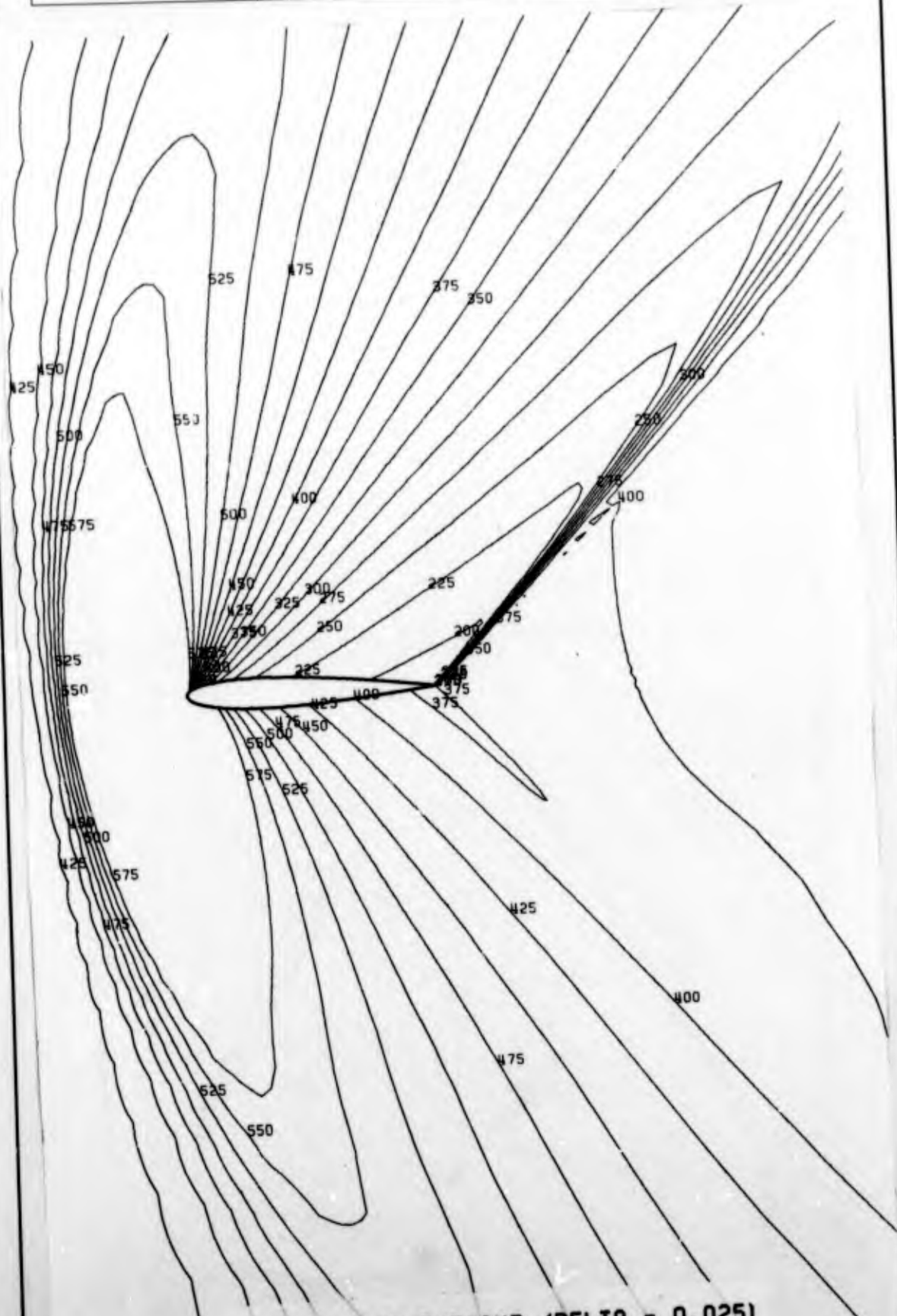
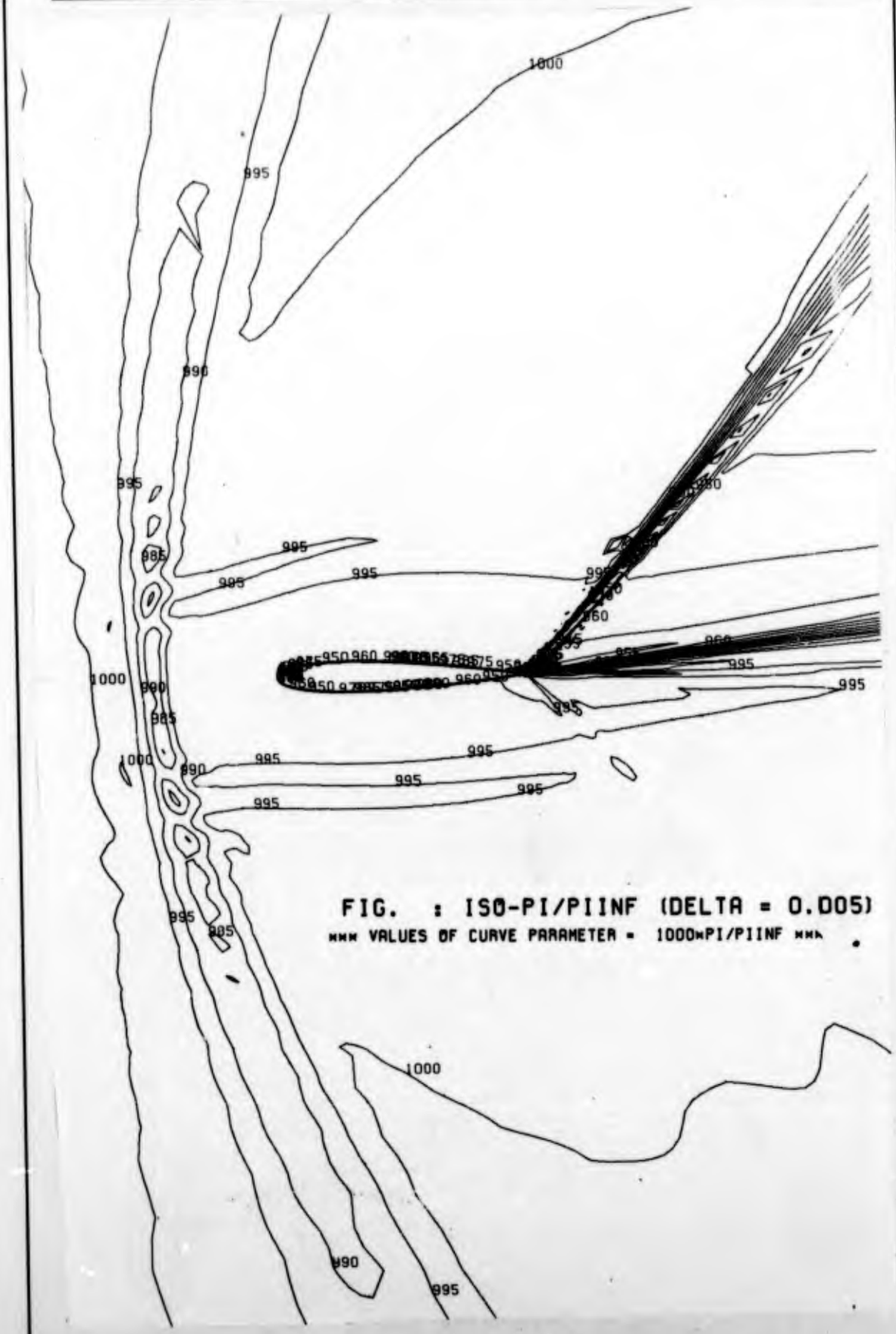


FIG. : ISO-P/PIINF (DELTA = 0.025)

VALUES OF CURVE PARAMETER = 1000*P/PIINF

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-20
	NACA 0012: MACH = 1.2, ALPHA = 7			


1000
995
990
995
995
995

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-21
	NACA 0012, MACH = 1.2, ALPHA = 7			

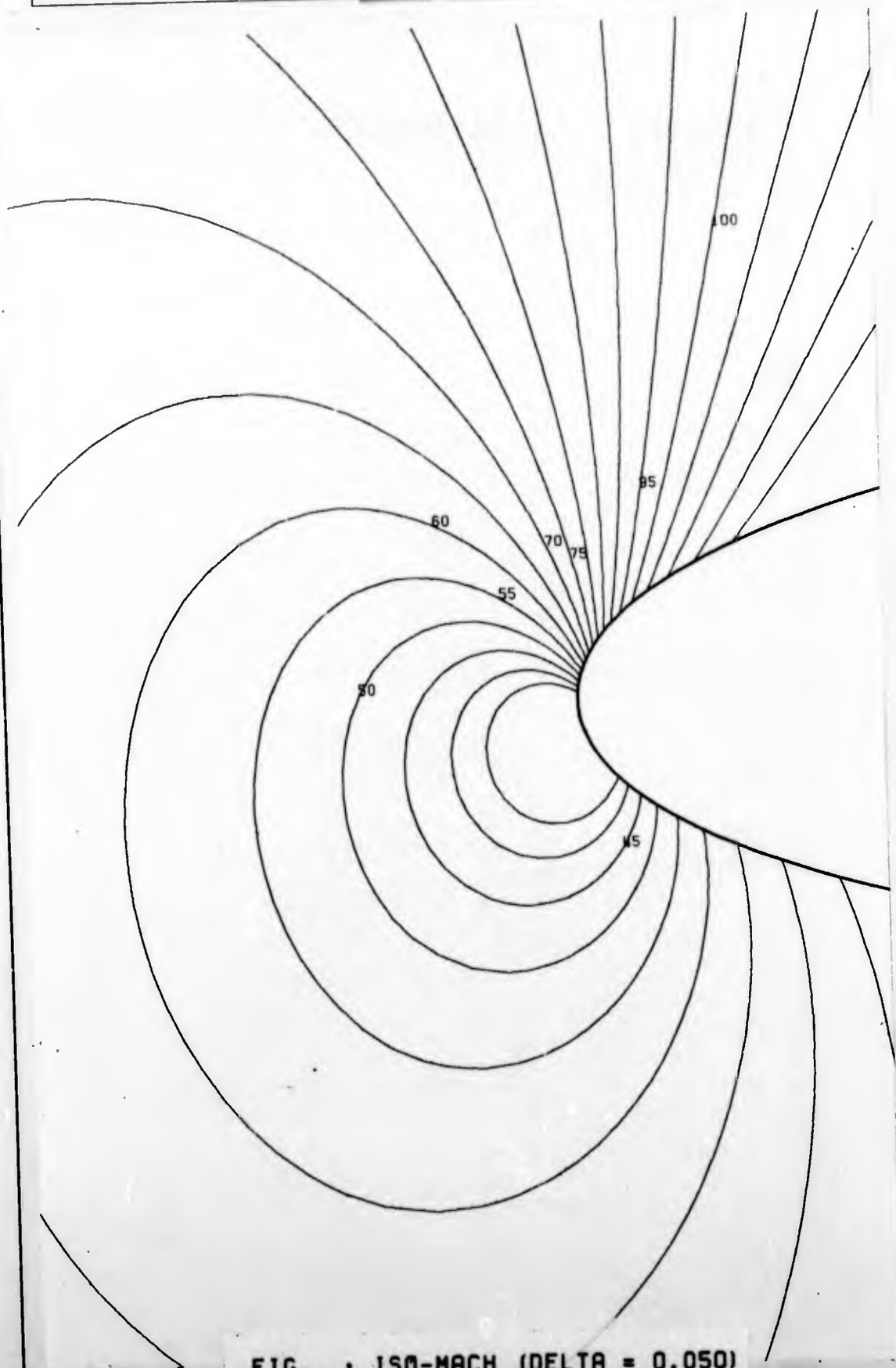


FIG. : ISO-MACH (DELTA = 0.050)

VALUES OF CURVE PARAMETER = 100*MACH

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-22
	NACA 0012: MACH = 1.2, ALPHA = 7			

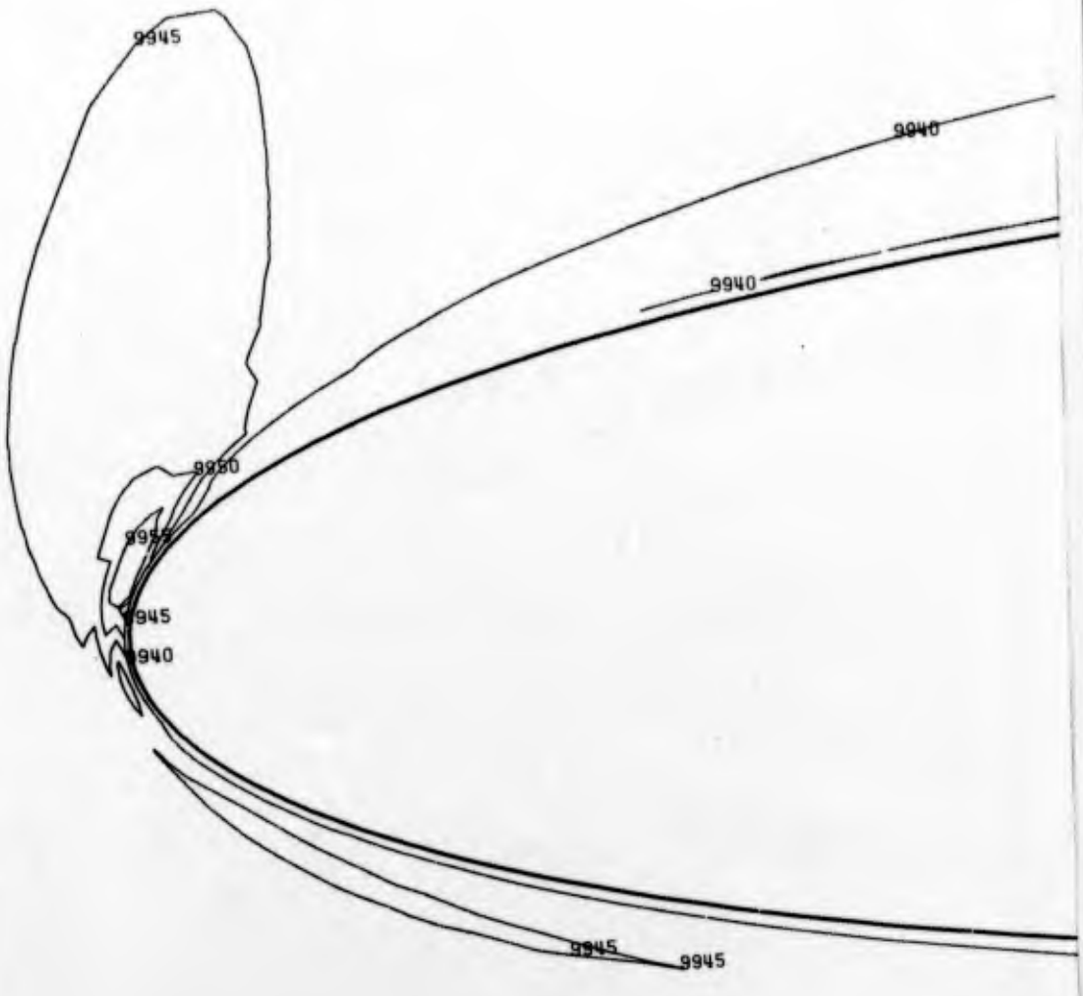


FIG. : ISO-PI/PIINF (DELTA = 0.0005)

*** VALUES OF CURVE PARAMETER = 10000*PI/PIINF ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-23
	NACA 0012: MACH = 1.2, ALPHA = 7			

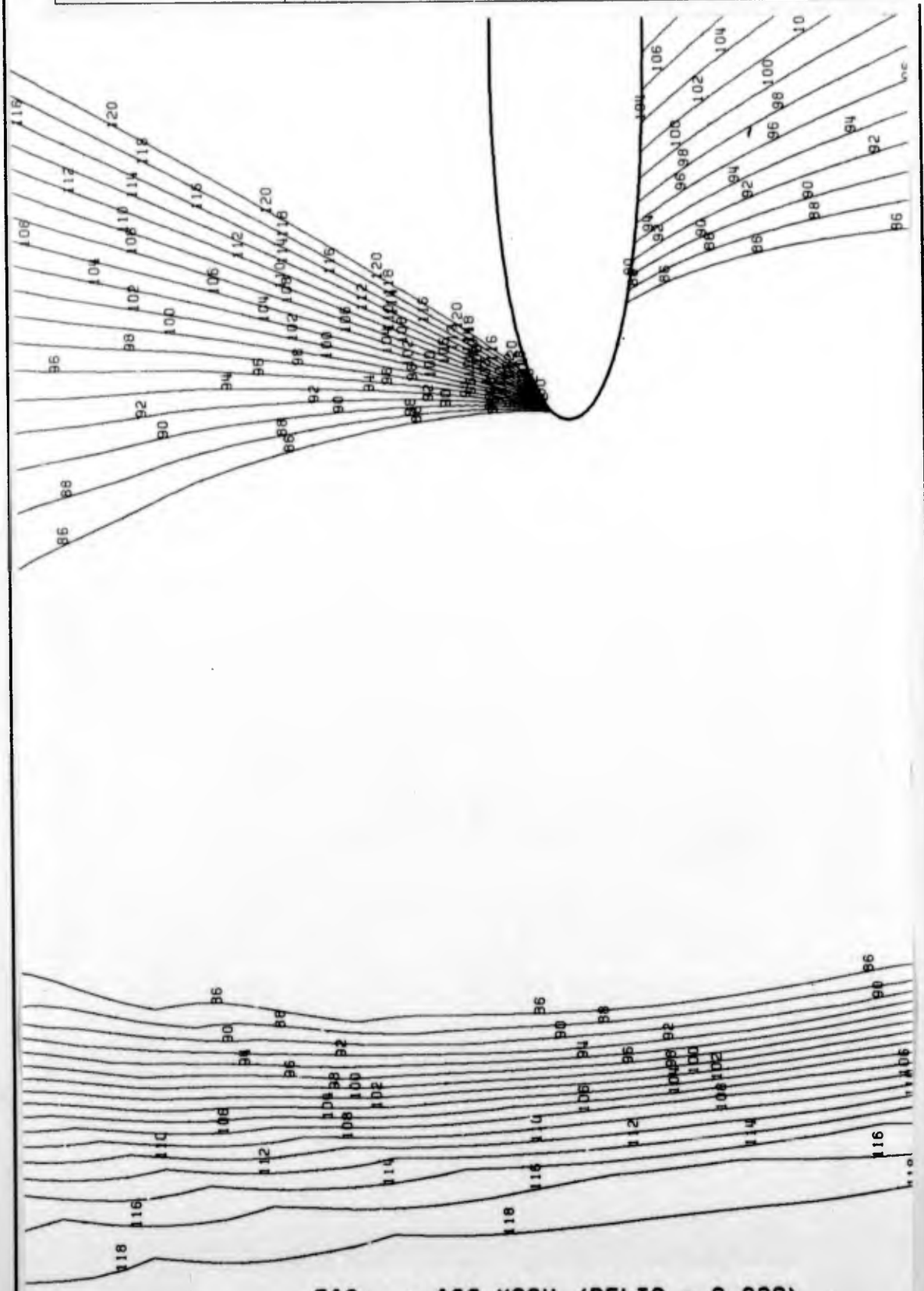


FIG. : ISO-MACH (DELTA = 0.020)

**** VALUES OF CURVE PARAMETER = 100*MACH ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-24
	NACA 0012: MACH = 1.2, ALPHA = 7			

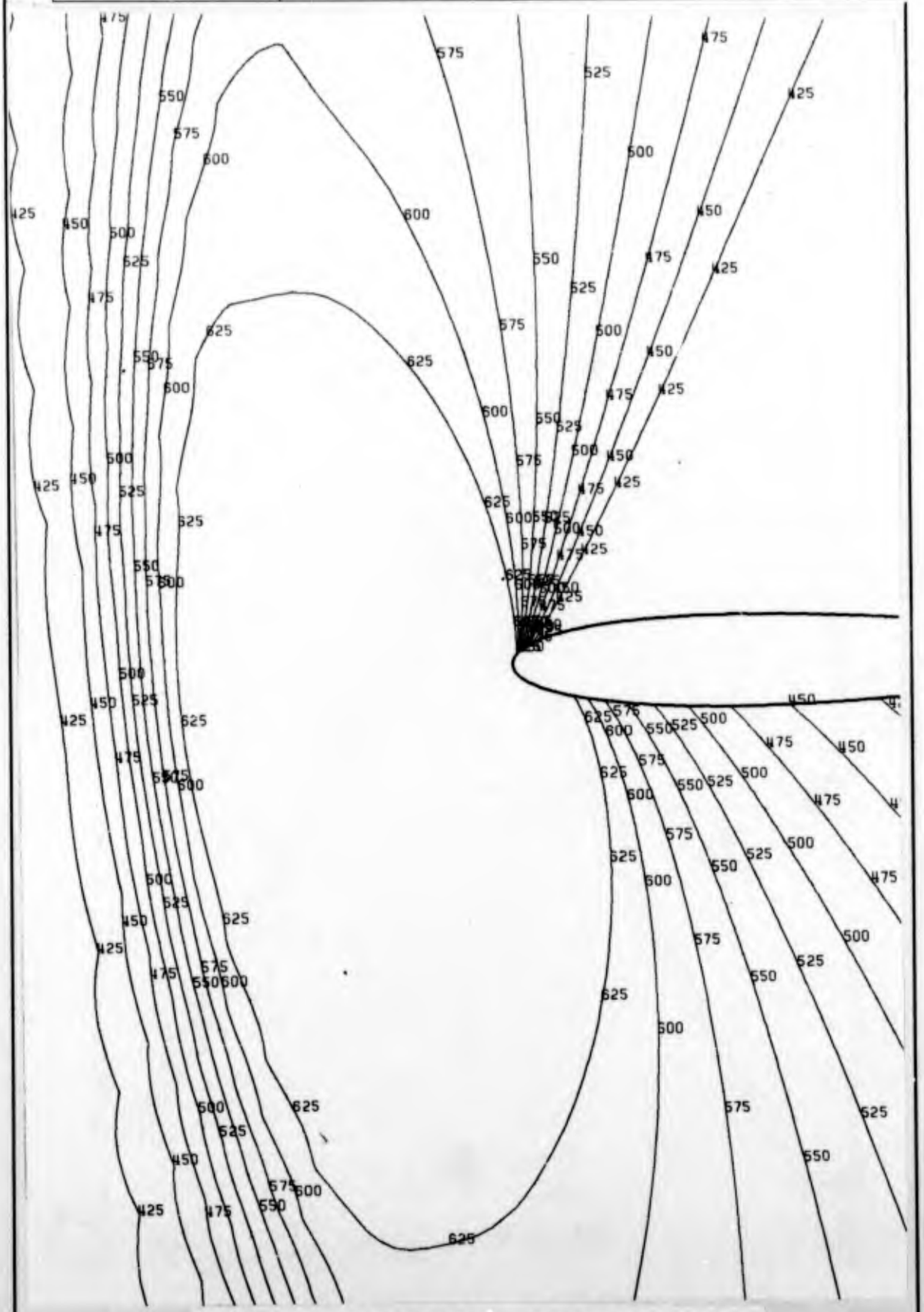
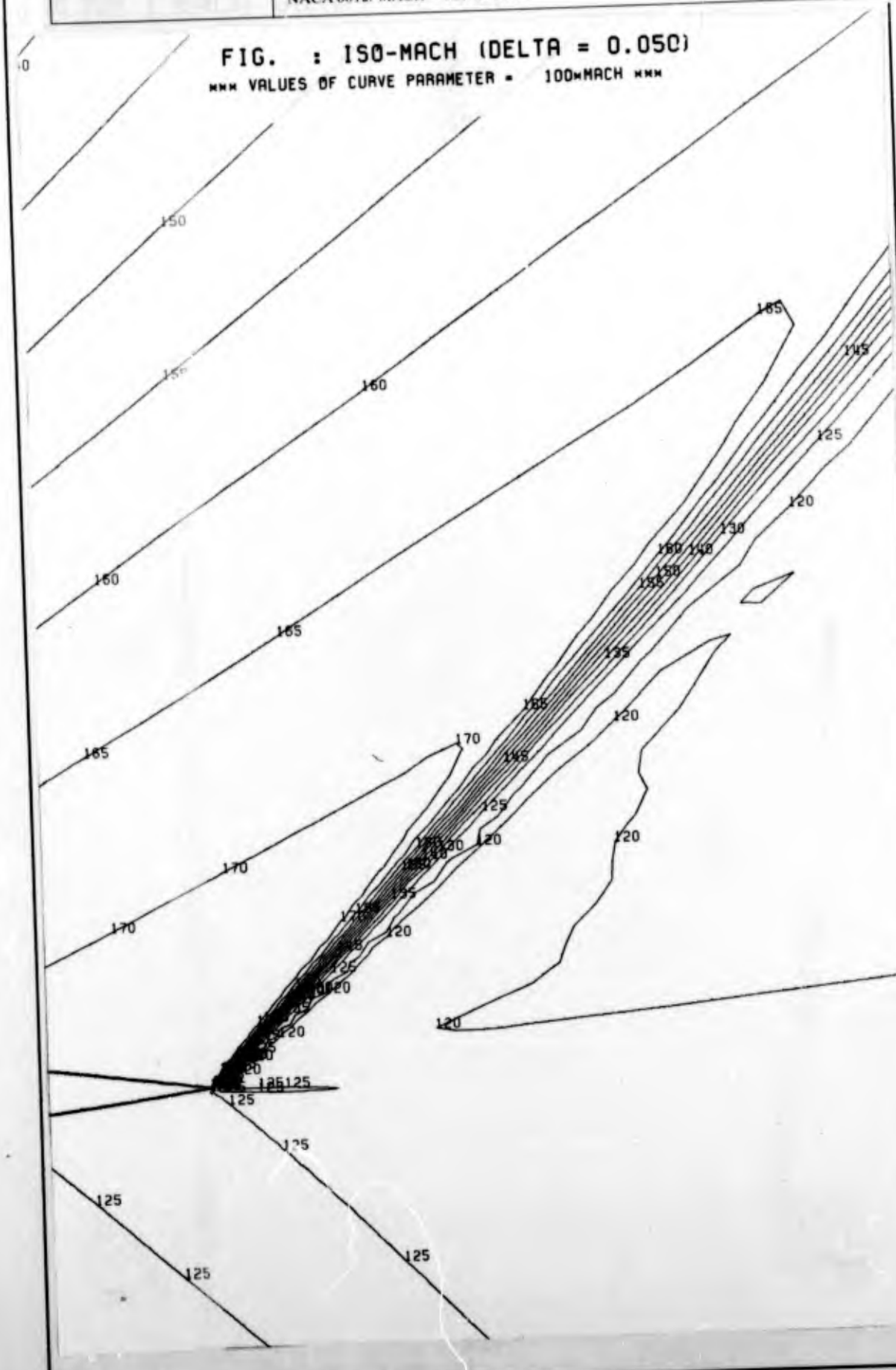


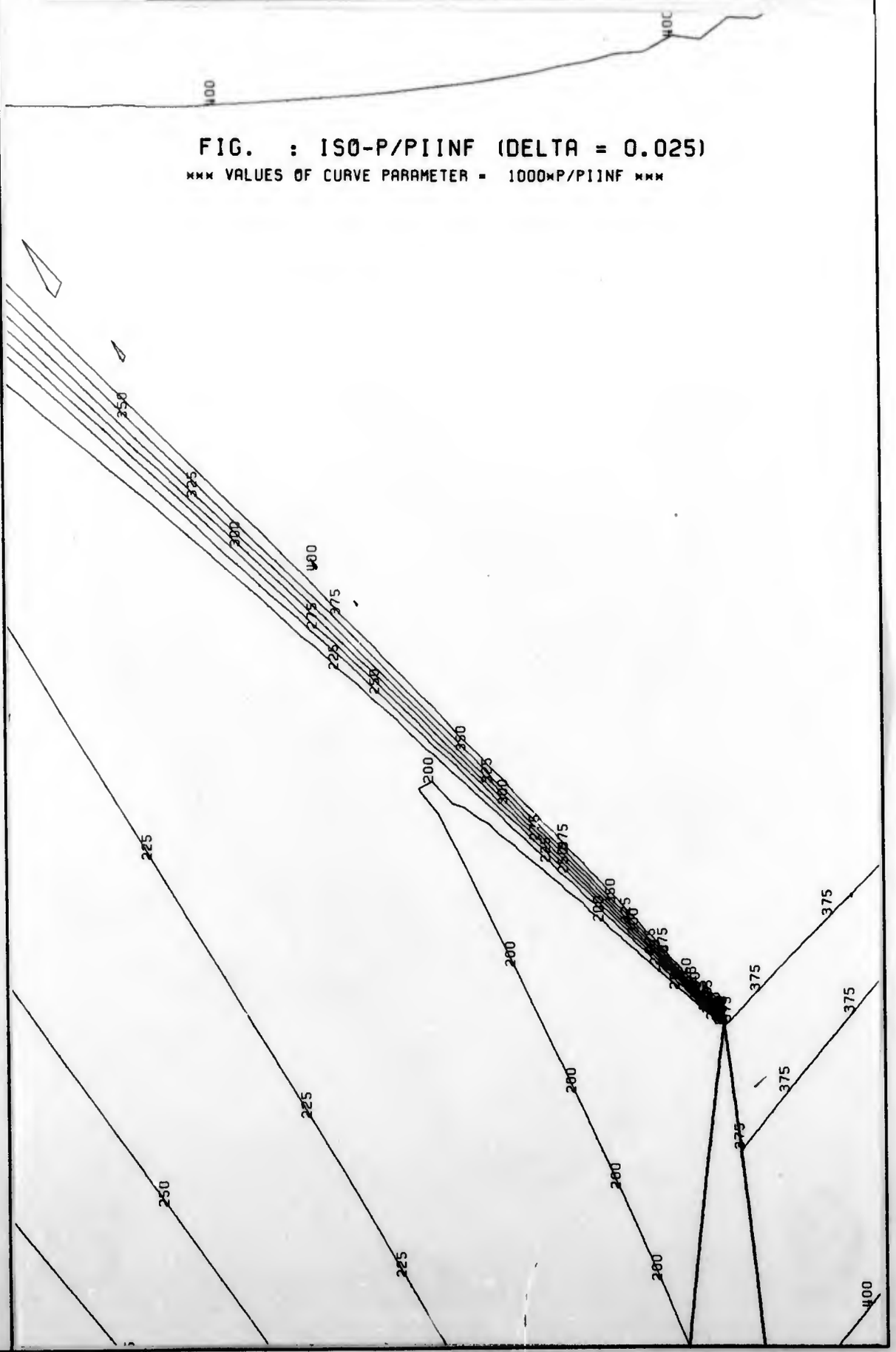
FIG. : ISO-P/PIINF (DELTA = 0.025)

**** VALUES OF CURVE PARAMETER = 1000*P/PIINF ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-25
	NACA 0012: MACH = 1.2, ALPHA = 7			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-26
	NACA 0012: MACH = 1.2, ALPHA = 7			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	05-9-27
	NACA 0012: MACH = 1.2, ALPHA = 7			

MESH	C_L	C_D	C_M	n-1	$(\Delta\rho/\Delta t)_{local}$ n = CYCLE	CYCLE
80 x 16	0.4733	0.1540	- 0.0991	0.62	$0.59 \cdot 10^{-4}$	500
160 x 32	0.5041	0.1539	- 0.1063	1.02	$0.14 \cdot 10^{-3}$	1000
320 x 64	0.5138	0.1538	- 0.1087	2.0	$0.10 \cdot 10^{-2}$	1000

PRATT & WHITNEY	AR 211		R-H.Ni	05-10-1
	NACA 0012: MACH = 1.2, ALPHA = 7			

N	X/C	Y/C	1-P/PIINF	CP	MACH	1-PI/PIINF
25	1.000000	0.0	0.713540	-0.302922	1.444790	0.028620
26	0.966960	-0.004590	0.597810	-0.024510	1.215920	0.004180
27	0.933930	-0.009010	0.621350	-0.081141	1.256980	0.010020
28	0.900910	-0.013240	0.619210	-0.075992	1.253070	0.009600
29	0.867930	-0.017310	0.614360	-0.064325	1.243150	0.010150
30	0.835000	-0.021220	0.611420	-0.057252	1.237640	0.009880
31	0.802140	-0.024970	0.607740	-0.048399	1.230420	0.010020
32	0.769370	-0.028570	0.604690	-0.041062	1.224590	0.009960
33	0.736710	-0.032010	0.601400	-0.033147	1.218290	0.009990
34	0.704180	-0.035300	0.598190	-0.025425	1.212200	0.009970
35	0.671810	-0.038420	0.594900	-0.017510	1.205970	0.009970
36	0.639630	-0.041370	0.591530	-0.009403	1.199630	0.009960
37	0.607650	-0.044150	0.588020	-0.000959	1.193070	0.009950
38	0.575910	-0.046740	0.584330	0.007919	1.186210	0.009930
39	0.544440	-0.049130	0.580270	0.017686	1.178710	0.009920
40	0.513270	-0.051320	0.575810	0.028415	1.170530	0.009900
41	0.482440	-0.053280	0.570930	0.040155	1.161620	0.009880
42	0.451990	-0.055000	0.565550	0.053098	1.151890	0.009850
43	0.421950	-0.056470	0.559620	0.067363	1.141240	0.009820
44	0.392370	-0.057670	0.553110	0.083025	1.129660	0.009790
45	0.363300	-0.058580	0.545900	0.100370	1.116930	0.009760
46	0.334800	-0.059180	0.537860	0.119712	1.102900	0.009720
47	0.306900	-0.059470	0.528890	0.141291	1.087380	0.009680
48	0.279670	-0.059420	0.518920	0.165276	1.070330	0.009630
49	0.253180	-0.059010	0.507990	0.191570	1.051840	0.009580
50	0.227480	-0.058250	0.496040	0.220318	1.031850	0.009540
51	0.202660	-0.057110	0.482900	0.251929	1.010140	0.009480
52	0.178780	-0.055590	0.468470	0.286643	0.986590	0.009420
53	0.155930	-0.053690	0.452500	0.325062	0.960820	0.009340
54	0.134190	-0.051390	0.434690	0.367908	0.932400	0.009260
55	0.113660	-0.048690	0.414730	0.415926	0.900920	0.009150
56	0.094430	-0.045610	0.392140	0.470270	0.865630	0.009030
57	0.076620	-0.042130	0.366480	0.532001	0.825840	0.008890
58	0.060330	-0.038260	0.336970	0.602993	0.780310	0.008700
59	0.045670	-0.034020	0.302010	0.687096	0.726320	0.008450
60	0.032780	-0.029410	0.259600	0.789122	0.660090	0.008090
61	0.021770	-0.024420	0.207130	0.915349	0.575420	0.007650
62	0.012790	-0.019050	0.140780	1.074967	0.459730	0.006810
63	0.005970	-0.013240	0.060790	1.267399	0.286470	0.005730
64	0.001540	-0.006890	0.006310	1.398461	0.033390	0.005540
65	0.0	0.0	0.057390	1.275578	0.280730	0.004360
66	0.001540	0.006890	0.219810	0.884845	0.602830	0.002660
67	0.005970	0.013240	0.393770	0.466349	0.871790	0.005230
68	0.012790	0.019050	0.494110	0.224961	1.031280	0.006410
69	0.021770	0.024420	0.561970	0.061710	1.146790	0.008160
70	0.032780	0.029410	0.600420	-0.030789	1.217160	0.008980
71	0.045670	0.034020	0.627920	-0.096946	1.270500	0.009390
72	0.060330	0.038260	0.649540	-0.148957	1.314390	0.009730
73	0.076620	0.042130	0.666650	-0.190119	1.350570	0.009980
74	0.094430	0.045610	0.680910	-0.224424	1.381850	0.010130
75	0.113660	0.048690	0.693360	-0.254375	1.410050	0.010260
76	0.134190	0.051390	0.704340	-0.280790	1.435690	0.010370
77	0.155930	0.053690	0.714130	-0.304342	1.459200	0.010450
78	0.178780	0.055590	0.722930	-0.325512	1.480920	0.010530
79	0.202660	0.057110	0.730900	-0.344685	1.501080	0.010600
80	0.227480	0.058250	0.738170	-0.362175	1.519900	0.010660
81	0.253180	0.059010	0.744810	-0.378149	1.537470	0.010710

NACA0012

MACH 1.200
ALPHA 7.000

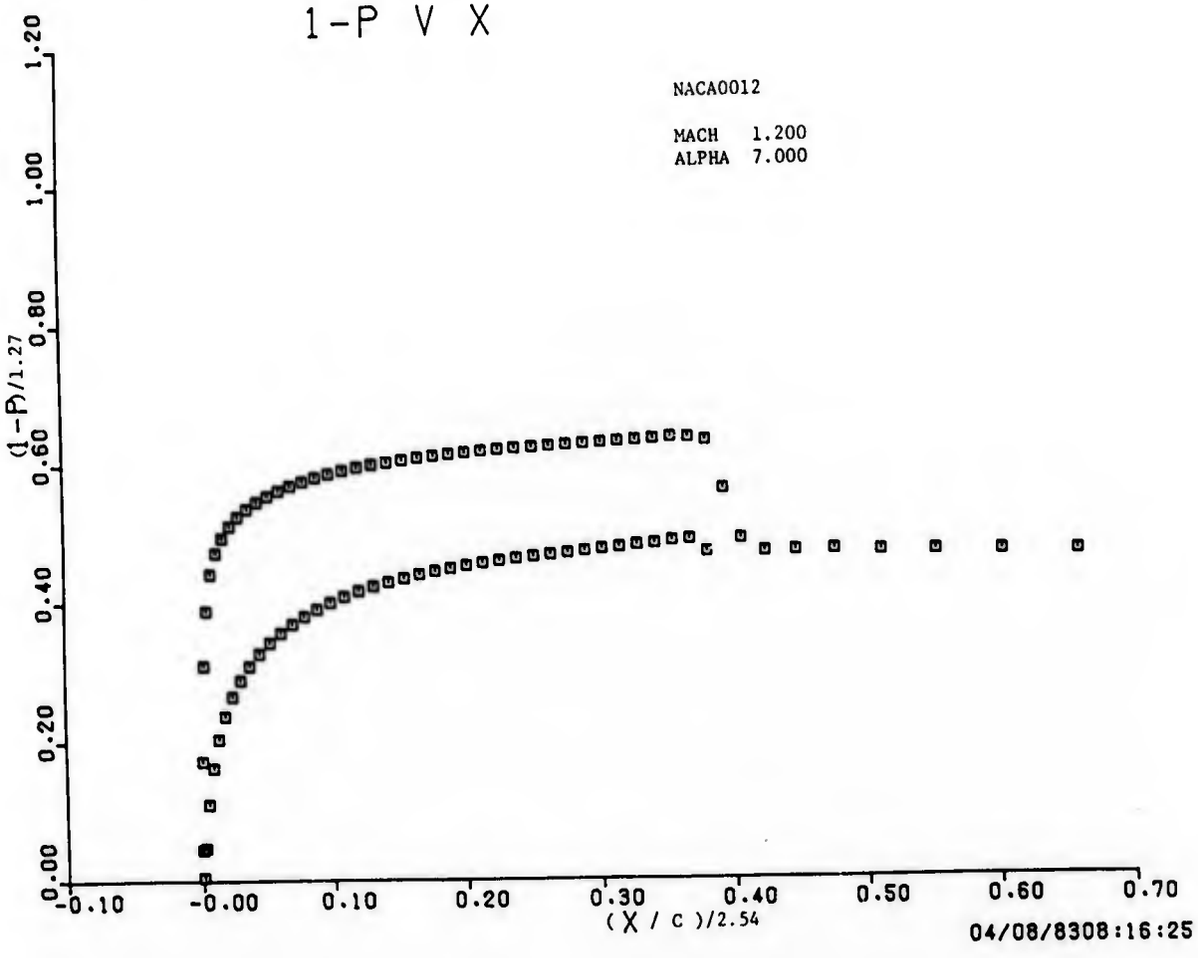
82	0.279670	0.059420	0.750910	-0.392823	1.553940	0.010760
83	0.306900	0.059470	0.756500	-0.406271	1.569370	0.010810
84	0.334800	0.059180	0.761590	-0.418516	1.583680	0.010850
85	0.363300	0.058580	0.766190	-0.429583	1.596820	0.010890
86	0.392370	0.057670	0.770340	-0.439566	1.608860	0.010930
87	0.421950	0.056470	0.774090	-0.448588	1.619940	0.010960
88	0.451990	0.055000	0.777530	-0.456863	1.630210	0.010980
89	0.482440	0.053280	0.780670	-0.464417	1.639730	0.011010
90	0.513270	0.051320	0.783530	-0.471297	1.648510	0.011030
91	0.544440	0.049130	0.786150	-0.477600	1.656640	0.011060
92	0.575910	0.046740	0.788550	-0.483374	1.664150	0.011080
93	0.607650	0.044150	0.790760	-0.488691	1.671140	0.011090
94	0.639630	0.041370	0.792850	-0.493719	1.677820	0.011100
95	0.671810	0.038420	0.794880	-0.498602	1.684350	0.011110
96	0.704180	0.035300	0.796850	-0.503341	1.690760	0.011120
97	0.736710	0.032010	0.798770	-0.507960	1.697060	0.011140
98	0.769370	0.028570	0.800710	-0.512627	1.703510	0.011110
99	0.802140	0.024970	0.802590	-0.517150	1.709720	0.011200
100	0.835000	0.021220	0.804700	-0.522226	1.716960	0.010980
101	0.867930	0.017310	0.806510	-0.526580	1.722760	0.011500
102	0.900910	0.013240	0.809480	-0.533725	1.733970	0.010020
103	0.933930	0.009010	0.808760	-0.531993	1.729780	0.012560
104	0.966960	0.004590	0.802940	-0.517992	1.718630	-0.000420
105	1.000000	0.0	0.713540	-0.302922	1.444790	0.028630

NACA0012

MACH 1.2000
ALPHA 7.0000

CL 0.51891
CD 0.15308
CM 0.10705

PRATT & WHITNEY	AR 211		R-H.Ni	05-10-3
	NACA 0012: MACH = 1.2, ALPHA = 7			



AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 05

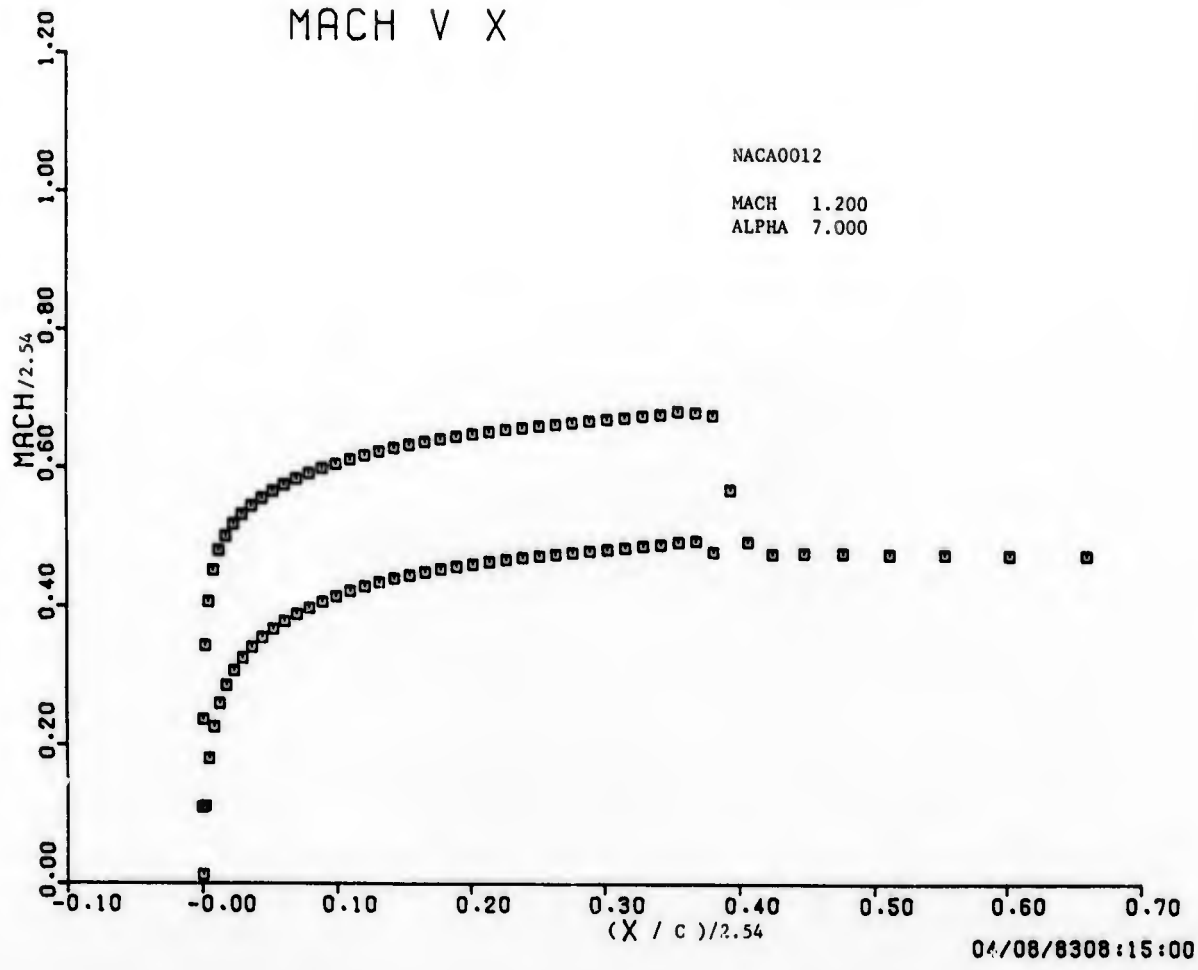
NACA 0012: MACH = 1.2, ALPHA = 7

Contributor No 10

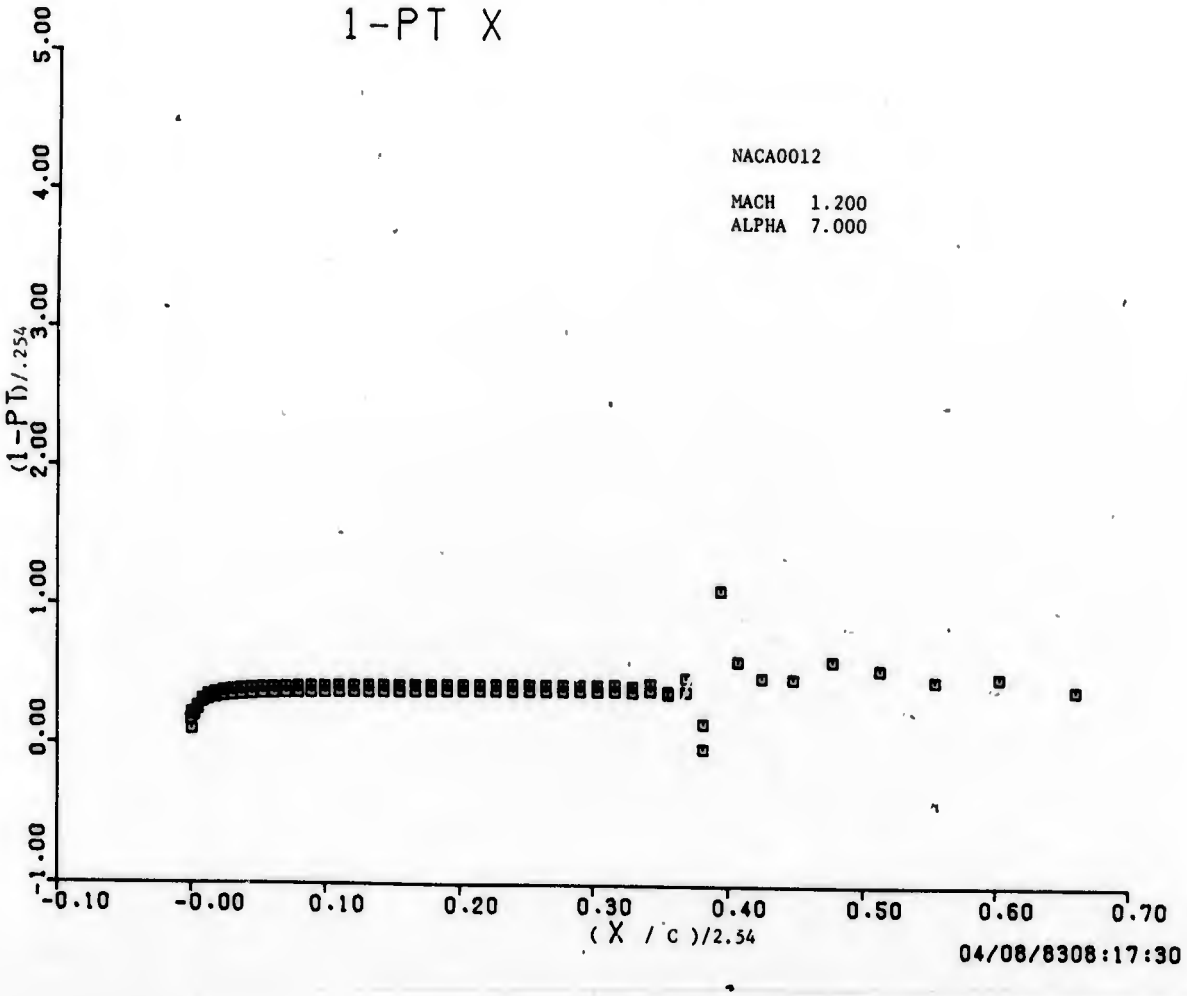
R-H.Ni

(Pratt & Whitney, U.S.A.)

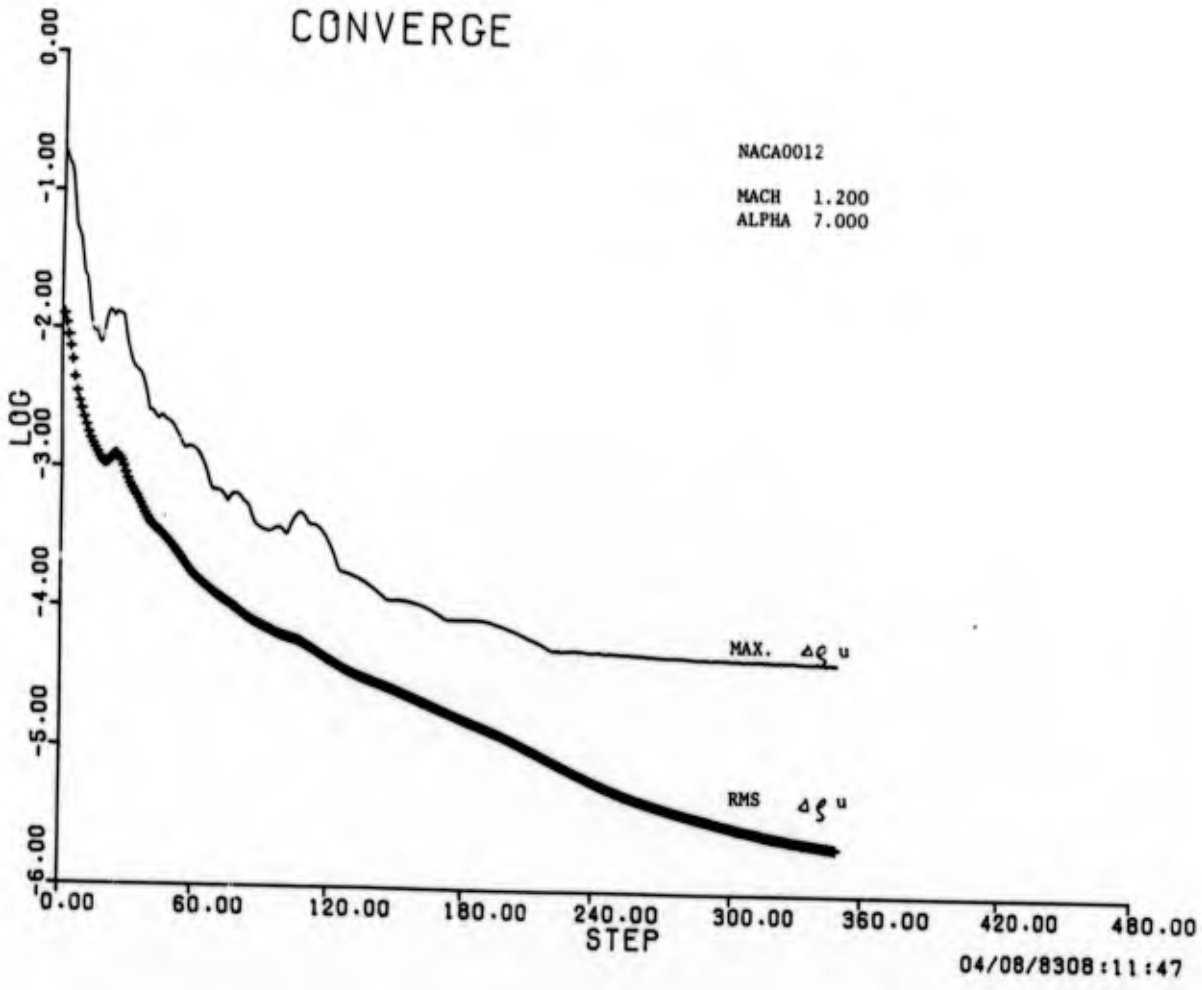
PRATT & WHITNEY	AR 211		R-H.Ni	05-10-4
	NACA 0012: MACH = 1.2, ALPHA = 7			



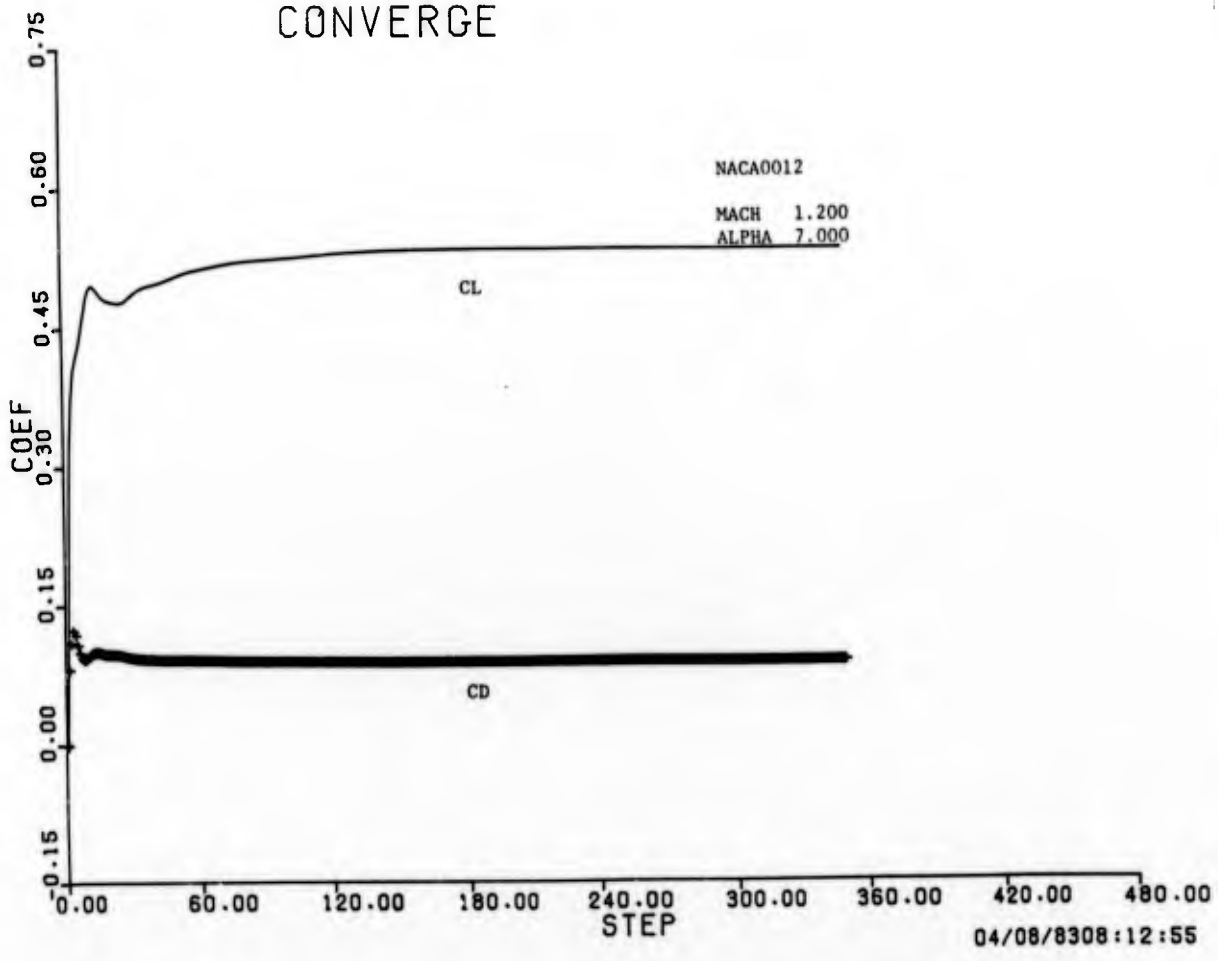
PRATT & WHITNEY	AR 211		R-H.Ni	05-10-5
	NACA 0012: MACH = 1.2, ALPHA = 7			



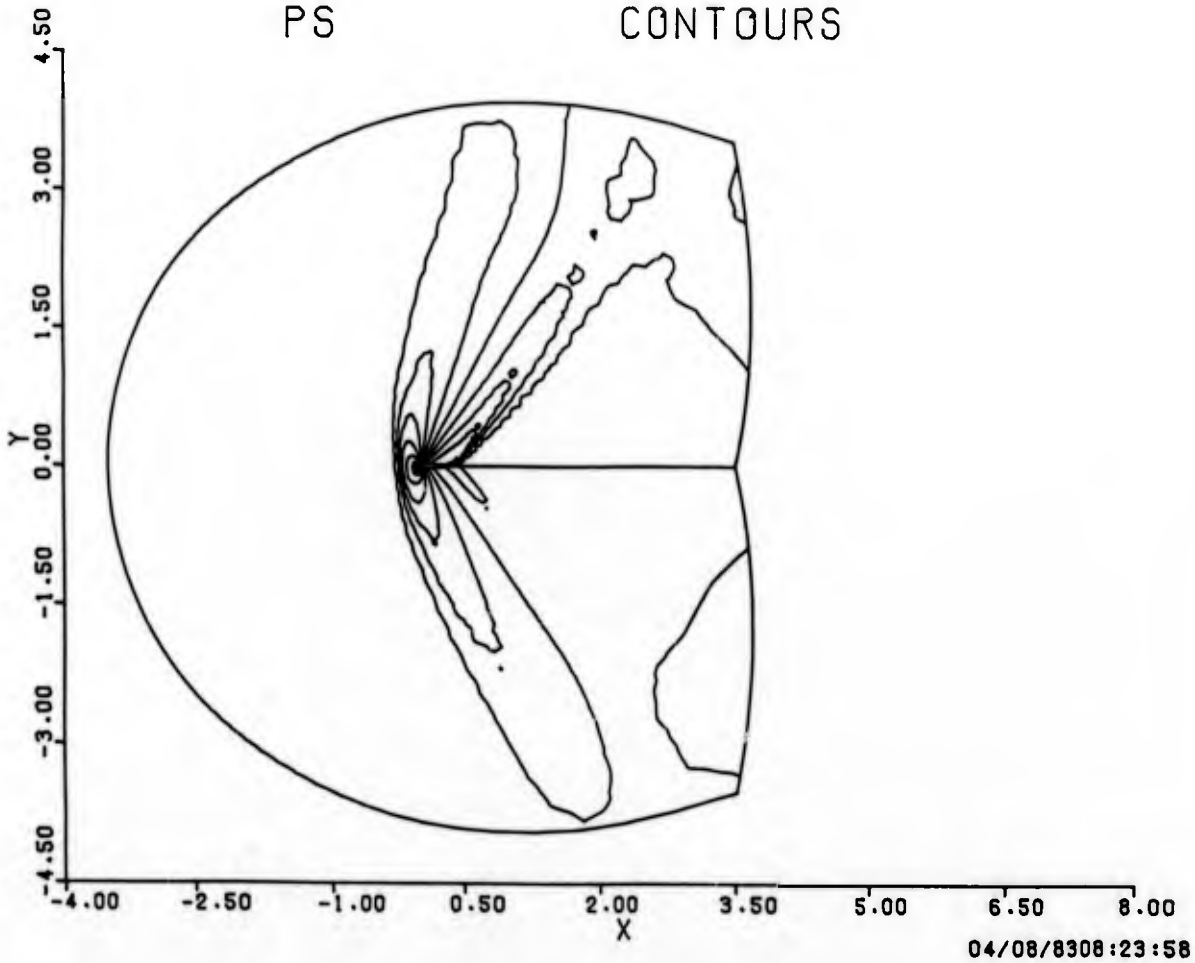
PRATT & WHITNEY	AR 211		R-H.Ni	05-10-6
	NACA 0012: MACH = 1.2, ALPHA = 7			



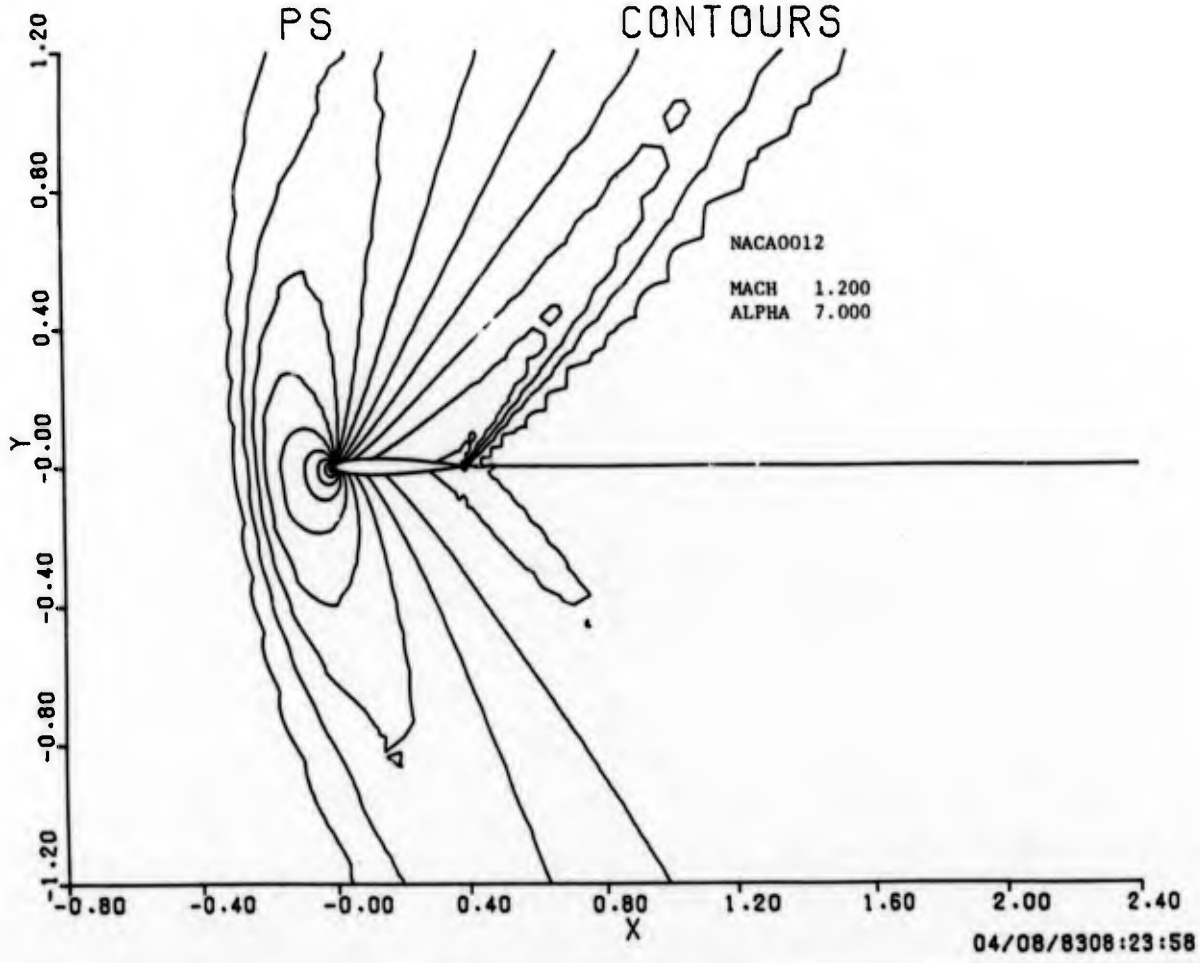
PRATT & WHITNEY	AR 211		R-H.Ni	05-10-7
	NACA 0012: MACH = 1.2, ALPHA = 7			



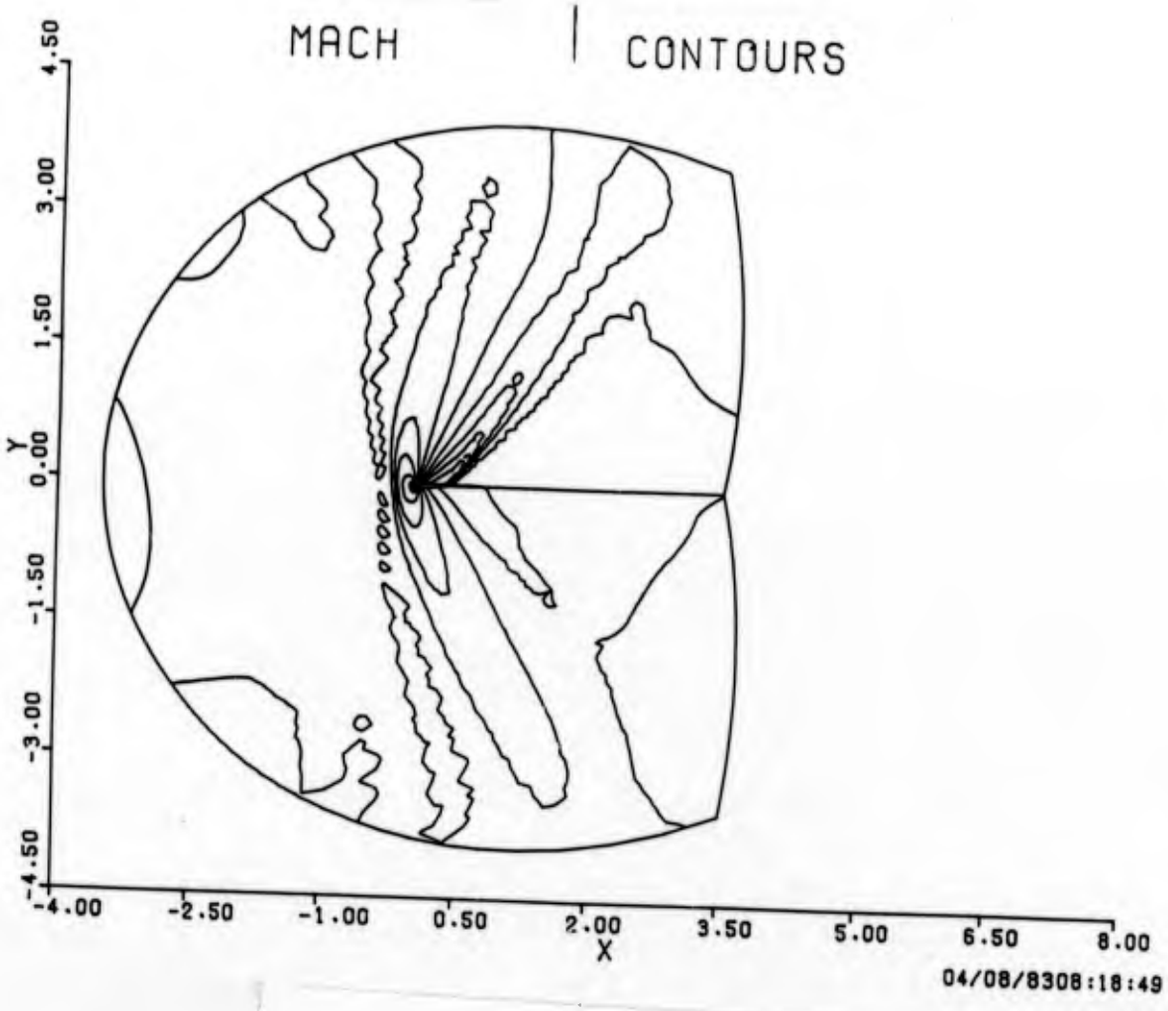
PRATT & WHITNEY	AR 211		R-H.Ni	05-10-8
	NACA 0012: MACH = 1.2, ALPHA = 7			



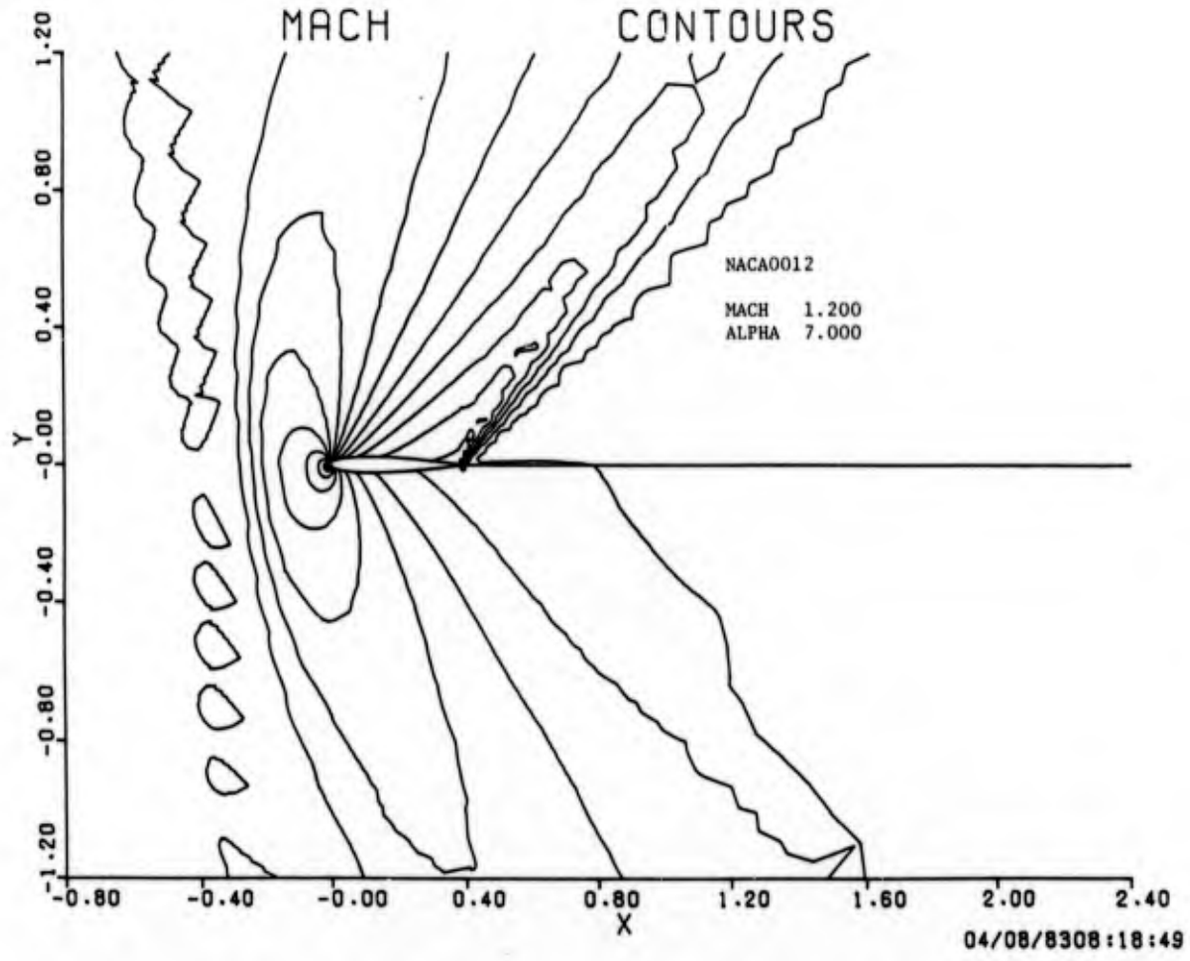
PRATT & WHITNEY	AR 211		R-H.Ni	05-10-9
	NACA 0012: MACH = 1.2, ALPHA = 7			



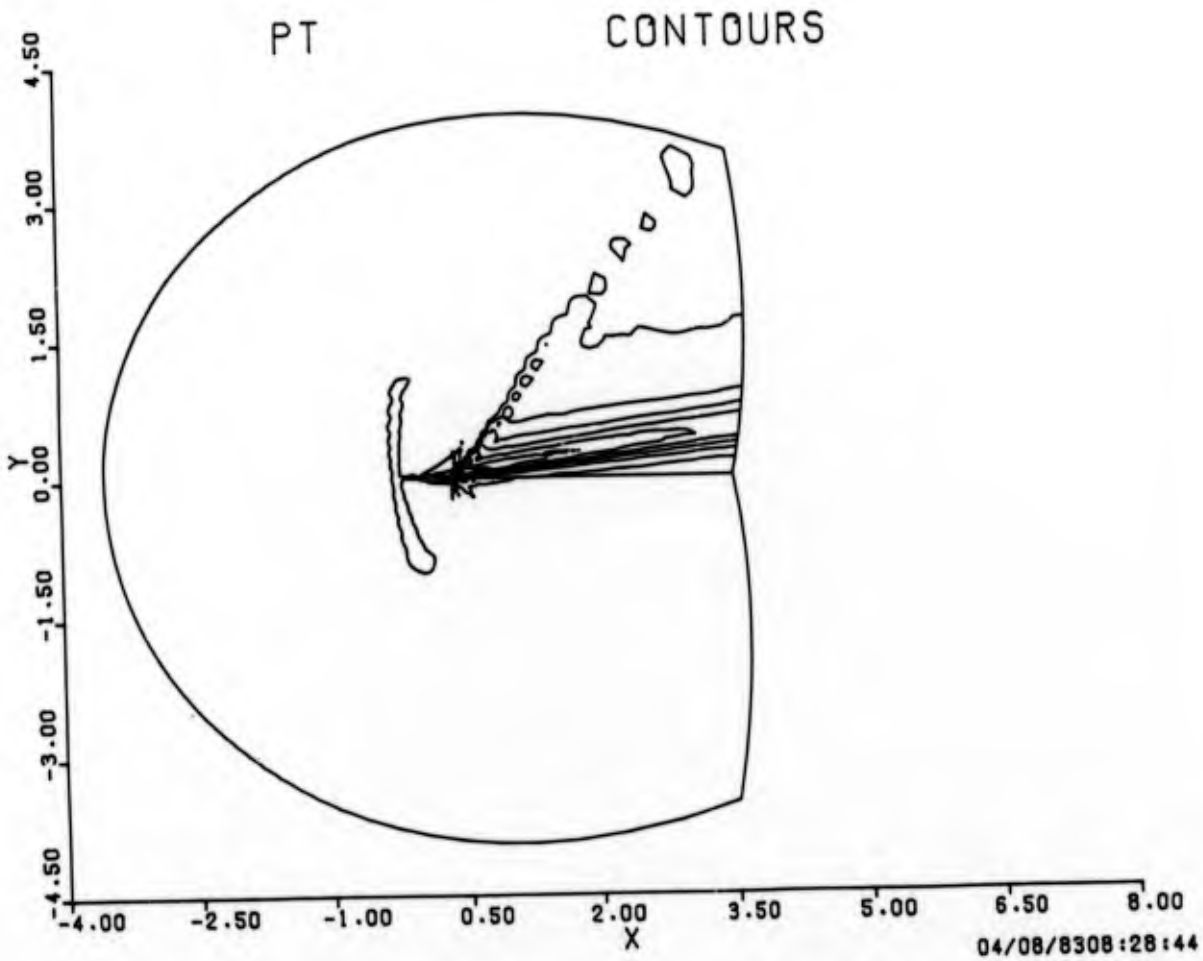
PRATT & WHITNEY	AR 211		R-H.Ni	05-10-10
	NACA 0012: MACH = 1.2, ALPHA = 7			



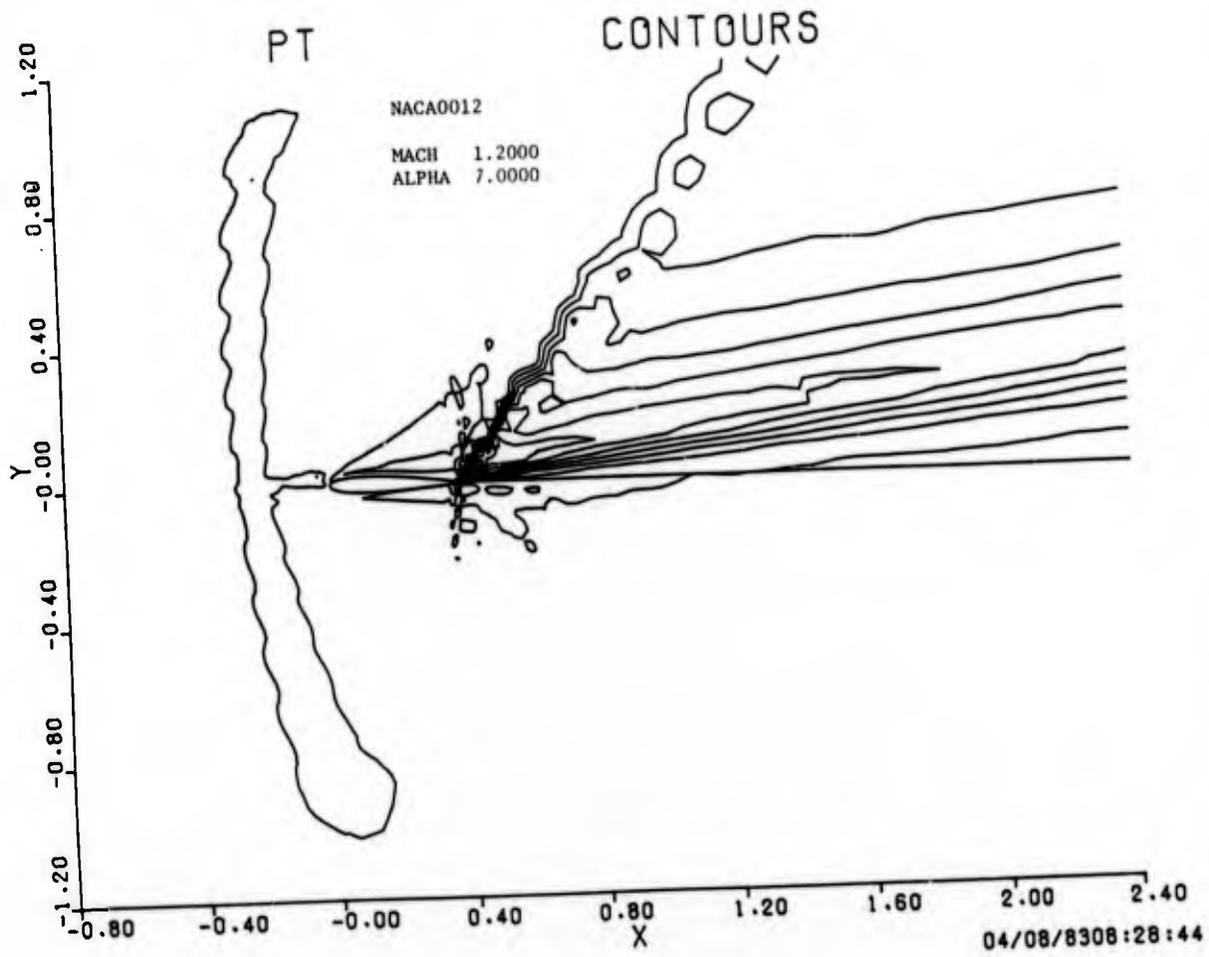
PRATT & WHITNEY	AR 211		R-H.Ni	05-10-11
	NACA 0012: MACH = 1.2, ALPHA = 7			



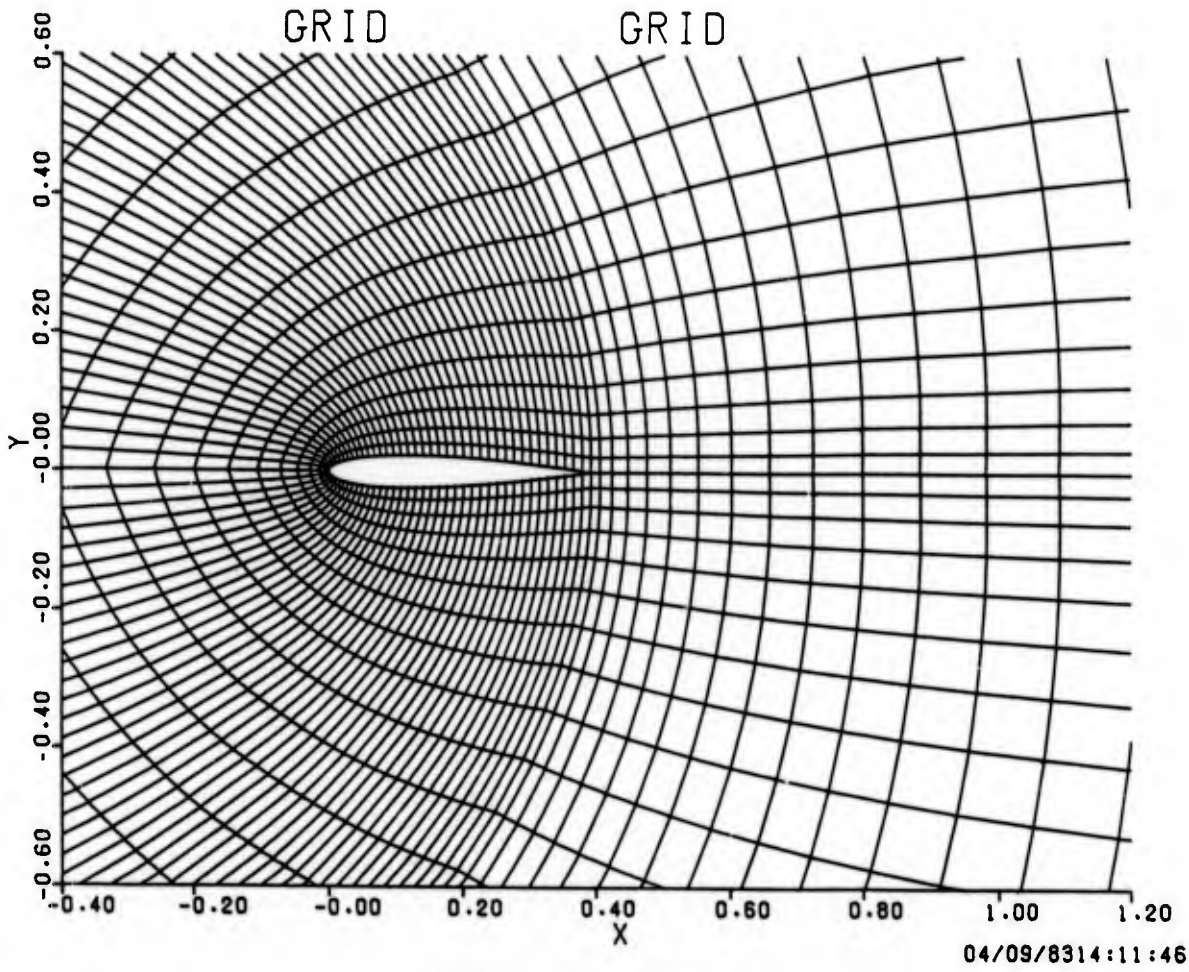
PRATT & WHITNEY	AR 211		R-H.Ni	05-10-12
	NACA 0012: MACH = 1.2, ALPHA = 7			



PRATT & WHITNEY	AR 211		R-H.Ni	05-10-13
	NACA 0012: MACH = 1.2, ALPHA = 7			



PRATT & WHITNEY	AR 211		R-H.Ni	05-10-14
	NACA 0012: MACH = 1.2, ALPHA = 7			



COMPUTIONAL MESH FOR NACA0012

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 06

RAE 2822: MACH = 0.75, ALPHA = 3

Contributor No 1

J.P.Veuillot and A.M.Vuillot

(O.N.E.R.A., France)

COMMENTS ON CALCULATION FOR TEST CASE 06

.* The computational domain is inscribed in the rectangle

- $4.00 \leq x/c \leq 6.97$, $- 6.00 \leq z/c \leq 6.00$

* Number of mesh points : 251 x 35 = 8 785 (195 mesh points on the profile)

* Artificial viscosity ;

D_1 term : $Q_{1i} = Q_{1j} = 0.25\ 10^{-2}$

D_2 term : $Q_{2i} = 0.4$, $Q_{2j} = 0.2$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-2
	RAE 2822: MACH = 0.75, ALPHA = 3			

WALL VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	.137813	.640347	.472170	-.004409
2	.000023	.000659	.171305	.516818	.531797	-.004678
3	.000101	.001327	.209674	.375298	.594086	-.003423
4	.000238	.002010	.246996	.237643	.653739	-.003383
5	.000442	.002718	.284588	.098992	.713179	-.004182
6	.000719	.003456	.321868	-.038510	.771830	-.005578
7	.001082	.004234	.359443	-.177098	.830338	-.006727
8	.001546	.005057	.396109	-.312335	.888137	-.008370
9	.002129	.005932	.432386	-.446137	.945740	-.009724
10	.002856	.006862	.464210	-.563515	.996813	-.010451
11	.003751	.007853	.491267	-.663308	1.041381	-.011290
12	.004837	.008910	.520640	-.771645	1.090403	-.011424
13	.006152	.010031	.546996	-.868856	1.135343	-.010981
14	.007729	.011215	.563624	-.930185	1.164157	-.010259
15	.009596	.012471	.578147	-.983752	1.189544	-.009154
16	.011796	.013789	.591340	-1.032411	1.213291	-.008368
17	.014361	.015175	.603187	-1.076105	1.235378	-.008076
18	.017335	.016617	.613514	-1.114197	1.254885	-.007657
19	.020748	.018116	.620321	-1.139303	1.267923	-.007352
20	.024635	.019671	.624937	-1.156326	1.276838	-.007116
21	.029026	.021278	.627768	-1.166770	1.282411	-.007058
22	.033947	.022934	.629530	-1.173266	1.285913	-.007049
23	.039422	.024631	.630204	-1.175755	1.287198	-.006965
24	.045467	.026367	.629756	-1.174101	1.286289	-.006946
25	.052095	.028138	.628928	-1.171047	1.284641	-.006951
26	.059315	.029936	.628079	-1.167914	1.282982	-.006994
27	.067130	.031753	.627238	-1.164815	1.281258	-.006922
28	.075539	.033580	.626422	-1.161805	1.279664	-.006957
29	.084537	.035412	.626098	-1.160608	1.279061	-.007012
30	.094119	.037232	.625830	-1.159623	1.278367	-.006789
31	.104271	.039040	.625448	-1.158212	1.277674	-.006877
32	.114983	.040830	.625946	-1.160050	1.278675	-.006896
33	.126242	.042579	.626521	-1.162169	1.279655	-.006679
34	.138032	.044295	.626692	-1.162799	1.279925	-.006586
35	.150337	.045972	.627439	-1.165554	1.281450	-.006642
36	.163142	.047597	.628944	-1.171108	1.284397	-.006574
37	.176433	.049155	.630255	-1.175940	1.286834	-.006332
38	.190192	.050656	.631150	-1.179243	1.288572	-.006259
39	.204402	.052097	.632473	-1.184124	1.291218	-.006250
40	.219048	.053465	.634199	-1.190488	1.294611	-.006147
41	.234116	.054754	.635710	-1.196061	1.297449	-.005860
42	.249587	.055969	.637247	-1.201729	1.300615	-.005937
43	.265445	.057105	.639622	-1.210492	1.305402	-.005886
44	.281679	.058134	.641850	-1.218708	1.309743	-.005606
45	.298268	.059080	.643513	-1.224842	1.313074	-.005500
46	.315196	.059936	.645557	-1.232382	1.317252	-.005465
47	.332449	.060694	.648297	-1.242486	1.322889	-.005432
48	.350010	.061334	.651302	-1.253569	1.329039	-.005296
49	.367859	.061860	.653969	-1.263407	1.334476	-.005099
50	.385977	.062275	.656468	-1.272626	1.339657	-.004993
51	.404337	.062581	.659554	-1.284006	1.346233	-.005058
52	.422909	.062753	.663272	-1.297721	1.354069	-.004929
53	.441648	.062785	.666779	-1.310654	1.361469	-.004738
54	.460495	.062688	.670190	-1.323236	1.368756	-.004592
55	.479373	.062457	.674460	-1.338983	1.378196	-.004742
56	.498183	.062070	.679916	-1.359109	1.390263	-.004745
57	.516810	.061505	.685182	-1.378531	1.401847	-.004447
58	.535117	.060802	.689689	-1.395156	1.411960	-.004295
59	.552965	.059978	.694730	-1.413747	1.423691	-.004527
60	.570222	.059027	.700462	-1.434887	1.436966	-.004436
61	.586778	.057956	.705191	-1.452330	1.447904	-.004119
62	.602548	.056834	.709238	-1.467257	1.457750	-.004378
63	.617495	.055659	.713161	-1.481727	1.466973	-.004017
64	.631622	.054498	.715747	-1.491263	1.473284	-.004032
65	.644976	.053275	.718946	-1.503064	1.481223	-.004142
66	.657642	.052052	.721772	-1.513487	1.488056	-.003893
67	.669722	.050857	.723953	-1.521531	1.493765	-.004274
68	.681335	.049636	.725933	-1.528833	1.498044	-.003263
69	.692594	.048430	.727833	-1.535842	1.504158	-.005171
70	.703603	.047190	.729784	-1.543038	1.506469	-.001315
71	.714440	.045951	.730612	-1.546093	1.513652	-.008712
72	.725159	.044662	.733715	-1.557537	1.511365	.006213
73	.735780	.043370	.738162	-1.573938	1.543199	-.023615
74	.746303	.042026	.746514	-1.604744	1.559533	-.014980
75	.756720	.040683	.564186	-.932257	1.045815	.129042

A.M. VEUILLOT

WALL VALUES - UPPER SIDE (Cont.)

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
76	.767040	.039302	.332853	-.079027	.700532	.074160
77	.777294	.037916	.311496	-.000255	.680610	.061175
78	.787533	.036481	.347623	-.133503	.722686	.076331
79	.797824	.035024	.329015	-.064871	.700048	.069236
80	.808241	.033501	.333866	-.082761	.705183	.071707
81	.818855	.031930	.330339	-.069752	.700165	.070975
82	.829727	.030276	.328676	-.063621	.697111	.071200
83	.840890	.028549	.325968	-.053631	.692629	.071153
84	.852348	.026741	.323157	-.043265	.687887	.071175
85	.864065	.024858	.320039	-.031765	.682624	.071193
86	.875967	.022909	.316560	-.018932	.676725	.071225
87	.887952	.020905	.312676	-.004605	.670160	.071231
88	.899894	.018872	.308459	.010949	.662980	.071265
89	.911663	.016824	.303822	.028050	.655083	.071286
90	.923138	.014793	.298869	.046317	.646638	.071291
91	.934219	.012793	.293660	.065531	.637679	.071326
92	.944843	.010841	.288036	.086275	.627977	.071351
93	.954982	.008944	.281986	.108587	.617501	.071365
94	.964651	.007099	.275246	.133449	.605593	.071496
95	.973897	.005304	.267475	.162111	.591961	.071494
96	.982800	.003535	.258063	.196825	.574791	.071831
97	.991462	.001781	.242262	.255105	.542523	.074315
98	1.000000	0.000000	.218982	.340969	.508519	.068229

SLIP LINE VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
99	1.008537	-.000671	.227588	.309226	.523190	.069179
100	1.017191	-.001248	.243367	.251027	.546812	.072807
101	1.026110	-.001777	.246431	.239729	.554464	.071411
102	1.035659	-.002283	.251905	.219537	.563804	.071793
103	1.046637	-.002805	.255591	.205942	.570735	.071576
104	1.060186	-.003375	.259822	.190335	.578158	.071670
105	1.077475	-.004010	.263922	.175216	.585453	.071659
106	1.099652	-.004704	.268249	.159255	.593016	.071717
107	1.128024	-.005435	.272637	.143069	.600645	.071777
108	1.164165	-.006167	.277072	.126714	.608282	.071863
109	1.209954	-.006846	.281476	.110468	.615795	.071977
110	1.267595	-.007388	.285770	.094631	.623035	.072128
111	1.339639	-.007680	.289865	.079527	.629847	.072323
112	1.429016	-.007570	.293677	.065470	.636091	.072563
113	1.539121	-.006863	.297132	.052727	.641627	.072865
114	1.673831	-.005317	.300178	.041489	.646248	.073326
115	1.837463	-.002649	.302766	.031945	.649804	.074001
116	2.034749	.001457	.304946	.023905	.652431	.074856
117	2.270820	.007390	.306774	.017164	.654354	.075792
118	2.551135	.015565	.308221	.011824	.655733	.076647
119	2.881376	.026413	.309314	.007792	.656732	.077327
120	3.267305	.040368	.310120	.004821	.657433	.077817
121	3.714591	.057843	.310694	.002704	.658051	.078140
122	4.228574	.079202	.311079	.001284	.658459	.078336
123	4.813942	.104710	.311312	.000424	.658724	.078441
124	5.473913	.134460	.311430	-.000010	.658851	.078499
125	6.199194	.167840	.311468	-.000149	.658822	.078572
126	6.968506	.203514	.311428	-.000003	.658746	.078579

VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-4
	RAE 2822: MACH = 0.75, ALPHA = 3			

WALL VALUES - LOWER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	0.000000	0.000000	.137813	.640347	.472170	-.004409
2	.000023	-.000659	.107553	.751956	.414310	-.004362
3	.000101	-.001327	.080015	.853522	.356120	-.004279
4	.000238	-.002010	.055474	.944039	.297206	-.004229
5	.000442	-.002718	.035120	1.019110	.237804	-.003618
6	.000719	-.003456	.019624	1.076264	.178584	-.002437
7	.001082	-.004234	.008623	1.116841	.119958	-.001399
8	.001546	-.005057	.002500	1.139425	.061860	-.000175
9	.002129	-.005932	.001141	1.144435	.004897	.001125
10	.002855	-.006864	.003983	1.133956	.050209	.002224
11	.003746	-.007858	.010374	1.110383	.103357	.002954
12	.004829	-.008919	.019719	1.075916	.154072	.003333
13	.006137	-.010049	.031290	1.033236	.201965	.003348
14	.007703	-.011251	.044547	.984342	.247050	.003100
15	.009559	-.012527	.059116	.930607	.289238	.002855
16	.011747	-.013873	.074254	.874771	328363	.002479
17	.014299	-.015293	.089775	.817524	.364719	.002165
18	.017257	-.016779	.105309	.760233	.398412	.001890
19	.020654	-.018331	.120537	.704064	.429481	.001649
20	.024527	-.019939	.135256	.649778	.457982	.001493
21	.028906	-.021602	.149317	.597915	.484231	.001312
22	.033817	-.023314	.163043	.547290	.508994	.001172
23	.039284	-.025067	.176233	.498641	.532027	.001135
24	.045327	-.026843	.188398	.453771	.552799	.001116
25	.051958	-.028641	.199771	.411824	.572070	.000957
26	.059183	-.030454	.210781	.371216	.590199	.000995
27	.067008	-.032263	.220762	.334401	.606476	.000999
28	.075429	-.034072	.230110	.299923	.621716	.000885
29	.084440	-.035873	.239250	.266212	.636302	.000925
30	.094034	-.037655	.247777	.234762	.649873	.000912
31	.104200	-.039418	.256012	.204391	.662946	.000858
32	.114925	-.041153	.264125	.174467	.675707	.000849
33	.126196	-.042849	.271804	.146143	.687680	.000885
34	.137999	-.044496	.278912	.119928	.698757	.000886
35	.150318	-.046096	.285782	.094588	.709479	.000843
36	.163135	-.047643	.292655	.069236	.720129	.000843
37	.176436	-.049130	.299375	.044453	.730525	.000837
38	.190206	-.050549	.305873	.020485	.740499	.000888
39	.204427	-.051895	.312243	-.003008	.750403	.000804
40	.219084	-.053169	.318808	-.027223	.760488	.000823
41	.234163	-.054347	.325126	-.050526	.770059	.000962
42	.249646	-.055441	.331577	-.074321	.780193	.000750
43	.265516	-.056448	.339178	-.102353	.791872	.000747
44	.281762	-.057323	.346718	-.130165	.803311	.000892
45	.298368	-.058059	.353752	-.156108	.814085	.000930
46	.315318	-.058645	.361385	-.184262	.826134	.000618
47	.332596	-.059061	.369689	-.214889	.838878	.000661
48	.350193	-.059212	.375695	-.237043	.847771	.001045
49	.368087	-.059105	.378389	-.246978	.851986	.000986
50	.386255	-.058742	.380026	-.253016	.854743	.000748
51	.404672	-.058111	.380644	-.255294	.855691	.000755
52	.423307	-.057158	.377994	-.245521	.851243	.001124
53	.442112	-.055902	.371711	-.222347	.841549	.001121
54	.461025	-.054390	.364323	-.195099	.830298	.000984
55	.479964	-.052644	.356689	-.166940	.818538	.000994
56	.498830	-.050684	.348047	-.135067	.805052	.001192
57	.517503	-.048546	.338308	-.099145	.790072	.001203
58	.535845	-.046311	.328922	-.064527	.775799	.001054
59	.553718	-.044022	.320581	-.033764	.762969	.001059
60	.570990	-.041720	.312656	-.004533	.750732	.001095
61	.587549	-.039441	.305029	.023597	.738997	.001075
62	.603317	-.037226	.298001	.049518	.728161	.001061
63	.618253	-.035096	.291717	.072696	.718510	.000996
64	.632367	-.033068	.286092	.093444	.709721	.001059
65	.645704	-.031128	.280663	.113468	.701346	.001006
66	.658349	-.029293	.275674	.131869	.693536	.001045
67	.670408	-.027528	.270862	.149617	.686077	.001001
68	.681997	-.025853	.266464	.165837	.679169	.001027
69	.693232	-.024222	.262308	.181166	.672707	.000979
70	.704214	-.022661	.258539	.195068	.666737	.001020
71	.715025	-.021117	.254803	.208846	.660906	.000974
72	.725716	-.019630	.251175	.222231	.655071	.001063
73	.736310	-.018148	.247398	.236159	.649241	.000938
74	.746803	-.016743	.244272	.247691	.644187	.001016
75	.757191	-.015341	.241057	.259549	.639126	.000971

AL-VEUILLOT

WALL VALUES - LOWER SIDE (Cont.)

N	X/C	Z/C	1-P/P INF	CP	MACH	1-PI/PIINF
76	.767481	-.014021	.238065	.270584	.634307	.001010
77	.777706	-.012699	.235040	.281742	.629521	.000968
78	.787915	-.011457	.232238	.292076	.624999	.000994
79	.798177	-.010202	.229401	.302540	.620435	.000998
80	.808564	-.009019	.226812	.312089	.616397	.000892
81	.819149	-.007823	.224519	.320546	.612436	.001098
82	.829991	-.006669	.221606	.331290	.608056	.000832
83	.841125	-.005528	.219231	.340050	.603765	.001175
84	.852553	-.004408	.215692	.353104	.598393	.000869
85	.864241	-.003377	.213720	.360376	.595181	.000863
86	.876116	-.002395	.211686	.367876	.591513	.001127
87	.888075	-.001487	.208554	.379430	.586601	.000949
88	.899994	-.000705	.206396	.387390	.583124	.000891
89	.911741	-.000055	.205000	.392539	.580745	.000948
90	.923197	.000461	.203781	.397034	.578740	.000942
91	.934263	.000842	.202807	.400625	.577106	.000959
92	.944874	.001091	.202021	.403526	.575794	.000966
93	.955003	.001204	.201736	.404354	.575534	.000881
94	.964663	.001180	.202741	.400869	.577122	.000864
95	.973904	.001038	.204623	.393927	.580189	.000898
96	.982803	.000792	.207121	.384715	.584317	.000893
97	.991462	.000450	.209736	.375071	.588118	.001276
98	1.000000	.000001	.213679	.360526	.596087	.000106

SLIP LINE VALUES - LOWER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
99	1.008537	-.000670	.227588	.309226	.619257	-.000402
100	1.017191	-.001248	.243367	.251027	.641307	.002211
101	1.026110	-.001776	.246431	.239729	.647775	.000881
102	1.035659	-.002282	.251905	.219537	.656085	.001182
103	1.046637	-.002804	.255591	.205942	.662161	.000963
104	1.060186	-.003375	.259822	.190335	.668757	.001018
105	1.077475	-.004010	.263922	.175216	.675251	.000968
106	1.099652	-.004703	.268249	.159255	.682023	.000973
107	1.128024	-.005434	.272637	.143069	.688893	.000963
108	1.164165	-.006166	.277072	.126714	.695811	.000958
109	1.209954	-.006845	.281476	.110468	.702665	.000958
110	1.267595	-.007387	.285770	.094631	.709329	.000962
111	1.339639	-.007679	.289865	.079527	.715663	.000976
112	1.429016	-.007569	.293677	.065470	.721543	.000996
113	1.539121	-.006862	.297132	.052727	.726857	.001023
114	1.673831	-.005315	.300178	.041489	.731502	.001081
115	1.837463	-.002648	.302766	.031945	.735448	.001127
116	2.034749	.001459	.304946	.023905	.738780	.001157
117	2.270820	.007392	.306774	.017164	.741536	.001216
118	2.551135	.015567	.308221	.011824	.743706	.001275
119	2.881376	.026415	.309314	.007792	.745346	.001318
120	3.267305	.040370	.310120	.004821	.746553	.001351
121	3.714591	.057846	.310694	.002704	.747411	.001375
122	4.228574	.079205	.311079	.001284	.747984	.001394
123	4.813942	.104713	.311312	.000424	.748321	.001415
124	5.473913	.134463	.311430	-.000010	.748505	.001413
125	6.199194	.167844	.311468	-.000149	.748636	.001344
126	6.968506	.203518	.311428	-.000003	.748492	.001422

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-6
	RAE 2822: MACH = 0.75, ALPHA = 3			

UPPER SURFACE

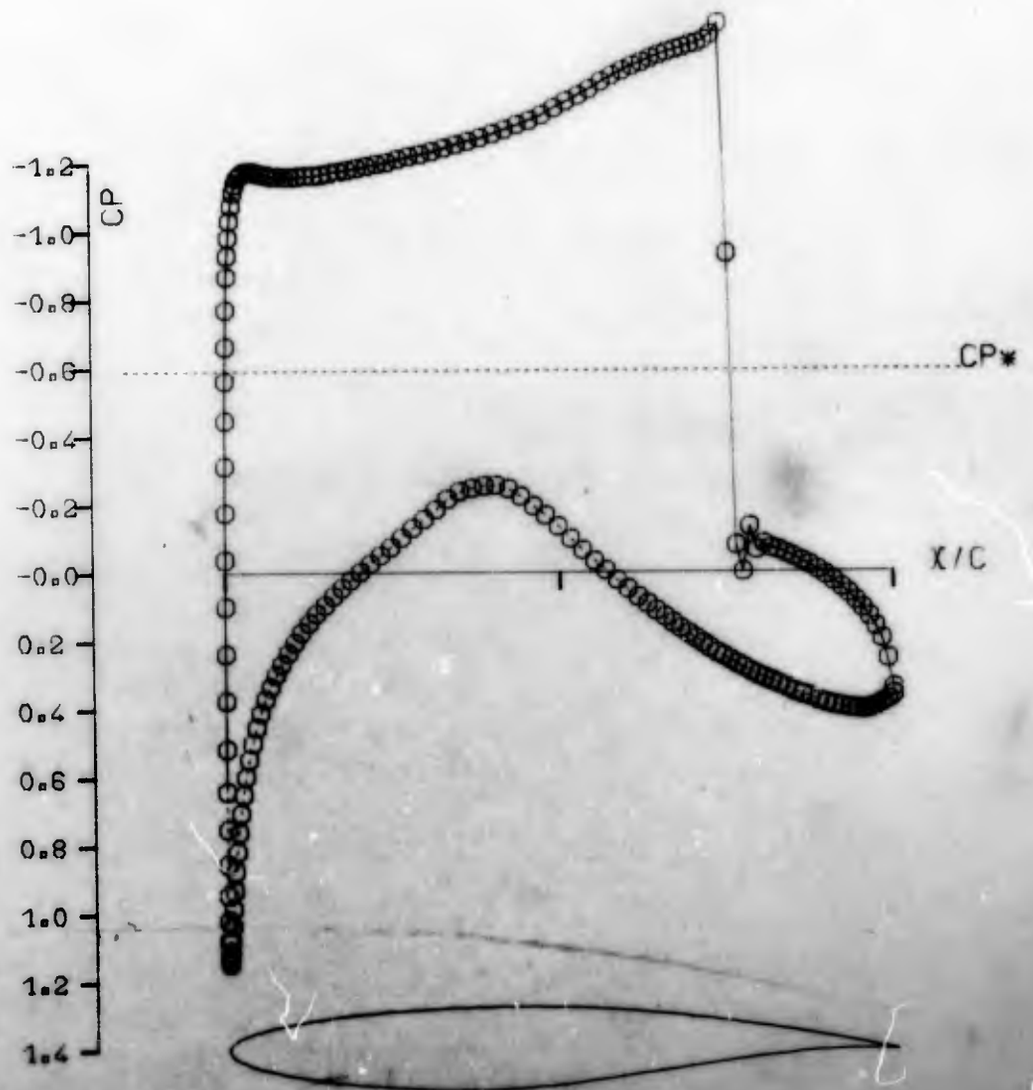
LOWER SURFACE

CL= 1.0975

CD= 0.0471

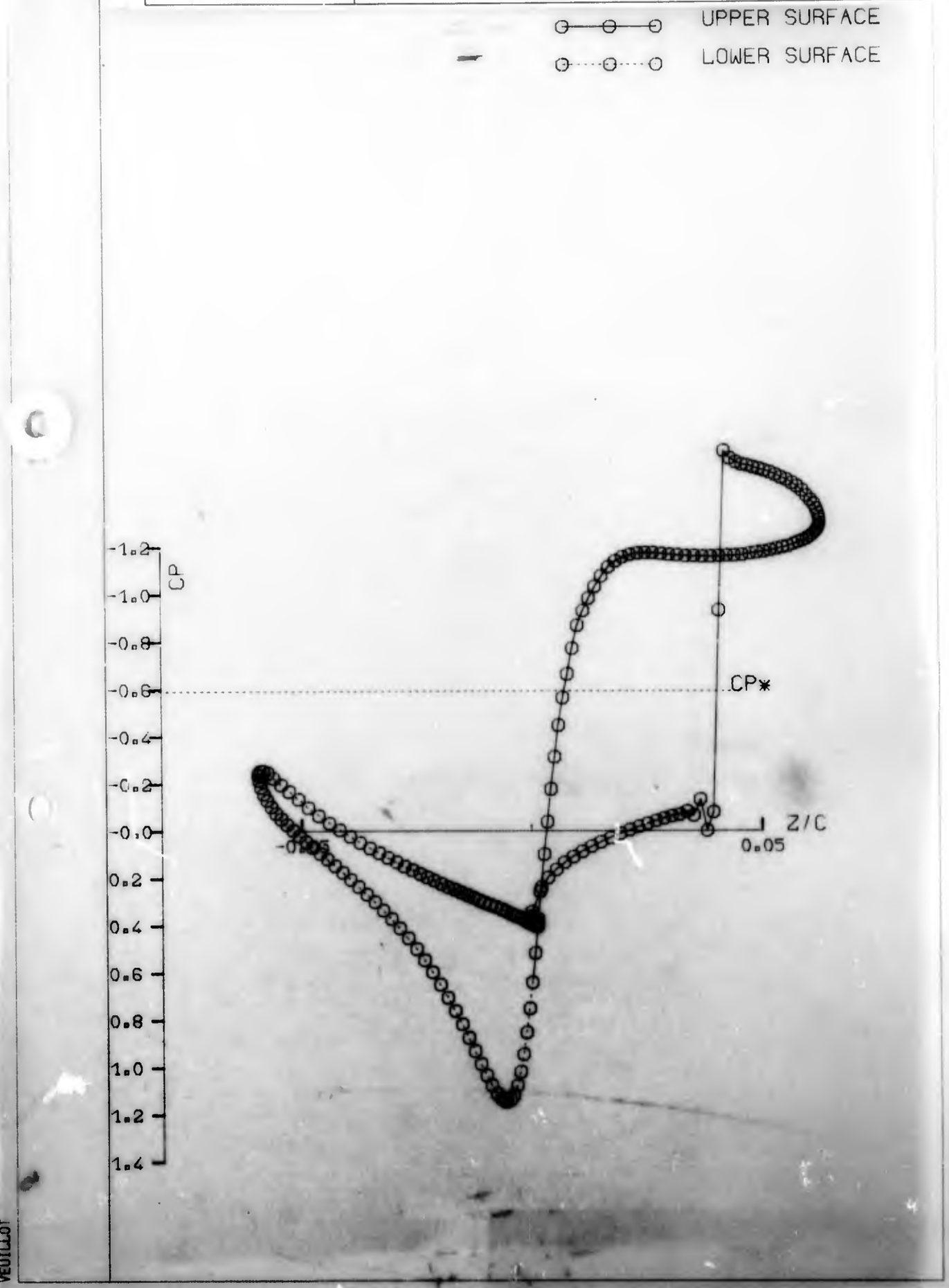
CM= -0.1946

Γ = 0.5340

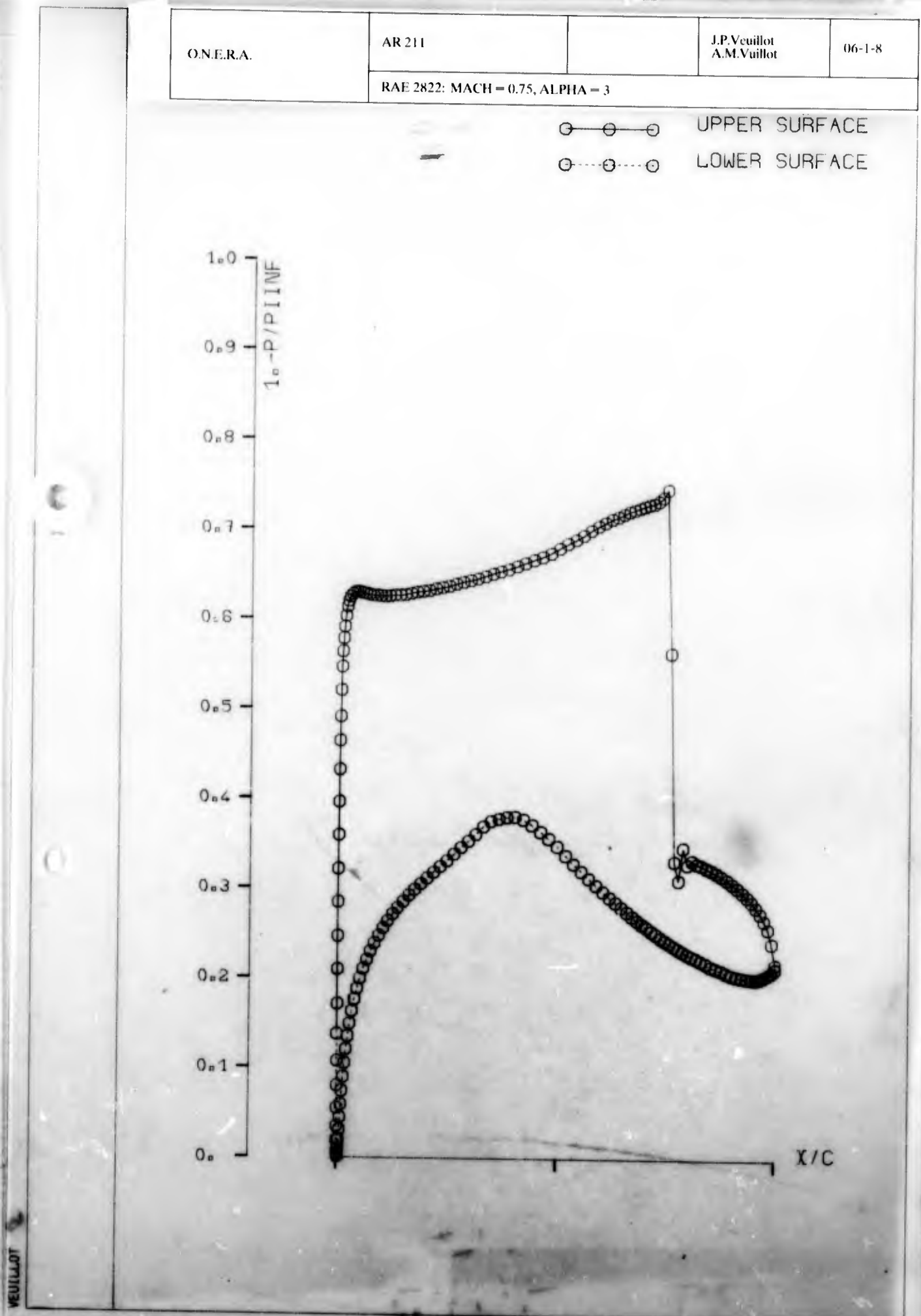


VEUILLOT

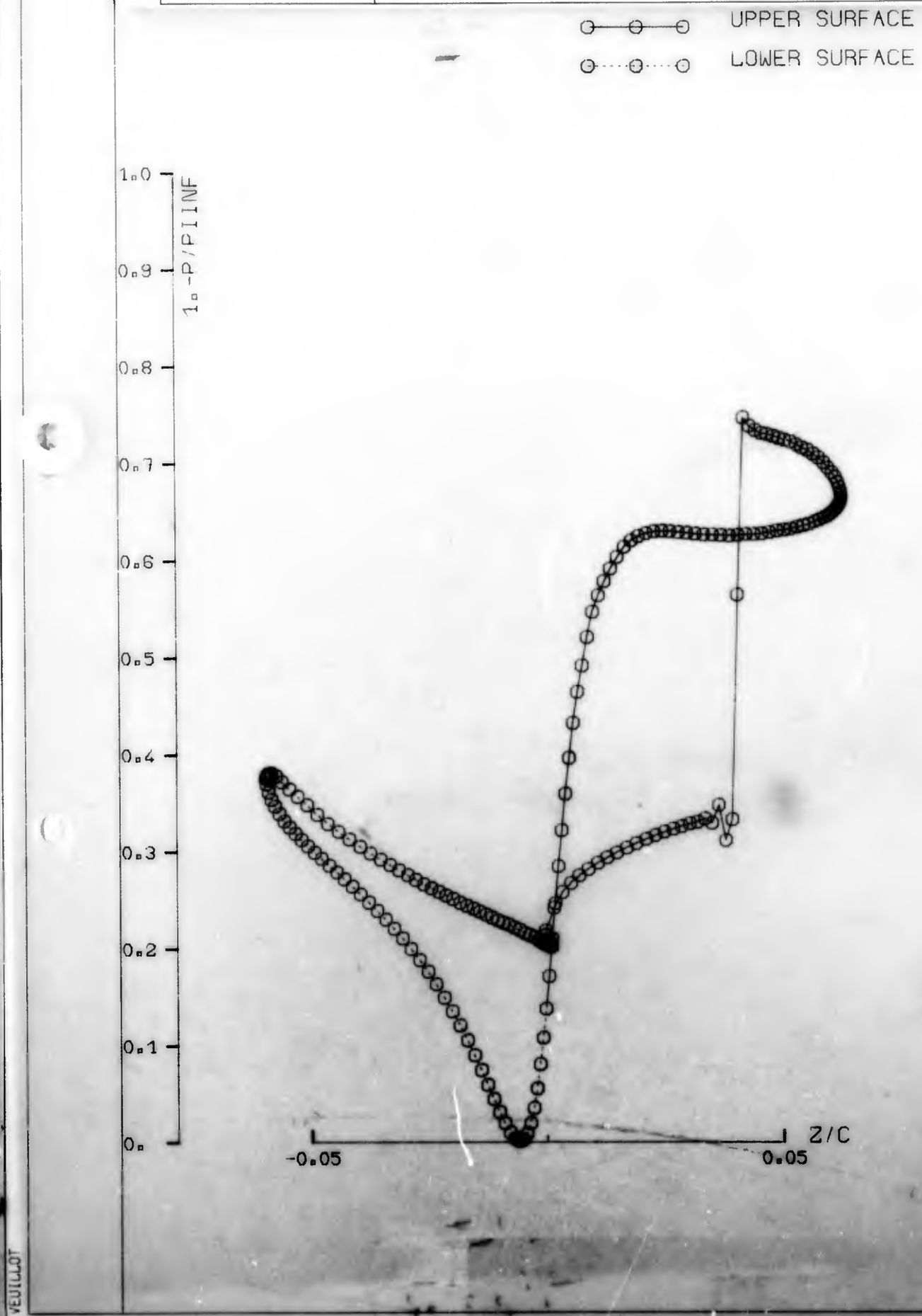
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-7
	RAE 2822: MACH = 0.75, ALPHA = 3			



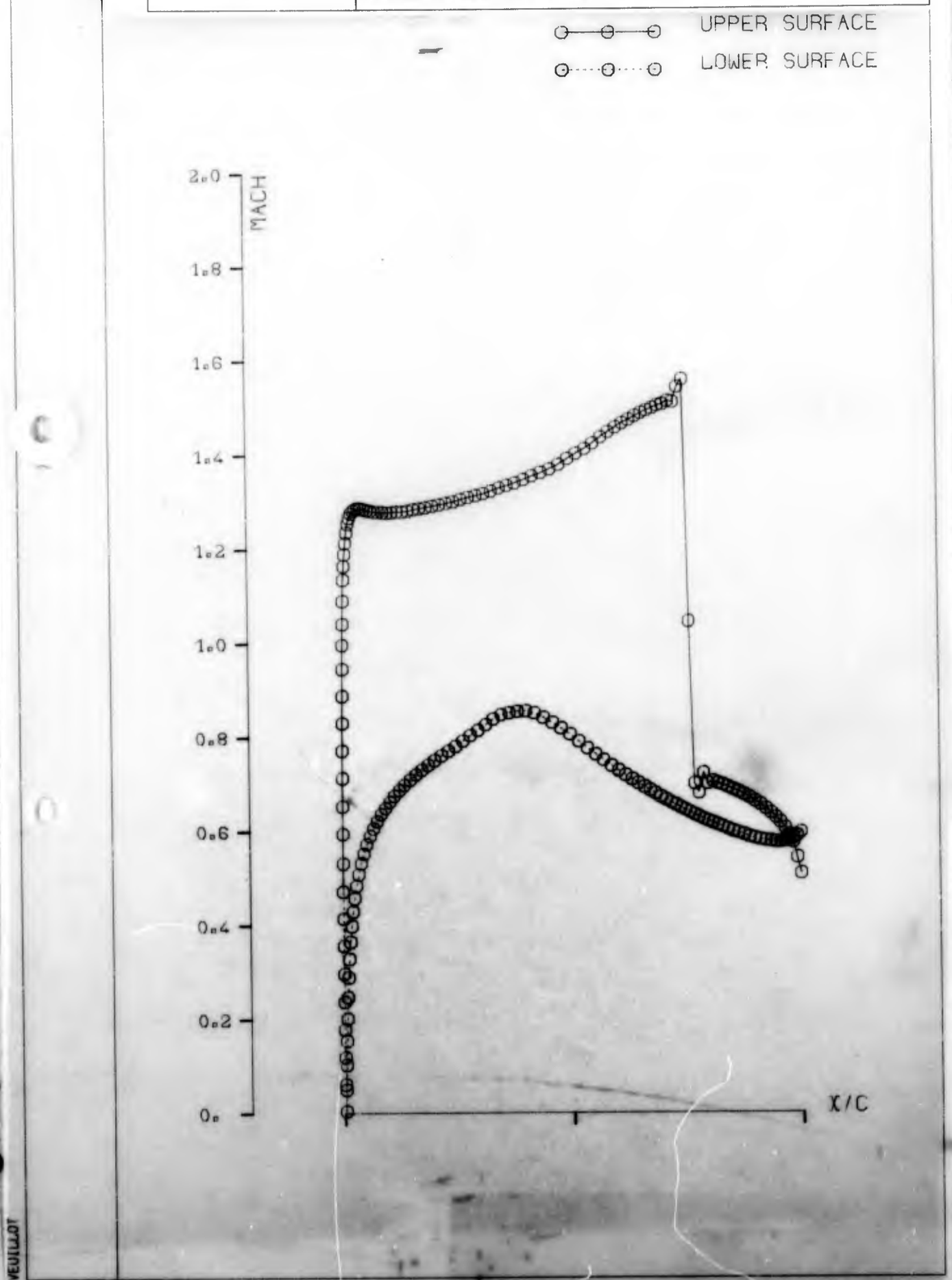
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-8
	RAE 2822: MACH = 0.75, ALPHA = 3			



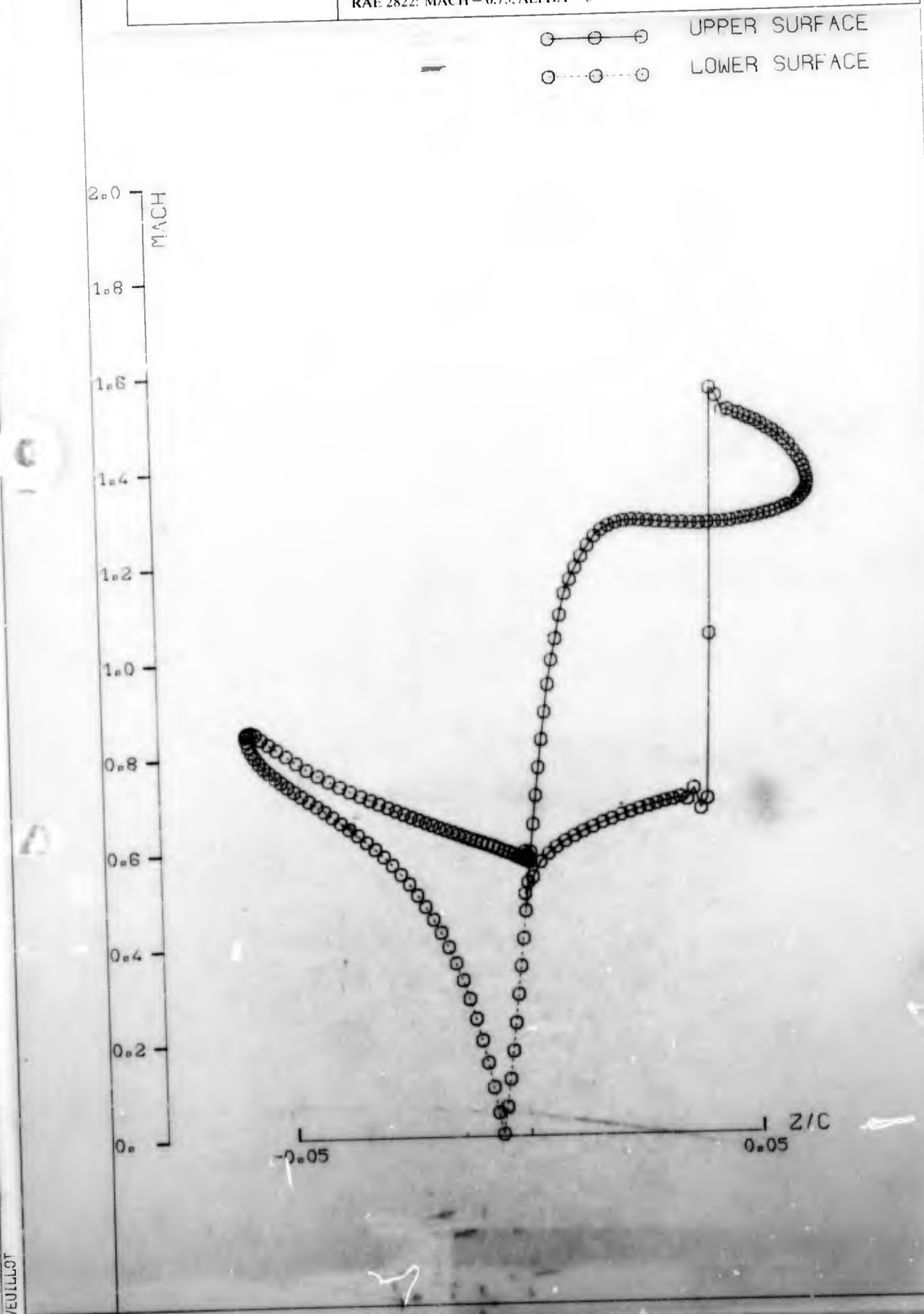
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-9
	RAE 2822: MACH = 0.75, ALPHA = 3			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-10
	RAE 2822: MACH = 0.75, ALPHA = 3			

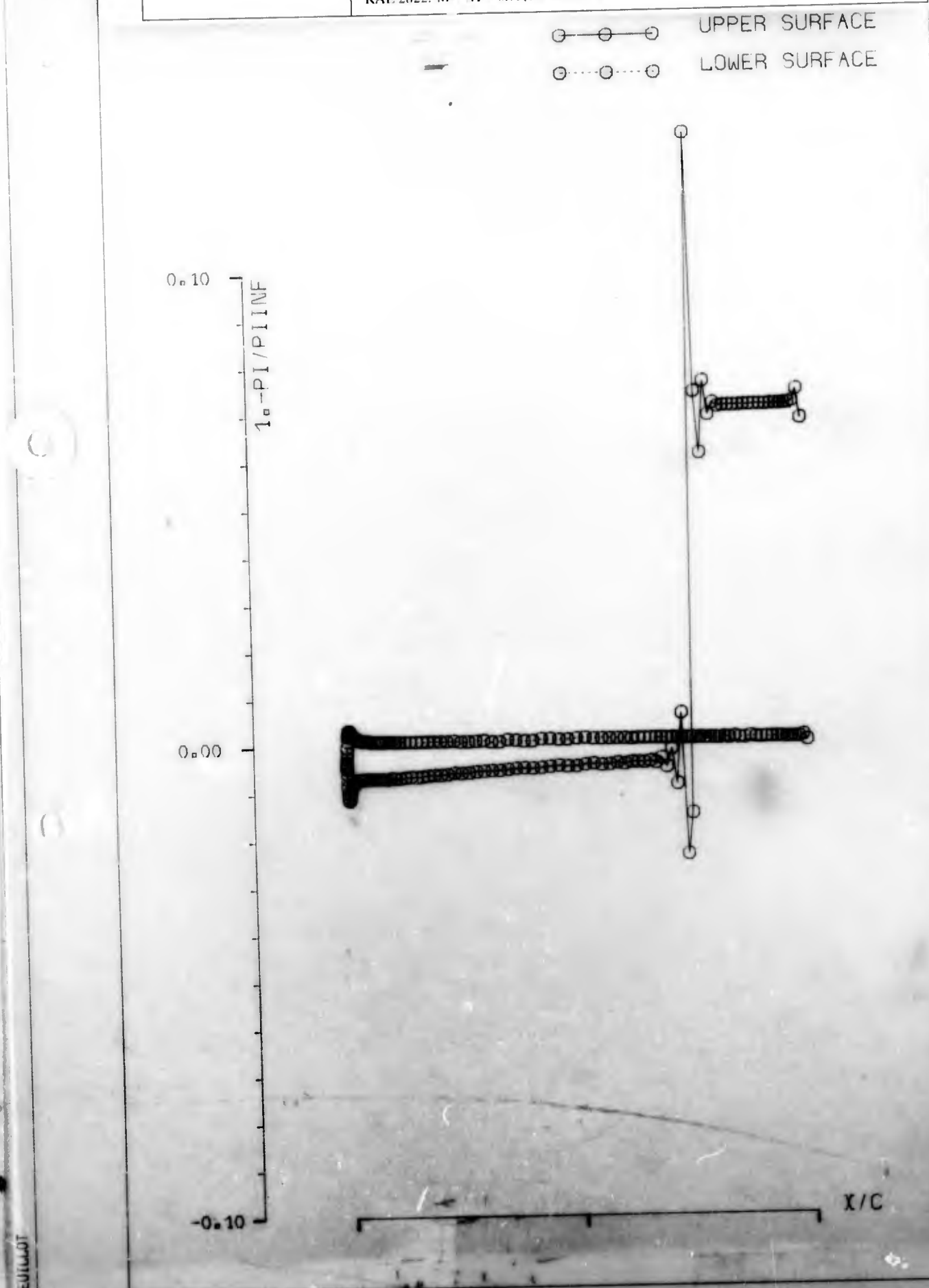


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-11
	RAE 2822: MACH = 0.75, ALPHA = 3			

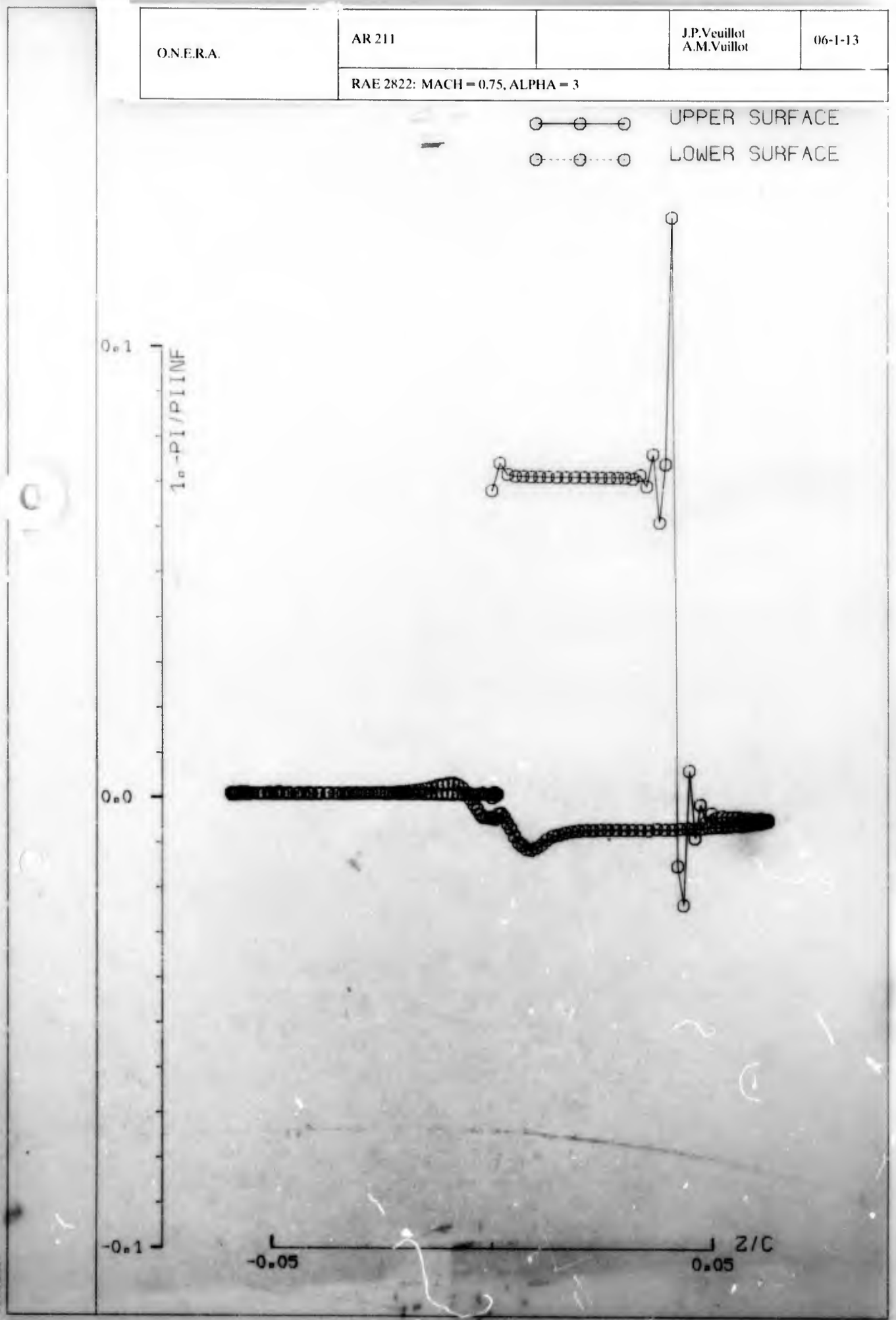


VEUILLOT

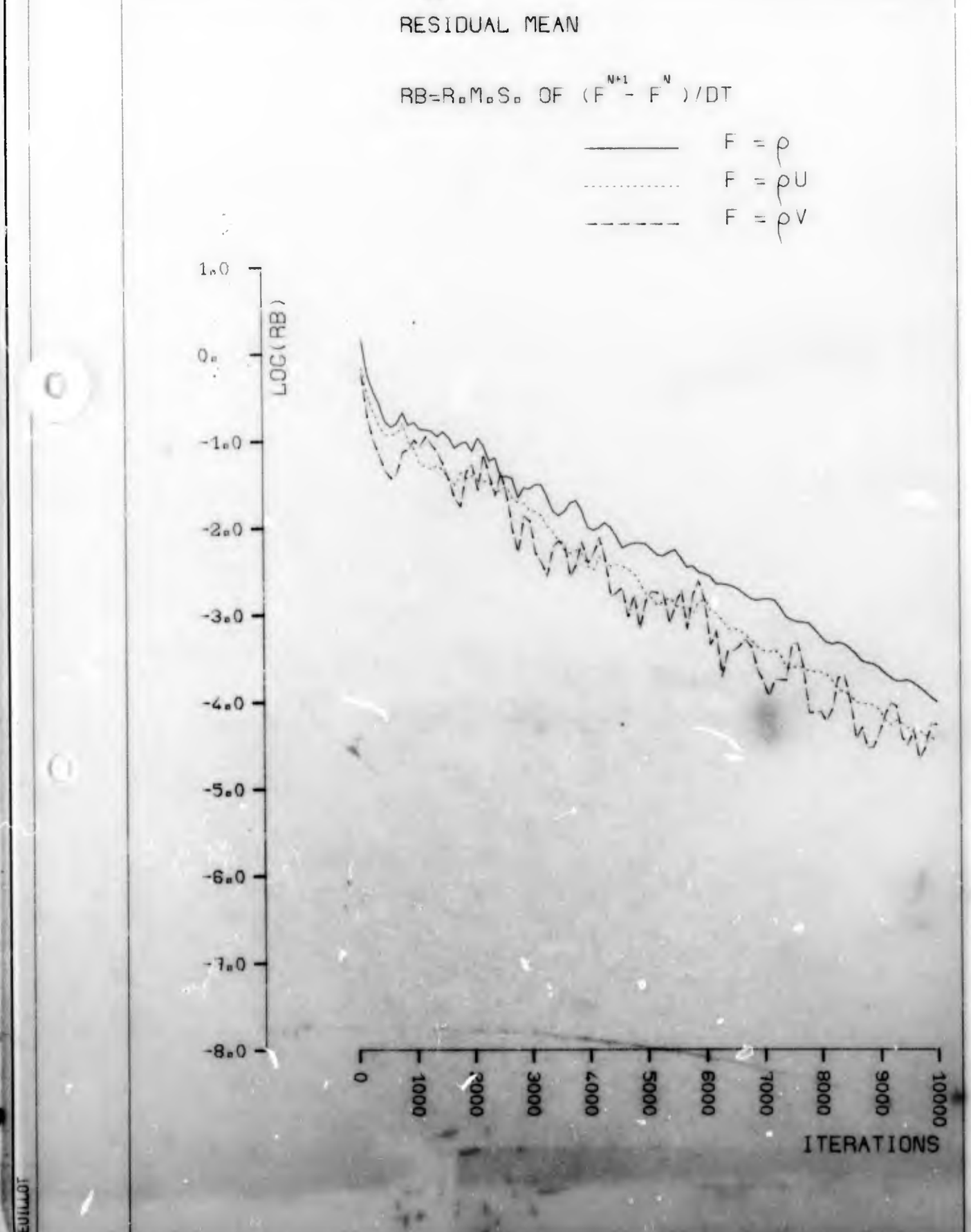
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-12
	RAE 2822: M CH = 0.75, ALPHA = 3			



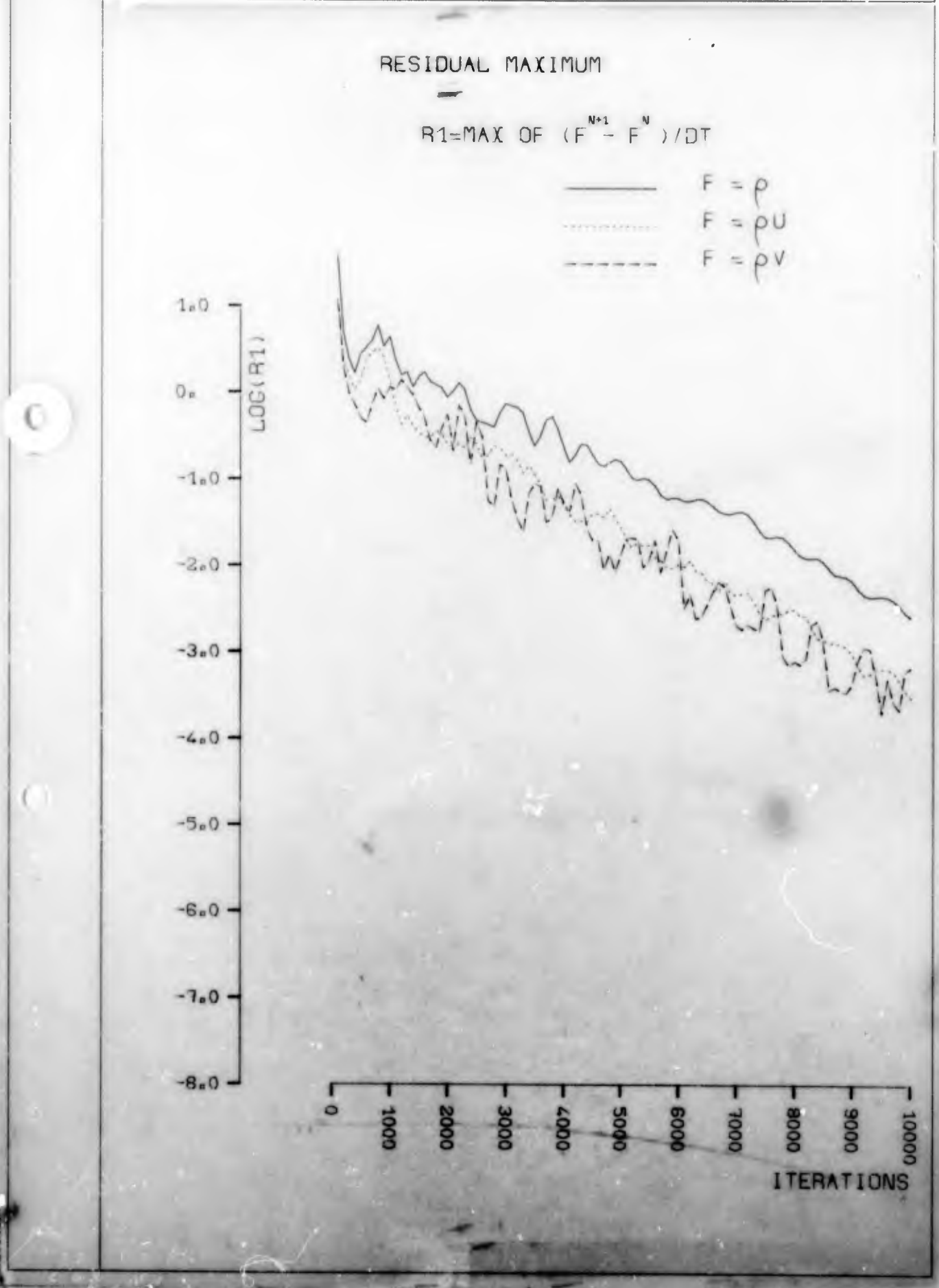
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-13
	RAE 2822: MACH = 0.75, ALPHA = 3			



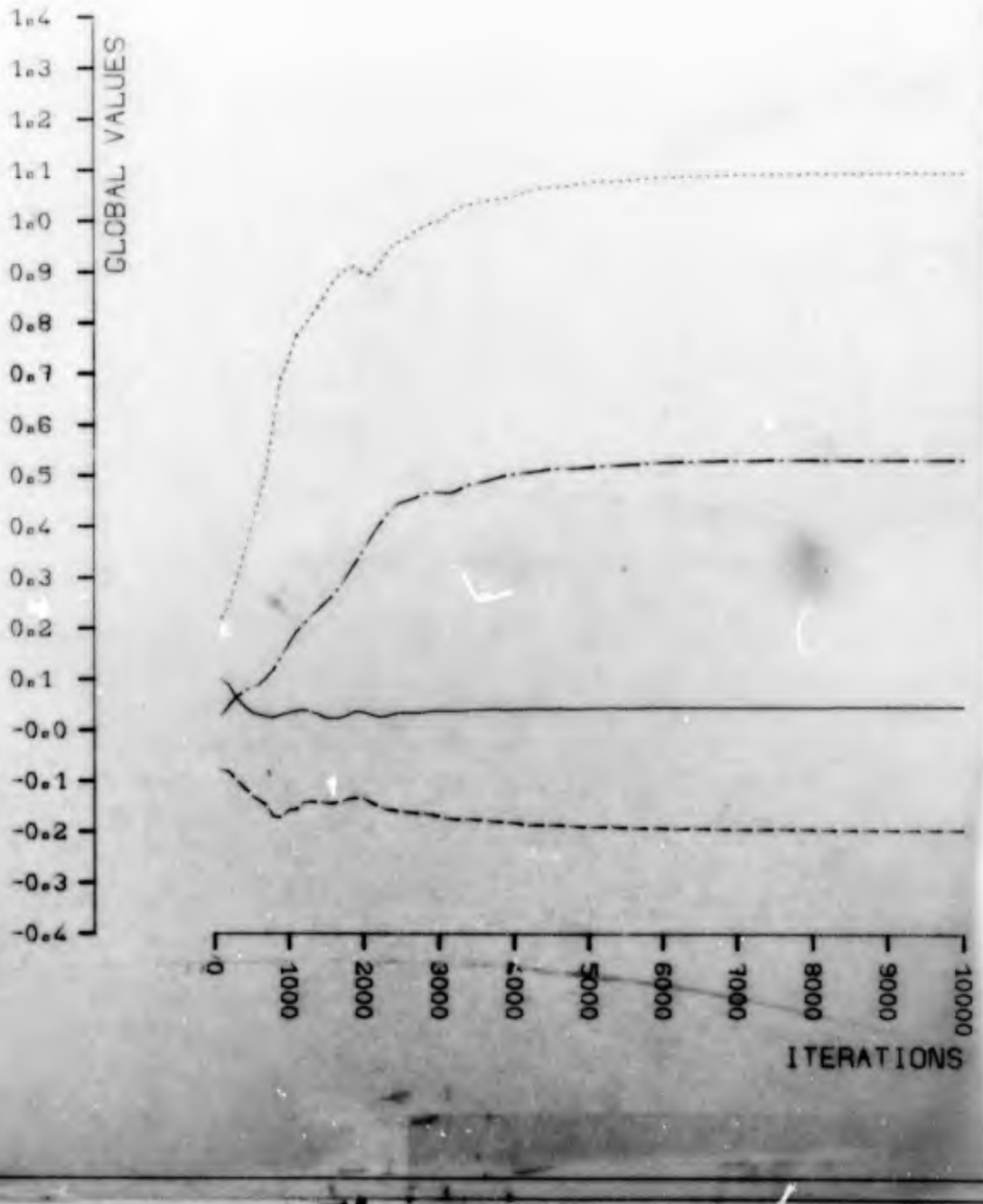
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-14
	RAE 2822: MACH = 0.75, ALPHA = 3			



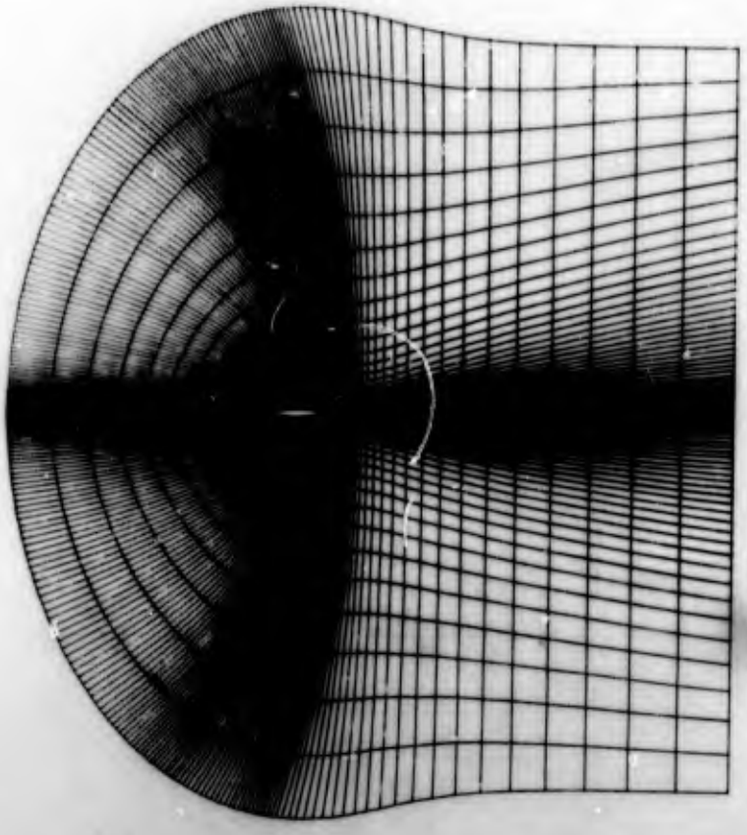
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-15
	RAE 2822: MACH = 0.75, ALPHA = 3			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-16
	RAE 2822: MACH = 0.75, ALPHA = 3			

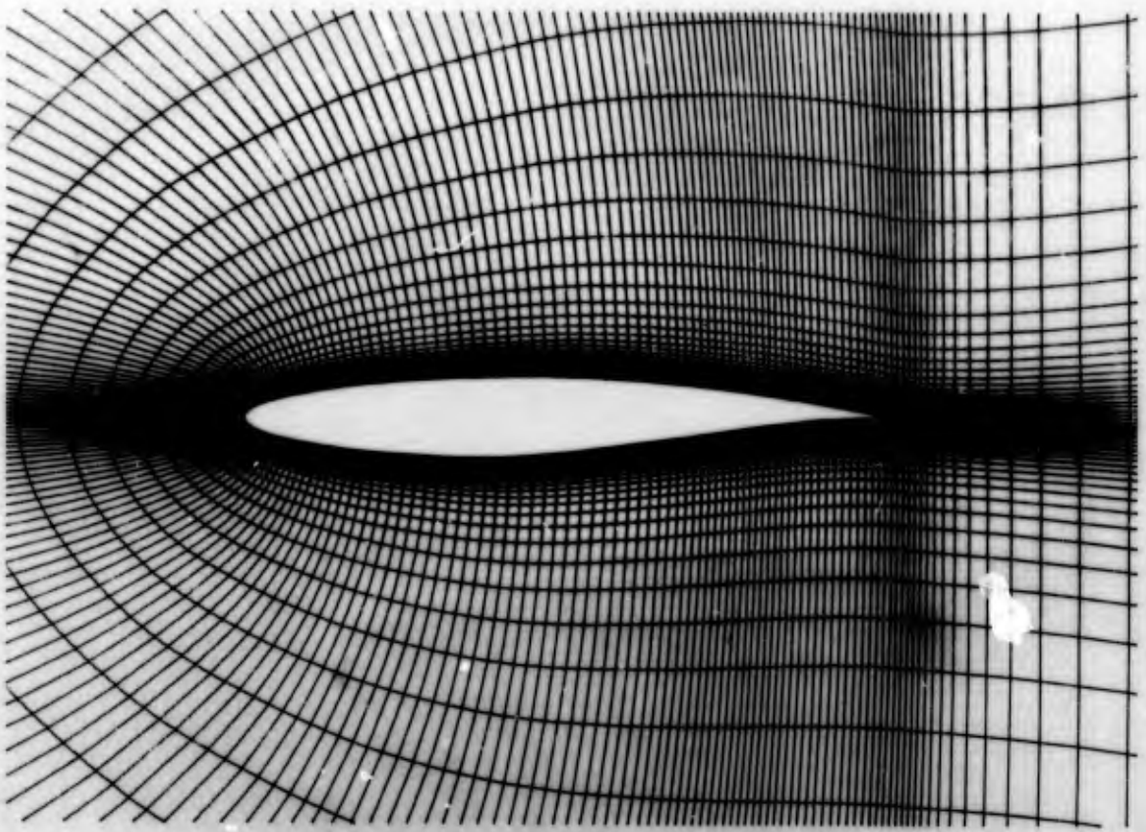


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-17
	RAE 2822: MACH = 0.75, ALPHA = 3			



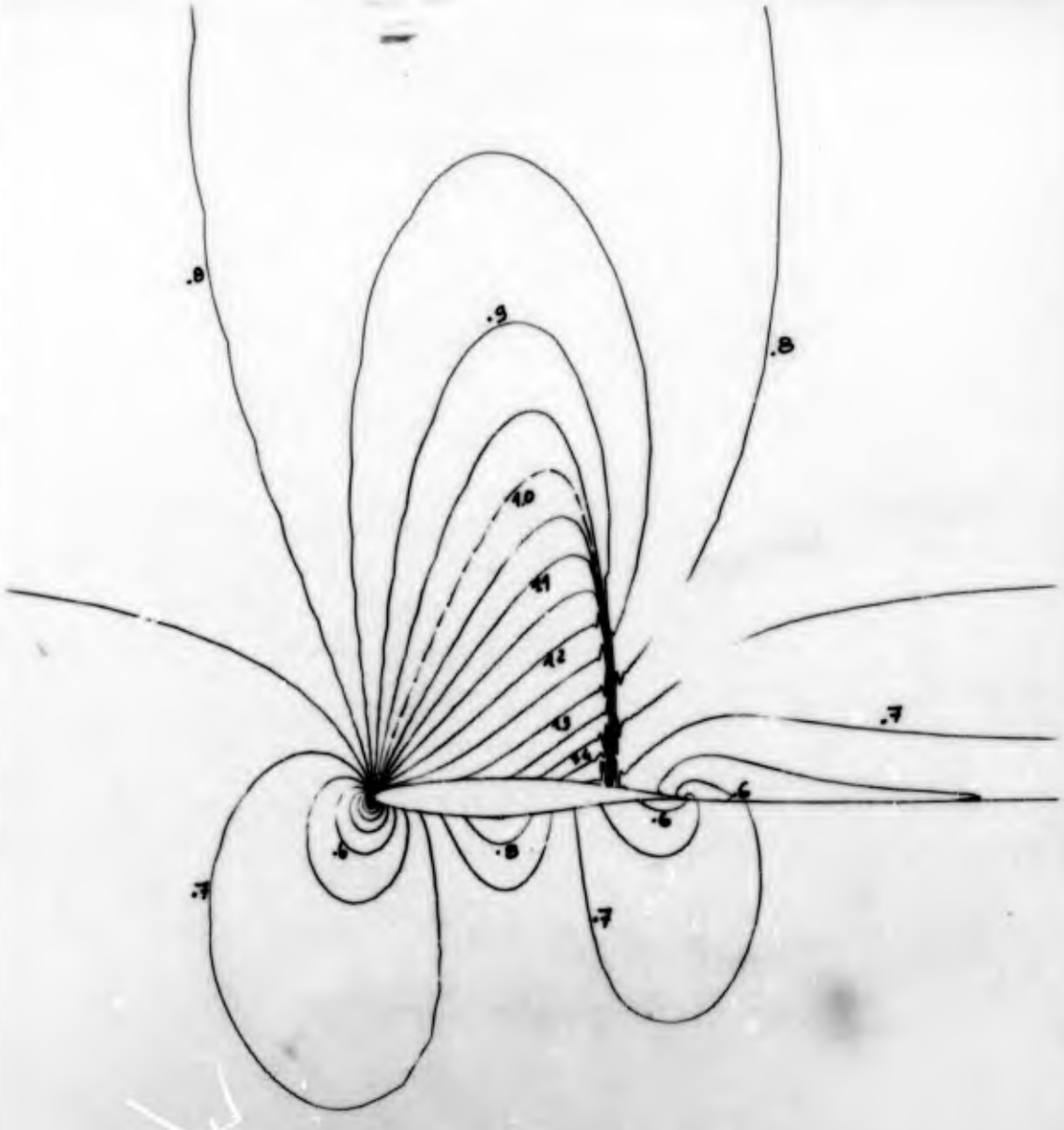
189X25 MESH (1CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-18
	RAE 2822: MACH = 0.75, ALPHA = 3			



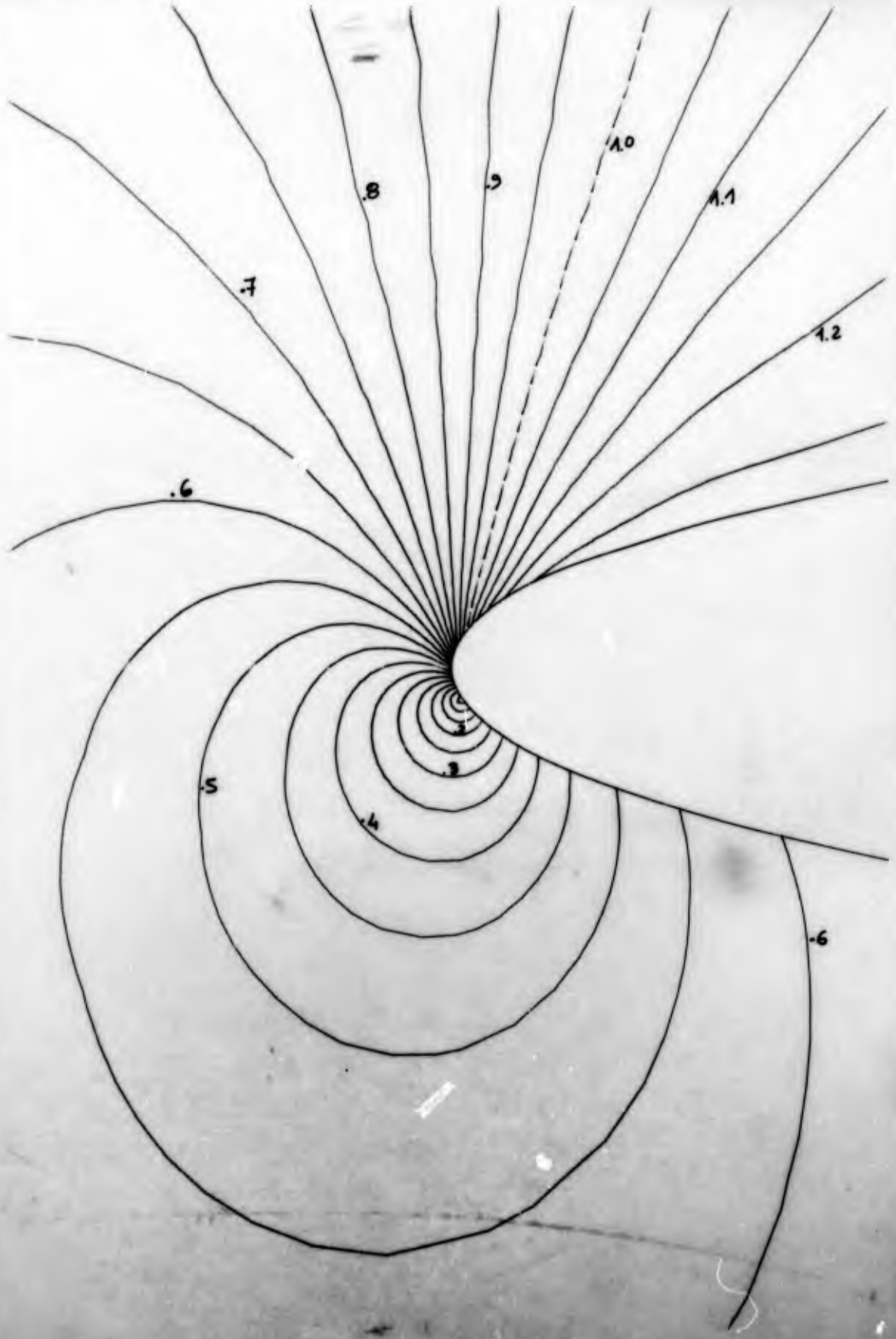
189X25 MESH PARTIAL VIEW (10CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-19
	RAE 2822: MACH = 0.75, ALPHA = 3			



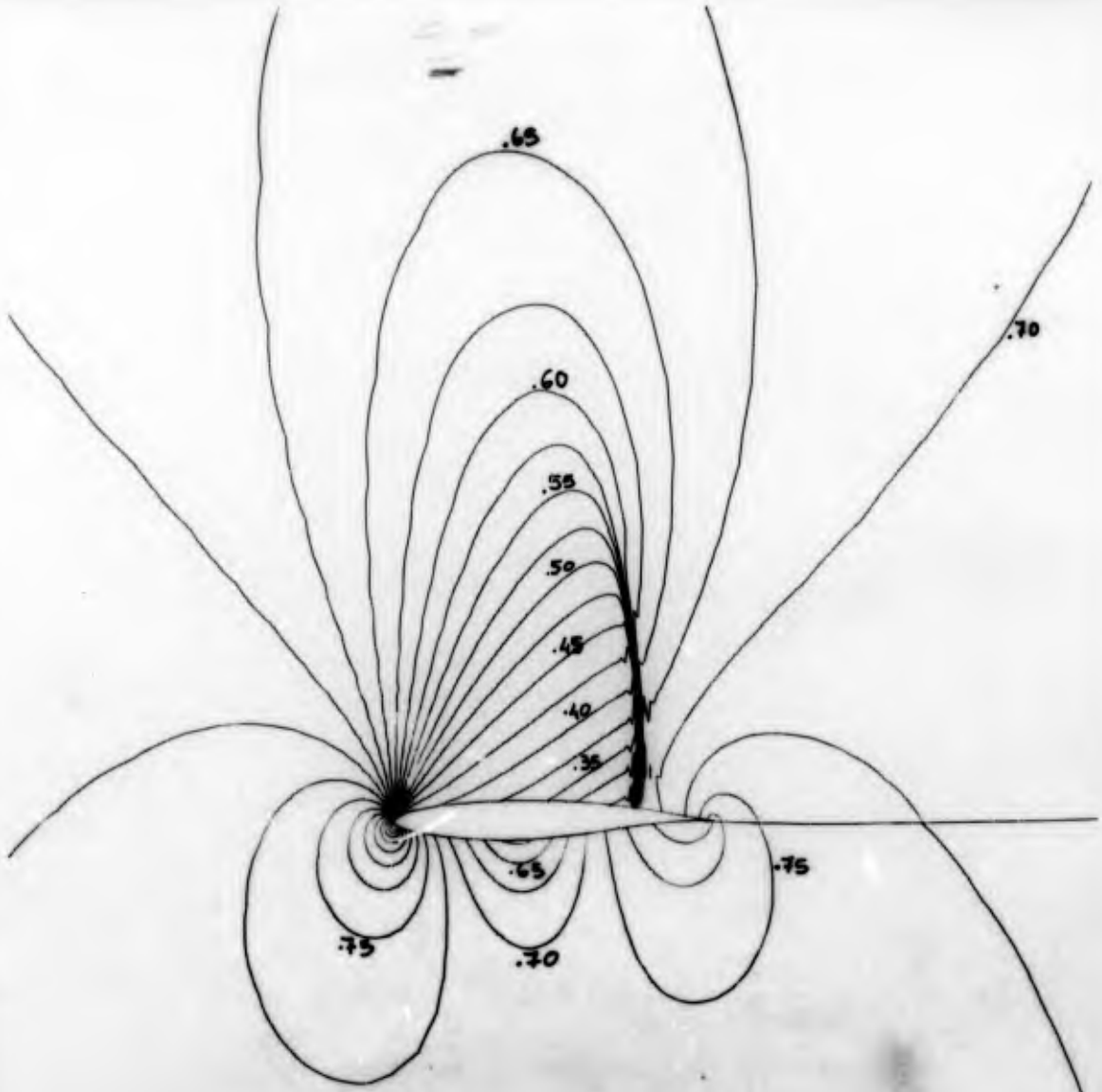
ISO-MACH LINES

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-20
	RAE 2822: MACH = 0.75, ALPHA = 3			



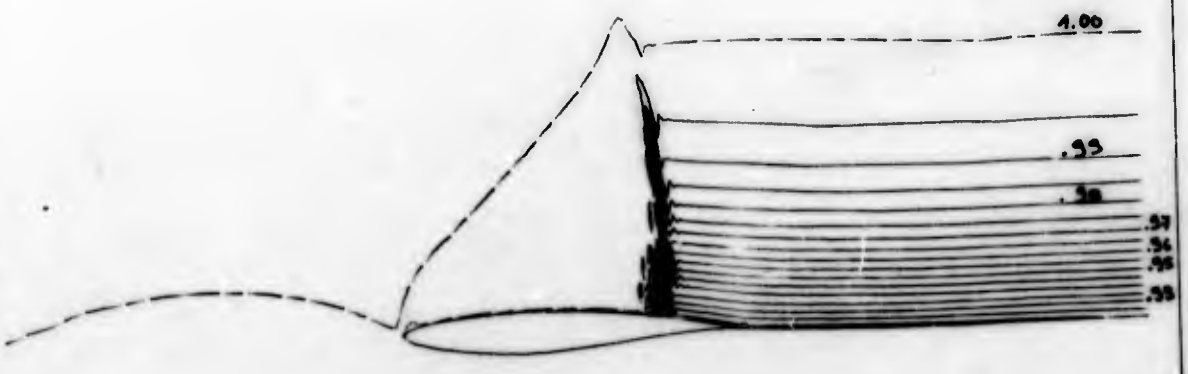
ISO-MACH LINES (DM=.05 100CM CHORD)

O.N.E.R.A	AR 211		J.P.Veuillot A.M.Vuillot	06-1-21
	RAE 2822: MACH = 0.75, ALPHA = 3			



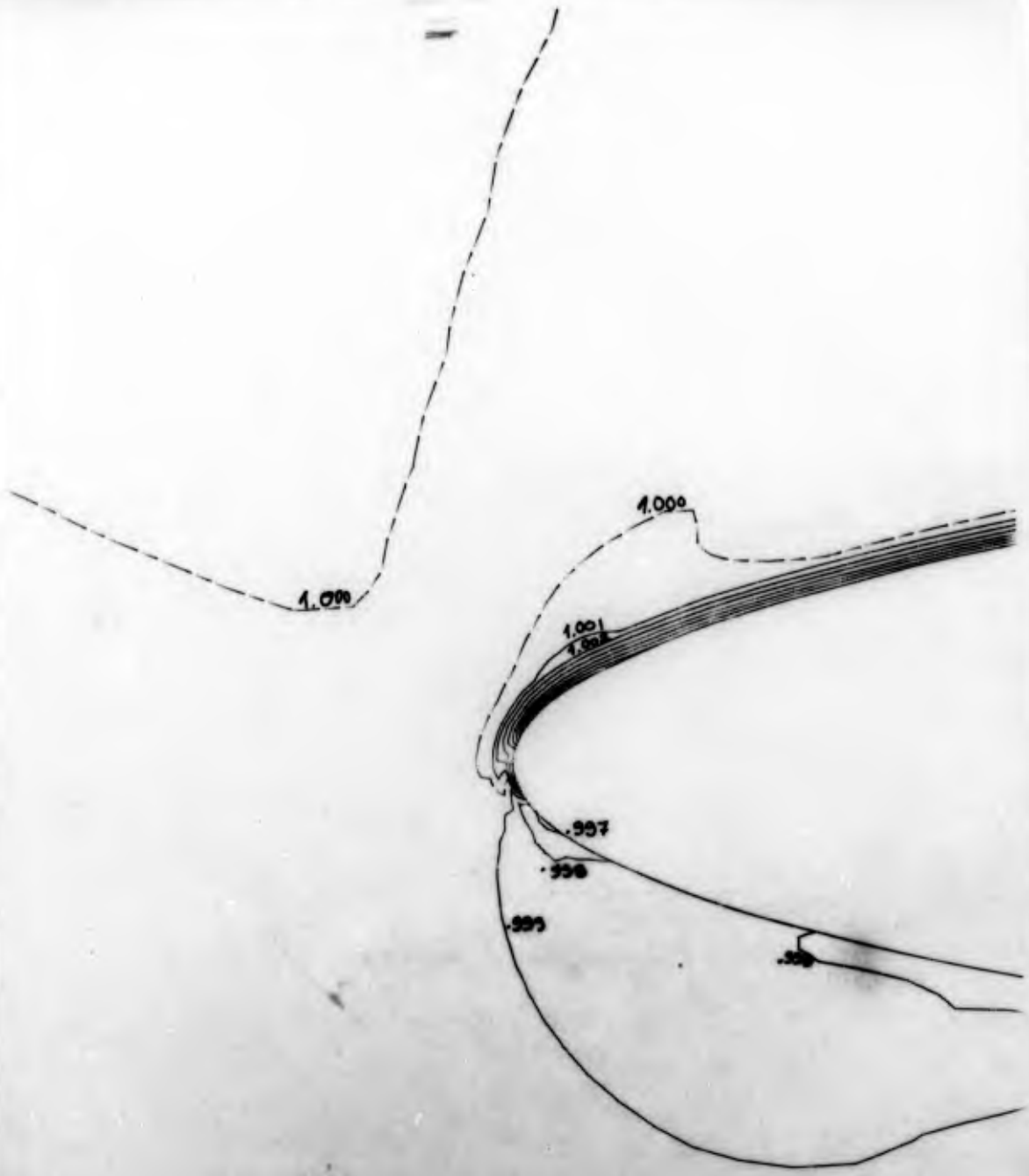
ISO-P/PIINF LINES

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-22
	RAE 2822: MACH = 0.75, ALPHA = 3			



ISO-PI/PIINF LINES (DPI/PIINF=.005)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	06-1-23
	RAE 2822: MACH = 0.75, ALPHA = 3			



ISO-PI/PIINF LINES (DPI/PIINF=.001)

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 06

RAE 2822: MACH = 0.75, ALPHA = 3

Contributor No 2

J.Sidès

(O.N.E.R.A., France)

O.N.E.R.A.	AR 211		J.Sidès	06-2-1
	RAE 2822: MACH = 0.75, ALPHA = 3			

COMMENTS ON CALCULATION FOR TEST CASE 06

C-Mesh

The mesh is generated algebrically from the data of points on the airfoil surface , on a cut-line and on an arbitrary external boundary. The global domain is divided into several subdomains and in each subdomain the mesh is constructed by means of an isoparametric method. The orthogonality to the airfoil surface is enforced for one family of mesh lines. Some local refinements are introduced in the vicinity of the leading edge , of the trailing edge and near the shock wave on the upper surface.

The total number of cells is : 298 x 34.

There are 230 points on the airfoil surface:

93 on the lower surface ,

137 on the upper surface.

In a parallel direction to the x-axis:

the distance between the leading edge and the external boundary is : 5 C (where C is the chord length),

the distance between the trailing edge and the external boundary is : 6 C.

In a parallel direction to the z-axis:

the distance between the airfoil surface and the external boundary is : about 6 c .

CONVERGENCE

The numerical results are reported after 4000 time steps of the implicit method but no doubt that 2500 steps would be sufficient to reach the converged solution.

10-811-120

O.N.E.R.A.	AR 211		J.Sides	06-2-2
	RAE 2822: MACH = 0.75, ALPHA = 3			

LOWER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.997465	.000141	.210152	.373537	.583643	.005225
2	.992327	.000406	.208405	.379981	.584058	.002708
3	.987052	.000636	.206727	.386168	.581282	.002712
4	.981637	.000831	.205651	.390138	.578826	.003222
5	.976079	.000989	.203992	.396255	.575943	.003321
6	.970374	.001110	.202624	.401301	.573357	.003555
7	.964519	.001186	.201861	.404117	.571861	.003722
8	.958509	.001215	.201055	.407089	.570546	.003701
9	.952342	.001195	.200590	.408805	.569673	.003773
10	.946013	.001120	.201051	.407103	.570218	.003941
11	.939519	.000992	.201447	.405644	.570960	.003880
12	.932856	.000813	.202056	.403395	.571863	.003965
13	.926020	.000584	.202530	.401649	.572672	.003950
14	.919005	.000301	.202993	.399940	.573428	.003963
15	.911809	-.000039	.204031	.396113	.575007	.004074
16	.904427	-.000440	.205276	.391519	.577067	.004082
17	.896854	-.000898	.206516	.386946	.579119	.004087
18	.889085	-.001414	.207745	.382415	.581149	.004092
19	.881116	-.001993	.209461	.376083	.583858	.004191
20	.872941	-.002634	.211248	.369493	.586817	.004185
21	.864555	-.003334	.212882	.363468	.589523	.004174
22	.855953	-.004095	.214473	.357598	.592140	.004174
23	.847129	-.004924	.216706	.349364	.595657	.004288
24	.838078	-.005821	.218936	.341139	.599368	.004242
25	.828794	-.006781	.221310	.332381	.603188	.004288
26	.819271	-.007807	.223670	.323677	.607029	.004291
27	.809502	-.008896	.225983	.315147	.610784	.004295
28	.799481	-.010053	.228317	.306539	.614574	.004291
29	.789202	-.011283	.231171	.296010	.619094	.004369
30	.778658	-.012584	.234011	.285535	.623736	.004322
31	.767843	-.013958	.237234	.273650	.628831	.004395
32	.756748	-.015404	.240434	.261845	.634001	.004367
33	.745366	-.016920	.243815	.249374	.639370	.004401
34	.733691	-.018511	.247410	.236116	.645103	.004404
35	.721714	-.020176	.251713	.220244	.651836	.004500
36	.709426	-.021909	.255861	.204946	.658483	.004444
37	.696818	-.023706	.260022	.189601	.665040	.004465
38	.683882	-.025569	.264809	.171941	.672495	.004549
39	.670609	-.027496	.269659	.154054	.680175	.004505
40	.656989	-.029482	.275242	.133462	.688799	.004622
41	.643011	-.031518	.280731	.113217	.697440	.004575
42	.628665	-.033595	.286352	.092487	.706165	.004616
43	.613940	-.035709	.292370	.070289	.715484	.004661
44	.598825	-.037855	.298567	.047433	.725119	.004655
45	.583309	-.040025	.305800	.020755	.736185	.004792
46	.567379	-.042202	.313028	-.005905	.747417	.004751
47	.551022	-.044369	.320392	-.033065	.758749	.004798
48	.534226	-.046512	.328835	-.064207	.771643	.004934
49	.516976	-.048607	.337363	-.095659	.784832	.004904
50	.499258	-.050622	.346069	-.127772	.798197	.004969
51	.481057	-.052526	.355003	-.160723	.811948	.005004
52	.462358	-.054277	.363501	-.192065	.825112	.004964
53	.443148	-.055828	.370770	-.218877	.836429	.004886
54	.423412	-.057132	.376111	-.238574	.844779	.004799
55	.403141	-.058147	.379039	-.249375	.849355	.004758
56	.382322	-.058836	.379373	-.250609	.849845	.004788
57	.360949	-.059166	.376601	-.240384	.845555	.004783
58	.339012	-.059110	.369883	-.215604	.835392	.004542
59	.316504	-.058660	.360225	-.179981	.820715	.004295
60	.293416	-.057835	.349680	-.141088	.804515	.004227
61	.269736	-.056656	.338706	-.100612	.787693	.004133
62	.245452	-.055130	.327950	-.060940	.771040	.004200
63	.220553	-.053248	.316957	-.020397	.754144	.004136
64	.195359	-.051011	.304767	.024564	.735742	.003722
65	.171604	-.048567	.294039	.064134	.719452	.003414
66	.150539	-.046091	.283332	.103623	.702531	.003658
67	.131862	-.043625	.272878	.142183	.686168	.003683
68	.115309	-.041184	.261942	.182519	.669042	.003634
69	.100641	-.038789	.250920	.223171	.651438	.003777
70	.087648	-.036457	.239831	.264069	.633742	.003788
71	.076144	-.034196	.228665	.305255	.615711	.003833
72	.065962	-.032008	.217444	.346642	.597428	.003852
73	.056959	-.029890	.205452	.390871	.577857	.003706
74	.049004	-.027838	.192596	.438289	.556395	.003666
75	.041981	-.025858	.179852	.485292	.534483	.003797
76	.035785	-.023946	.166030	.536272	.510870	.003469
77	.030337	-.022057	.150885	.592133	.483996	.003304
78	.025542	-.020320	.136840	.643933	.457361	.003703
79	.021336	-.018608	.120709	.703432	.427796	.002817
80	.017657	-.016954	.105097	.761014	.395593	.003168

40 911 120

O.N.E.R.A.	AR 211		J.Sidès	06-2-3
	RAE 2822: MACH = 0.75, ALPHA = 3			

LOWER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
81	.014450	-.015355	.087810	.824775	.359891	.002393
82	.011668	-.013811	.071303	.885658	.321010	.002569
83	.009268	-.012317	.053750	.950396	.277420	.001784
84	.007213	-.010873	.037770	1.009337	.229494	.001826
85	.005476	-.009474	.022429	1.065921	.175380	.001218
86	.004025	-.008122	.009931	1.112015	.115137	.000713
87	.002840	-.006822	.001901	1.141634	.047219	.000342
88	.001903	-.005570	.001758	1.142162	.022094	.001417
89	.001176	-.004380	.005131	1.129721	.098814	-.001686
90	.000659	-.003265	.022811	1.064509	.186491	-.001186
91	.000322	-.002224	.048344	.970336	.267491	-.000179
92	.000117	-.001263	.077954	.851127	.349828	-.003480
93	.000022	-.000403	.122817	.695655	.435654	.000643

40-911-120

O.N.E.R.A.	AR 211		J.Sidès	06-2-4
	RAE 2822: MACH = 0.75, ALPHA = 3			

UPPER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
94	.000022	.000404	.159629	.559882	.501392	.002215
95	.000113	.001241	.192465	.438771	.561040	.000090
96	.000296	.002129	.240232	.262593	.636123	.002361
97	.000574	.003048	.291550	.073313	.717807	.001400
98	.000968	.003987	.346217	-.128317	.800924	.002497
99	.001497	.004948	.387017	-.278800	.859142	.007459
100	.002143	.005927	.414207	-.379087	.902357	.006709
101	.002903	.006912	.461836	-.554756	.980522	.004033
102	.003798	.007897	.501756	-.701994	1.044505	.005843
103	.004824	.008885	.507573	-.723450	1.051974	.008581
104	.005969	.009879	.526097	-.791772	1.085900	.005620
105	.007249	.010868	.566921	-.942344	1.158856	.004156
106	.008670	.011856	.581216	-.995071	1.183704	.005742
107	.010222	.012854	.578226	-.984042	1.178007	.005990
108	.011917	.013856	.594745	-1.044971	1.210450	.003752
109	.013767	.014859	.602947	-1.075220	1.225288	.004683
110	.015770	.015872	.605663	-1.085237	1.230351	.004859
111	.017940	.016890	.618455	-1.132418	1.256420	.003180
112	.020286	.017913	.621563	-1.143882	1.261943	.003965
113	.022813	.018953	.622247	-1.146407	1.263100	.004224
114	.025534	.020005	.629428	-1.172890	1.278338	.002928
115	.028460	.021072	.629318	-1.172485	1.277452	.003824
116	.031603	.022156	.631615	-1.180956	1.282226	.003598
117	.034979	.023256	.634712	-1.192453	1.289044	.002875
118	.038599	.024377	.632609	-1.184623	1.284058	.003823
119	.042481	.025519	.634959	-1.193293	1.289414	.002996
120	.046642	.026682	.633905	-1.189404	1.287029	.003340
121	.051099	.027872	.633368	-1.187423	1.285882	.003426
122	.055872	.029087	.633687	-1.188599	1.286783	.003079
123	.060981	.030327	.632443	-1.184012	1.283907	.003578
124	.066451	.031593	.633240	-1.186951	1.285900	.003055
125	.072304	.032885	.631770	-1.181528	1.282557	.003571
126	.078566	.034203	.632285	-1.183430	1.283859	.003214
127	.085265	.035547	.631645	-1.181068	1.282315	.003560
128	.092430	.036913	.632365	-1.183726	1.283962	.003293
129	.100093	.038303	.631512	-1.180579	1.282080	.003517
130	.108287	.039719	.631650	-1.181085	1.282363	.003508
131	.117049	.041151	.632457	-1.184062	1.283963	.003539
132	.126416	.042598	.632976	-1.185977	1.285031	.003507
133	.136430	.044062	.632901	-1.185703	1.284795	.003624
134	.147133	.045540	.633618	-1.188347	1.286248	.003614
135	.158573	.047021	.634733	-1.192460	1.288455	.003674
136	.170800	.048500	.636037	-1.197270	1.291106	.003660
137	.183867	.049973	.637013	-1.200869	1.293027	.003739
138	.197830	.051435	.638205	-1.205265	1.295471	.003710
139	.212750	.052879	.639533	-1.210163	1.298090	.003829
140	.228691	.054293	.641256	-1.216517	1.301696	.003716
141	.245723	.055667	.642754	-1.222041	1.304477	.004111
142	.263323	.056944	.644829	-1.229696	1.308596	.004320
143	.280706	.058068	.647285	-1.238755	1.313794	.004159
144	.297653	.059043	.648655	-1.243806	1.316466	.004393
145	.314171	.059883	.651073	-1.252726	1.321561	.004320
146	.330272	.060596	.653332	-1.261056	1.326272	.004349
147	.345965	.061193	.655456	-1.268891	1.330659	.004465
148	.361259	.061680	.658116	-1.278704	1.336342	.004389
149	.376164	.062067	.660363	-1.286989	1.341095	.004425
150	.390689	.062366	.662400	-1.294503	1.345412	.004474
151	.404844	.062583	.664592	-1.302589	1.350111	.004487
152	.418638	.062723	.666876	-1.311013	1.354994	.004549
153	.432079	.062789	.669478	-1.320608	1.360657	.004524
154	.445176	.062785	.672010	-1.329948	1.366192	.004514
155	.457937	.062719	.674262	-1.338254	1.371044	.004639
156	.470372	.062592	.676977	-1.348269	1.377048	.004627
157	.482487	.062406	.679902	-1.359055	1.383520	.004665
158	.494291	.062163	.682919	-1.370185	1.390235	.004722
159	.505792	.061864	.686122	-1.381999	1.397476	.004698
160	.516996	.061512	.689182	-1.393285	1.404400	.004742
161	.527912	.061114	.692183	-1.404351	1.411266	.004751
162	.538546	.060671	.695115	-1.415167	1.418012	.004781
163	.548906	.060189	.698075	-1.426082	1.424894	.004782
164	.558998	.059670	.700906	-1.436526	1.431466	.004871
165	.568829	.059116	.703871	-1.447462	1.438458	.004885
166	.578405	.058528	.707000	-1.459001	1.445955	.004816
167	.587734	.057910	.709820	-1.469403	1.452722	.004818
168	.596821	.057268	.712135	-1.477942	1.458254	.004911
169	.605673	.056605	.714557	-1.486876	1.464264	.004746
170	.614296	.055926	.716644	-1.494573	1.469386	.004730
171	.622695	.055236	.718257	-1.500523	1.473284	.004835
172	.630878	.054538	.719948	-1.506758	1.477503	.004783
173	.638848	.053832	.721686	-1.513170	1.481832	.004774
174	.646613	.053120	.723415	-1.519545	1.486148	.004777

O.N.E.R.A.	AR 211		J.Sides	06-2-5
	RAE 2822: MACH = 0.75, ALPHA = 3			

UPPER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
175	.654176	.052402	.725105	-1.525780	1.490416	.004746
176	.661544	.051681	.726551	-1.531112	1.494046	.004772
177	.668722	.050960	.727763	-1.535584	1.497089	.004813
178	.675713	.050240	.729070	-1.540404	1.500483	.004712
179	.682525	.049521	.730296	-1.544926	1.503629	.004690
180	.689160	.048806	.731320	-1.548704	1.506220	.004737
181	.695624	.048096	.732246	-1.552119	1.508571	.004777
182	.701921	.047392	.733231	-1.555752	1.511108	.004779
183	.708055	.046693	.734289	-1.559653	1.513836	.004790
184	.714031	.045999	.735371	-1.563645	1.516630	.004809
185	.719852	.045311	.736393	-1.567414	1.519274	.004831
186	.725524	.044630	.737342	-1.570913	1.521784	.004783
187	.731048	.043955	.738235	-1.574206	1.524249	.004599
188	.736430	.043288	.739102	-1.577404	1.526764	.004252
189	.741673	.042627	.739950	-1.580533	1.529235	.003906
190	.746781	.041975	.740682	-1.583233	1.530948	.004227
191	.751822	.041323	.740721	-1.583375	1.528340	.008155
192	.756919	.040656	.746331	-1.604067	1.541650	.010565
193	.762132	.039967	.733576	-1.557023	1.477984	.052557
194	.767463	.039254	.488862	-.654440	.895378	.139825
195	.772914	.038516	.320262	-.032585	.662586	.087424
196	.778490	.037751	.331394	-.073643	.679868	.088896
197	.784191	.036958	.330864	-.071688	.679877	.088167
198	.790022	.036137	.331161	-.072785	.680277	.088254
199	.795984	.035287	.330748	-.071251	.679590	.088233
200	.802081	.034407	.330263	-.069474	.678754	.088241
201	.808316	.033496	.329618	-.067095	.677639	.088247
202	.814693	.032553	.328804	-.064093	.676237	.088250
203	.821213	.031576	.327835	-.060519	.674565	.088256
204	.827881	.030564	.326692	-.056302	.672595	.088259
205	.834699	.029516	.325373	-.051438	.670338	.088250
206	.841671	.028429	.323847	-.045809	.667653	.088294
207	.848800	.027304	.321956	-.038835	.664366	.088314
208	.856091	.026143	.320096	-.031973	.661208	.088273
209	.863547	.024945	.318539	-.026232	.658534	.088259
210	.871171	.023704	.316791	-.019782	.655390	.088349
211	.878878	.022428	.314307	-.010624	.651028	.088393
212	.886496	.021151	.311595	-.000620	.646381	.088342
213	.893942	.019890	.309219	.008145	.642258	.088332
214	.901219	.018644	.306851	.016878	.638070	.088375
215	.908330	.017410	.304156	.026819	.633318	.088404
216	.915280	.016190	.301308	.037324	.628329	.088401
217	.922072	.014985	.298523	.047595	.623465	.088378
218	.928710	.013795	.295736	.057873	.618487	.088426
219	.935197	.012617	.292551	.069622	.612792	.088472
220	.941537	.011453	.289148	.082172	.606835	.088413
221	.947733	.010306	.285964	.093917	.601248	.088352
222	.953788	.009171	.282640	.106176	.595195	.088431
223	.959705	.008047	.278531	.121333	.587937	.088346
224	.965488	.006939	.274382	.136633	.580914	.088022
225	.971139	.005845	.270452	.151129	.573969	.087896
226	.976660	.004758	.265237	.170363	.565116	.087446
227	.982056	.003684	.259209	.192596	.555387	.086541
228	.987328	.002621	.252332	.217963	.544472	.085337
229	.992481	.001571	.243063	.252150	.529369	.083884
230	.997514	.000524	.230251	.299402	.500558	.086575

40 911 120

O.N.E.R.A.	AR 211		J.Sidès	06-2-6
	RAE 2822: MACH = 0.75, ALPHA = 3			

UPPER SURFACE

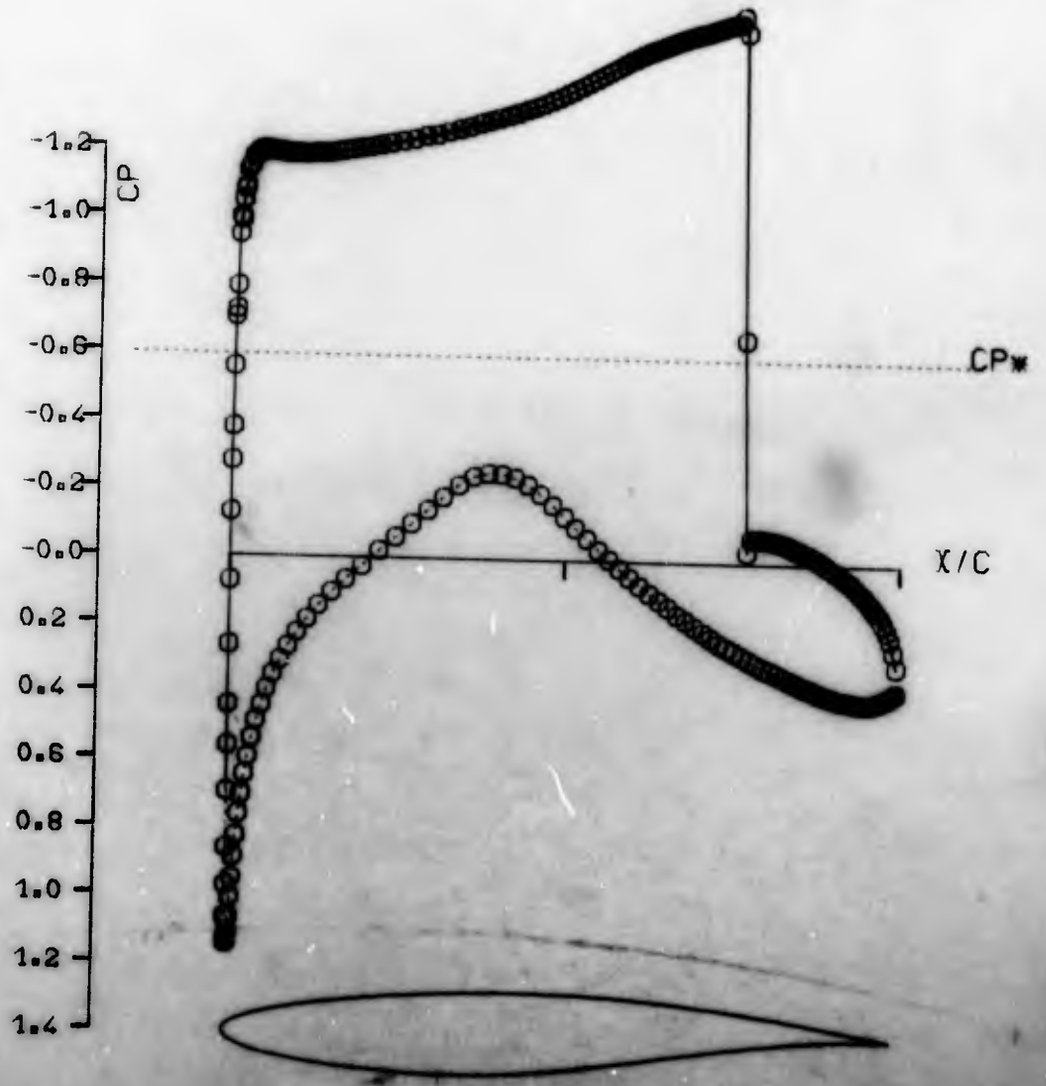
LOWER SURFACE

CL= 1.1292

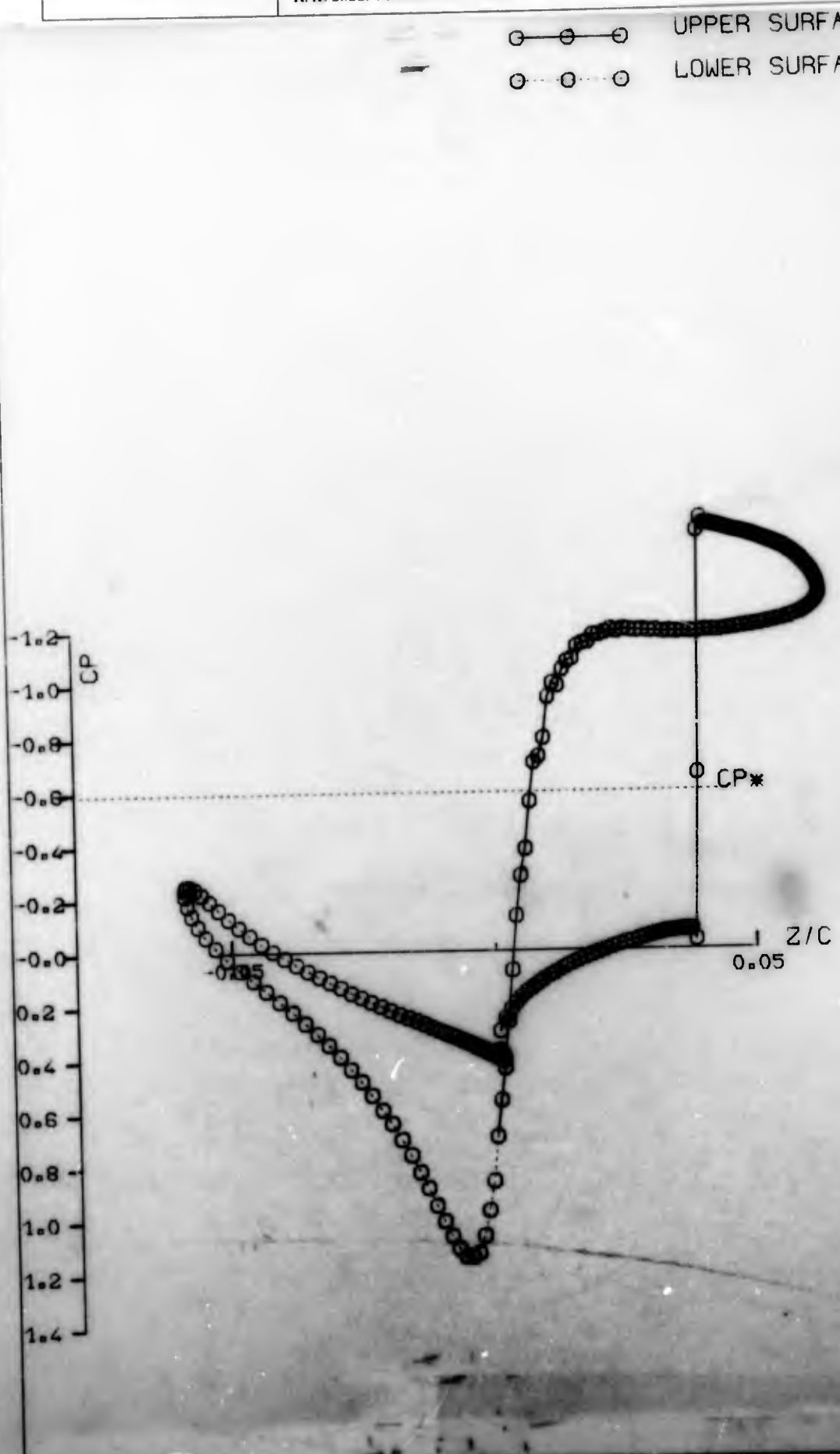
CD= 0.0504

CM= -0.2035

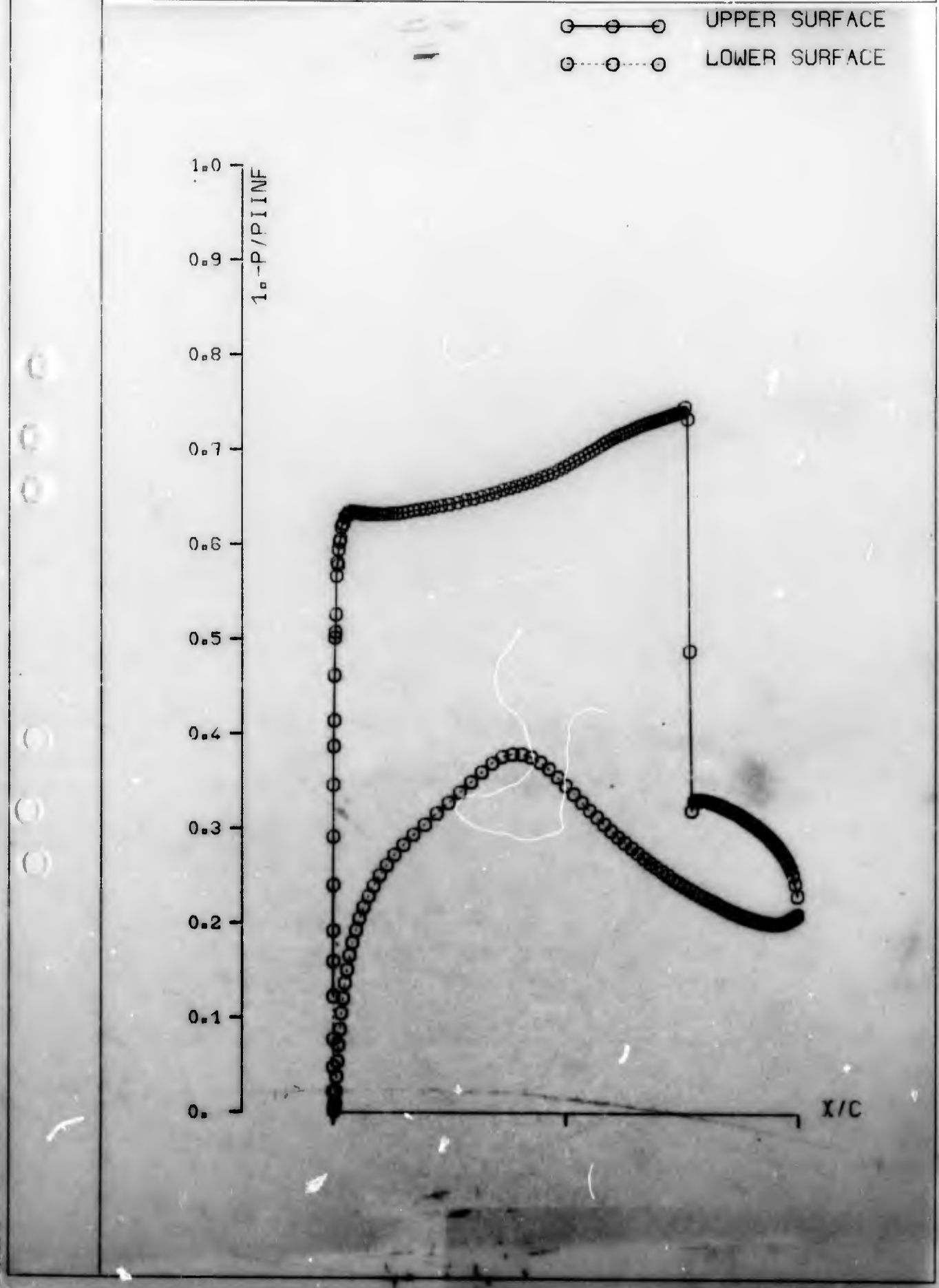
Γ = 0.5440



O.N.E.R.A.	AR 211		J.Sidès	06-2-7
	RAE 2822: MACH = 0.75, ALPHA = 3			

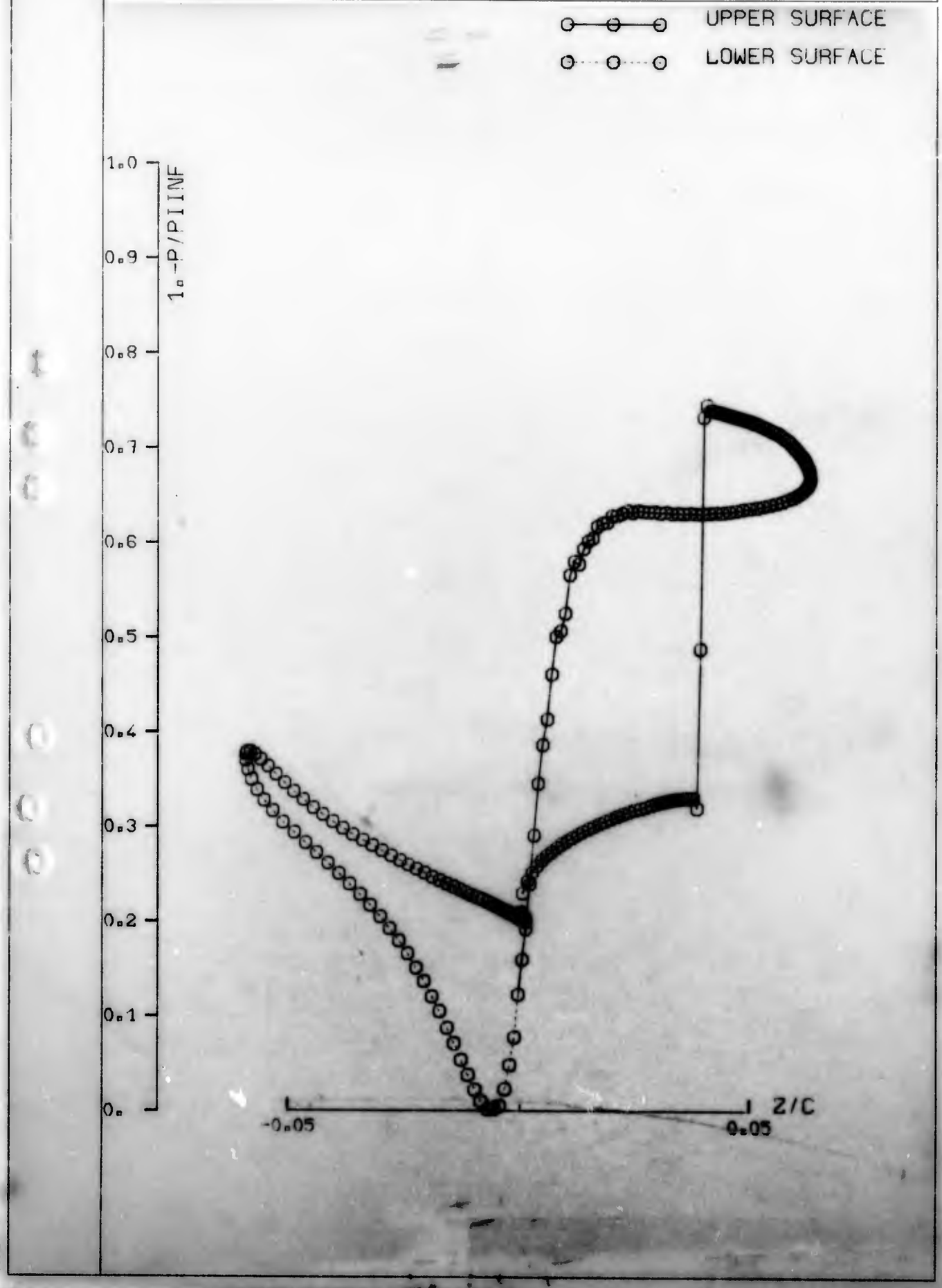


O.N.E.R.A.	AR 211		J.Sidès	06-2-8
	RAE 2822: MACH = 0.75, ALPHA = 3			



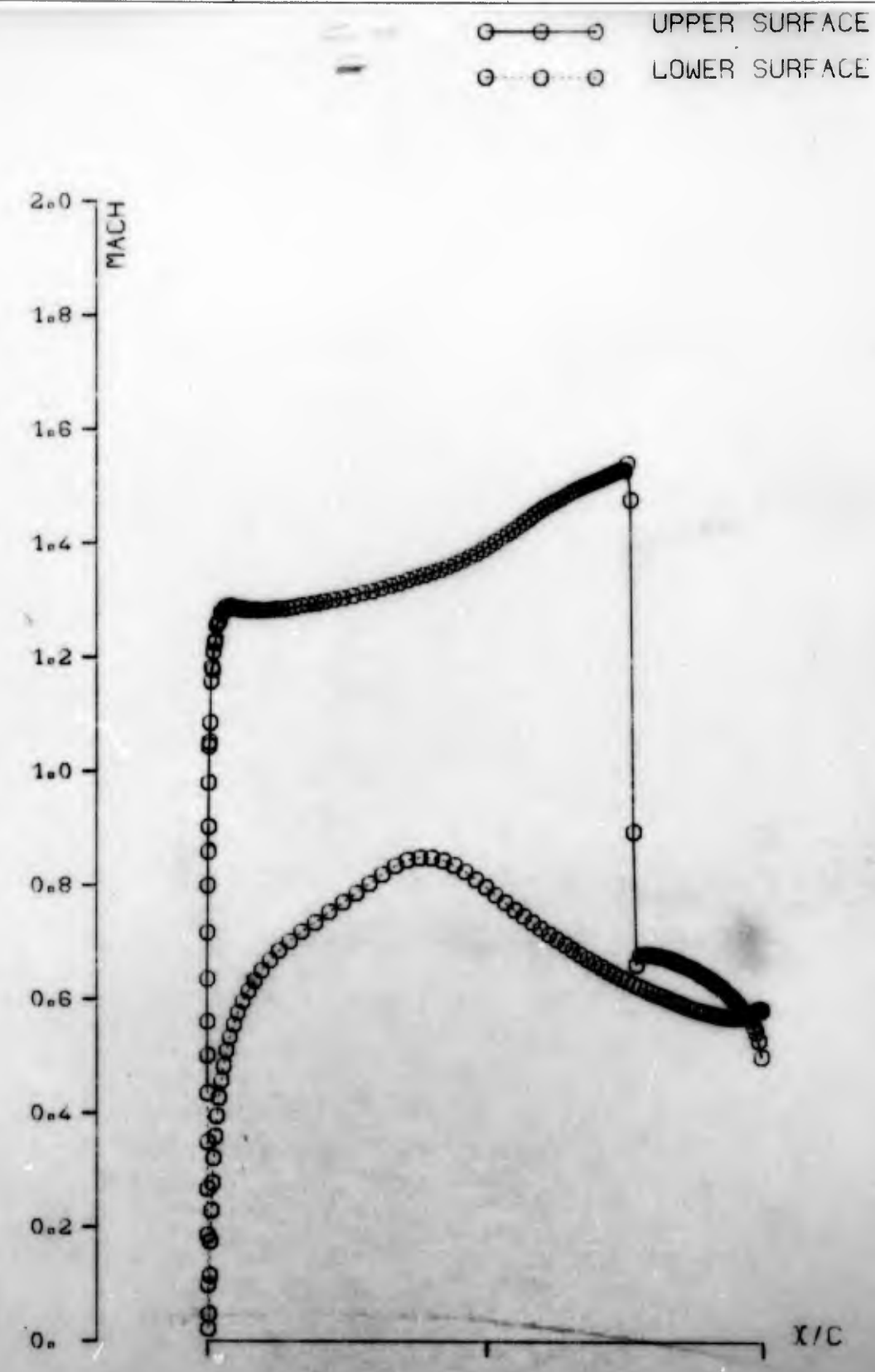
SIDES J

O.N.E.R.A.	AR 211		J.Sidès	06-2-9
	RAE 2822: MACH = 0.75, ALPHA = 3			

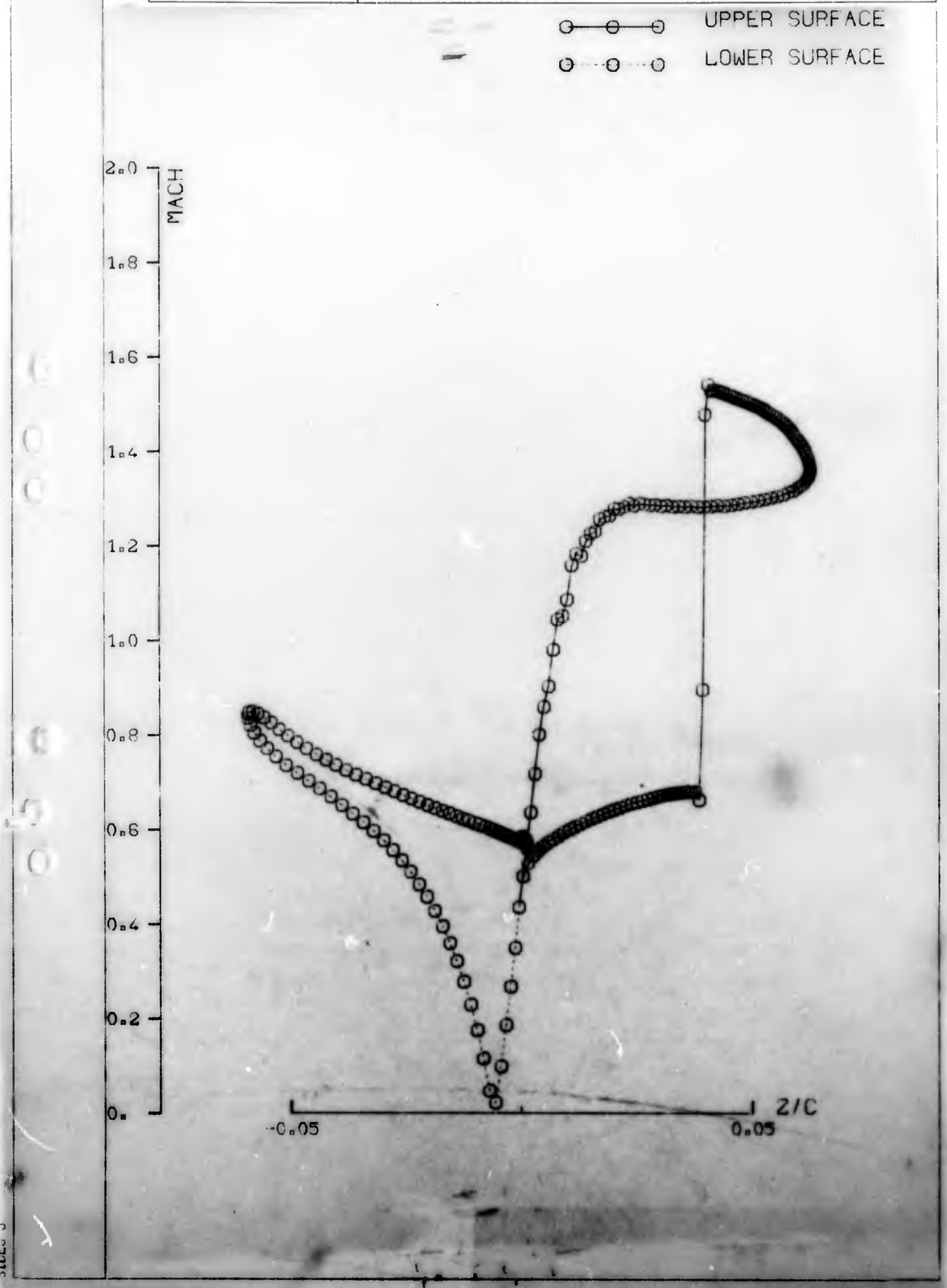


SIDES J

O.N.E.R.A.	AR 211		J.Sidès	06-2-10
	RAE 2822: MACH = 0.75, ALPHA = 3			



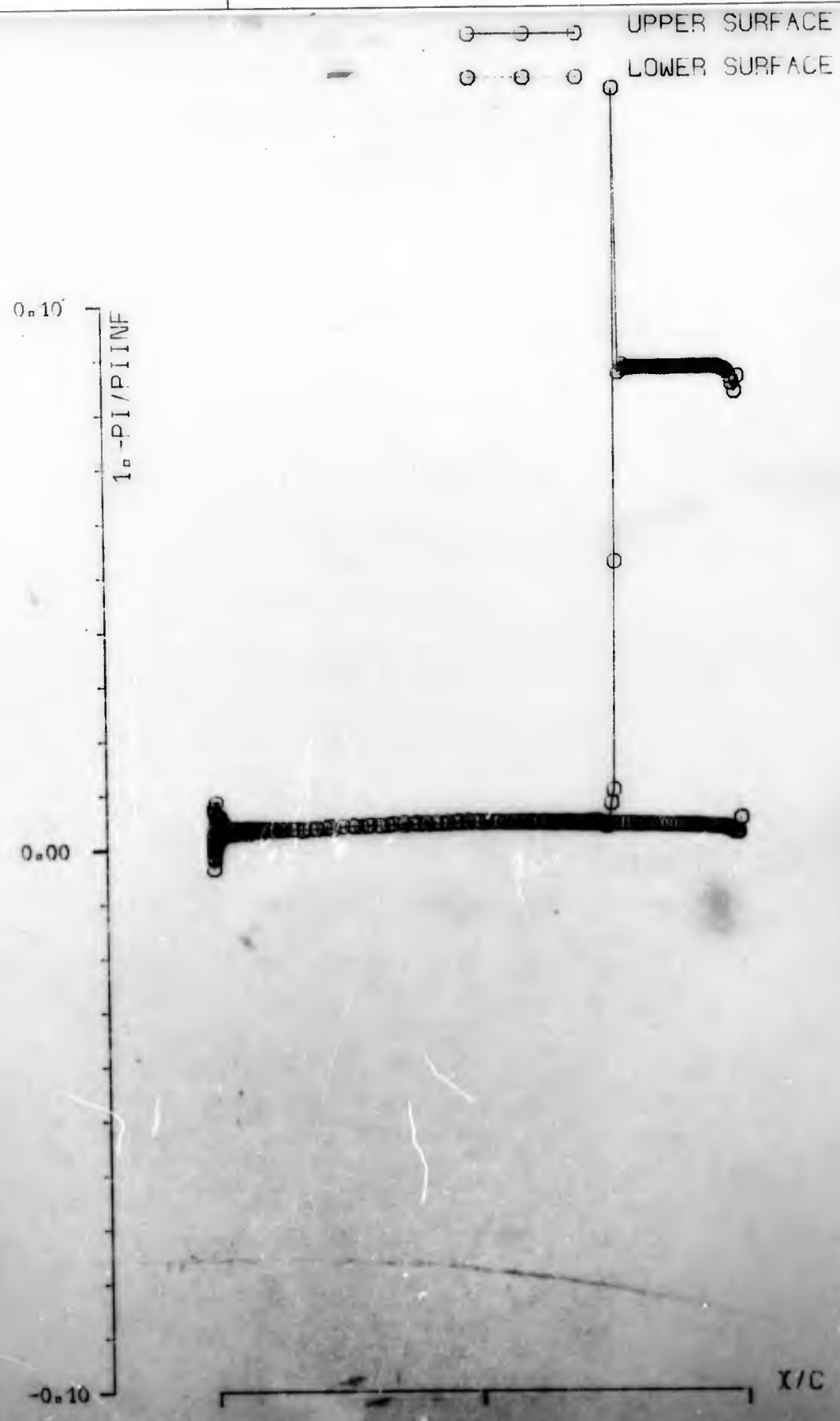
O.N.E.R.A.	AR 211		J.Sidès	06-2-11
	RAE 2822: MACH = 0.75, ALPHA = 3			



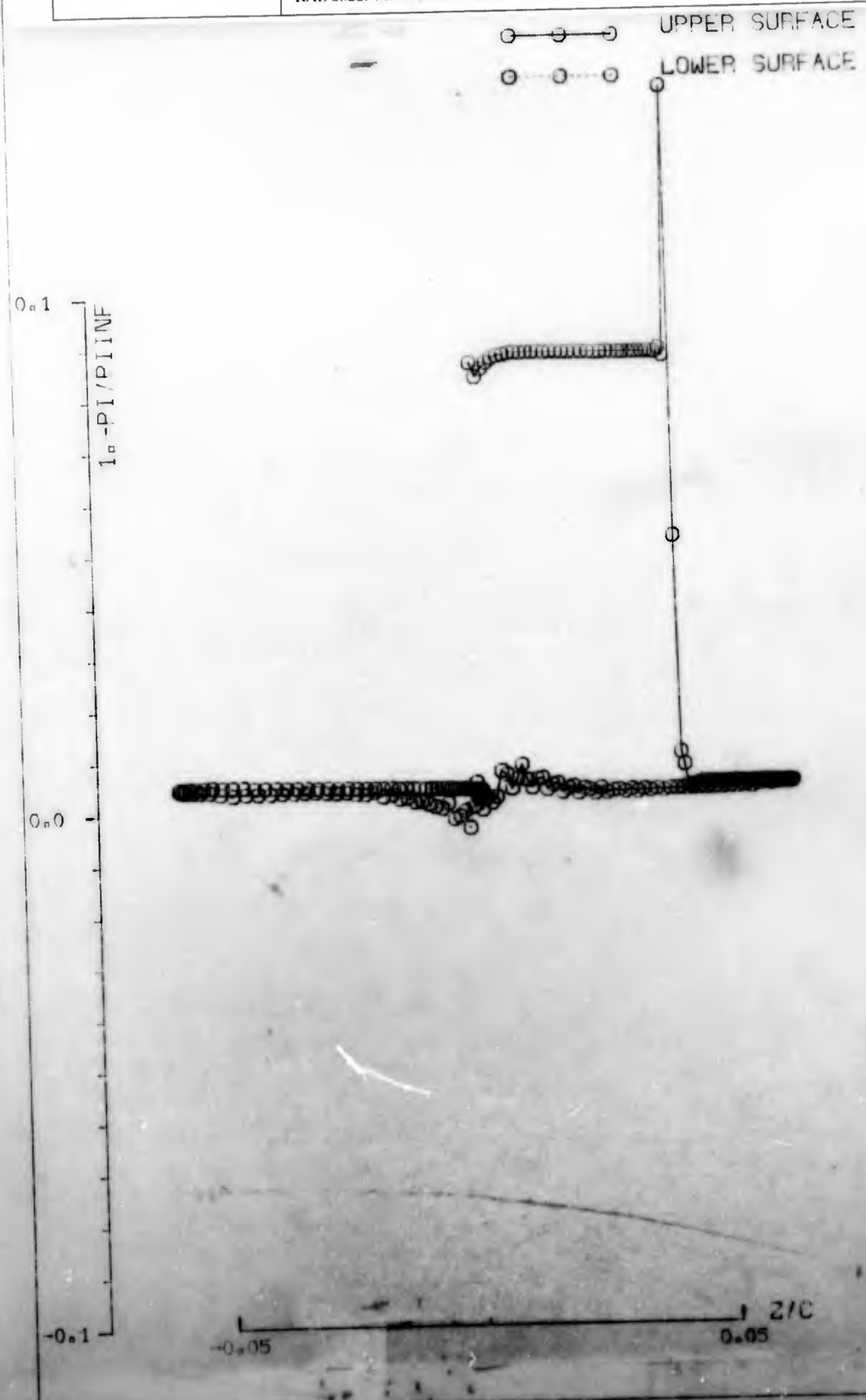
SIDES J

	05-8-13		05-8-14		05-8-15		05-8-16		05-8-17		05-8-18		FICHE Nº 9
05-8-19		05-8-20		TEST CASE 05 CONTRIBUTOR 9	05-9-1	05-9-2	05-9-3	05-9-4	05-9-5	05-9-6	05-9-7	05-9-8	05-9-9	
05-9-10	05-9-11	05-9-12	05-9-13	05-9-14	05-9-15	05-9-16	05-9-17	05-9-18	05-9-19	05-9-20	05-9-21	05-9-22	05-9-23	
05-9-24	05-9-25	05-9-26	05-9-27	TEST CASE 05 CONTRIBUTOR 10	05-10-1	05-10-2	05-10-3	05-10-4	05-10-5	05-10-6	05-10-7	05-10-8	05-10-9	
05-10-10	05-10-11	05-10-12	05-10-13	05-10-14	TEST CASE 06 CONTRIBUTOR 1	06-1-1	06-1-2	06-1-3	06-1-4	06-1-5	06-1-6	06-1-7	06-1-8	
06-1-9	06-1-10	06-1-11	06-1-12	06-1-13	06-1-14	06-1-15	06-1-16	06-1-17	06-1-18	06-1-19	06-1-20	06-1-21	06-1-22	
06-1-23	TEST CASE 06 CONTRIBUTOR 2	06-2-1	06-2-2	06-2-3	06-2-4	06-2-5	06-2-6	06-2-7	06-2-8	06-2-9	06-2-10	06-2-11	CONTINUED	

O.N.E.R.A.	AR 211		J.Sidès	06-2-12
	RAE 2822: MACH = 0.75, ALPHA = 3			



O.N.E.R.A.	AR 211		J.Sidès	06-2-13
	RAE 2822: MACH = 0.75, ALPHA = 3			



O.N.E.R.A.	AR 211		J.Sidès	06-2-14
	RAE 2822: MACH = 0.75, ALPHA = 3			

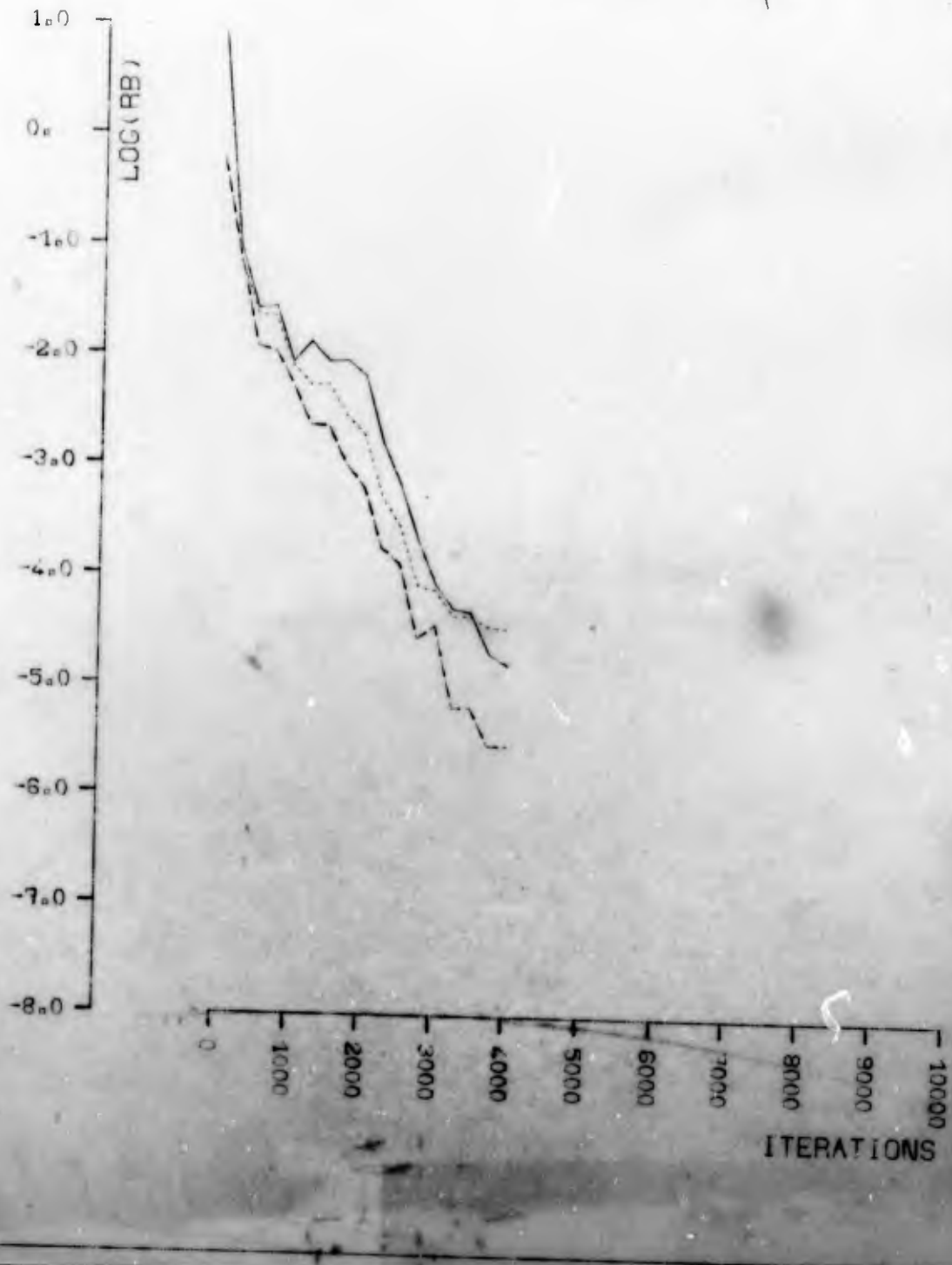
RESIDUAL MEAN

RB=R.M.S. OF $(F^{N+1} - F^{N})/DT$

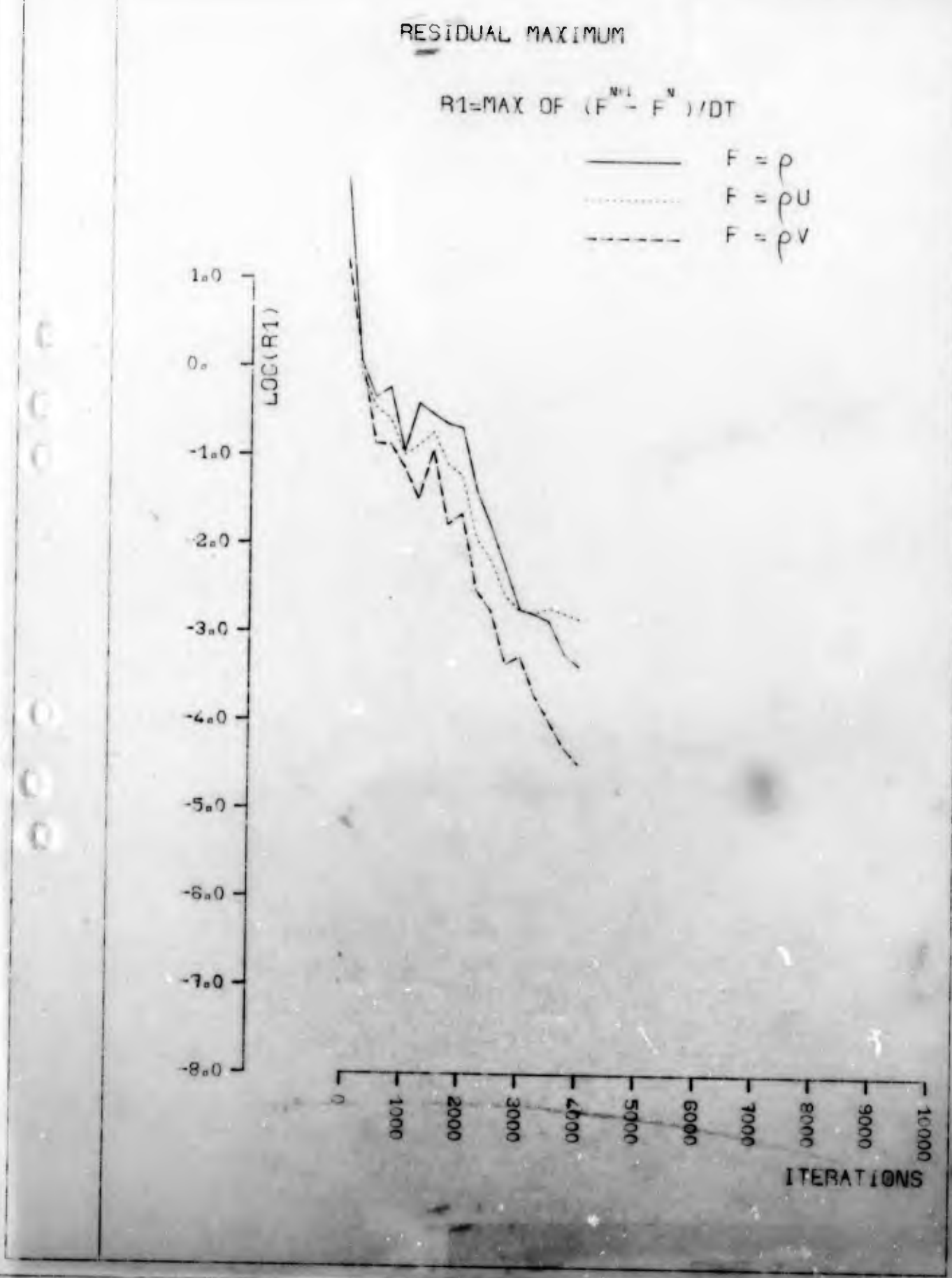
——— $F = \rho$

..... $F = \rho U$

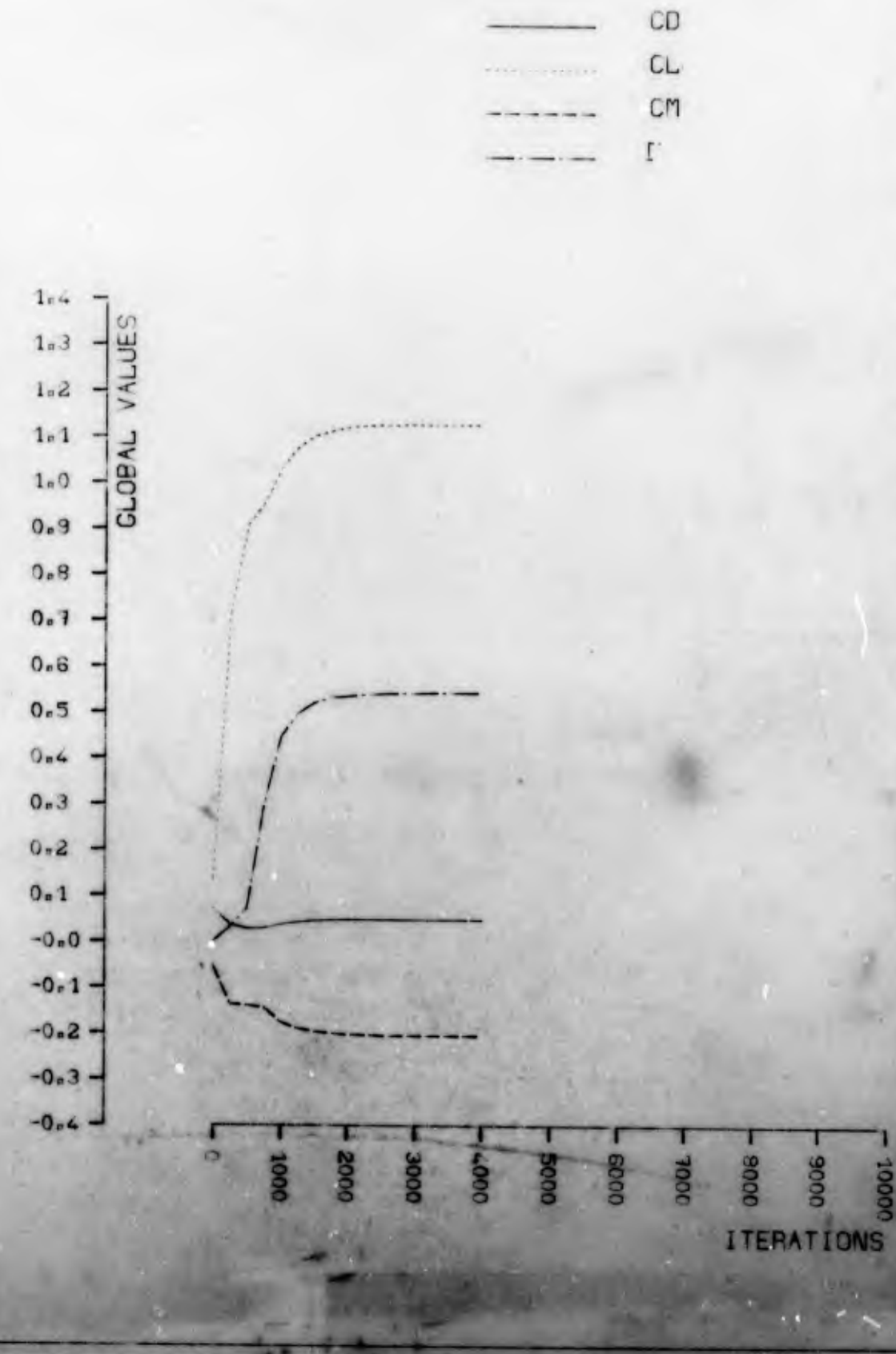
– – – $F = \rho V$



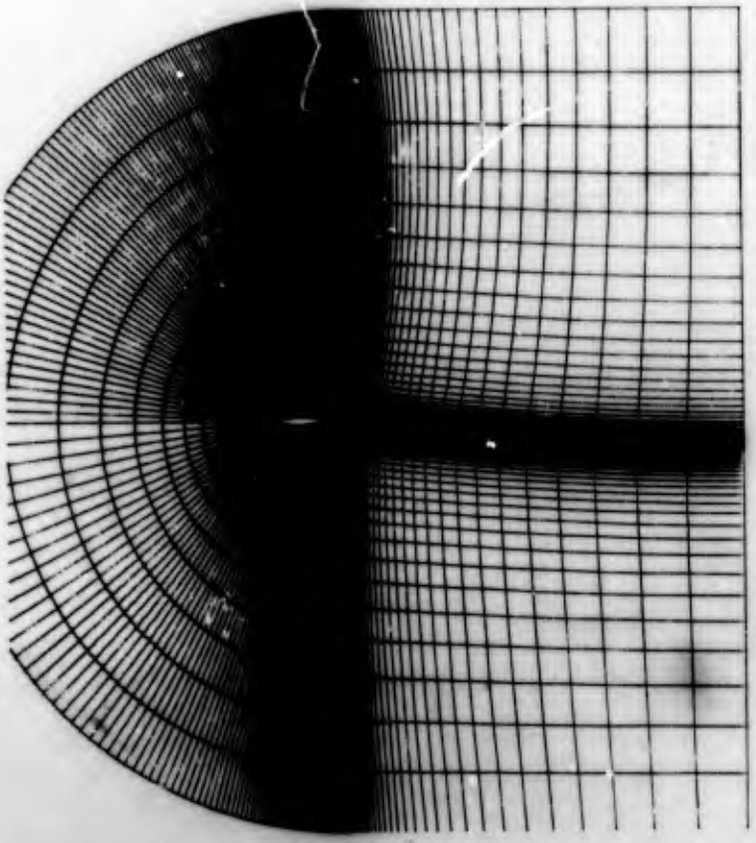
O.N.E.R.A.	AR 211		J.Sidès	06-2-15
	RAE 2822: MACH = 0.75, ALPHA = 3			



O.N.E.R.A.	AR 211		J.Sidès	06-2-16
	RAE 2822: MACH = 0.75, ALPHA = 3			



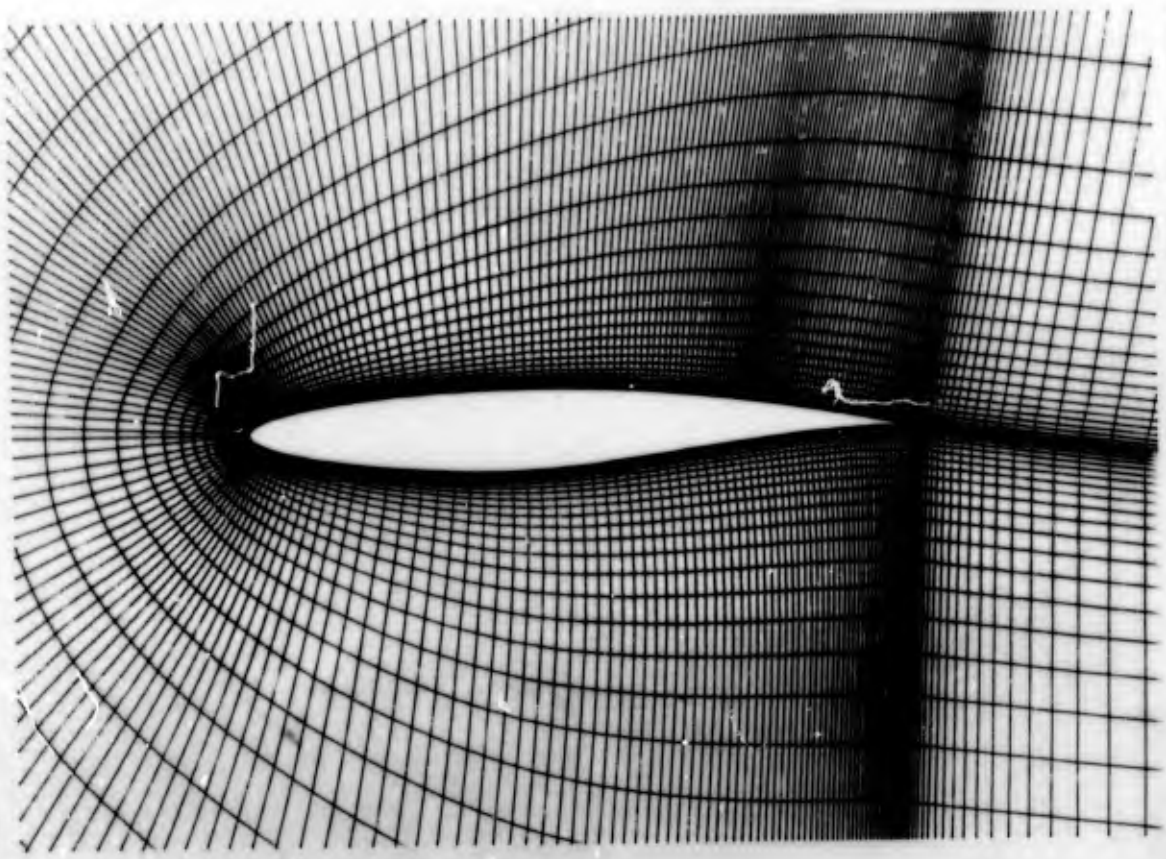
O.N.E.R.A.	AR 211		J.Sidès	06-2-17
	RAE 2822: MACH = 0.75, ALPHA = 3			



299X35 MESH CHORD = 1 CM

AR-SIDES

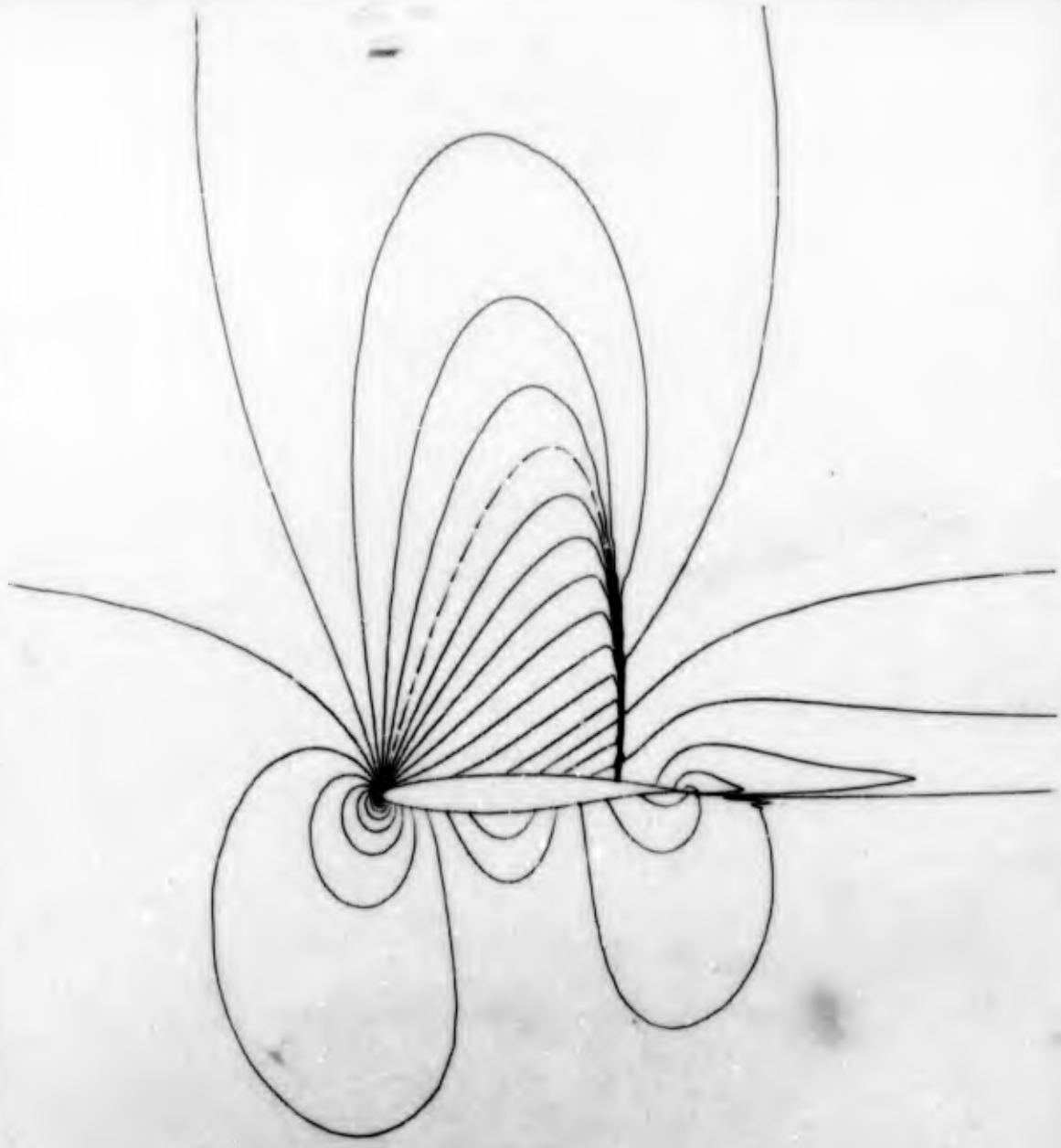
O.N.E.R.A.	AR 211		J.Sidès	06-2-18
	RAE 2822: MACH = 0.75, ALPHA = 3			



299X35 MESH (PARTIAL VIEW)

AB-SIDES

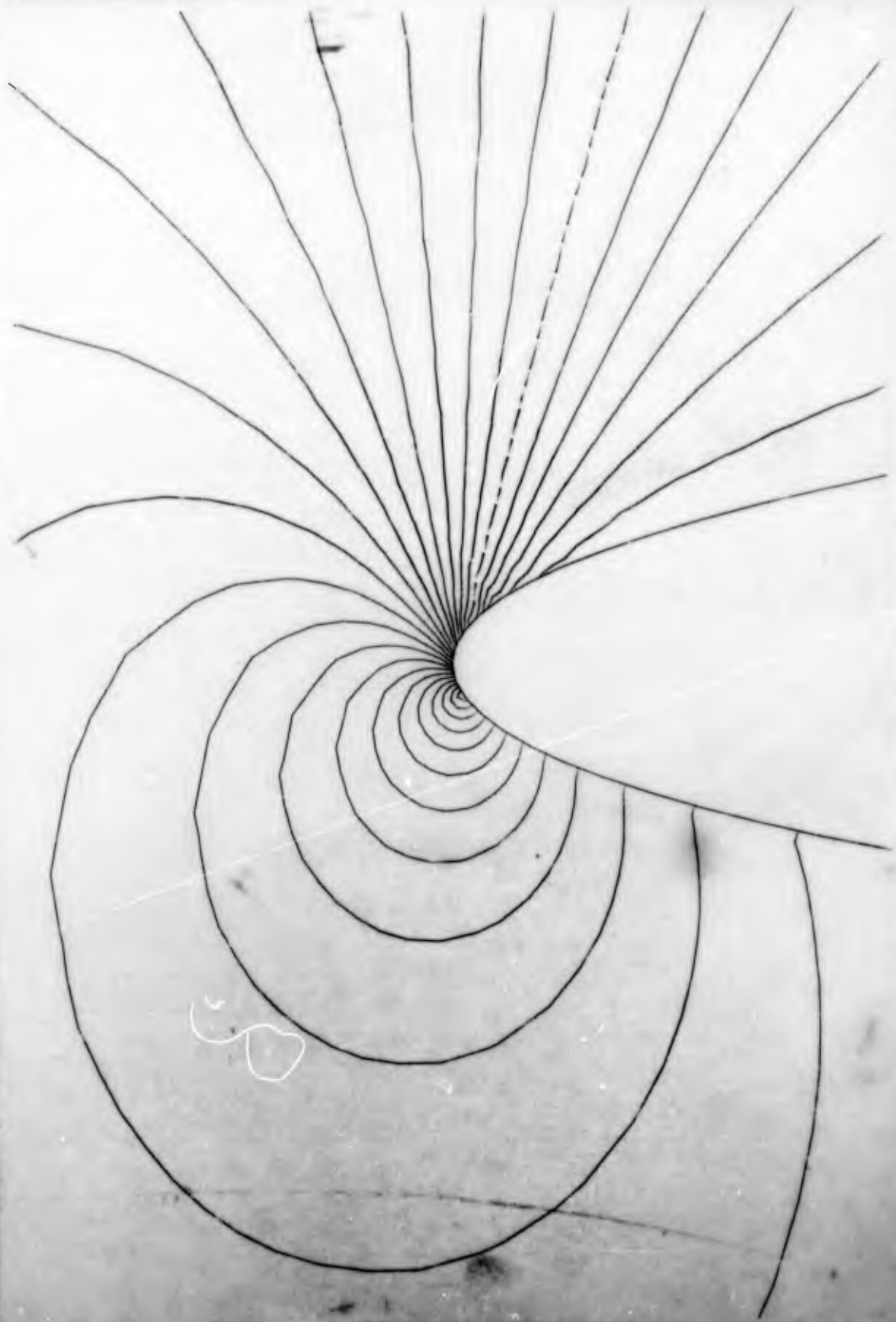
O.N.E.R.A.	AR 211		J.Sidès	06-2-19
	RAE 2822: MACH = 0.75, ALPHA = 3			



ISO-MACH LINES DM=0.050 CHORD = 5 CM

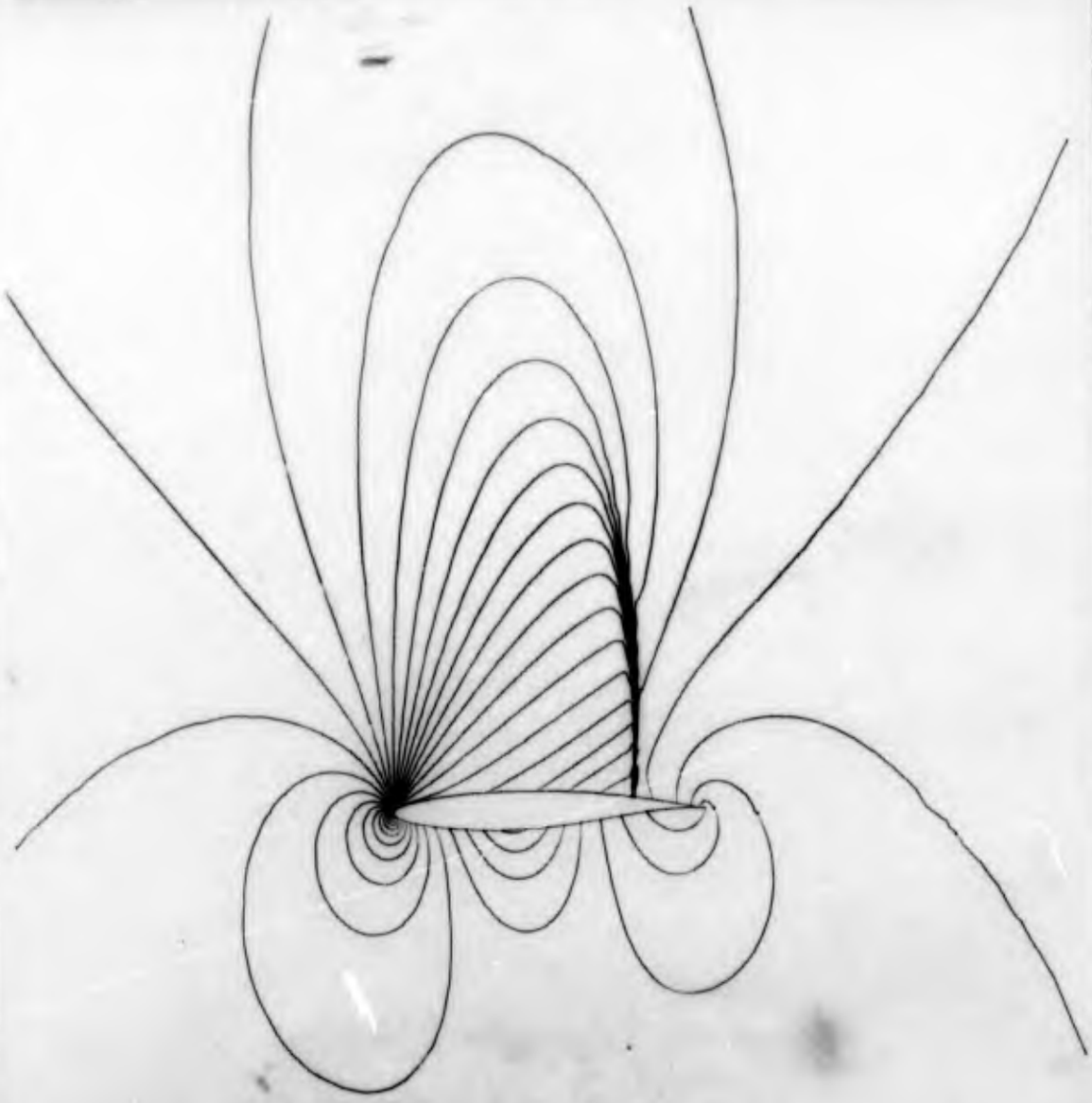
AB-SIDES

O.N.E.R.A.	AR 211		J.Sidès	06-2-20
	RAE 2822: MACH = 0.75, ALPHA = 3			



AB-SIDES

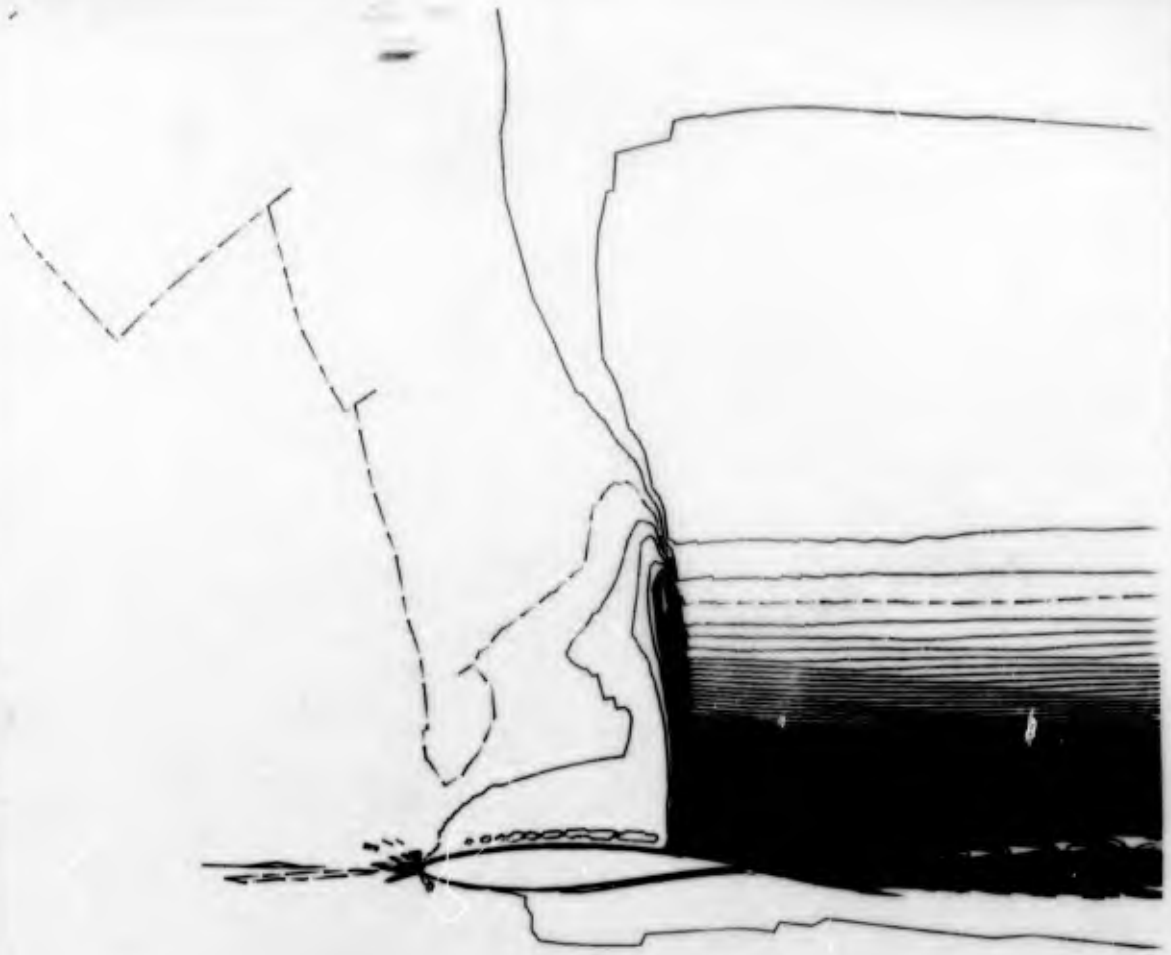
O.N.E.R.A.	AR 211		J.Sidès	06-2-21
	RAE 2822: MACH = 0.75, ALPHA = 3			



ISO-P/PIINF DP=0.025 CHORD= 5 CM

AB-SIDES

O.N.E.R.A.	AR 211		J.Sidès	06-2-22
	RAE 2822: MACH = 0.75, ALPHA = 3			



ISO-PI/PIINF DPI=0.001 CHORD= 5 CM

AB-SIDES

O.N.E.R.A.	AR 211		J.Sidès	06-2-23
	RAE 2822: MACH = 0.75, ALPHA = 3			

ISO-PI/PIINF DPI=0.001 CHORD= 100CM

J.SIDES

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 06

RAE 2822: MACH = 0.75, ALPHA = 3

Contributor No 3

C.C.Lytton

(R.A.E., G.B.)

R.A.E.	AR 211		C.C.Lytton	06-3-1
	RAE 2822: MACH = 0.75, ALPHA = 3			

NON-STANDARD RUNS FOR CASE 6: RAE 2822, M=0.75, A=3.0

Standard data: Grid 87 (160 x 24), Fdpth = 16.0 (chords)

	CL	CM	CD (contour)	CD (shock)	GAMMA (surface)	GAMMA (first row)
Standard	1.0971	-0.1894	0.0461	0.0452	0.5149	0.5225
Fdpth = 8.0	1.0903	***	0.0453	0.0430	***	***
Fdpth =32.0	1.1031	-0.1909	0.0465	0.0458	0.5215	0.5288
158 x 24	1.1076	-0.1932	0.0473	0.0457	0.5301	0.5373
156 x 24	1.0983	-0.1901	0.0464	0.0446	0.5115	0.5233
Grid 41	1.0894	-0.1876	0.0458	0.0443	0.4954	0.5051
320 x 48	1.0923	-0.1869	0.0449	0.0425	0.5069	0.5130
Zero-vort. b/c	1.0951	-0.1885	0.0455	0.0453	0.5186	0.5181
Pioneer program*	1.0948	-0.1932	0.0479	0.0385	0.5159	0.5205

*(fractional-step, global-dump)

*** Not available, dump destroyed

RAE 2822 MACH 0.750 ALPHA 3.000 0<X<1:

VERSION 87: KEEPS WALL CELLS ROUGHLY SAME ASPECT RATIO

AFTER K=1, CELL DEPTHS INCREASE IN GEOMETRIC PROGRESSION

TOTAL CELL DEPTH =16.0*CHORD

JL	KL	NEND	NPRNT
160	24	0	0

CP*	P(CR)	CPS	P(ST)
-0.5912	0.9742	1.1486	1.8442

J	X/C	Z/C	1-P/H	CP	M	1-PI/H
2	1.000	0.0000	0.1991	0.4142	0.5642	0.0060
3	0.999	0.0001	0.2045	0.3943	0.5759	0.0040
4	0.997	0.0001	0.2074	0.3836	0.5811	0.0037
5	0.995	0.0003	0.2085	0.3796	0.5831	0.0036
6	0.992	0.0004	0.2080	0.3816	0.5827	0.0032
7	0.988	0.0006	0.2070	0.3853	0.5816	0.0028
8	0.983	0.0008	0.2056	0.3902	0.5796	0.0026
9	0.978	0.0009	0.2041	0.3958	0.5775	0.0023
10	0.972	0.0011	0.2029	0.4004	0.5756	0.0021
11	0.965	0.0012	0.2019	0.4041	0.5741	0.0021
12	0.957	0.0012	0.2011	0.4070	0.5729	0.0020
13	0.948	0.0011	0.2012	0.4067	0.5729	0.0021
14	0.939	0.0010	0.2017	0.4048	0.5734	0.0024
15	0.930	0.0007	0.2026	0.4015	0.5748	0.0024
16	0.919	0.0003	0.2039	0.3964	0.5770	0.0025
17	0.908	-0.0003	0.2055	0.3907	0.5794	0.0026
18	0.896	-0.0010	0.2074	0.3838	0.5822	0.0028
19	0.884	-0.0018	0.2096	0.3755	0.5856	0.0031
20	0.871	-0.0028	0.2122	0.3660	0.5894	0.0034
21	0.857	-0.0040	0.2150	0.3555	0.5937	0.0037
22	0.843	-0.0054	0.2181	0.3441	0.5984	0.0039
23	0.828	-0.0069	0.2216	0.3315	0.6037	0.0042
24	0.813	-0.0085	0.2253	0.3176	0.6096	0.0044
25	0.797	-0.0104	0.2293	0.3028	0.6158	0.0046
26	0.781	-0.0123	0.2336	0.2869	0.6225	0.0048
27	0.764	-0.0144	0.2382	0.2702	0.6296	0.0050
28	0.747	-0.0167	0.2432	0.2515	0.6374	0.0052
29	0.730	-0.0191	0.2488	0.2311	0.6460	0.0055
30	0.712	-0.0216	0.2547	0.2093	0.6551	0.0057
31	0.694	-0.0242	0.2610	0.1862	0.6648	0.0059
32	0.675	-0.0268	0.2677	0.1615	0.6752	0.0061
33	0.656	-0.0296	0.2747	0.1355	0.6861	0.0063
34	0.637	-0.0323	0.2822	0.1079	0.6976	0.0064
35	0.618	-0.0351	0.2899	0.0794	0.7096	0.0065
36	0.599	-0.0379	0.2980	0.0497	0.7222	0.0064
37	0.579	-0.0406	0.3064	0.0185	0.7353	0.0064
38	0.559	-0.0433	0.3153	-0.0143	0.7492	0.0064
39	0.540	-0.0458	0.3246	-0.0486	0.7636	0.0064
40	0.520	-0.0483	0.3342	-0.0842	0.7784	0.0064
41	0.500	-0.0505	0.3439	-0.1198	0.7935	0.0063
42	0.480	-0.0526	0.3532	-0.1540	0.8081	0.0060
43	0.460	-0.0545	0.3616	-0.1852	0.8214	0.0058
44	0.441	-0.0560	0.3687	-0.2112	0.8326	0.0055
45	0.421	-0.0573	0.3736	-0.2293	0.8405	0.0051

R.A.E.	AR 211		C.C.Lytton	06-3-3
	RAE 2822: MACH = 0.75, ALPHA = 3			

46	0.401	-0.0582	0.3773	-0.2428	0.8461	0.0052
47	0.382	-0.0589	0.3765	-0.2400	0.8454	0.0048
48	0.363	-0.0592	0.3740	-0.2307	0.8415	0.0048
49	0.344	-0.0592	0.3689	-0.2121	0.8340	0.0045
50	0.325	-0.0589	0.3618	-0.1857	0.8234	0.0040
51	0.306	-0.0584	0.3536	-0.1557	0.8112	0.0036
52	0.288	-0.0576	0.3453	-0.1249	0.7987	0.0033
53	0.270	-0.0567	0.3371	-0.0948	0.7863	0.0031
54	0.253	-0.0557	0.3295	-0.0665	0.7745	0.0031
55	0.236	-0.0545	0.3221	-0.0395	0.7633	0.0030
56	0.219	-0.0532	0.3151	-0.0134	0.7524	0.0030
57	0.203	-0.0518	0.3081	0.0122	0.7417	0.0030
58	0.187	-0.0502	0.3010	0.0384	0.7308	0.0029
59	0.172	-0.0486	0.2938	0.0651	0.7197	0.0028
60	0.157	-0.0469	0.2863	0.0926	0.7083	0.0027
61	0.143	-0.0452	0.2786	0.1209	0.6965	0.0025
62	0.129	-0.0433	0.2706	0.1505	0.6841	0.0024
63	0.116	-0.0414	0.2621	0.1818	0.6710	0.0022
64	0.104	-0.0394	0.2531	0.2150	0.6570	0.0020
65	0.092	-0.0373	0.2436	0.2500	0.6423	0.0018
66	0.081	-0.0352	0.2336	0.2872	0.6264	0.0015
67	0.070	-0.0330	0.2226	0.3276	0.6092	0.0012
68	0.061	-0.0308	0.2107	0.3715	0.5903	0.0009
69	0.052	-0.0285	0.1975	0.4201	0.5692	0.0003
70	0.043	-0.0262	0.1830	0.4738	0.5456	-0.0003
71	0.035	-0.0238	0.1668	0.5335	0.5189	-0.0011
72	0.028	-0.0214	0.1489	0.5996	0.4886	-0.0020
73	0.022	-0.0190	0.1285	0.6749	0.4530	-0.0033
74	0.017	-0.0165	0.1064	0.7562	0.4124	-0.0046
75	0.012	-0.0140	0.0803	0.8523	0.3606	-0.0061
76	0.008	-0.0115	0.0529	0.9536	0.2972	-0.0070
77	0.005	-0.0090	0.0213	1.0700	0.2100	-0.0092
78	0.003	-0.0064	-0.0006	1.1508	0.1068	-0.0086
79	0.001	-0.0039	-0.0054	1.1684	0.1054	-0.0132
80	0.000	-0.0013	0.0594	0.9295	0.3036	-0.0027
81	0.000	0.0013	0.1858	0.4633	0.5192	0.0215
82	0.001	0.0039	0.3232	-0.0435	0.7326	0.0330
83	0.003	0.0064	0.4203	-0.4015	0.8896	0.0305
84	0.005	0.0089	0.4945	-0.6752	1.0027	0.0401
85	0.008	0.0114	0.5518	-0.8864	1.1074	0.0341
86	0.012	0.0139	0.5825	-0.9998	1.1609	0.0374
87	0.017	0.0163	0.6053	-1.0840	1.2091	0.0315
88	0.022	0.0187	0.6190	-1.1343	1.2345	0.0331
89	0.028	0.0210	0.6260	-1.1602	1.2490	0.0325
90	0.035	0.0234	0.6294	-1.1728	1.2558	0.0325
91	0.043	0.0257	0.6309	-1.1781	1.2589	0.0324
92	0.052	0.0280	0.6313	-1.1797	1.2603	0.0317
93	0.061	0.0302	0.6314	-1.1800	1.2615	0.0303
94	0.070	0.0325	0.6315	-1.1806	1.2640	0.0275
95	0.081	0.0347	0.6314	-1.1800	1.2650	0.0258
96	0.092	0.0368	0.6310	-1.1788	1.2651	0.0248
97	0.104	0.0390	0.6309	-1.1783	1.2649	0.0247
98	0.116	0.0410	0.6311	-1.1790	1.2655	0.0244
99	0.129	0.0430	0.6313	-1.1797	1.2656	0.0247
100	0.143	0.0450	0.6318	-1.1815	1.2667	0.0246
101	0.157	0.0468	0.6326	-1.1846	1.2683	0.0247
102	0.172	0.0486	0.6340	-1.1897	1.2717	0.0240
103	0.187	0.0503	0.6354	-1.1951	1.2750	0.0235
104	0.203	0.0520	0.6369	-1.2006	1.2784	0.0230
105	0.219	0.0535	0.6384	-1.2060	1.2819	0.0224

R.A.E.	AR 211		C.C.Lytton	06-3-4
	RAE 2822: MACH = 0.75, ALPHA = 3			

106	0.236	0.0549	0.6400	-1.2119	1.2856	0.0218
107	0.253	0.0562	0.6418	-1.2184	1.2893	0.0217
108	0.270	0.0574	0.6438	-1.2260	1.2938	0.0214
109	0.288	0.0585	0.6461	-1.2343	1.2987	0.0210
110	0.306	0.0595	0.6483	-1.2425	1.3034	0.0209
111	0.325	0.0604	0.6505	-1.2505	1.3077	0.0213
112	0.344	0.0611	0.6531	-1.2601	1.3131	0.0215
113	0.363	0.0617	0.6558	-1.2701	1.3188	0.0214
114	0.382	0.0622	0.6587	-1.2808	1.3250	0.0214
115	0.401	0.0625	0.6617	-1.2917	1.3312	0.0217
116	0.421	0.0627	0.6651	-1.3046	1.3386	0.0217
117	0.441	0.0628	0.6686	-1.3175	1.3459	0.0222
118	0.460	0.0627	0.6730	-1.3334	1.3552	0.0224
119	0.480	0.0624	0.6772	-1.3491	1.3644	0.0227
120	0.500	0.0620	0.6825	-1.3685	1.3760	0.0229
121	0.520	0.0614	0.6877	-1.3877	1.3880	0.0228
122	0.540	0.0606	0.6934	-1.4090	1.4010	0.0231
123	0.559	0.0596	0.6993	-1.4306	1.4149	0.0228
124	0.579	0.0585	0.7049	-1.4511	1.4281	0.0227
125	0.599	0.0571	0.7100	-1.4699	1.4406	0.0223
126	0.618	0.0556	0.7146	-1.4871	1.4522	0.0221
127	0.637	0.0540	0.7189	-1.5028	1.4627	0.0220
128	0.656	0.0522	0.7228	-1.5171	1.4725	0.0219
129	0.675	0.0503	0.7263	-1.5303	1.4815	0.0219
130	0.694	0.0483	0.7295	-1.5419	1.4897	0.0215
131	0.712	0.0463	0.7323	-1.5523	1.4954	0.0238
132	0.730	0.0441	0.7388	-1.5764	1.5173	0.0168
133	0.747	0.0419	0.5061	-0.7182	0.9582	0.1091
134	0.764	0.0397	0.3418	-0.1119	0.6968	0.0896
135	0.781	0.0374	0.3398	-0.1048	0.6939	0.0893
136	0.797	0.0351	0.3374	-0.0957	0.6901	0.0889
137	0.813	0.0328	0.3346	-0.0854	0.6858	0.0885
138	0.828	0.0305	0.3313	-0.0734	0.6807	0.0882
139	0.843	0.0283	0.3277	-0.0599	0.6749	0.0878
140	0.857	0.0260	0.3238	-0.0458	0.6688	0.0874
141	0.871	0.0238	0.3198	-0.0309	0.6624	0.0869
142	0.884	0.0216	0.3156	-0.0153	0.6557	0.0865
143	0.896	0.0195	0.3112	0.0009	0.6487	0.0860
144	0.908	0.0175	0.3066	0.0177	0.6415	0.0855
145	0.919	0.0155	0.3019	0.0352	0.6339	0.0850
146	0.930	0.0136	0.2970	0.0531	0.6260	0.0845
147	0.939	0.0119	0.2920	0.0718	0.6178	0.0840
148	0.948	0.0102	0.2868	0.0909	0.6094	0.0835
149	0.957	0.0086	0.2815	0.1105	0.6007	0.0830
150	0.965	0.0071	0.2761	0.1303	0.5917	0.0826
151	0.972	0.0058	0.2704	0.1513	0.5823	0.0821
152	0.978	0.0045	0.2645	0.1731	0.5723	0.0816
153	0.983	0.0034	0.2582	0.1963	0.5615	0.0812
154	0.988	0.0025	0.2515	0.2210	0.5497	0.0809
155	0.992	0.0017	0.2444	0.2473	0.5369	0.0806
156	0.995	0.0011	0.2366	0.2761	0.5230	0.0801
157	0.997	0.0006	0.2275	0.3097	0.5075	0.0790
158	0.999	0.0002	0.2162	0.3511	0.4879	0.0777
159	1.000	0.0000	0.2054	0.3910	0.4663	0.0777

R.A.E.	AR 211		C.C.Lytton	06-3-5
	RAE 2822: MACH = 0.75, ALPHA = 3			

CL= 1.09710 CD= 0.04615 CM= -0.18938

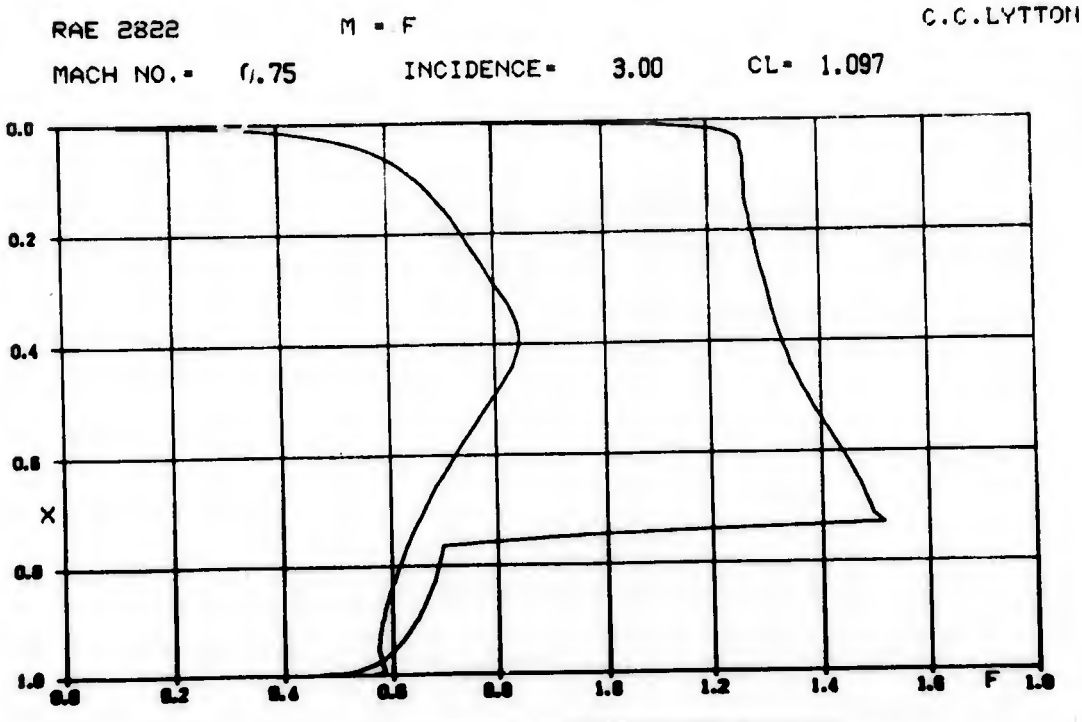
GAMMA AROUND PROFILE = 0.51486

K	GAMMA
1	0.52246
2	0.53962
3	0.53990
4	0.53568
5	0.53699
6	0.53967
7	0.53931
8	0.53910
9	0.53931
10	0.54425
11	0.54689
12	0.54892
13	0.55018
14	0.54894
15	0.55032
16	0.55142
17	0.55257
18	0.55319
19	0.55435
20	0.55522
21	0.55731
22	0.55936
23	0.57060

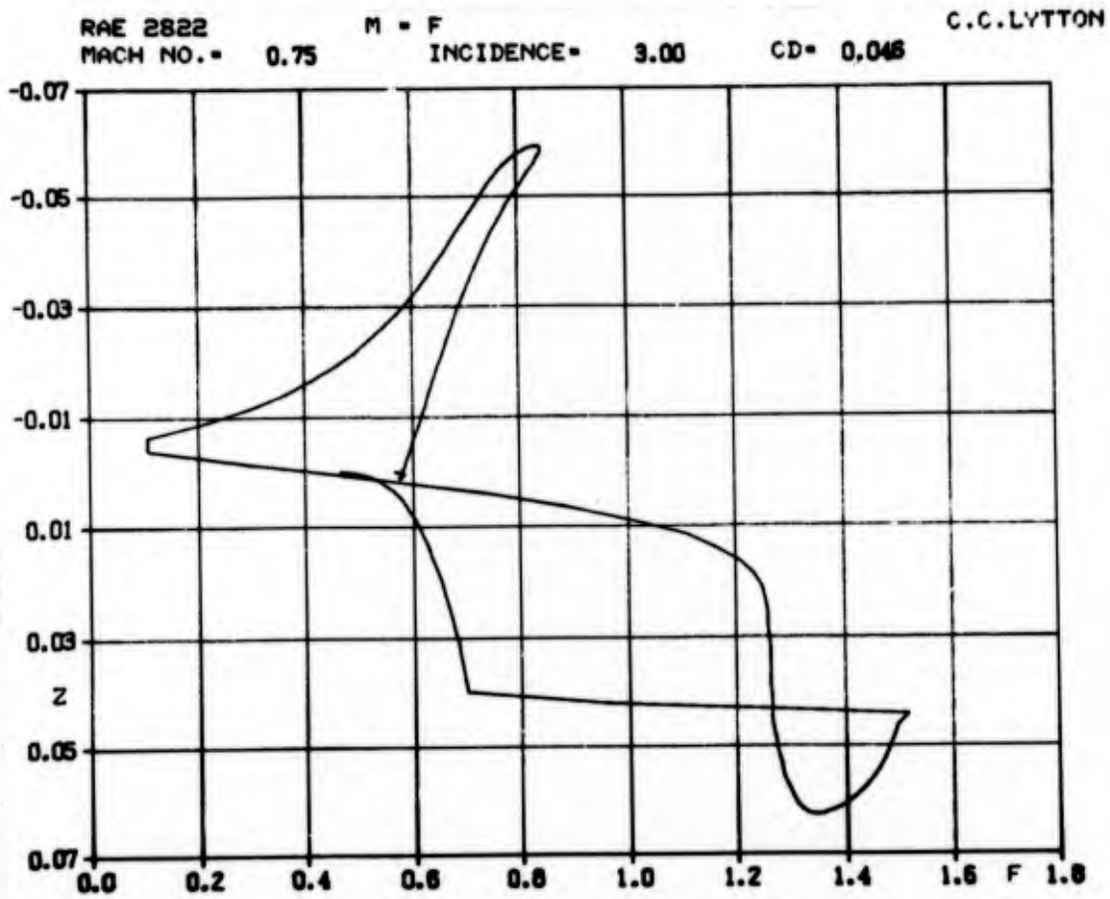
NO SHOCK ON -1 SURFACE

CD (SHOCK INTEGRAL - Mk.2) = 0.04525

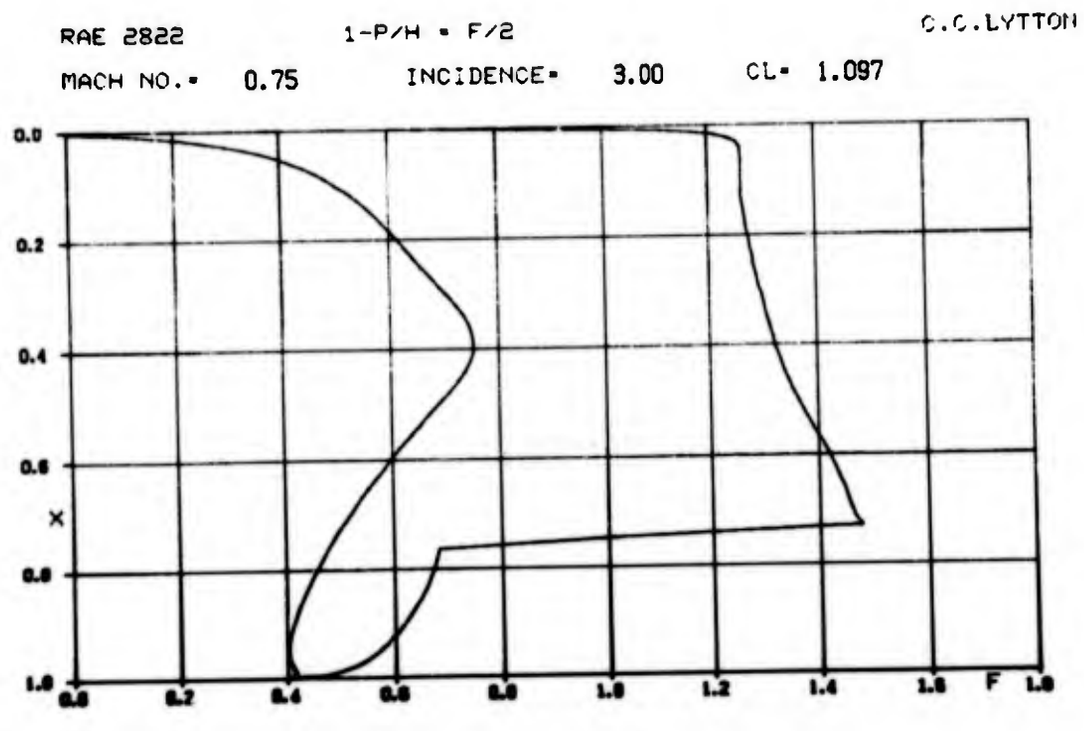
R.A.E.	AR 211		C.C.Lytton	06-3-6
	RAE 2822: MACH = 0.75, ALPHA = 3			



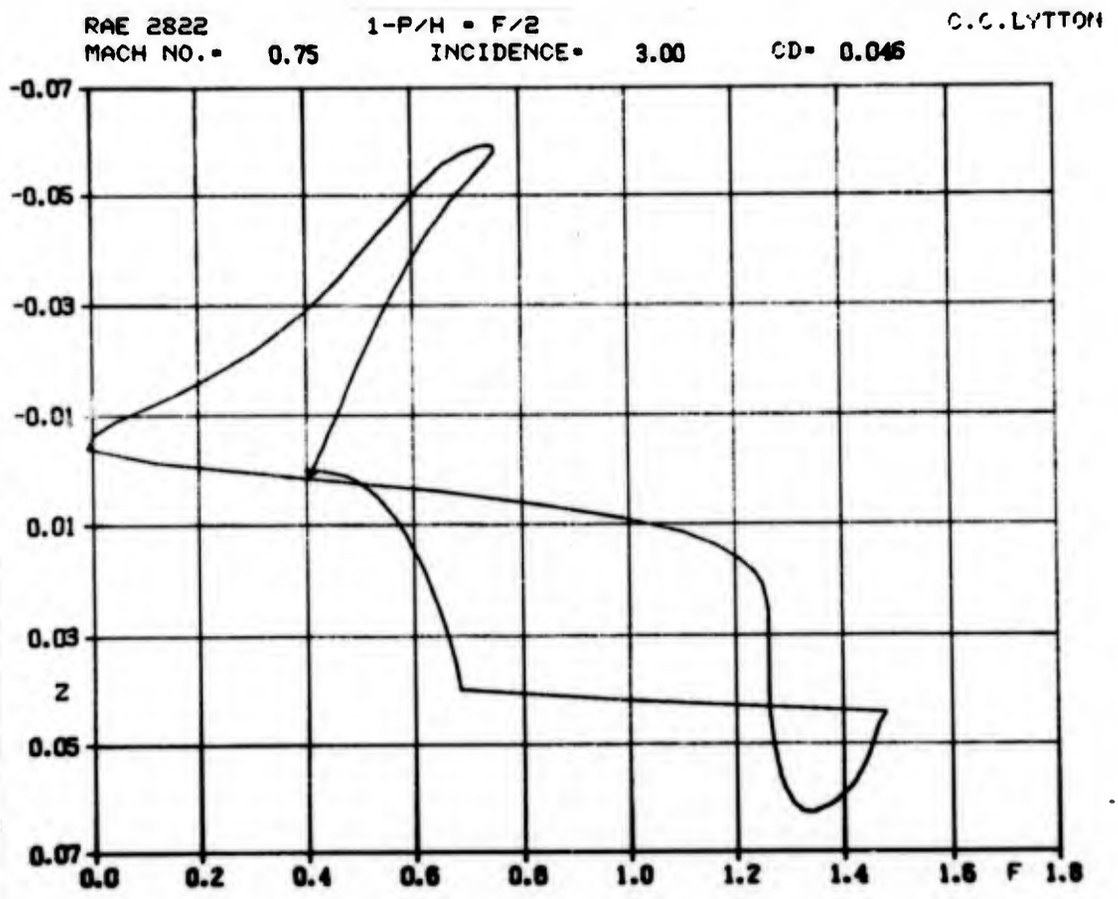
R.A.E.	AR 211		C.C.Lytton	06-3-7
	RAE 2822: MACH = 0.75, ALPHA = 3			



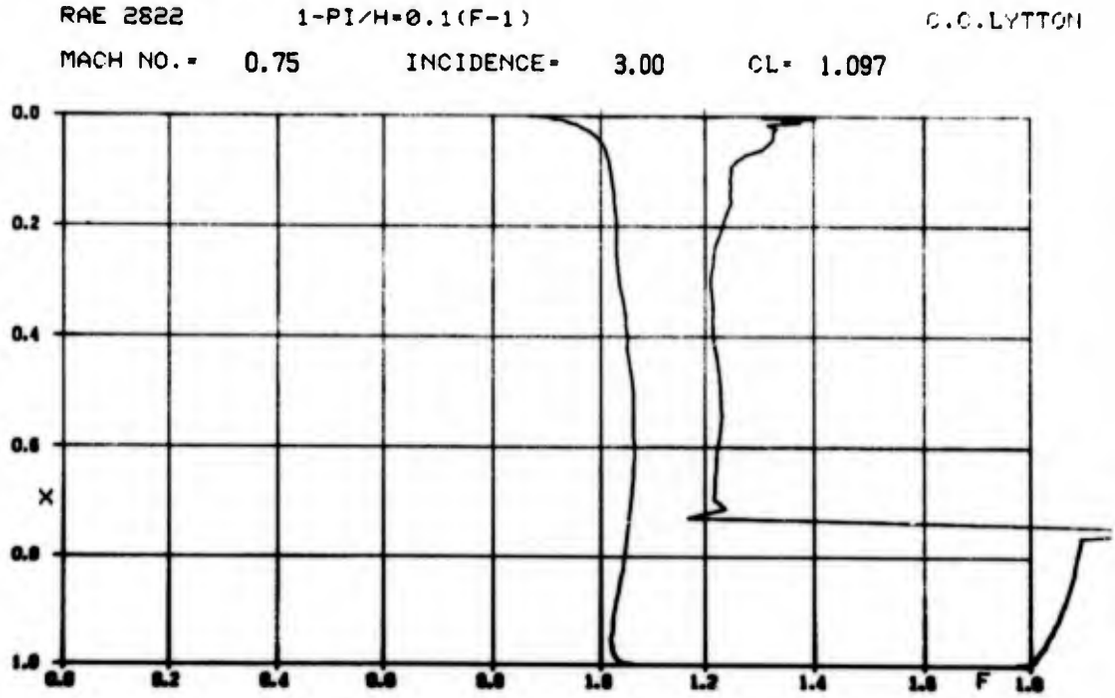
R.A.E.	AR 211		C.C.Lytton	06-3-8
	RAE 2822: MACH = 0.75, ALPHA = 3			



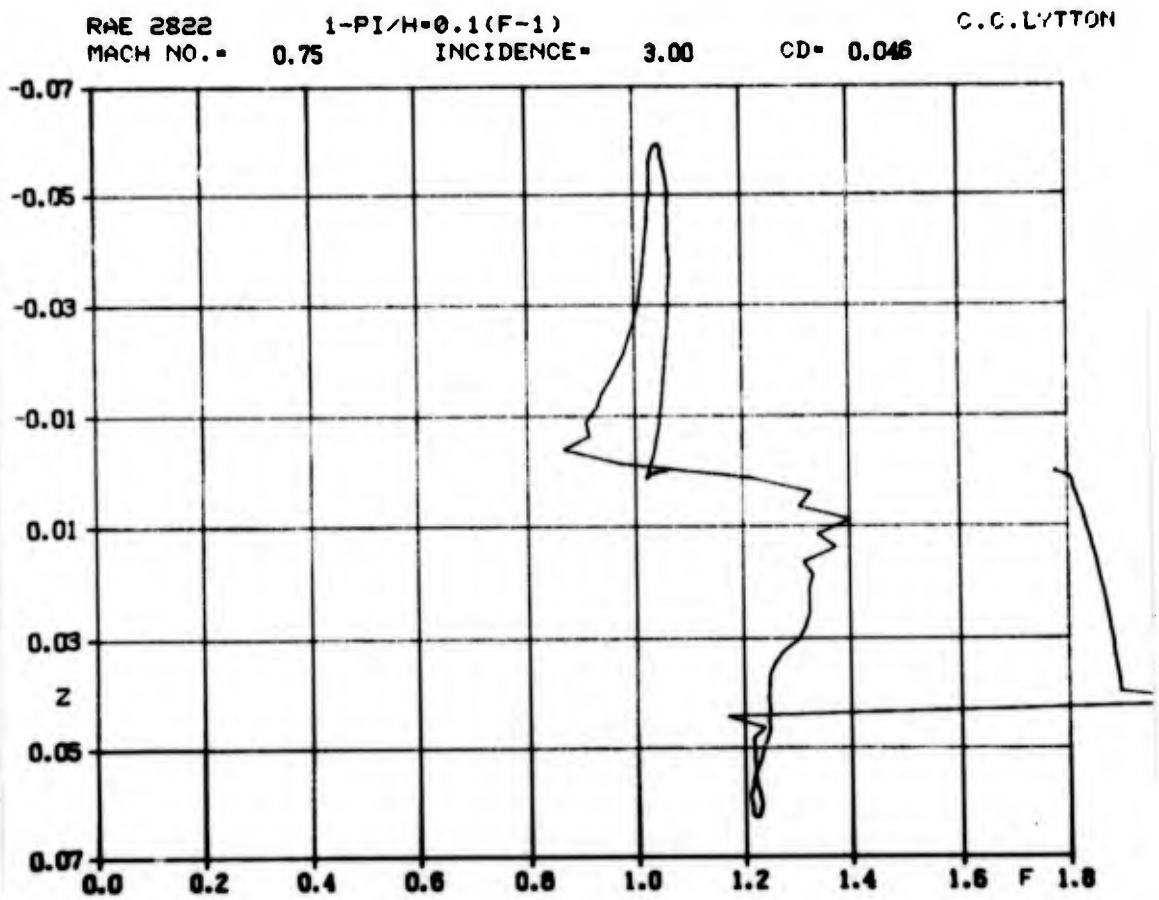
R.A.E.	AR 211		C.C.Lytton	06-3-9
	RAE 2822: MACH = 0.75, ALPHA = 3			



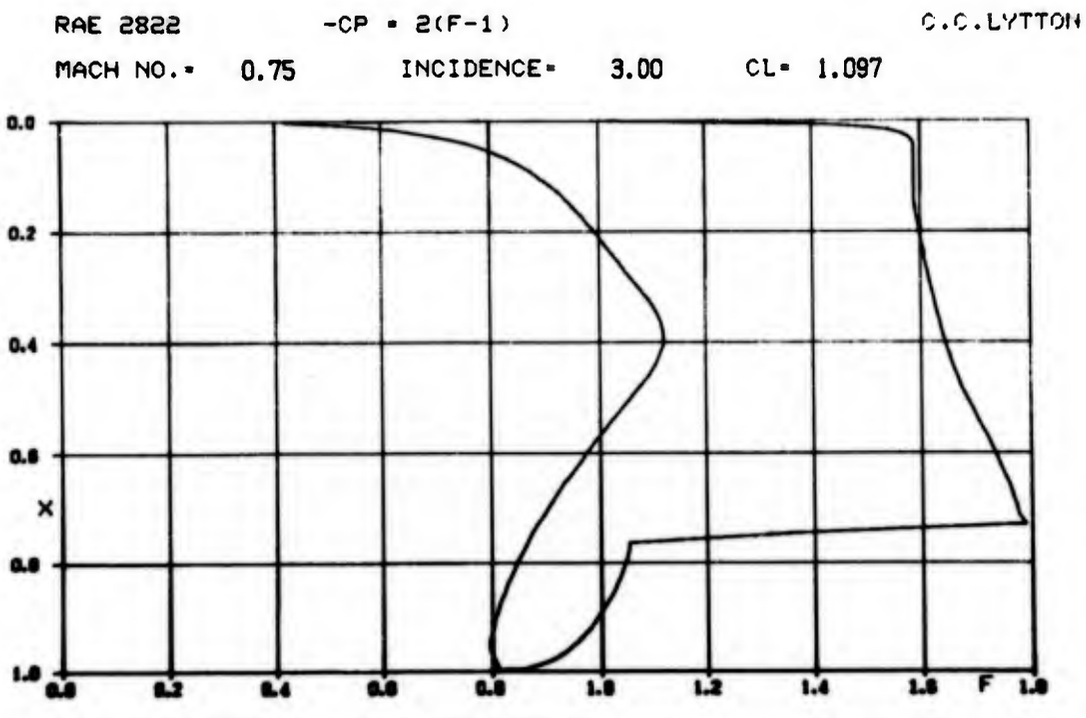
R.A.E.	AR 211		C.C.Lytton	06-3-10
	RAE 2822: MACH = 0.75, ALPHA = 3			



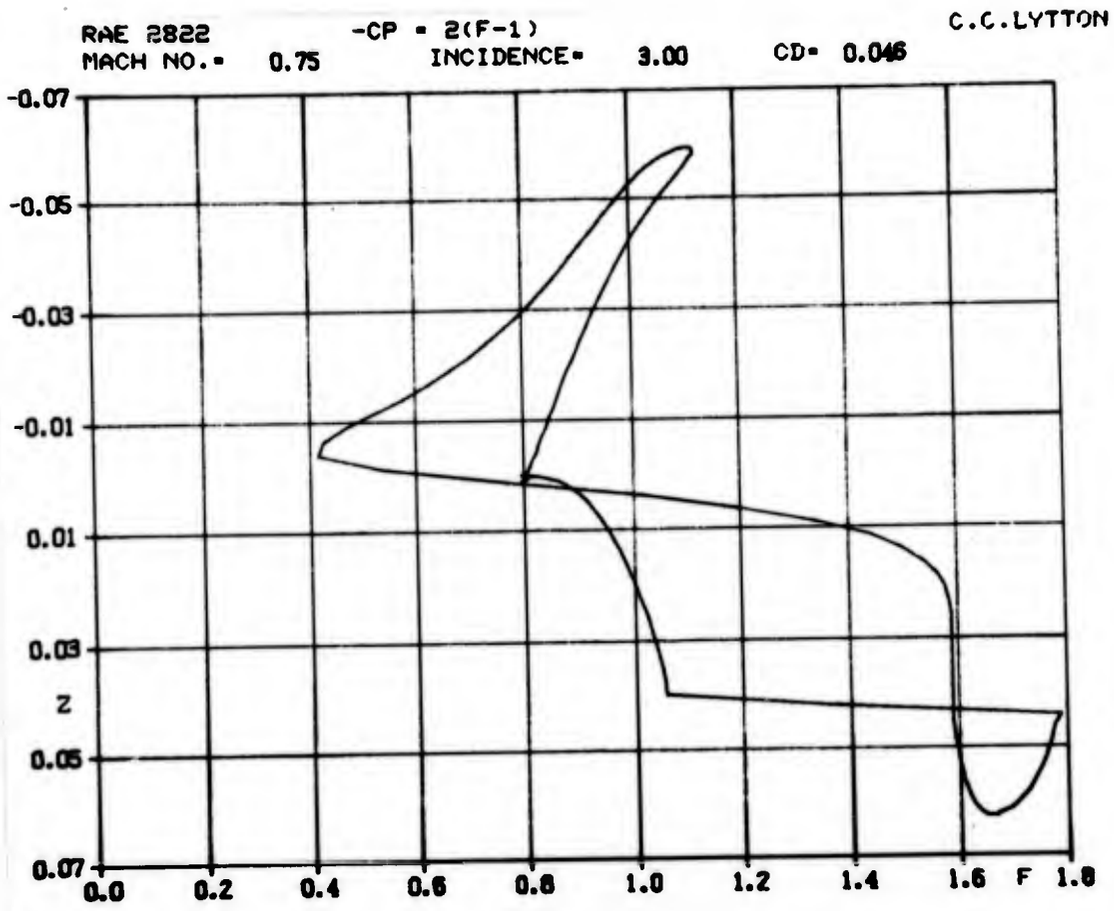
R.A.E.	AR 211		C.C.Lytton	06-3-11
	RAE 2822: MACH = 0.75, ALPHA = 3			



R.A.E.	AR 211		C.C.Lytton	06-3-12
	RAE 2822: MACH = 0.75, ALPHA = 3			

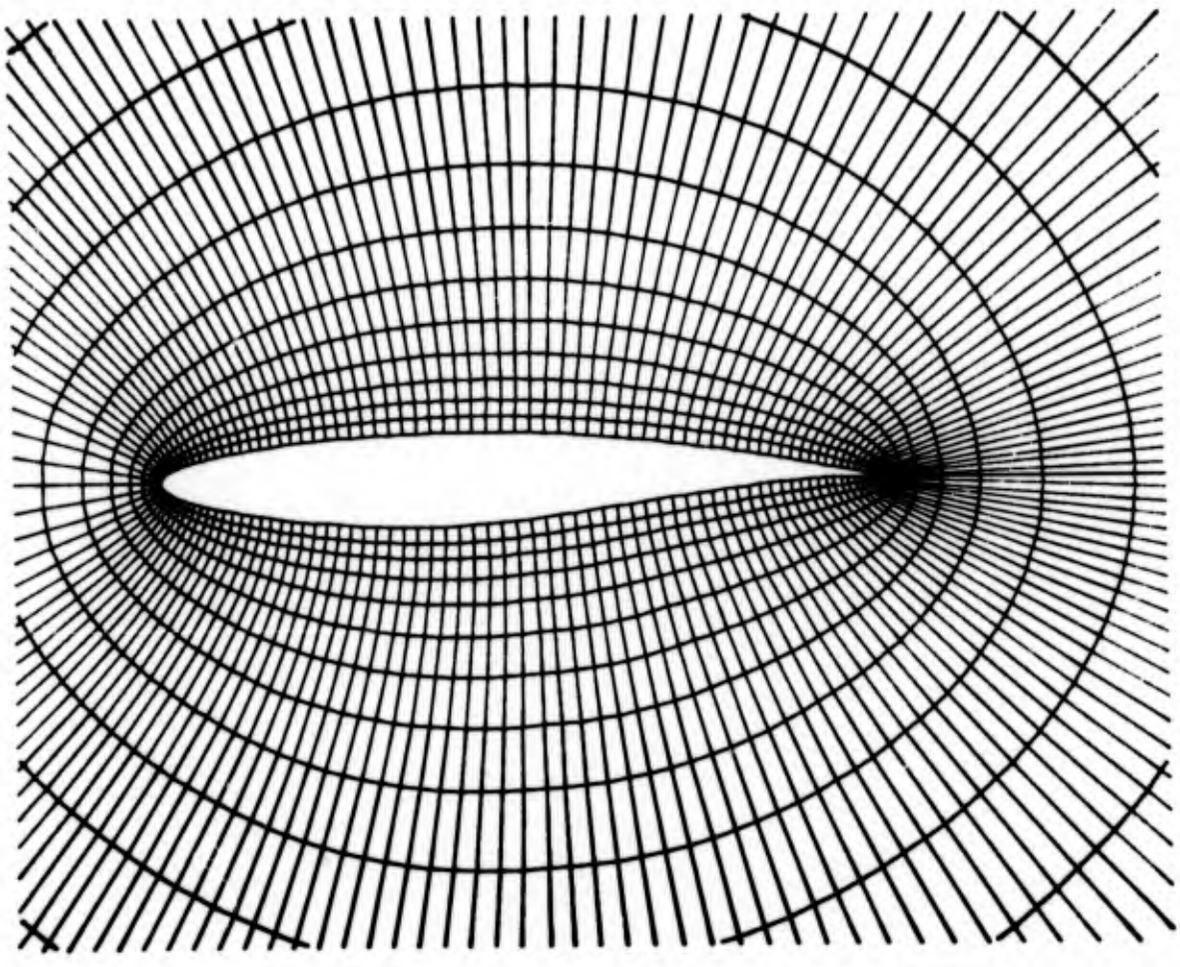


R.A.E.	AR 211		C.C.Lytton	06-3-13
	RAE 2822: MACH = 0.75, ALPHA = 3			

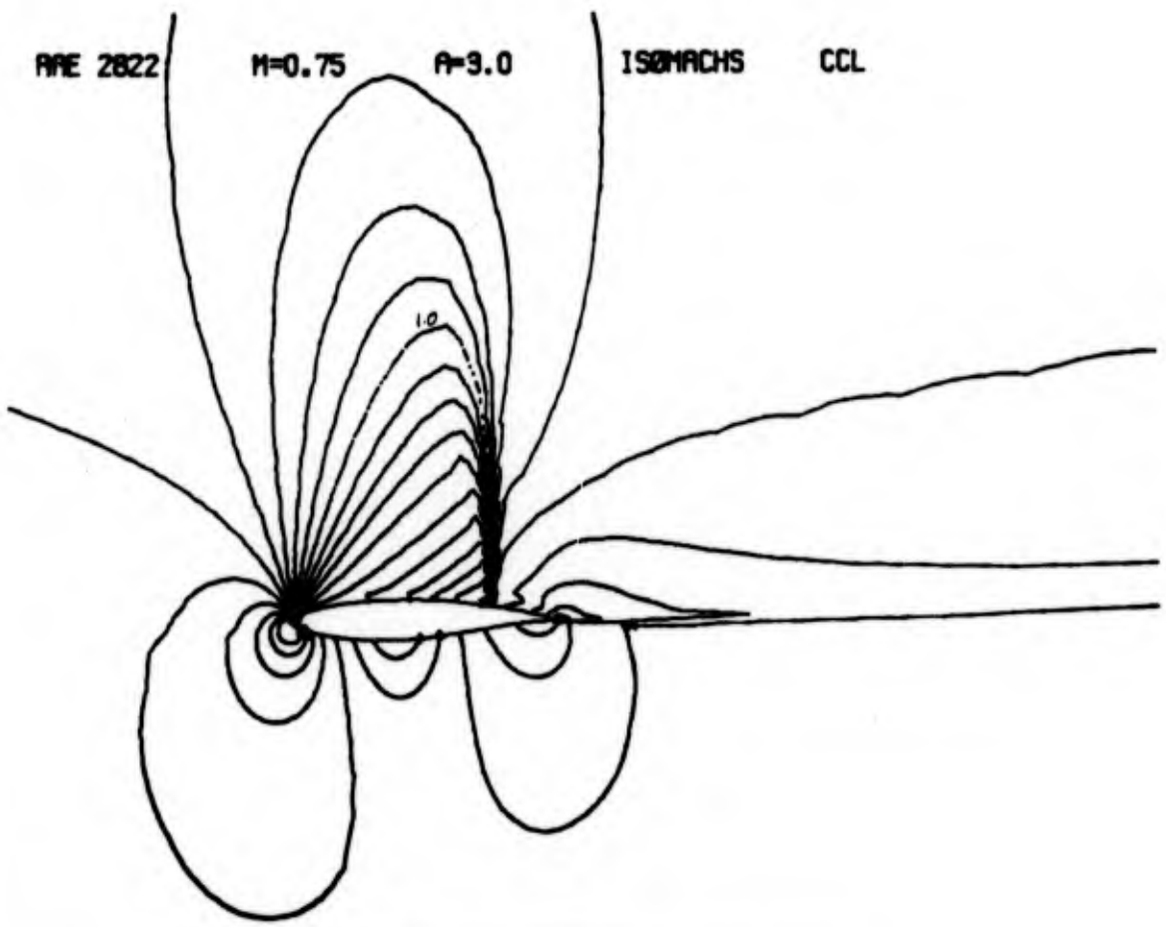


R.A.E.	AR 211		C.C.Lytton	06-3-14
	RAE 2822: MACH = 0.75, ALPHA = 3			

RAE 2822 160 x 24 GRID



R.A.E.	AR 211		C.C.Lytton	06-3-15
	RAE 2822: MACH = 0.75, ALPHA = 3			



AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 06

RAE 2822: MACH = 0.75, ALPHA = 3

Contributor No 6

M.D.Salas and J.C.South, Jr

(N.A.S.A. – Langley, U.S.A.)

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-1
	RAE 2822: MACH = 0.75, ALPHA = 3			

NASA Langley Research Center - AGARD case 06
RAE 2822 Mach=0.750 alpha=3.000 (deg)
Cl=1.1008 Cd=0.0450 Cm=-0.1902

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-2
	RAE 2822: MACH = 0.75, ALPHA = 3			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
1	.000200	.001636	.220571	.335106	.595345	.009443
2	.000845	.003716	.326732	-.056450	.766781	.006478
3	.001986	.005767	.421233	-.405001	.923257	-.004104
4	.003646	.007793	.491215	-.663116	1.040071	-.009808
5	.005832	.009803	.537813	-.834987	1.120494	-.012374
6	.008533	.011799	.571142	-.957915	1.182193	-.016186
7	.011749	.013780	.594874	-1.045444	1.227223	-.018152
8	.015475	.015741	.609947	-1.101040	1.252743	-.014052
9	.019707	.017681	.620491	-1.139928	1.272242	-.012766
10	.024449	.019602	.629520	-1.173229	1.288773	-.010983
11	.029695	.021508	.632263	-1.183349	1.292010	-.007907
12	.035427	.023403	.633079	-1.186359	1.292255	-.006004
13	.041650	.025284	.635278	-1.194470	1.296109	-.005220
14	.048352	.027145	.635058	-1.193658	1.294969	-.004271
15	.055514	.028990	.633394	-1.187521	1.291167	-.003659
16	.063132	.030821	.632712	-1.185004	1.289194	-.002843
17	.071195	.032631	.631843	-1.181800	1.287201	-.002506
18	.079688	.034417	.631746	-1.181442	1.286882	-.002337
19	.088606	.036173	.631698	-1.181265	1.286722	-.002251
20	.097939	.037898	.631072	-1.178956	1.285230	-.001930
21	.107673	.039594	.630424	-1.176565	1.283662	-.001565
22	.117796	.041249	.632049	-1.182559	1.287232	-.001987
23	.128295	.042855	.632612	-1.184636	1.288124	-.001663
24	.139164	.044421	.631936	-1.182140	1.286757	-.001652
25	.150393	.045941	.633339	-1.187318	1.289540	-.001598
26	.161962	.047407	.634207	-1.190520	1.291216	-.001499
27	.173866	.048817	.635485	-1.195231	1.294071	-.001875
28	.186095	.050173	.635886	-1.196712	1.294458	-.001298
29	.198630	.051473	.637020	-1.200892	1.297237	-.001955
30	.211459	.052713	.638108	-1.204905	1.298886	-.001193
31	.224569	.053894	.639130	-1.208677	1.301587	-.002039
32	.237943	.055009	.640713	-1.214514	1.304245	-.001262
33	.251568	.056060	.641462	-1.217278	1.306250	-.001908
34	.265428	.057040	.643945	-1.226435	1.311014	-.001460
35	.279513	.057940	.646082	-1.234317	1.315983	-.002234
36	.293813	.058771	.646670	-1.236486	1.316519	-.001303
37	.308308	.059536	.648074	-1.241665	1.320146	-.002290
38	.322973	.060221	.650848	-1.251896	1.325338	-.001499
39	.337798	.060826	.652199	-1.256877	1.328735	-.002291
40	.352773	.061351	.654847	-1.266645	1.333903	-.001759
41	.367884	.061792	.656743	-1.273639	1.338317	-.002334
42	.383114	.062147	.659642	-1.284331	1.344311	-.002130
43	.398444	.062417	.661170	-1.289965	1.347690	-.002306
44	.413855	.062607	.663570	-1.298819	1.352817	-.002298
45	.429330	.062707	.666486	-1.309573	1.359262	-.002541
46	.444861	.062712	.669755	-1.321630	1.366393	-.002613
47	.460426	.062622	.672433	-1.331509	1.372287	-.002686
48	.476007	.062437	.675596	-1.343173	1.379380	-.002896
49	.491587	.062147	.679830	-1.358789	1.388973	-.003199
50	.507158	.061747	.683888	-1.373758	1.398055	-.003204

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-3
	RAE 2822: MACH = 0.75, ALPHA = 3			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
51	.522713	.061236	.687797	-1.388177	1.407200	-.003649
52	.538243	.060611	.693012	-1.407408	1.419357	-.003996
53	.553734	.059876	.695500	-1.416586	1.424885	-.003693
54	.569169	.059026	.701745	-1.439619	1.440581	-.005298
55	.584545	.058055	.705764	-1.454444	1.448990	-.003721
56	.599860	.056975	.710161	-1.470661	1.461169	-.006107
57	.615105	.055795	.714108	-1.485218	1.469277	-.004022
58	.630266	.054529	.715301	-1.489620	1.473805	-.006360
59	.645326	.053184	.719733	-1.505965	1.483837	-.005113
60	.660276	.051753	.722689	-1.516870	1.492362	-.006829
61	.675101	.050253	.725974	-1.528984	1.499308	-.004951
62	.689781	.048692	.727468	-1.534494	1.504643	-.007229
63	.704302	.047076	.729513	-1.542038	1.508448	-.005203
64	.718647	.045411	.732618	-1.553492	1.518480	-.008254
65	.732801	.043700	.724059	-1.521922	1.486827	.006123
66	.746751	.041945	.577776	-.982382	1.114756	.081780
67	.760486	.040154	.353718	-.155984	.730626	.078251
68	.773986	.038343	.331449	-.073848	.702010	.070986
69	.787236	.036513	.333907	-.082915	.705981	.071099
70	.800225	.034662	.332270	-.076874	.703128	.071196
71	.812935	.032801	.330770	-.071344	.700653	.071169
72	.825349	.030941	.328840	-.064224	.697046	.071480
73	.837458	.029085	.326342	-.055010	.692919	.071430
74	.849252	.027240	.323675	-.045173	.688092	.071717
75	.860711	.025414	.320695	-.034182	.683175	.071640
76	.871810	.023613	.318052	-.024436	.678339	.071952
77	.882539	.021838	.314543	-.011492	.672514	.071873
78	.892893	.020092	.311054	.001376	.666358	.072075
79	.902851	.018386	.307284	.015282	.660047	.072009
80	.912399	.016726	.303779	.028211	.653849	.072195
81	.921528	.015115	.299745	.043086	.647001	.072170
82	.930221	.013560	.296290	.055829	.640945	.072281
83	.938468	.012059	.291871	.072128	.633268	.072349
84	.946256	.010624	.287710	.087478	.626174	.072288
85	.953569	.009258	.283495	.103022	.618662	.072451
86	.960401	.007968	.278914	.119918	.610804	.072372
87	.966738	.006757	.275010	.134320	.603761	.072536
88	.972565	.005627	.270016	.152737	.594914	.072593
89	.977872	.004582	.265071	.170976	.586261	.072534
90	.982654	.003626	.259211	.192591	.575569	.072723
91	.986895	.002771	.253425	.213931	.565694	.072376
92	.990577	.002026	.247529	.235677	.554166	.072967
93	.993693	.001390	.242082	.255766	.545191	.072319
94	.996229	.000865	.234177	.284925	.528677	.073579
95	.998169	.000460	.225306	.317644	.514909	.071744
96	.999495	.000185	.217298	.347178	.495312	.074434
97	1.000175	.000040	.213458	.361343	.472791	.083354
98	1.000170	.000010	.182730	.474677	.520669	.016841
99	.999455	.000055	.195142	.428897	.562167	.002574
100	.998044	.000135	.197731	.419348	.571837	-.001414

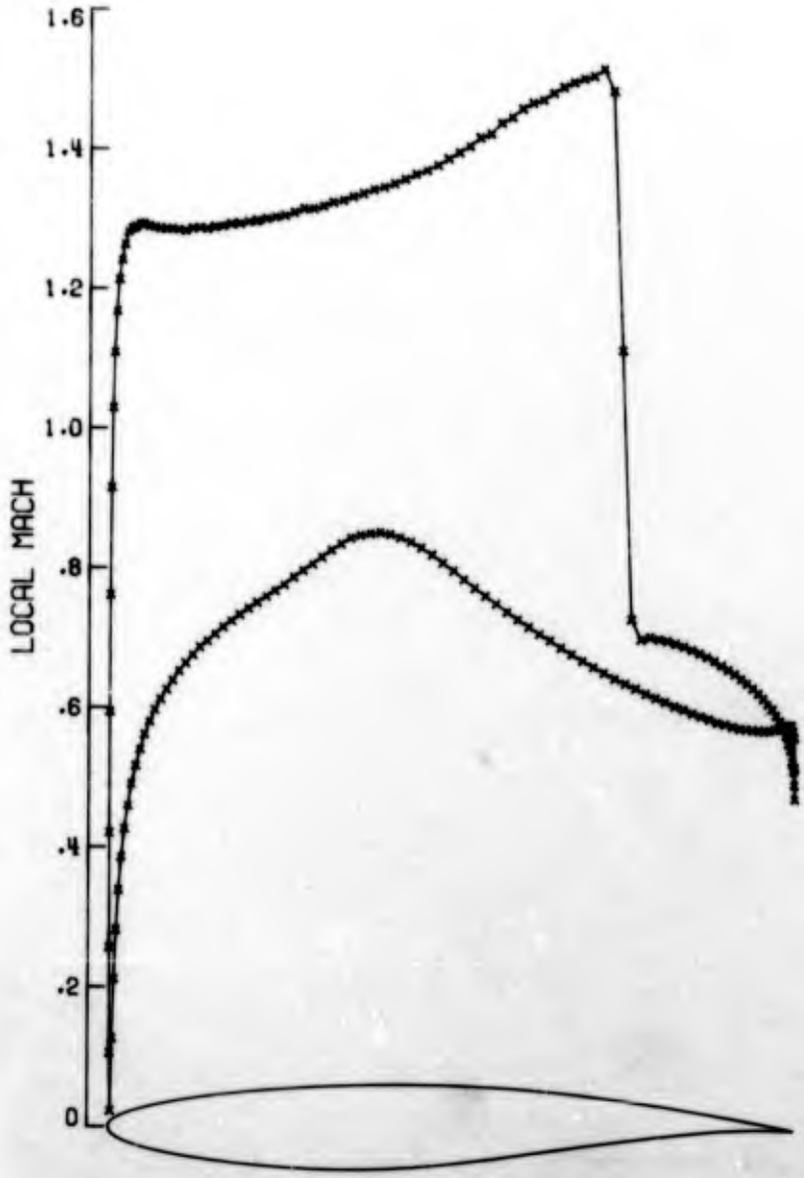
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-4
	RAE 2822: MACH = 0.75, ALPHA = 3			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
101	.995959	.000245	.204556	.394175	.580296	.000733
102	.993203	.000385	.202488	.401805	.580601	-.002098
103	.989766	.000540	.203746	.397164	.579901	.000015
104	.985655	.000700	.203173	.399275	.580976	-.001523
105	.980878	.000860	.202379	.402206	.578128	-.000354
106	.975431	.001005	.201054	.407091	.577064	-.001207
107	.969314	.001120	.200351	.409686	.574880	-.000434
108	.962537	.001190	.198805	.415389	.573135	-.001051
109	.955119	.001190	.198,22	.415692	.572140	-.000405
110	.947071	.001105	.199198	.413938	.573232	-.000632
111	.938413	.000930	.199663	.412223	.573487	-.000244
112	.929175	.000655	.200556	.408927	.575085	-.000332
113	.919367	.000270	.201244	.406390	.576024	-.000181
114	.909013	-.000240	.202815	.400597	.578515	-.000100
115	.898144	-.000880	.205098	.392176	.581986	.000126
116	.886780	-.001646	.206617	.386573	.584598	.000043
117	.874956	-.002546	.209563	.375708	.589003	.000377
118	.862692	-.003576	.211879	.367166	.593001	.000219
119	.850008	-.004737	.214824	.356303	.597399	.000540
120	.836943	-.006027	.218116	.344162	.602864	.000459
121	.823523	-.007438	.221238	.332645	.607668	.000667
122	.809763	-.008968	.225043	.318614	.613753	.000723
123	.795688	-.010609	.228380	.306305	.619077	.000768
124	.781328	-.012359	.232090	.292623	.624963	.000830
125	.766713	-.014220	.236830	.275139	.632333	.001011
126	.751863	-.016171	.240999	.259760	.639011	.000990
127	.736803	-.018206	.245589	.242831	.646152	.001122
128	.721568	-.020322	.250952	.223050	.654578	.001183
129	.706182	-.022498	.256077	.204148	.662570	.001267
130	.690667	-.024724	.261664	.183543	.671273	.001343
131	.675036	-.026989	.267439	.162244	.680292	.001376
132	.659321	-.029280	.273488	.139930	.689641	.001473
133	.643545	-.031581	.280160	.115322	.699909	.001590
134	.627720	-.033872	.285998	.093791	.709055	.001527
135	.611859	-.036148	.292626	.069343	.719168	.001679
136	.595989	-.038398	.299272	.044831	.729570	.001572
137	.580128	-.040609	.306528	.018071	.740542	.001790
138	.564293	-.042765	.313930	-.009230	.752069	.001685
139	.548502	-.044846	.321239	-.036189	.763163	.001840
140	.532766	-.046841	.328501	-.062975	.774481	.001703
141	.517101	-.048742	.336528	-.092581	.786638	.001887
142	.501526	-.050528	.344514	-.122036	.799012	.001796
143	.486040	-.052178	.351726	-.148636	.810040	.001862
144	.470655	-.053684	.359052	-.175658	.821353	.001826
145	.455379	-.055029	.365688	-.200132	.831542	.001860
146	.440214	-.056200	.370899	-.219351	.839655	.001781
147	.425154	-.057190	.375149	-.235027	.846195	.001803
148	.410199	-.057995	.378008	-.245571	.850695	.001716
149	.395353	-.058611	.379317	-.250401	.852675	.001762
150	.380608	-.059036	.378234	-.246405	.851212	.001541

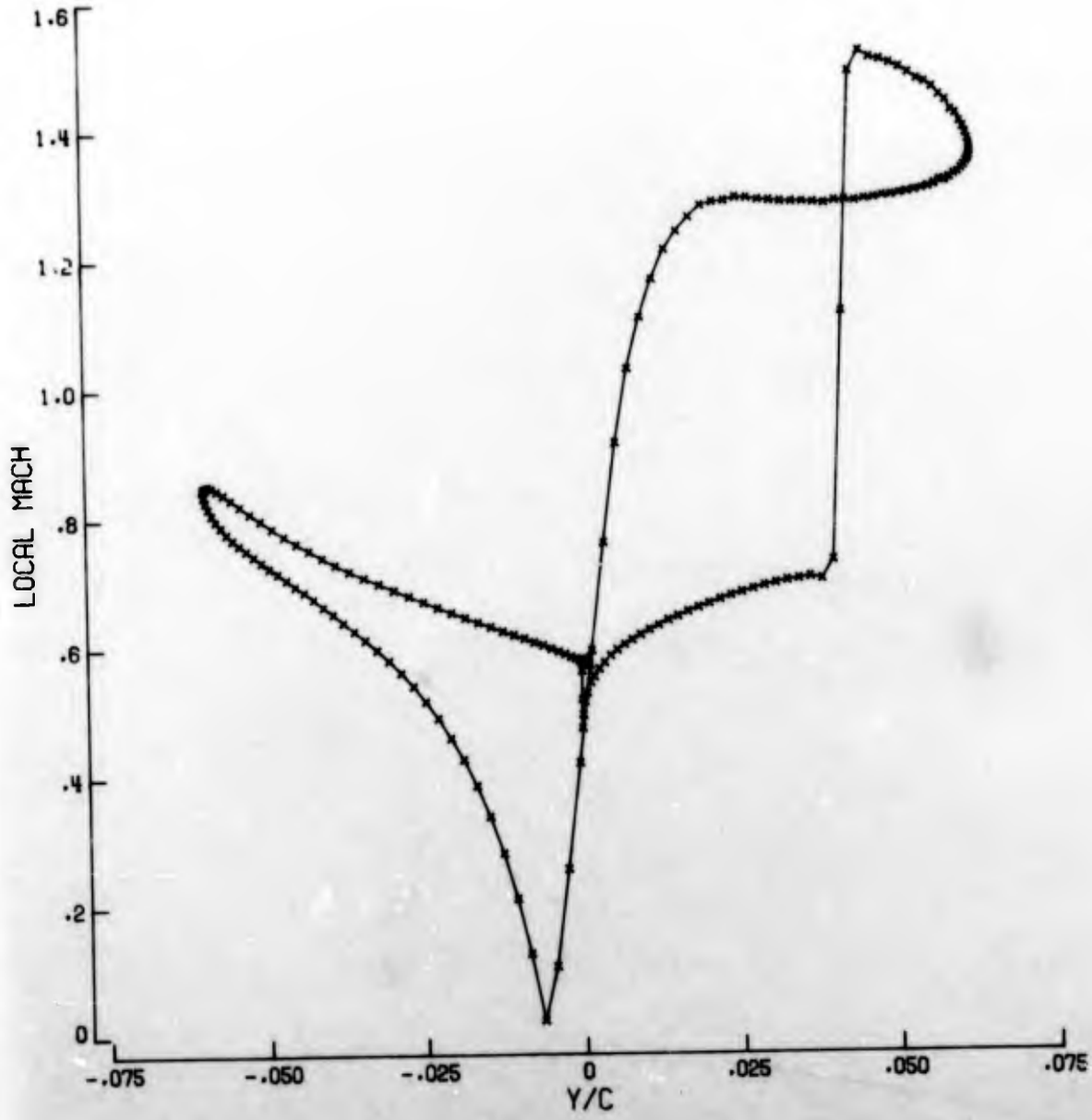
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	86-6-5
	RAE 2822: MACH = 0.75, ALPHA = 3			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
151	.365973	-.059281	.376614	-.240432	.848560	.001698
152	.351448	-.059351	.374179	-.231450	.844913	.001579
153	.337028	-.059241	.368499	-.210500	.836253	.001474
154	.322713	-.058971	.362722	-.189194	.827275	.001552
155	.308513	-.058560	.356107	-.164794	.817332	.001308
156	.294443	-.058025	.349770	-.141422	.807367	.001526
157	.280508	-.057380	.343676	-.118945	.798177	.001347
158	.266733	-.056630	.337432	-.095915	.788390	.001532
159	.253139	-.055785	.330278	-.069528	.777719	.001213
160	.239739	-.054864	.324869	-.049579	.768996	.001604
161	.226559	-.053874	.319474	-.029681	.760957	.001353
162	.213615	-.052808	.313900	-.009119	.752041	.001667
163	.200920	-.051673	.308083	.012335	.743347	.001411
164	.188496	-.050473	.302360	.033444	.734224	.001680
165	.176357	-.049212	.296651	.054498	.725563	.001530
166	.164518	-.047892	.290955	.075509	.716468	.001779
167	.152994	-.046511	.284294	.100076	.706403	.001532
168	.141800	-.045081	.278037	.123155	.696349	.001814
169	.130951	-.043605	.272197	.144694	.687289	.001767
170	.120457	-.042075	.265225	.170410	.676246	.001876
171	.110334	-.040494	.257512	.198858	.664234	.001776
172	.100590	-.038874	.250600	.224351	.652987	.002052
173	.091232	-.037208	.241898	.256447	.639509	.001762
174	.082279	-.035507	.233863	.286081	.626093	.002223
175	.073746	-.033777	.225111	.318364	.612347	.001931
176	.065643	-.032011	.215923	.352252	.596809	.002398
177	.057975	-.030211	.205607	.390301	.580224	.002107
178	.050753	-.028375	.194730	.430418	.561477	.002572
179	.043985	-.026504	.182059	.477152	.540486	.002225
180	.037678	-.024604	.168685	.526481	.516650	.002710
181	.031841	-.022678	.153903	.581001	.490758	.002462
182	.026474	-.020727	.137355	.642034	.459777	.002814
183	.021588	-.018762	.120161	.705453	.426481	.002953
184	.017191	-.016776	.100457	.778129	.386023	.003078
185	.013285	-.014770	.079351	.855974	.338551	.003345
186	.009873	-.012749	.056926	.938682	.282056	.003355
187	.006962	-.010714	.034353	1.021939	.213282	.003254
188	.004557	-.008673	.014868	1.093806	.131067	.002971
189	.002656	-.006627	.003822	1.134549	.014847	.003668
190	.001270	-.004577	.011424	1.106511	.111234	.002835
191	.000405	-.002516	.049794	.964990	.259866	.004113
192	.000050	-.000445	.123209	.694209	.422037	.008935

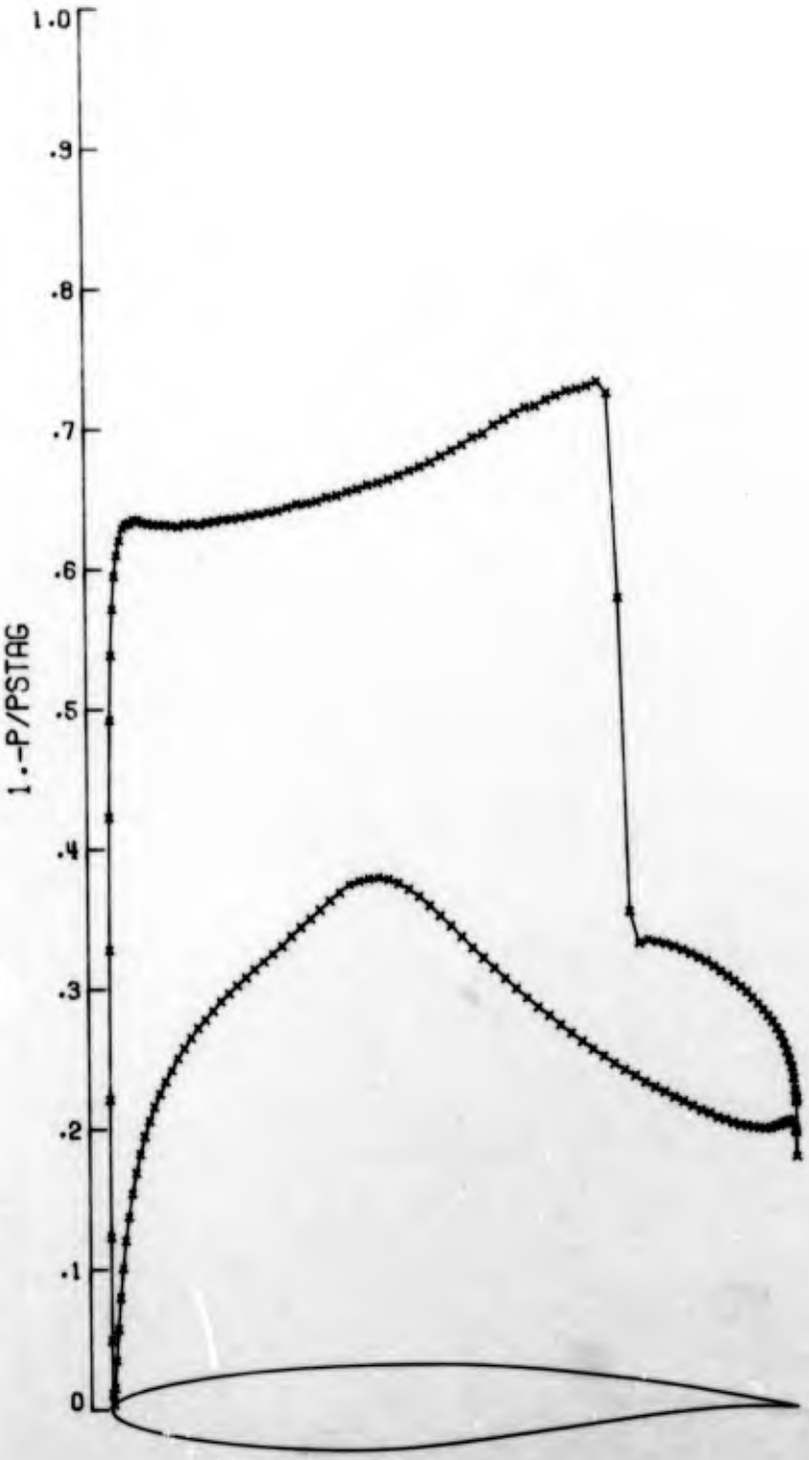
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-6
	RAE 2822: MACH = 0.75, ALPHA = 3			



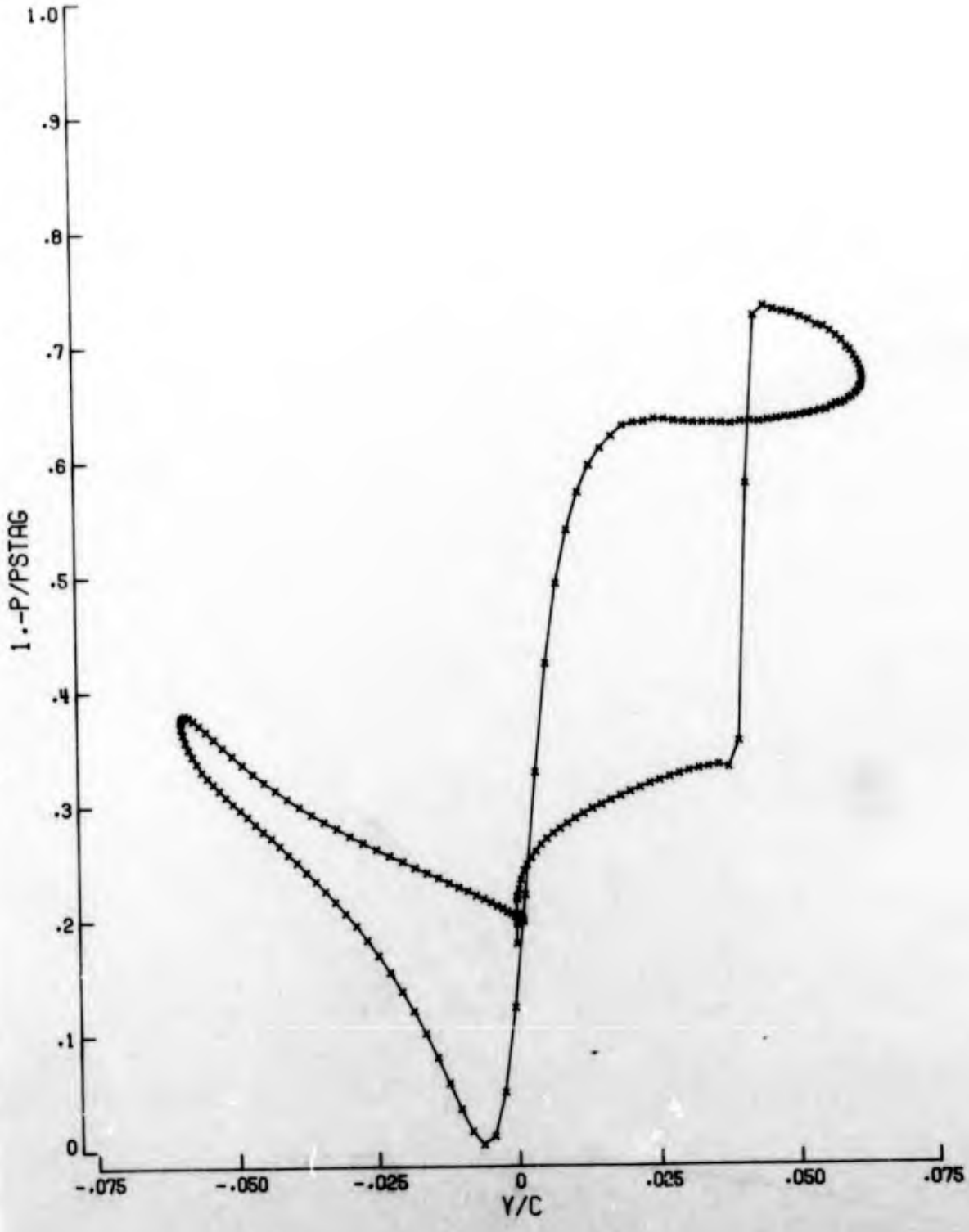
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-7
	RAE 2822: MACH = 0.75, ALPHA = 3			



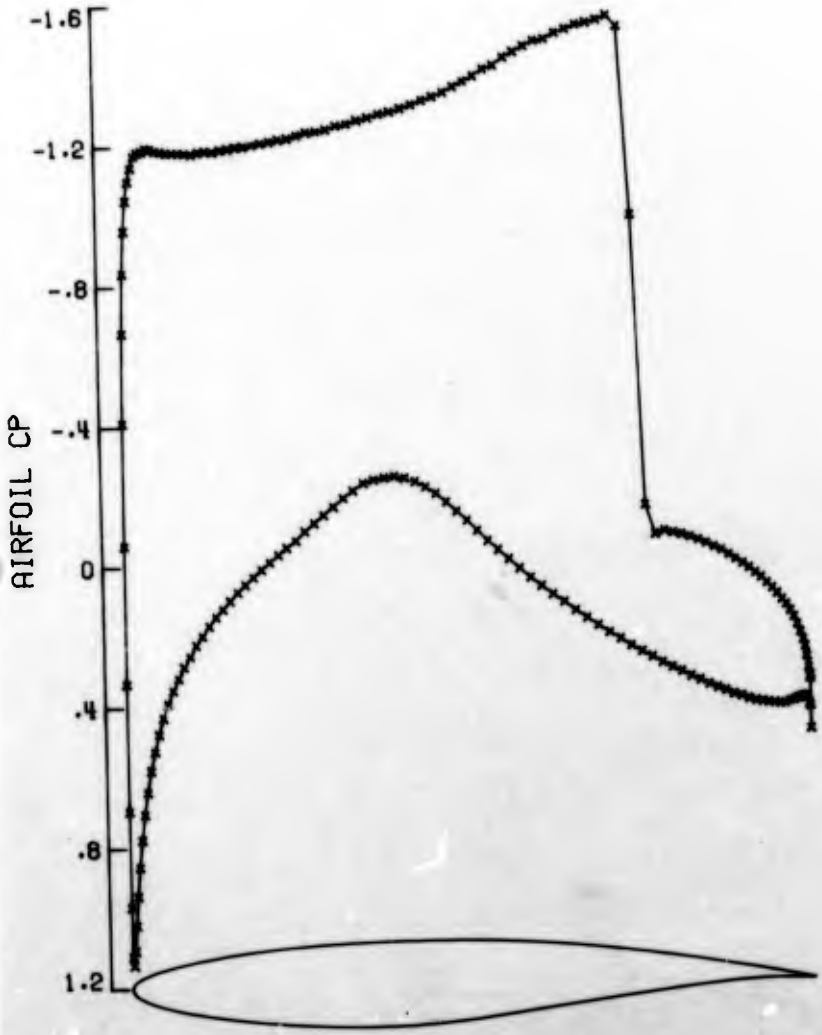
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-8
	RAE 2822: MACH = 0.75, ALPHA = 3			



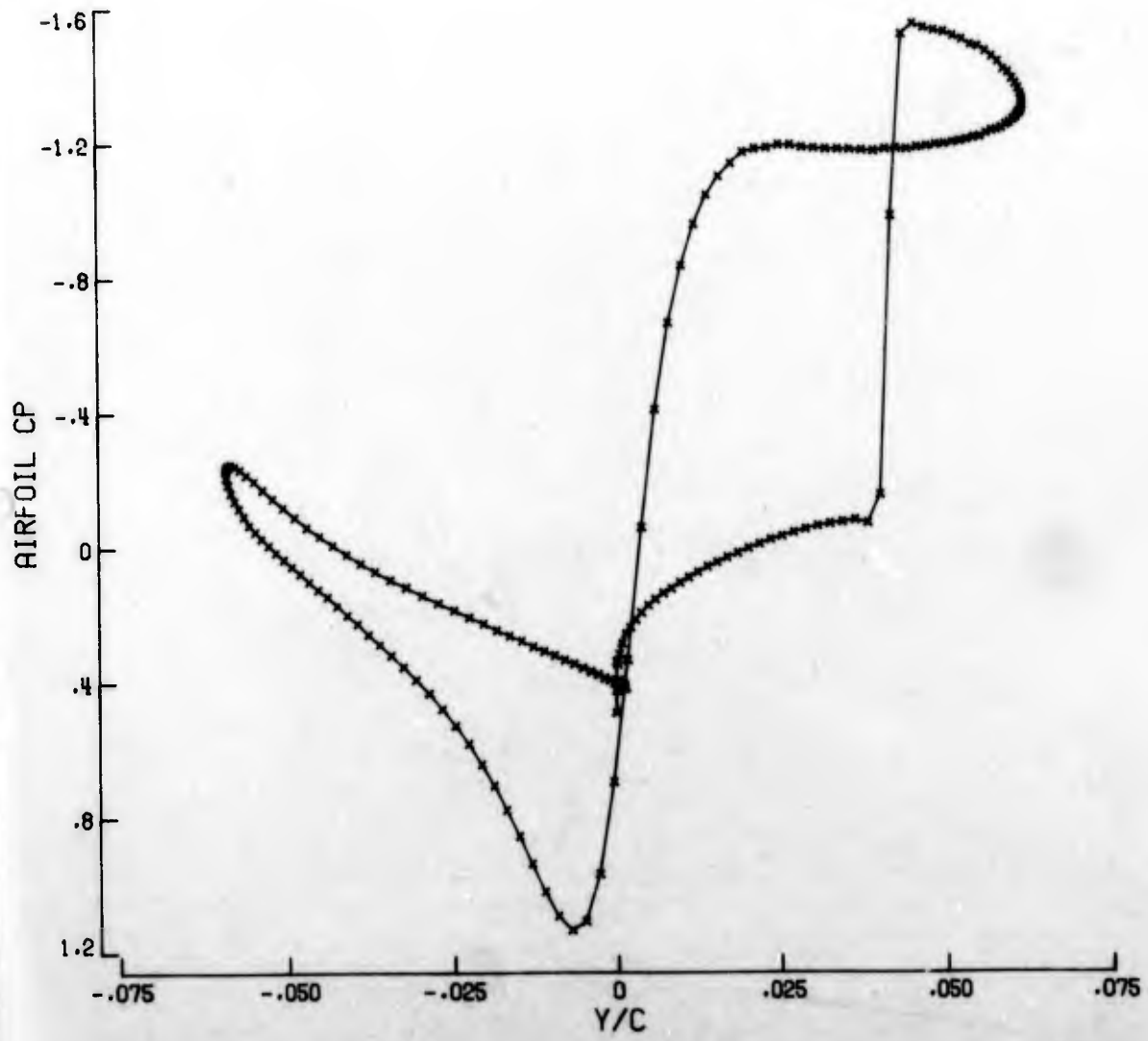
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-9
	RAE 2822: MACH = 0.75, ALPHA = 3			



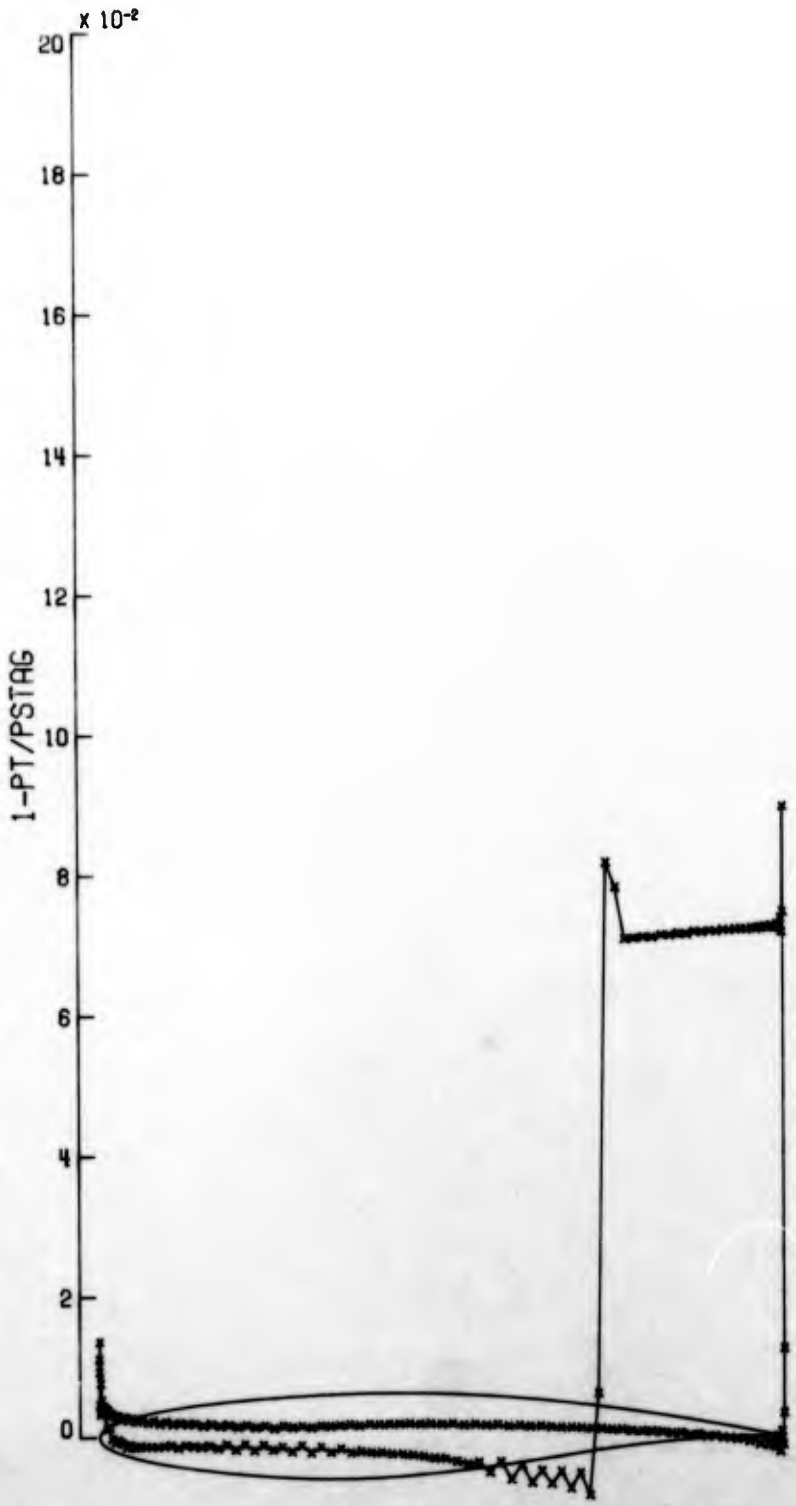
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-10
	RAE 2822: MACH = 0.75, ALPHA = 3			



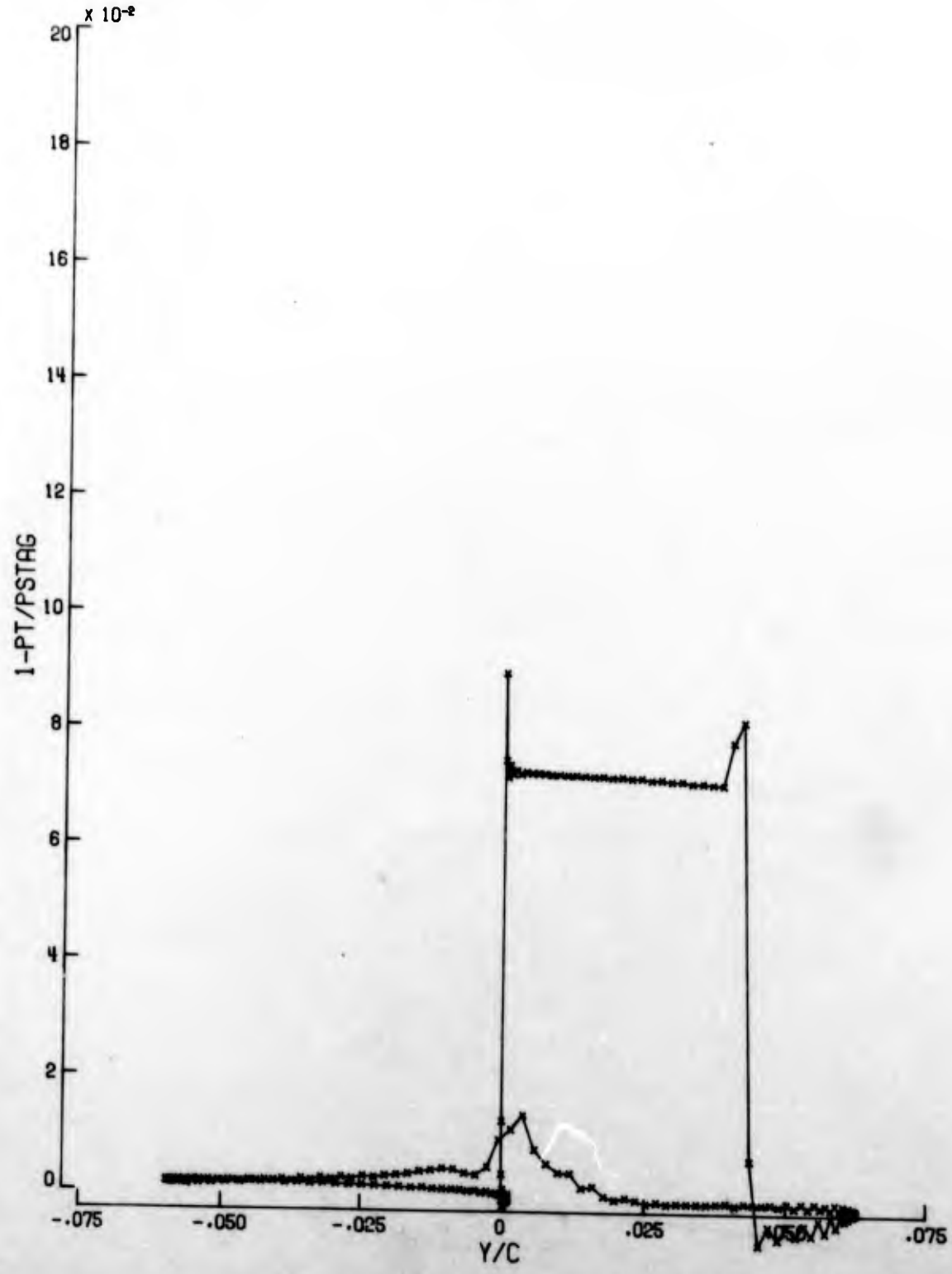
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-11
	RAE 2822: MACH = 0.75, ALPHA = 3			



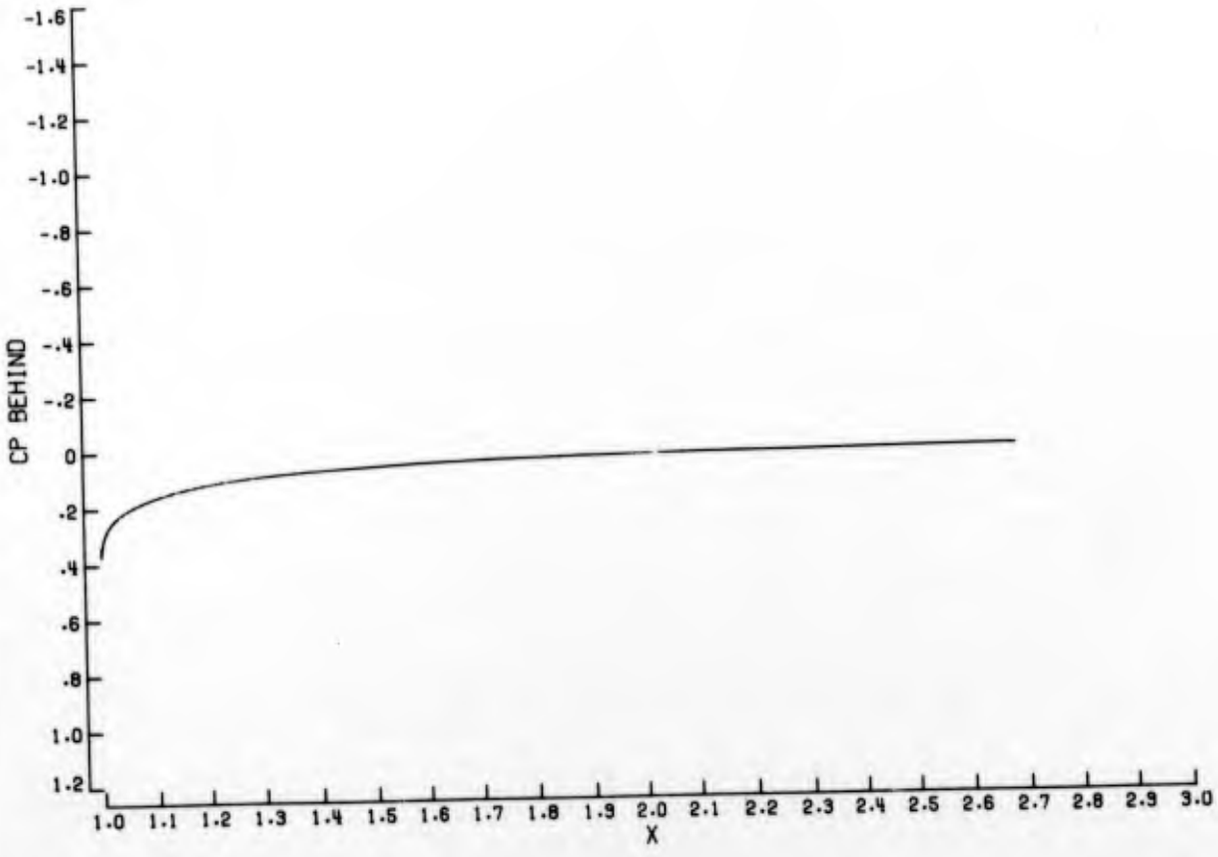
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-12
	RAE 2822: MACH = 0.75, ALPHA = 3			



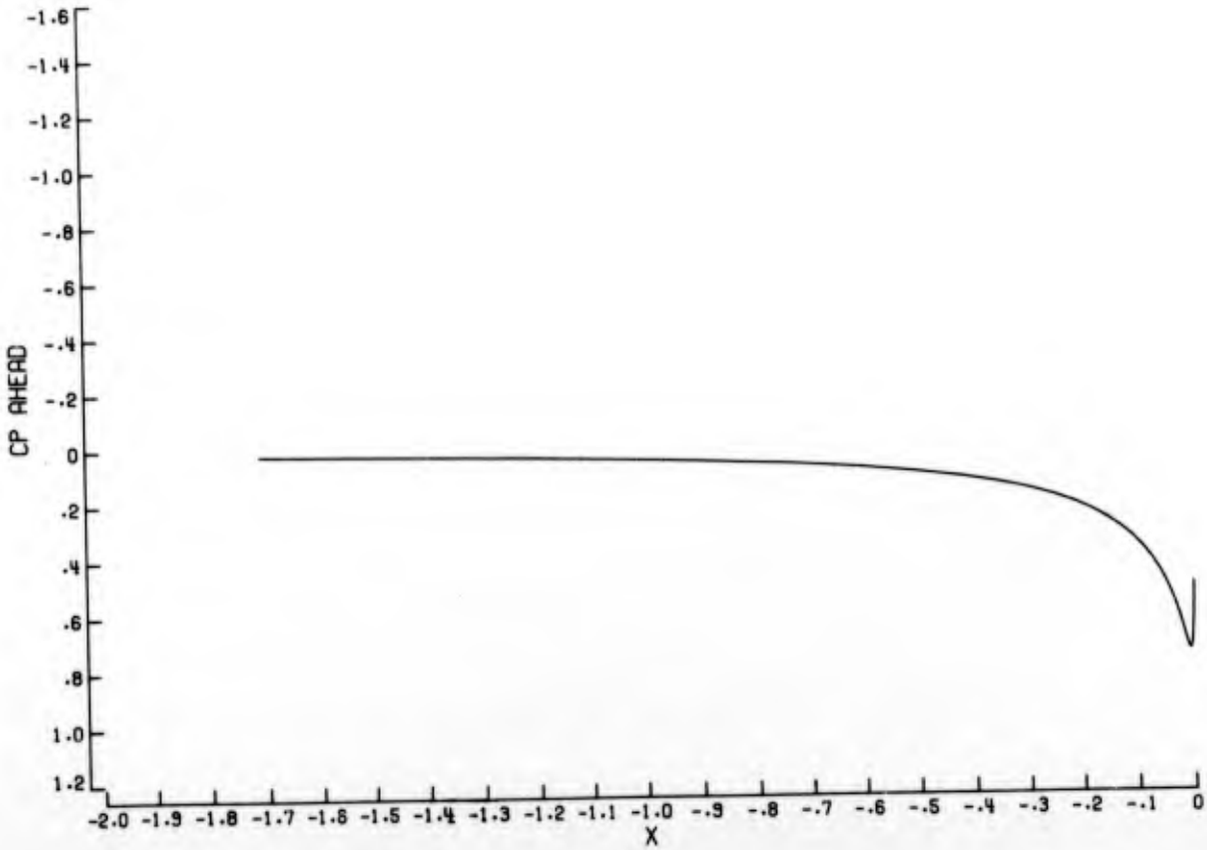
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-13
	RAE 2822: MACH = 0.75, ALPHA = 3			



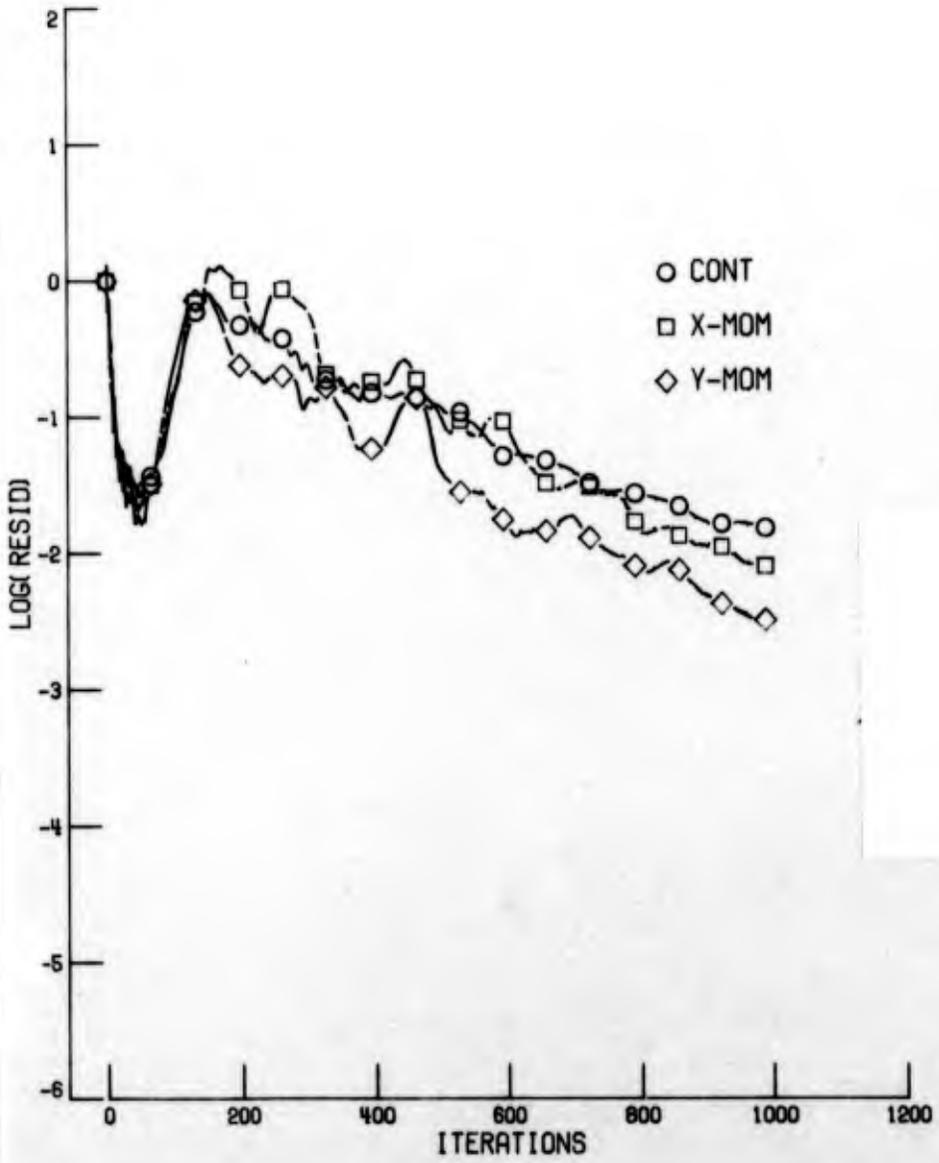
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-14
	RAE 2822: MACH = 0.75, ALPHA = 3			



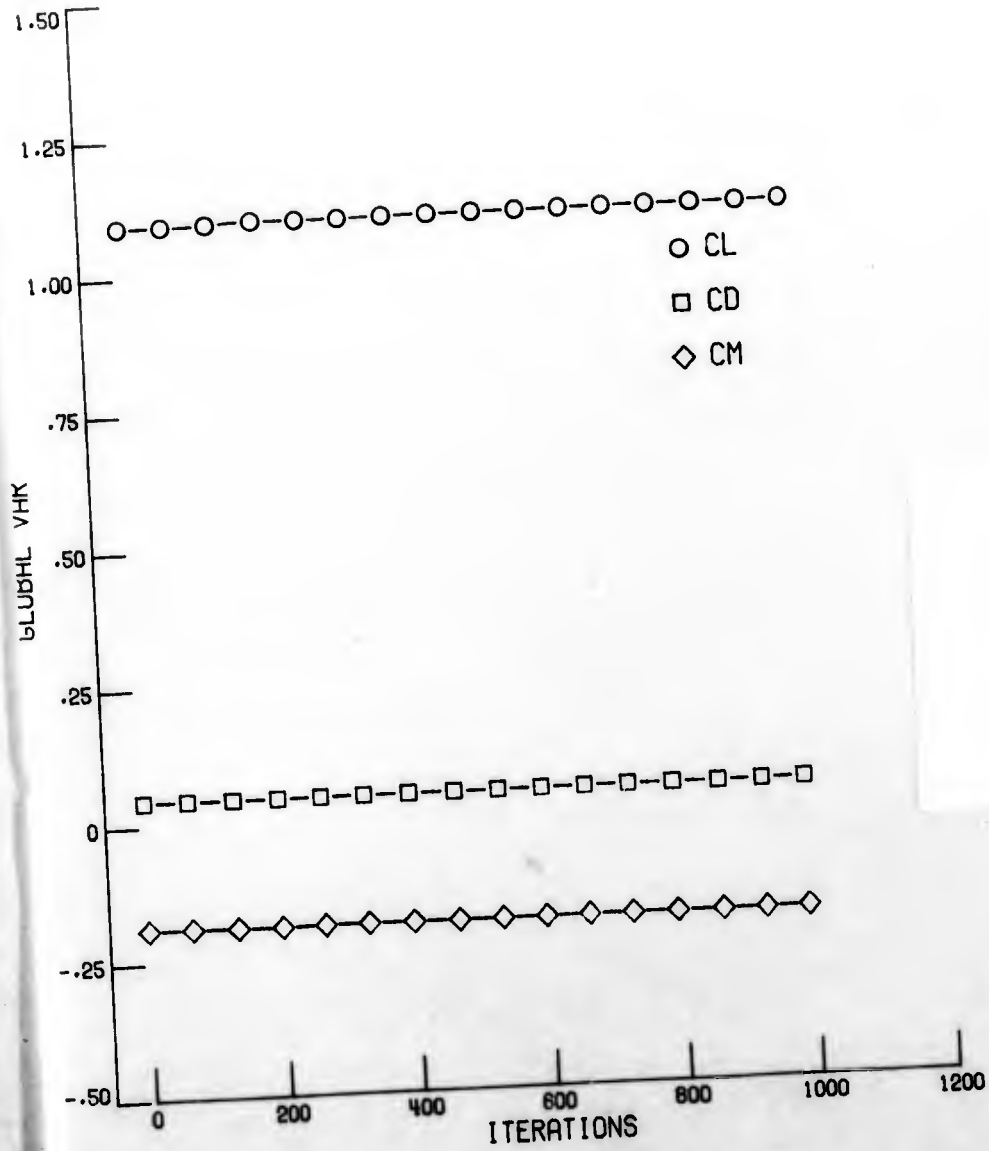
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-15
	RAE 2822: MACH = 0.75, ALPHA = 3			



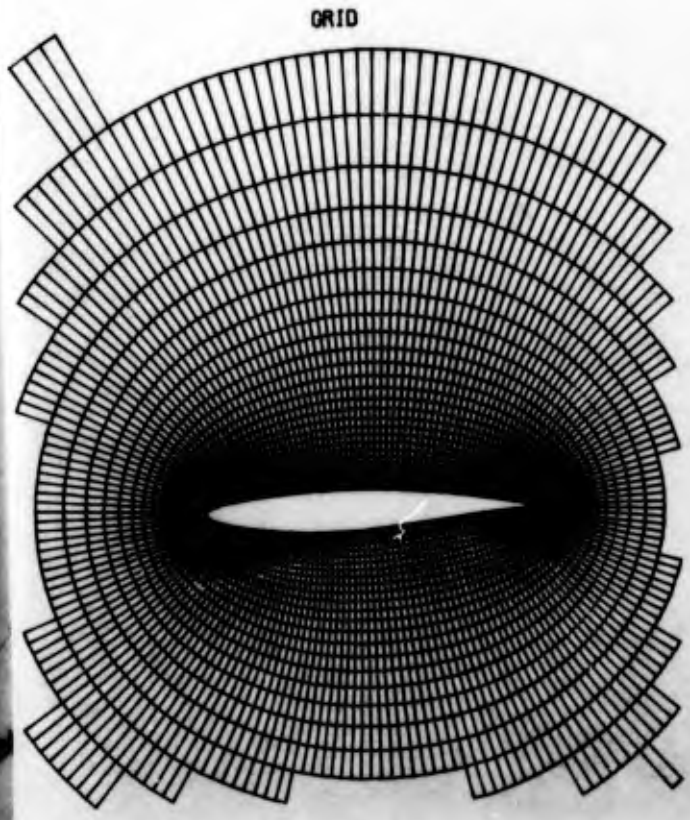
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-16
	RAE 2822: MACH = 0.75, ALPHA = 3			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-17
	RAE 2822: MACH = 0.75, ALPHA = 3			

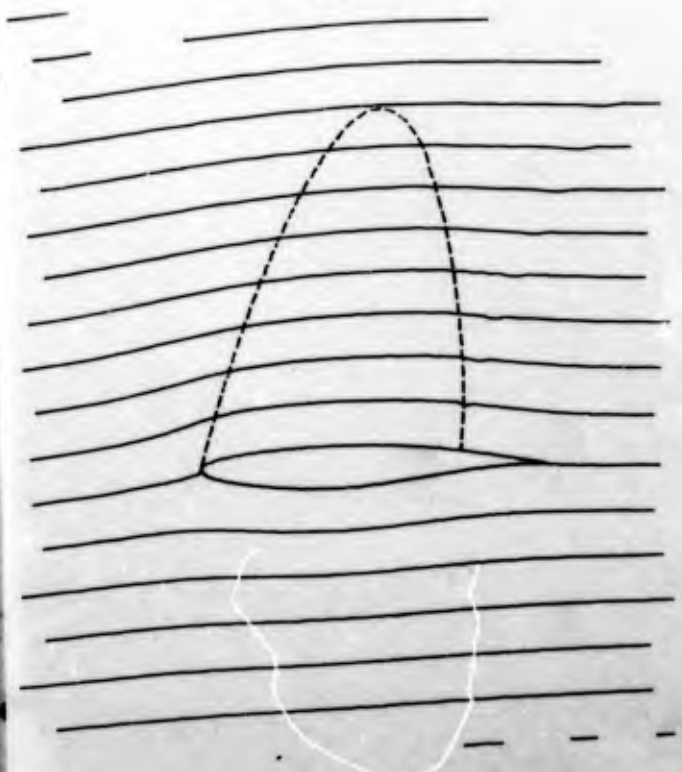


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-18
	RAE 2822: MACH = 0.75, ALPHA = 3			

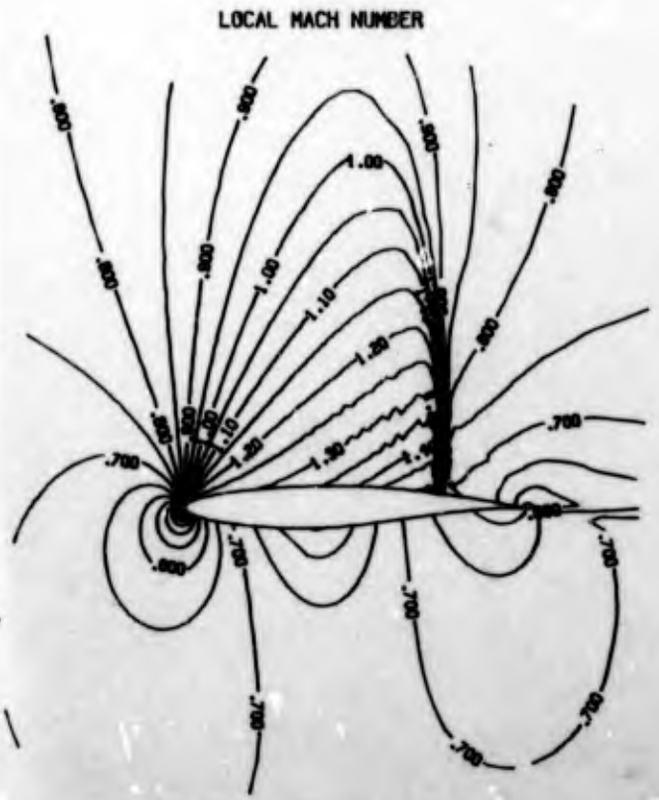


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-19
	RAE 2822: MACH = 0.75, ALPHA = 3			

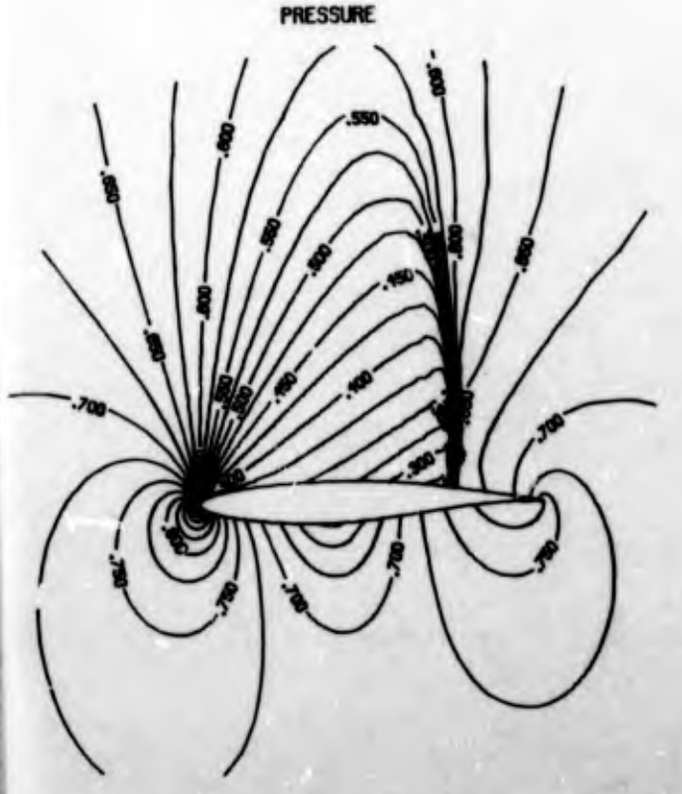
STREAMLINES



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-20
	RAE 2822: MACH = 0.75, ALPHA = 3			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-21
	RAE 2822: MACH = 0.75, ALPHA = 3			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-22
	RAE 2822: MACH = 0.75, ALPHA = 3			

TOTAL PRESSURE

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	06-6-23
	RAE 2822: MACH = 0.75, ALPHA = 3			

ENTROPY

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 06

RAE 2822: MACH = 0.75, ALPHA = 3

Contributor No 9

W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-1
	RAE 2822: MACH = 0.75, ALPHA = 3			

DORNIER/JAMESON AGARD FDP-WG07 EUFOIL TEST CASE:
RAE 2822 M=0.750 ALPHA=3.0 GRID (322*66) FILE G9.J008.RAE01

N	X/C(%)	Z/C(%)	1-P/PIINF	CP	MACH	1-PI/PIINF
2	0.999868	0.000009	0.179192	0.487719	0.535966	0.001949
3	0.999356	0.000042	0.194175	0.432456	0.563961	0.000049
4	0.998357	0.000099	0.201064	0.407049	0.575600	-0.000083
5	0.996881	0.000178	0.204313	0.395065	0.581055	-0.000147
6	0.994937	0.000281	0.204930	0.392790	0.582145	-0.000206
7	0.992531	0.000400	0.205312	0.391378	0.582401	0.000081
8	0.989667	0.000530	0.204834	0.393142	0.581971	-0.000192
9	0.986350	0.000667	0.204044	0.396058	0.580579	-0.000122
10	0.982585	0.000802	0.203587	0.397741	0.579607	0.000042
11	0.978379	0.000930	0.202673	0.401112	0.578355	-0.000154
12	0.973736	0.001046	0.201298	0.406184	0.576160	-0.000213
13	0.968662	0.001139	0.200486	0.409180	0.574534	-0.000001
14	0.963166	0.001197	0.199855	0.411505	0.573628	-0.000107
15	0.957253	0.001216	0.199082	0.414359	0.572488	-0.000215
16	0.950931	0.001183	0.198954	0.414831	0.572058	-0.000052
17	0.944210	0.001089	0.199475	0.412910	0.572909	-0.000041
18	0.937097	0.000931	0.200124	0.410515	0.574065	-0.000100
19	0.929603	0.000708	0.200674	0.408485	0.575007	-0.000122
20	0.921737	0.000415	0.201195	0.406564	0.575920	-0.000162
21	0.913511	0.000044	0.202286	0.402539	0.577564	-0.000038
22	0.904934	-0.000413	0.203734	0.397198	0.579998	-0.000070
23	0.896018	-0.000953	0.205121	0.392083	0.582410	-0.000166
24	0.886776	-0.001580	0.206858	0.385677	0.585135	-0.000061
25	0.877219	-0.002295	0.208987	0.377827	0.588585	-0.000030
26	0.867359	-0.003097	0.210928	0.370668	0.591938	-0.000162
27	0.857211	-0.003983	0.212931	0.363280	0.595158	-0.000118
28	0.846786	-0.004959	0.215447	0.353999	0.599148	-0.000031
29	0.836097	-0.006024	0.218212	0.343800	0.603704	-0.000077
30	0.825160	-0.007170	0.220996	0.333533	0.608228	-0.000086
31	0.813986	-0.008393	0.223659	0.323712	0.612575	-0.000120
32	0.802590	-0.009691	0.226377	0.313684	0.616951	-0.000112
33	0.790986	-0.011067	0.229430	0.302424	0.621802	-0.000064
34	0.779188	-0.012519	0.232767	0.290118	0.627168	-0.000077
35	0.767209	-0.014041	0.236277	0.277172	0.632772	-0.000073
36	0.755063	-0.015627	0.239778	0.264258	0.638406	-0.000113
37	0.742765	-0.017272	0.243425	0.250806	0.644196	-0.000109
38	0.730328	-0.018975	0.247586	0.235460	0.650682	-0.000018
39	0.717767	-0.020730	0.251961	0.219325	0.657648	-0.000062
40	0.705094	-0.022524	0.256211	0.203649	0.664419	-0.000130
41	0.692323	-0.024351	0.260593	0.187487	0.671247	-0.000080
42	0.679468	-0.026208	0.265304	0.170111	0.678608	-0.000063
43	0.666542	-0.028089	0.270329	0.151576	0.686454	-0.000057
44	0.653557	-0.029983	0.275533	0.132381	0.694559	-0.000054
45	0.640527	-0.031879	0.280701	0.113320	0.702631	-0.000088
46	0.627464	-0.033769	0.285829	0.094406	0.710583	-0.000086
47	0.614381	-0.035646	0.291027	0.075235	0.718641	-0.000095
48	0.601289	-0.037508	0.296532	0.054932	0.727112	-0.000061
49	0.588200	-0.039347	0.302452	0.033097	0.736192	-0.000010
50	0.575127	-0.041153	0.308392	0.011190	0.745416	-0.000078
51	0.562079	-0.042915	0.314194	-0.010211	0.754381	-0.000114
52	0.549068	-0.044627	0.320251	-0.032550	0.763608	-0.000037
53	0.536105	-0.046282	0.326640	-0.056117	0.773406	-0.000021
54	0.523200	-0.047872	0.332981	-0.079505	0.783206	-0.000083
55	0.510364	-0.049384	0.339196	-0.102426	0.792743	-0.000080
56	0.497605	-0.050812	0.345491	-0.125644	0.802346	-0.000020
57	0.484934	-0.052149	0.351771	-0.148808	0.811990	-0.000023
58	0.472359	-0.053384	0.357684	-0.170615	0.821103	-0.000052
59	0.459890	-0.054509	0.363051	-0.190414	0.829350	-0.000044
60	0.447535	-0.055517	0.367798	-0.207920	0.836648	-0.000038
61	0.435303	-0.056405	0.371800	-0.222680	0.842814	-0.000040
62	0.423201	-0.057170	0.374866	-0.233989	0.847562	-0.000065
63	0.411237	-0.057810	0.376933	-0.241614	0.850753	-0.000067
64	0.399419	-0.058327	0.377999	-0.245545	0.852411	-0.000080
65	0.387753	-0.058723	0.378149	-0.246099	0.852640	-0.000077
66	0.376245	-0.059003	0.377481	-0.243636	0.851600	-0.000066
67	0.364901	-0.059170	0.375973	-0.238070	0.849277	-0.000073
68	0.353727	-0.059228	0.373496	-0.228938	0.845494	-0.000107
69	0.342728	-0.059184	0.370114	-0.216464	0.840291	-0.000115
70	0.331909	-0.059045	0.366017	-0.201352	0.833990	-0.000124
71	0.321273	-0.058821	0.361434	-0.184447	0.826942	-0.000127
72	0.310824	-0.058522	0.356649	-0.166800	0.819570	-0.000108
73	0.300566	-0.058159	0.351870	-0.149172	0.812219	-0.000101
74	0.290501	-0.057740	0.347225	-0.132042	0.805076	-0.000089
75	0.280631	-0.057271	0.342799	-0.115715	0.798248	-0.000056
76	0.270958	-0.056758	0.338422	-0.099571	0.791546	-0.000072
77	0.261485	-0.056204	0.333884	-0.082836	0.784631	-0.000118
78	0.252213	-0.055615	0.329370	-0.066185	0.777695	-0.000115
79	0.243142	-0.054999	0.325376	-0.051455	0.771486	-0.000041
80	0.234273	-0.054360	0.321973	-0.038905	0.766211	0.000005

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-2
	RAE 2822: MACH = 0.75, ALPHA = 3			

81	0.225607	-0.053696	0.318569	-0.026347	0.761034	-0.000048
82	0.217145	-0.053007	0.314666	-0.011952	0.755112	-0.000121
83	0.208885	-0.052294	0.310612	0.003001	0.748844	-0.000092
84	0.200828	-0.051564	0.307026	0.016228	0.743239	-0.000011
85	0.192974	-0.050822	0.303910	0.027720	0.738415	0.000011
86	0.185320	-0.050063	0.300706	0.039537	0.733518	-0.000028
87	0.177868	-0.049287	0.296988	0.053251	0.727843	-0.000086
88	0.170615	-0.048494	0.293015	0.067904	0.721679	-0.000061
89	0.163560	-0.047690	0.289180	0.082049	0.715711	-0.000028
90	0.156700	-0.046878	0.285596	0.095268	0.710143	-0.000013
91	0.150036	-0.046060	0.282126	0.108064	0.704769	-0.000021
92	0.143563	-0.045234	0.278664	0.120833	0.699386	-0.000016
93	0.137281	-0.044401	0.275150	0.133795	0.693916	-0.000011
94	0.131188	-0.043561	0.271514	0.147206	0.688250	-0.000012
95	0.125280	-0.042715	0.267704	0.161259	0.682313	-0.000021
96	0.119556	-0.041864	0.263779	0.175735	0.676164	-0.000014
97	0.114013	-0.041008	0.259809	0.190376	0.669929	-0.000006
98	0.108647	-0.040151	0.255828	0.205061	0.663665	0.0
99	0.103457	-0.039292	0.251820	0.219843	0.657344	0.000005
100	0.098440	-0.038433	0.247767	0.234792	0.650932	0.000014
101	0.093591	-0.037574	0.243658	0.249946	0.644417	0.000014
102	0.088909	-0.036716	0.239498	0.265290	0.637796	0.000022
103	0.084391	-0.035860	0.235294	0.280796	0.631081	0.000030
104	0.080032	-0.035005	0.231044	0.296471	0.624270	0.000034
105	0.075830	-0.034153	0.226735	0.312367	0.617338	0.000039
106	0.071782	-0.033304	0.222363	0.328490	0.610274	0.000045
107	0.067885	-0.032457	0.217922	0.344871	0.603066	0.000055
108	0.064135	-0.031614	0.213378	0.361631	0.595660	0.000057
109	0.060529	-0.030773	0.208669	0.378999	0.587944	0.000065
110	0.057065	-0.029934	0.203725	0.397235	0.579815	0.000055
111	0.053738	-0.029099	0.198602	0.416129	0.571311	0.000068
112	0.050546	-0.028268	0.193363	0.435452	0.562567	0.000077
113	0.047484	-0.027442	0.188093	0.454889	0.553689	0.000094
114	0.044551	-0.026622	0.182770	0.474522	0.544671	0.000097
115	0.041742	-0.025806	0.177320	0.494622	0.535353	0.000108
116	0.039055	-0.024995	0.171629	0.515614	0.525548	0.000107
117	0.036487	-0.024187	0.165581	0.537921	0.515039	0.000093
118	0.034033	-0.023385	0.159293	0.561114	0.503935	0.000114
119	0.031692	-0.022588	0.152862	0.584833	0.492459	0.000120
120	0.029459	-0.021799	0.146389	0.608707	0.480724	0.000141
121	0.027331	-0.021017	0.139892	0.632668	0.468778	0.000157
122	0.025304	-0.020242	0.133301	0.656978	0.456481	0.000160
123	0.023377	-0.019474	0.126557	0.681855	0.443657	0.000175
124	0.021545	-0.018712	0.119562	0.707652	0.430125	0.000173
125	0.019806	-0.017955	0.112303	0.734425	0.415752	0.000176
126	0.018158	-0.017204	0.104844	0.761937	0.400601	0.000188
127	0.016596	-0.016457	0.097220	0.790057	0.384680	0.000196
128	0.015117	-0.015716	0.089431	0.818787	0.367900	0.000204
129	0.013719	-0.014979	0.081482	0.848105	0.350146	0.000209
130	0.012397	-0.014246	0.073411	0.877875	0.331365	0.000216
131	0.011150	-0.013516	0.065245	0.907993	0.311449	0.000223
132	0.009973	-0.012788	0.057025	0.938309	0.290281	0.000225
133	0.008864	-0.012061	0.048809	0.968514	0.267712	0.000229
134	0.007820	-0.011333	0.040612	0.998845	0.243455	0.000218
135	0.006839	-0.010601	0.032532	1.028646	0.217186	0.000211
136	0.005918	-0.009864	0.024719	1.057466	0.188684	0.000198
137	0.005054	-0.009118	0.017443	1.084299	0.157836	0.000204
138	0.004248	-0.008362	0.010890	1.108471	0.124173	0.000175
139	0.003500	-0.007591	0.005499	1.128353	0.087434	0.000168
140	0.002811	-0.006802	0.001888	1.141672	0.049428	0.000181
141	0.002183	-0.005993	0.000847	1.145514	0.030289	0.000206
142	0.001619	-0.005161	0.003410	1.136058	0.067553	0.000224
143	0.001128	-0.004305	0.010930	1.108321	0.124024	0.000243
144	0.000717	-0.003425	0.024794	1.057189	0.188924	0.000211
145	0.000395	-0.002523	0.046107	0.978578	0.260328	0.000085
146	0.000168	-0.001604	0.075424	0.870446	0.336965	-0.000171
147	0.000041	-0.000674	0.112690	0.732998	0.418096	-0.000710
148	0.000017	0.000259	0.156472	0.571517	0.500728	-0.001087
149	0.000099	0.001189	0.203442	0.398276	0.580951	-0.001163
150	0.000279	0.002105	0.251621	0.220579	0.658209	-0.000994
151	0.000554	0.003003	0.298946	0.046026	0.731430	-0.000608
152	0.000914	0.003875	0.342796	-0.115704	0.797801	0.000383
153	0.001353	0.004719	0.381398	-0.258083	0.856079	0.001571
154	0.001859	0.005533	0.414549	-0.380352	0.906401	0.002910
155	0.002424	0.006317	0.442951	-0.485108	0.950352	0.003918
156	0.003041	0.007074	0.468703	-0.580090	0.991428	0.004275
157	0.003704	0.007805	0.492343	-0.667284	1.029951	0.004528
158	0.004412	0.008512	0.512653	-0.742193	1.063797	0.004672
159	0.005163	0.009199	0.529405	-0.803980	1.092291	0.004758
160	0.005953	0.009868	0.543503	-0.855976	1.117035	0.004414

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-3
	RAE 2822: MACH = 0.75, ALPHA = 3			

161	0.006782	0.010521	0.556054	-0.902269	1.139564	0.003932
162	0.007651	0.011161	0.567007	-0.942667	1.159568	0.003450
163	0.008560	0.011790	0.576027	-0.975936	1.176277	0.003038
164	0.009507	0.012411	0.583176	-1.002304	1.189695	0.002682
165	0.010495	0.013024	0.589065	-1.024023	1.200947	0.002267
166	0.011524	0.013633	0.594346	-1.043501	1.211130	0.001883
167	0.012595	0.014236	0.599345	-1.061938	1.220796	0.001583
168	0.013710	0.014835	0.604324	-1.080301	1.230464	0.001331
169	0.014869	0.015431	0.609304	-1.098673	1.240189	0.001116
170	0.016075	0.016023	0.613964	-1.115858	1.249278	0.001019
171	0.017327	0.016613	0.617999	-1.130740	1.257189	0.000966
172	0.018628	0.017201	0.621347	-1.143090	1.263815	0.000897
173	0.019977	0.017788	0.623992	-1.152845	1.269109	0.000800
174	0.021376	0.018374	0.626027	-1.160352	1.273226	0.000690
175	0.022825	0.018961	0.627648	-1.166330	1.276546	0.000561
176	0.024326	0.019549	0.629042	-1.171472	1.279416	0.000441
177	0.025880	0.020138	0.630318	-1.176176	1.282030	0.000357
178	0.027488	0.020729	0.631560	-1.180757	1.284559	0.000302
179	0.029152	0.021320	0.632779	-1.185254	1.287029	0.000277
180	0.030873	0.021914	0.633880	-1.189314	1.289228	0.000301
181	0.032653	0.022509	0.634771	-1.192602	1.291000	0.000338
182	0.034491	0.023106	0.635435	-1.195050	1.292325	0.000361
183	0.036391	0.023705	0.635877	-1.196679	1.293220	0.000361
184	0.038354	0.024307	0.636132	-1.197621	1.293750	0.000342
185	0.040380	0.024912	0.636230	-1.197982	1.293963	0.000321
186	0.042471	0.025520	0.636193	-1.197845	1.293900	0.000304
187	0.044630	0.026131	0.636035	-1.197263	1.293588	0.000296
188	0.046856	0.026745	0.635771	-1.196289	1.293050	0.000301
189	0.049153	0.027364	0.635438	-1.195061	1.292370	0.000307
190	0.051521	0.027986	0.635092	-1.193786	1.291665	0.000315
191	0.053962	0.028612	0.634778	-1.192629	1.291018	0.000332
192	0.056478	0.029242	0.634539	-1.191744	1.290523	0.000349
193	0.059072	0.029876	0.634377	-1.191148	1.290184	0.000366
194	0.061744	0.030512	0.634229	-1.190601	1.289865	0.000393
195	0.064496	0.031153	0.634029	-1.189865	1.289442	0.000421
196	0.067331	0.031796	0.633750	-1.188834	1.288869	0.000435
197	0.070250	0.032444	0.633394	-1.187523	1.288144	0.000444
198	0.073255	0.033095	0.633032	-1.186189	1.287416	0.000443
199	0.076347	0.033749	0.632759	-1.185183	1.286873	0.000437
200	0.079530	0.034407	0.632636	-1.184728	1.286619	0.000445
201	0.082804	0.035068	0.632687	-1.184916	1.286725	0.000440
202	0.086173	0.035730	0.632826	-1.185427	1.286987	0.000461
203	0.089637	0.036395	0.632883	-1.185638	1.287081	0.000489
204	0.093199	0.037061	0.632765	-1.185202	1.286837	0.000498
205	0.096860	0.037731	0.632445	-1.184022	1.286180	0.000517
206	0.100622	0.038403	0.632059	-1.182600	1.285419	0.000498
207	0.104488	0.039079	0.631853	-1.181839	1.285026	0.000469
208	0.108459	0.039755	0.631964	-1.182248	1.285254	0.000462
209	0.112538	0.040432	0.632407	-1.183882	1.286157	0.000445
210	0.116726	0.041108	0.632968	-1.185953	1.287253	0.000489
211	0.121026	0.041784	0.633346	-1.187347	1.287990	0.000525
212	0.125439	0.042459	0.633416	-1.187604	1.288112	0.000548
213	0.129966	0.043134	0.633224	-1.186895	1.287727	0.000544
214	0.134610	0.043810	0.633035	-1.186198	1.287381	0.000498
215	0.139373	0.044486	0.633072	-1.186335	1.287477	0.000470
216	0.144255	0.045160	0.633388	-1.187501	1.288124	0.000455
217	0.149260	0.045832	0.633898	-1.189384	1.289134	0.000479
218	0.154388	0.046501	0.634441	-1.191383	1.290204	0.000513
219	0.159642	0.047165	0.634959	-1.193294	1.291241	0.000525
220	0.165023	0.047825	0.635451	-1.195110	1.292240	0.000521
221	0.170532	0.048479	0.635924	-1.196853	1.293204	0.000510
222	0.176171	0.049129	0.636369	-1.198495	1.294111	0.000504
223	0.181941	0.049773	0.636782	-1.200020	1.294950	0.000503
224	0.187844	0.050412	0.637185	-1.201507	1.295773	0.000494
225	0.193880	0.051044	0.637610	-1.203073	1.296638	0.000491
226	0.200051	0.051669	0.638068	-1.204762	1.297569	0.000489
227	0.206357	0.052287	0.638571	-1.206617	1.298592	0.000492
228	0.212800	0.052896	0.639136	-1.208700	1.299741	0.000491
229	0.219381	0.053496	0.639769	-1.211037	1.301038	0.000485
230	0.226100	0.054086	0.640446	-1.213533	1.302418	0.000487
231	0.232958	0.054664	0.641104	-1.215959	1.303761	0.000487
232	0.239955	0.055231	0.641720	-1.218230	1.305006	0.000510
233	0.247093	0.055787	0.642373	-1.220641	1.306350	0.000503
234	0.254370	0.056328	0.643240	-1.223836	1.308136	0.000493
235	0.261789	0.056854	0.644368	-1.227998	1.310492	0.000447
236	0.269347	0.057363	0.645565	-1.232414	1.312949	0.000459
237	0.277047	0.057854	0.646482	-1.235797	1.314815	0.000500
238	0.284886	0.058329	0.647050	-1.237891	1.315958	0.000544
239	0.292865	0.058789	0.647563	-1.239781	1.317044	0.000511
240	0.300983	0.059232	0.648418	-1.242937	1.318869	0.000441

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-4
	RAE 2822: MACH = 0.75, ALPHA = 3			

241	0.309239	0.059655	0.649646	-1.247466	1.321437	0.000421
242	0.317633	0.060055	0.650953	-1.252285	1.324134	0.000458
243	0.326164	0.060432	0.652082	-1.256450	1.326447	0.000521
244	0.334830	0.060787	0.653091	-1.260172	1.328563	0.000519
245	0.343630	0.061118	0.654268	-1.264513	1.331062	0.000481
246	0.352562	0.061423	0.655731	-1.269908	1.334176	0.000431
247	0.361626	0.061698	0.657314	-1.275749	1.337508	0.000450
248	0.370819	0.061945	0.658756	-1.281065	1.340529	0.000497
249	0.380138	0.062162	0.660028	-1.285759	1.343231	0.000502
250	0.389582	0.062350	0.661288	-1.290404	1.345934	0.000477
251	0.399148	0.062509	0.662652	-1.295434	1.348856	0.000466
252	0.408833	0.062635	0.664173	-1.301046	1.352115	0.000475
253	0.418634	0.062728	0.665908	-1.307446	1.355865	0.000452
254	0.428549	0.062783	0.667818	-1.314491	1.360000	0.000443
255	0.438574	0.062799	0.669726	-1.321526	1.364119	0.000473
256	0.448705	0.062776	0.671539	-1.328213	1.368043	0.000511
257	0.458938	0.062713	0.673412	-1.335120	1.372159	0.000490
258	0.469271	0.062608	0.675574	-1.343098	1.376945	0.000449
259	0.479697	0.062457	0.678047	-1.352219	1.382412	0.000454
260	0.490214	0.062256	0.680738	-1.362144	1.388393	0.000463
261	0.500816	0.062002	0.683578	-1.372619	1.394753	0.000470
262	0.511497	0.061693	0.686489	-1.383353	1.401313	0.000478
263	0.522253	0.061327	0.689419	-1.394160	1.407969	0.000484
264	0.533079	0.060905	0.692359	-1.405004	1.414707	0.000473
265	0.543968	0.060424	0.695310	-1.415888	1.421504	0.000488
266	0.554914	0.059885	0.698349	-1.427098	1.428570	0.000489
267	0.565911	0.059284	0.701620	-1.439163	1.436284	0.000422
268	0.576953	0.058619	0.705063	-1.451860	1.444433	0.000413
269	0.588033	0.057888	0.708383	-1.464107	1.452328	0.000458
270	0.599143	0.057095	0.711405	-1.475254	1.459621	0.000435
271	0.610277	0.056244	0.714059	-1.485041	1.466030	0.000482
272	0.621429	0.055339	0.716361	-1.493531	1.471669	0.000465
273	0.632590	0.054385	0.718602	-1.501798	1.477178	0.000472
274	0.643752	0.053382	0.720974	-1.510548	1.483189	0.000277
275	0.654909	0.052328	0.723376	-1.519405	1.489013	0.000517
276	0.666052	0.051227	0.725496	-1.527225	1.494576	0.000170
277	0.677174	0.050083	0.727411	-1.534286	1.498939	0.000854
278	0.688265	0.048900	0.729011	-1.540190	1.503736	-0.000204
279	0.699318	0.047681	0.731017	-1.547585	1.507878	0.001212
280	0.710325	0.046427	0.732643	-1.553584	1.513828	-0.001362
281	0.721276	0.045138	0.731959	-1.551062	1.507600	0.005114
282	0.732161	0.043814	0.710352	-1.471369	1.436940	0.028769
283	0.742973	0.042458	0.613140	-1.112820	1.172934	0.094219
284	0.753701	0.041075	0.465937	-0.569890	0.886832	0.109478
285	0.764337	0.039670	0.346469	-0.129250	0.713622	0.082310
286	0.774872	0.038245	0.331595	-0.074393	0.695771	0.076341
287	0.785295	0.036801	0.331704	-0.074795	0.695820	0.076452
288	0.795596	0.035340	0.331174	-0.072840	0.694838	0.076524
289	0.805767	0.033867	0.330146	-0.069047	0.693110	0.076519
290	0.815796	0.032386	0.328889	-0.064410	0.690962	0.076543
291	0.825673	0.030899	0.327362	-0.058781	0.688372	0.076553
292	0.835389	0.029407	0.325484	-0.051851	0.685158	0.076586
293	0.844934	0.027914	0.323185	-0.043372	0.681157	0.076674
294	0.854296	0.026429	0.320733	-0.034329	0.677047	0.076640
295	0.863467	0.024958	0.318617	-0.026523	0.673579	0.076542
296	0.872434	0.023495	0.316493	-0.018692	0.669827	0.076656
297	0.881187	0.022042	0.313679	-0.008313	0.664891	0.076774
298	0.889716	0.020607	0.310601	0.003040	0.659757	0.076683
299	0.898011	0.019194	0.307856	0.013164	0.655114	0.076645
300	0.906059	0.017805	0.305048	0.023523	0.650161	0.076756
301	0.913851	0.016441	0.301858	0.035287	0.644643	0.076788
302	0.921377	0.015109	0.298676	0.047024	0.639266	0.076712
303	0.928624	0.013810	0.295586	0.058419	0.633879	0.076756
304	0.935583	0.012546	0.292153	0.071082	0.627769	0.076880
305	0.942243	0.011323	0.288520	0.084483	0.621548	0.076812
306	0.948594	0.010145	0.285206	0.096704	0.615888	0.076727
307	0.954625	0.009012	0.281759	0.109418	0.609596	0.076922
308	0.960325	0.007928	0.277667	0.124512	0.602323	0.076981
309	0.965686	0.006901	0.273752	0.138952	0.595723	0.076760
310	0.970697	0.005932	0.270263	0.151820	0.589407	0.076853
311	0.975346	0.005019	0.266037	0.167406	0.581585	0.077063
312	0.979625	0.004170	0.261199	0.185251	0.573095	0.076936
313	0.983525	0.003390	0.256664	0.201976	0.565019	0.076867
314	0.987035	0.002682	0.251986	0.219230	0.556233	0.077066
315	0.990147	0.002050	0.246751	0.238541	0.546695	0.077034
316	0.992850	0.001498	0.241606	0.257515	0.537572	0.076787
317	0.995135	0.001025	0.236029	0.278085	0.526735	0.077077
318	0.996991	0.000636	0.228708	0.305089	0.512398	0.077405
319	0.998408	0.000339	0.220385	0.335785	0.498124	0.076366
320	0.999374	0.000135	0.212418	0.365172	0.480821	0.077426
321	0.999871	0.000028	0.197992	0.418377	0.450826	0.077976

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-5
	RAE 2822: MACH = 0.75, ALPHA = 3			

RAE 2822 M=0.75, ALPHA=3.00
RESULTS AT FAR-FIELD BOUNDARY (J=65)

I	X/C(%)	Z/C(%)	RHO	U	V	P
2	46.359985	-4.066651	0.999797	0.885714	0.044208	0.999948
3	46.219818	-5.415069	1.000102	0.886419	0.044150	1.000075
4	46.040100	-6.758522	1.000034	0.886216	0.044068	1.000060
5	45.820984	-8.095677	1.000063	0.886045	0.044109	1.000132
6	45.562729	-9.425212	1.000074	0.886028	0.044062	1.000147
7	45.265671	-10.745819	1.000113	0.885988	0.044055	1.000196
8	44.930191	-12.056208	1.000121	0.885927	0.044031	1.000220
9	44.556686	-13.355105	1.000147	0.885877	0.044022	1.000258
10	44.145676	-14.641258	1.000160	0.885824	0.044003	1.000286
11	43.697632	-15.913436	1.000179	0.885771	0.043993	1.000319
12	43.213165	-17.170425	1.000194	0.885716	0.043979	1.000346
13	42.692886	-18.411072	1.000210	0.885661	0.043969	1.000377
14	42.137451	-19.634201	1.000223	0.885604	0.043959	1.000405
15	41.547562	-20.838715	1.000237	0.885547	0.043951	1.000434
16	40.923996	-22.023529	1.000251	0.885489	0.043944	1.000462
17	40.267517	-23.187592	1.000264	0.885430	0.043939	1.000490
18	39.578979	-24.329880	1.000278	0.885370	0.043934	1.000519
19	38.859207	-25.449432	1.000291	0.885310	0.043932	1.000547
20	38.109131	-26.545288	1.000304	0.885248	0.043931	1.000576
21	37.329666	-27.616592	1.000318	0.885187	0.043932	1.000606
22	36.521790	-28.662460	1.000332	0.885123	0.043934	1.000636
23	35.686478	-29.682083	1.000346	0.885060	0.043939	1.000667
24	34.824768	-30.674728	1.000361	0.884996	0.043945	1.000697
25	33.937683	-31.639633	1.000377	0.884931	0.043953	1.000729
26	33.026306	-32.576157	1.000393	0.884866	0.043963	1.000761
27	32.091705	-33.483658	1.000409	0.884801	0.043976	1.000794
28	31.134979	-34.361557	1.000426	0.884735	0.043991	1.000828
29	30.157257	-35.209320	1.000444	0.884669	0.044009	1.000862
30	29.159668	-36.026489	1.000463	0.884603	0.044030	1.000897
31	28.143356	-36.812592	1.000482	0.884537	0.044053	1.000933
32	27.109451	-37.567261	1.000502	0.884470	0.044080	1.000969
33	26.059128	-38.290161	1.000522	0.884405	0.044109	1.001005
34	24.993546	-38.981003	1.000543	0.884340	0.044143	1.001042
35	23.913849	-39.639542	1.000565	0.884276	0.044179	1.001080
36	22.821213	-40.265579	1.000586	0.884213	0.044220	1.001117
37	21.716797	-40.858978	1.000607	0.884152	0.044264	1.001153
38	20.601730	-41.419647	1.000629	0.884092	0.044312	1.001190
39	19.477188	-41.947495	1.000651	0.884035	0.044365	1.001225
40	18.344284	-42.442551	1.000674	0.883979	0.044421	1.001261
41	17.204163	-42.904816	1.000696	0.883927	0.044482	1.001296
42	16.057922	-43.334396	1.000718	0.883878	0.044547	1.001329
43	14.906671	-43.731384	1.000739	0.883832	0.044617	1.001361
44	13.751483	-44.095963	1.000760	0.883791	0.044691	1.001392
45	12.593429	-44.428314	1.000781	0.883753	0.044769	1.001421
46	11.433554	-44.728683	1.000802	0.883720	0.044851	1.001449
47	10.272885	-44.997330	1.000821	0.883692	0.044937	1.001475
48	9.112426	-45.234589	1.000841	0.883669	0.045027	1.001499
49	7.953158	-45.440796	1.000860	0.883651	0.045121	1.001522
50	6.796037	-45.616318	1.000880	0.883638	0.045218	1.001543
51	5.641994	-45.761581	1.000900	0.883631	0.045320	1.001564
52	4.491932	-45.876999	1.000918	0.883632	0.045426	1.001580
53	3.346728	-45.963074	1.000937	0.883640	0.045537	1.001595
54	2.207233	-46.020264	1.000983	0.883620	0.045646	1.001645
55	1.074265	-46.049103	1.000990	0.883588	0.045685	1.001660
56	-0.051385	-46.050125	1.001010	0.883585	0.045762	1.001680
57	-1.168959	-46.023895	1.001011	0.883578	0.045823	1.001682
58	-2.277724	-45.971008	1.001017	0.883586	0.045891	1.001684
59	-3.376985	-45.892044	1.001014	0.883594	0.045955	1.001678
60	-4.466072	-45.787628	1.001011	0.883611	0.046019	1.001671
61	-5.544352	-45.658401	1.001004	0.883629	0.046082	1.001658
62	-6.611217	-45.505020	1.000997	0.883653	0.046143	1.001644
63	-7.666100	-45.328125	1.000987	0.883679	0.046203	1.001627
64	-8.708459	-45.128403	1.000976	0.883709	0.046262	1.001608
65	-9.737786	-44.906525	1.000963	0.883741	0.046318	1.001586
66	-10.753608	-44.663208	1.000950	0.883775	0.046373	1.001564
67	-11.755479	-44.399139	1.000936	0.883811	0.046425	1.001539
68	-12.742989	-44.115005	1.000920	0.883849	0.046476	1.001514
69	-13.715755	-43.811523	1.000905	0.883887	0.046524	1.001489
70	-14.673429	-43.489426	1.000889	0.883927	0.046571	1.001462
71	-15.615692	-43.149384	1.000873	0.883967	0.046615	1.001435
72	-16.542252	-42.792130	1.000856	0.884008	0.046658	1.001408
73	-17.452850	-42.418381	1.000840	0.884049	0.046699	1.001380
74	-18.347260	-42.028824	1.000824	0.884090	0.046738	1.001353
75	-19.225281	-41.624176	1.000808	0.884132	0.046775	1.001326
76	-20.086731	-41.205109	1.000792	0.884173	0.046810	1.001299
77	-20.931458	-40.772324	1.000775	0.884214	0.046843	1.001272
78	-21.759338	-40.326508	1.000759	0.884255	0.046875	1.001245
79	-22.570282	-39.868317	1.000744	0.884295	0.046906	1.001219
80	-23.364197	-39.398422	1.000729	0.884335	0.046935	1.001194

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-6
	RAE 2822: MACH = 0.75, ALPHA = 3			

81	-24.141052	-38.917465	1.000714	0.884373	0.046963	1.001168
82	-24.900787	-38.426102	1.000699	0.884412	0.046989	1.001143
83	-25.643417	-37.924942	1.000685	0.884450	0.047014	1.001120
84	-26.368958	-37.414627	1.000671	0.884487	0.047038	1.001096
85	-27.077423	-36.895737	1.000658	0.884524	0.047061	1.001073
86	-27.768875	-36.368881	1.000645	0.884560	0.047083	1.001050
87	-28.443375	-35.834641	1.000632	0.884594	0.047104	1.001028
88	-29.101013	-35.293549	1.000620	0.884629	0.047124	1.001007
89	-29.741882	-34.746201	1.000607	0.884663	0.047143	1.000986
90	-30.366119	-34.193100	1.000596	0.884696	0.047161	1.000966
91	-30.973846	-33.634766	1.000585	0.884728	0.047178	1.000946
92	-31.565201	-33.071732	1.000573	0.884760	0.047195	1.000927
93	-32.140350	-32.504456	1.000563	0.884791	0.047211	1.000908
94	-32.699448	-31.933426	1.000552	0.884821	0.047226	1.000890
95	-33.242706	-31.359085	1.000542	0.884852	0.047241	1.000872
96	-33.770294	-30.781906	1.000532	0.884880	0.047255	1.000854
97	-34.282425	-30.202271	1.000523	0.884909	0.047269	1.000837
98	-34.779297	-29.620621	1.000513	0.884937	0.047282	1.000820
99	-35.261139	-29.037338	1.000504	0.884964	0.047294	1.000805
100	-35.728165	-28.452805	1.000495	0.884992	0.047306	1.000789
101	-36.180618	-27.867386	1.000486	0.885018	0.047318	1.000773
102	-36.618744	-27.281403	1.000479	0.885043	0.047329	1.000758
103	-37.042755	-26.695206	1.000470	0.885069	0.047340	1.000744
104	-37.452927	-26.109085	1.000463	0.885094	0.047351	1.000730
105	-37.849503	-25.523376	1.000455	0.885118	0.047361	1.000715
106	-38.232727	-24.938324	1.000447	0.885142	0.047371	1.000702
107	-38.602875	-24.354202	1.000440	0.885166	0.047380	1.000689
108	-38.960190	-23.771286	1.000433	0.885189	0.047389	1.000675
109	-39.304947	-23.189774	1.000426	0.885211	0.047398	1.000663
110	-39.637375	-22.609909	1.000420	0.885234	0.047406	1.000650
111	-39.957779	-22.031891	1.000413	0.885256	0.047415	1.000638
112	-40.266388	-21.455933	1.000406	0.885277	0.047423	1.000626
113	-40.563477	-20.882187	1.000400	0.885299	0.047430	1.000614
114	-40.849304	-20.310822	1.000394	0.885320	0.047438	1.000603
115	-41.124130	-19.742004	1.000388	0.885340	0.047445	1.000591
116	-41.388199	-19.175873	1.000381	0.885361	0.047452	1.000580
117	-41.641785	-18.612534	1.000376	0.885381	0.047459	1.000569
118	-41.885132	-18.052109	1.000370	0.885401	0.047465	1.000558
119	-42.118484	-17.494720	1.000365	0.885419	0.047472	1.000547
120	-42.342087	-16.940430	1.000360	0.885439	0.047478	1.000538
121	-42.556213	-16.389343	1.000354	0.885458	0.047484	1.000527
122	-42.761063	-15.841507	1.000349	0.885476	0.047490	1.000517
123	-42.956909	-15.296982	1.000344	0.885494	0.047495	1.000507
124	-43.143951	-14.755816	1.000339	0.885513	0.047501	1.000498
125	-43.322418	-14.218045	1.000334	0.885531	0.047506	1.000488
126	-43.492554	-13.683695	1.000329	0.885548	0.047511	1.000479
127	-43.654572	-13.152782	1.000324	0.885566	0.047516	1.000469
128	-43.808670	-12.625315	1.000319	0.885583	0.047521	1.000461
129	-43.955063	-12.101292	1.000315	0.885601	0.047526	1.000451
130	-44.093964	-11.580702	1.000311	0.885617	0.047530	1.000443
131	-44.225540	-11.063528	1.000306	0.885634	0.047535	1.000434
132	-44.350021	-10.549743	1.000301	0.885651	0.047539	1.000425
133	-44.467575	-10.039314	1.000298	0.885667	0.047543	1.000417
134	-44.578384	-9.532199	1.000293	0.885684	0.047547	1.000408
135	-44.682602	-9.028348	1.000289	0.885699	0.047551	1.000400
136	-44.780411	-8.527708	1.000285	0.885715	0.047555	1.000392
137	-44.871979	-8.030216	1.000280	0.885731	0.047559	1.000383
138	-44.957428	-7.535804	1.000277	0.885747	0.047562	1.000376
139	-45.036911	-7.044396	1.000273	0.885762	0.047566	1.000367
140	-45.110550	-6.555914	1.000269	0.885778	0.047569	1.000360
141	-45.178467	-6.070272	1.000265	0.885793	0.047572	1.000352
142	-45.240768	-5.587381	1.000261	0.885808	0.047576	1.000344
143	-45.297546	-5.107146	1.000257	0.885823	0.047579	1.000337
144	-45.348877	-4.629470	1.000254	0.885839	0.047582	1.000329
145	-45.394867	-4.154250	1.000250	0.885854	0.047585	1.000321
146	-45.435562	-3.681385	1.000246	0.885869	0.047587	1.000314
147	-45.471054	-3.210770	1.000242	0.885884	0.047590	1.000306
148	-45.501419	-2.742296	1.000239	0.885898	0.047593	1.000299
149	-45.526733	-2.275856	1.000236	0.885913	0.047595	1.000292
150	-45.547089	-1.811337	1.000232	0.885927	0.047598	1.000284
151	-45.562561	-1.348624	1.000228	0.885942	0.047600	1.000278
152	-45.573227	-0.887602	1.000225	0.885956	0.047602	1.000270
153	-45.579193	-0.428149	1.000221	0.885970	0.047605	1.000263
154	-45.580505	0.029858	1.000218	0.885984	0.047607	1.000256
155	-45.577271	0.486543	1.000215	0.885999	0.047609	1.000249
156	-45.569504	0.942034	1.000211	0.886014	0.047611	1.000241
157	-45.557281	1.396461	1.000208	0.886027	0.047613	1.000235
158	-45.540634	1.849954	1.000204	0.886042	0.047615	1.000228
159	-45.519562	2.302645	1.000201	0.886056	0.047617	1.000220
160	-45.494095	2.754665	1.000197	0.886071	0.047619	1.000214

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-7
	RAE 2822: MACH = 0.75, ALPHA = 3			

161	-45.464233	3.206147	1.000194	0.886086	0.047621	1.000206
162	-45.429993	3.657222	1.000191	0.886099	0.047622	1.000199
163	-45.391342	4.108022	1.000187	0.886114	0.047624	1.000192
164	-45.348267	4.558676	1.000184	0.886128	0.047625	1.000185
165	-45.300766	5.009316	1.000180	0.886143	0.047627	1.000178
166	-45.248779	5.460070	1.000177	0.886158	0.047628	1.000171
167	-45.192291	5.911064	1.000174	0.886173	0.047629	1.000164
168	-45.131256	6.362426	1.000170	0.886188	0.047631	1.000156
169	-45.065598	6.814277	1.000167	0.886202	0.047632	1.000150
170	-44.995300	7.266739	1.000163	0.886218	0.047633	1.000142
171	-44.920258	7.719933	1.000160	0.886232	0.047634	1.000134
172	-44.840439	8.173974	1.000156	0.886248	0.047635	1.000128
173	-44.755753	8.628977	1.000153	0.886263	0.047636	1.000120
174	-44.666122	9.085054	1.000150	0.886278	0.047637	1.000113
175	-44.571457	9.542314	1.000146	0.886294	0.047638	1.000105
176	-44.471680	10.000858	1.000142	0.886310	0.047638	1.000098
177	-44.366684	10.460792	1.000139	0.886325	0.047639	1.000091
178	-44.256363	10.922208	1.000135	0.886341	0.047640	1.000083
179	-44.140594	11.385201	1.000132	0.886357	0.047640	1.000075
180	-44.019287	11.849859	1.000128	0.886374	0.047640	1.000068
181	-43.892319	12.316266	1.000125	0.886389	0.047641	1.000059
182	-43.759537	12.784500	1.000121	0.886406	0.047641	1.000051
183	-43.620819	13.254635	1.000117	0.886423	0.047641	1.000044
184	-43.476044	13.726738	1.000113	0.886440	0.047641	1.000036
185	-43.325043	14.200871	1.000110	0.886457	0.047641	1.000028
186	-43.167679	14.677093	1.000106	0.886474	0.047641	1.000020
187	-43.003799	15.155450	1.000102	0.886492	0.047641	1.000011
188	-42.833237	15.635987	1.000098	0.886509	0.047640	1.000003
189	-42.655838	16.118729	1.000094	0.886527	0.047640	0.999995
190	-42.471405	16.603729	1.000091	0.886545	0.047639	0.999986
191	-42.279785	17.091003	1.000087	0.886564	0.047639	0.999978
192	-42.080795	17.580551	1.000083	0.886582	0.047638	0.999969
193	-41.874237	18.072372	1.000078	0.886602	0.047637	0.999960
194	-41.659927	18.566498	1.000074	0.886621	0.047636	0.999951
195	-41.437683	19.062897	1.000070	0.886641	0.047635	0.999942
196	-41.207275	19.561539	1.000066	0.886661	0.047634	0.999933
197	-40.968536	20.062408	1.000061	0.886681	0.047632	0.999923
198	-40.721222	20.565460	1.000057	0.886701	0.047631	0.999914
199	-40.465164	21.070648	1.000052	0.886722	0.047629	0.999904
200	-40.200104	21.577927	1.000048	0.886744	0.047627	0.999894
201	-39.925858	22.087204	1.000044	0.886765	0.047625	0.999884
202	-39.642197	22.598419	1.000039	0.886787	0.047623	0.999874
203	-39.348877	23.111465	1.000034	0.886809	0.047621	0.999863
204	-39.045700	23.626266	1.000030	0.886832	0.047618	0.999853
205	-38.732437	24.142685	1.000024	0.886856	0.047616	0.999842
206	-38.408844	24.660599	1.000019	0.886880	0.047613	0.999831
207	-38.074692	25.179871	1.000014	0.886904	0.047609	0.999820
208	-37.729752	25.700363	1.000009	0.886929	0.047606	0.999808
209	-37.373795	26.221893	1.000003	0.886954	0.047602	0.999796
210	-37.006592	26.744308	0.999998	0.886978	0.047598	0.999784
211	-36.627899	27.267410	0.999993	0.887005	0.047594	0.999772
212	-36.237488	27.791000	0.999987	0.887031	0.047589	0.999759
213	-35.835129	28.314850	0.999981	0.887060	0.047584	0.999747
214	-35.420593	28.838745	0.999975	0.887087	0.047579	0.999734
215	-34.993652	29.362442	0.999968	0.887116	0.047574	0.999720
216	-34.554092	29.885681	0.999962	0.887145	0.047567	0.999706
217	-34.101669	30.408188	0.999955	0.887175	0.047561	0.999692
218	-33.636185	30.929672	0.999949	0.887205	0.047554	0.999678
219	-33.157425	31.449844	0.999942	0.887237	0.047547	0.999663
220	-32.665161	31.968369	0.999934	0.887269	0.047539	0.999648
221	-32.159195	32.484940	0.999927	0.887302	0.047530	0.999632
222	-31.639343	32.999207	0.999919	0.887336	0.047521	0.999616
223	-31.105408	33.510788	0.999911	0.887370	0.047512	0.999599
224	-30.557205	34.019333	0.999903	0.887405	0.047501	0.999582
225	-29.994568	34.524445	0.999895	0.887442	0.047490	0.999565
226	-29.417313	35.025711	0.999886	0.887478	0.047478	0.999547
227	-28.825287	35.522720	0.999877	0.887516	0.047465	0.999529
228	-28.218353	36.015030	0.999868	0.887555	0.047452	0.999510
229	-27.596375	36.502213	0.999858	0.887594	0.047437	0.999491
230	-26.959213	36.983765	0.999849	0.887634	0.047421	0.999471
231	-26.306778	37.459244	0.999838	0.887675	0.047405	0.999451
232	-25.639947	37.928146	0.999828	0.887717	0.047387	0.999430
233	-24.955673	38.389954	0.999817	0.887760	0.047368	0.999409
234	-24.256836	38.844162	0.999806	0.887804	0.047347	0.999387
235	-23.542435	39.290237	0.999795	0.887847	0.047325	0.999365
236	-22.812393	39.727615	0.999784	0.887892	0.047302	0.999342
237	-22.066711	40.155762	0.999772	0.887938	0.047277	0.999319
238	-21.305389	40.574112	0.999760	0.887984	0.047250	0.999296
239	-20.528427	40.982056	0.999748	0.888030	0.047221	0.999272
240	-19.735886	41.379028	0.999736	0.888077	0.047191	0.999249

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-8
	RAE 2822: MACH = 0.75, ALPHA = 3			

241	-18.927826	41.764404	0.999723	0.888124	0.047159	0.999225
242	-18.104294	42.137604	0.999711	0.888171	0.047124	0.999201
243	-17.265411	42.497986	0.999698	0.888218	0.047088	0.999177
244	-16.411316	42.844925	0.999686	0.888264	0.047049	0.999154
245	-15.542146	43.177780	0.999674	0.888310	0.047008	0.999131
246	-14.658064	43.495926	0.999663	0.888354	0.046965	0.999109
247	-13.759274	43.798706	0.999652	0.888398	0.046920	0.999088
248	-12.845999	44.085480	0.999642	0.888440	0.046872	0.999067
249	-11.918489	44.355576	0.999632	0.888480	0.046822	0.999049
250	-10.977022	44.608353	0.999625	0.888517	0.046769	0.999032
251	-10.021901	44.843155	0.999618	0.888552	0.046714	0.999017
252	-9.053457	45.059311	0.999614	0.888584	0.046658	0.999005
253	-8.072051	45.256180	0.999610	0.888610	0.046599	0.998996
254	-7.078071	45.433090	0.999612	0.888634	0.046538	0.998993
255	-6.071936	45.589401	0.999613	0.888646	0.046477	0.998992
256	-5.054092	45.724472	0.999627	0.888658	0.046410	0.999003
257	-4.025019	45.837646	0.999637	0.888649	0.046352	0.999017
258	-2.985224	45.928314	0.999677	0.888639	0.046267	0.999060
259	-1.935244	45.995834	0.999712	0.888575	0.046241	0.999111
260	-0.875648	46.039597	0.999809	0.888523	0.046097	0.999223
261	0.192965	46.058990	0.999811	0.888573	0.045956	0.999215
262	1.269967	46.053452	0.999813	0.888613	0.045821	0.999209
263	2.354699	46.022400	0.999823	0.888636	0.045692	0.999215
264	3.446472	45.965271	0.999832	0.888654	0.045567	0.999220
265	4.544567	45.881531	0.999838	0.888666	0.045447	0.999225
266	5.648236	45.770676	0.999845	0.888672	0.045332	0.999232
267	6.756703	45.632187	0.999852	0.888671	0.045221	0.999240
268	7.869164	45.465591	0.999859	0.888665	0.045115	0.999250
269	8.984783	45.270462	0.999866	0.888652	0.045013	0.999262
270	10.102705	45.046371	0.999873	0.888634	0.044916	0.999275
271	11.222042	44.792908	0.999881	0.888611	0.044824	0.999290
272	12.341885	44.509720	0.999889	0.888583	0.044736	0.999306
273	13.461300	44.196472	0.999898	0.888551	0.044653	0.999324
274	14.579329	43.852859	0.999906	0.888515	0.044574	0.999343
275	15.694993	43.478607	0.999915	0.888474	0.044501	0.999363
276	16.807281	43.073502	0.999924	0.888431	0.044431	0.999384
277	17.915192	42.637314	0.999933	0.888385	0.044366	0.999405
278	19.017685	42.169891	0.999942	0.888337	0.044306	0.999427
279	20.113693	41.671[illegible]	0.999951	0.888286	0.044249	0.999449
280	21.202148	41.14[illegible]	0.999959	0.888233	0.044197	0.999472
281	22.281982	40.579[illegible]	0.999967	0.888179	0.044148	0.999494
282	23.352081	39.986038	0.999975	0.888124	0.044103	0.999517
283	24.411346	39.361420	0.999982	0.888067	0.044061	0.999539
284	25.458679	38.705444	0.999989	0.888009	0.044023	0.999560
285	26.492935	38.018250	0.999995	0.887952	0.043988	0.999582
286	27.513000	37.299988	1.000000	0.887894	0.043956	0.999602
287	28.517746	36.550903	1.000005	0.887835	0.043927	0.999622
288	29.506058	35.771255	1.000009	0.887777	0.043900	0.999641
289	30.476807	34.961349	1.000012	0.887718	0.043875	0.999660
290	31.428864	34.121567	1.000014	0.887660	0.043853	0.999678
291	32.361130	33.252289	1.000016	0.887601	0.043833	0.999695
292	33.272476	32.354004	1.000018	0.887543	0.043814	0.999711
293	34.161819	31.427170	1.000019	0.887485	0.043798	0.999726
294	35.028091	30.472382	1.000019	0.887429	0.043783	0.999741
295	35.870209	29.490219	1.000018	0.887373	0.043770	0.999755
296	36.687134	28.481308	1.000017	0.887317	0.043758	0.999768
297	37.477829	27.446365	1.000015	0.887263	0.043747	0.999781
298	38.241287	26.386108	1.000013	0.887210	0.043738	0.999792
299	38.976517	25.301315	1.000011	0.887158	0.043729	0.999803
300	39.682571	24.192810	1.000009	0.887108	0.043722	0.999813
301	40.358521	23.061462	1.000006	0.887059	0.043715	0.999823
302	41.003479	21.908188	1.000003	0.887012	0.043708	0.999831
303	41.616562	20.733917	0.999999	0.886967	0.043702	0.999839
304	42.196930	19.539642	0.999996	0.886925	0.043696	0.999846
305	42.743820	18.326370	0.999992	0.886886	0.043690	0.999853
306	43.256470	17.095200	0.999988	0.886850	0.043683	0.999857
307	43.734146	15.847197	0.999984	0.886819	0.043676	0.999861
308	44.176193	14.583487	0.999978	0.886788	0.043666	0.999863
309	44.581985	13.305233	0.999972	0.886763	0.043656	0.999864
310	44.950928	12.013621	0.999970	0.886760	0.043649	0.999862
311	45.282501	10.709861	0.999957	0.886721	0.043622	0.999860
312	45.576187	9.395190	0.999918	0.886608	0.043589	0.999850
313	45.831589	8.070869	0.999947	0.886749	0.043612	0.999843
314	46.048279	6.738176	1.000071	0.887282	0.043646	0.999832
315	46.225967	5.398408	0.999965	0.886917	0.043457	0.999820
316	46.364334	4.052876	0.999269	0.884399	0.043229	0.999764
317	46.463165	2.702902	0.998589	0.881751	0.043428	0.999748
318	46.522278	1.349822	0.998730	0.882283	0.044050	0.999748
319	46.541565	-0.005021	0.999584	0.885199	0.044332	0.999864
320	46.520950	-1.360281	1.000043	0.886994	0.044300	0.999869
321	46.460403	-2.714608	1.000134	0.886840	0.044085	1.000001
322	36.047195	-1.757484	0.999797	0.885714	0.044208	0.999948

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-9
	RAE 2822: MACH = 0.75, ALPHA = 3			

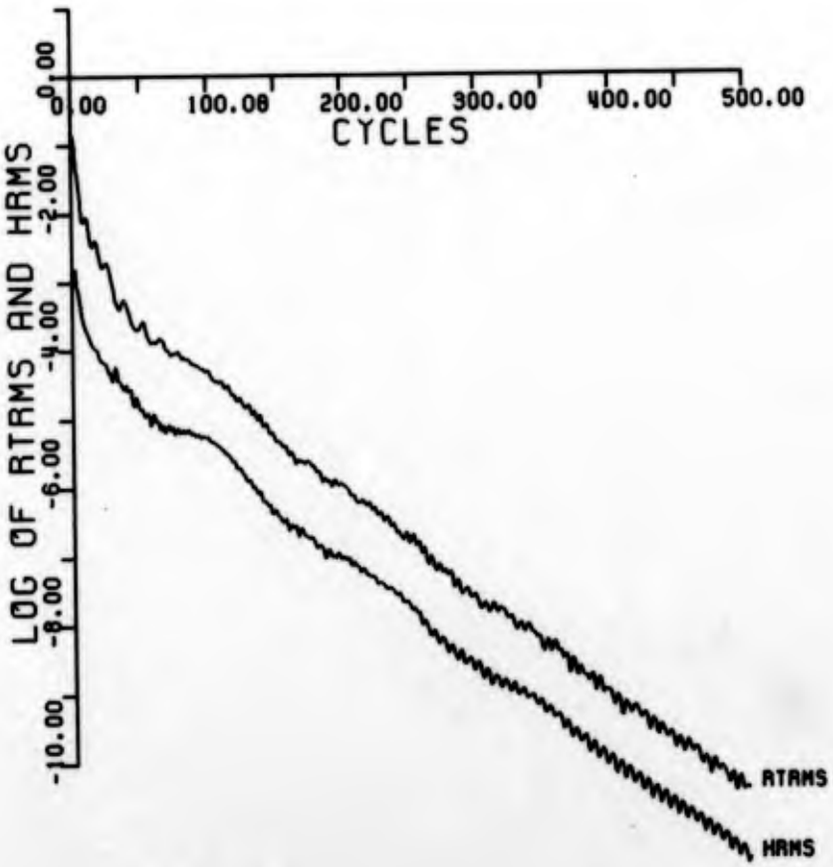


FIG. : CONVERGENCE BEHAVIOUR (DR/DT AND H)

RAE 2822 M=0.750, ALPHA=3.0
GRID SEQUENCE : 40×8->80×16->160×32->320×64

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-10
	RAE 2822: MACH = 0.75, ALPHA = 3			

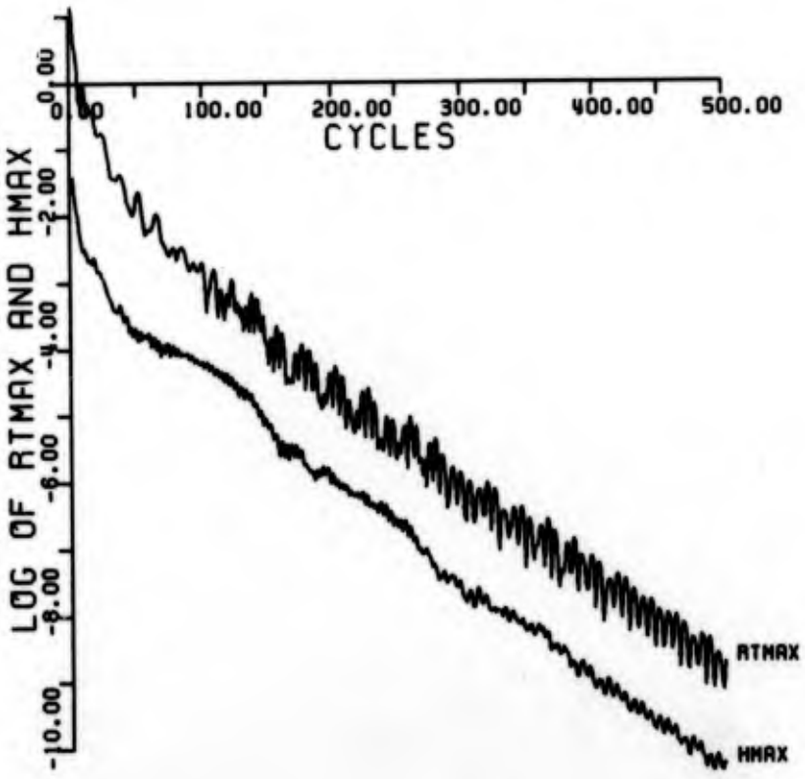


FIG. : CONVERGENCE BEHAVIOUR (DR/DT AND H)

RAE 2822 M=0.750, ALPHA=3.0

GRID SEQUENCE : 40×8->80×16->160×32->320×64

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-11
	RAE 2822: MACH = 0.75, ALPHA = 3			

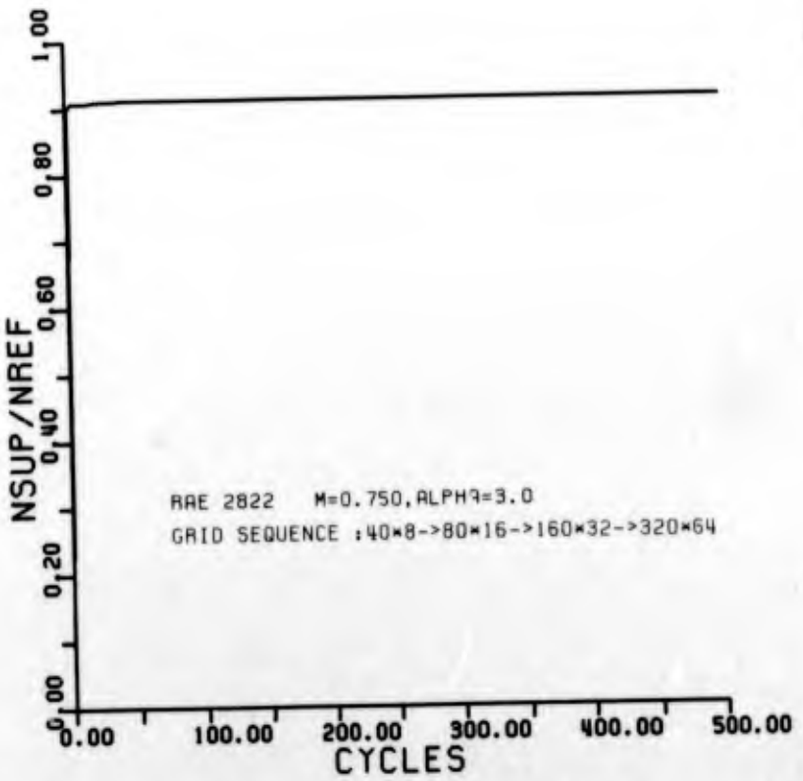


FIG. : CONVERGENCE BEHAVIOUR (NSUP/NREF), NREF=3000

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-12
	RAE 2822: MACH = 0.75, ALPHA = 3			

C_L = 1.1044

C_D = 0.0448

C_M = - 0.1897

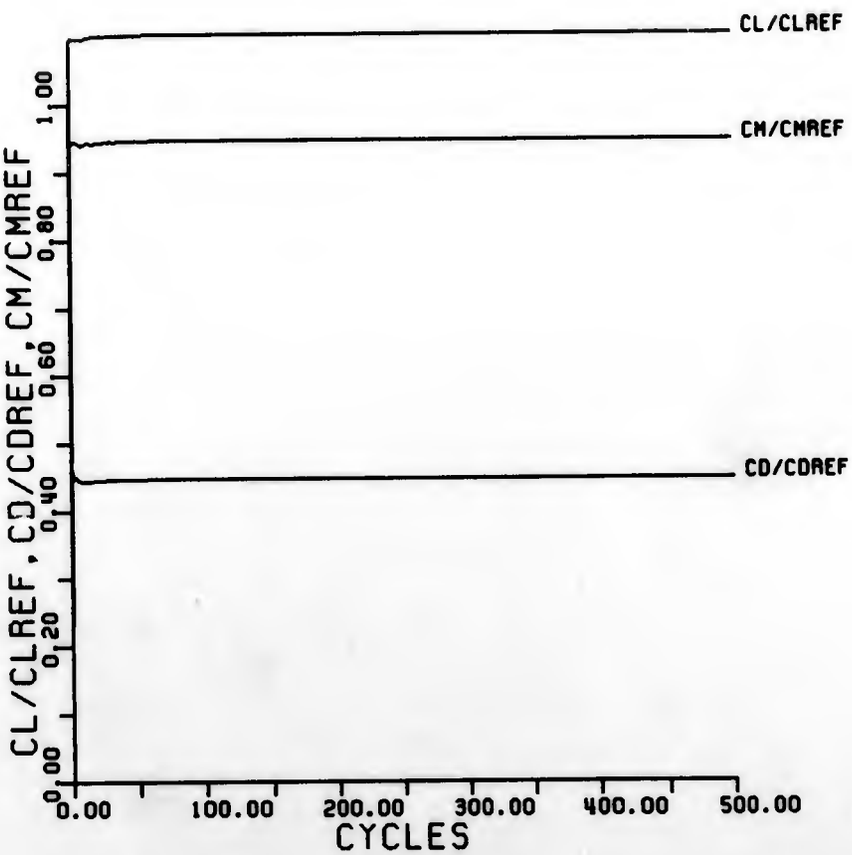


FIG. : CONVERGENCE BEHAVIOUR (CL,CD,CM)/REF

RAE 2822 M=0.750,ALPHA=3.0

REF-VALUES:CLREF=1.0,CDREF=0.10,CMREF=-0.20

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-13
	RAE 2822: MACH = 0.75, ALPHA = 3			

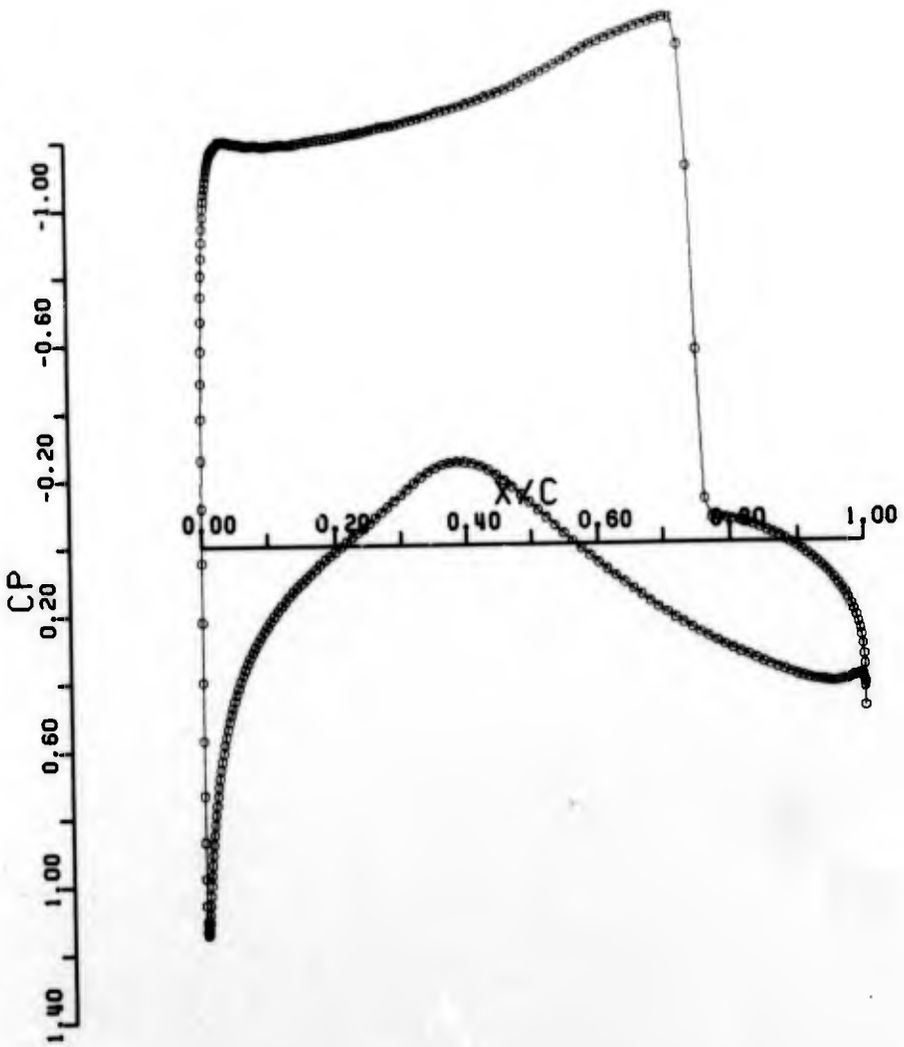


FIG. : CP (X/C) ON RAE 2822

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-14
	RAE 2822: MACH = 0.75, ALPHA = 3			

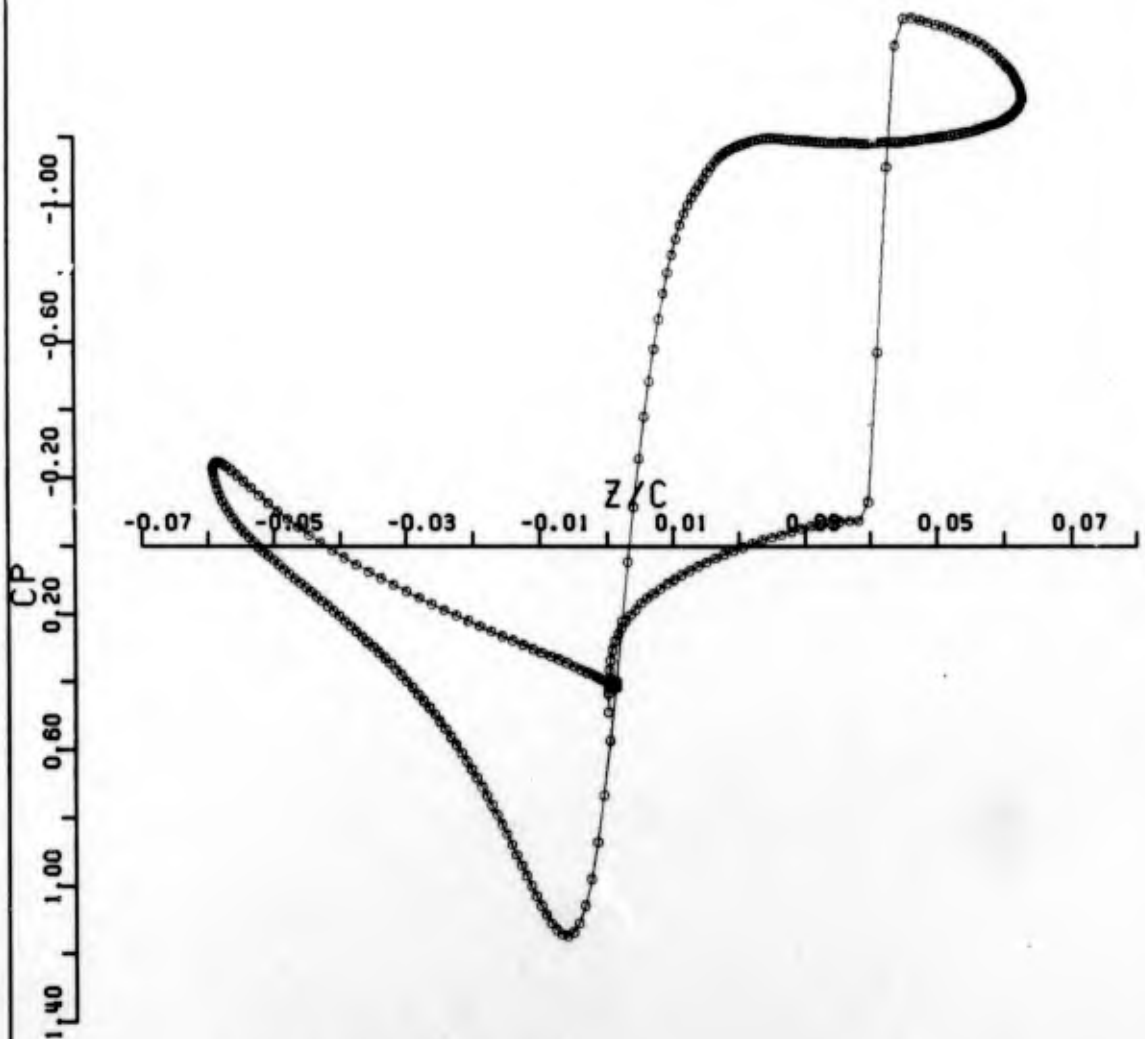


FIG. : CP(Z/C) ON RAE 2822

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-15
	RAE 2822: MACH = 0.75, ALPHA = 3			

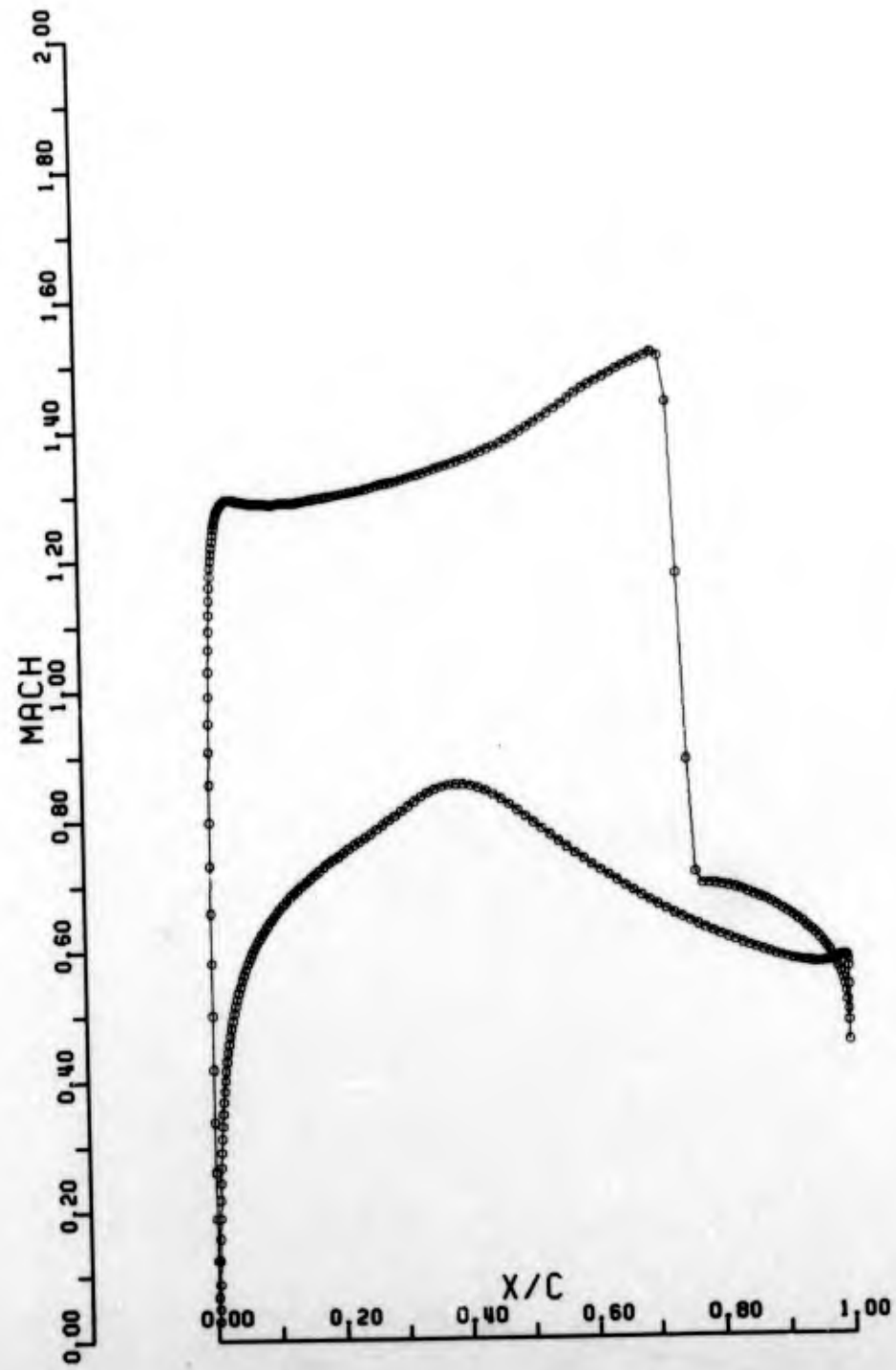


FIG. : MACH(X/C) ON RAE 2822

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-16
	RAE 2822: MACH = 0.75, ALPHA = 3			

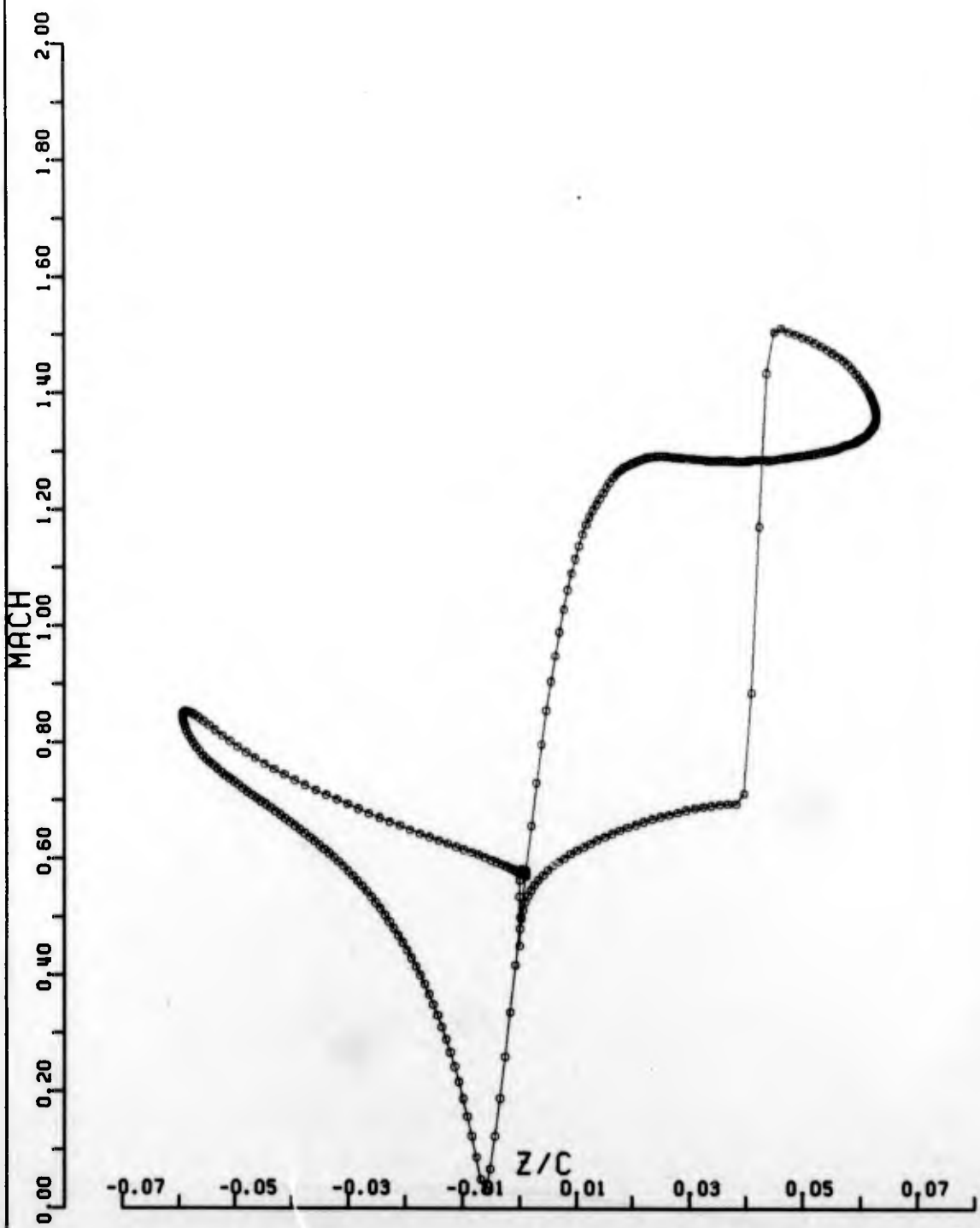


FIG. : MACH(Z/C) ON RAE 2822

DOKNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-17
	RAE 2822: MACH = 0.75, ALPHA = 3			

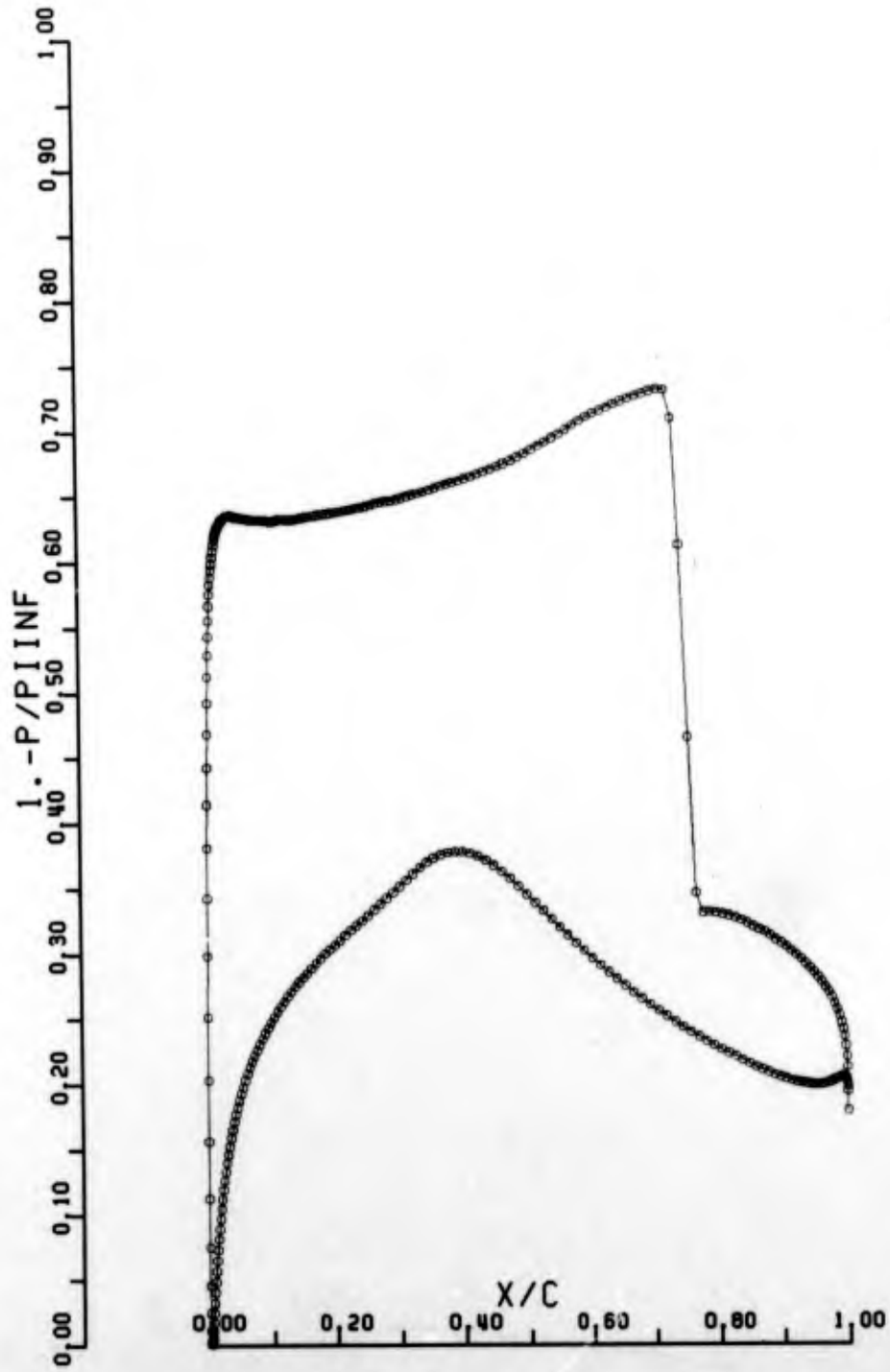


FIG. : 1.-P/PIINF VS. X/C ON RAE 2822

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-18
	RAE 2822: MACH = 0.75, ALPHA = 3			

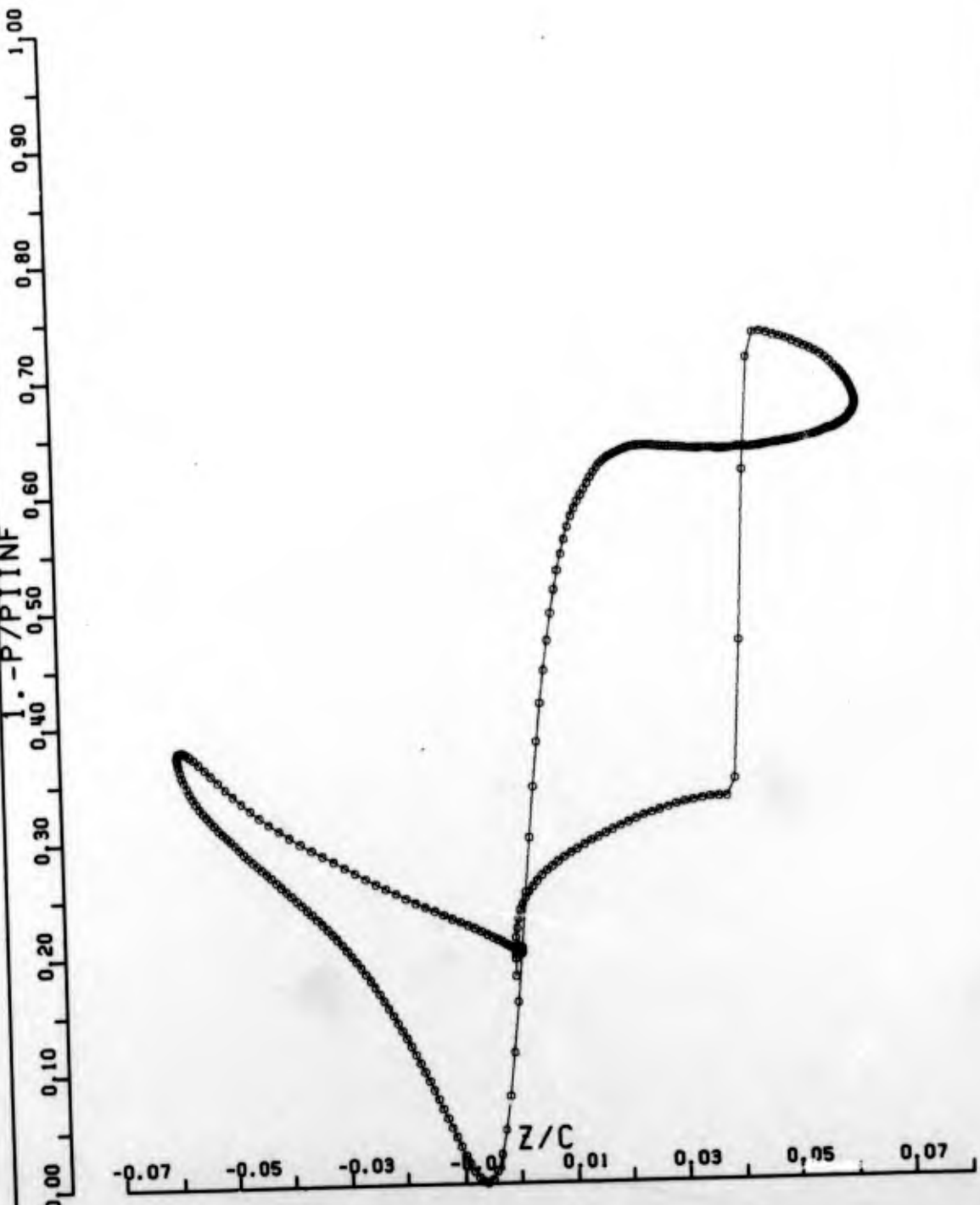


FIG. : 1.-P/PIINF VS. Z/C ON RAE 2822

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-19
	RAE 2822: MACH = 0.75, ALPHA = 3			

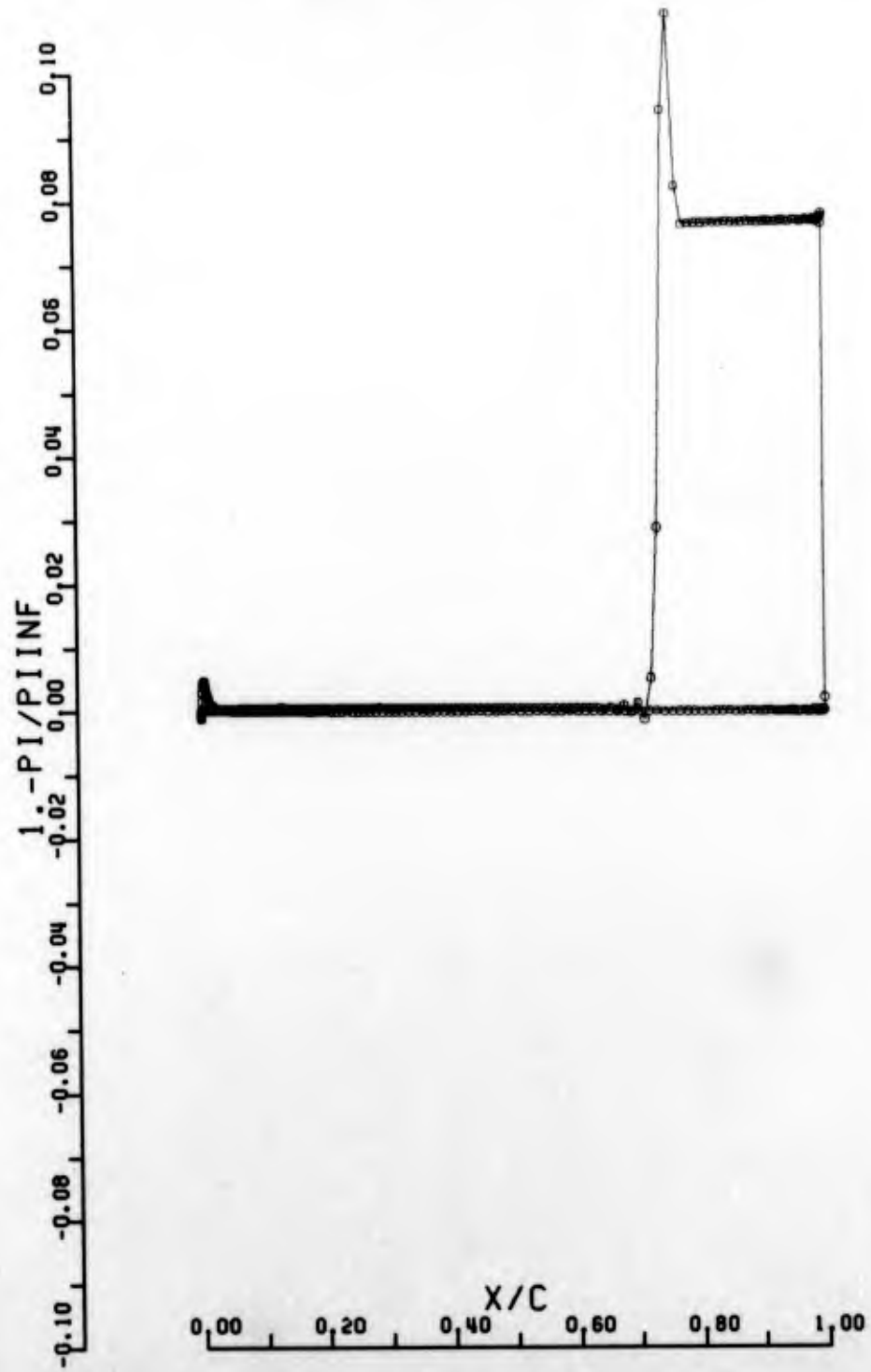


FIG. : 1.-PI/PIINF VS. X/C ON RAE 2822

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-20
	RAE 2822: MACH = 0.75, ALPHA = 3			

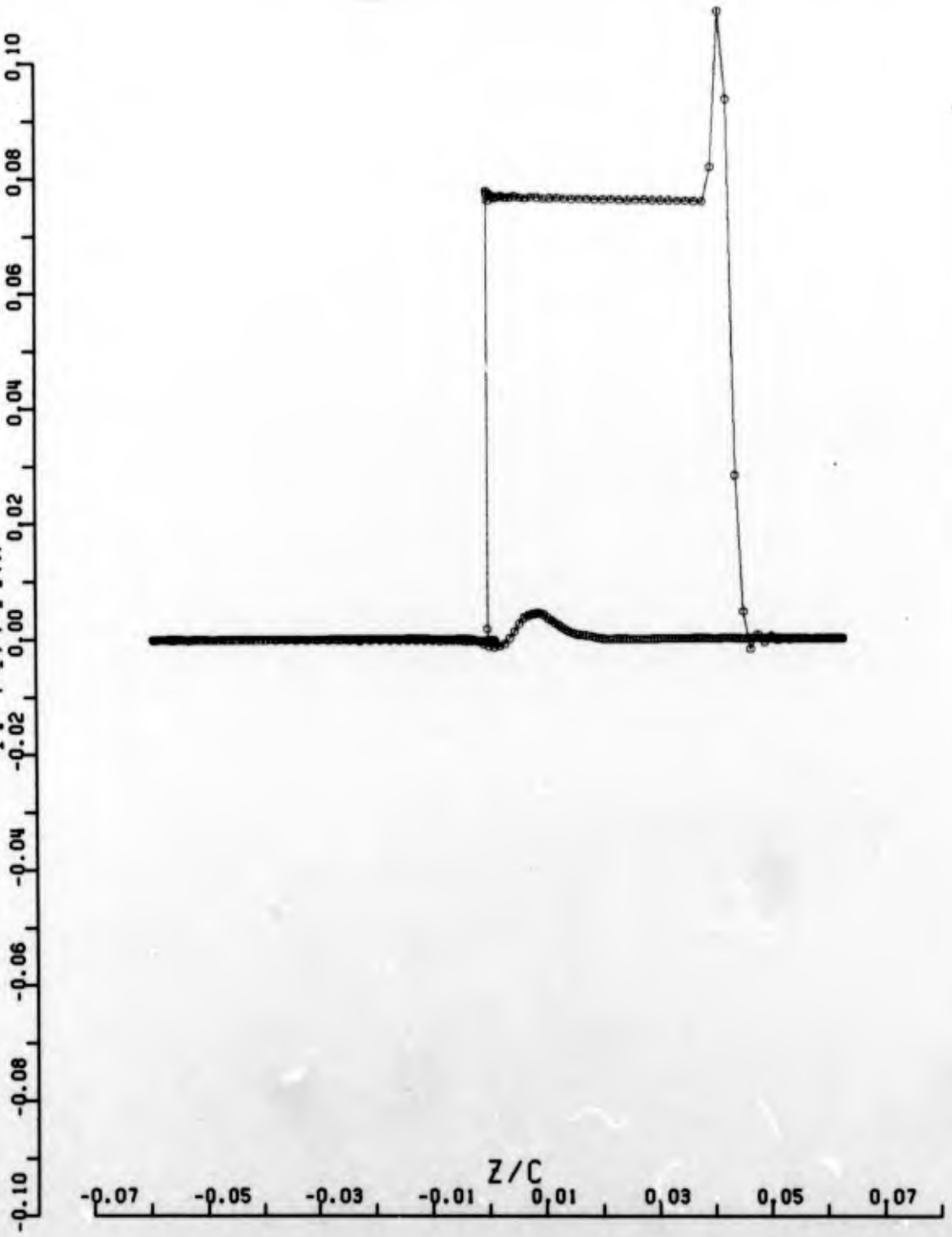
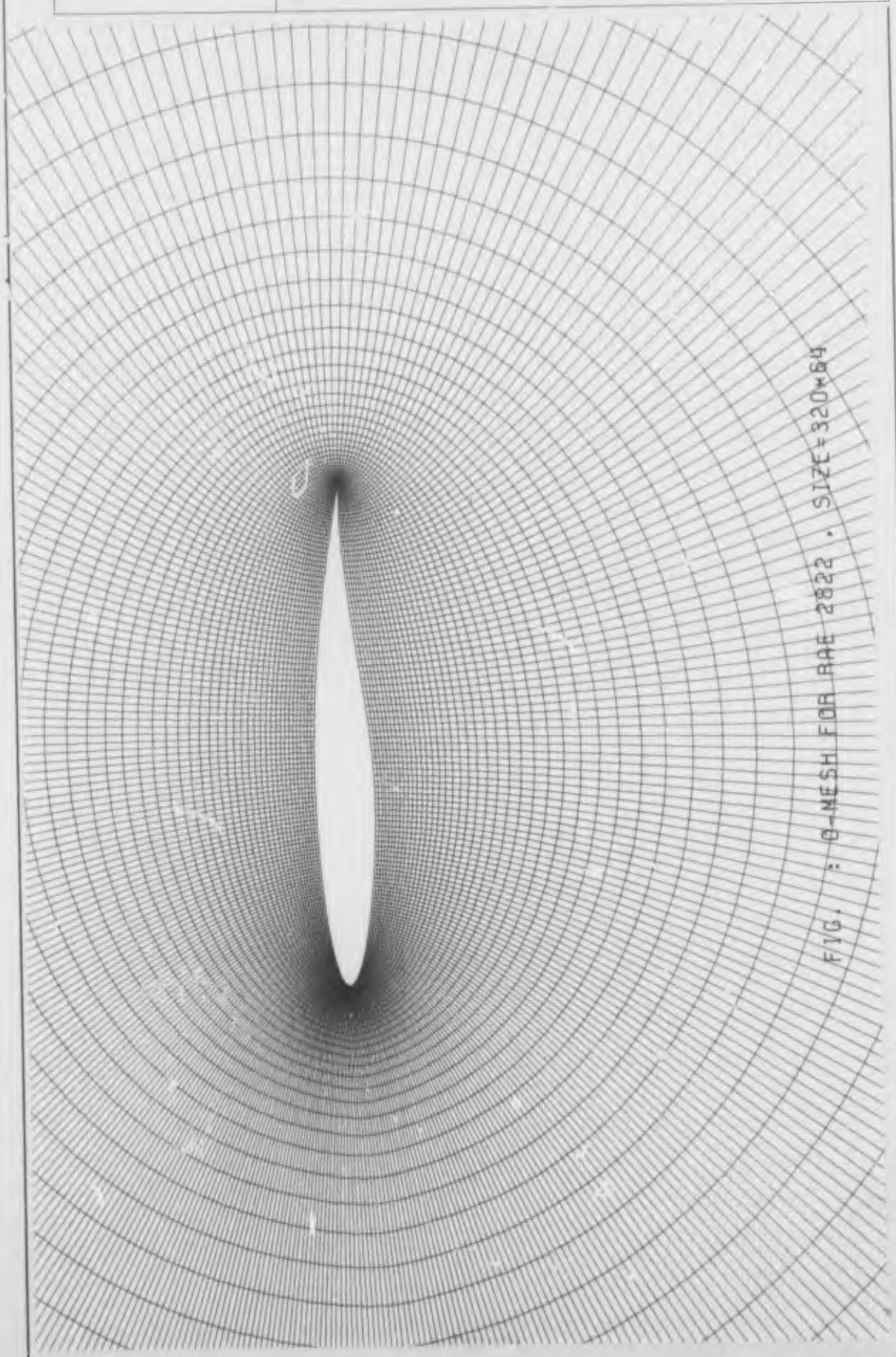
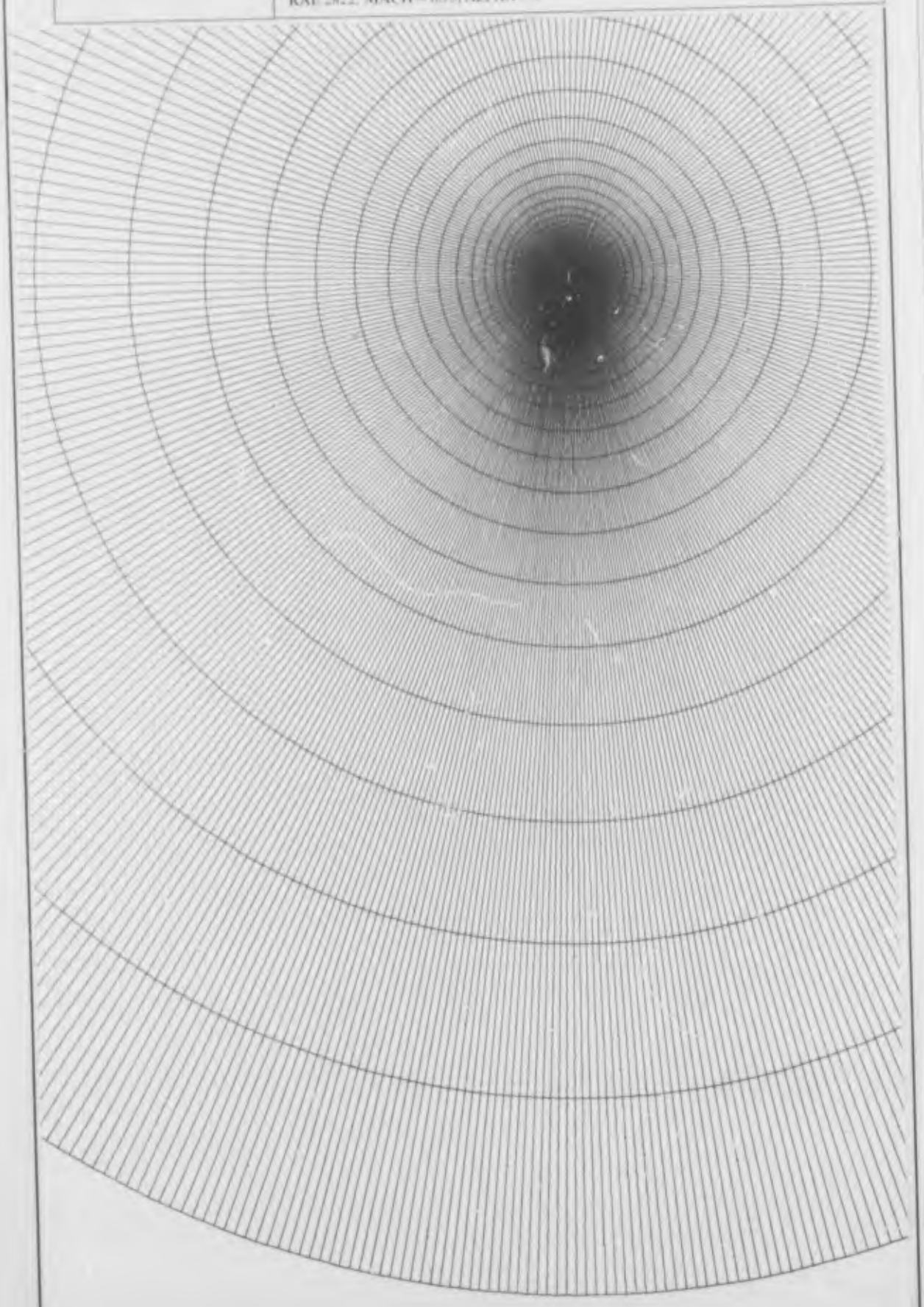


FIG. : 1.-PI/PIINF VS. Z/C ON RAE 2822

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-21
	RAE 2822: MACH = 0.75, ALPHA = 3			



DORNIER/JAMESON	AR 211		W Schmidt A Jameson	06-9-22
	RAE 2822: MACH = 0.75, ALPHA = 3			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-23
	RAE 2822: MACH = 0.75, ALPHA = 3			

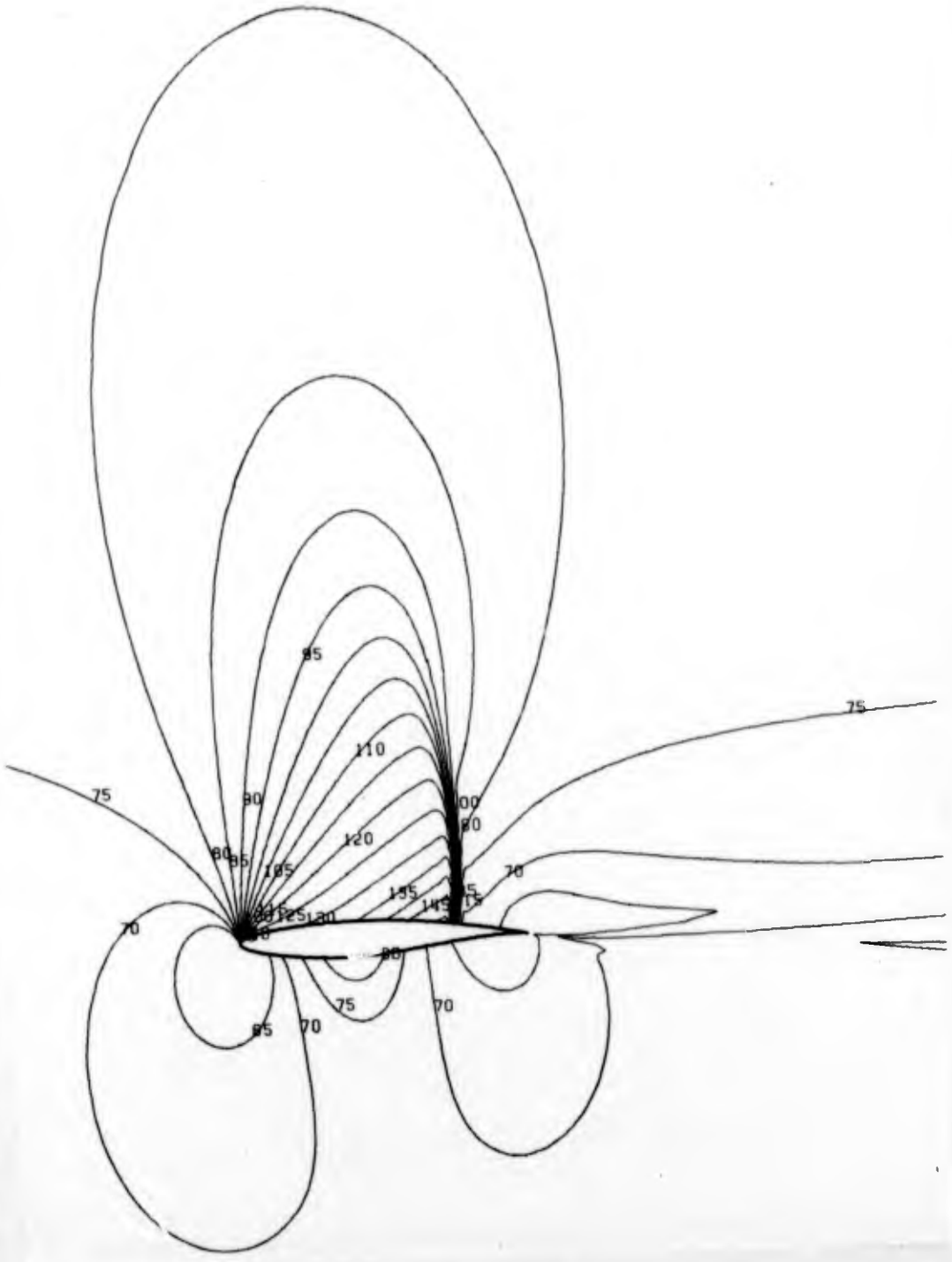


FIG. : ISO-MACH (DELTA = 0.050)

**** VALUES OF CURVE PARAMETER = 100*MACH ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-24
	RAE 2822: MACH = 0.75, ALPHA = 3			

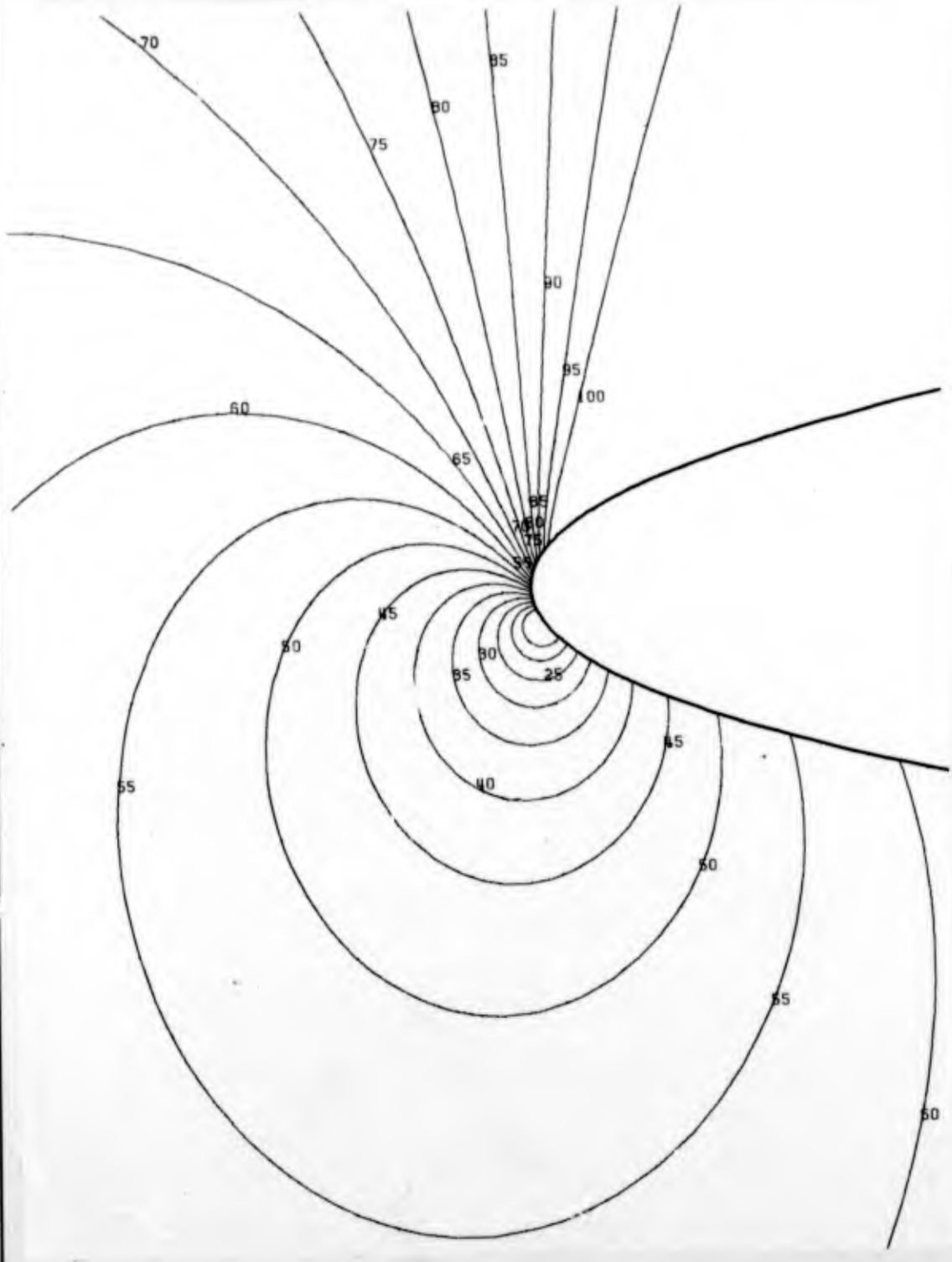


FIG. : ISO-MACH (DELTA = 0.050)

*** VALUES OF CURVE PARAMETER = 100*MACH ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-25
	RAE 2822: MACH = 0.75, ALPHA = 3			

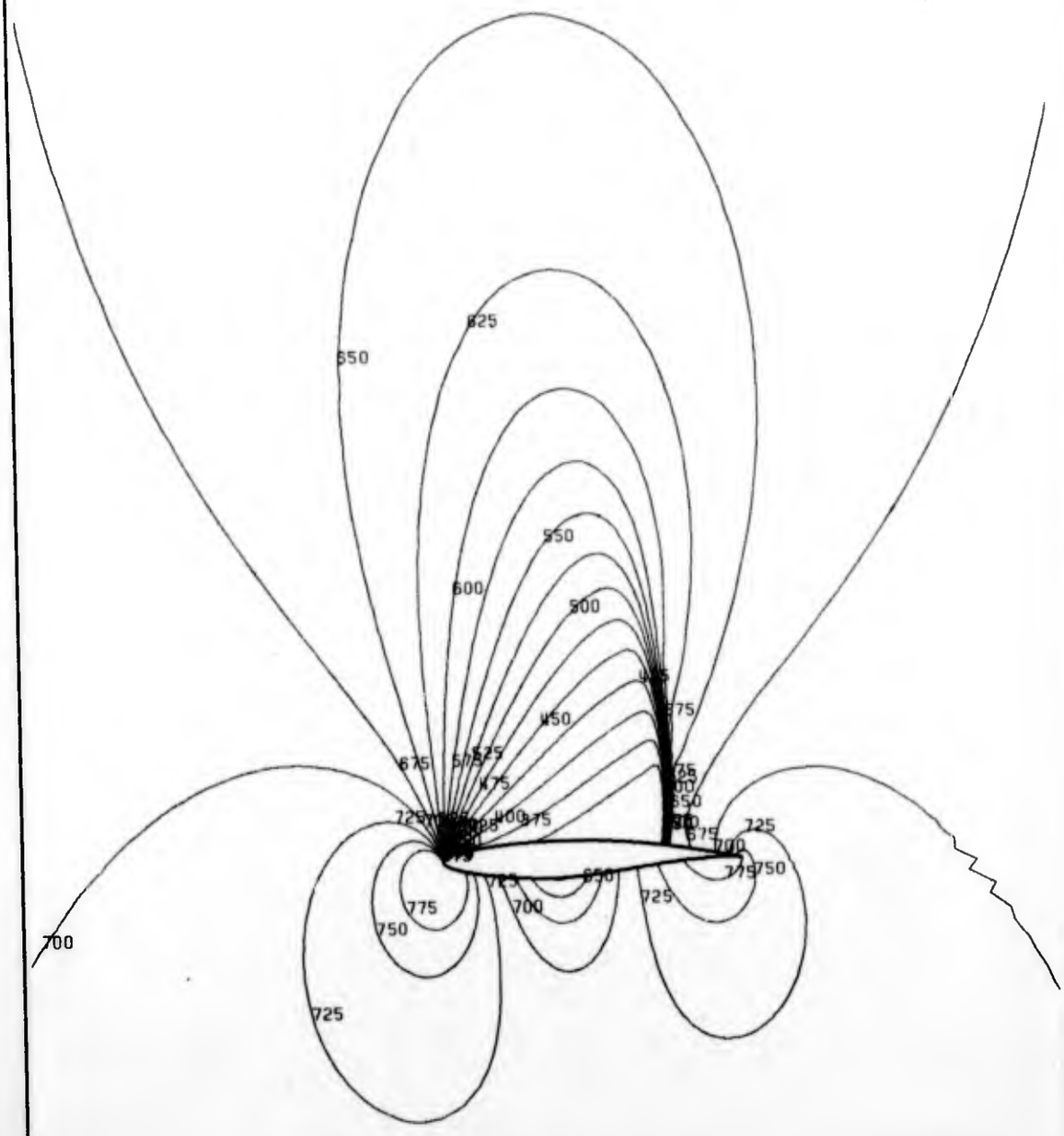


FIG. : ISO-P/PIINF (DELTA = 0.025)

*** VALUES OF CURVE PARAMETER = 1000*P/PIINF ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-26
	RAE 2822: MACH = 0.75, ALPHA = 3			

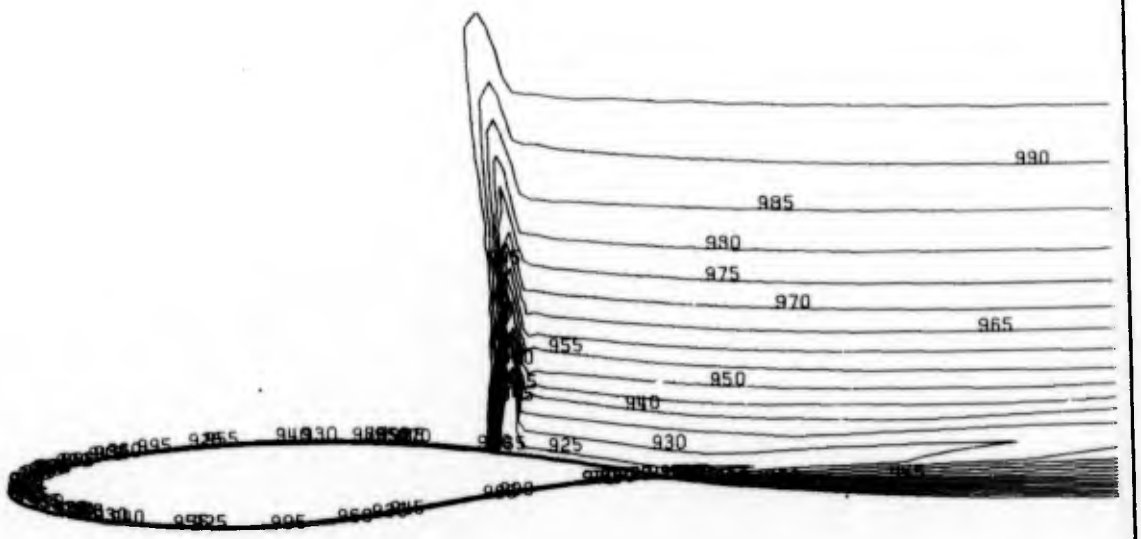


FIG. : ISO-PI/PIINF (DELTA = 0.0050)

*** VALUES OF CURVE PARAMETER = 1000*PI/PIINF ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	06-9-27
	RAE 2822: MACH = 0.75, ALPHA = 3			

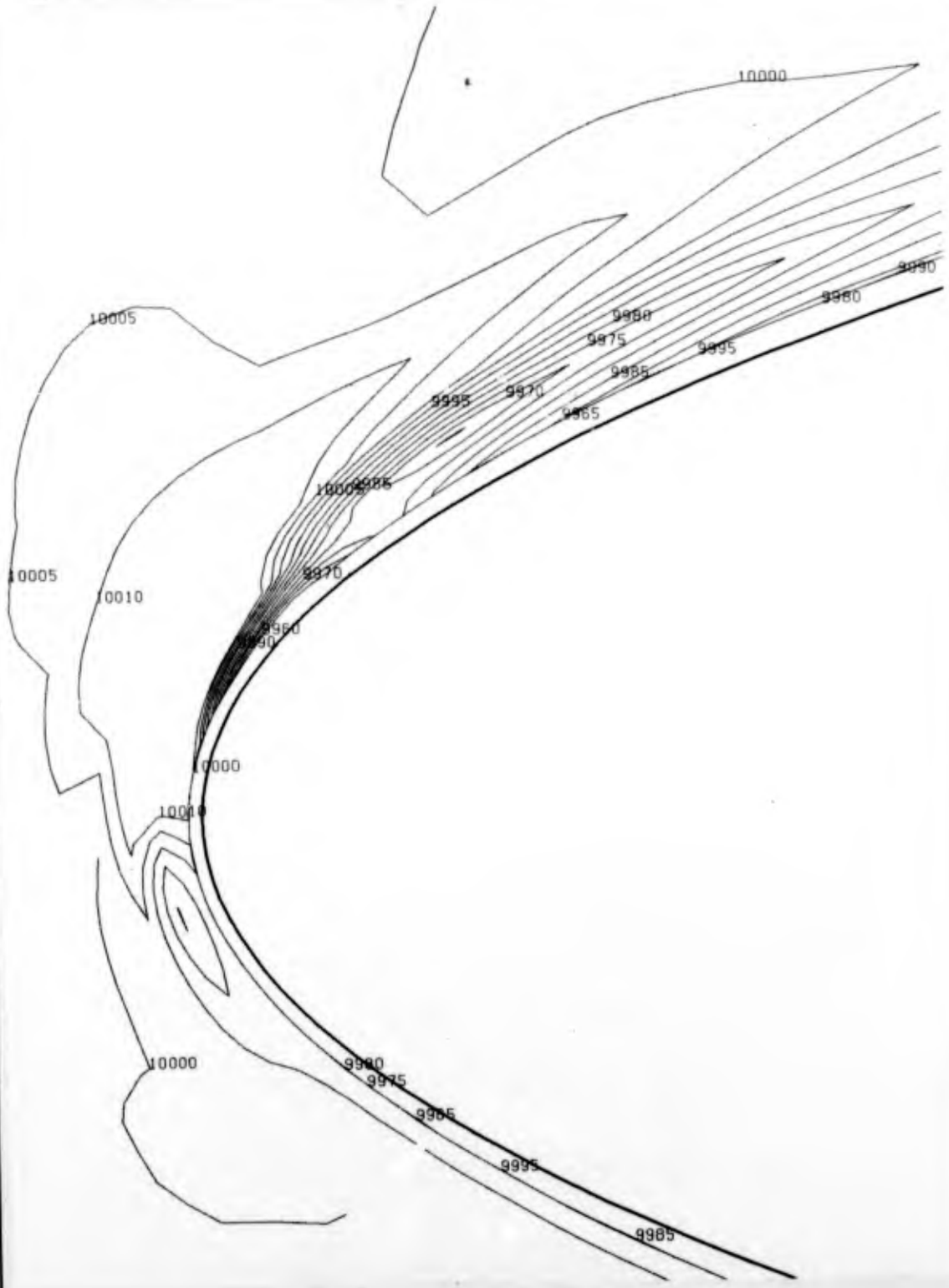


FIG. : ISO-PI/PIINF (DELTA = 0.0005)

**** VALUES OF CURVE PARAMETER = 10000*PI/PIINF ****

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 07

NLR 7301: MACH = 0.720957, ALPHA = −0.194

Contributor No 1

J.P.Veuillot and A.M.Vuillot

(O.N.E.R.A., France)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-1
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

COMMENTS ON CALCULATION FOR TEST CASE 07

* The computational domain is inscribed in the rectangle

  $-\ 3.94 \leq x/c \leq 6.86\ ,\ -\ 5.91 \leq z/c \leq 5.91$

* Number of mesh points : 251 x 35 = 8 785 (195 mesh points on the profile)

* Artificial viscosity ;

  D_1 term : $Q_{1i} = Q_{1j} = 0.5\ 10^{-2}$

  D_2 term : $Q_{2i} = 0.4\ ,\ Q_{2j} = 0.2$

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-2
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

WALL VALUES - UPPER SIDE

N	X/C	Z/C	1-P/P1INF	CP	MACH	1-P1/P1INF
1	-0.000008	0.000000	0.001019	1.132844	0.007928	0.000975
2	0.000003	0.001873	0.003147	1.124577	0.043560	0.001822
3	0.000104	0.003758	0.006121	1.113024	0.076622	0.002030
4	0.000296	0.005664	0.010377	1.096489	0.108361	0.002219
5	0.000583	0.007599	0.015280	1.077441	0.140016	0.001700
6	0.000881	0.009595	0.022394	1.049806	0.173910	0.001540
7	0.001272	0.011650	0.032059	1.012255	0.209287	0.002055
8	0.001743	0.013784	0.042649	0.971115	0.245621	0.001606
9	0.002307	0.016008	0.056455	0.917480	0.285513	0.001508
10	0.002979	0.018334	0.073645	0.850699	0.328523	0.001751
11	0.003802	0.020761	0.093594	0.773200	0.373524	0.001940
12	0.004785	0.023298	0.116379	0.684684	0.421302	0.001633
13	0.005952	0.025947	0.143940	0.577612	0.474048	0.001541
14	0.007331	0.028708	0.176543	0.450952	0.532044	0.001499
15	0.008959	0.031567	0.215063	0.301305	0.597116	0.001066
16	0.010866	0.034514	0.261710	0.120086	0.672234	0.000578
17	0.013113	0.037507	0.316301	-0.091993	0.756967	0.000503
18	0.015748	0.040504	0.378035	-0.331822	0.854094	-0.001782
19	0.018814	0.043454	0.449469	-0.609338	0.966829	-0.002992
20	0.022401	0.046247	0.518596	-0.877888	1.081810	-0.005056
21	0.026509	0.048844	0.572887	-1.088805	1.173597	-0.000884
22	0.031164	0.051168	0.593746	-1.169838	1.209291	0.002811
23	0.036196	0.053392	0.592592	-1.165356	1.206651	0.003430
24	0.041607	0.055506	0.595193	-1.175460	1.211197	0.003878
25	0.047395	0.057509	0.602056	-1.202123	1.224774	0.003127
26	0.053567	0.059380	0.610361	-1.234386	1.240707	0.003128
27	0.060111	0.061134	0.617650	-1.262703	1.254936	0.003058
28	0.067021	0.062775	0.622747	-1.282506	1.264562	0.003591
29	0.074288	0.064323	0.623539	-1.285581	1.265971	0.003800
30	0.081893	0.065816	0.621584	-1.277987	1.262131	0.003770
31	0.089839	0.067256	0.618288	-1.265182	1.255313	0.004220
32	0.098119	0.068659	0.614863	-1.251875	1.249310	0.003302
33	0.106735	0.070025	0.613508	-1.246611	1.246562	0.003450
34	0.115700	0.071311	0.610038	-1.233130	1.239538	0.003848
35	0.124988	0.072588	0.605239	-1.214487	1.230640	0.003408
36	0.134612	0.073814	0.601524	-1.200056	1.223372	0.003638
37	0.144564	0.075005	0.597431	-1.184155	1.215763	0.003432
38	0.154843	0.076155	0.594000	-1.170823	1.209316	0.003401
39	0.165448	0.077257	0.590799	-1.158390	1.203337	0.003370
40	0.176375	0.078313	0.587610	-1.146001	1.197392	0.003363
41	0.187624	0.079320	0.584446	-1.133708	1.191531	0.003344
42	0.199190	0.080280	0.581463	-1.122121	1.186068	0.003282
43	0.211073	0.081187	0.578736	-1.111526	1.181059	0.003269
44	0.223272	0.082040	0.576112	-1.101331	1.176272	0.003242
45	0.235784	0.082836	0.573598	-1.091566	1.171698	0.003222
46	0.248607	0.083573	0.571172	-1.082142	1.167297	0.003207
47	0.261739	0.084248	0.568820	-1.073003	1.163047	0.003189
48	0.275178	0.084859	0.566553	-1.064197	1.158959	0.003179
49	0.288918	0.085402	0.564373	-1.055729	1.155046	0.003164
50	0.302957	0.085875	0.562303	-1.047686	1.151339	0.003149
51	0.317286	0.086273	0.560319	-1.039979	1.147790	0.003145
52	0.331898	0.086594	0.558383	-1.032459	1.144330	0.003149
53	0.346786	0.086834	0.556524	-1.025236	1.141007	0.003162
54	0.361937	0.086991	0.554858	-1.018763	1.138073	0.003129
55	0.377342	0.087060	0.553501	-1.013493	1.135661	0.003136
56	0.392988	0.087035	0.552333	-1.008955	1.133590	0.003139
57	0.408861	0.086915	0.551352	-1.005141	1.131850	0.003144
58	0.424948	0.086694	0.550581	-1.002145	1.130478	0.003157
59	0.441235	0.086370	0.550066	-1.000145	1.129571	0.003154
60	0.457707	0.085936	0.549892	-0.999469	1.129265	0.003154
61	0.474351	0.085387	0.550040	-1.000044	1.129520	0.003161
62	0.491153	0.084716	0.550424	-1.001538	1.130214	0.003142
63	0.508099	0.083918	0.550910	-1.003425	1.131000	0.003232
64	0.525176	0.082980	0.551525	-1.005816	1.131895	0.003474
65	0.542370	0.081897	0.553607	-1.013904	1.135705	0.003317
66	0.559670	0.080655	0.559245	-1.035805	1.146404	0.002468
67	0.577057	0.079236	0.565617	-1.060559	1.159071	0.000882
68	0.594503	0.077630	0.559525	-1.036895	1.146714	0.002710
69	0.611985	0.075812	0.528058	-0.914646	1.086875	0.008546
70	0.629492	0.073778	0.481756	-0.734769	1.008971	0.008649
71	0.647023	0.071513	0.447615	-0.602136	0.957439	0.004314
72	0.664573	0.069026	0.436793	-0.560094	0.941609	0.002747
73	0.682127	0.066322	0.434973	-0.553020	0.937710	0.003874
74	0.699643	0.063430	0.427331	-0.523334	0.924639	0.004958
75	0.717070	0.060368	0.413370	-0.469095	0.902577	0.005051

AL-VEUILLOT

WALL VALUES - UPPER SIDE (Cont.)

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
76	0.734361	0.057166	0.398356	-0.410767	0.879417	0.004712
77	0.751470	0.053848	0.384796	-0.358088	0.858422	0.004614
78	0.768351	0.050446	0.372105	-0.308785	0.838703	0.004671
79	0.784952	0.046991	0.359719	-0.260669	0.819557	0.004676
80	0.801220	0.043518	0.347804	-0.214381	0.801194	0.004652
81	0.817100	0.040055	0.336499	-0.170462	0.783777	0.004635
82	0.832537	0.036636	0.325806	-0.128920	0.767295	0.004620
83	0.847477	0.033287	0.315722	-0.089745	0.751734	0.004608
84	0.861871	0.030037	0.306245	-0.052926	0.737092	0.004590
85	0.875673	0.026906	0.297354	-0.018385	0.723310	0.004587
86	0.888843	0.023915	0.288963	0.014212	0.710268	0.004585
87	0.901354	0.021077	0.281055	0.044934	0.697949	0.004572
88	0.913186	0.018406	0.273661	0.073660	0.686370	0.004579
89	0.924333	0.015905	0.266755	0.100488	0.675588	0.004523
90	0.934804	0.013579	0.260327	0.125460	0.665351	0.004611
91	0.944619	0.011408	0.253706	0.151182	0.654839	0.004635
92	0.953818	0.009405	0.247222	0.176372	0.644668	0.004516
93	0.962455	0.007555	0.241447	0.198806	0.635344	0.004595
94	0.970596	0.005842	0.235588	0.221567	0.625852	0.004664
95	0.978324	0.004249	0.229607	0.244804	0.616176	0.004680
96	0.985730	0.002760	0.223299	0.269311	0.605545	0.004984
97	0.992917	0.001352	0.214201	0.304653	0.589325	0.005996
98	0.999992	0.000000	0.200787	0.356765	0.572565	0.001854

SLIP LINE VALUES - UPPER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
99	1.007062	-0.000896	0.206198	0.335745	0.580204	0.002866
100	1.014230	-0.001720	0.215862	0.298202	0.593175	0.005137
101	1.021624	-0.002508	0.219399	0.284461	0.599662	0.004604
102	1.029549	-0.003302	0.223611	0.268099	0.606473	0.004653
103	1.038678	-0.004161	0.227395	0.253396	0.612716	0.004581
104	1.049970	-0.005156	0.231417	0.237772	0.619263	0.004553
105	1.064416	-0.006340	0.235755	0.220920	0.626284	0.004531
106	1.083002	-0.007749	0.240414	0.202821	0.633788	0.004514
107	1.106859	-0.009410	0.245342	0.183673	0.641694	0.004496
108	1.137370	-0.011349	0.250456	0.163806	0.649863	0.004479
109	1.176200	-0.013587	0.255648	0.143637	0.658123	0.004463
110	1.225348	-0.016142	0.260791	0.123657	0.666272	0.004451
111	1.287167	-0.019024	0.265751	0.104387	0.674101	0.004444
112	1.364408	-0.022238	0.270401	0.086323	0.681412	0.004443
113	1.460270	-0.025784	0.274634	0.069880	0.688048	0.004445
114	1.578486	-0.029652	0.278374	0.055348	0.693900	0.004447
115	1.723365	-0.033828	0.281584	0.042880	0.698924	0.004440
116	1.899811	-0.038291	0.284261	0.032477	0.703128	0.004417
117	2.113348	-0.043012	0.286436	0.024028	0.706557	0.004383
118	2.370136	-0.047952	0.288150	0.017369	0.709285	0.004330
119	2.676989	-0.053068	0.289467	0.012255	0.711416	0.004257
120	3.041376	-0.058319	0.290456	0.008410	0.713057	0.004165
121	3.471425	-0.063665	0.291184	0.005583	0.714304	0.004061
122	3.975919	-0.069084	0.291705	0.003561	0.715237	0.003949
123	4.564269	-0.074579	0.292066	0.002156	0.715933	0.003828
124	5.246042	-0.080217	0.292313	0.001199	0.716473	0.003686
125	6.019165	-0.086075	0.292486	0.000525	0.716909	0.003534
126	6.862138	-0.092285	0.292621	0.000002	0.717189	0.003470

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-4
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

WALL VALUES - LOWER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	-0.000008	0.000000	0.001019	1.132844	0.007928	0.000975
2	-0.000004	-0.001873	0.001811	1.129769	0.029993	0.001182
3	0.000068	-0.003761	0.004554	1.119111	0.068465	0.001284
4	0.000232	-0.005673	0.009448	1.100100	0.108243	0.001300
5	0.000490	-0.007617	0.016626	1.072211	0.150375	0.000973
6	0.000835	-0.009606	0.027371	1.030468	0.196349	0.000869
7	0.001309	-0.011640	0.042445	0.971908	0.245611	0.001397
8	0.001946	-0.013715	0.060692	0.901021	0.295619	0.001965
9	0.002770	-0.015826	0.080818	0.822834	0.345220	0.001824
10	0.003771	-0.017981	0.103826	0.733448	0.396933	0.001034
11	0.004957	-0.020183	0.132472	0.622163	0.453587	0.000972
12	0.006369	-0.022414	0.164981	0.495870	0.512110	0.001373
13	0.008043	-0.024657	0.197970	0.367711	0.568893	0.001091
14	0.009990	-0.026901	0.231875	0.235995	0.625392	0.000202
15	0.012228	-0.029132	0.266650	0.100897	0.680178	0.000400
16	0.014797	-0.031314	0.296062	-0.013368	0.725871	0.000410
17	0.017685	-0.033448	0.319757	-0.105418	0.763018	-0.000201
18	0.020896	-0.035528	0.340714	-0.186835	0.795164	-0.000173
19	0.024430	-0.037550	0.357692	-0.252795	0.821160	-0.000097
20	0.028291	-0.039513	0.370751	-0.303525	0.841138	0.000018
21	0.032478	-0.041421	0.380772	-0.342455	0.856558	0.000055
22	0.036994	-0.043280	0.389102	-0.374819	0.869460	0.000032
23	0.041843	-0.045093	0.396413	-0.403219	0.880699	0.000131
24	0.047033	-0.046858	0.402433	-0.426608	0.890085	0.000098
25	0.052570	-0.048580	0.407480	-0.446215	0.897950	0.000092
26	0.058463	-0.050249	0.410934	-0.459632	0.903237	0.000202
27	0.064715	-0.051868	0.412216	-0.464614	0.905172	0.000277
28	0.071330	-0.053438	0.412125	-0.464261	0.905058	0.000247
29	0.078303	-0.054969	0.411974	-0.463674	0.904948	0.000109
30	0.085638	-0.056460	0.412345	-0.465113	0.905512	0.000125
31	0.093334	-0.057911	0.412738	-0.466640	0.906159	0.000089
32	0.101390	-0.059322	0.413102	-0.468057	0.906822	-0.000012
33	0.109805	-0.060688	0.413017	-0.467726	0.906575	0.000112
34	0.118577	-0.062005	0.411910	-0.463423	0.904738	0.000228
35	0.127697	-0.063290	0.411231	-0.460788	0.903975	-0.000094
36	0.137161	-0.064549	0.412796	-0.466865	0.906527	-0.000213
37	0.146969	-0.065762	0.415220	-0.476285	0.910205	-0.000089
38	0.157117	-0.066927	0.417094	-0.483563	0.913145	-0.000099
39	0.167603	-0.068038	0.418601	-0.489419	0.915528	-0.000123
40	0.178424	-0.069092	0.419897	-0.494453	0.917573	-0.000138
41	0.189575	-0.070085	0.421103	-0.499138	0.919479	-0.000154
42	0.201053	-0.071016	0.422352	-0.503990	0.921463	-0.000181
43	0.212857	-0.071880	0.423654	-0.509049	0.923492	-0.000163
44	0.224985	-0.072673	0.424865	-0.513752	0.925382	-0.000150
45	0.237432	-0.073391	0.425975	-0.518065	0.927107	-0.000127
46	0.250198	-0.074030	0.427013	-0.522099	0.928730	-0.000114
47	0.263279	-0.074586	0.428020	-0.526011	0.930290	-0.000087
48	0.276672	-0.075053	0.428951	-0.529627	0.931732	-0.000060
49	0.290373	-0.075427	0.429802	-0.532933	0.933045	-0.000028
50	0.304375	-0.075701	0.430581	-0.535959	0.934241	0.000007
51	0.318674	-0.075871	0.431360	-0.538985	0.935459	0.000019
52	0.333261	-0.075929	0.432223	-0.542338	0.936787	0.000057
53	0.348126	-0.075867	0.433149	-0.545935	0.938224	0.000085
54	0.363261	-0.075676	0.434174	-0.549917	0.939862	0.000064
55	0.378653	-0.075343	0.435225	-0.554001	0.941454	0.000143
56	0.394291	-0.074849	0.435913	-0.556672	0.942580	0.000100
57	0.410162	-0.074184	0.436143	-0.557567	0.942936	0.000109
58	0.426254	-0.073312	0.435222	-0.553987	0.941411	0.000185
59	0.442552	-0.072222	0.432566	-0.543670	0.937309	0.000079
60	0.459042	-0.070880	0.427786	-0.525102	0.929694	0.000166
61	0.475711	-0.069253	0.419561	-0.493147	0.916610	0.000340
62	0.492544	-0.067327	0.407456	-0.446121	0.897268	0.000790
63	0.509523	-0.065106	0.392347	-0.387423	0.873672	0.000895
64	0.526630	-0.062656	0.377178	-0.328496	0.850551	0.000534
65	0.543847	-0.059997	0.363851	-0.276720	0.830068	0.000477
66	0.561162	-0.057138	0.351381	-0.228275	0.810846	0.000523
67	0.578553	-0.054092	0.339092	-0.180534	0.791976	0.000515
68	0.595992	-0.050865	0.326767	-0.132652	0.773012	0.000546
69	0.613454	-0.047461	0.314010	-0.083092	0.753322	0.000617
70	0.630929	-0.043891	0.300596	-0.030982	0.732565	0.000695
71	0.648413	-0.040178	0.286706	0.022979	0.711060	0.000710
72	0.665904	-0.036363	0.272904	0.076600	0.689671	0.000643
73	0.683385	-0.032492	0.259714	0.127841	0.669082	0.000592
74	0.700819	-0.028611	0.247250	0.176264	0.649473	0.000547
75	0.718155	-0.024768	0.235501	0.221908	0.630816	0.000513

AC-VEUILLOT

WALL VALUES - LOWER SIDE (Cont.)

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
76	0.735348	-0.021003	0.224357	0.265200	0.612901	0.000519
77	0.752357	-0.017360	0.213735	0.306465	0.595675	0.000498
78	0.769136	-0.013894	0.203875	0.344771	0.579588	0.000415
79	0.785636	-0.010659	0.195096	0.378874	0.565099	0.000345
80	0.801807	-0.007691	0.187389	0.408817	0.552118	0.000370
81	0.817595	-0.005021	0.180593	0.435220	0.540775	0.000230
82	0.832947	-0.002687	0.175046	0.456768	0.531215	0.000268
83	0.847812	-0.000666	0.170145	0.475807	0.522656	0.000327
84	0.862138	0.001002	0.166002	0.491902	0.515720	0.000130
85	0.875882	0.002320	0.163407	0.501982	0.511140	0.000151
86	0.889005	0.003323	0.161567	0.509134	0.507813	0.000209
87	0.901476	0.004038	0.160104	0.514817	0.505180	0.000241
88	0.913275	0.004485	0.159211	0.518286	0.503792	0.000112
89	0.924397	0.004673	0.159497	0.517174	0.504342	0.000083
90	0.934848	0.004659	0.160548	0.513092	0.506064	0.000175
91	0.944649	0.004473	0.161774	0.508328	0.508170	0.000215
92	0.953838	0.004148	0.163384	0.502072	0.511243	0.000054
93	0.962466	0.003685	0.166046	0.491732	0.515777	0.000144
94	0.970602	0.003139	0.168958	0.480419	0.520646	0.000289
95	0.978327	0.002496	0.172056	0.468384	0.526348	0.000062
96	0.985731	0.001760	0.176846	0.449776	0.534912	-0.000159
97	0.992917	0.000927	0.184114	0.421539	0.548334	-0.000903
98	0.999992	0.000001	0.195491	0.377342	0.566628	-0.000303

SLIP LINE VALUES - LOWER SIDE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
99	1.007062	-0.000895	0.206198	0.335745	0.584314	-0.000268
100	1.014230	-0.001719	0.215862	0.298202	0.598373	0.001102
101	1.021624	-0.002508	0.219399	0.284461	0.605037	0.000389
102	1.029549	-0.003301	0.223611	0.268099	0.611885	0.000367
103	1.038678	-0.004160	0.227395	0.253396	0.618098	0.00028
104	1.049970	-0.005155	0.231417	0.237772	0.624604	0.000246
105	1.064417	-0.006339	0.235755	0.220920	0.631578	0.000221
106	1.083002	-0.007748	0.240414	0.202821	0.639032	0.000202
107	1.106859	-0.009410	0.245342	0.183673	0.646881	0.000186
108	1.137370	-0.011348	0.250456	0.163806	0.654991	0.000172
109	1.176200	-0.013586	0.255648	0.143637	0.663188	0.000164
110	1.225348	-0.016141	0.260791	0.123657	0.671269	0.000166
111	1.287167	-0.019023	0.265751	0.104387	0.679022	0.000183
112	1.364408	-0.022237	0.270401	0.086323	0.686249	0.000218
113	1.460270	-0.025783	0.274634	0.069880	0.692789	0.000271
114	1.578486	-0.029651	0.278374	0.055348	0.698531	0.000343
115	1.723365	-0.033827	0.281584	0.042880	0.703420	0.000431
116	1.899811	-0.038290	0.284261	0.032177	0.707462	0.000534
117	2.113348	-0.043011	0.286436	0.024028	0.710707	0.000651
118	2.370136	-0.047950	0.288150	0.017369	0.713236	0.000767
119	2.676989	-0.053066	0.289467	0.012255	0.715159	0.000874
120	3.041376	-0.058317	0.290456	0.008410	0.716589	0.000967
121	3.471425	-0.063663	0.291184	0.005583	0.717630	0.001045
122	3.975919	-0.069081	0.291705	0.003561	0.718372	0.001104
123	4.564269	-0.074576	0.292066	0.002156	0.718887	0.001145
124	5.246042	-0.080213	0.292313	0.001199	0.719222	0.001187
125	6.019165	-0.086071	0.292486	0.000525	0.719438	0.001235
126	6.862138	-0.092280	0.292621	0.000002	0.719693	0.001193

AL-VEUILLOT

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-6
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

UPPER SURFACE

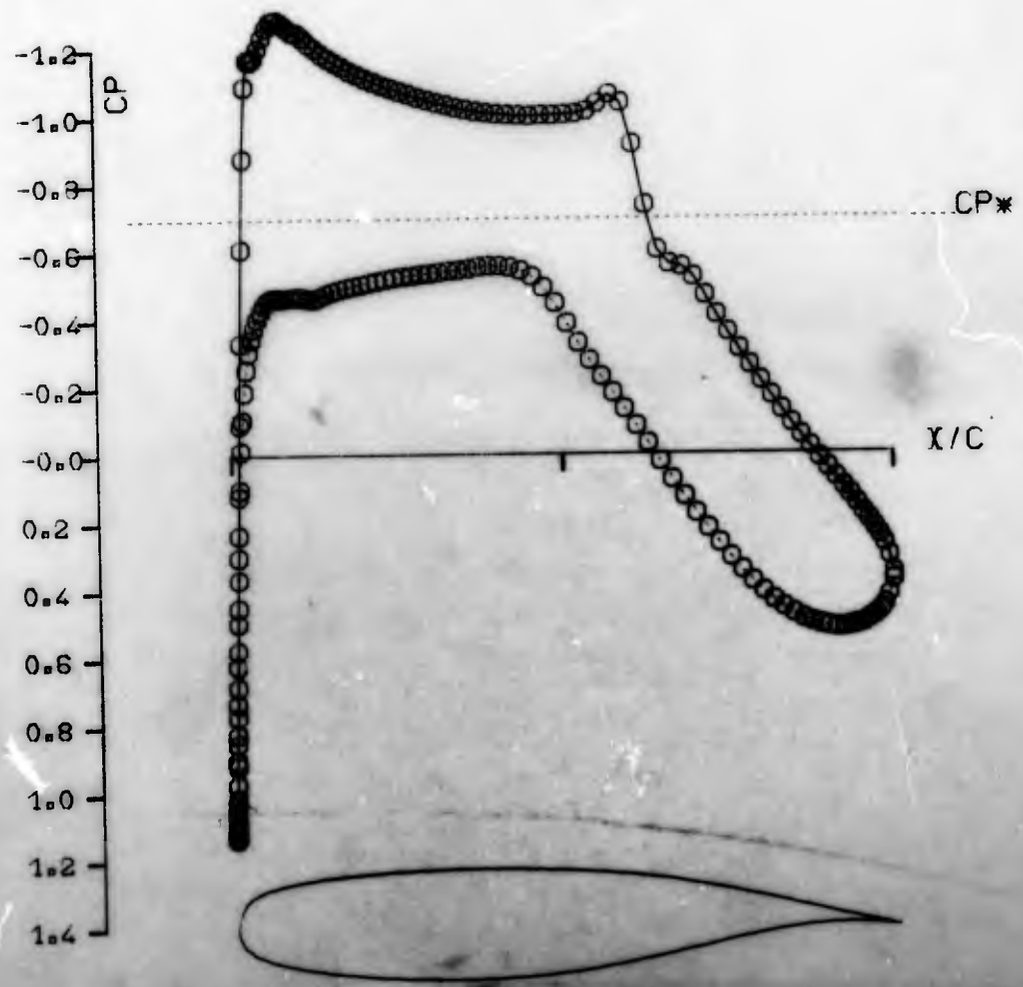
LOWER SURFACE

CL= 0.5878

CD= 0.0016

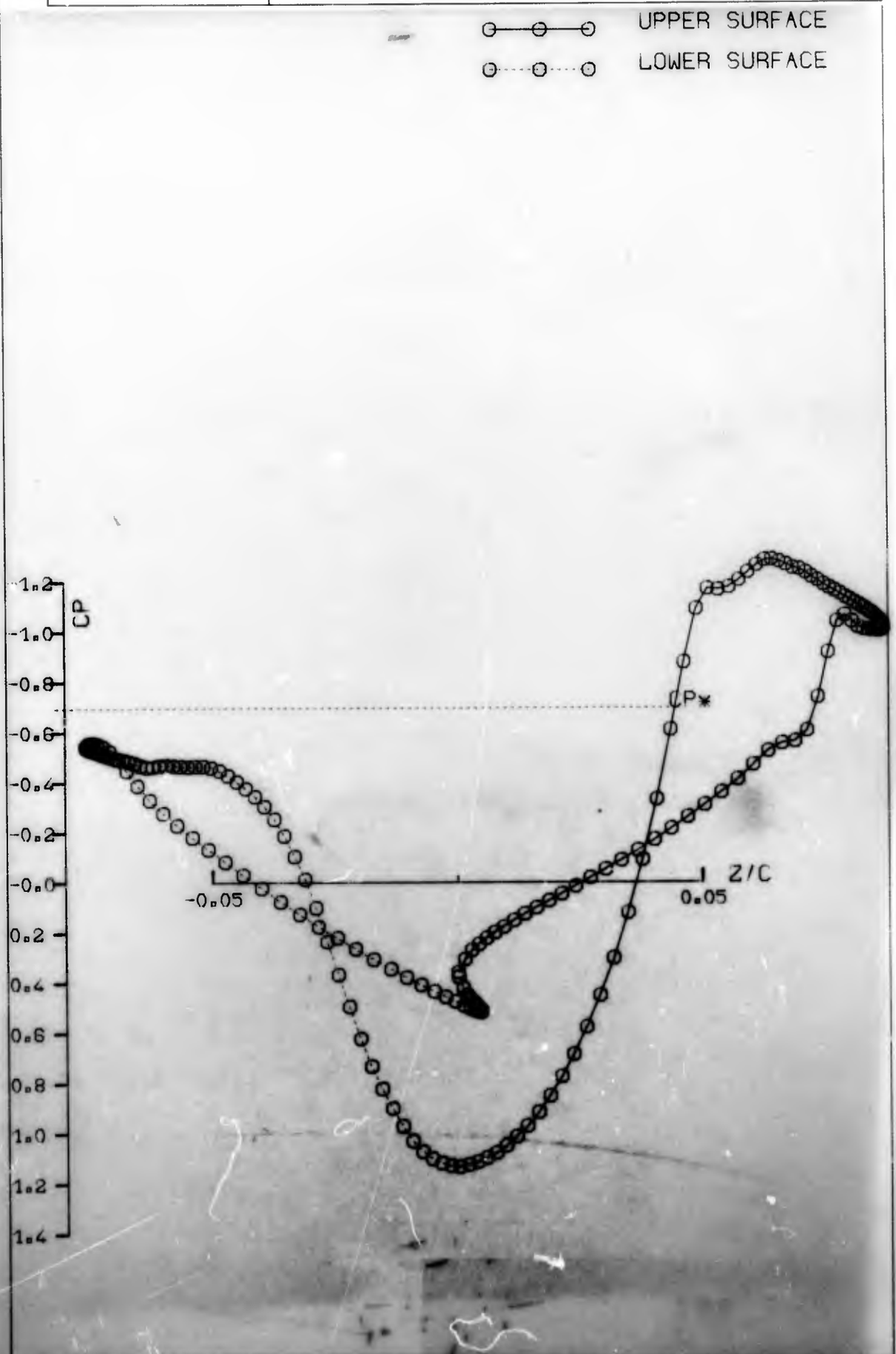
CM= -0.1347

Γ = 0.2900



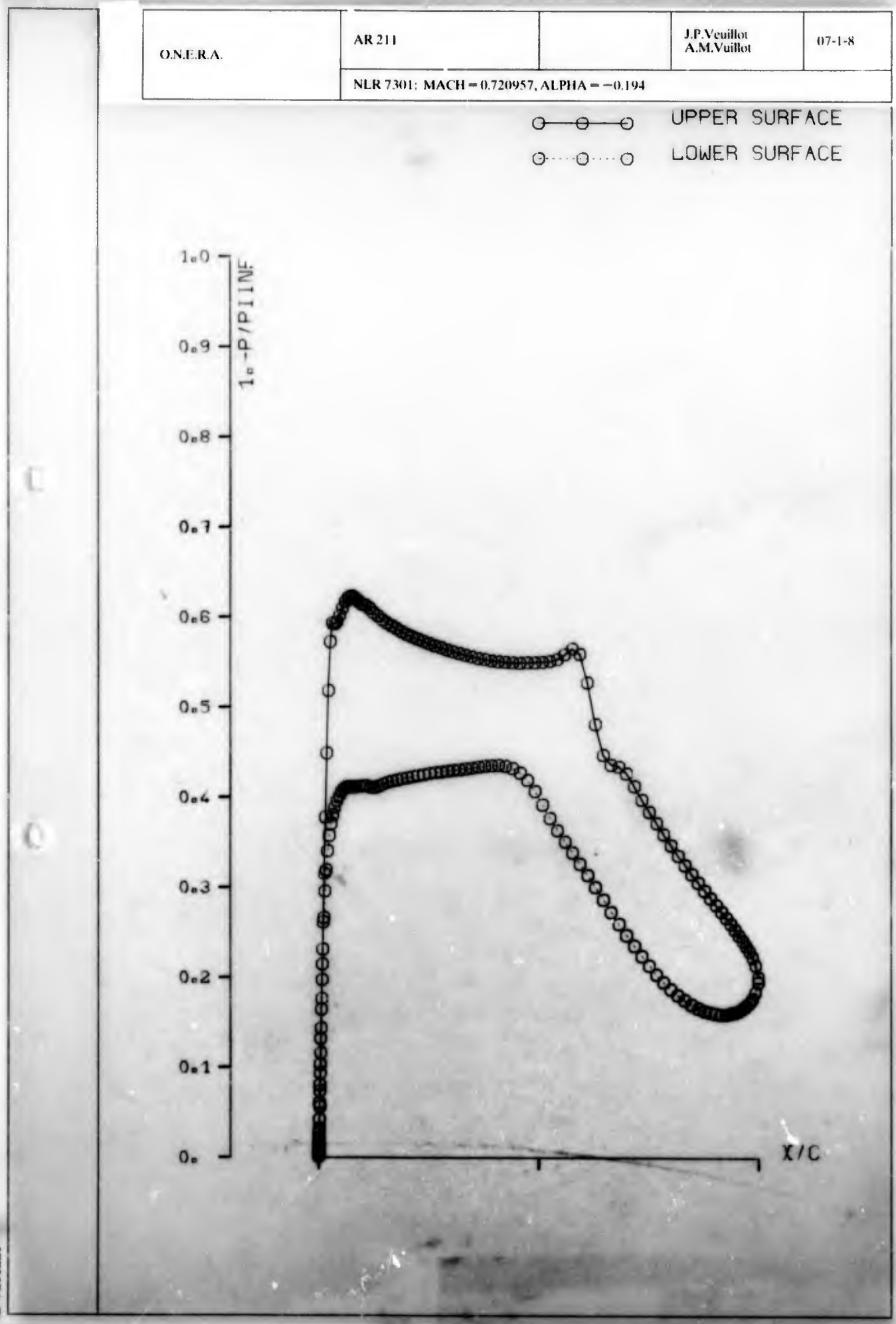
AL-VEUILLO

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-7
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



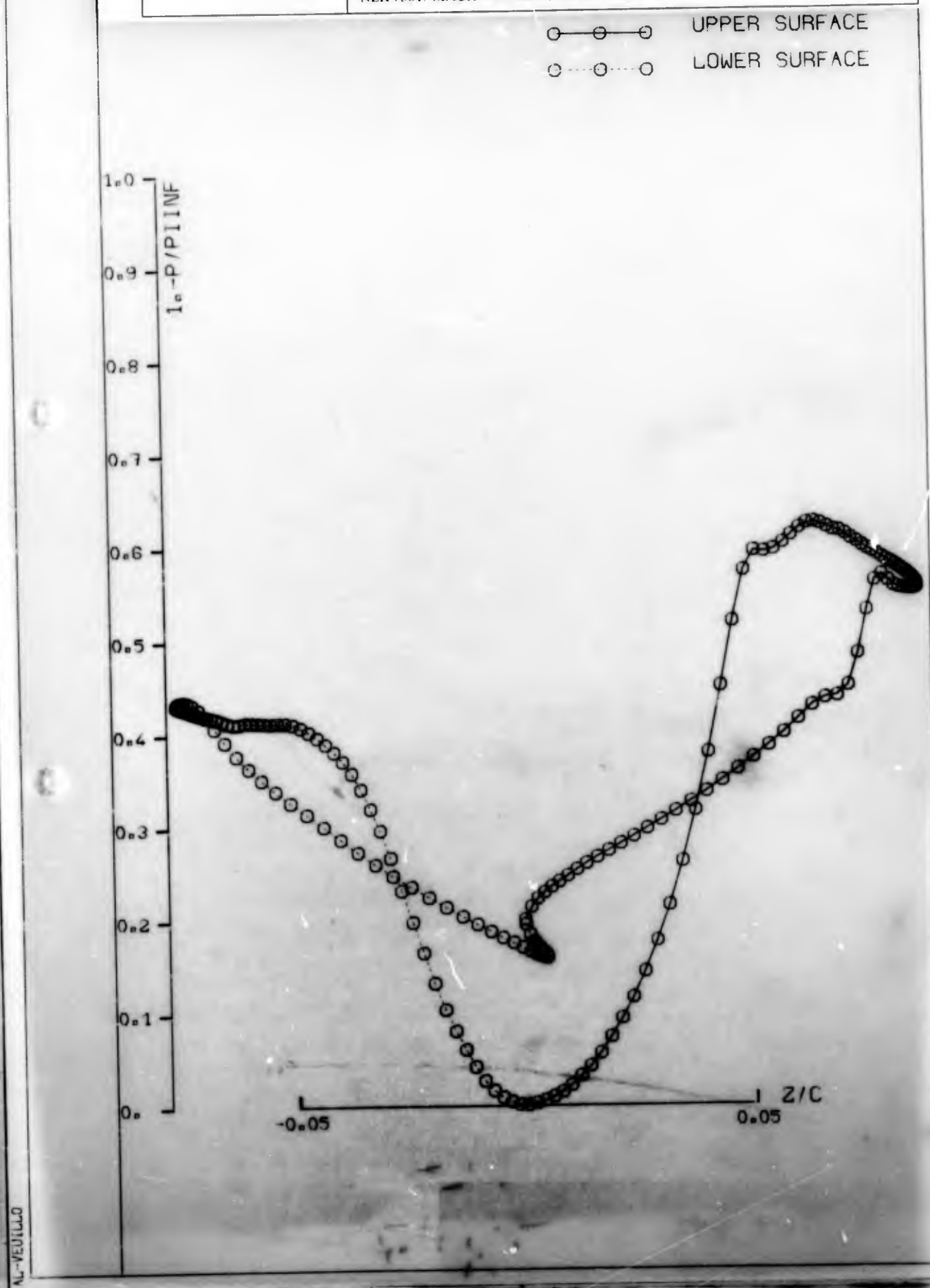
AL-VEUILLO

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-8
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

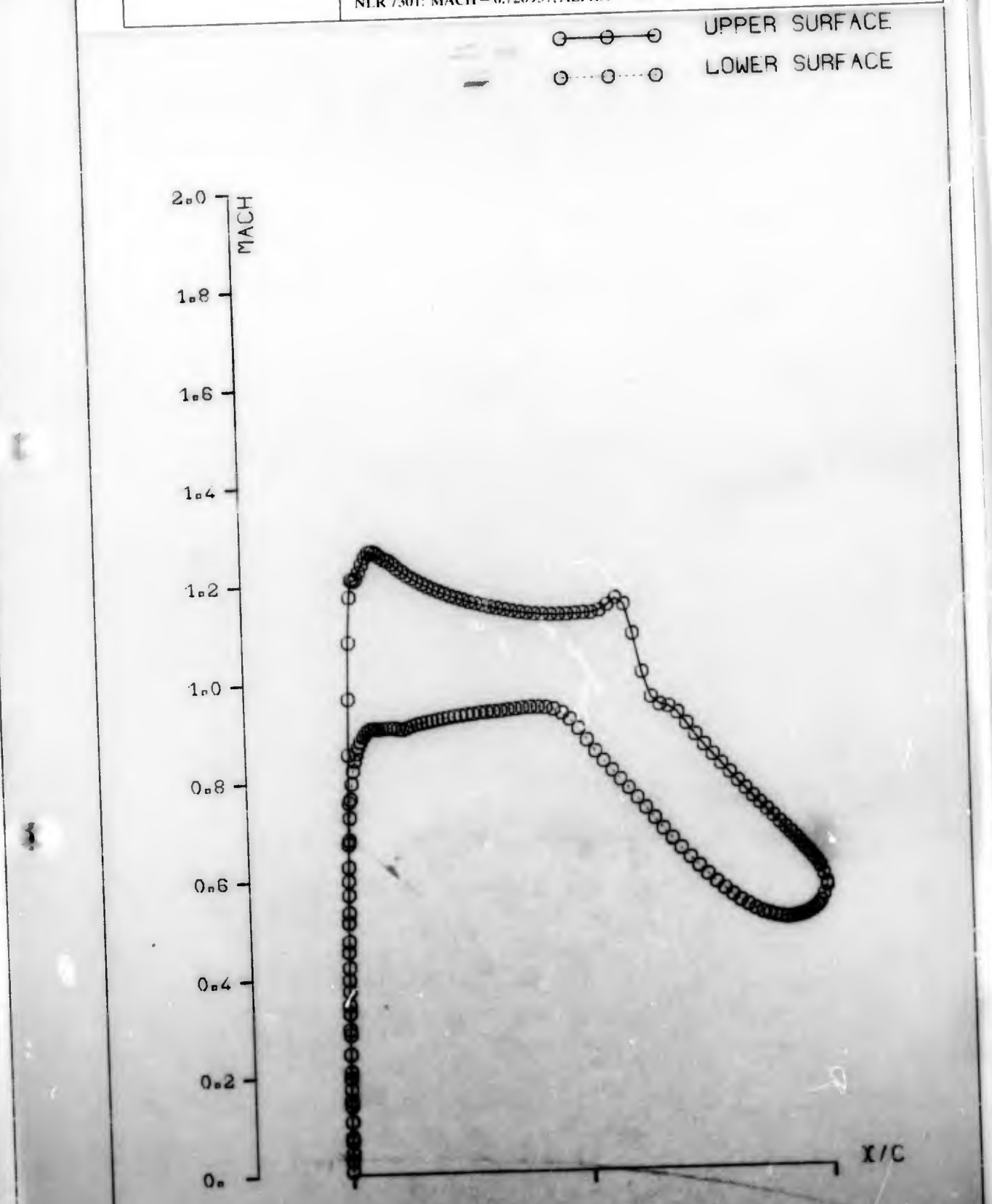


AL-VEUILLO

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-9
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

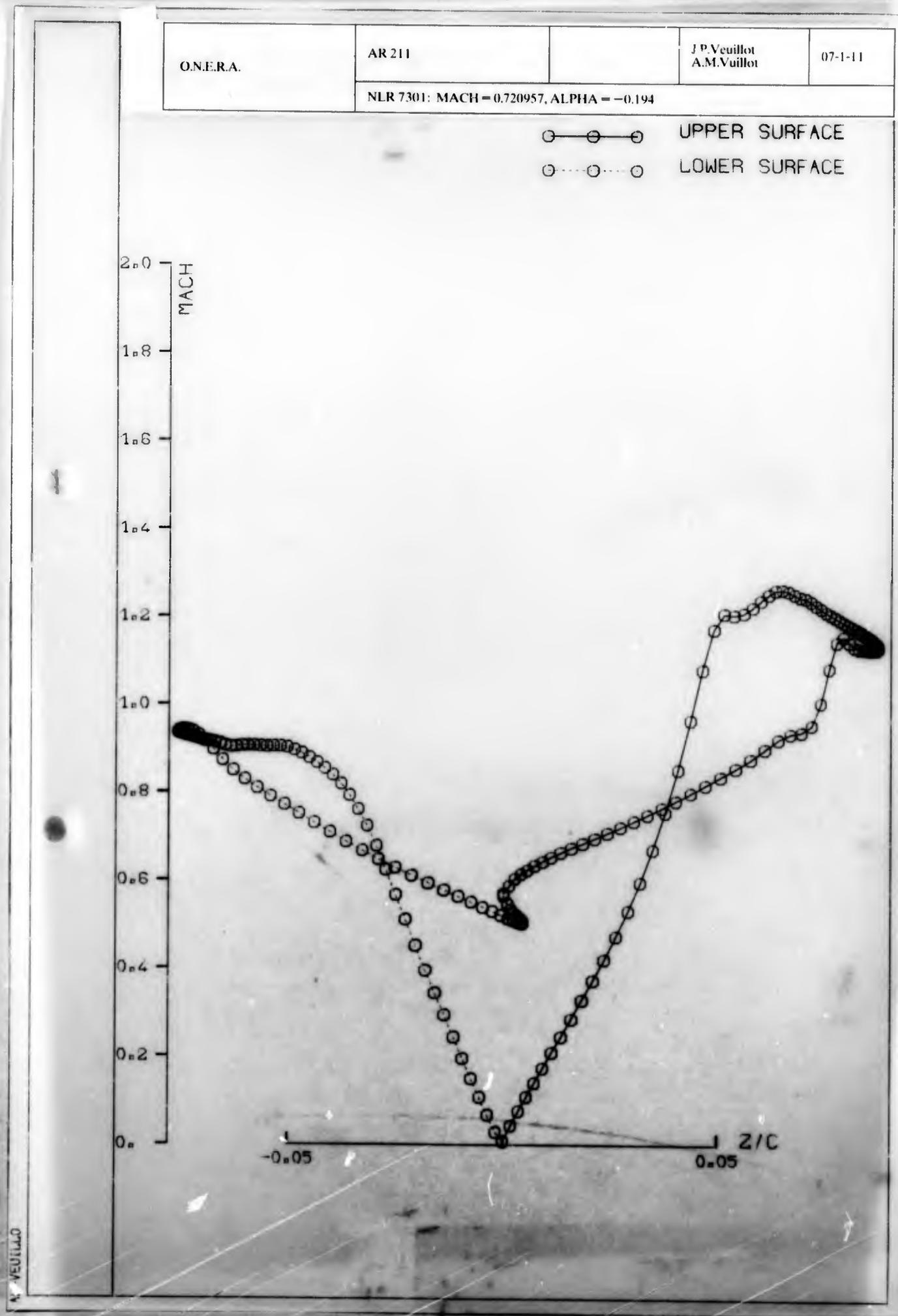


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-10
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

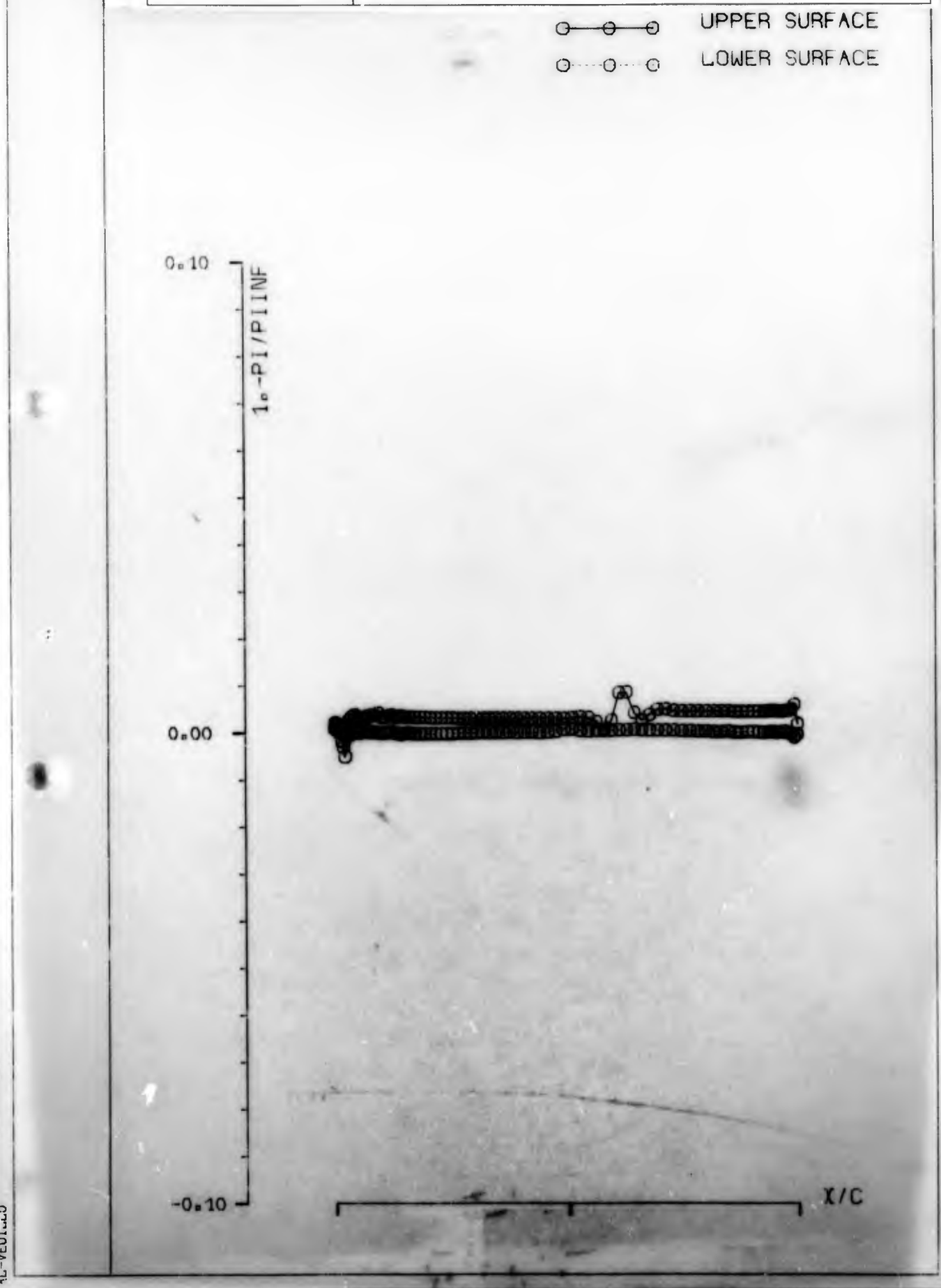


AL-VEUILLO

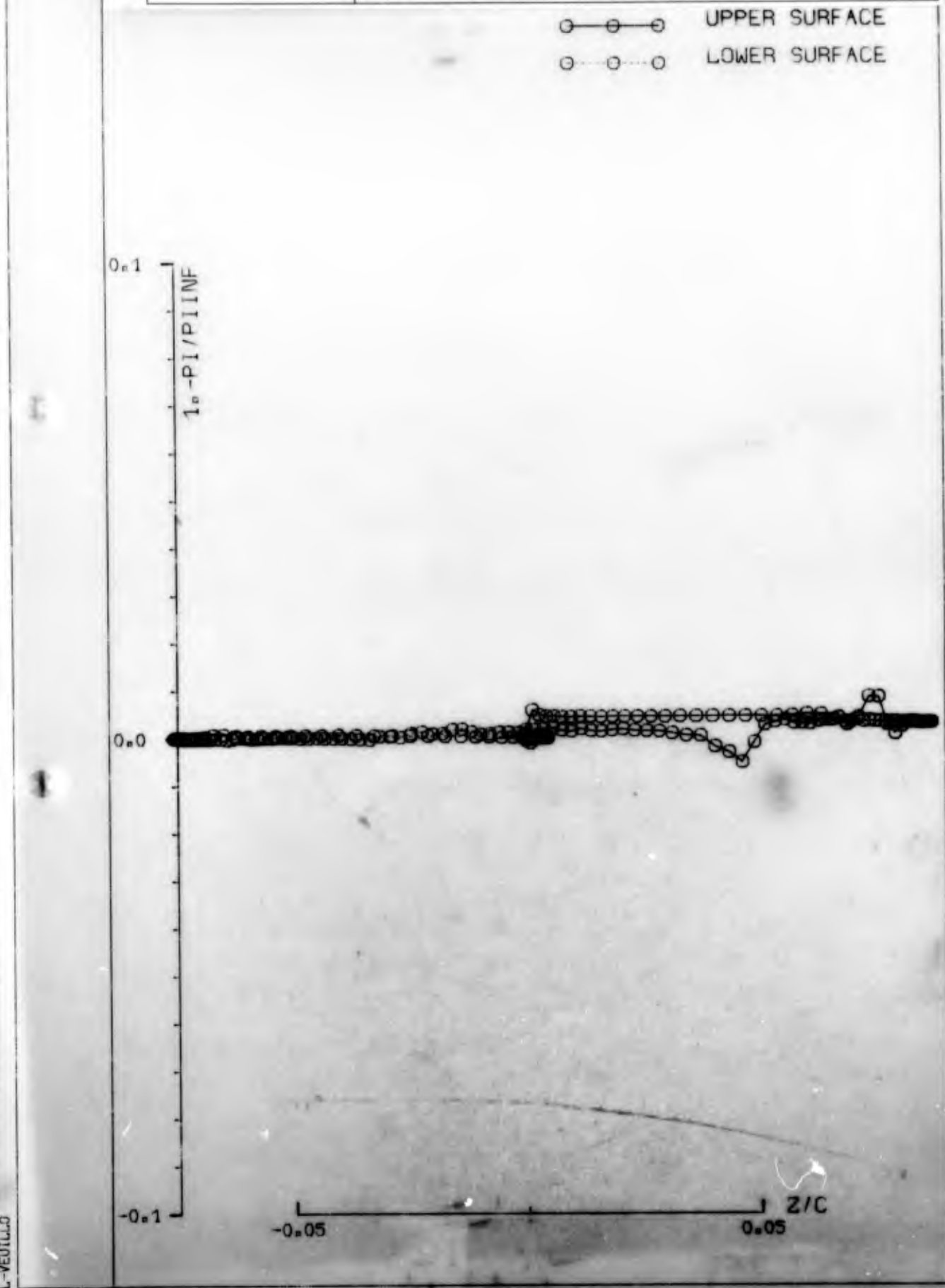
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-11
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



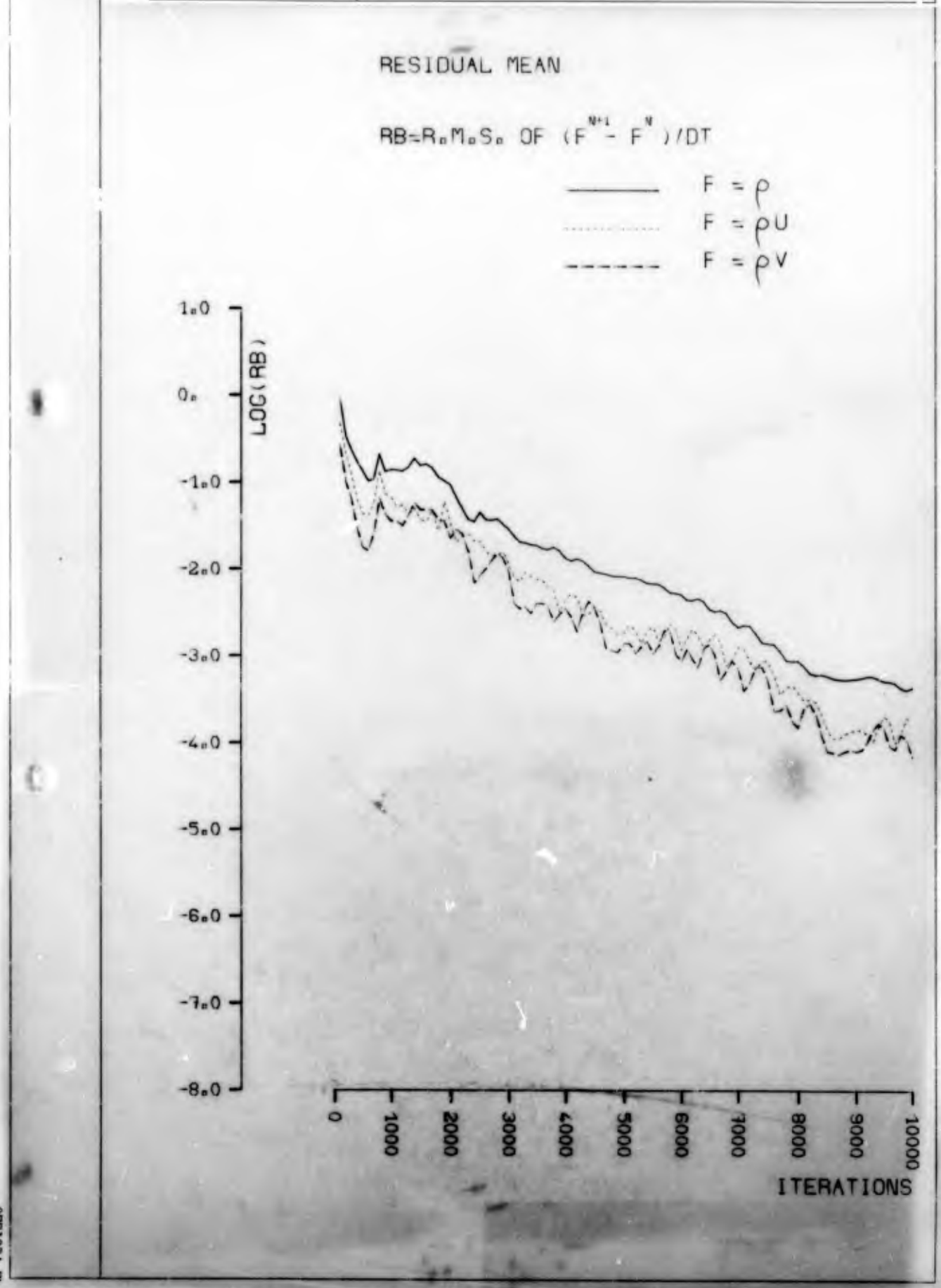
O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-12
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-13
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-14
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



AL-VEUILLO

		06-2-12	06-2-13	06-2-14	06-2-15	06-2-16	06-2-17	06-2-18	06-2-19	06-2-20	106-2-21	06-2-22	06-2-23	FICHE Nº 10
TEST CASE 06 Contributor 3	06-3-1	06-3-2	06-3-3	06-3-4	06-3-5	06-3-6	06-3-7	06-3-8	06-3-9	06-3-10	06-3-11	06-3-12	06-3-13	
06-3-14	06-3-15	TEST CASE 06 Contributor 6	06-6-1	06-6-2	06-6-3	06-6-4	06-6-5	06-6-6	06-6-7	06-6-8	06-6-9	06-6-10	06-6-11	
06-6-12	06-6-13	06-6-14	06-6-15	06-6-16	06-6-17	06-6-18	06-6-19	06-6-20	06-6-21	06-6-22	06-6-23	TEST CASE 06 Contributor 9	06-9-1	
06-9-2	06-9-3	06-9-4	06-9-5	06-9-6	06-9-7	06-9-8	06-9-9	06-9-10	06-9-11	06-9-12	06-9-13	06-9-14	06-9-15	
06-9-16	06-9-17	06-9-18	06-9-19	06-9-20	06-9-21	06-9-22	06-9-23	06-9-24	06-9-25	06-9-26	06-9-27	TEST CASE 07 Contributor 1	07-1-1	
07-1-2	07-1-3	07-1-4	07-1-5	07-1-6	07-1-7	07-1-8	07-1-9	07-1-10	07-1-11	07-1-12	07-1-13	07-1-14	CONTINUED	

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 07

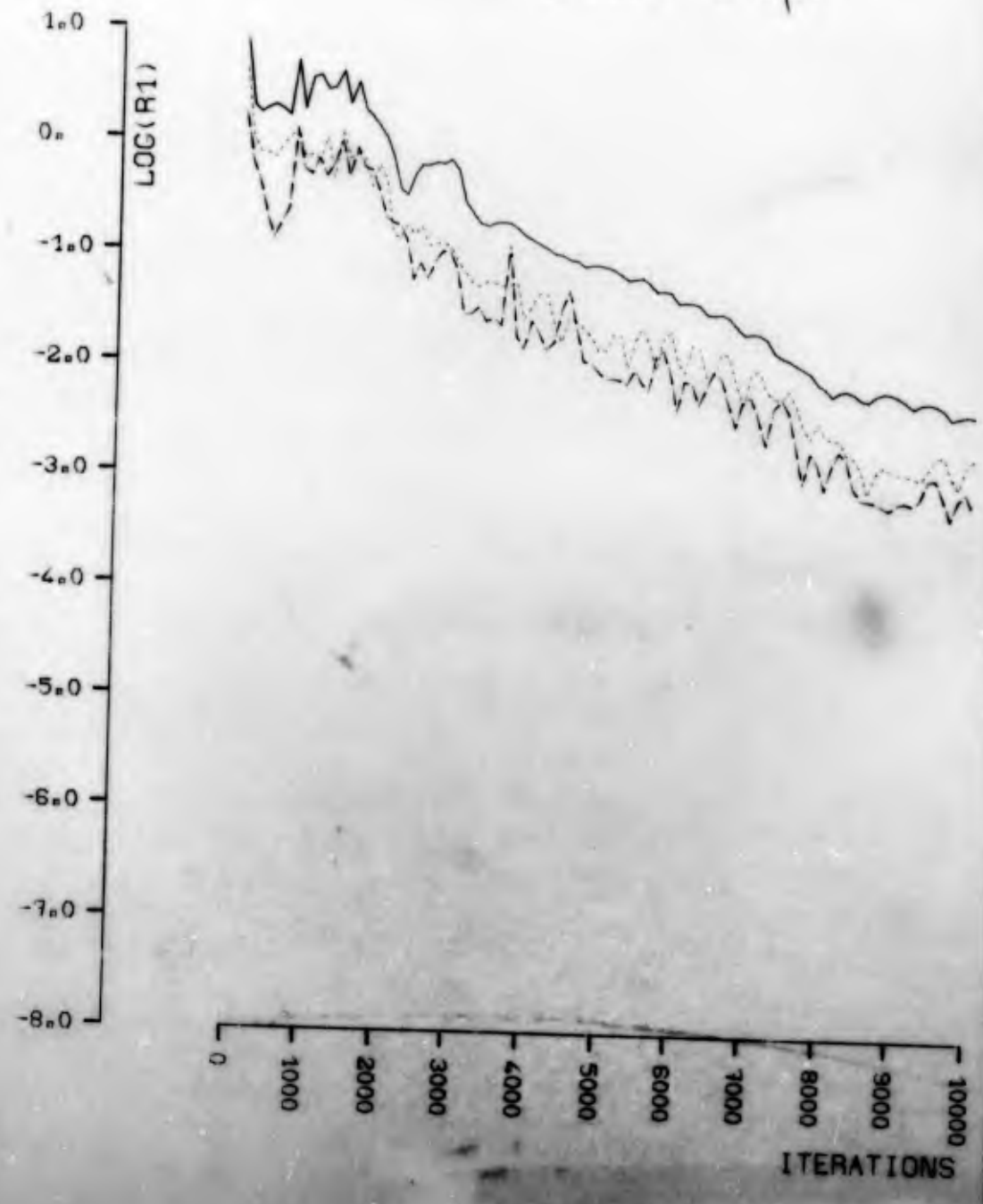
NLR 7301: MACH = 0.720957, ALPHA = −0.194

Contributor No 2

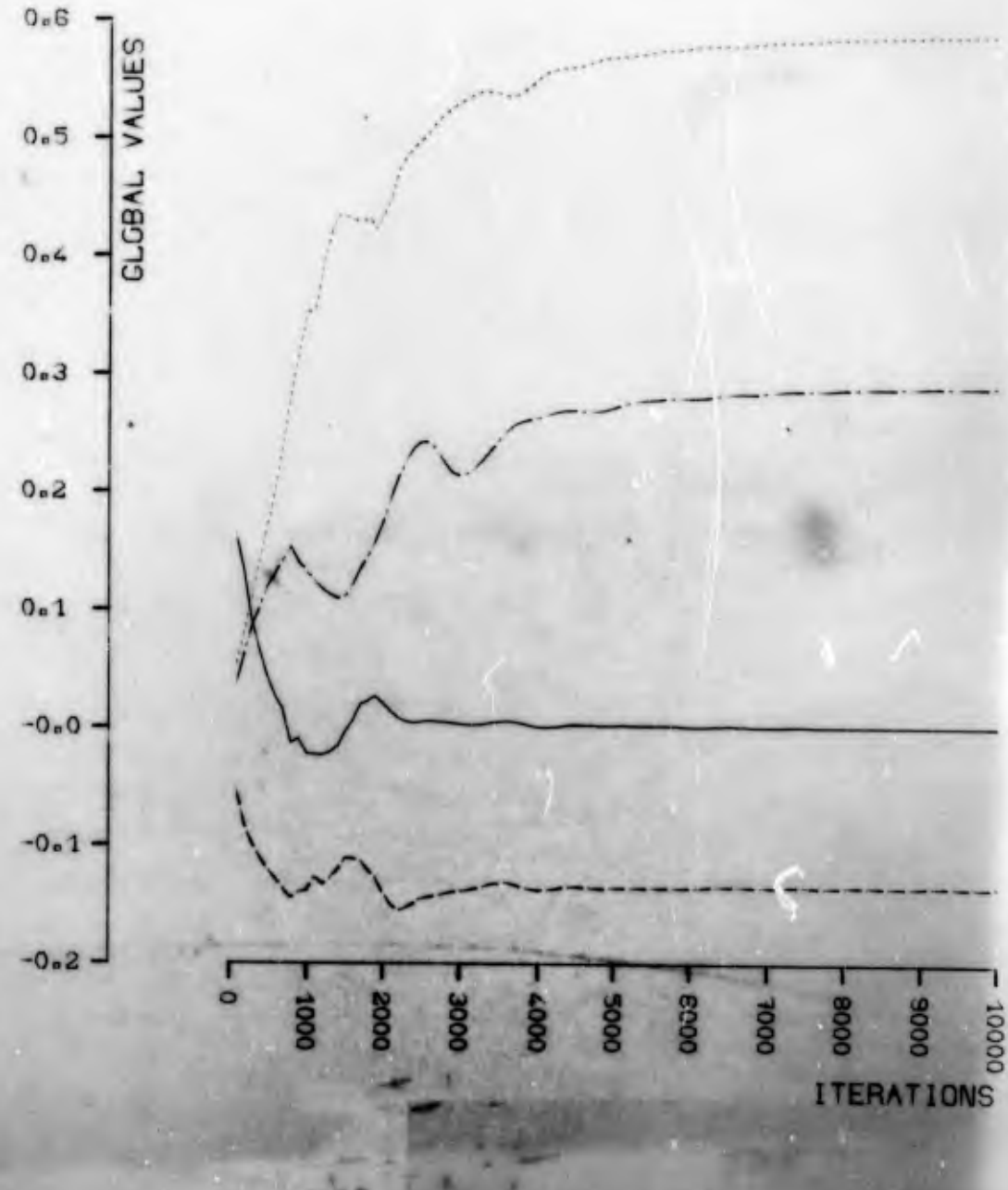
J.Sidès

(O.N.E.R.A., France)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-15
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

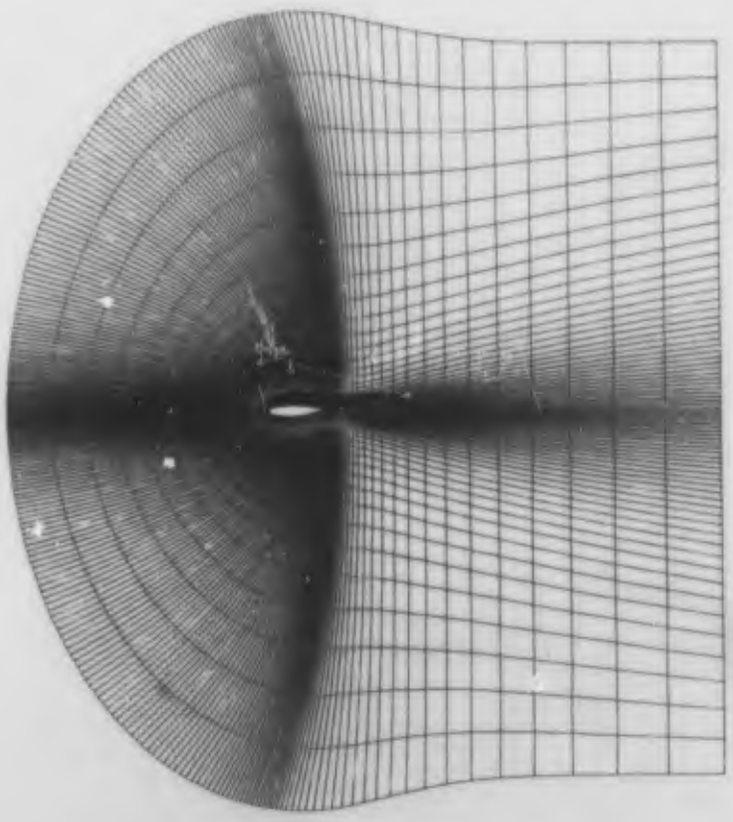


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-16
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



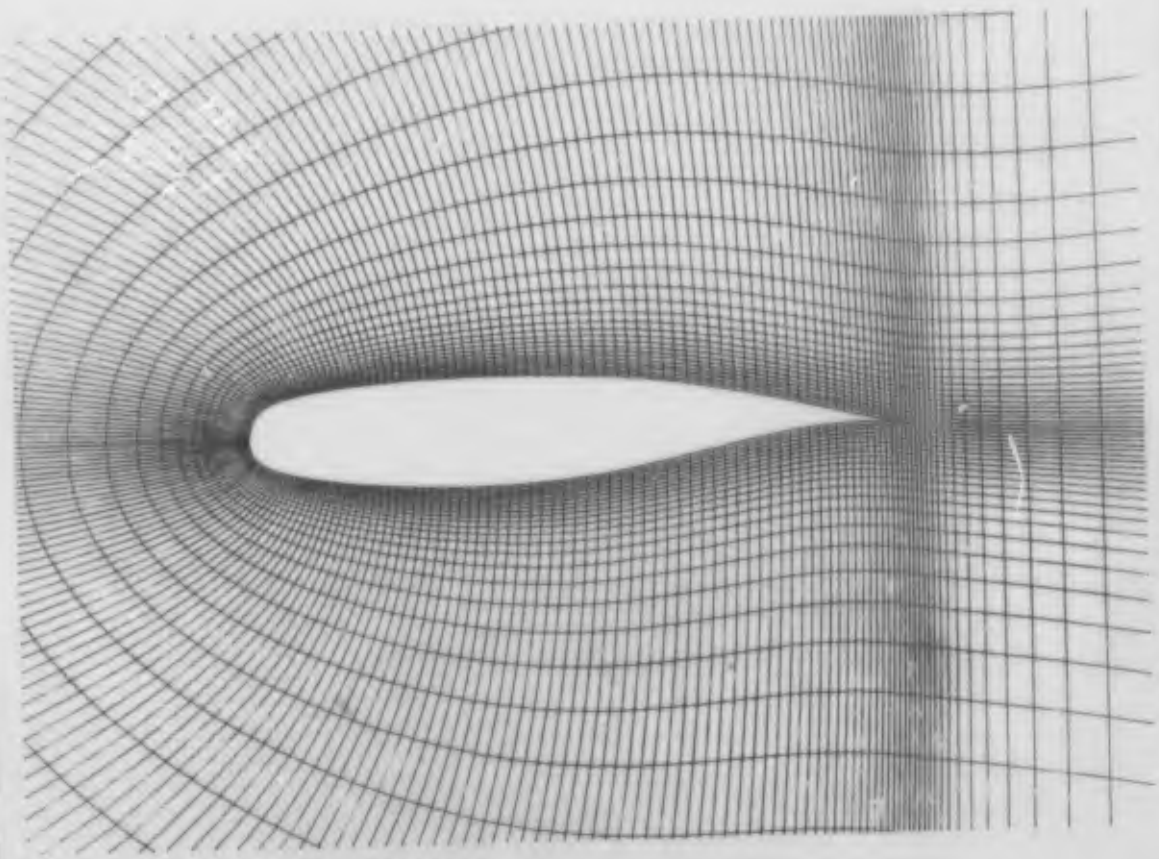
AL-VEUILLO

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-17
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



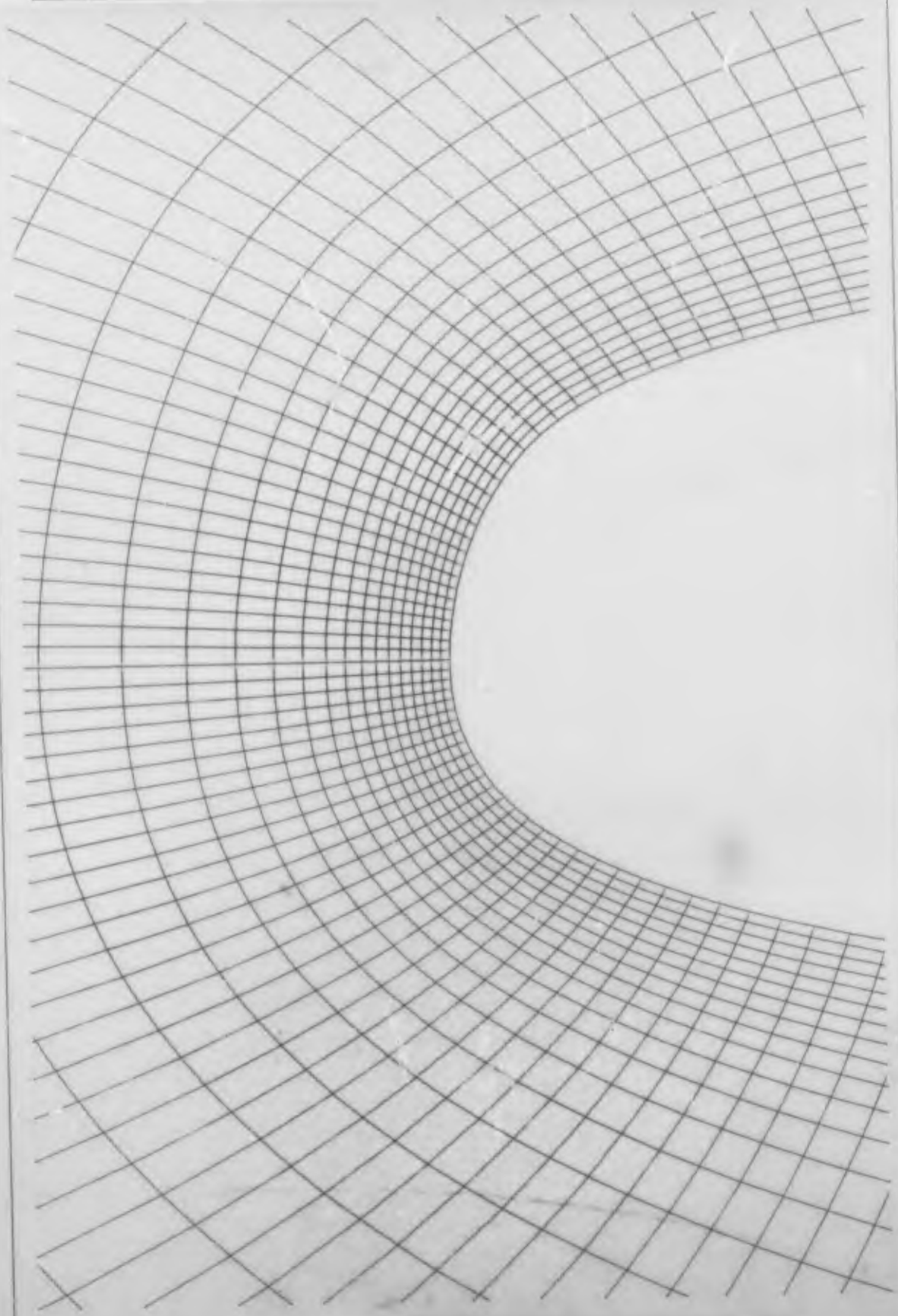
251X35 MESH (1CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-18
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

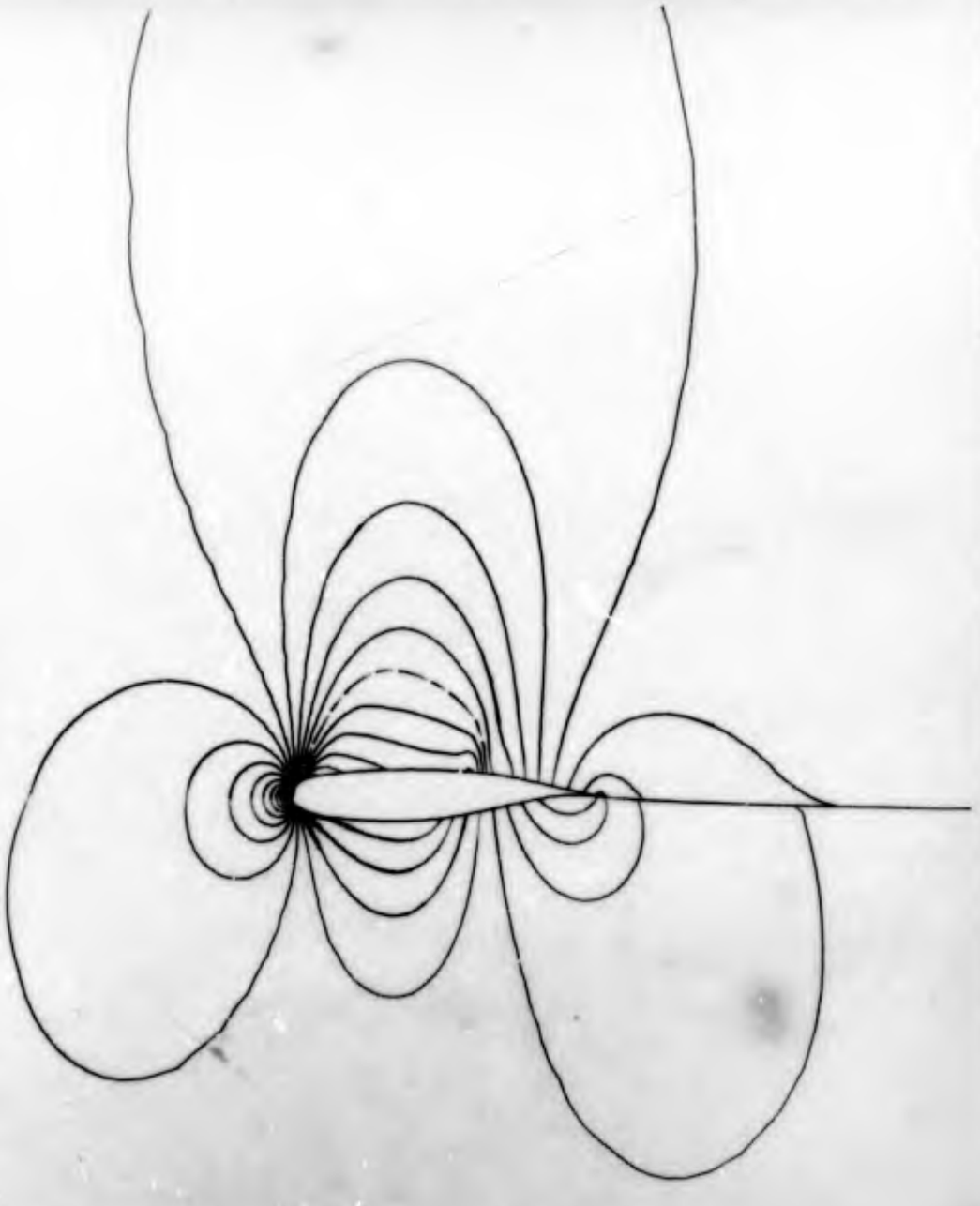


251X35 MESH PARTIAL VIEW (10CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-19
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

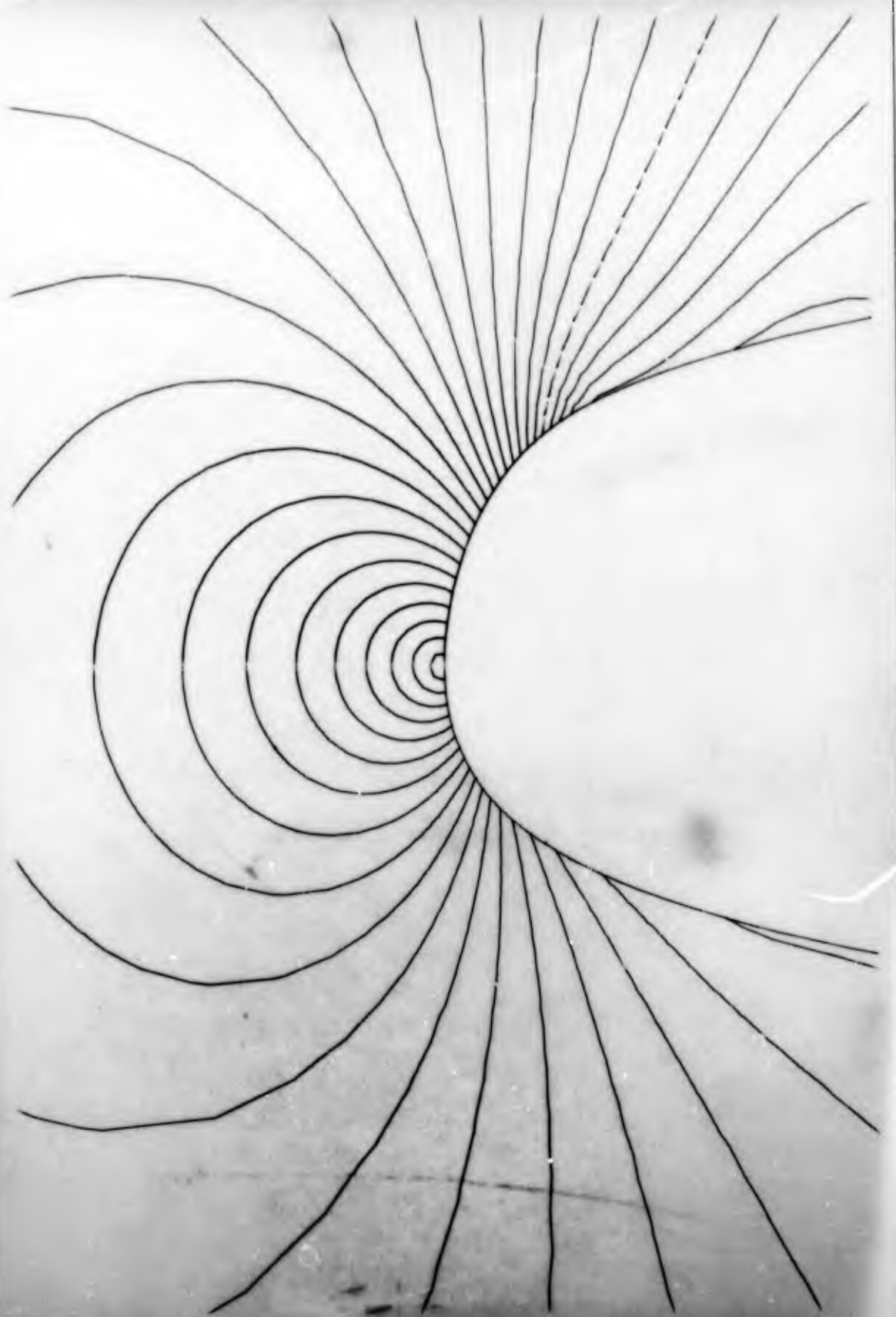


O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-20
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



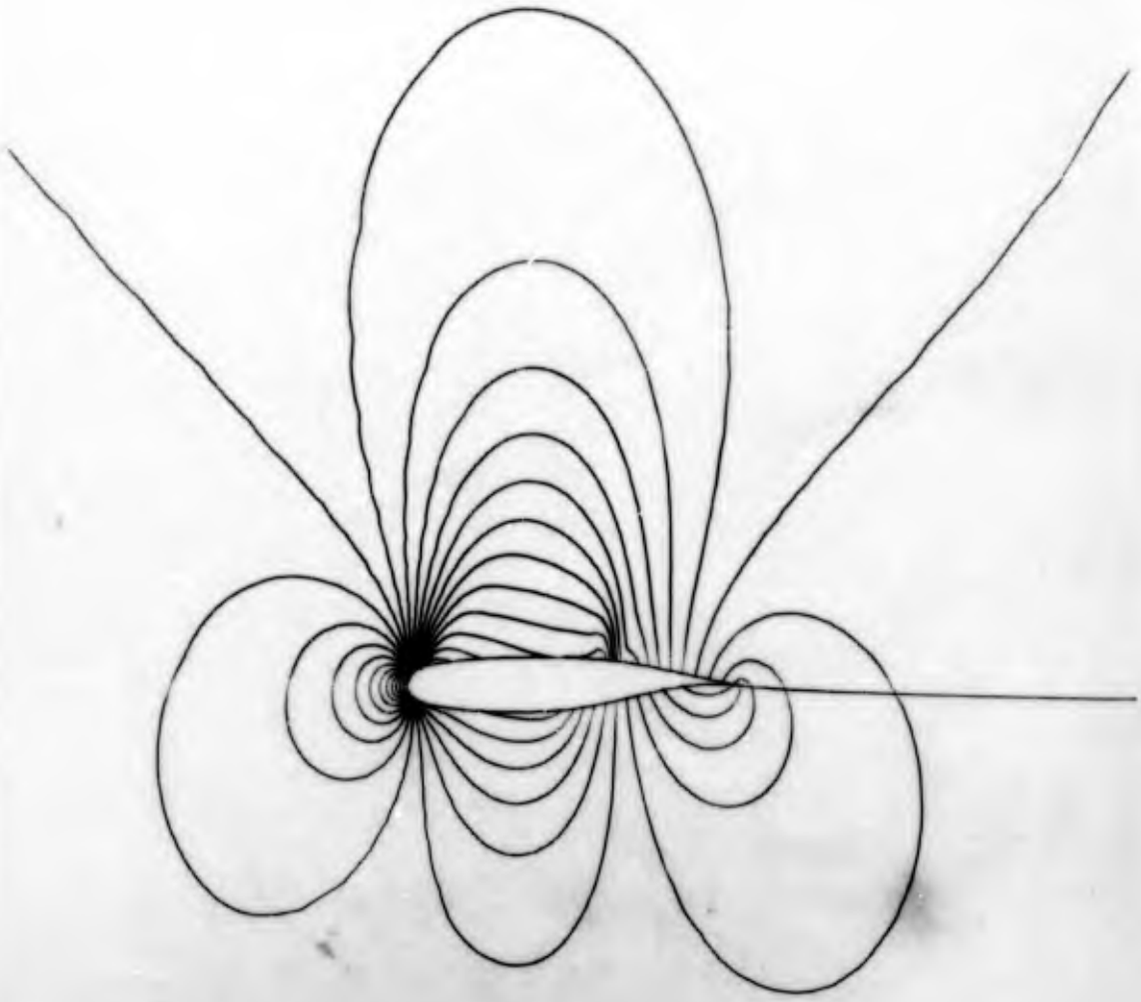
ISO-MACH LINES

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-21
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



ISO-MACH LINES (DM=.05 100CM CHORD)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-22
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



ISO-P/PIINF LINES

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-23
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

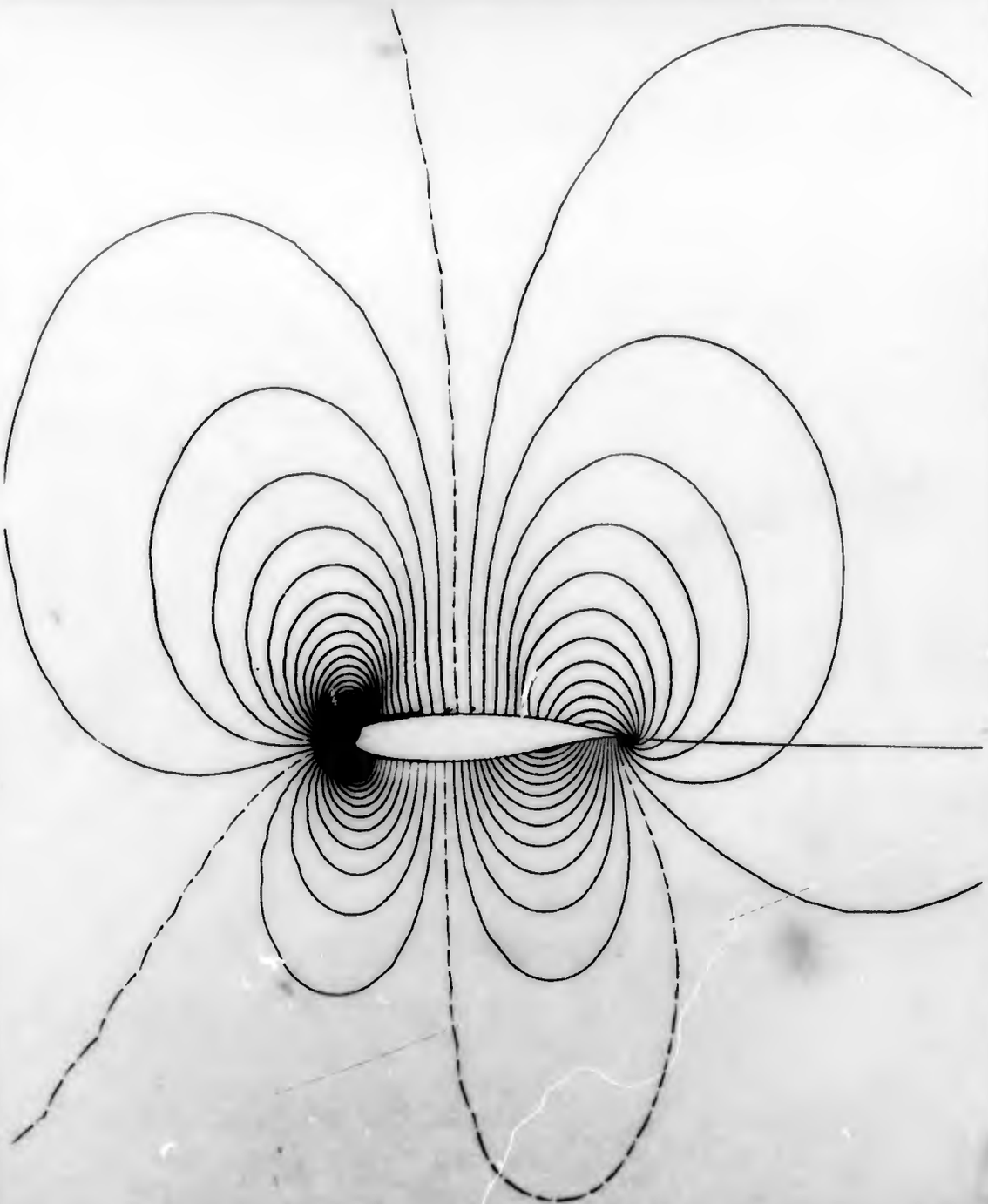
ISO-PI/PIINF LINES (DPI/PIINF=.005)

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-24
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

ISO-PI/PIINF LINES (DPI/PIINF=.001)

A_∞ M_∞ V_∞

O.N.E.R.A.	AR 211		J.P.Veuillot A.M.Vuillot	07-1-25
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



ISO-TETA LINES (DTETA=1.00)

COMMENTS ON CALCULATION FOR TEST CASE 07

C-Mesh

The mesh is generated algebrically from the data of points on the airfoil surface , on a cut-line and on an arbitrary external boundary. The global domain is divided into several subdomains and in each subdomain the mesh is constructed by means of an isoparametric method. The orthogonality to the airfoil surface is enforced for one family of mesh lines. Some local refinements are introduced in the vicinity of the leading edge , of the trailing edge and near the shock wave on the upper surface.

The total number of cells is : 298 x 34.

There are 230 points on the airfoil surface:

93 on the lower surface ,

137 on the upper surface.

In a parallel direction to the x-axis:

the distance between the leading edge and the external boundary is : 5 C (where C is the chord length),

the distance between the trailing edge and the external boundary is : 6 C.

In a parallel direction to the z-axis:

the distance between the airfoil surface and the external boundary is : about 6 c .

CONVERGENCE

The numerical results are reported after 4000 time steps of the implicit method but no doubt that 2500 steps would be sufficient to reach the converged solution.

O.N.E.R.A.	AR 211		J.Sides	07-2-2
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

LOWER SURFACE

N	x/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
1	.997438	.000341	.189992	.398702	.555232	.001305
2	.992243	.001005	.182781	.426718	.543221	.001151
3	.986904	.001626	.177730	.446339	.534218	.001407
4	.981418	.002196	.174136	.460303	.527669	.001653
5	.975781	.002714	.171284	.471381	.522546	.001775
6	.969990	.003181	.168832	.480908	.518167	.001846
7	.964043	.003592	.166774	.488902	.514454	.001921
8	.957935	.003945	.165009	.495761	.511292	.001962
9	.951664	.004235	.163520	.501545	.508610	.002000
10	.945225	.004458	.162292	.506315	.506392	.002032
11	.938614	.004609	.161342	.510008	.504654	.002068
12	.931829	.004683	.160643	.512722	.503372	.002096
13	.924865	.004674	.160200	.514443	.502540	.002126
14	.917720	.004578	.160036	.515080	.502195	.002162
15	.910388	.004388	.160134	.514700	.502323	.002192
16	.902868	.004100	.160490	.513317	.502911	.002223
17	.895154	.003709	.161117	.510880	.503977	.002255
18	.887243	.003209	.162046	.507272	.505569	.002292
19	.879132	.002595	.163276	.502494	.507694	.002327
20	.870817	.001863	.164801	.496570	.510338	.002360
21	.862293	.001008	.166660	.489348	.513552	.002400
22	.853557	.000026	.168883	.480711	.517387	.002443
23	.844604	-.001087	.171457	.470710	.521828	.002480
24	.835429	-.002332	.174417	.459212	.526903	.002527
25	.826028	-.003711	.177751	.446259	.532606	.002568
26	.816396	-.005226	.181446	.431905	.538901	.002607
27	.806526	-.006876	.185515	.416098	.545793	.002648
28	.796414	-.008663	.189992	.398706	.553334	.002688
29	.786052	-.010587	.194962	.379395	.561642	.002739
30	.775434	-.012645	.200469	.358003	.570785	.002791
31	.764554	-.014834	.206497	.334582	.580732	.002841
32	.753401	-.017147	.213027	.309217	.591430	.002890
33	.741968	-.019579	.220046	.281946	.602846	.002941
34	.730244	-.022118	.227466	.253121	.614845	.002977
35	.718220	-.024758	.235276	.222780	.627383	.003017
36	.705885	-.027488	.243473	.190934	.640463	.003049
37	.693229	-.030302	.252186	.157088	.654259	.003096
38	.680242	-.033190	.261535	.120768	.668966	.003150
39	.666910	-.036139	.271571	.081777	.684663	.003210
40	.653222	-.039133	.282277	.040185	.701320	.003271
41	.639162	-.042151	.293483	-.003346	.718695	.003317
42	.624717	-.045168	.304842	-.047478	.736285	.003327
43	.609872	-.048162	.316047	-.091006	.753618	.003305
44	.594614	-.051114	.327076	-.133855	.770648	.003284
45	.578930	-.054011	.338070	-.176565	.787601	.003266
46	.562809	-.056842	.349310	-.220229	.804908	.003269
47	.546239	-.059593	.361221	-.266501	.823226	.003310
48	.529208	-.062248	.374111	-.316579	.843061	.003381
49	.511700	-.064782	.389174	-.375096	.866189	.003597
50	.493702	-.067146	.405650	-.439104	.891844	.003596
51	.475194	-.069271	.419267	-.492005	.913644	.003084
52	.456163	-.071096	.427196	-.522810	.926458	.002718
53	.436602	-.072611	.431693	-.540281	.933566	.002711
54	.416505	-.073829	.433596	-.547671	.936697	.002575
55	.395863	-.074759	.433765	-.548330	.937005	.002531
56	.374668	-.075411	.432932	-.545094	.935747	.002464
57	.352910	-.075789	.431643	-.540087	.933770	.002396
58	.330577	-.075894	.430498	-.535638	.932014	.002337
59	.307660	-.075715	.429464	-.531619	.930431	.002280
60	.284145	-.075232	.428322	-.527184	.928675	.002231
61	.260023	-.074415	.426865	-.521523	.926425	.002178
62	.235281	-.073227	.424975	-.514179	.923502	.002118
63	.209913	-.071619	.422398	-.504167	.919502	.002057
64	.184247	-.069561	.417699	-.485913	.912522	.001621
65	.160053	-.067192	.416376	-.480775	.911470	.000505
66	.138608	-.064683	.411138	-.460426	.903045	.000759
67	.119603	-.062111	.412020	-.463852	.903926	.001298
68	.102770	-.059505	.412337	-.465082	.905228	.000421
69	.087877	-.056846	.411977	-.463684	.904132	.001002
70	.074713	-.054147	.412107	-.464191	.904684	.000622
71	.063098	-.051407	.411470	-.461715	.903683	.000629
72	.052874	-.048612	.406922	-.444048	.896940	.000245
73	.043903	-.045758	.398567	-.411588	.884048	.000127
74	.036063	-.042855	.387055	-.366864	.866475	-.000161
75	.029249	-.039906	.372288	-.309497	.844150	-.000647
76	.023378	-.036906	.350882	-.226337	.812462	-.001870
77	.018383	-.033853	.321474	-.112089	.768567	-.003002
78	.014203	-.030763	.285007	.029581	.713551	-.003932
79	.010784	-.027662	.238442	.210482	.642001	-.004863
80	.008052	-.024605	.192342	.389573	.564202	-.002407

40-911-120

O.N.E.R.A.	AR 211		J.Sidès	07-2-3
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

LOWER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
81	.005909	-.021660	.148482	.559966	.488128	-.002204
82	.004258	-.018877	.111436	.703887	.417038	-.001528
83	.002992	-.016295	.082636	.815773	.356088	-.001403
84	.002042	-.013925	.059156	.906989	.301344	-.002020
85	.001360	-.011762	.040631	.978956	.250651	-.002227
86	.000887	-.009803	.026734	1.032945	.205641	-.002382
87	.000563	-.008042	.016662	1.072072	.166796	-.002621
88	.000342	-.006467	.009602	1.099500	.133413	-.002793
89	.000195	-.005061	.004811	1.118113	.104736	-.002852
90	.000103	-.003807	.001322	1.131666	.079385	-.003090
91	.000047	-.002692	-.000973	1.140582	.056186	-.003186
92	.000017	-.001702	-.002605	1.146923	.033811	-.003407
93	.000004	-.000823	-.003140	1.149002	.012154	-.003244

O.N.E.R.A.	AR 211		J.Sidès	07-2-4
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

UPPER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
94	.000004	.000007	-.001604	1.143034	.005647	-.001626
95	.000018	.000869	-.003397	1.149999	.015830	-.003573
96	.000049	.001789	-.002459	1.146354	.035830	-.003360
97	.000100	.002770	-.001195	1.141444	.055163	-.003329
98	.000173	.003816	.000678	1.134167	.074923	-.003254
99	.000272	.004931	.003204	1.124354	.095354	-.003154
100	.000398	.006117	.006466	1.111685	.116622	-.003026
101	.000556	.007378	.010558	1.095785	.138821	-.002853
102	.000752	.008719	.015505	1.076567	.162149	-.002734
103	.000993	.010144	.021521	1.053196	186733	-.002571
104	.001283	.011658	.028696	1.025323	.212662	-.002403
105	.001629	.013266	037202	.992276	.240291	-.002277
106	.002041	.014970	.047384	.952720	.269763	-.002032
107	.002525	.016777	.059367	.906169	.302231	-.002164
108	.003099	.018688	.074346	.847975	.338075	-.001852
109	.003786	.020704	.091044	.783108	.375050	-.001647
110	.004598	.022826	.109989	.709507	.414013	-.001453
111	.005548	.025053	.131991	.624031	.456344	-.001269
112	.006654	.027387	.158029	.522876	.503924	-.001382
113	.007942	.029821	.189368	.401128	.557353	-.001021
114	.009444	.032346	.224588	.264303	.615450	-.001222
115	.011192	.034946	.265965	.103557	.680541	-.000850
116	.013219	.037602	.312594	-.077593	.753791	-.001890
117	.015569	.040280	.368439	-.294543	.839435	-.001895
118	.018286	.042934	.427938	-.525693	.934471	-.004891
119	.021419	.045501	.494864	-.785692	1.042283	-.005226
120	.025005	.047910	.552247	-1.008618	1.139927	-.005076
121	.029048	.050123	.598974	-1.190148	1.221528	-.000306
122	.033505	.052208	.599092	-1.190607	1.219174	.003082
123	.038344	.054239	.600490	-1.196038	1.223066	.001454
124	.043588	.056197	.605365	-1.214977	1.232569	.001181
125	.049258	.058071	.612418	-1.242377	1.246208	.001111
126	.055371	.059858	.619318	-1.269182	1.259673	.001099
127	.061948	.061559	.626149	-1.295720	1.273215	.001027
128	.069010	.063185	.629810	-1.309944	1.280609	.000901
129	.076576	.064761	.628904	-1.306423	1.278795	.000905
130	.084673	.066309	.626603	-1.297484	1.274226	.000881
131	.093332	.067836	.623867	-1.286855	1.268911	.000730
132	.102588	.069345	.620288	-1.272950	1.261764	.000848
133	.112480	.070836	.616980	-1.260101	1.255397	.000696
134	.123047	.072310	.612825	-1.243958	1.247200	.000840
135	.134334	.073764	.608972	-1.228990	1.239874	.000681
136	.146387	.075197	.604584	-1.211942	1.231281	.000908
137	.159257	.076604	.601016	-1.198081	1.224671	.000656
138	.172998	.077976	.596519	-1.180611	1.215790	.001137
139	.187194	.079268	.592894	-1.166529	1.208934	.001187
140	.201322	.080434	.589755	-1.154335	1.203048	.001205
141	.215303	.081479	.586905	-1.143261	1.197716	.001237
142	.229139	.082411	.584395	-1.133509	1.193044	.001259
143	.242828	.083240	.582173	-1.124880	1.188919	.001286
144	.256372	.083972	.580238	-1.117362	1.185335	.001313
145	.269771	.084613	.578549	-1.110798	1.182208	.001344
146	.283027	.085170	.577087	-1.105119	1.179509	.001370
147	.296140	.085647	.575779	-1.100037	1.177098	.001395
148	.309112	.086048	.574543	-1.095236	1.174826	.001416
149	.321943	.086377	.573272	-1.090300	1.172489	.001445
150	.334634	.086638	.571987	-1.085308	1.170138	.001463
151	.347188	.086833	.570583	-1.079854	1.167569	.001490
152	359604	.086966	.569116	-1.074153	1.164899	.001506
153	.371885	.087039	.567569	-1.068145	1.162082	.001533
154	.384030	.087055	.566090	-1.062397	1.159399	.001553
155	.396043	.087014	.564674	-1.056896	1.156828	.001581
156	.407923	.086920	.563452	-1.052151	1.154615	.001605
157	.419672	.086773	.562416	-1.048123	1.152734	.001633
158	.431292	.086575	.561589	-1.044911	1.151230	.001662
159	.442783	.086328	.561022	-1.042710	1.150198	.001684
160	.454146	.086034	.560631	-1.041189	1.149474	.001714
161	.465383	.085691	.560380	-1.040216	1.149005	.001742
162	.476495	.085303	.560205	-1.039537	1.148663	.001779
163	.487484	.084868	.560133	-1.039257	1.148528	.001787
164	.498349	.084387	.559801	-1.037964	1.147892	.001839
165	.509093	.083861	.559426	-1.036509	1.147244	.001813
166	.519716	.083290	.558284	-1.032074	1.145136	.001905
167	.530220	.082673	.557257	-1.028083	1.143376	.001815
168	.540605	.082011	.554850	-1.018733	1.138922	.002039
169	.550873	.081302	.553982	-1.015361	1.137583	.001786
170	.561023	.080545	.550356	-1.001274	1.130506	.002625
171	.571059	.079741	.554468	-1.017247	1.138835	.001291
172	.580978	.078887	.538411	-.954869	1.108753	.003665
173	.590784	.077983	.489811	-.766061	1.024871	.005579
174	.600476	.077028	.451641	-.617775	.965379	.002615

511 120

O.N.E.R.A.	AR 211		J.Sidès	07-2-5
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

UPPER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
175	.610056	.076020	.465278	-.670752	.987436	.002475
176	.619523	.074960	.475666	-.711111	1.004125	.002678
177	.628879	.073849	.479493	-.725976	1.010316	.002746
178	.638125	.072687	.474911	-.708177	1.002777	.002815
179	.647261	.071477	.468421	-.682963	.992211	.002837
180	.656289	.070223	.461434	-.655820	.980916	.002838
181	.665210	.068927	.454356	-.628324	.969531	.002841
182	.674025	.067592	.447222	-.600610	.958107	.002851
183	.682736	.066223	.440152	-.573143	.946840	.002859
184	.691344	.064822	.433246	-.546314	.935878	.002871
185	.699850	.063392	.426412	-.519761	.925077	.002876
186	.708256	.061937	.419601	-.493305	.914375	.002860
187	.716562	.060459	.412958	-.467497	.903967	.002848
188	.724771	.058960	.406400	-.442019	.893707	.002853
189	.732883	.057444	.399944	-.416939	.883635	.002858
190	.740900	.055913	.393594	-.392271	.873761	.002853
191	.748823	.054369	.387340	-.367974	.864060	.002845
192	.756654	.052815	.381226	-.344219	.854592	.002839
193	.764395	.051253	.375257	-.321030	.845363	.002834
194	.772045	.049686	.369429	-.298389	.836365	.002829
195	.779607	.048114	.363722	-.276220	.827567	.002821
196	.787082	.046541	.358156	-.254595	.818993	.002814
197	.794472	.044969	.352732	-.233524	.810644	.002807
198	.801777	.043398	.347438	-.212959	.802497	.002802
199	.808998	.041830	.342262	-.192850	.794537	.002793
200	.816138	.040267	.337225	-.173280	.786791	.002785
201	.823197	.038711	.332307	-.154177	.779226	.002780
202	.830177	.037162	.327495	-.135481	.771826	.002771
203	.837078	.035622	.322813	-.117291	.764621	.002763
204	.843901	.034093	.318238	-.099518	.757577	.002757
205	.850649	.032574	.313752	-.082090	.750664	.002751
206	.857321	.031067	.309366	-.065052	.743908	.002738
207	.863919	.029573	.305098	-.048472	.737317	.002737
208	.870444	.028094	.300885	-.032103	.730812	.002726
209	.876898	.026629	.296781	-.016158	.724468	.002716
210	.883280	.025179	.292752	-.000509	.718225	.002715
211	.889592	.023746	.288766	.014976	.712055	.002699
212	.895835	.022329	.284883	.030061	.706020	.002698
213	.902010	.020930	.281020	.045071	.700018	.002685
214	.908118	.019549	.277231	.059790	.694118	.002677
215	.914159	.018186	.273476	.074376	.688257	.002673
216	.920136	.016843	.269746	.088868	.682439	.002654
217	.926047	.015521	.266094	.103055	.676712	.002654
218	.931895	.014218	.262422	.117321	.670973	.002627
219	.937681	.012937	.258811	.131350	.665283	.002629
220	.943404	.011677	.255102	.145760	.659461	.002600
221	.949067	.010439	.251407	.160113	.653625	.002591
222	.954669	.009225	.247619	.174830	.647648	.002563
223	.960213	.008035	.243814	.189609	.641642	.002524
224	.965698	.006871	.239996	.204445	.635610	.002472
225	.971126	.005734	.236121	.219498	.629501	.002397
226	.976498	.004626	.232132	.234996	.623241	.002278
227	.981814	.003546	.227914	.251380	.616691	.002081
228	.987076	.002497	.223215	.269637	.609433	.001807
229	.992283	.001478	.217399	.292230	.599983	.001803
230	.997437	.000488	.209392	.323339	.583414	.004442

40 911 120

O.N.E.R.A.	AR 211		J.Sidès	07-2-6
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

UPPER SURFACE

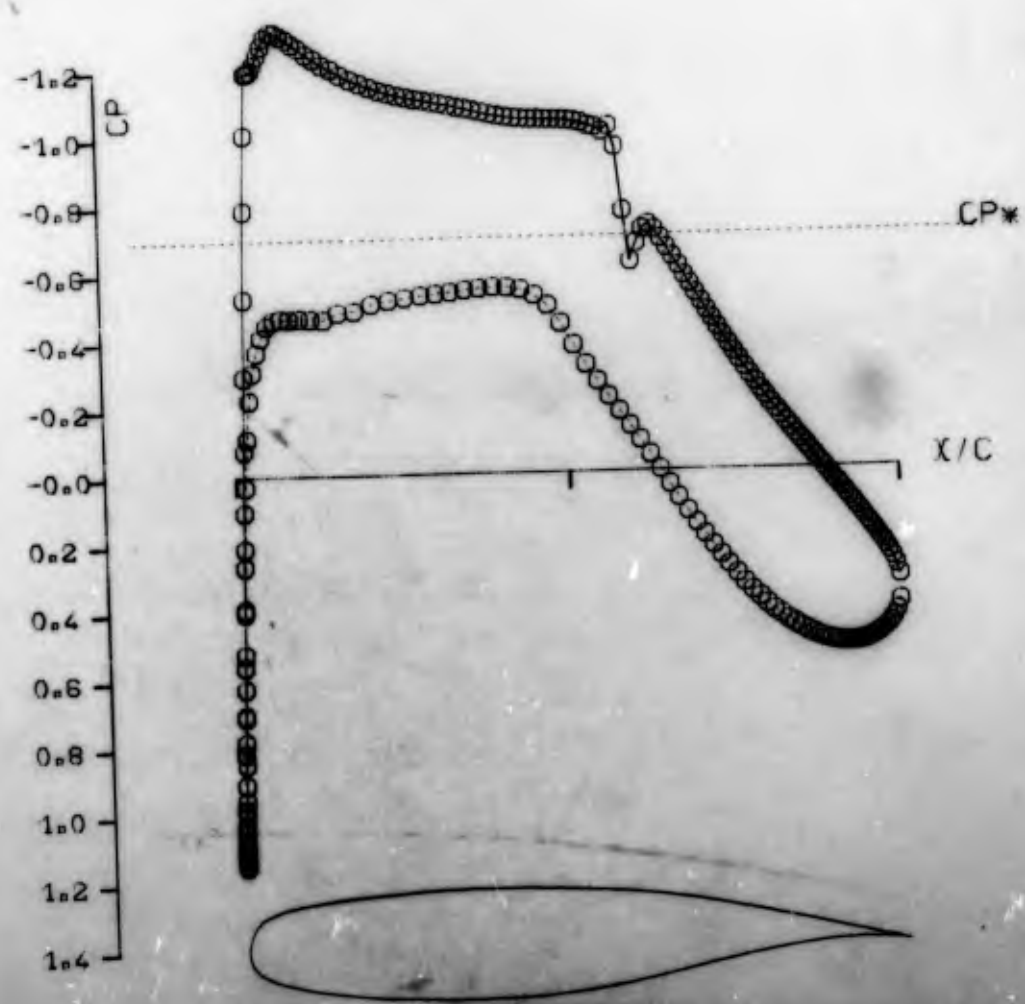
LOWER SURFACE

CL= 0.6015

CD= 0.0011

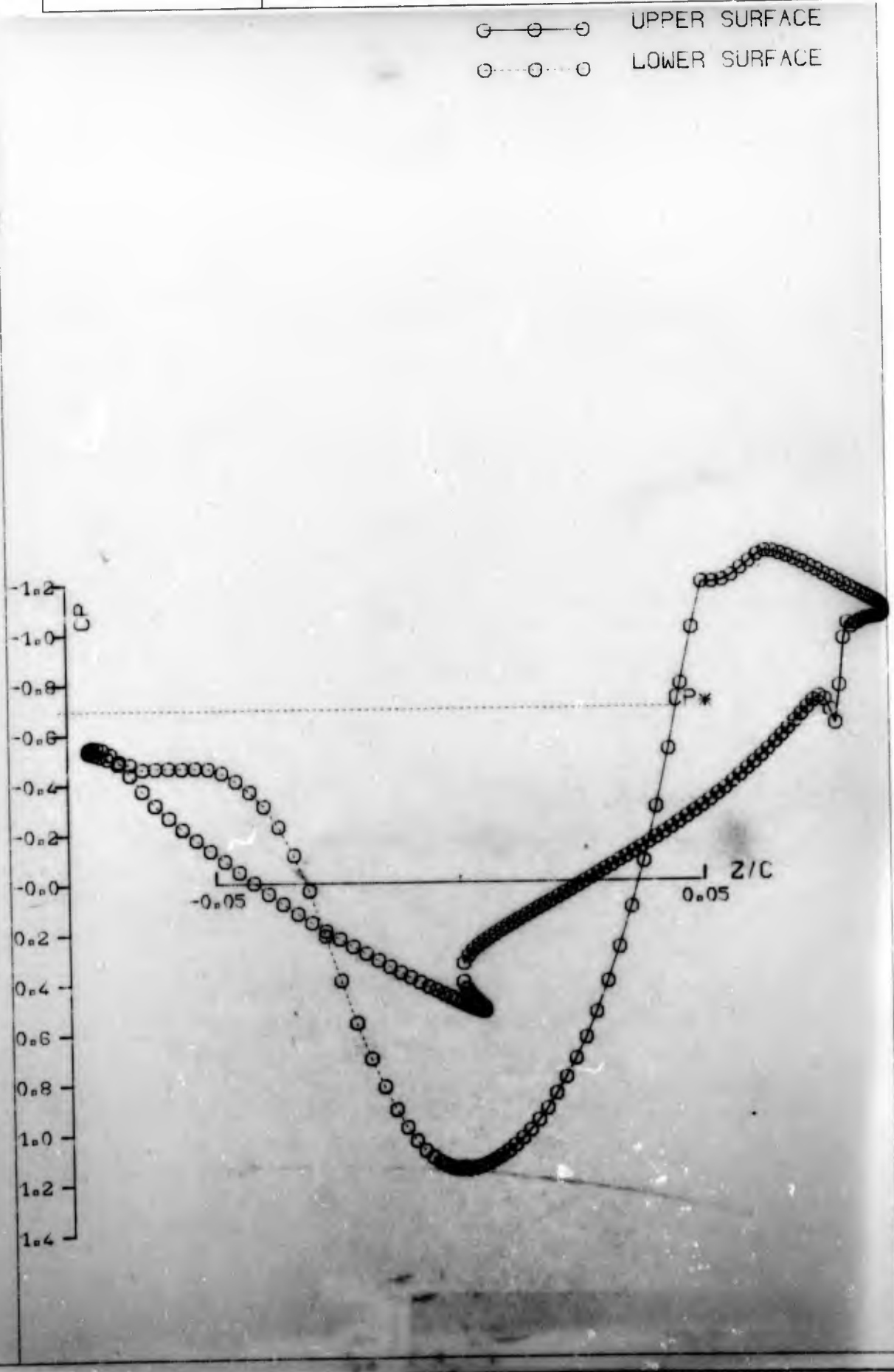
CM= -0.1333

Γ = 0.3012



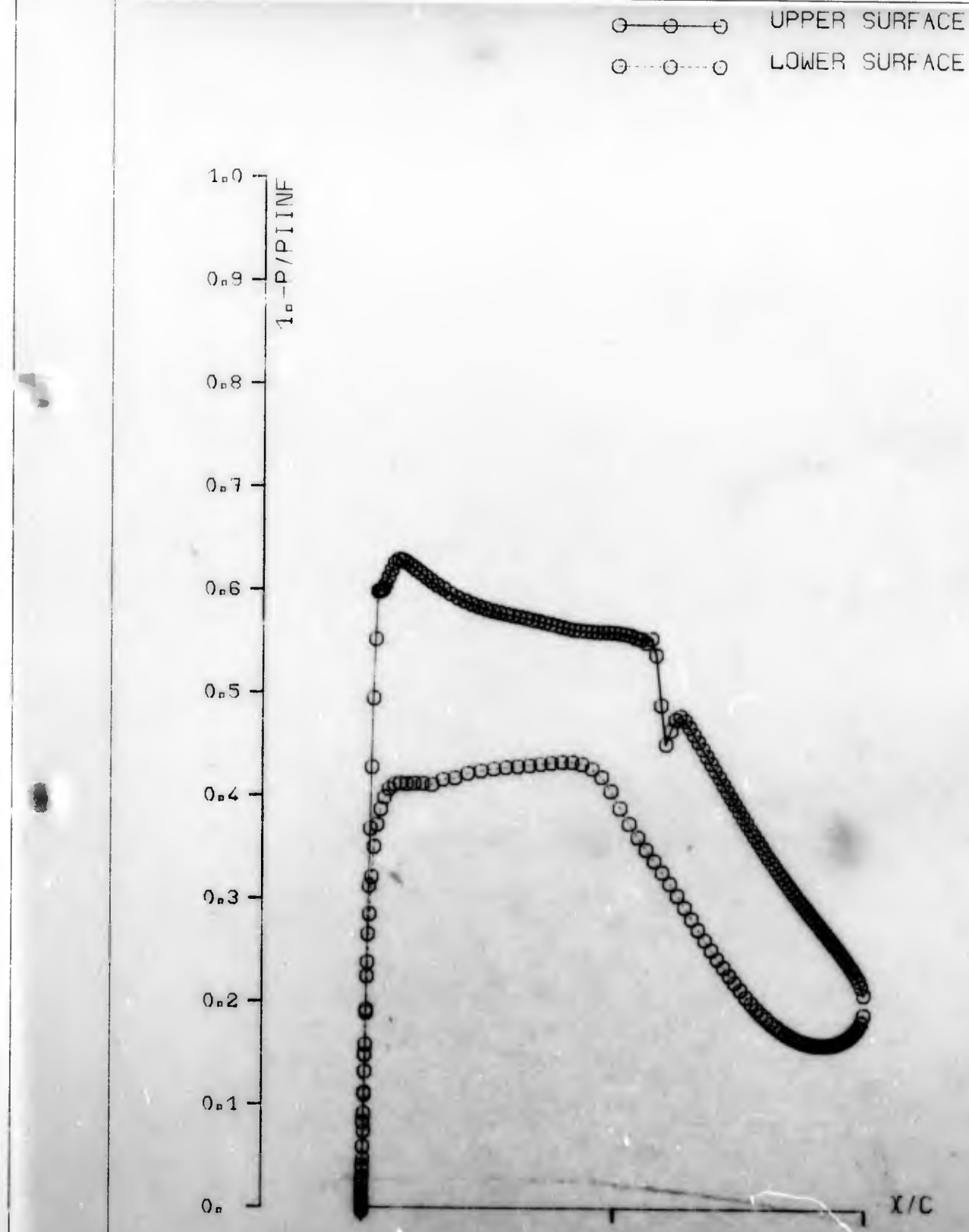
SIDES 1

O.N.E.R.A.	AR 211		J.Sidès	07-2-7
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



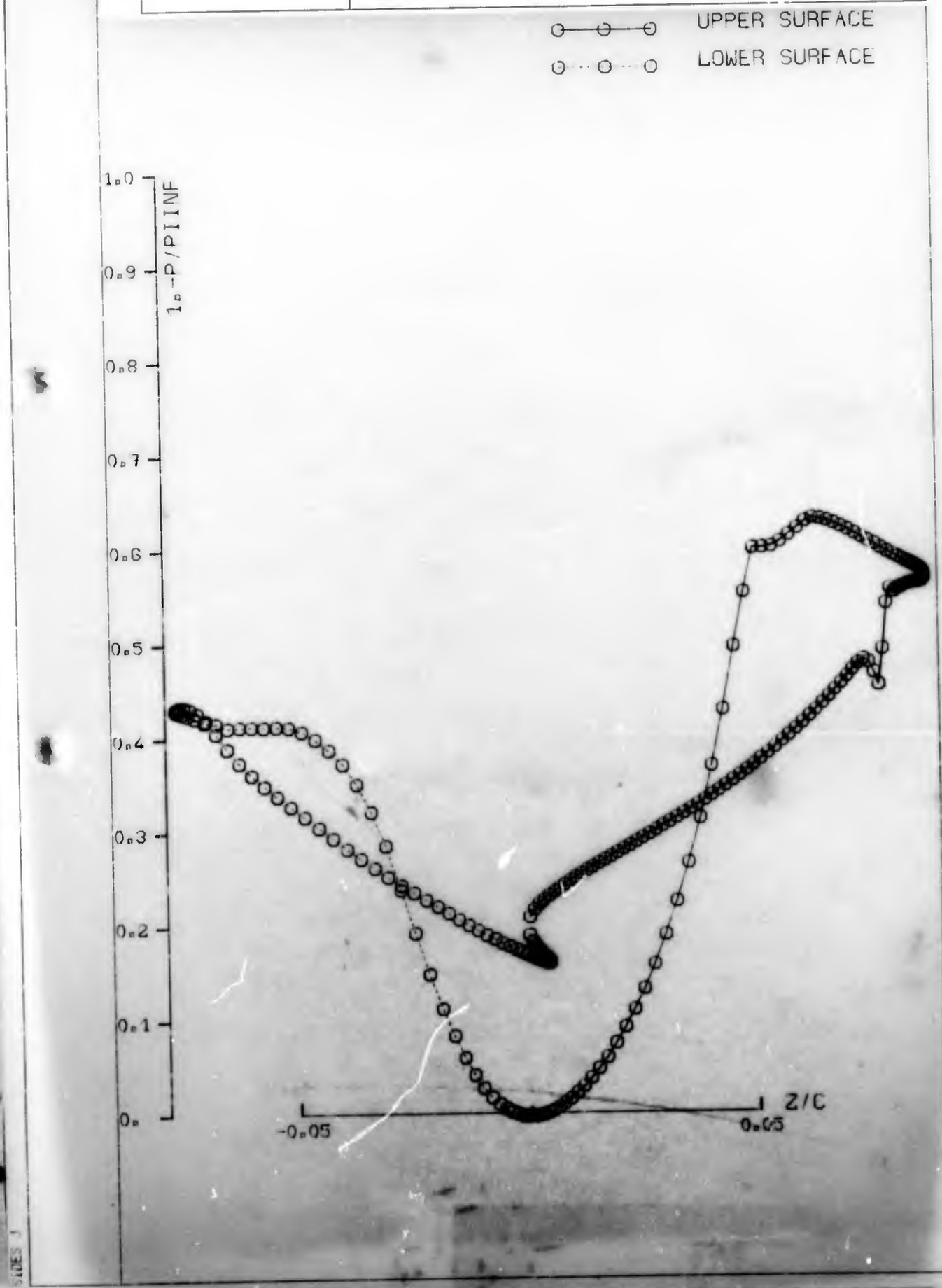
J SIDES

O.N.E.R.A.	AR 211		J.Sidès	07-2-8
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



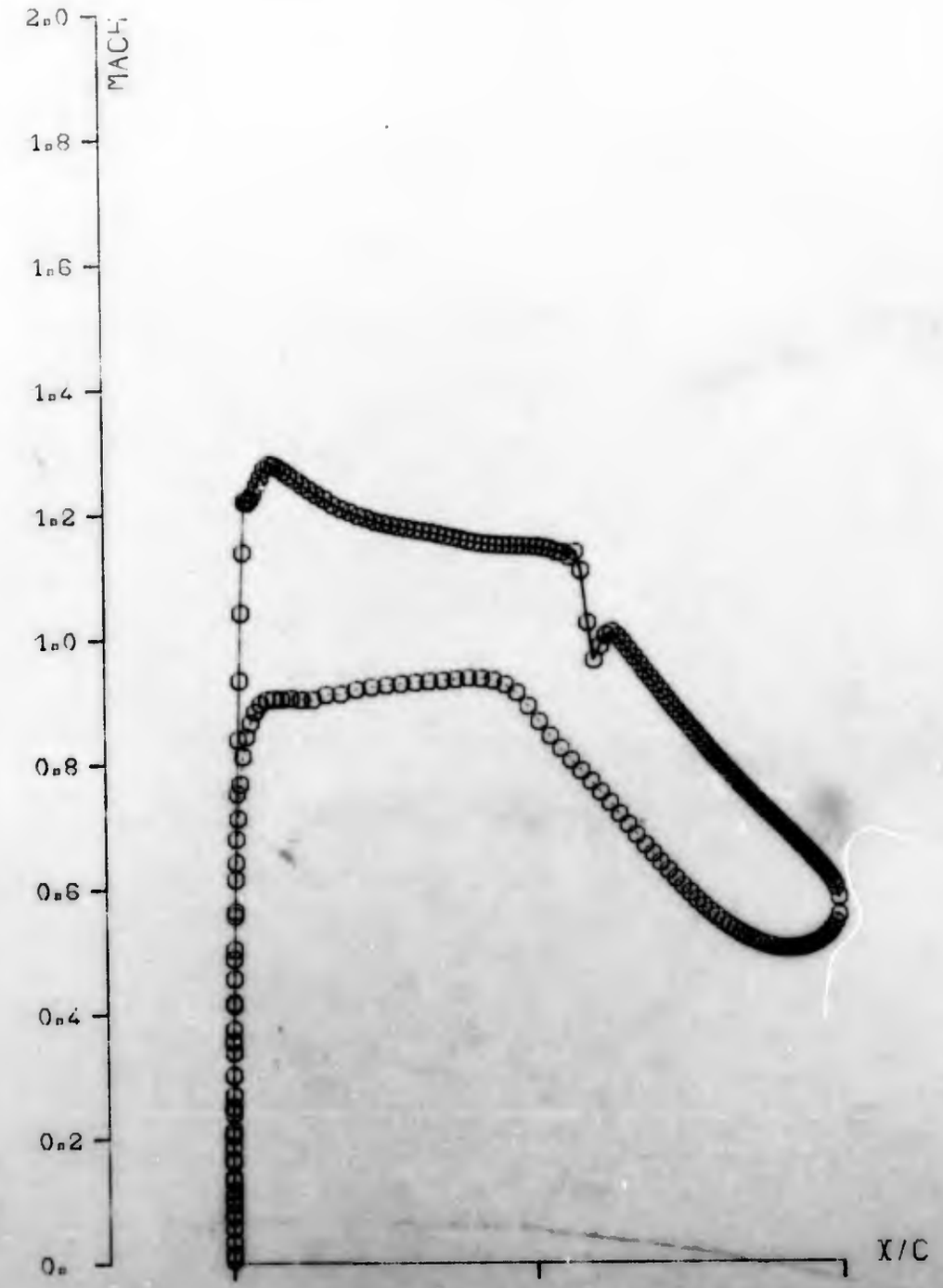
SIDES J

O.N.E.R.A.	AR 211		J.Sidès	07-2-9
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

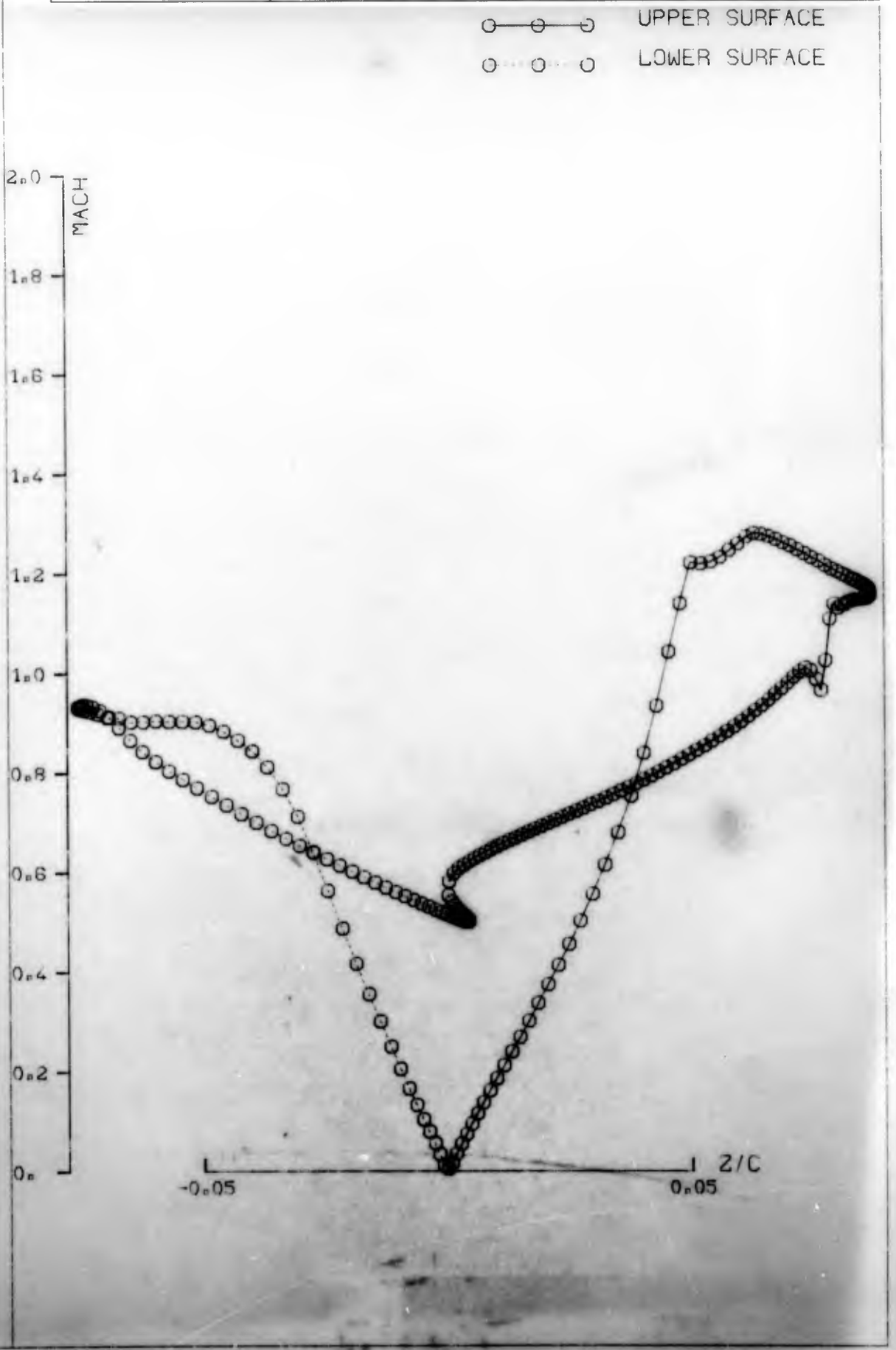


SIDES 1

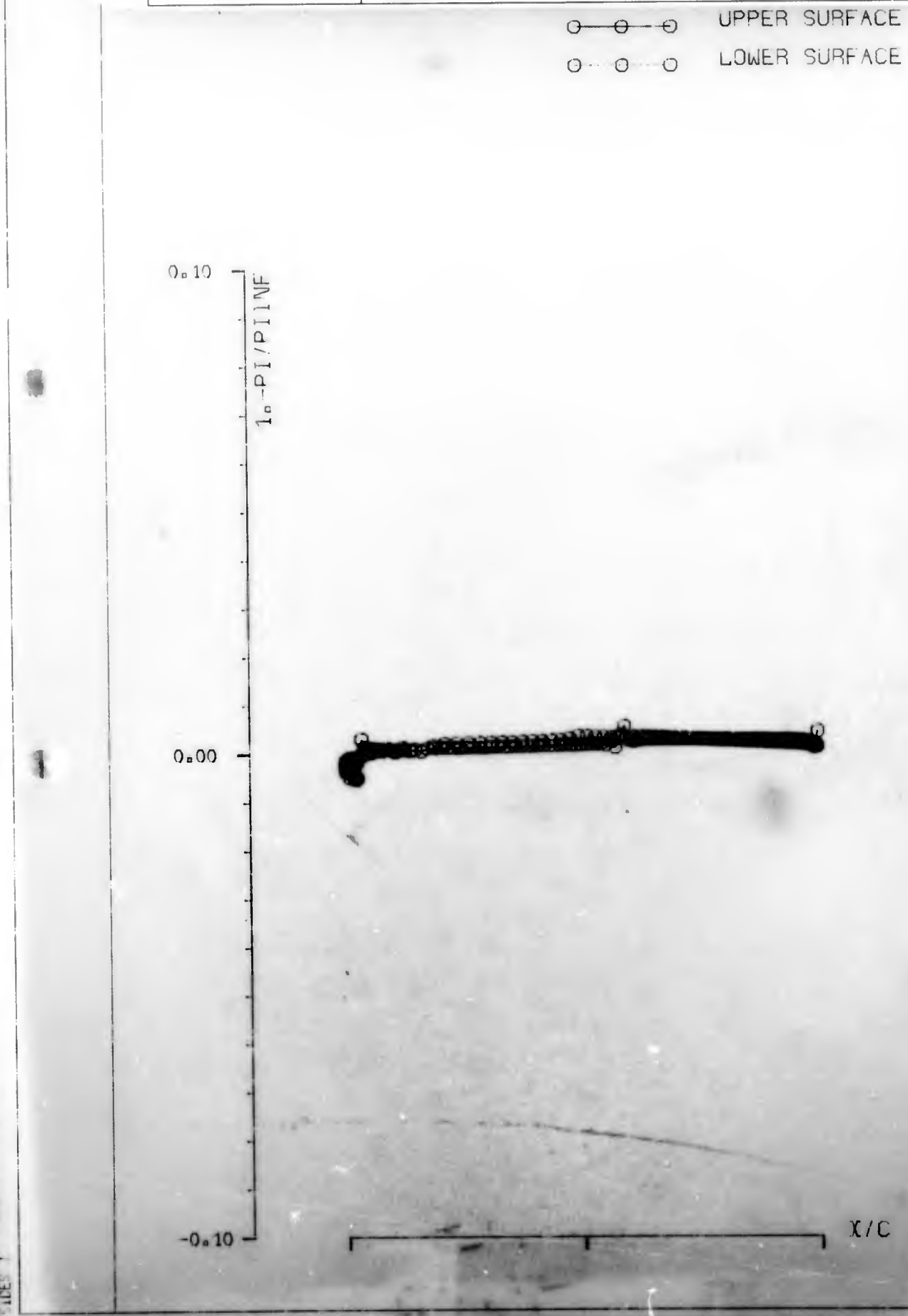
O.N.E.R.A.	AR 211		J.Sidès	07-2-10
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



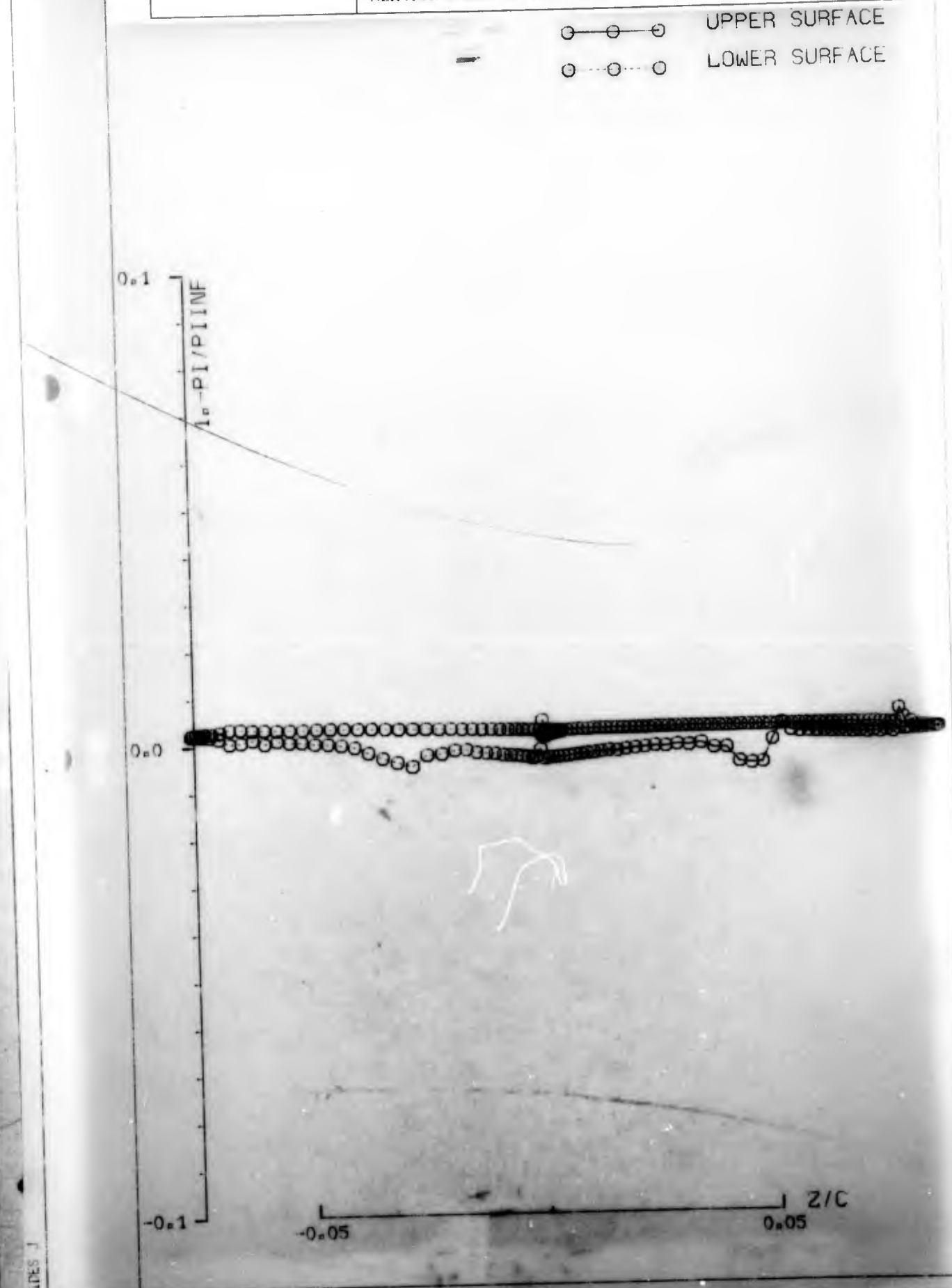
O.N.E.R.A.	AR 211		J.Sidès	07-2-11
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



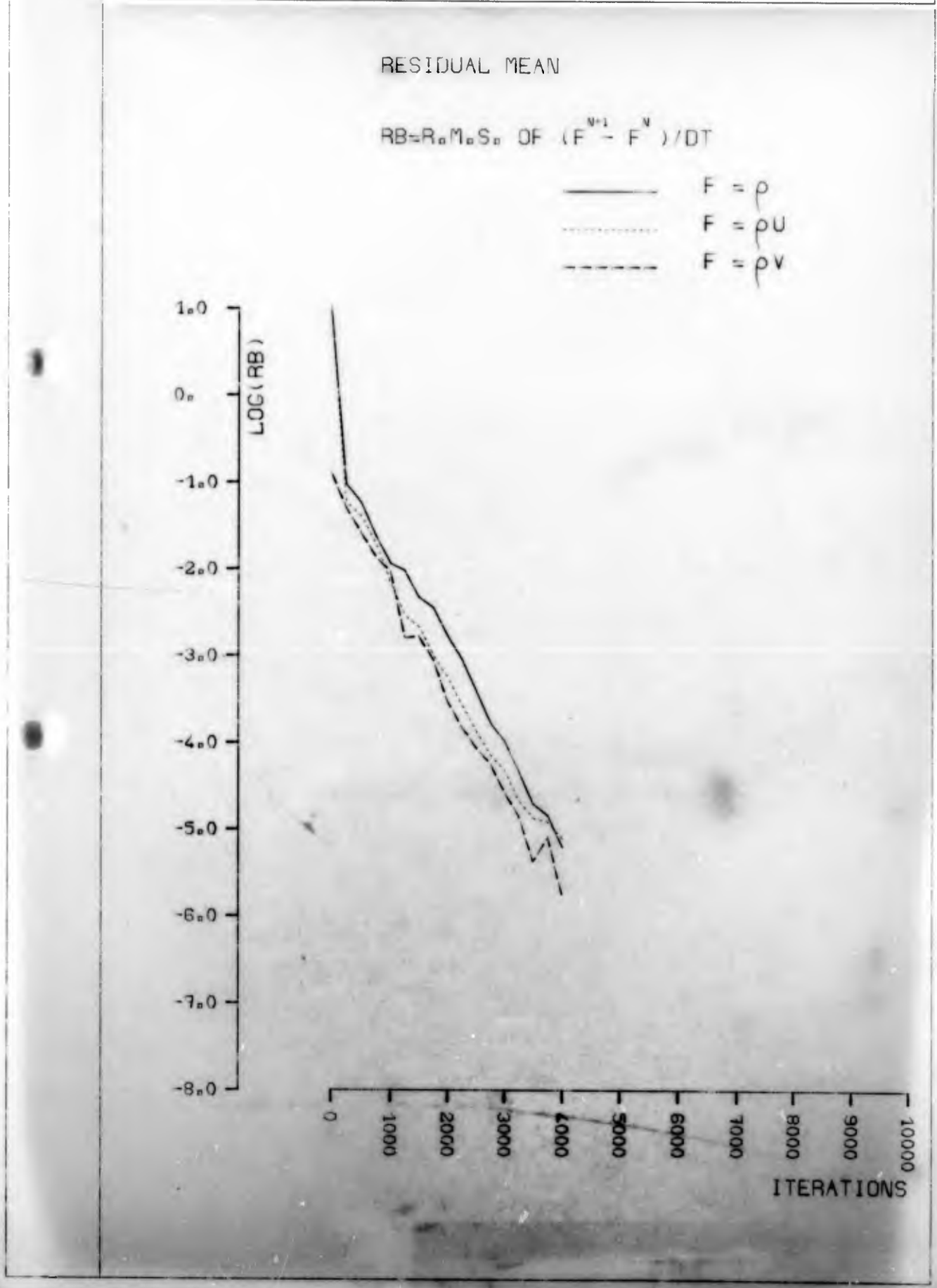
O.N.E.R.A.	AR 211		J.Sidès	07-2-12
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



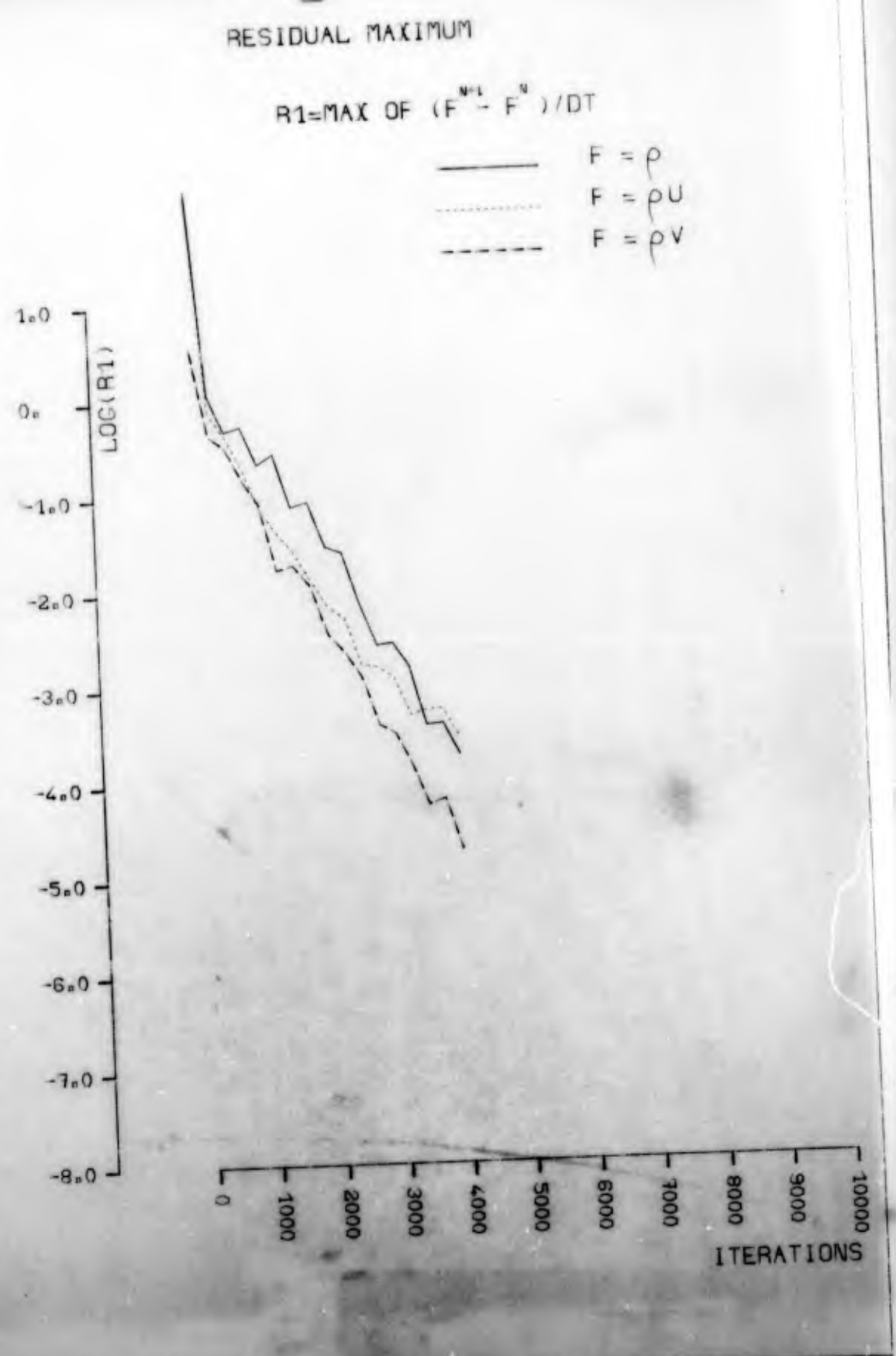
O.N.E.R.A.	AR 211		J.Sidès	07-2-13
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



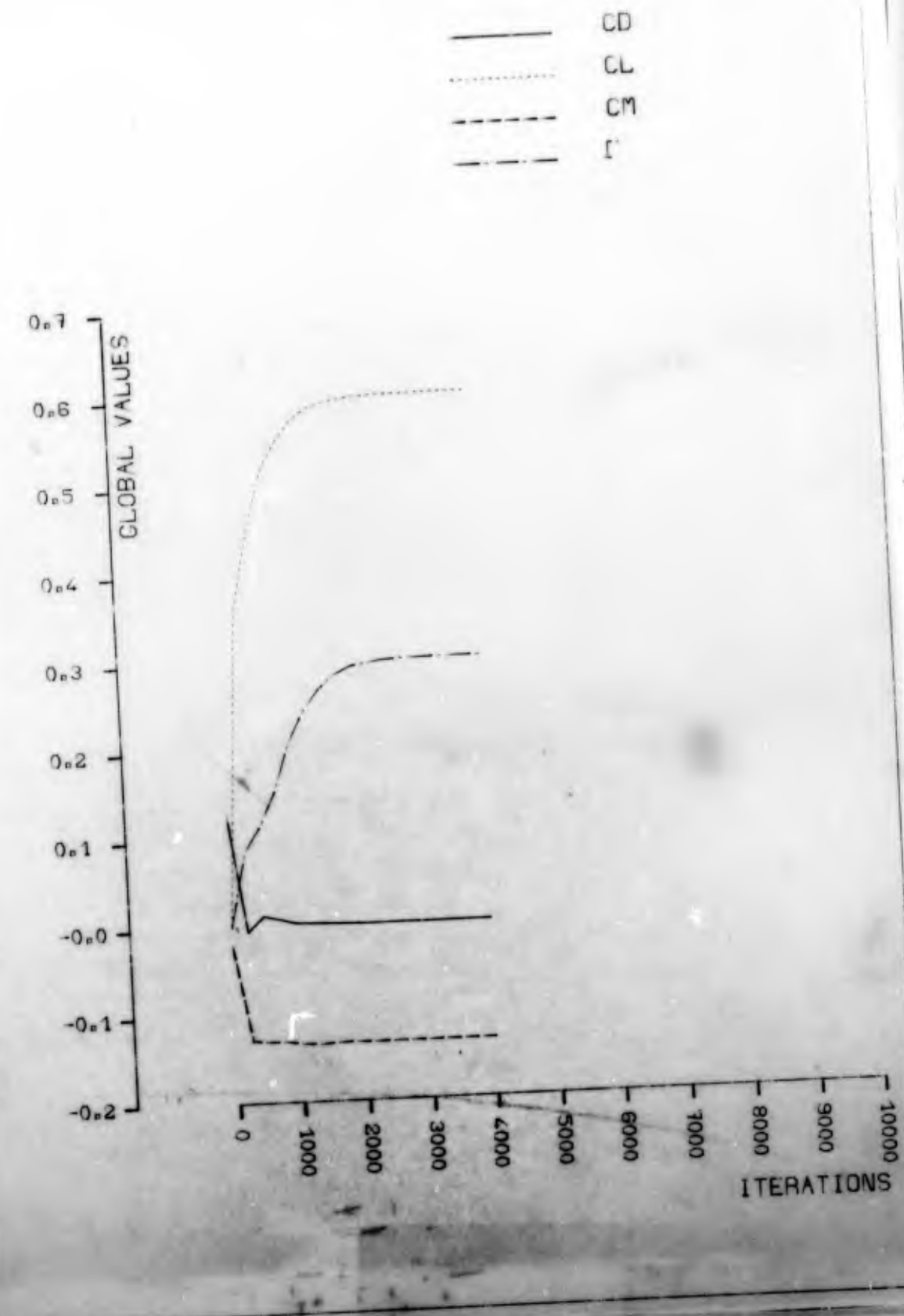
O.N.E.R.A.	AR 211		J.Sidès	07-2-14
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



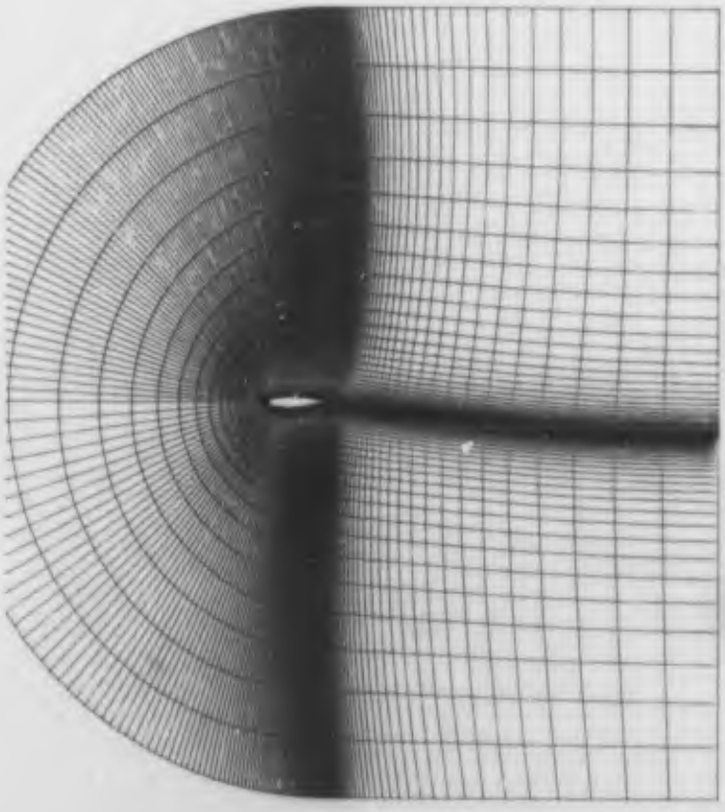
O.N.E.R.A.	AR 211		J.Sidès	07-2-15
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



O.N.E.R.A.	AR 211		J.Sidès	07-2-16
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

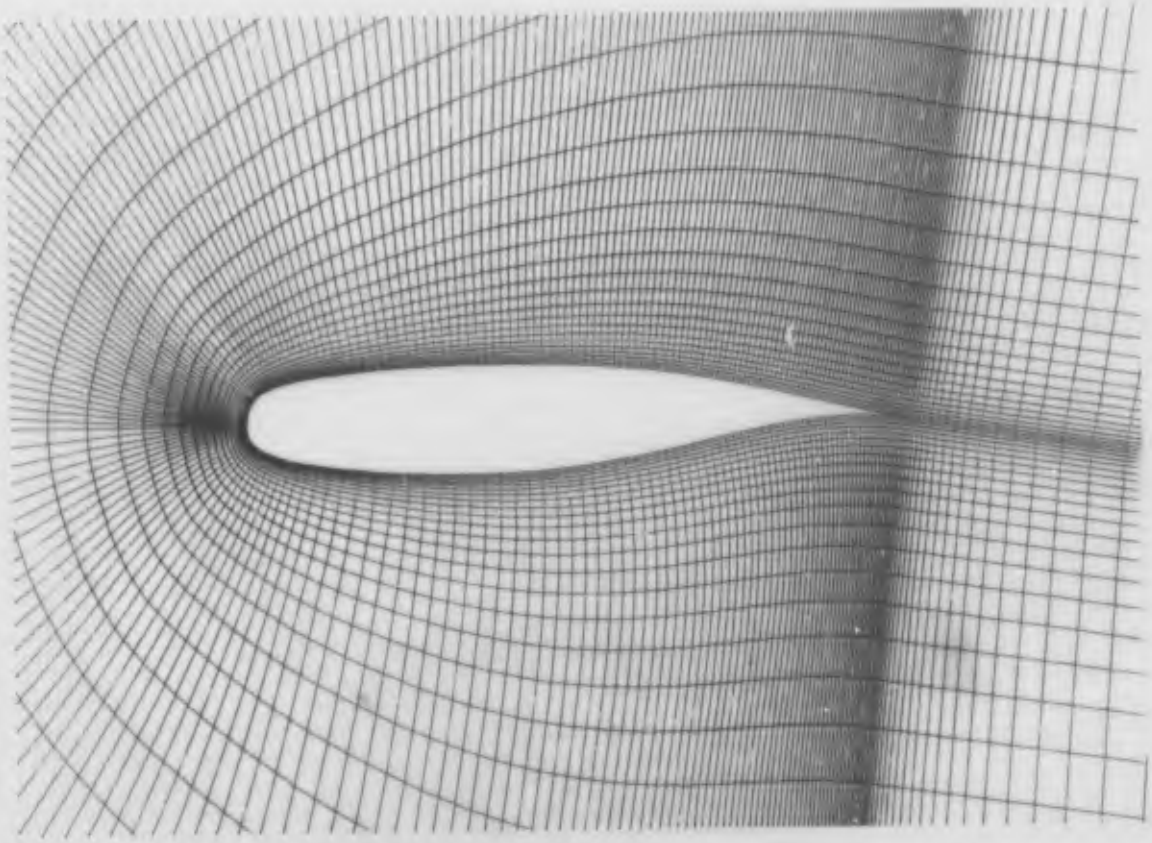


O.N.E.R.A.	AR 211		J.Sidès	07-2-17
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



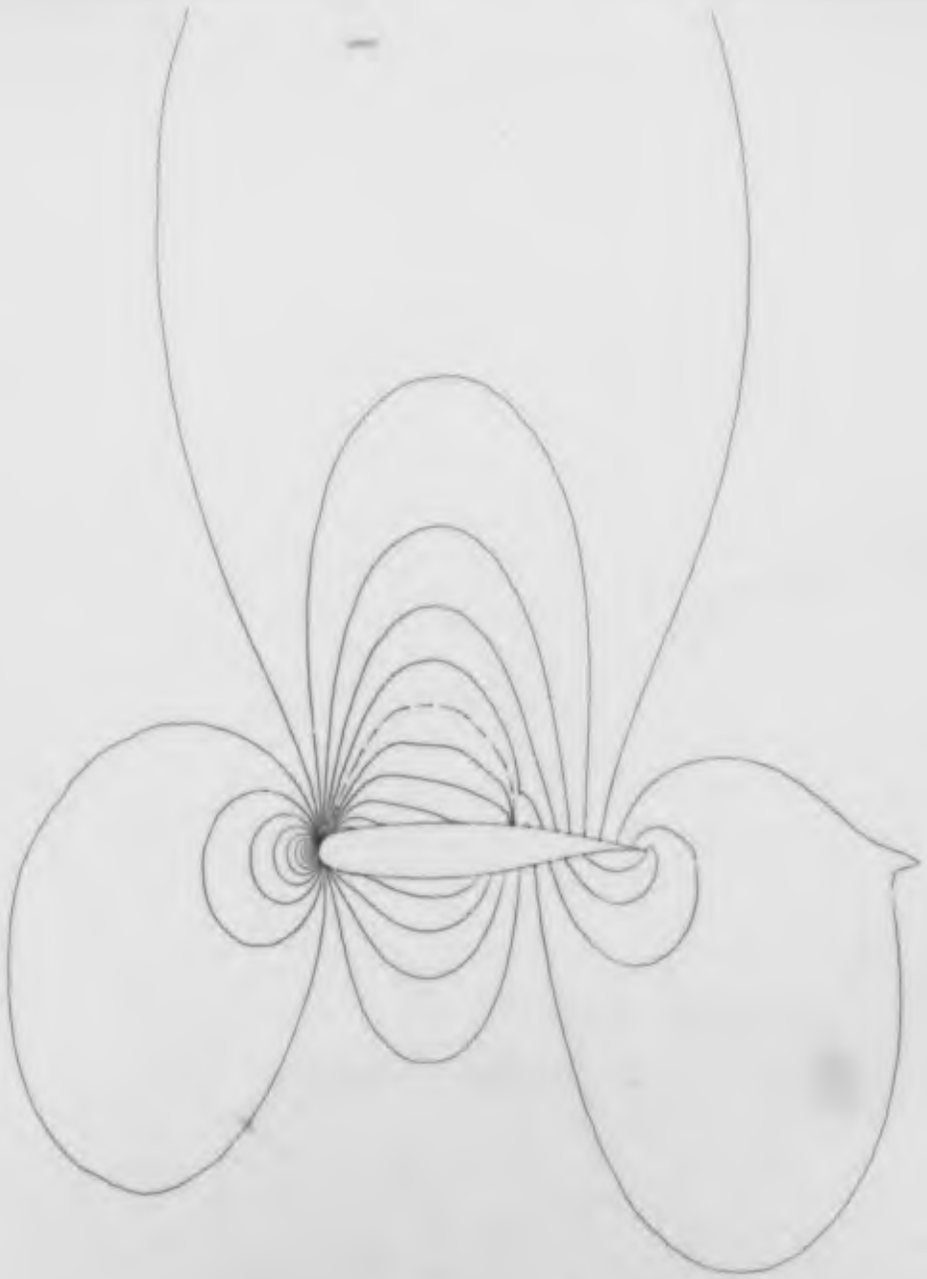
299X35 MESH CHORD = 1 CM

O.N.E.R.A.	AR 211		J.Sidès	07-2-18
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



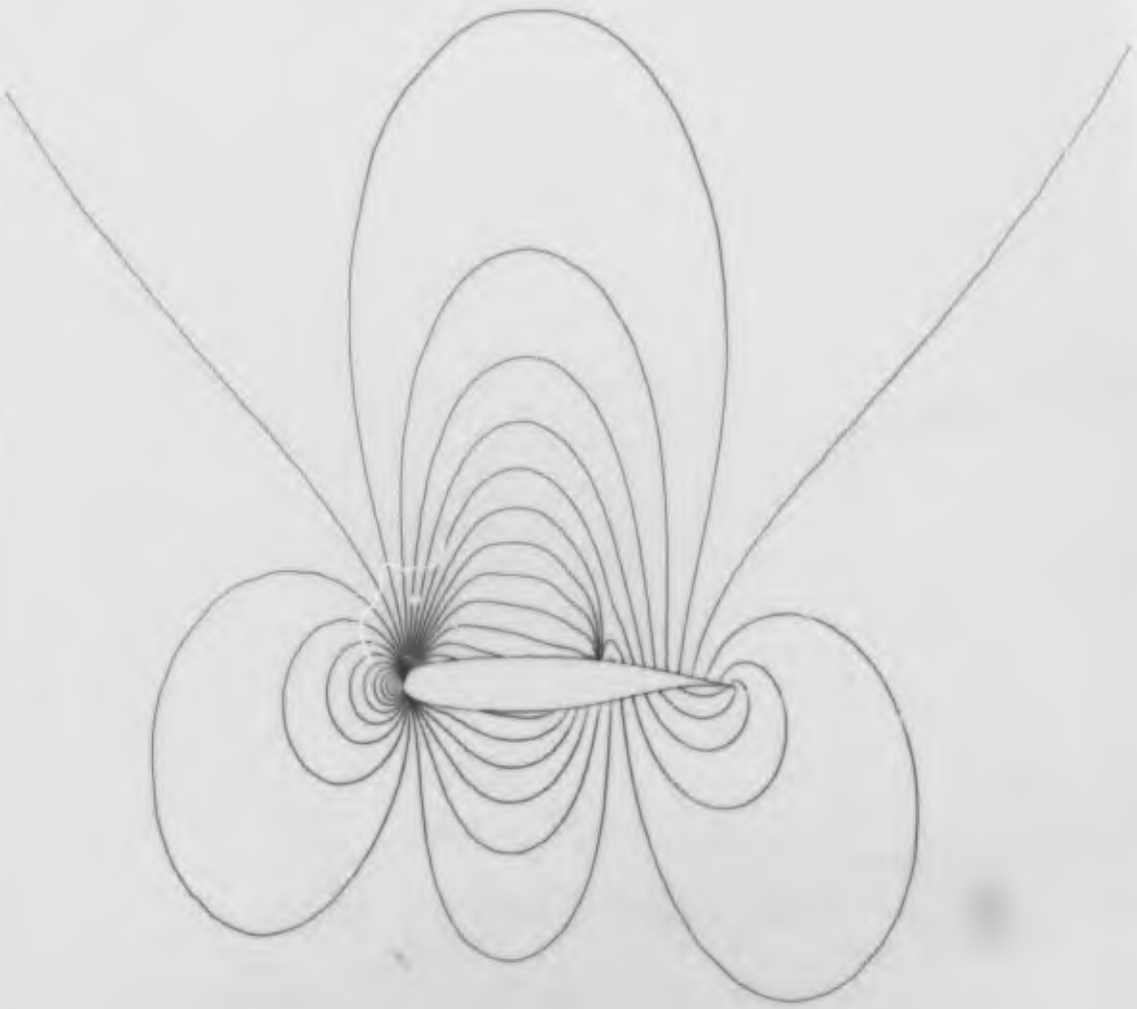
299X35 MESH (PARTIAL VIEW)

O.N.E.R.A.	AR 211		J.Sid	07-2-19
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



ISO-MACH LINES DM=0.050 CHORD = 5 CM

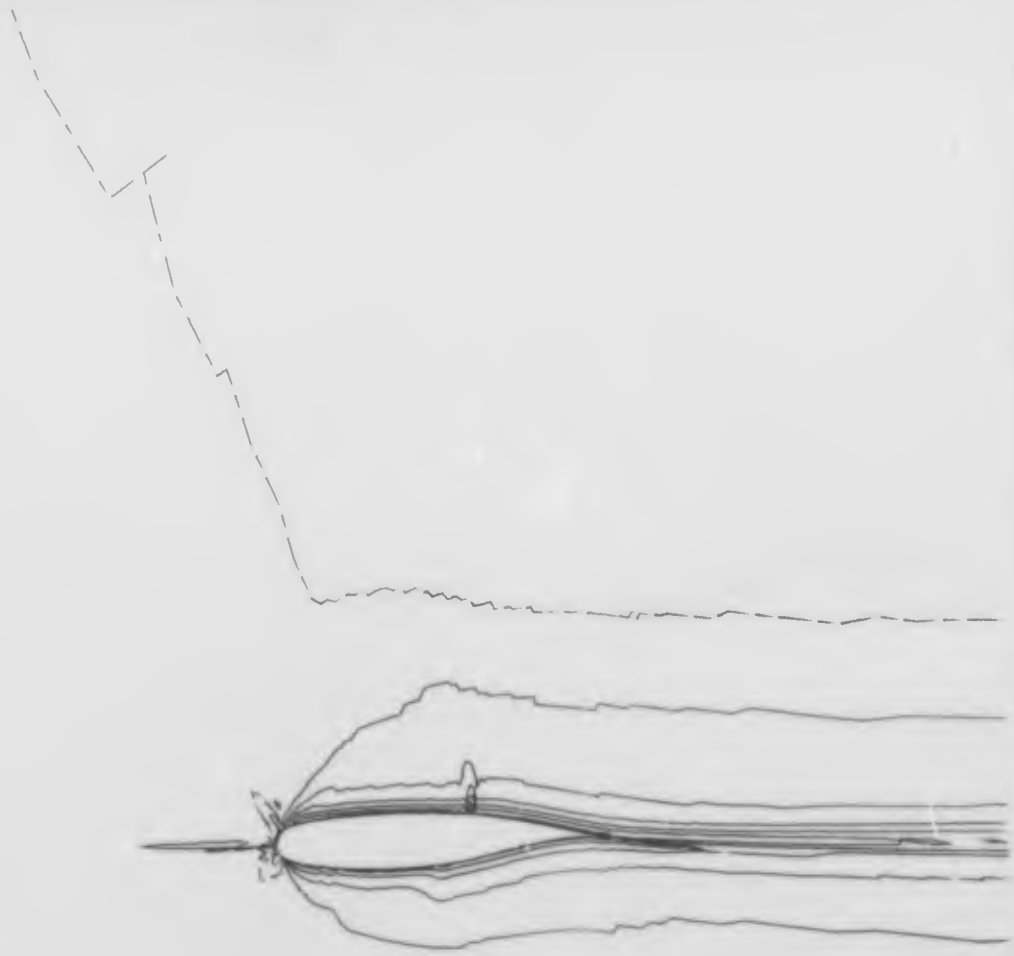
O.N.E.R.A.	AR 211		J.Sidès	07-2-20
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



ISO-P/PIINF DP=0.025 CHORD= 5 CM

AB-SIDES

O.N.E.R.A.	AR 211		J.Sidès	07-2-2'
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



ISO-PI/PIINF DPI=0.001 CHORD= 5 CM

AR-SIDES

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 07

NLR 7301: MACH = 0.720957, ALPHA = −0.194

Contributor No 3

C.C.Lytton

(R.A.E., G.B.)

R.A.E.	AR 211		C.C.Lytton	07-3-1
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

NLR 7301 MACH 0.721 ALPHA −0.194 0<X<1:

VERSION 87: KEEPS WALL CELLS ROUGHLY SAME ASPECT RATIO

AFTER K=1, CELL DEPTHS INCREASE IN GEOMETRIC PROGRESSION

TOTAL CELL DEPTH =16.0*CHORD

JL	KL	NEND	NPRNT
160	24	0	0

CP*	P(CR)	CPS	P(ST)
-0.6959	1.0262	1.1368	1.9426

J	X/C	Z/C	1-P/H	CP	M	1-PI/H
2	1.000	0.0000	0.1936	0.3845	0.5462	0.0123
3	0.999	0.0001	0.1927	0.3880	0.5456	0.0117
4	0.997	0.0004	0.1906	0.3961	0.5420	0.0116
5	0.995	0.0007	0.1872	0.4093	0.5366	0.0113
6	0.992	0.0011	0.1835	0.4237	0.5307	0.0109
7	0.988	0.0015	0.1800	0.4374	0.5249	0.0107
8	0.983	0.0020	0.1769	0.4493	0.5196	0.0106
9	0.978	0.0025	0.1742	0.4600	0.5148	0.0106
10	0.972	0.0031	0.1717	0.4696	0.5104	0.0106
11	0.965	0.0036	0.1692	0.4793	0.5060	0.0105
12	0.957	0.0040	0.1671	0.4876	0.5021	0.0106
13	0.948	0.0043	0.1653	0.4946	0.4987	0.0107
14	0.939	0.0046	0.1638	0.5003	0.4958	0.0109
15	0.930	0.0047	0.1626	0.5050	0.4936	0.0109
16	0.919	0.0046	0.1625	0.5056	0.4930	0.0111
17	0.908	0.0043	0.1630	0.5037	0.4933	0.0115
18	0.896	0.0037	0.1638	0.5002	0.4948	0.0115
19	0.884	0.0029	0.1654	0.4942	0.4973	0.0117
20	0.871	0.0018	0.1676	0.4856	0.5010	0.0120
21	0.857	0.0004	0.1706	0.4739	0.5059	0.0123
22	0.843	-0.0014	0.1744	0.4590	0.5123	0.0126
23	0.828	-0.0034	0.1793	0.4402	0.5203	0.0130
24	0.813	-0.0058	0.1851	0.4175	0.5300	0.0133
25	0.797	-0.0086	0.1920	0.3909	0.5413	0.0137
26	0.781	-0.0116	0.1999	0.3603	0.5544	0.0141
27	0.764	-0.0149	0.2088	0.3255	0.5692	0.0144
28	0.747	-0.0185	0.2188	0.2868	0.5856	0.0146
29	0.730	-0.0223	0.2295	0.2450	0.6032	0.0148
30	0.712	-0.0262	0.2411	0.2000	0.6220	0.0149
31	0.694	-0.0302	0.2533	0.1525	0.6418	0.0150
32	0.675	-0.0343	0.2667	0.1007	0.6631	0.0151
33	0.656	-0.0384	0.2811	0.0445	0.6860	0.0151
34	0.637	-0.0425	0.2960	-0.0134	0.7098	0.0149
35	0.618	-0.0465	0.3108	-0.0705	0.7333	0.0145
36	0.599	-0.0503	0.3249	-0.1254	0.7557	0.0142
37	0.579	-0.0540	0.3386	-0.1786	0.7772	0.0140
38	0.559	-0.0574	0.3522	-0.2316	0.7986	0.0139
39	0.540	-0.0606	0.3664	-0.2867	0.8208	0.0138
40	0.520	-0.0636	0.3821	-0.3479	0.8455	0.0137
41	0.500	-0.0663	0.3995	-0.4152	0.8729	0.0134
42	0.480	-0.0687	0.4152	-0.4762	0.8984	0.0125
43	0.460	-0.0707	0.4252	-0.5152	0.9148	0.0120
44	0.441	-0.0723	0.4309	-0.5372	0.9238	0.0120
45	0.421	-0.0736	0.4334	-0.5470	0.9279	0.0120

R.A.E.	AR 211		C.C.Lytton	07-3-2
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

46	0.401	−0.0745	0.4339	−0.5491	0.9287	0.0120
47	0.382	−0.0752	0.4332	−0.5463	0.9276	0.0119
48	0.363	−0.0757	0.4321	−0.5421	0.9259	0.0119
49	0.344	−0.0759	0.4308	−0.5371	0.9238	0.0120
50	0.325	−0.0759	0.4299	−0.5334	0.9223	0.0120
51	0.306	−0.0757	0.4289	−0.5297	0.9207	0.0120
52	0.288	−0.0754	0.4280	−0.5262	0.9193	0.0120
53	0.270	−0.0748	0.4269	−0.5218	0.9175	0.0120
54	0.253	−0.0741	0.4257	−0.5171	0.9156	0.0120
55	0.236	−0.0733	0.4244	−0.5120	0.9135	0.0120
56	0.219	−0.0723	0.4229	−0.5063	0.9112	0.0120
57	0.203	−0.0711	0.4212	−0.4996	0.9084	0.0121
58	0.187	−0.0699	0.4194	−0.4925	0.9055	0.0121
59	0.172	−0.0685	0.4174	−0.4850	0.9024	0.0121
60	0.157	−0.0669	0.4155	−0.4774	0.8993	0.0121
61	0.143	−0.0653	0.4128	−0.4671	0.8951	0.0121
62	0.129	−0.0635	0.4087	−0.4510	0.8887	0.0121
63	0.116	−0.0617	0.4105	−0.4580	0.8911	0.0125
64	0.104	−0.0597	0.4111	−0.4602	0.8921	0.0124
65	0.092	−0.0577	0.4100	−0.4561	0.8903	0.0125
66	0.081	−0.0555	0.4093	−0.4535	0.8891	0.0126
67	0.070	−0.0532	0.4091	−0.4525	0.8886	0.0128
68	0.061	−0.0508	0.4076	−0.4467	0.8861	0.0129
69	0.052	−0.0482	0.4017	−0.4240	0.8770	0.0128
70	0.043	−0.0455	0.3930	−0.3901	0.8630	0.0131
71	0.035	−0.0426	0.3790	−0.3356	0.8410	0.0132
72	0.028	−0.0395	0.3665	−0.2875	0.8204	0.0145
73	0.022	−0.0362	0.3414	−0.1898	0.7816	0.0141
74	0.017	−0.0327	0.3084	−0.0615	0.7302	0.0140
75	0.012	−0.0288	0.2557	0.1434	0.6508	0.0107
76	0.008	−0.0246	0.1952	0.3783	0.5505	0.0112
77	0.005	−0.0200	0.1261	0.6470	0.4255	0.0102
78	0.003	−0.0150	0.0748	0.8463	0.3020	0.0144
79	0.001	−0.0097	0.0300	1.0204	0.1716	0.0098
80	0.000	−0.0035	0.0078	1.1063	0.0643	0.0050
81	0.000	0.0031	0.0101	1.0977	0.0853	0.0050
82	0.001	0.0097	0.0275	1.0299	0.1898	0.0028
83	0.003	0.0166	0.0657	0.8814	0.3042	0.0038
84	0.005	0.0234	0.1262	0.6464	0.4292	0.0083
85	0.008	0.0299	0.1971	0.3712	0.5590	0.0073
86	0.012	0.0359	0.2936	−0.0040	0.7119	0.0097
87	0.017	0.0413	0.3979	−0.4092	0.8794	0.0040
88	0.022	0.0459	0.4926	−0.7772	1.0144	0.0233
89	0.028	0.0497	0.5830	−1.1282	1.1615	0.0378
90	0.035	0.0530	0.5820	−1.1245	1.1622	0.0349
91	0.043	0.0560	0.5863	−1.1412	1.1703	0.0347
92	0.052	0.0587	0.6009	−1.1977	1.1973	0.0356
93	0.061	0.0612	0.6117	−1.2397	1.2176	0.0363
94	0.070	0.0635	0.6172	−1.2612	1.2300	0.0344
95	0.081	0.0656	0.6170	−1.2603	1.2316	0.0319
96	0.092	0.0676	0.6136	−1.2473	1.2260	0.0306
97	0.104	0.0695	0.6082	−1.2263	1.2163	0.0294
98	0.116	0.0714	0.6015	−1.2003	1.2037	0.0291
99	0.129	0.0731	0.5954	−1.1764	1.1922	0.0288
100	0.143	0.0748	0.5899	−1.1552	1.1821	0.0284
101	0.157	0.0764	0.5850	−1.1362	1.1733	0.0279
102	0.172	0.0779	0.5803	−1.1179	1.1649	0.0274
103	0.187	0.0793	0.5758	−1.1001	1.1568	0.0270
104	0.203	0.0806	0.5715	−1.0838	1.1493	0.0267
105	0.219	0.0817	0.5676	−1.0686	1.1424	0.0265

R.A.E.	AR 211		C.C.Lytton	07-3-3
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

106	0.236	0.0828	0.5640	−1.0543	1.1358	0.0262
107	0.253	0.0838	0.5605	−1.0407	1.1297	0.0260
108	0.270	0.0846	0.5574	−1.0287	1.1243	0.0258
109	0.288	0.0854	0.5548	−1.0185	1.1198	0.0256
110	0.306	0.0860	0.5522	−1.0087	1.1154	0.0254
111	0.325	0.0864	0.5498	−0.9993	1.1112	0.0253
112	0.344	0.0868	0.5478	−0.9915	1.1077	0.0252
113	0.363	0.0870	0.5458	−0.9838	1.1043	0.0250
114	0.382	0.0870	0.5432	−0.9735	1.0998	0.0249
115	0.401	0.0870	0.5393	−0.9587	1.0931	0.0248
116	0.421	0.0867	0.5356	−0.9439	1.0865	0.0247
117	0.441	0.0864	0.5316	−0.9284	1.0796	0.0247
118	0.460	0.0858	0.5283	−0.9157	1.0739	0.0247
119	0.480	0.0852	0.5256	−0.9051	1.0691	0.0248
120	0.500	0.0843	0.5254	−0.9044	1.0688	0.0248
121	0.520	0.0833	0.5209	−0.8871	1.0610	0.0248
122	0.540	0.0821	0.5223	−0.8926	1.0634	0.0249
123	0.559	0.0806	0.5261	−0.9073	1.0699	0.0249
124	0.579	0.0790	0.5298	−0.9216	1.0763	0.0249
125	0.599	0.0772	0.5276	−0.9129	1.0725	0.0249
126	0.618	0.0751	0.4988	−0.8010	1.0228	0.0254
127	0.637	0.0728	0.4693	−0.6865	0.9740	0.0252
128	0.656	0.0702	0.4589	−0.6460	0.9568	0.0253
129	0.675	0.0674	0.4452	−0.5928	0.9343	0.0255
130	0.694	0.0644	0.4306	−0.5362	0.9106	0.0258
131	0.712	0.0613	0.4162	−0.4801	0.8873	0.0260
132	0.730	0.0581	0.4020	−0.4252	0.8646	0.0262
133	0.747	0.0547	0.3883	−0.3718	0.8426	0.0265
134	0.764	0.0513	0.3752	−0.3210	0.8217	0.0266
135	0.781	0.0479	0.3628	−0.2728	0.8020	0.0268
136	0.797	0.0444	0.3509	−0.2265	0.7831	0.0269
137	0.813	0.0410	0.3396	−0.1827	0.7652	0.0270
138	0.828	0.0376	0.3290	−0.1414	0.7484	0.0270
139	0.843	0.0344	0.3192	−0.1032	0.7328	0.0270
140	0.857	0.0312	0.3100	−0.0675	0.7182	0.0270
141	0.871	0.0281	0.3013	−0.0337	0.7045	0.0269
142	0.884	0.0251	0.2931	−0.0020	0.6915	0.0268
143	0.896	0.0223	0.2855	0.0277	0.6794	0.0267
144	0.908	0.0196	0.2783	0.0557	0.6680	0.0266
145	0.919	0.0171	0.2715	0.0820	0.6572	0.0264
146	0.930	0.0147	0.2652	0.1066	0.6471	0.0262
147	0.939	0.0126	0.2591	0.1300	0.6375	0.0260
148	0.948	0.0106	0.2533	0.1527	0.6283	0.0258
149	0.957	0.0087	0.2477	0.1742	0.6195	0.0255
150	0.965	0.0071	0.2426	0.1944	0.6114	0.0252
151	0.972	0.0056	0.2376	0.2137	0.6037	0.0247
152	0.978	0.0044	0.2329	0.2318	0.5965	0.0243
153	0.983	0.0033	0.2285	0.2489	0.5898	0.0238
154	0.988	0.0023	0.2242	0.2656	0.5831	0.0234
155	0.992	0.0016	0.2200	0.2822	0.5763	0.0231
156	0.995	0.0010	0.2155	0.2995	0.5692	0.0227
157	0.997	0.0005	0.2105	0.3191	0.5615	0.0220
158	0.999	0.0002	0.2039	0.3445	0.5515	0.0212
159	1.000	0.0000	0.1984	0.3659	0.5432	0.0203

R.A.E.	AR 211		C.C.Lytton	07-3-4
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

CL= 0.55868 CD= 0.00237 CM= -0.12900

GAMMA AROUND PROFILE = 0.27173

K	GAMMA
1	0.27136
2	0.27519
3	0.27240
4	0.27861
5	0.27987
6	0.28128
7	0.28230
8	0.28213
9	0.28146
10	0.28071
11	0.28052
12	0.28001
13	0.27993
14	0.28019
15	0.28009
16	0.28065
17	0.28052
18	0.28095
19	0.28150
20	0.28190
21	0.28293
22	0.28404
23	0.29017

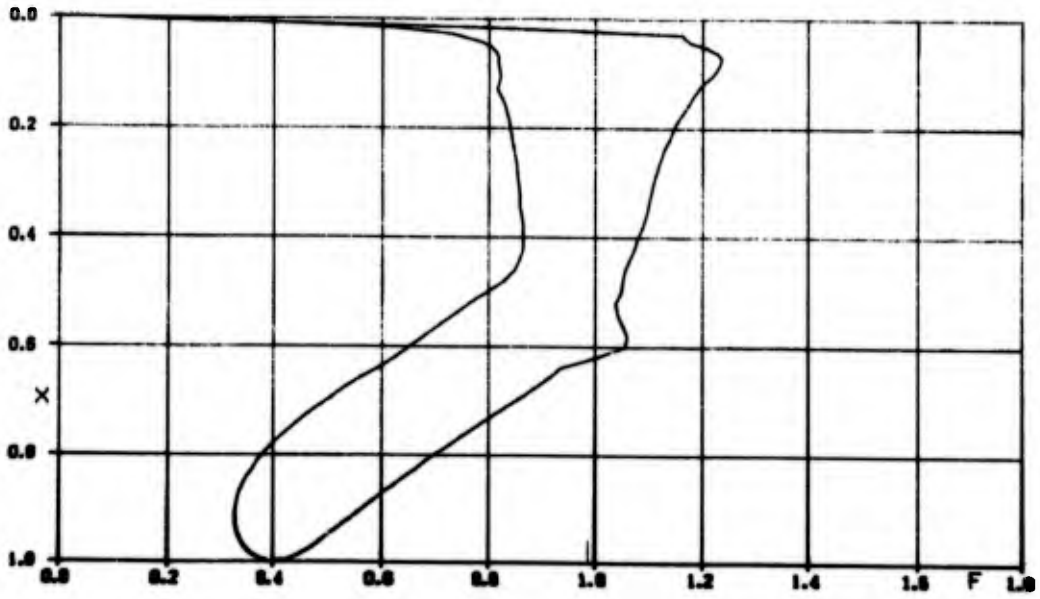
NO SHOCK ON -1 SURFACE

CD (SHOCK INTEGRAL - Mk.2) = 0.00030

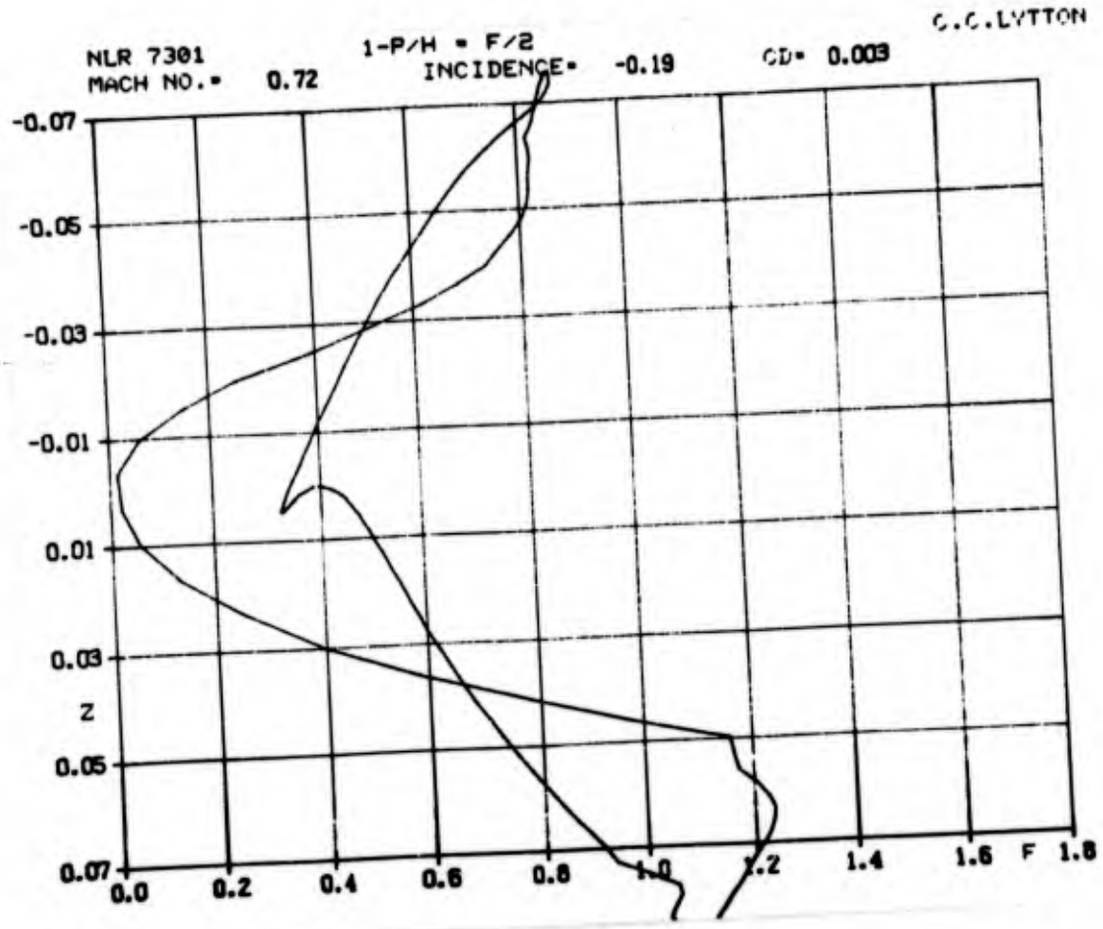
R.A.E.	AR 211		C.C.Lytton	07-3-5
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

NLR 7301 1-P/H = F/2 C.C.LYTTON

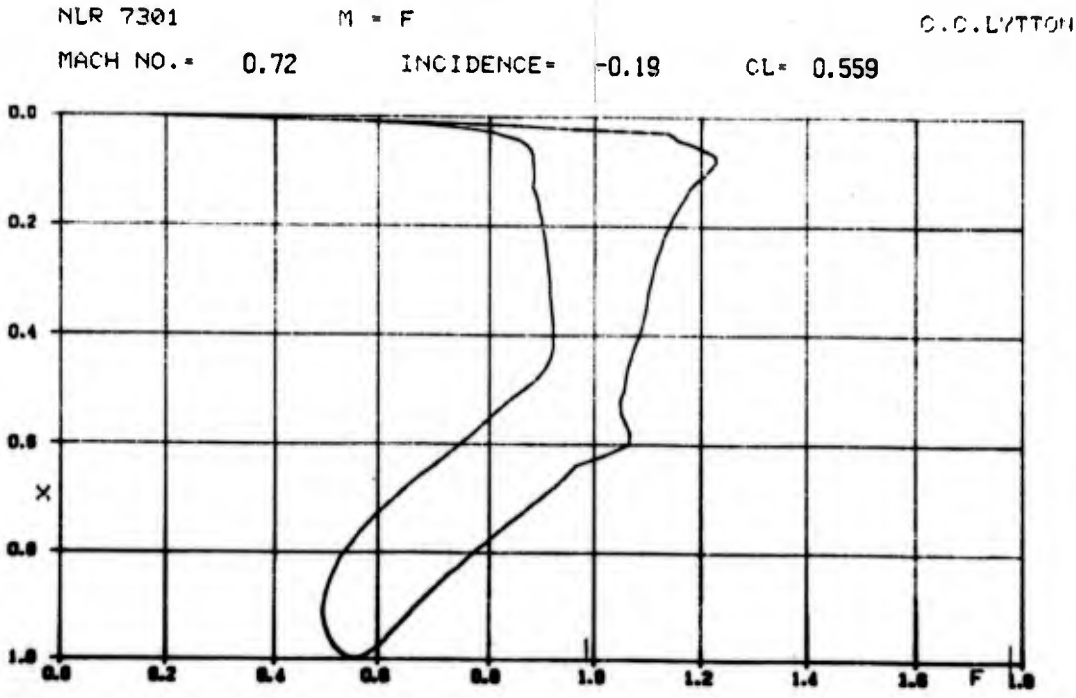
MACH NO.= 0.72 INCIDENCE= -0.19 CL= 0.559



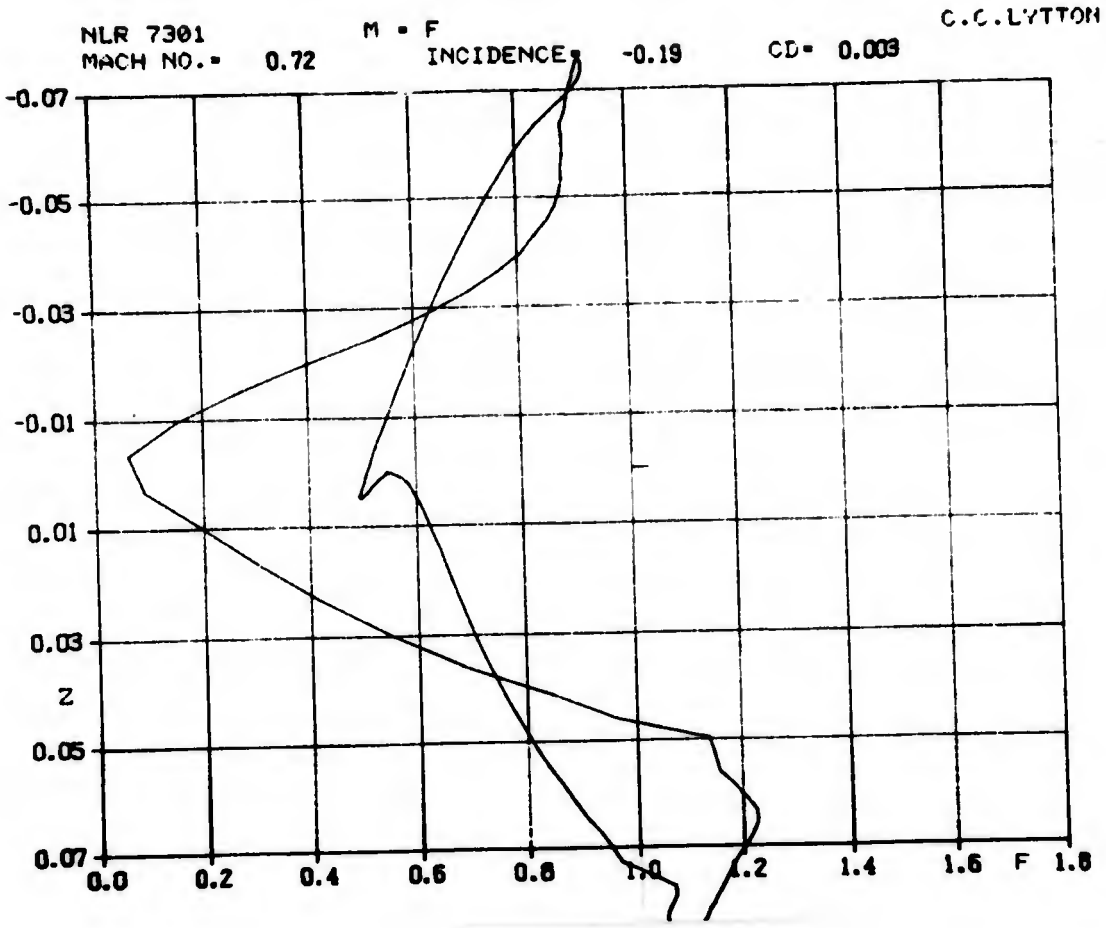
R.A.E.	AR 211		C.C.Lytton	07-3-6
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



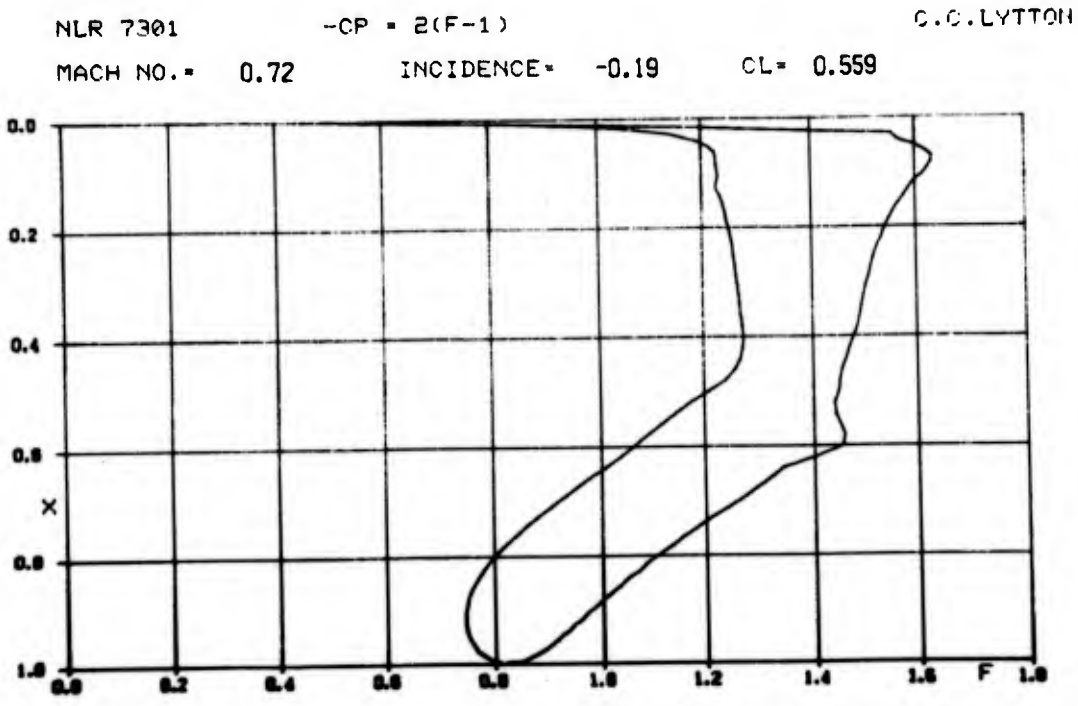
R.A.E.	AR 211		C.C.Lytton	07-3-7
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



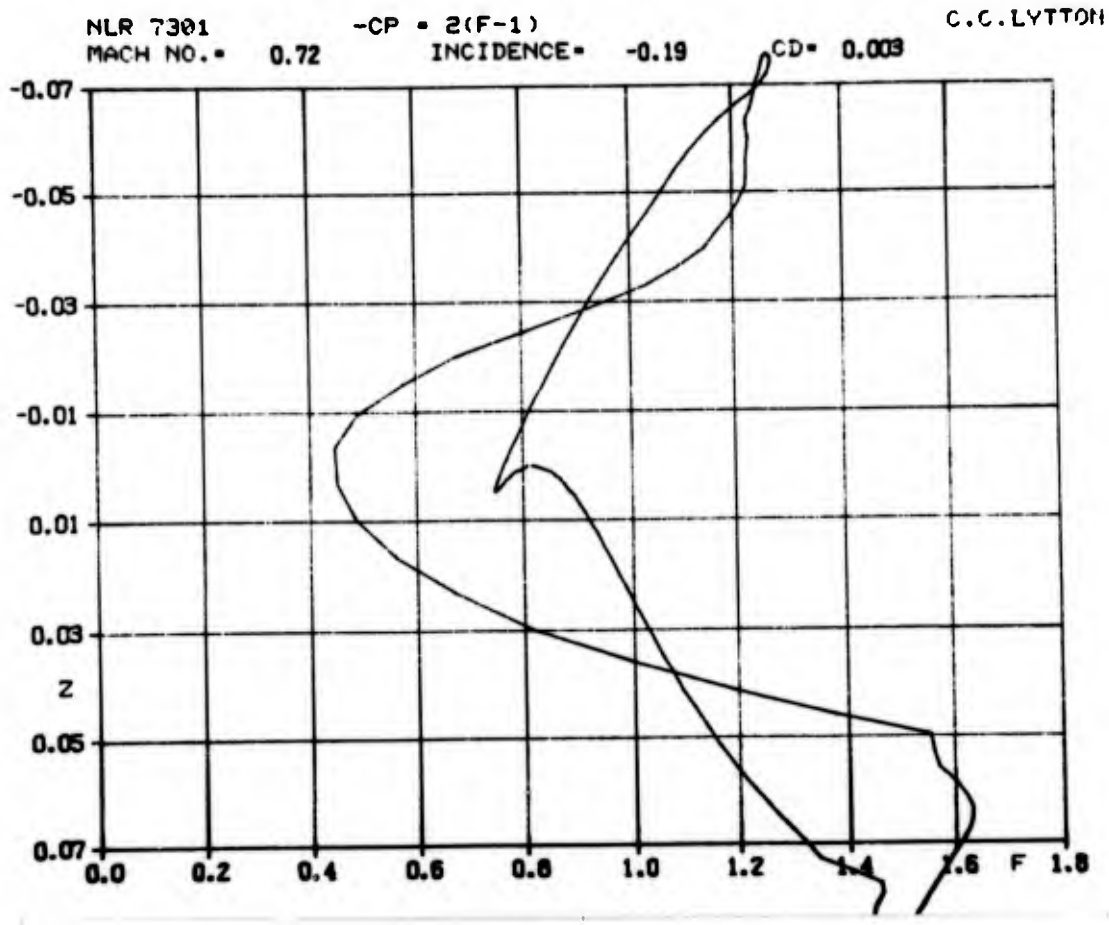
R.A.E.	AR 211		C.C.Lytton	07-3-8
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



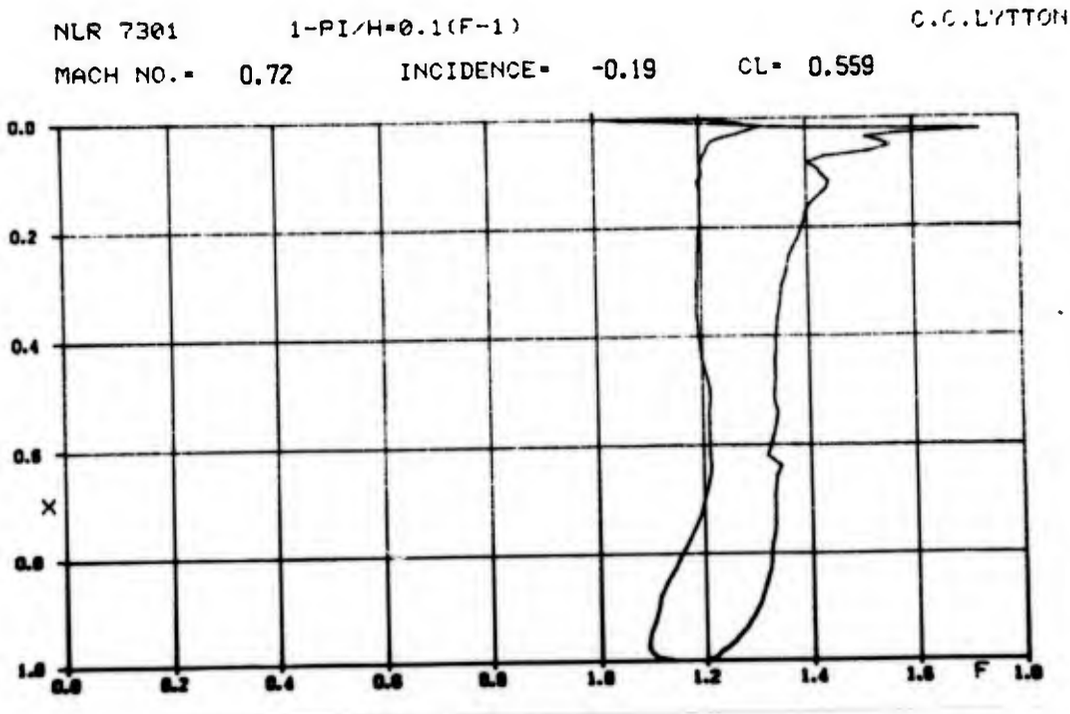
R.A.E.	AR 211		C.C.Lytton	07-3-9
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



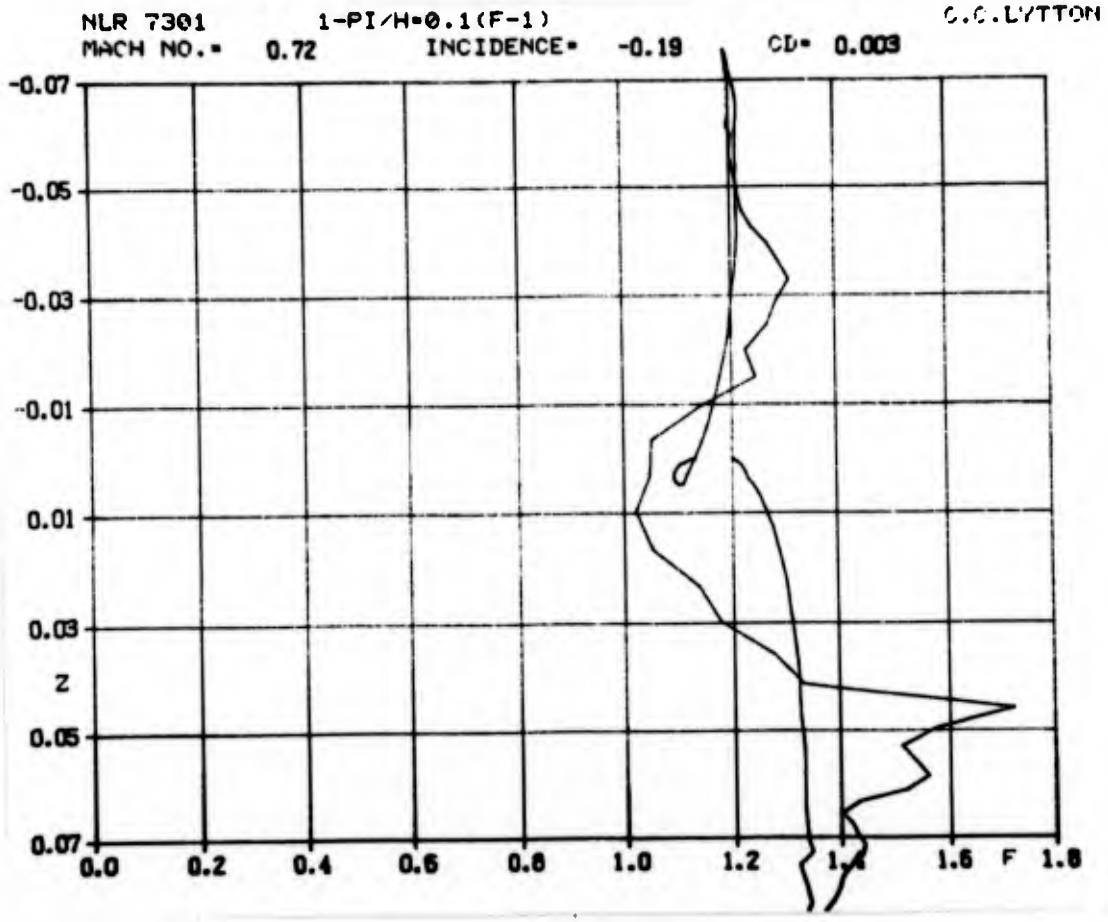
R.A.E.	AR 211		C.C.Lytton	07-3-10
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



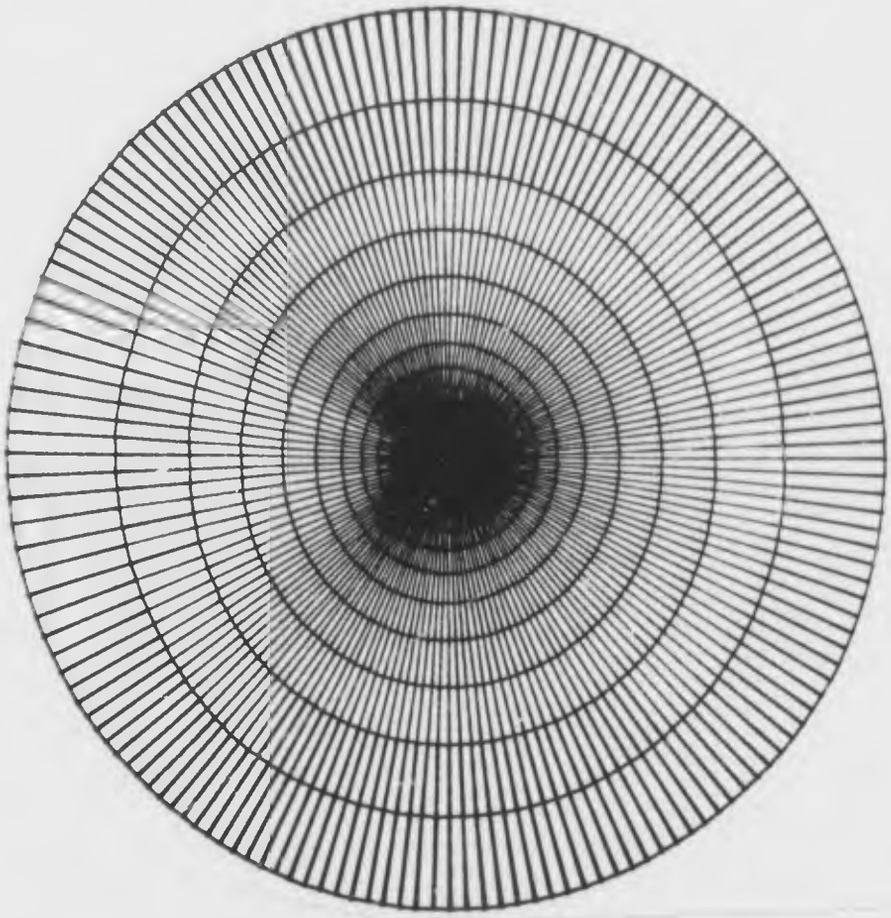
R.A.E.	AR 211		C.C.Lytton	07-3-11
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



R.A.E.	AR 211		C.C.Lytton	07-3-12
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

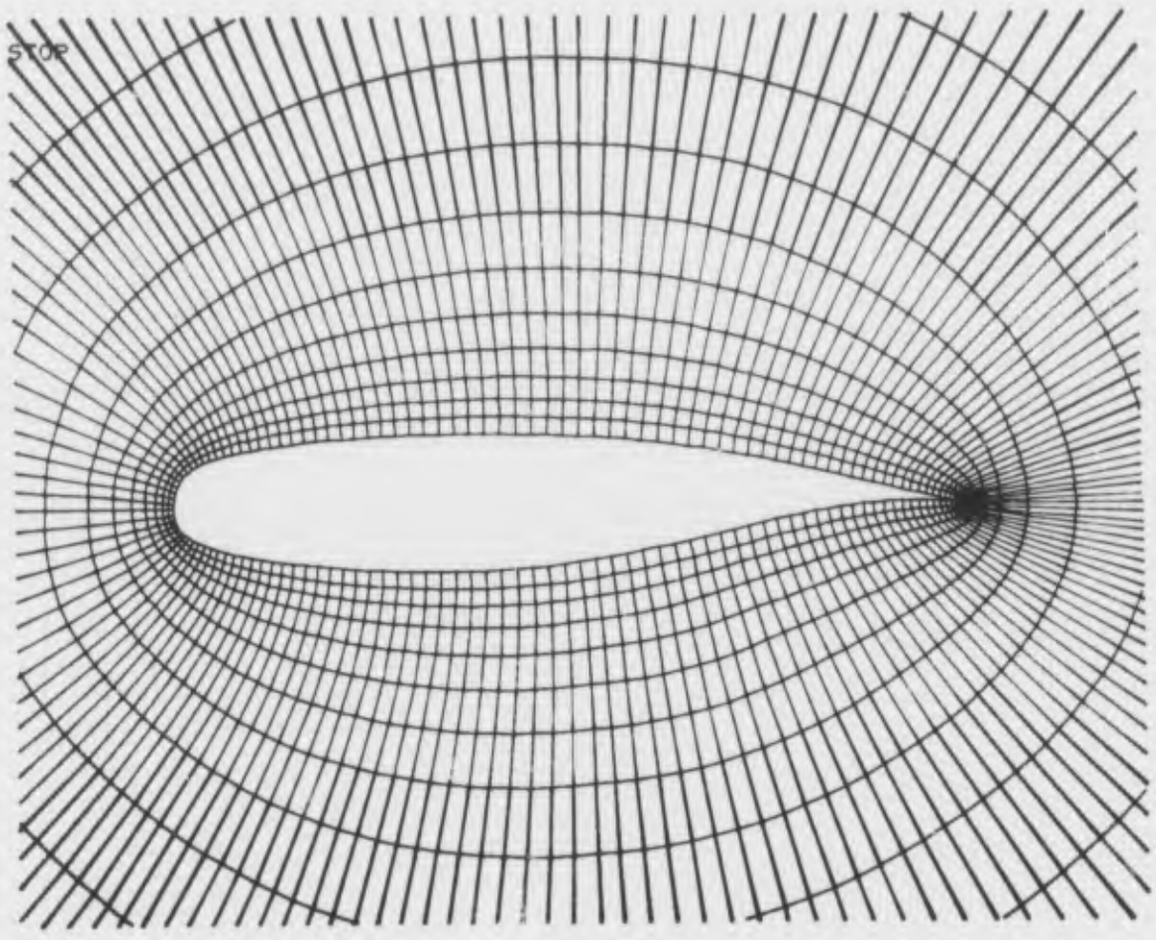


R.A.E.	AR 211		C.C.Lytton	07-3-13
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



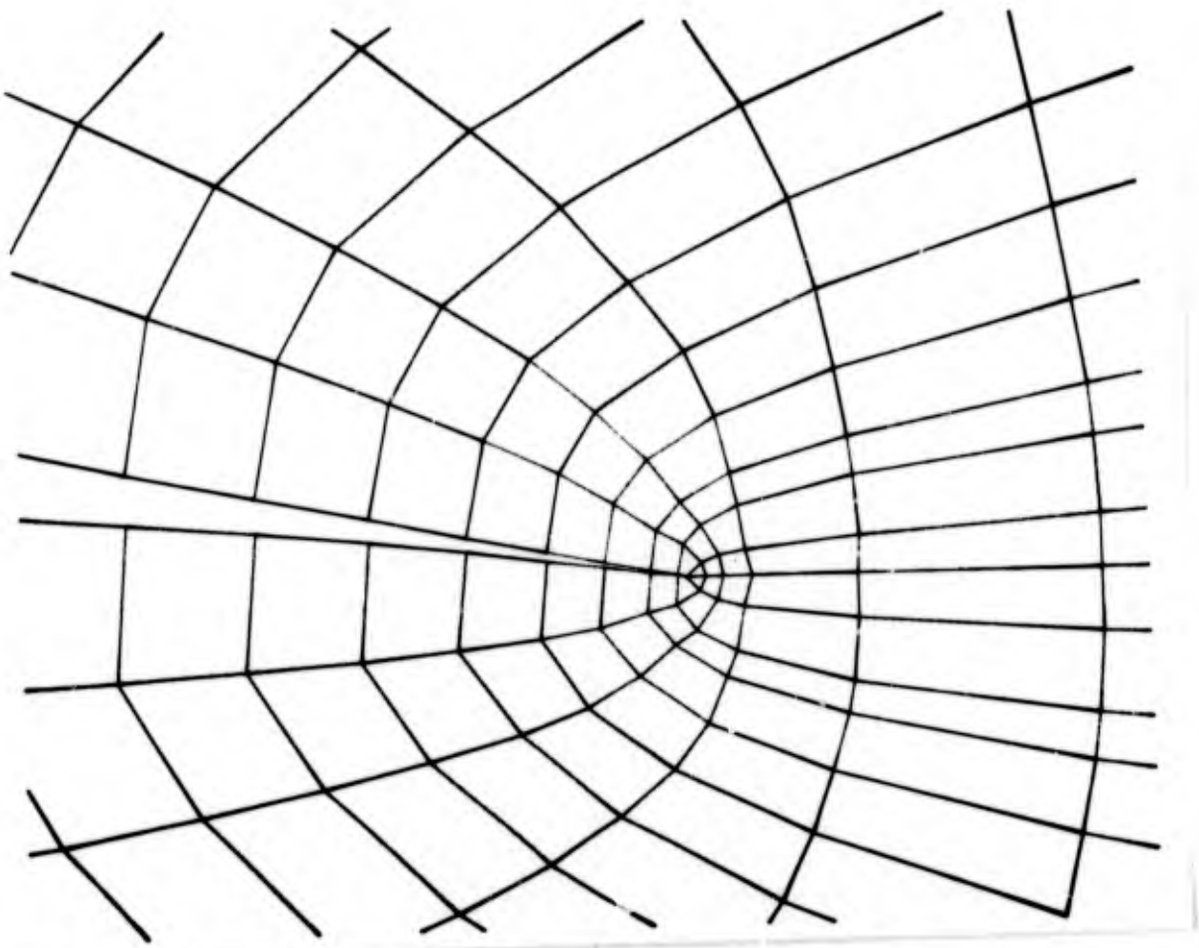
NLR 7301 Grid (16 chords out)

R.A.E.	AR 211		C.C.Lytton	07-3-14
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



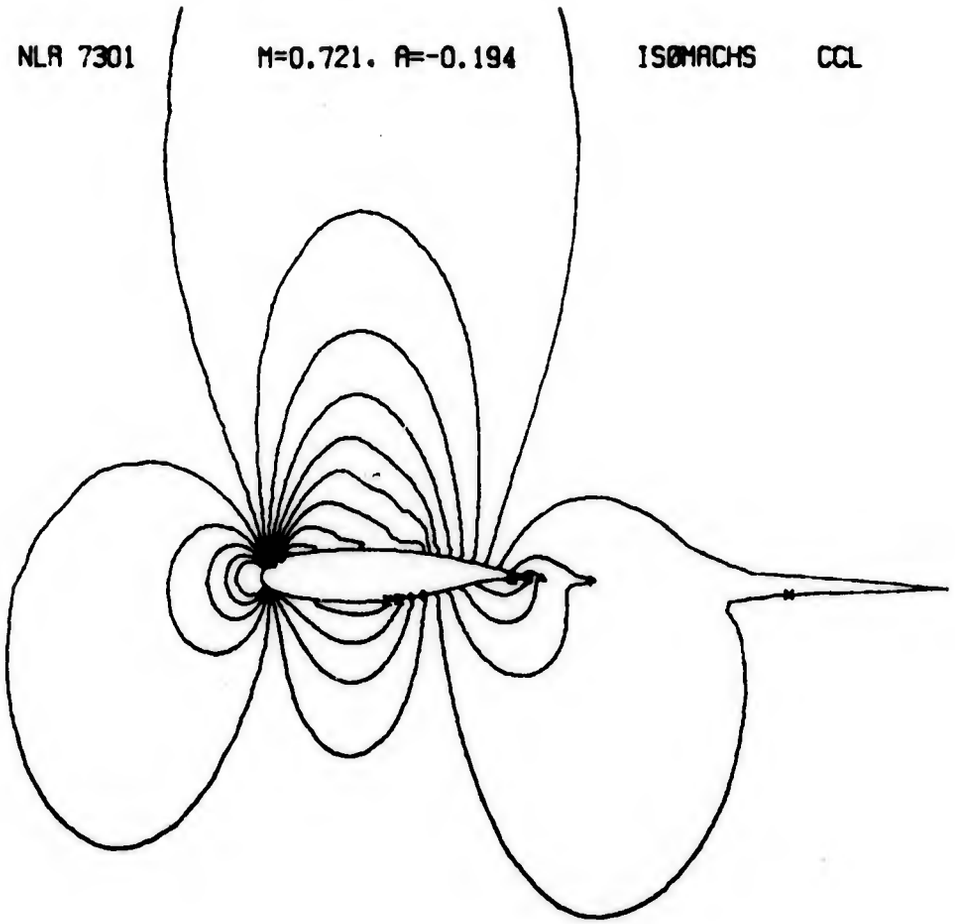
Grid near NLR 7301

R.A.E.	AR 211		C.C.Lytton	07-3-15
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

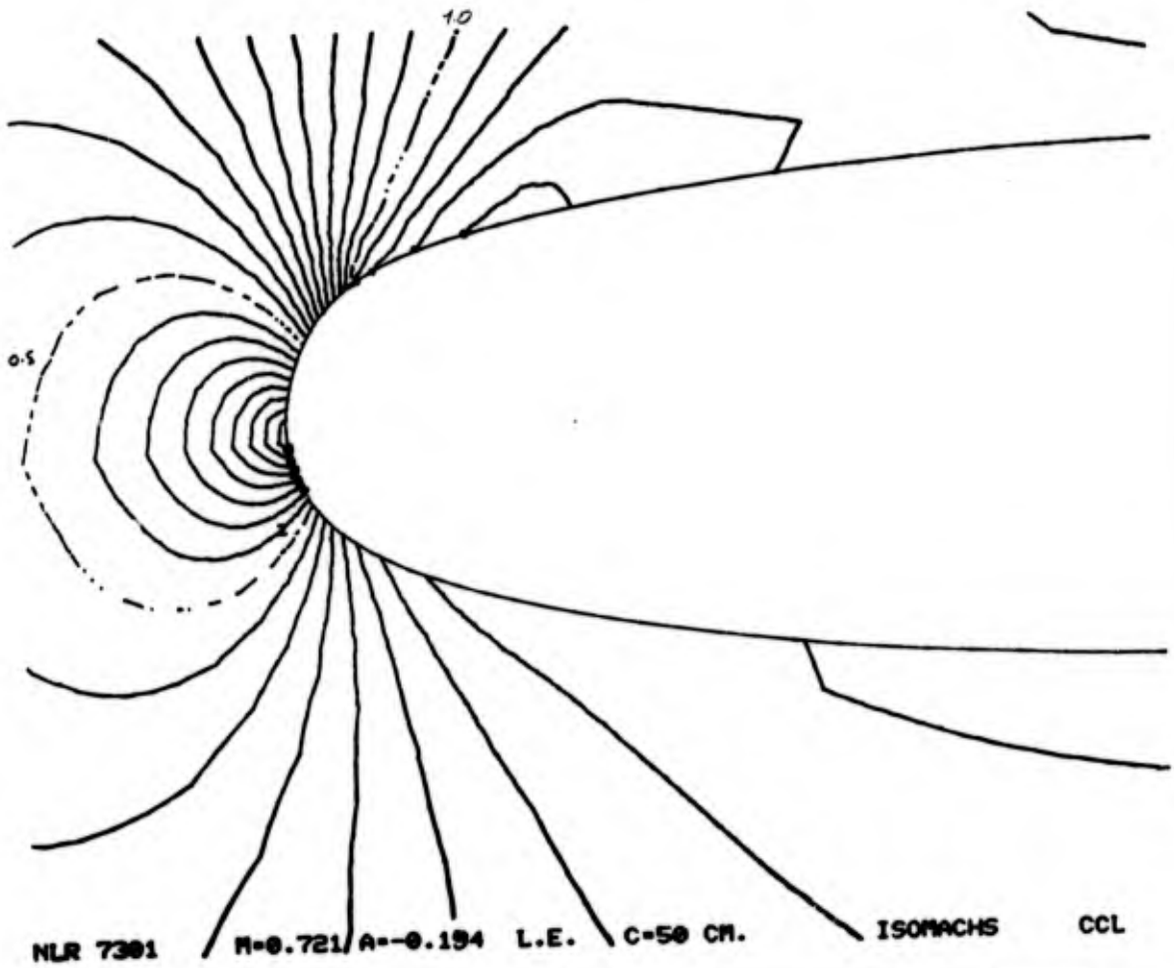


NLR 7301; $0.985 < x < 1.035$, $|y| < 0.015$

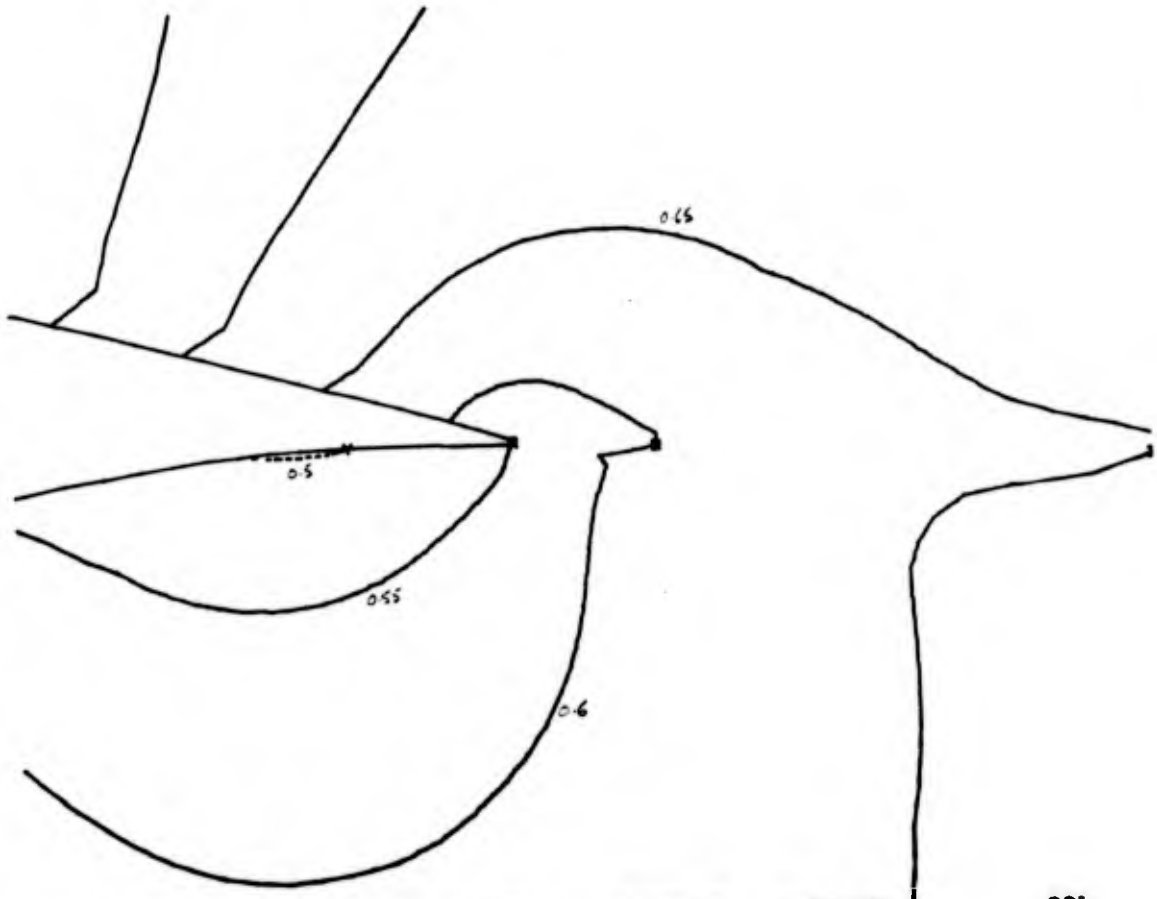
R.A.E.	AR 211		C.C.Lytton	07-3-16
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



R.A.E.	AR 211		C.C.Lytton	07-3-17
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



R.A.E.	AR 211		C.C.Lytton	67-3-18
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



T.E. NLR 7301 M=0.721, A= -0.194 ISOMACHS C=50 CM. CCL

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 07

NLR 7301: MACH = 0.720957, ALPHA = −0.194

Contributor No 6

M.D.Salas and J.C.South, Jr

(N.A.S.A. – Langley, U.S.A.)

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-1
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

NASA Langley Research Center - AGARD case 07
NLR 7301 Mach=0.721 alpha=0.000 (deg)
Cl=0.6431 Cd=0.0013 Cm=-0.1350

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-2
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
1	.000020	-.000251	.001803	1.129798	.011612	.001709
2	.000211	.004032	.006917	1.109930	.086929	.001654
3	.000712	.008371	.019936	1.059355	.162679	.001660
4	.001520	.012729	.039936	.981656	.235461	.002157
5	.002623	.017068	.067431	.874840	.313287	.001772
6	.004037	.021351	.102265	.739515	.389396	.003312
7	.005768	.025544	.143853	.577948	.473007	.002099
8	.007824	.029622	.193867	.383648	.557251	.004609
9	.010217	.033549	.248881	.169924	.650682	.001701
10	.012945	.037295	.315009	-.086972	.750688	.004555
11	.016035	.040816	.389777	-.377440	.872144	-.001705
12	.019530	.044066	.469982	-.689027	.985222	.013777
13	.023493	.047020	.546902	-.987854	1.136622	-.012828
14	.028027	.049679	.601041	-1.198181	1.231265	-.008021
15	.033208	.052151	.611905	-1.240386	1.254309	-.011073
16	.038970	.054559	.599403	-1.191816	1.225226	-.004118
17	.045215	.056881	.597672	-1.185091	1.218913	-.000105
18	.051935	.059047	.611852	-1.240177	1.246764	-.001089
19	.059178	.061044	.626740	-1.298018	1.277648	-.003367
20	.066972	.062904	.634090	-1.326572	1.292836	-.004024
21	.075313	.064680	.633954	-1.326041	1.290746	-.001557
22	.084165	.066395	.633122	-1.322809	1.288787	-.001172
23	.093504	.068050	.631518	-1.316577	1.284863	-.000223
24	.103304	.069645	.628960	-1.306643	1.280210	-.000853
25	.113546	.071180	.625905	-1.294773	1.273577	-.000112
26	.124214	.072660	.621411	-1.277315	1.264860	-.000338
27	.135288	.074084	.618059	-1.264291	1.257799	.000305
28	.146753	.075443	.615464	-1.254209	1.253224	-.000352
29	.158590	.076737	.611761	-1.239824	1.245374	.000527
30	.170783	.077971	.608202	-1.225998	1.239019	-.000153
31	.183316	.079140	.605668	-1.216153	1.233489	.000731
32	.196171	.080238	.602994	-1.205768	1.229029	-.000125
33	.209337	.081266	.600651	-1.196664	1.223783	.000913
34	.222793	.082219	.598955	-1.190077	1.221475	-.000282
35	.236526	.083097	.596449	-1.180338	1.215573	.001248
36	.250519	.083899	.595125	-1.175197	1.214388	-.000469
37	.264753	.084616	.594146	-1.171394	1.211170	.001337
38	.279218	.085253	.592067	-1.163316	1.208692	-.000525
39	.293893	.085810	.591076	-1.159465	1.205325	.001454
40	.308759	.086282	.589753	-1.154326	1.204513	-.000714
41	.323801	.086668	.588638	-1.149993	1.200619	.001655
42	.339003	.086969	.587327	-1.144902	1.200170	-.000939
43	.354350	.087179	.586901	-1.143247	1.197297	.001773
44	.369823	.087300	.585285	-1.136967	1.196545	-.001152
45	.385401	.087330	.584767	-1.134955	1.193209	.001940
46	.401069	.087265	.583398	-1.129639	1.193313	-.001485
47	.416813	.087104	.582759	-1.127154	1.189276	.002224
48	.432612	.086843	.581724	-1.123133	1.190675	-.002070
49	.448451	.086487	.580126	-1.116927	1.183941	.002849
50	.464310	.086036	.579342	-1.113880	1.186931	-.002891

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-3
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
51	.480169	.085484	.577911	-1.108322	1.179183	.003736
52	.496013	.084827	.578798	-1.111767	1.186868	-.004106
53	.511822	.084060	.579929	-1.116161	1.182560	.004162
54	.527580	.083182	.572603	-1.087701	1.175408	-.003889
55	.543274	.082194	.583533	-1.130164	1.191385	.001345
56	.558887	.081086	.538172	-.953940	1.108668	.003255
57	.574400	.079847	.455246	-.631780	.967874	.006349
58	.589802	.078477	.442705	-.583061	.951421	.002274
59	.605085	.076973	.463139	-.662442	.984160	.002269
60	.620242	.075318	.477157	-.716901	1.006224	.003066
61	.635278	.073512	.475606	-.710876	1.003770	.002978
62	.650184	.071561	.466120	-.674024	.987985	.003414
63	.664960	.069470	.453302	-.624228	.967519	.003207
64	.679615	.067248	.442271	-.581374	.949648	.003489
65	.694135	.064906	.430840	-.536967	.931610	.003384
66	.708509	.062458	.419260	-.491977	.913074	.003695
67	.722733	.059920	.408214	-.449066	.895920	.003522
68	.736792	.057302	.397368	-.406930	.878666	.003876
69	.750675	.054619	.386081	-.363082	.861299	.003692
70	.764377	.051885	.375818	-.323212	.845151	.003950
71	.777884	.049117	.365420	-.282817	.829175	.003851
72	.791175	.046328	.356111	-.246652	.814648	.004013
73	.804235	.043530	.346193	-.208120	.799408	.003961
74	.817050	.040741	.337249	-.173374	.785530	.004053
75	.829598	.037972	.328935	-.141076	.772777	.003991
76	.841866	.035234	.319991	-.106330	.758809	.004154
77	.853838	.032546	.312450	-.077033	.747416	.003915
78	.865489	.029912	.305123	-.048568	.735718	.004254
79	.876804	.027344	.297346	-.018356	.724058	.003893
80	.887758	.024857	.290708	.007433	.713438	.004175
81	.898336	.022459	.283937	.033736	.703185	.003915
82	.908517	.020157	.278351	.055437	.694210	.004142
83	.918277	.017955	.271652	.081461	.683954	.003939
84	.927606	.015864	.266288	.102300	.675479	.003984
85	.936479	.013888	.260582	.124470	.666493	.003980
86	.944875	.012032	.255315	.144929	.658319	.003852
87	.952779	.010302	.249760	.166510	.649415	.003928
88	.960172	.008707	.245291	.183873	.642550	.003721
89	.967033	.007242	.240828	.201210	.635163	.003932
90	.973348	.005913	.235405	.222279	.626855	.003613
91	.979100	.004725	.232313	.234291	.621788	.003686
92	.984271	.003671	.227344	.253595	.613683	.003746
93	.988841	.002759	.224100	.266198	.608976	.003306
94	.992793	.001981	.220549	.279995	.602432	.003907
95	.996123	.001334	.216426	.296012	.596782	.003059
96	.998816	.000818	.213423	.307675	.590727	.003934
97	1.000853	.000426	.207764	.329662	.582243	.003284
98	1.002227	.000166	.202068	.351792	.573778	.002543
99	1.002924	.000035	.204141	.343737	.564722	.011855
100	1.002919	.000025	.178426	.443638	.532167	.003695

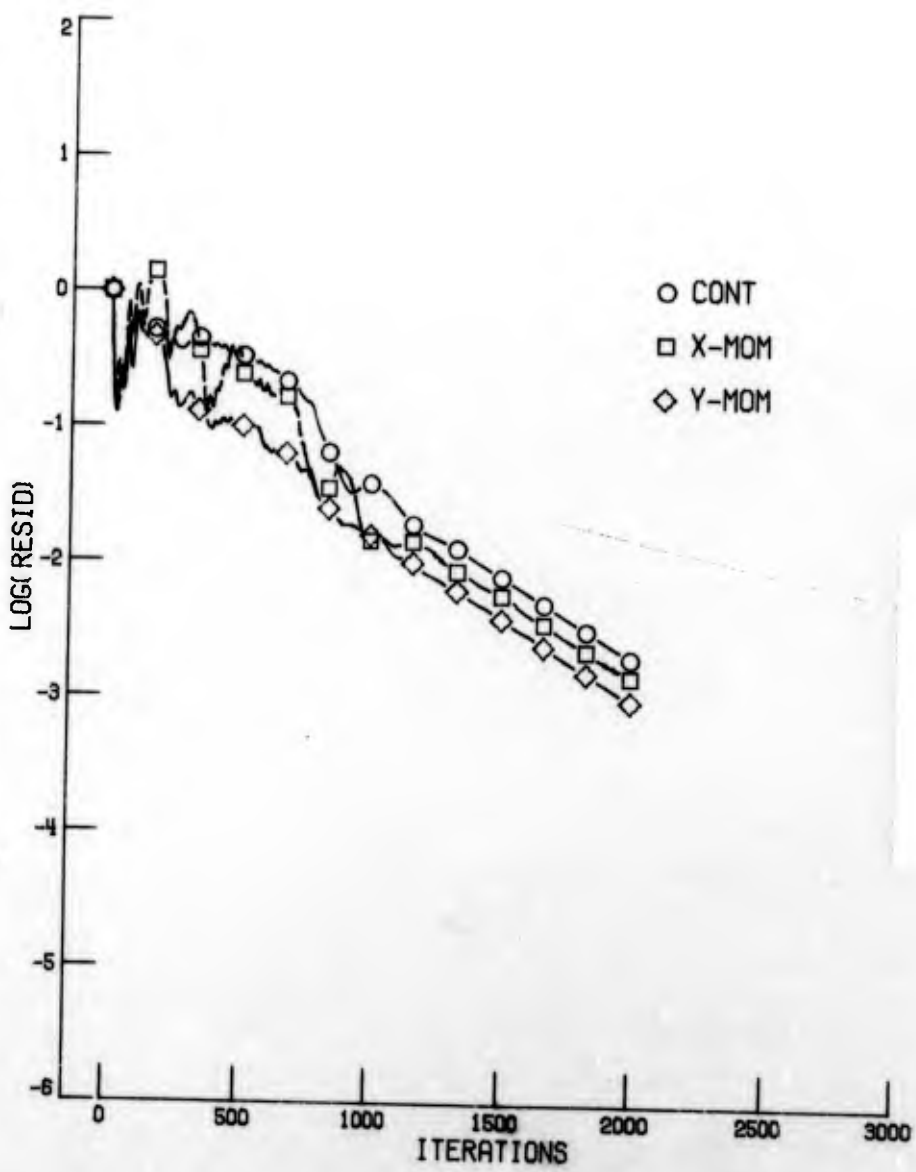
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-4
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
101	1.002202	.000120	.186449	.412467	.549400	.001190
102	1.000767	.000311	.186093	.413852	.552953	-.001834
103	.998611	.000597	.182981	.425942	.547462	-.001662
104	.995717	.000963	.179419	.439781	.542095	-.002149
105	.992065	.001394	.176706	.450320	.536920	-.001755
106	.987652	.001876	.173387	.463214	.531549	-.001979
107	.982476	.002387	.170665	.473788	.526416	-.001665
108	.976527	.002909	.167716	.485243	.521508	-.001802
109	.969807	.003416	.165049	.495604	.516546	-.001579
110	.962314	.003877	.162777	.504430	.512548	-.001562
111	.954053	.004263	.160732	.512375	.508728	-.001406
112	.945040	.004539	.159353	.517735	.506101	-.001273
113	.935285	.004674	.158495	.521066	.504292	-.001075
114	.924808	.004639	.157555	.524716	.502579	-.001042
115	.913648	.004394	.157794	.523790	.502572	-.000754
116	.901842	.003907	.158294	.521847	.503372	-.000696
117	.889433	.003155	.159866	.515740	.505653	-.000360
118	.876478	.002117	.161764	.508368	.508957	-.000330
119	.863022	.000777	.164889	.496226	.513882	.000054
120	.849129	-.000868	.168450	.482392	.520061	.000082
121	.834865	-.002814	.173337	.463408	.527957	.000485
122	.820285	-.005046	.178559	.443118	.536920	.000501
123	.805439	-.007543	.185039	.417945	.547392	.000912
124	.790377	-.010282	.191685	.392127	.558700	.000850
125	.775145	-.013236	.199808	.360571	.571726	.001261
126	.759788	-.016371	.208378	.327275	.585975	.001208
127	.744340	-.019641	.218077	.289595	.601299	.001638
128	.728822	-.023006	.227401	.253375	.616630	.001466
129	.713254	-.026437	.238039	.212048	.633179	.001901
130	.697646	-.029902	.248116	.172898	.649599	.001592
131	.682017	-.033378	.259639	.128131	.667274	.002042
132	.666384	-.036834	.271251	.083023	.685846	.001735
133	.650756	-.040234	.282997	.037390	.703771	.002084
134	.635143	-.043560	.295736	-.012101	.723739	.001903
135	.619539	-.046775	.307668	-.058457	.741961	.002109
136	.603941	-.049859	.318999	-.102475	.759631	.001920
137	.588343	-.052808	.329999	-.145208	.776479	.001999
138	.572745	-.055617	.340343	-.185392	.792605	.001788
139	.557162	-.058285	.351176	-.227480	.809183	.001872
140	.541604	-.060808	.362360	-.270930	.826567	.001705
141	.526081	-.063175	.373708	-.315013	.844015	.001756
142	.510613	-.065377	.386636	-.365239	.864079	.001680
143	.495215	-.067388	.400451	-.418907	.885412	.001802
144	.479893	-.069174	.412180	-.464475	.903775	.001735
145	.464616	-.070719	.419975	-.494757	.916060	.001658
146	.449354	-.072033	.424476	-.512242	.923259	.001520
147	.434106	-.073136	.427447	-.523786	.927911	.001551
148	.418879	-.074044	.428515	-.527934	.929688	.001446
149	.403672	-.074771	.428463	-.527731	.929514	.001548
150	.388505	-.075333	.427440	-.523758	.928005	.001434

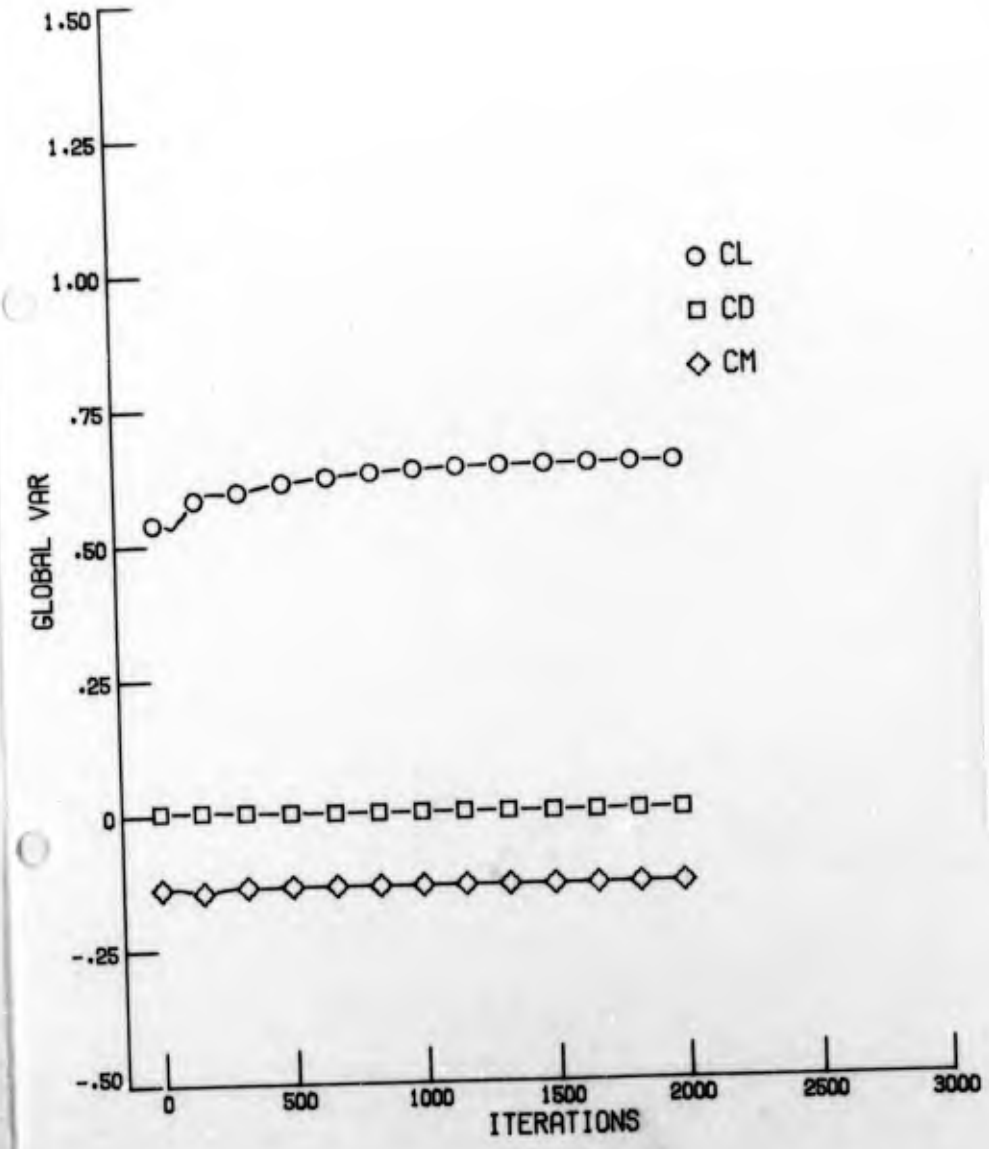
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-5
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

N	x/c	y/c	1-P/Piinf	Cp	Mach	1-Pi/Piinf
151	.373394	-.075744	.426623	-.520581	.926541	.001628
152	.358352	-.076015	.425166	-.514924	.924427	.001431
153	.343401	-.076155	.424554	-.512545	.923162	.001762
154	.328555	-.076170	.423234	-.507416	.921364	.001455
155	.313840	-.076065	.422444	-.504348	.919732	.001884
156	.299270	-.075844	.421048	-.498924	.917893	.001495
157	.284865	-.075513	.420735	-.497708	.916878	.002069
158	.270641	-.075072	.418878	-.490495	.914472	.001511
159	.256613	-.074525	.418193	-.487834	.912740	.002230
160	.242800	-.073878	.417333	-.484491	.911873	.001703
161	.229218	-.073126	.415274	-.476494	.908165	.002227
162	.215887	-.072278	.413770	-.470652	.906099	.001913
163	.202822	-.071340	.413095	-.468027	.904577	.002418
164	.190032	-.070307	.410840	-.459269	.901400	.002038
165	.177534	-.069184	.408795	-.451324	.897740	.002539
166	.165351	-.067980	.407811	-.447502	.896372	.002357
167	.153494	-.066691	.405873	-.439973	.893022	.002705
168	.141969	-.065317	.402548	-.427056	.888047	.002479
169	.130794	-.063872	.400348	-.418507	.884240	.002883
170	.119991	-.062368	.399552	-.415414	.883137	.002736
171	.109589	-.060803	.401156	-.421646	.885022	.003392
172	.099608	-.059163	.400334	-.418452	.884171	.002933
173	.090053	-.057442	.399379	-.414742	.882006	.003654
174	.080935	-.055647	.398000	-.409384	.880378	.003102
175	.072268	-.053776	.397875	-.408902	.879361	.003976
176	.064073	-.051825	.397689	-.408177	.879504	.003516
177	.056364	-.049779	.393563	-.392149	.872641	.003986
178	.049142	-.047637	.389083	-.374742	.865720	.003941
179	.042406	-.045395	.382157	-.347837	.854857	.004064
180	.036167	-.043048	.370949	-.304297	.837475	.004098
181	.030429	-.040600	.360574	-.263988	.820693	.004860
182	.025213	-.038043	.342807	-.194965	.793637	.004503
183	.020518	-.035364	.321530	-.112309	.758856	.006363
184	.016340	-.032551	.292439	.000708	.714693	.005474
185	.012689	-.029586	.255010	.146116	.653618	.007397
186	.009544	-.026457	.209386	.323359	.582795	.004906
187	.006876	-.023152	.161328	.510060	.498648	.006052
188	.004654	-.019681	.113902	.694306	.413060	.003481
189	.002864	-.016075	.075013	.845384	.325261	.004681
190	.001520	-.012348	.041795	.974435	.240894	.002304
191	.000627	-.008476	.018326	1.065607	.151063	.002556
192	.000145	-.004439	.004760	1.118310	.069742	.001367

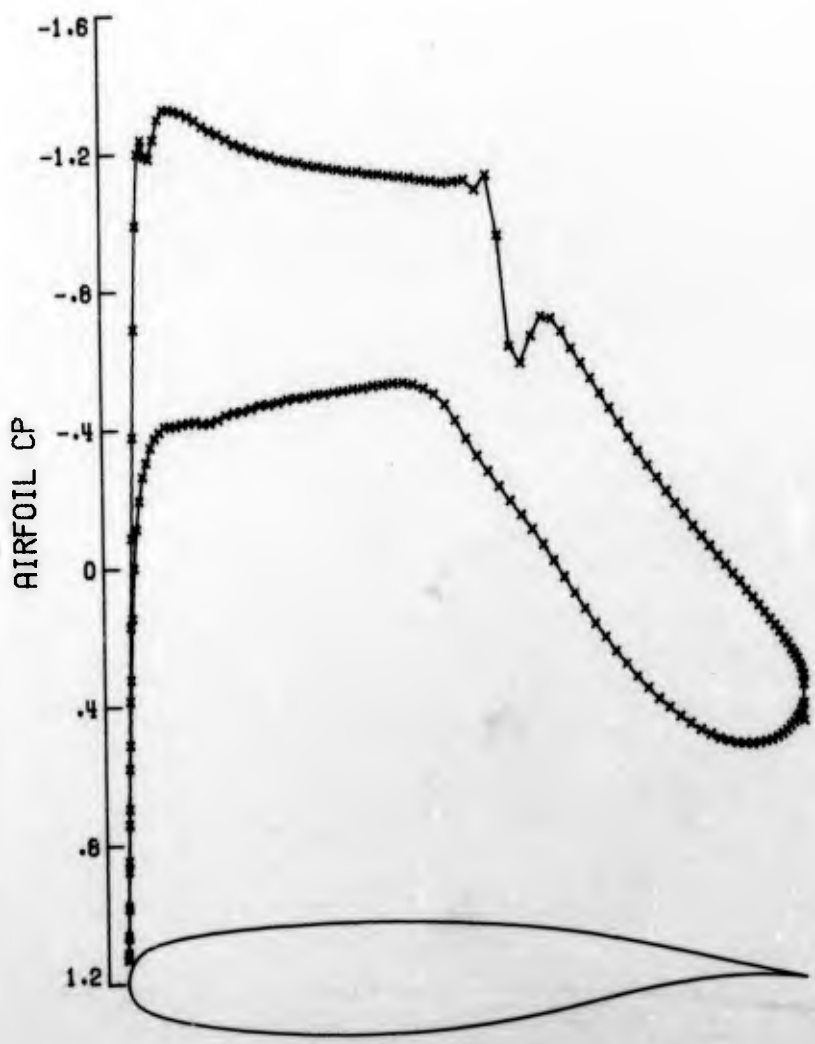
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-6
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



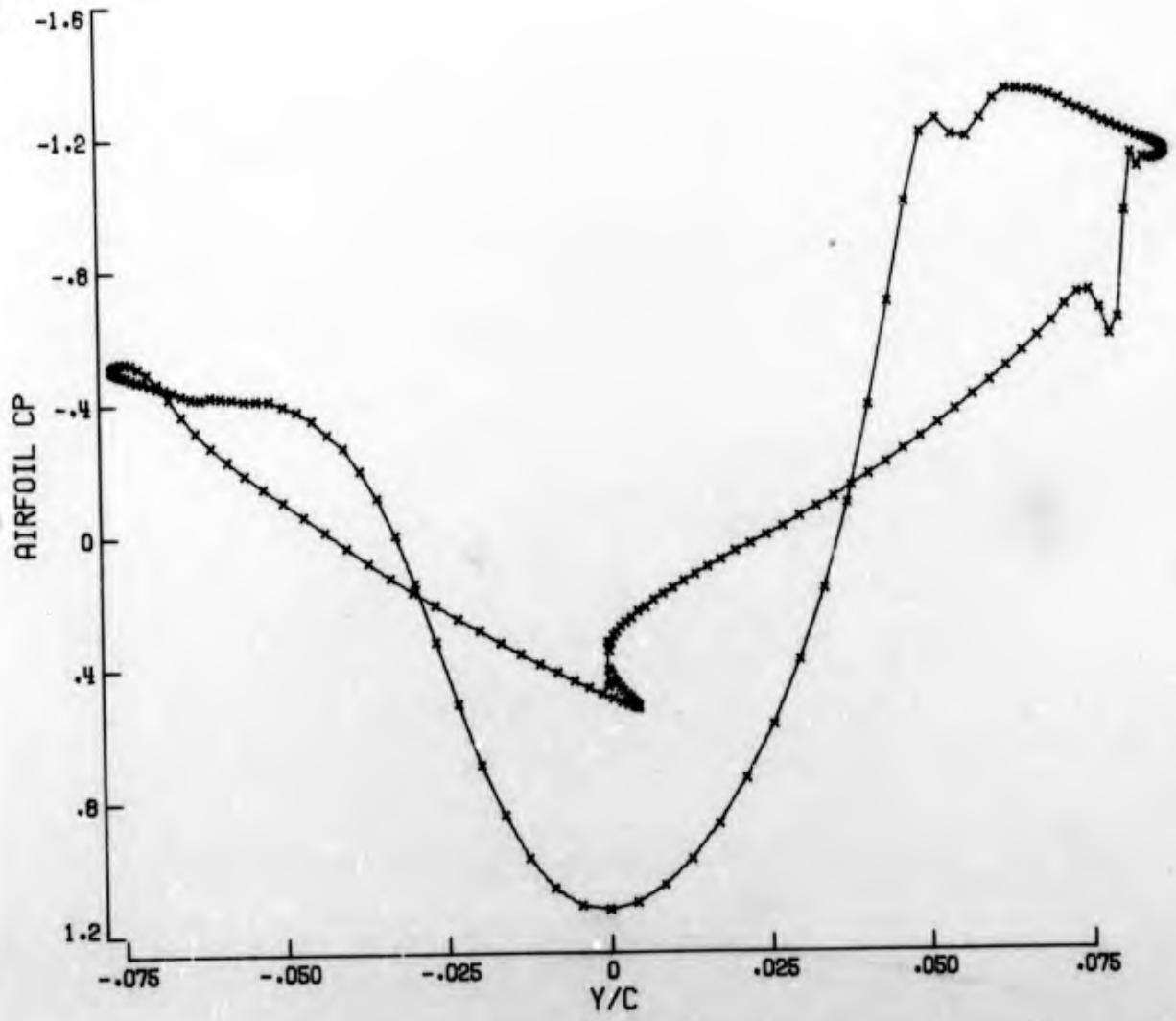
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-7
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



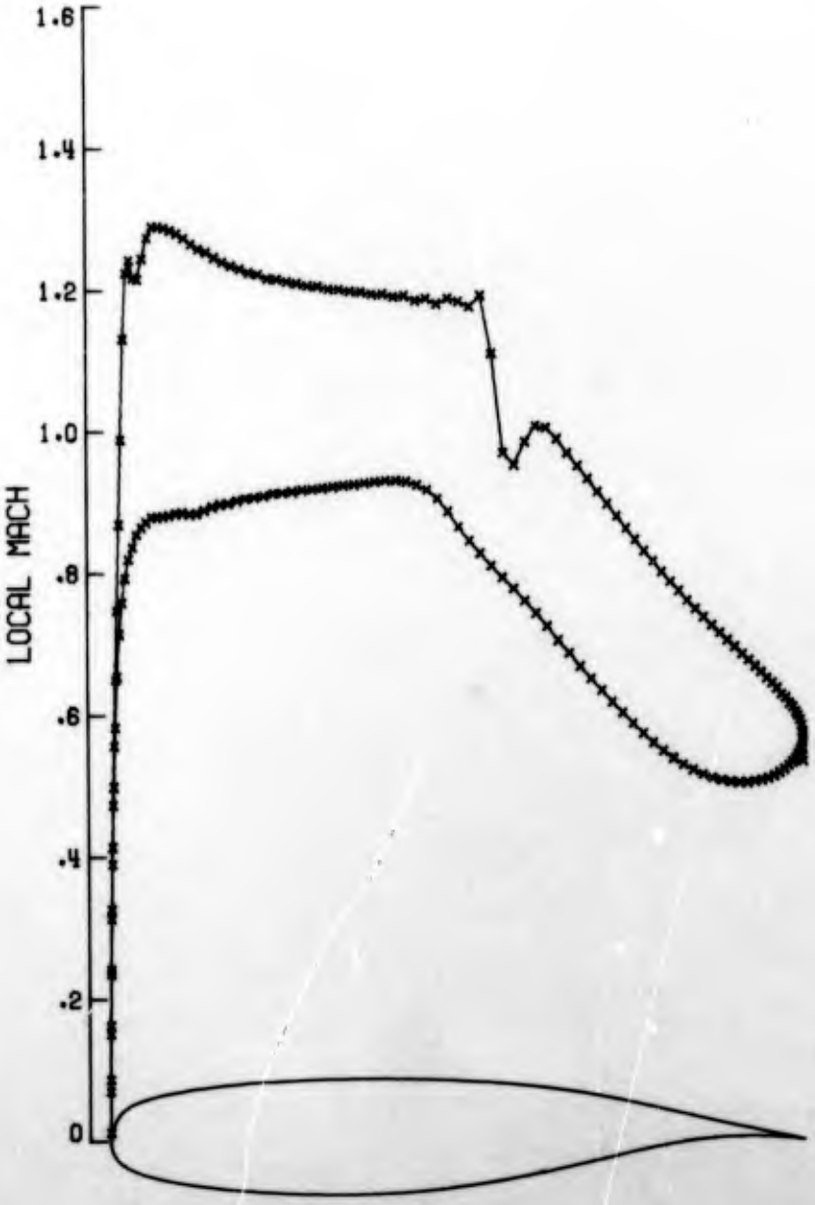
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-8
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



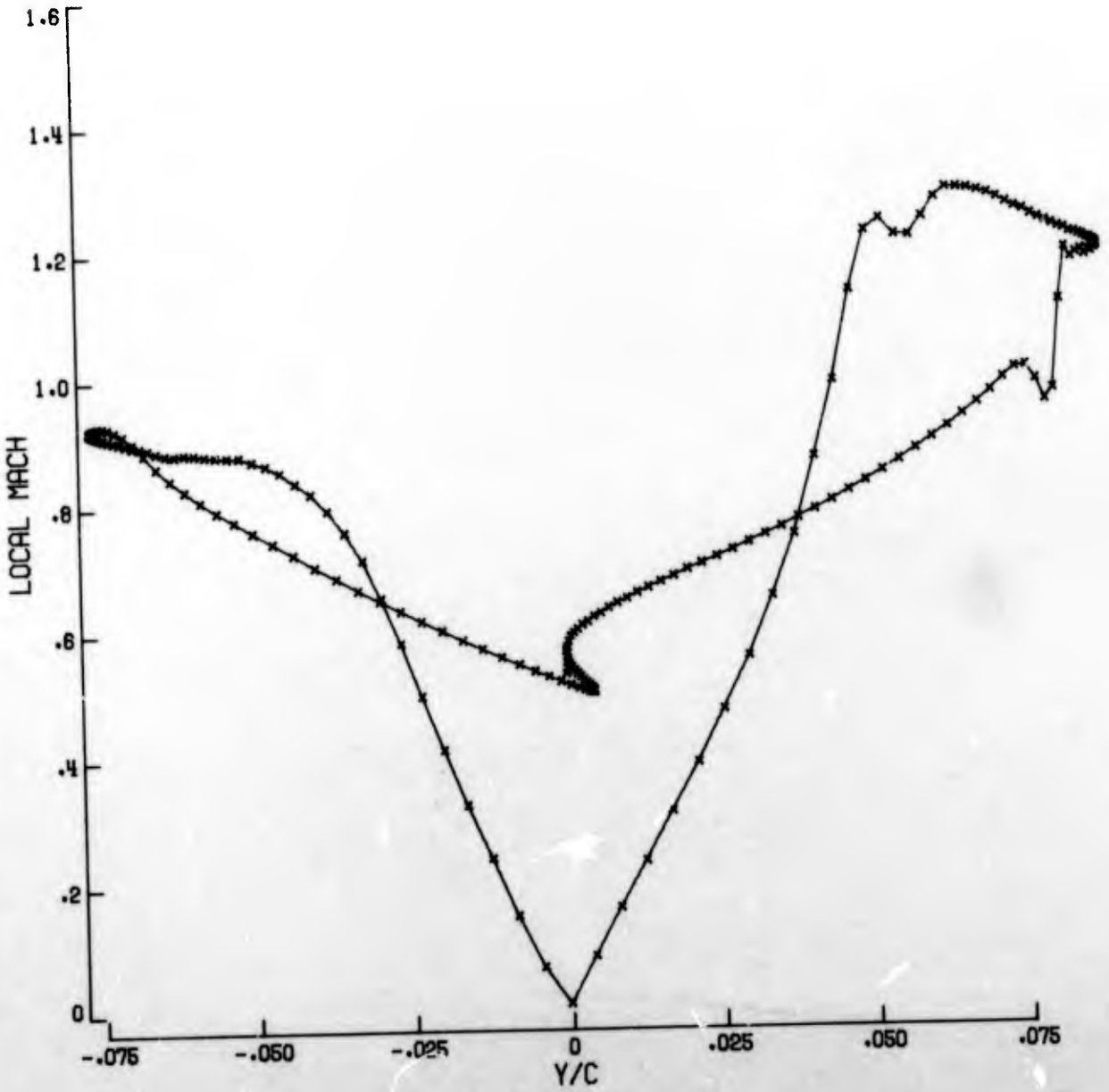
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-9
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



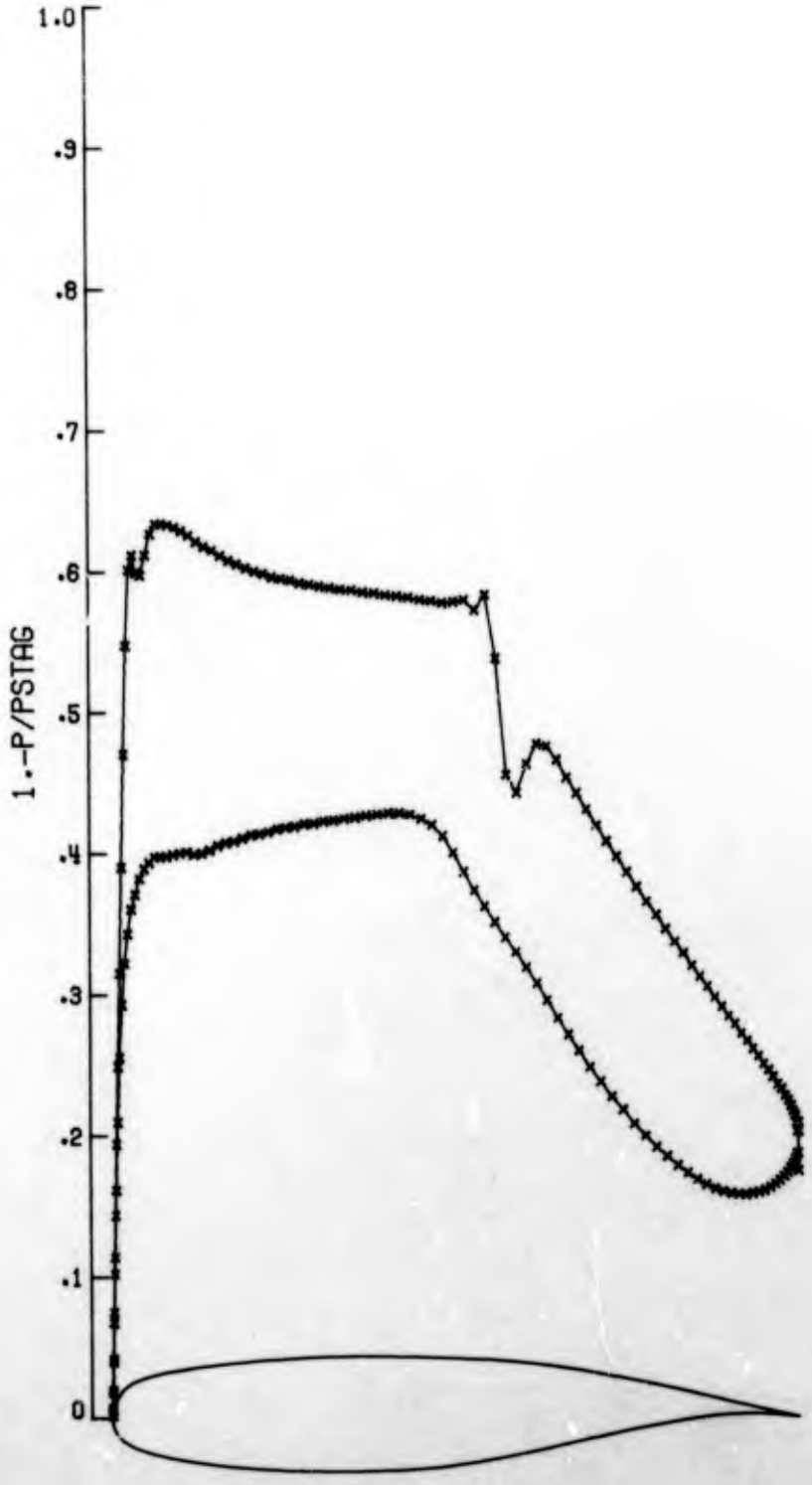
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-10
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



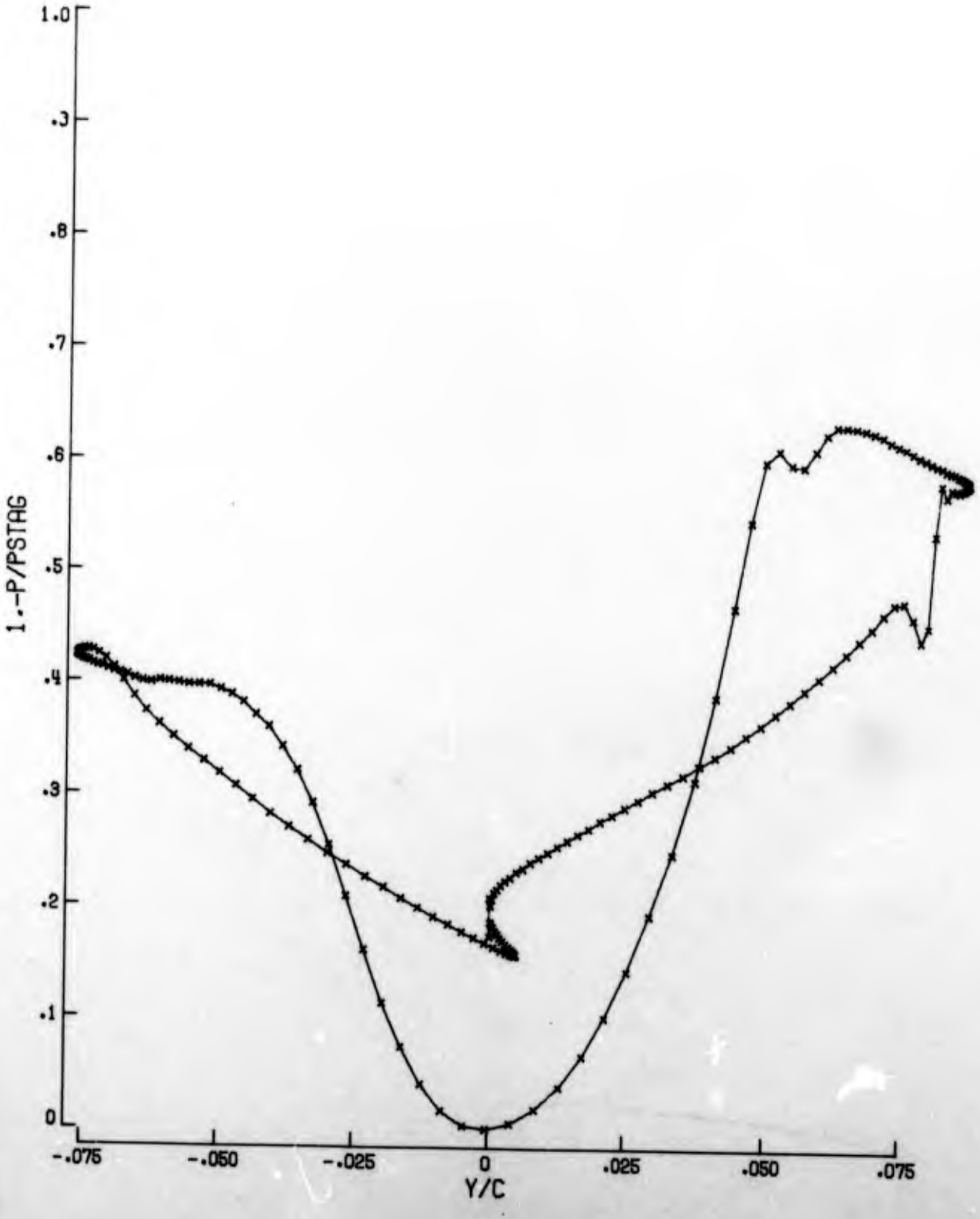
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-11
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



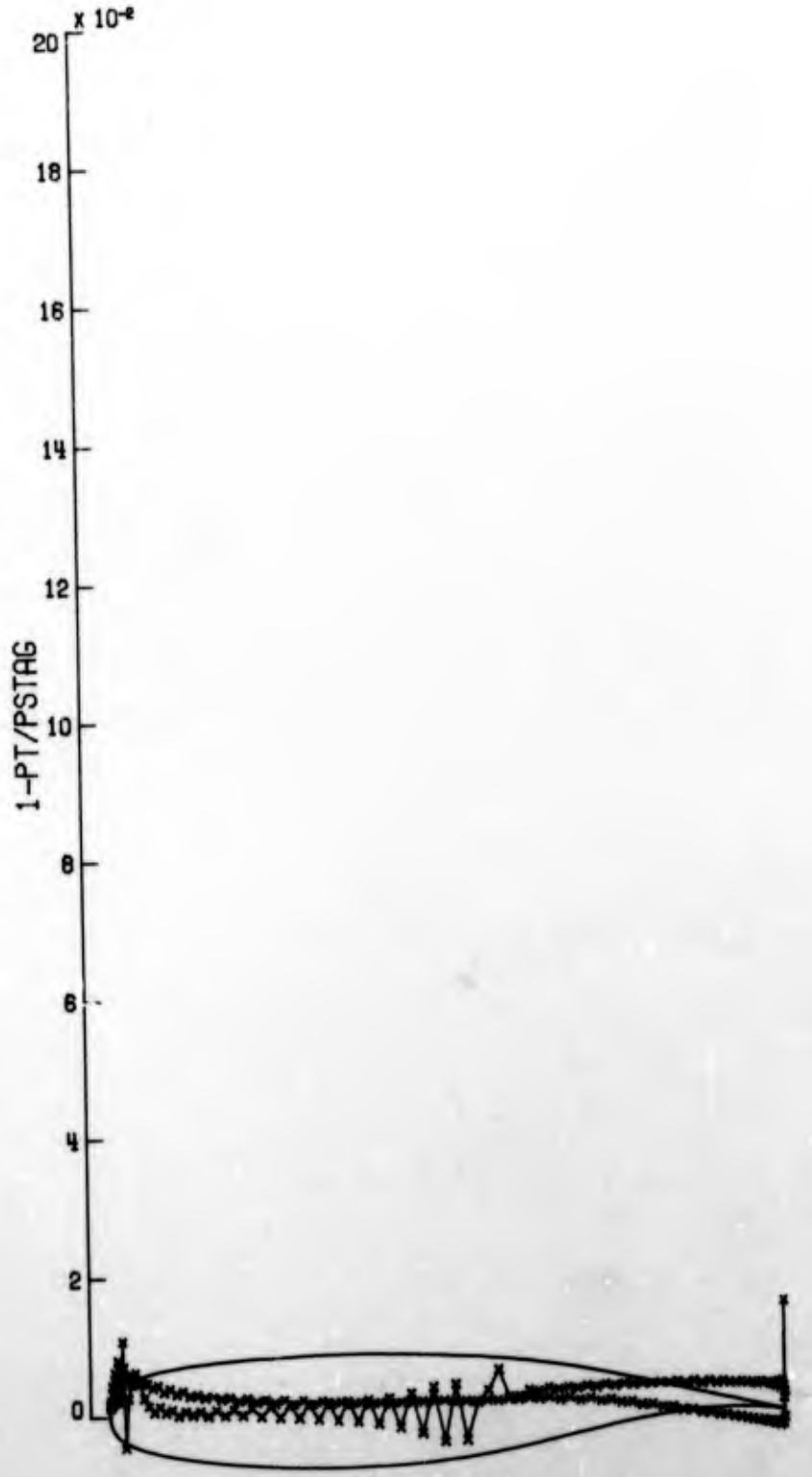
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-12
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



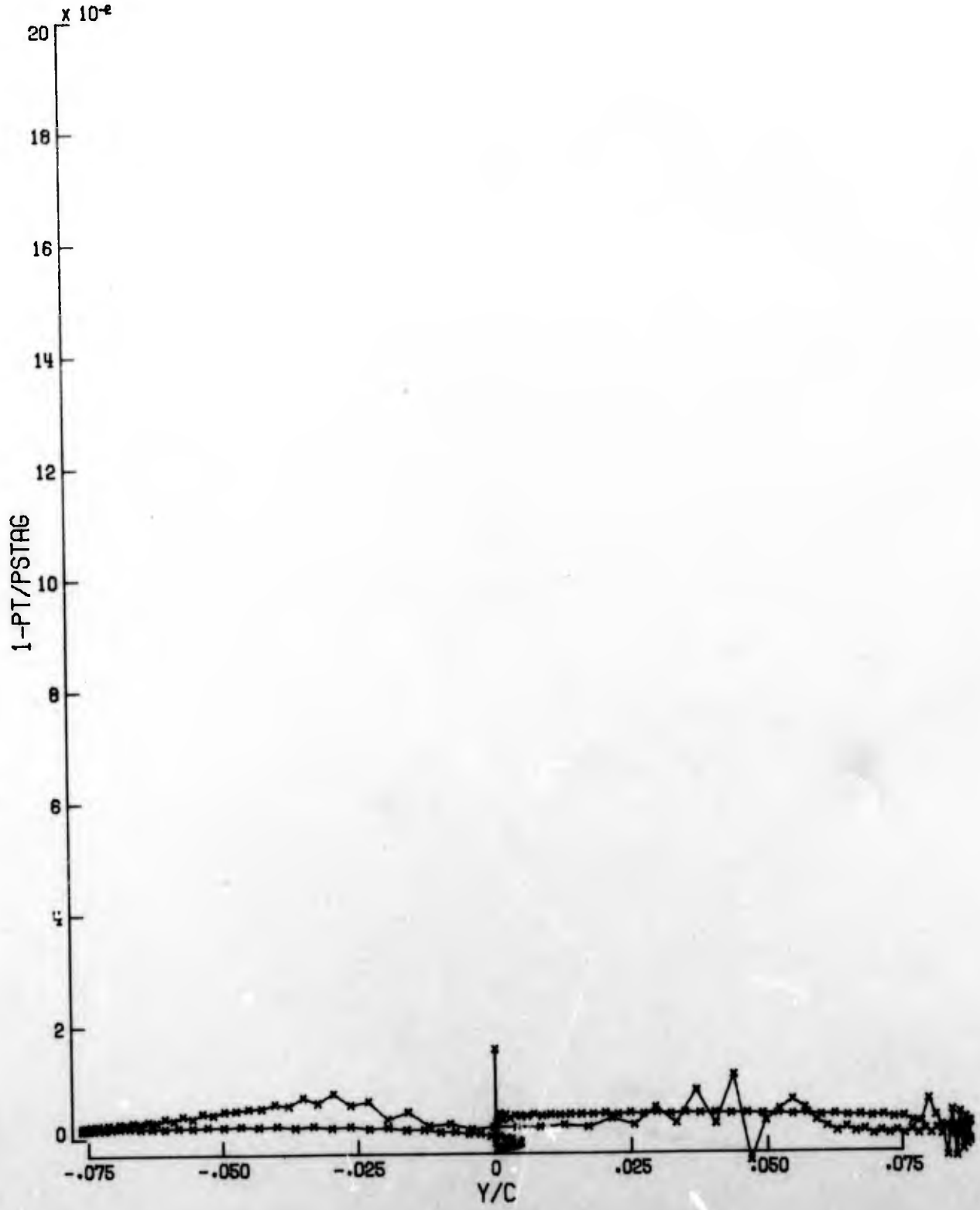
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-13
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



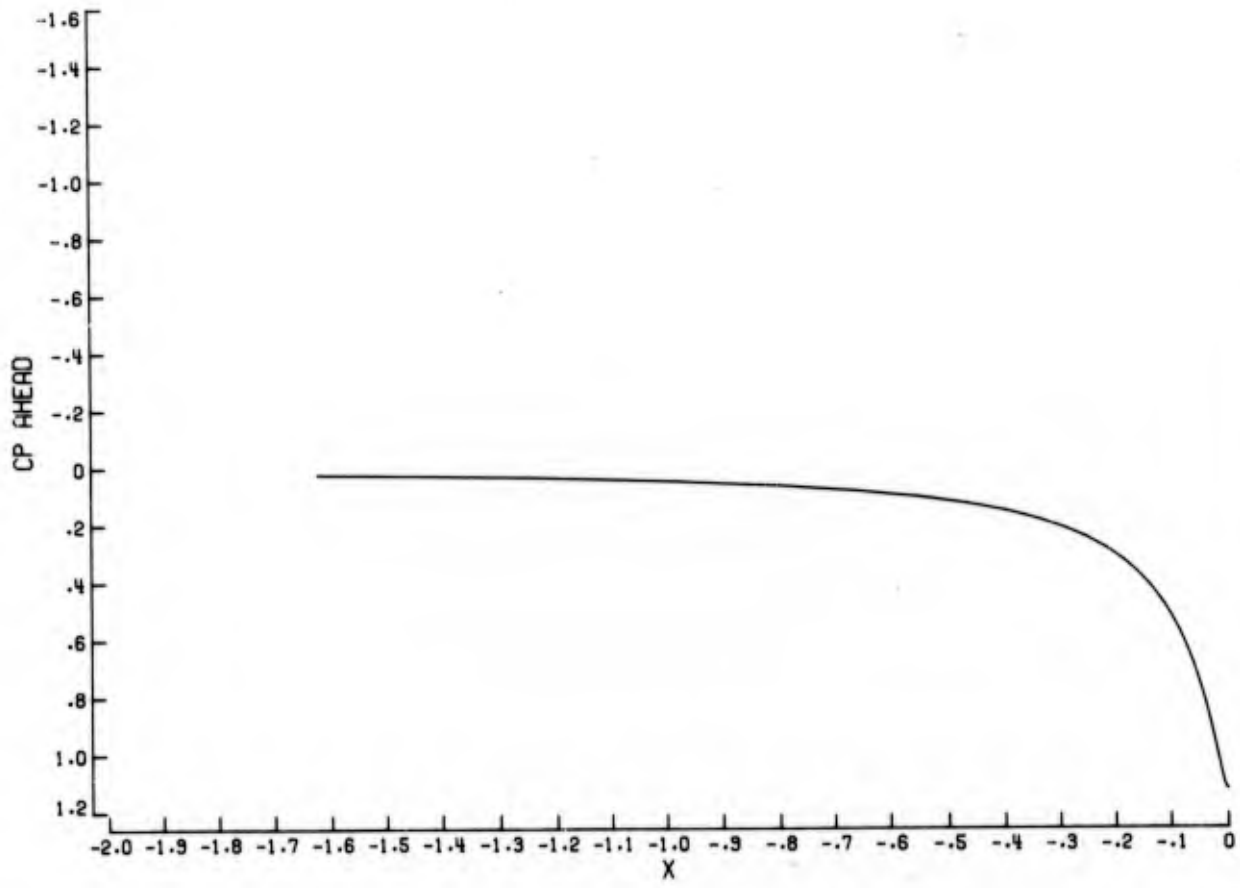
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-14
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



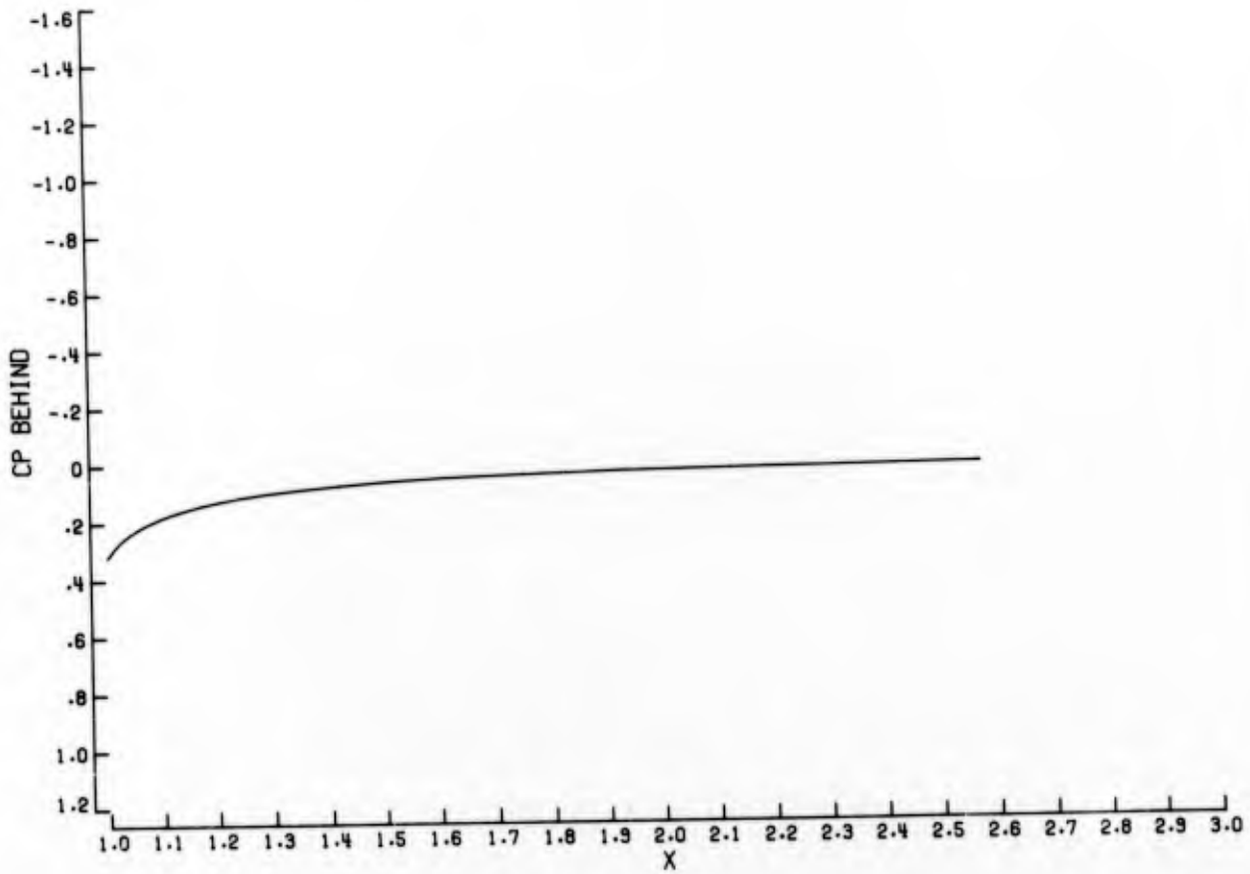
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-15
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



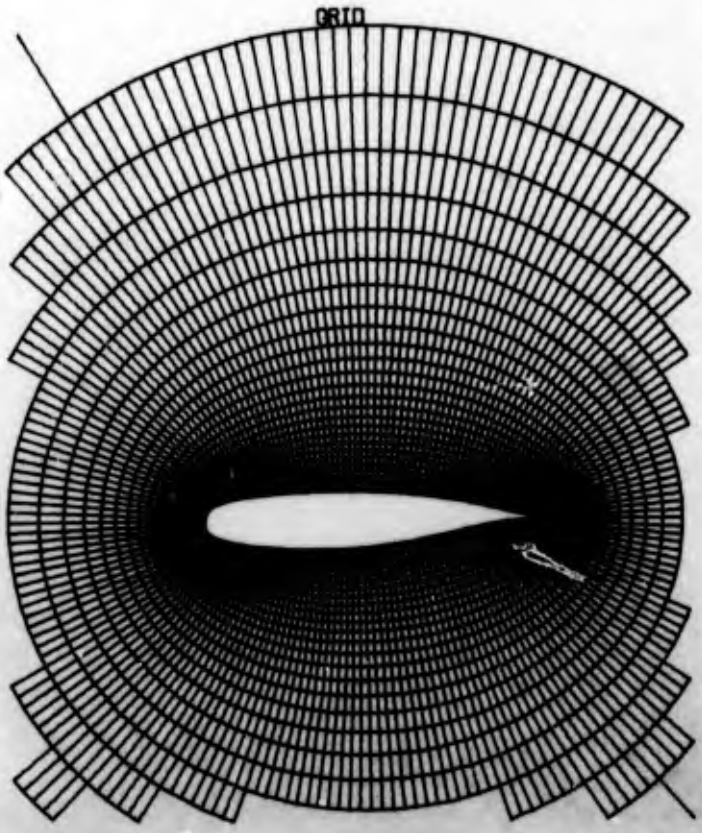
N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-16
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-17
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

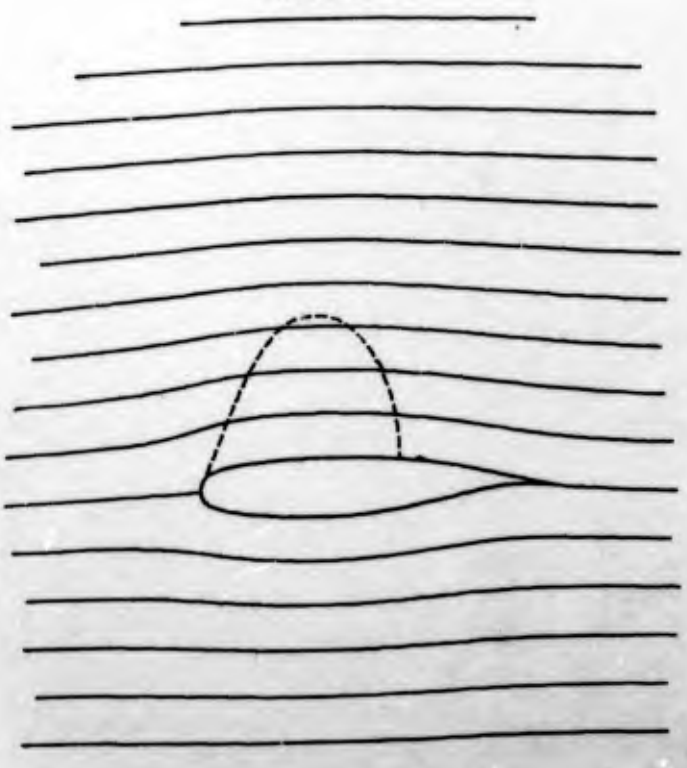


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-18
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

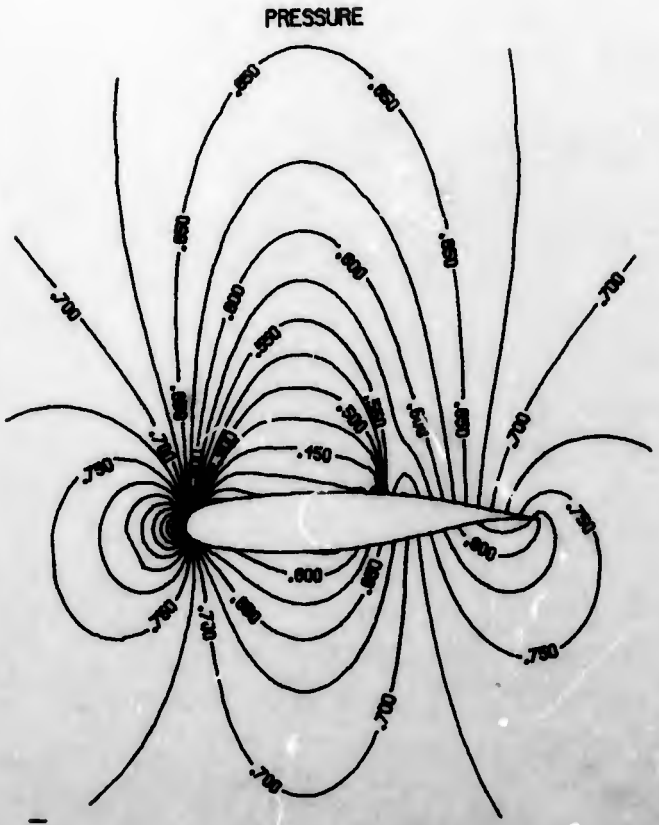


N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-19
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

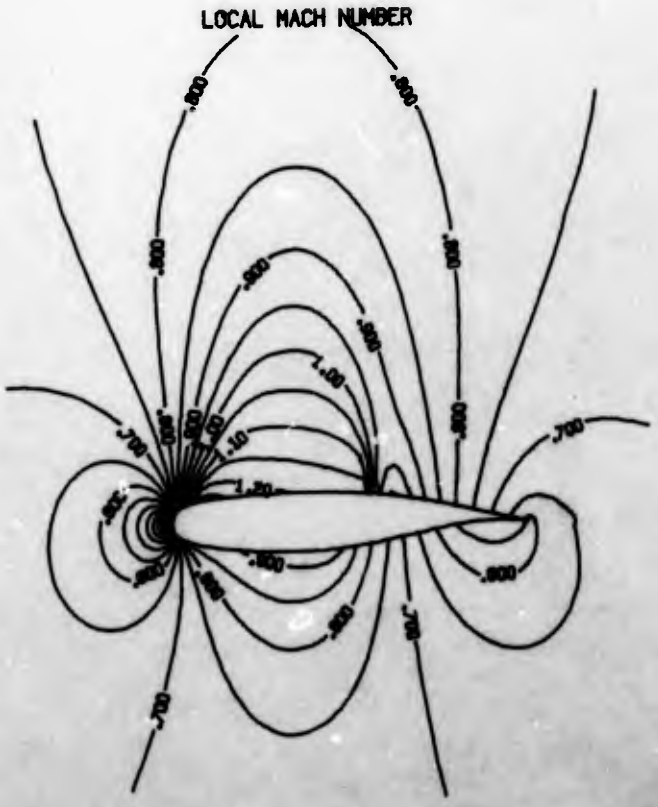
STREAMLINES



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-20
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-21
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-22
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

TOTAL PRESSURE

N.A.S.A. LANGLEY	AR 211		M.D.Salas J.C.South, Jr	07-6-23
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

ENTROPY

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 07

NLR 7301: MACH = 0.720957, ALPHA =−0.194

Contributor No 8

A.Rizzi

(F.F.A., Sweden)

F.F.A.	AR 211		A.Rizzi	07-8-1
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

NLR MESH 3 160 × 32 SOLUTION 28/6 (01.02) after 2000 cycles SOLUTION No. 8.4

I	X/C	Y/C	1-P/PIINF	CF	MACH	1-PI/PIINF
1	0.999233	0.000104	0.193388	0.385569	0.560502	0.000945
2	0.996220	0.000503	0.187320	0.407140	0.552144	0.001900
3	0.990341	0.001227	0.181230	0.432743	0.541449	0.000923
4	0.981774	0.002143	0.174255	0.459341	0.529691	0.000560
5	0.970706	0.003099	0.168474	0.482300	0.519314	0.000644
6	0.957323	0.003937	0.163876	0.500163	0.511323	0.000585
7	0.941815	0.004494	0.160634	0.512756	0.505747	0.000494
8	0.924371	0.004608	0.158973	0.519183	0.502861	0.000467
9	0.905179	0.004128	0.159094	0.518738	0.503092	0.000453
10	0.884424	0.002931	0.161189	0.510600	0.506802	0.000452
11	0.862287	0.000929	0.165500	0.493354	0.514339	0.000492
12	0.838944	-0.001917	0.172182	0.467392	0.525899	0.000562
13	0.814566	-0.005591	0.181100	0.433246	0.541272	0.000514
14	0.789318	-0.010027	0.192522	0.388873	0.560457	0.000627
15	0.763357	-0.015119	0.206562	0.334331	0.583609	0.000797
16	0.736836	-0.020707	0.222546	0.272234	0.609804	0.000690
17	0.709895	-0.026606	0.239979	0.204510	0.637903	0.000554
18	0.682672	-0.032645	0.259303	0.129437	0.668247	0.000783
19	0.655293	-0.038664	0.280479	0.047170	0.701148	0.000988
20	0.627876	-0.044485	0.301763	-0.035515	0.734329	0.000705
21	0.600533	-0.049949	0.321513	-0.112241	0.765123	0.000243
22	0.573365	-0.054971	0.340262	-0.185080	0.794027	0.000160
23	0.546467	-0.059524	0.360096	-0.262131	0.824189	0.000514
24	0.519925	-0.063584	0.382757	-0.350169	0.858446	0.001387
25	0.493815	-0.067093	0.405161	-0.437206	0.893117	0.001531
26	0.468209	-0.069947	0.420306	-0.496043	0.918098	-0.000391
27	0.443163	-0.072116	0.428295	-0.527079	0.930583	-0.000208
28	0.418748	-0.073692	0.431416	-0.539204	0.935493	-0.000028
29	0.394996	-0.074782	0.431735	-0.540443	0.935999	0.000008
30	0.371952	-0.075470	0.430759	-0.536652	0.934363	0.000144
31	0.349552	-0.075823	0.429397	-0.531359	0.932171	0.000218
32	0.328124	-0.075894	0.428102	-0.526329	0.930074	0.000296
33	0.307389	-0.075720	0.426377	-0.521572	0.928138	0.000301
34	0.287465	-0.075331	0.425641	-0.516770	0.926172	0.000322
35	0.268363	-0.074751	0.424306	-0.511581	0.924066	0.000325
36	0.250089	-0.074002	0.422887	-0.506071	0.921804	0.000366
37	0.232646	-0.073105	0.421356	-0.500121	0.919386	0.000381
38	0.216033	-0.072076	0.419693	-0.493662	0.916758	0.000400
39	0.200242	-0.070934	0.417937	-0.486836	0.913980	0.000424
40	0.185265	-0.069693	0.416200	-0.480092	0.911194	0.000499
41	0.171091	-0.068368	0.414401	-0.473103	0.908341	0.000547
42	0.157702	-0.066973	0.412345	-0.465115	0.905071	0.000658

F.F.A.	AR 211		A.Rizzi	07-8-2
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

43	0.145063	-0.065518	0.409598	-0.453667	0.900621	0.000374
44	0.133213	-0.064014	0.406197	-0.441231	0.895919	0.000094
45	0.122073	-0.062489	0.406555	-0.442623	0.895412	0.001590
46	0.111632	-0.060952	0.407525	-0.446394	0.897496	0.000677
47	0.101875	-0.059385	0.407191	-0.445090	0.896595	0.000622
48	0.092769	-0.057790	0.406560	-0.442640	0.895700	0.001013
49	0.084292	-0.056176	0.406045	-0.440638	0.894914	0.000970
50	0.076415	-0.054547	0.405771	-0.439575	0.894322	0.001159
51	0.069112	-0.052906	0.405719	-0.439374	0.894034	0.001426
52	0.062353	-0.051250	0.404911	-0.435846	0.892563	0.001367
53	0.056113	-0.049577	0.402371	-0.426366	0.888605	0.001466
54	0.050363	-0.047890	0.398602	-0.411725	0.882526	0.001716
55	0.045075	-0.046192	0.393640	-0.392059	0.874468	0.001862
56	0.040224	-0.044487	0.387106	-0.367073	0.864287	0.002017
57	0.035782	-0.042779	0.379777	-0.338590	0.852608	0.002370
58	0.031724	-0.041071	0.371649	-0.307014	0.839742	0.002625
59	0.028025	-0.039364	0.362554	-0.271661	0.825223	0.002992
60	0.024662	-0.037654	0.351559	-0.228969	0.807807	0.003121
61	0.021611	-0.035937	0.337524	-0.173667	0.785541	0.002972
62	0.018850	-0.034212	0.319362	-0.105827	0.758589	0.002906
63	0.016357	-0.032482	0.301762	-0.035512	0.730013	0.003441
64	0.014114	-0.030747	0.282104	0.040859	0.699049	0.002840
65	0.012100	-0.028994	0.257954	0.134079	0.661331	0.001954
66	0.010299	-0.027219	0.230303	0.242101	0.617303	0.001743
67	0.008692	-0.025430	0.201709	0.353185	0.572291	0.001178
68	0.007265	-0.023644	0.176411	0.451465	0.528674	0.001770
69	0.006004	-0.021858	0.151044	0.550012	0.484734	0.000704
70	0.004895	-0.020059	0.124328	0.653301	0.436563	0.000114
71	0.003925	-0.018271	0.101173	0.743755	0.390558	0.000433
72	0.003084	-0.016523	0.083053	0.814225	0.350324	0.000532
73	0.002362	-0.014814	0.068072	0.880120	0.310676	-0.000223
74	0.001749	-0.013090	0.050760	0.939526	0.269637	0.000088
75	0.001238	-0.011523	0.036223	0.996059	0.227301	-0.000400
76	0.000823	-0.009491	0.024394	1.043201	0.183587	-0.000197
77	0.000493	-0.007585	0.014284	1.081310	0.140234	-0.000308
78	0.000257	-0.005592	0.006983	1.109554	0.096560	-0.000378
79	0.000099	-0.003534	0.002467	1.127218	0.053298	-0.000290
80	0.000021	-0.001452	0.000358	1.135799	0.011352	-0.000376
81	0.000021	0.000621	0.000422	1.135163	0.014804	-0.000293
82	0.000099	0.002682	0.002411	1.127435	0.054079	-0.000358
83	0.000257	0.004762	0.006367	1.112069	0.092059	-0.000285
84	0.000493	0.006897	0.012078	1.089861	0.129406	-0.000273
85	0.000823	0.009114	0.019876	1.059587	0.167492	-0.000205
86	0.001236	0.011403	0.029344	1.020863	0.207565	-0.000457
87	0.001749	0.013757	0.042612	0.971260	0.247833	0.000223
88	0.002362	0.016169	0.057 4	0.915116	0.290283	-0.000404

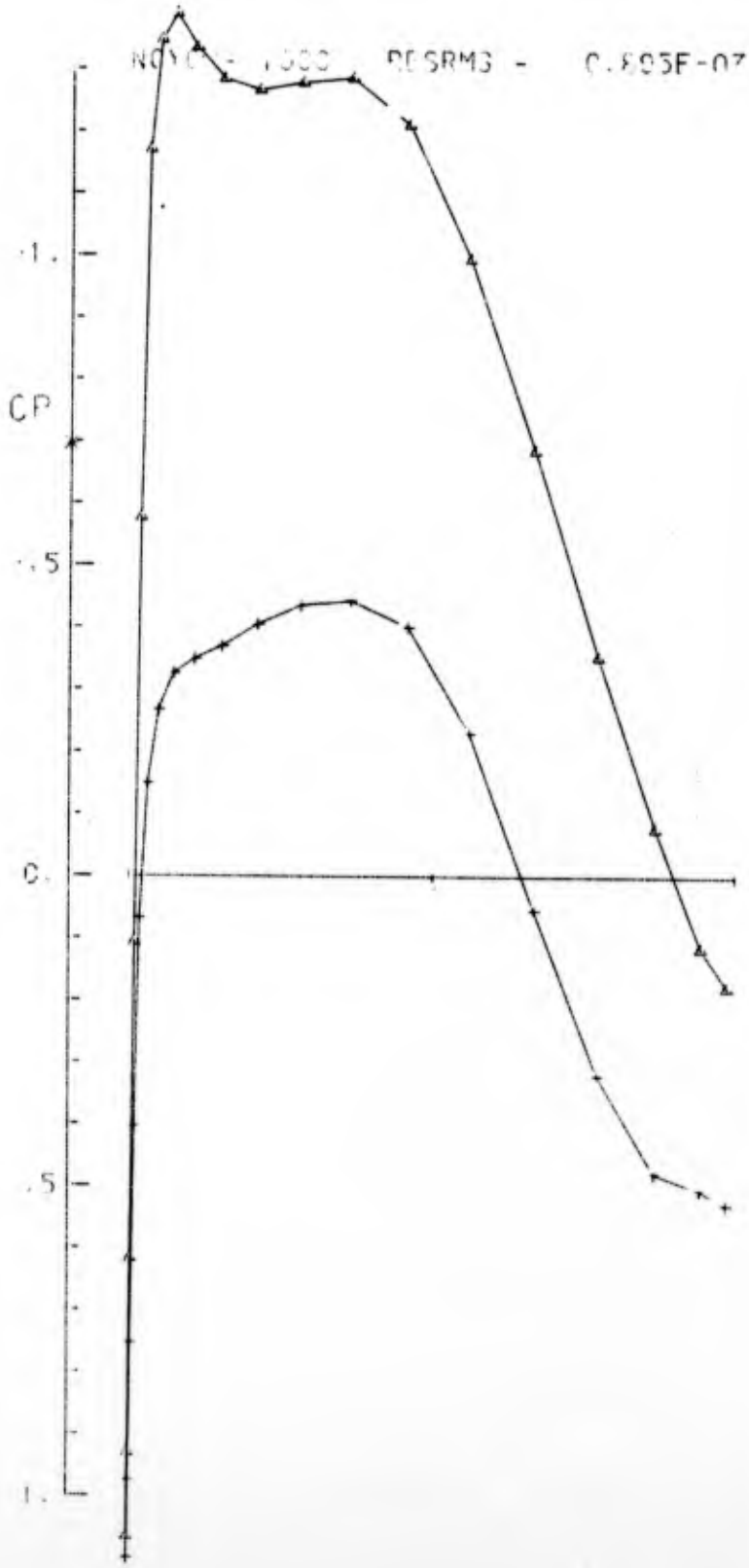
F.F.A.	AR 211		A.Rizzi	07-8-3
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

89	0.003084	0.018629	0.076011	0.841508	0.336694	-0.000248
90	0.003925	0.021087	0.097125	0.759482	0.382993	0.000112
91	0.004895	0.023546	0.119339	0.673182	0.428361	0.000180
92	0.006004	0.026033	0.144632	0.574923	0.476510	0.000107
93	0.007266	0.028571	0.175034	0.456816	0.530669	-0.000276
94	0.008692	0.031120	0.210491	0.319065	0.588762	0.000550
95	0.010299	0.033660	0.248502	0.171399	0.650645	-0.000266
96	0.012100	0.036183	0.290753	0.007258	0.714457	0.001756
97	0.014114	0.038676	0.337934	-0.176036	0.739889	-0.002395
98	0.016357	0.041106	0.393169	-0.390617	0.868941	0.003889
99	0.018850	0.043446	0.448867	-0.607000	0.960575	-0.004142
100	0.021611	0.045660	0.511574	-0.850610	1.055562	0.004319
101	0.024662	0.047719	0.565665	-1.060743	1.156540	-0.005611
102	0.028025	0.049613	0.602698	-1.203499	1.225354	0.008538
103	0.031724	0.051410	0.606509	-1.219423	1.233612	0.010395
104	0.035782	0.053199	0.602543	-1.204034	1.223113	0.005539
105	0.040224	0.054975	0.602870	-1.205284	1.223453	0.003950
106	0.045075	0.056717	0.607049	-1.221521	1.232746	0.004049
107	0.050363	0.058415	0.613184	-1.245354	1.245399	0.003929
108	0.056113	0.060063	0.619810	-1.271095	1.258793	0.003596
109	0.062353	0.061658	0.625546	-1.293377	1.270771	0.003012
110	0.069112	0.063209	0.628637	-1.305385	1.277014	0.003378
111	0.076415	0.064730	0.628229	-1.303801	1.276110	0.003220
112	0.084292	0.066239	0.626109	-1.295566	1.271849	0.002713
113	0.092769	0.067741	0.623468	-1.285306	1.266638	0.002617
114	0.101873	0.069232	0.620381	-1.273313	1.260623	0.002597
115	0.111632	0.070713	0.616921	-1.259872	1.253848	0.002593
116	0.122070	0.072178	0.613163	-1.245349	1.246610	0.002505
117	0.133213	0.073625	0.609291	-1.230227	1.239092	0.002491
118	0.145083	0.075048	0.605301	-1.214730	1.231465	0.002425
119	0.157702	0.076440	0.601408	-1.199606	1.224097	0.002329
120	0.171091	0.077794	0.597676	-1.185106	1.217073	0.002272
121	0.185266	0.079099	0.594070	-1.171097	1.210333	0.002203
122	0.200242	0.080346	0.590609	-1.157653	1.203905	0.002127
123	0.216033	0.081526	0.587306	-1.144821	1.197816	0.002038
124	0.232646	0.082626	0.584132	-1.132488	1.191987	0.001971
125	0.250089	0.083635	0.581013	-1.120373	1.186282	0.001909
126	0.268363	0.084540	0.577924	-1.108370	1.180668	0.001825
127	0.287465	0.085329	0.574830	-1.096350	1.175064	0.001759
128	0.307389	0.085986	0.571634	-1.083934	1.169281	0.001722
129	0.328124	0.086498	0.568294	-1.070959	1.163261	0.001681
130	0.349652	0.086849	0.564901	-1.057777	1.157181	0.001629
131	0.371952	0.087022	0.561590	-1.044918	1.151307	0.001545
132	0.394996	0.087000	0.558390	-1.032483	1.145674	0.001444
133	0.418748	0.086765	0.555023	-1.019403	1.139775	0.001341
134	0.443163	0.086296	0.550354	-1.003208	1.132430	0.001312

F.F.A.	AR 211		A Rizzi	07-8-4
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

135	0.468209	0.085571	0.545067	-0.980726	1.122212	0.001366
136	0.493815	0.084564	0.537211	-0.950205	1.108378	0.001547
137	0.519925	0.083244	0.527758	-0.913480	1.092042	0.001564
138	0.546467	0.081575	0.516171	-0.876237	1.075882	0.001290
139	0.573365	0.079500	0.503365	-0.842029	1.061537	0.000828
140	0.600533	0.076966	0.490198	-0.806414	1.046154	0.000571
141	0.627876	0.073910	0.476540	-0.767238	1.029834	0.001042
142	0.655293	0.070305	0.462462	-0.683901	0.993359	0.001895
143	0.682672	0.066179	0.444393	-0.589619	0.954175	0.002120
144	0.709895	0.061601	0.419071	-0.491244	0.914476	0.001718
145	0.736836	0.056653	0.395976	-0.401522	0.878646	0.001506
146	0.763357	0.051432	0.375087	-0.320371	0.846304	0.001530
147	0.789313	0.046044	0.355630	-0.244783	0.816265	0.001595
148	0.814566	0.040596	0.337756	-0.173789	0.788155	0.001605
149	0.838944	0.035195	0.320377	-0.107328	0.762075	0.001571
150	0.862287	0.029939	0.304774	-0.047211	0.738063	0.001536
151	0.884424	0.024920	0.290477	0.008331	0.715993	0.001488
152	0.905179	0.020217	0.277363	0.059274	0.695602	0.001495
153	0.924371	0.015902	0.265251	0.106331	0.676717	0.001429
154	0.941815	0.012034	0.254061	0.149304	0.659177	0.001359
155	0.957323	0.008663	0.243612	0.190397	0.642507	0.001446
156	0.970706	0.005830	0.233790	0.228554	0.626583	0.001569
157	0.981774	0.003560	0.224403	0.264242	0.612371	0.000726
158	0.990341	0.001653	0.216215	0.296830	0.598344	0.000108
159	0.996220	0.000719	0.209042	0.324695	0.578447	0.004955
160	0.999233	0.000145	0.201497	0.354008	0.561971	0.006981

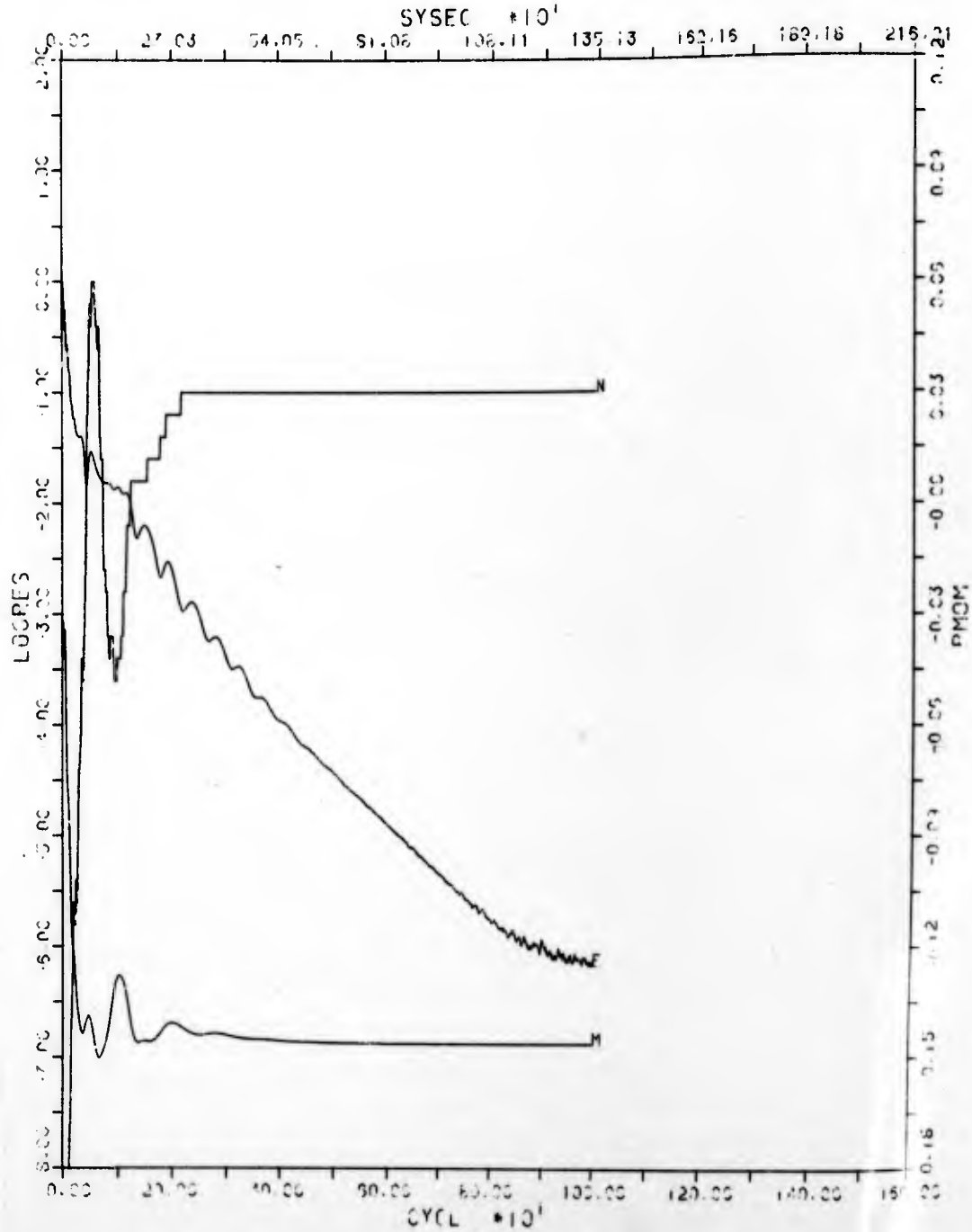
F.F.A.	AR 211		A.Rizzi	07-8-5
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

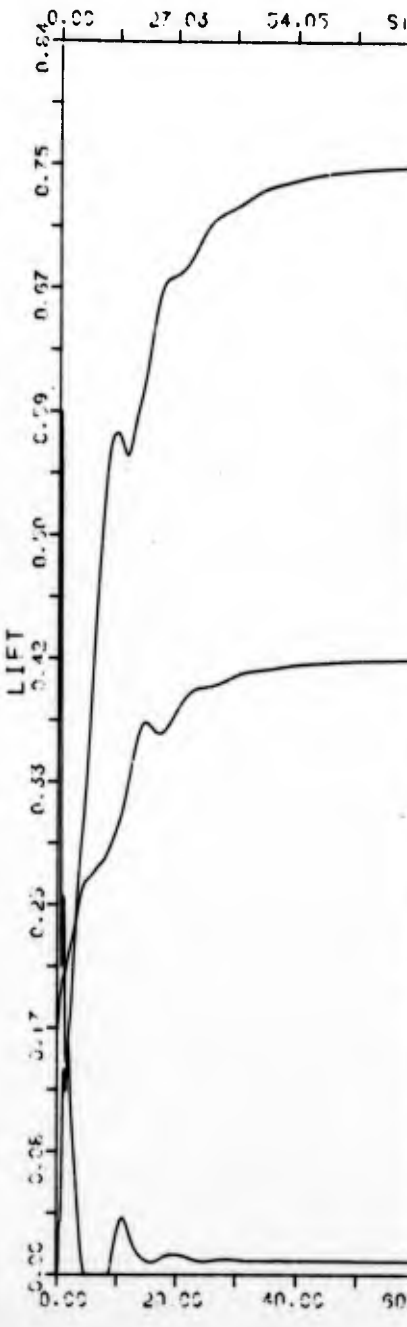


F.F.A.

28/6 V07 NONISO VOR IN/OUT TOCO UNORO NLRMESH3 NO2 .01 .02

PITCH	-0.150	CCIRC	0.387	CELLS	40X 6		
MACH	0.721	ALPHA	-0.194	RESAF	0.695E-07		
RATE	0.986	RESAS	0.133E+00	DRAG	0.648E-02		
NSUP	35	LIFT	0.752E+00	RESMX	-0.238E-06	4	1
CYCL	1000	SYSEC	0.135E+04				

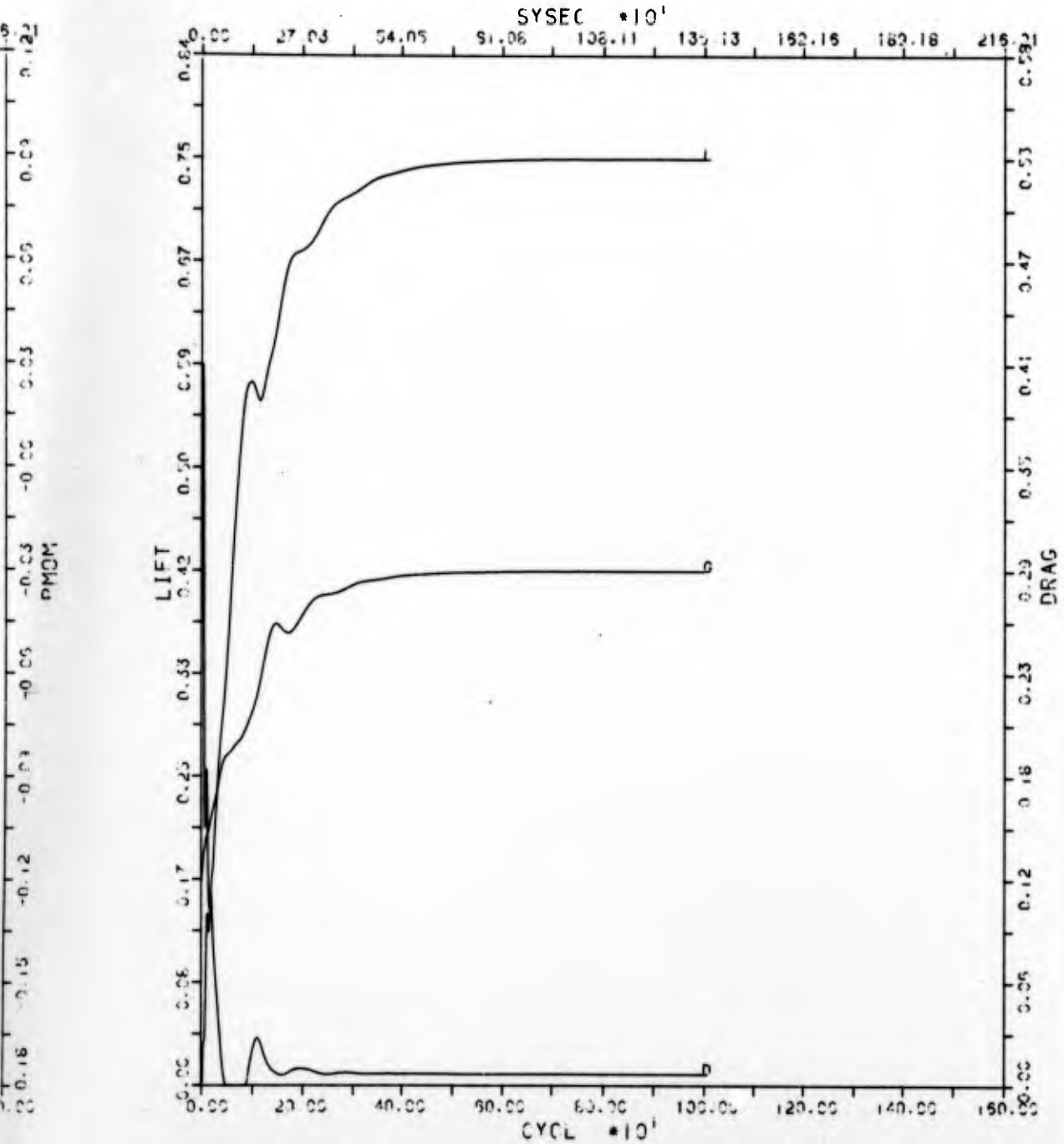




F.F.A.	AR 211		A.Rizzi	07-8-6
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

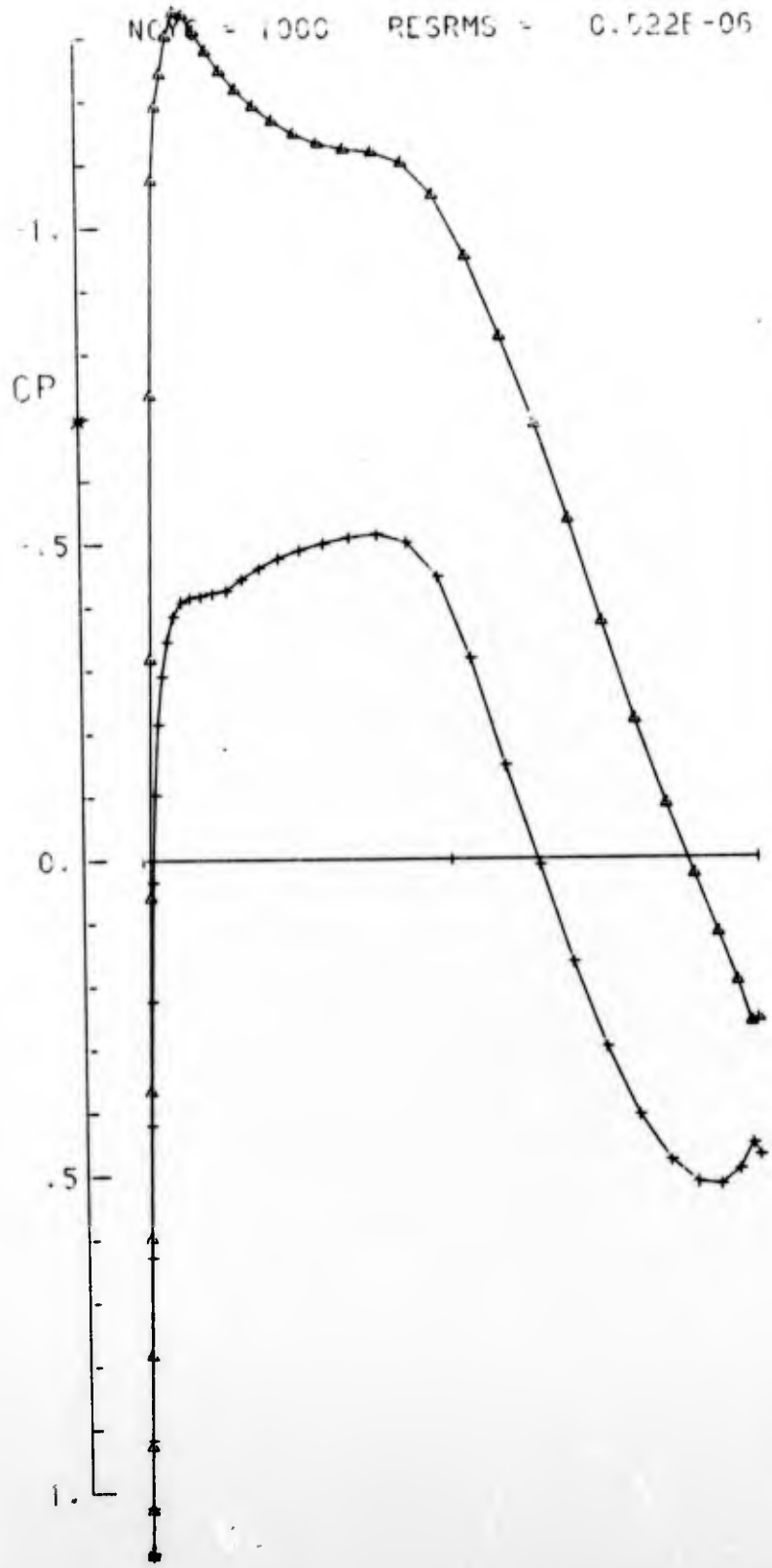
RO NLRMESH3 NO2 .01 .02

CELLS 40X 8
RESAE 0.695E-07
DRAG 0.648E-02
RESMX -0.238E-06 4 1



2

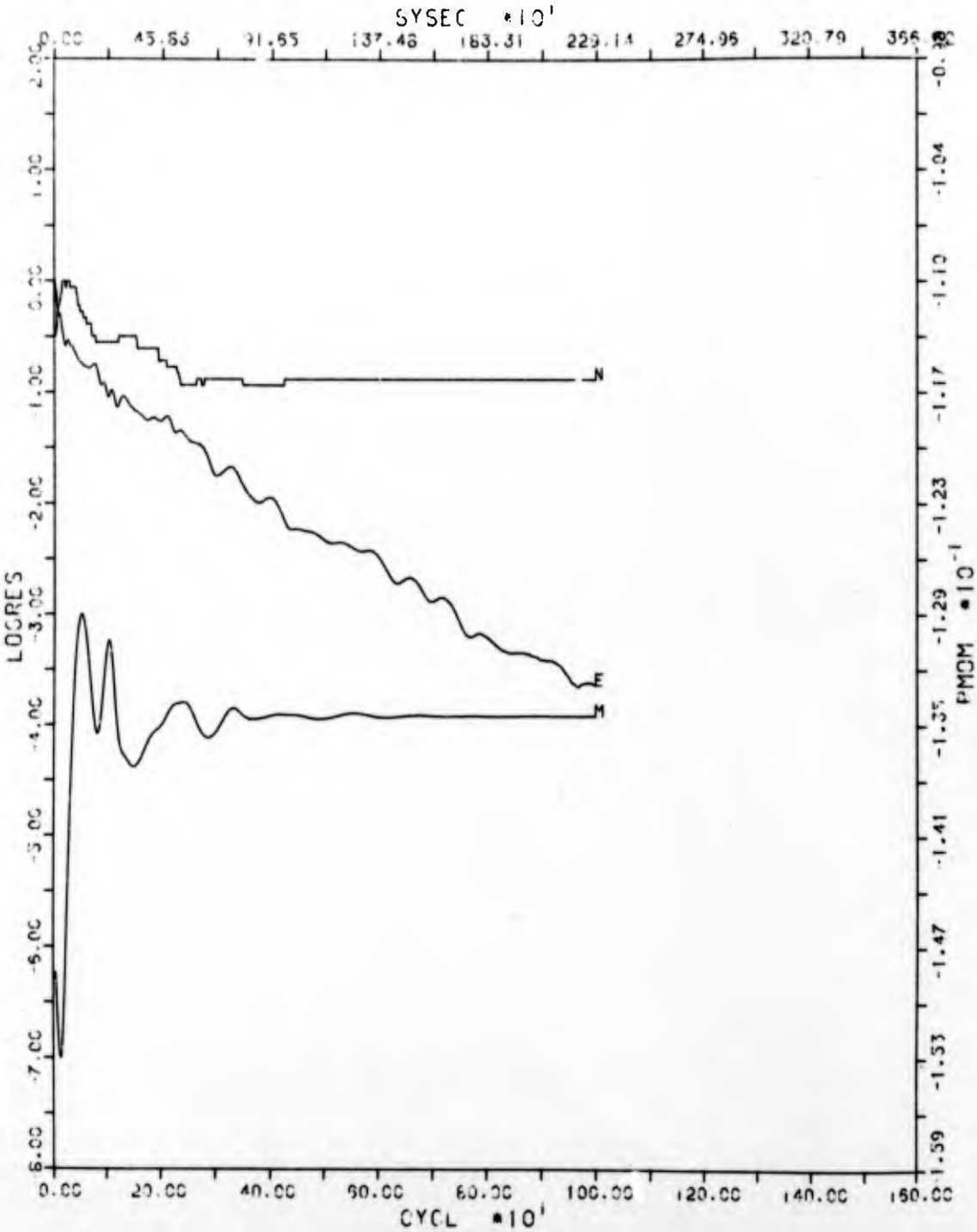
F.F.A.	AR 211		A.Rizzi	07-8-7
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

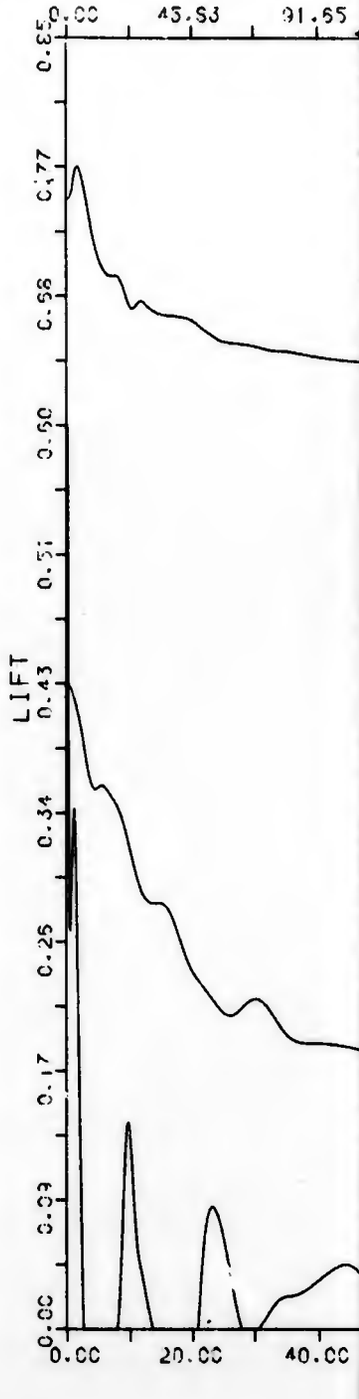


F.F.A.

28/6 V07 NONISO VOR IN/OUT TOGO UNORO NLRMESH3 NO2 .01 .02

PITCH	-0.134	GCIRC	0.319		
MACH	0.721	ALPHA	-0.194	CELLS	80X16
RATE	0.992	RESAS	0.221E-02	RESAE	0.522E-06
NSUP	130	LIFT	0.635E+00	DRAG	0.959E-03
CYCL	1000	SYSEC	0.229E+04	RESMX	0.179E-05 25

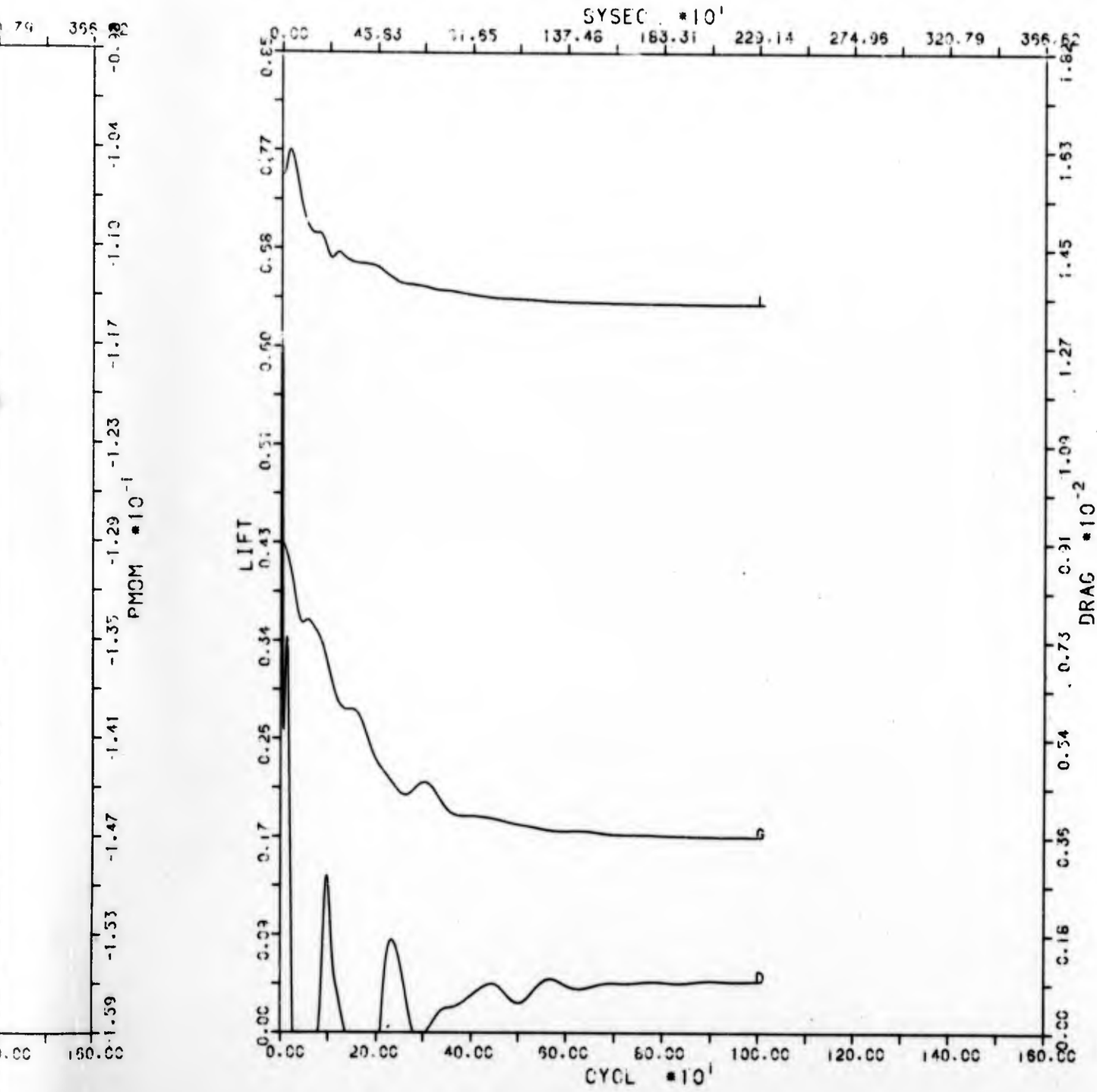




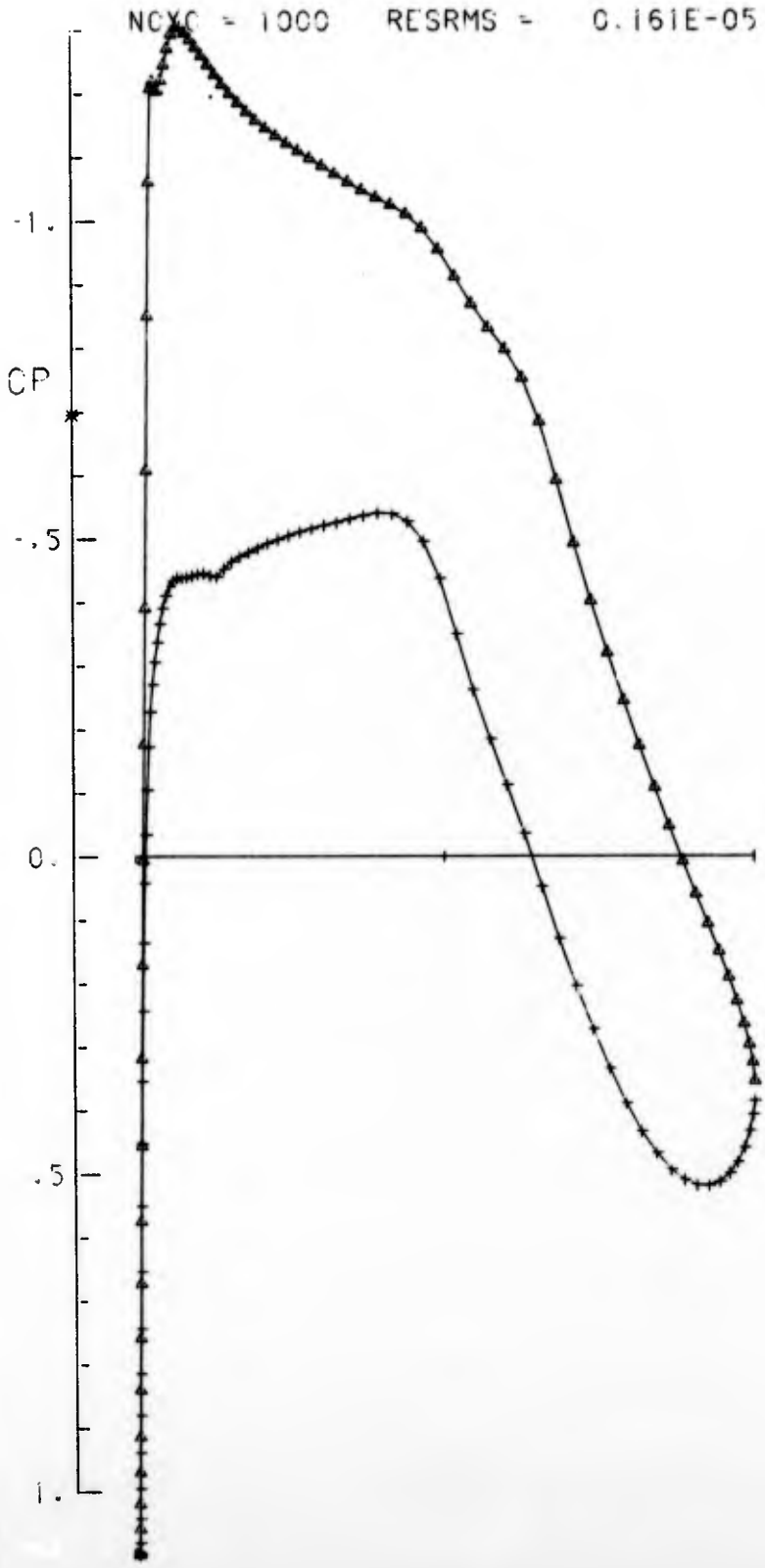
F.F.A.	AR 211		A.Rizzi	07-8-8
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

UNORO NLRMESH3 NO2 .01 .02

CELLS 80X16
RESAE 0.522E-06
DRAG 0.959E-03
RESMX 0.179E-05 25 1



F.F.A.	AR 211		A.Rizzi	07-8-9
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

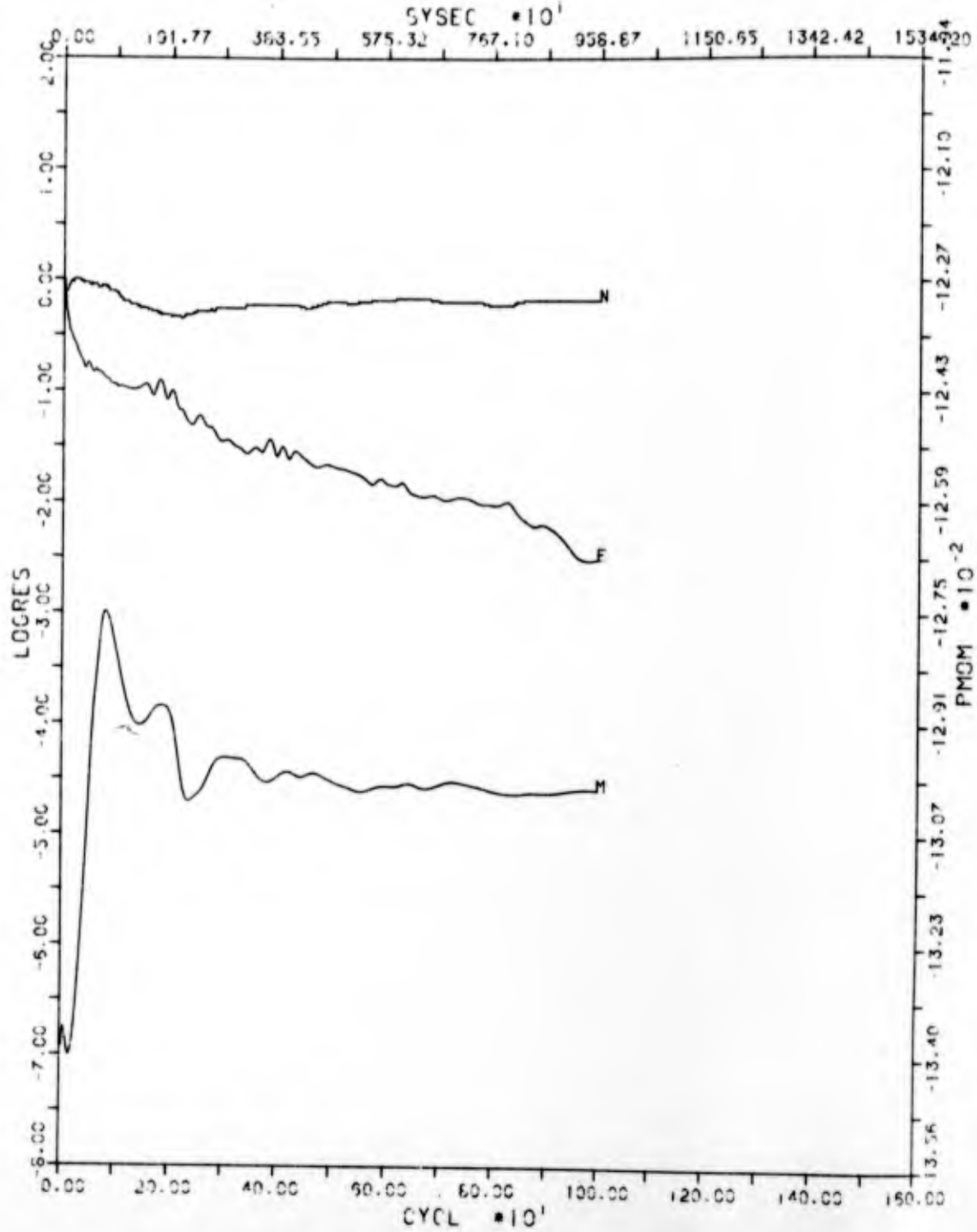


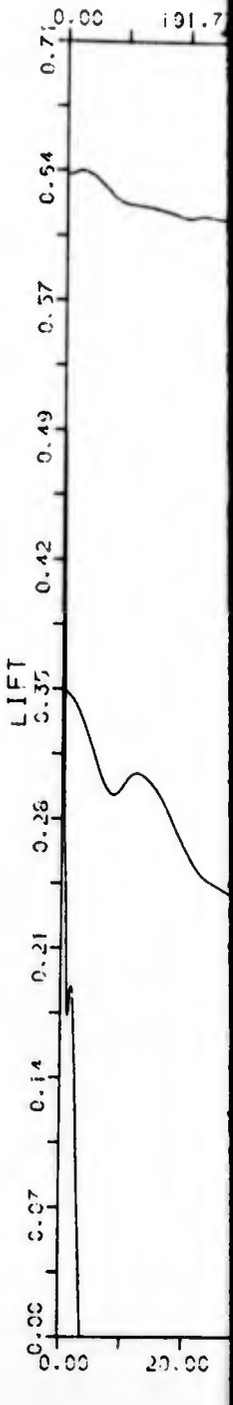
SAME AS PREVIOUS MESH 3 SOLUTION EXCEPT COEFFICIENT 2nd Dif. filte

28/6 V07 NONISO VOR IN/OUT TOOO UNORO N MESH3 NO2 .

PITCH	-0.130	CCIRC	0.298
MACH	0.721	ALPHA	-0.194
RATE	0.994	RESAS	0.532E-03
NSUP	517	LIFT	0.597E+00
CYCL	1000	SYSEC	0.959E+04

LLS 160X32
SAE 0.151E-05
DRAG 0.198E-03
RESMX 0.894E-05



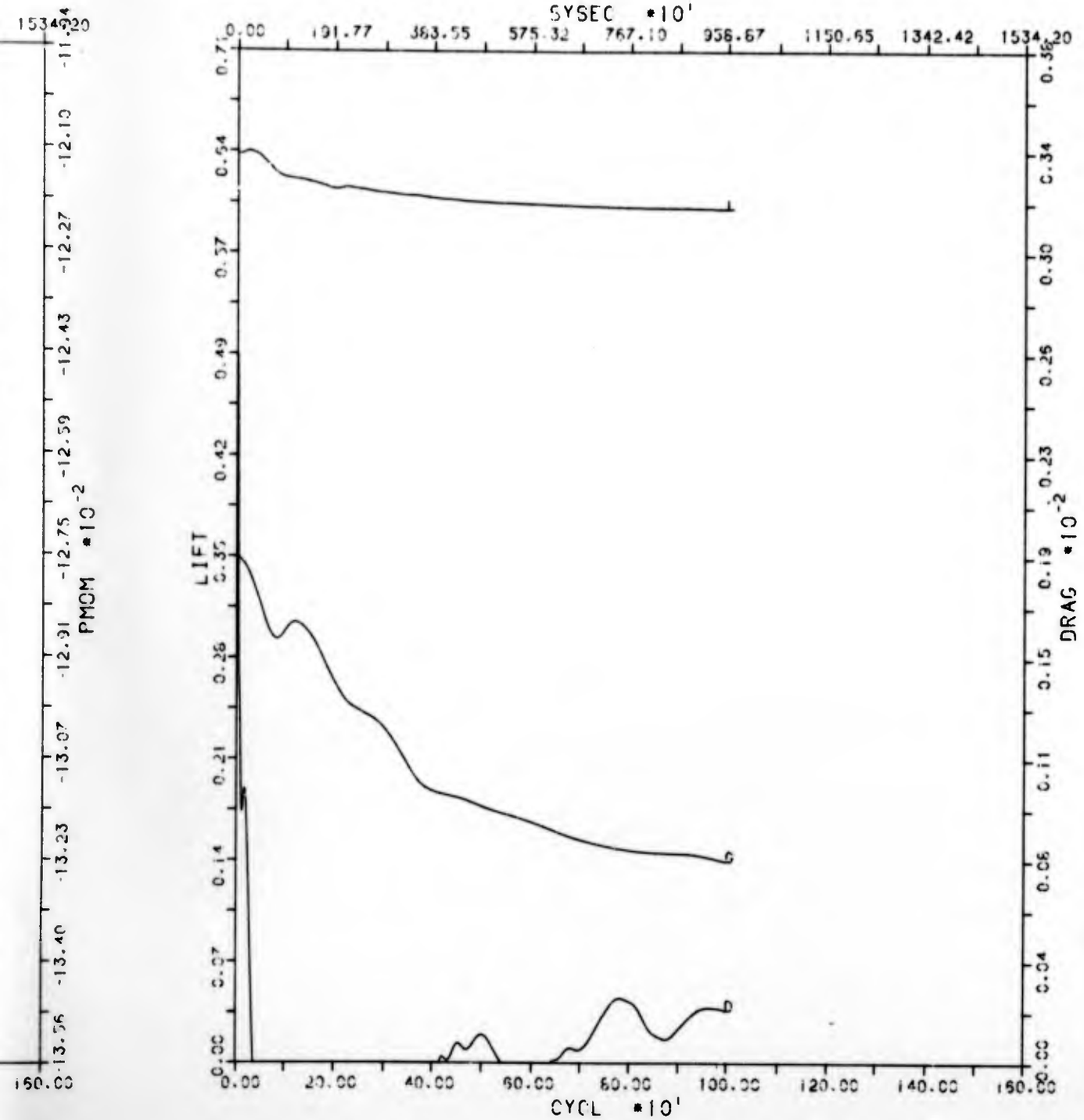


F.F.A.	AR 211		A.Rizzi	07-8-10
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

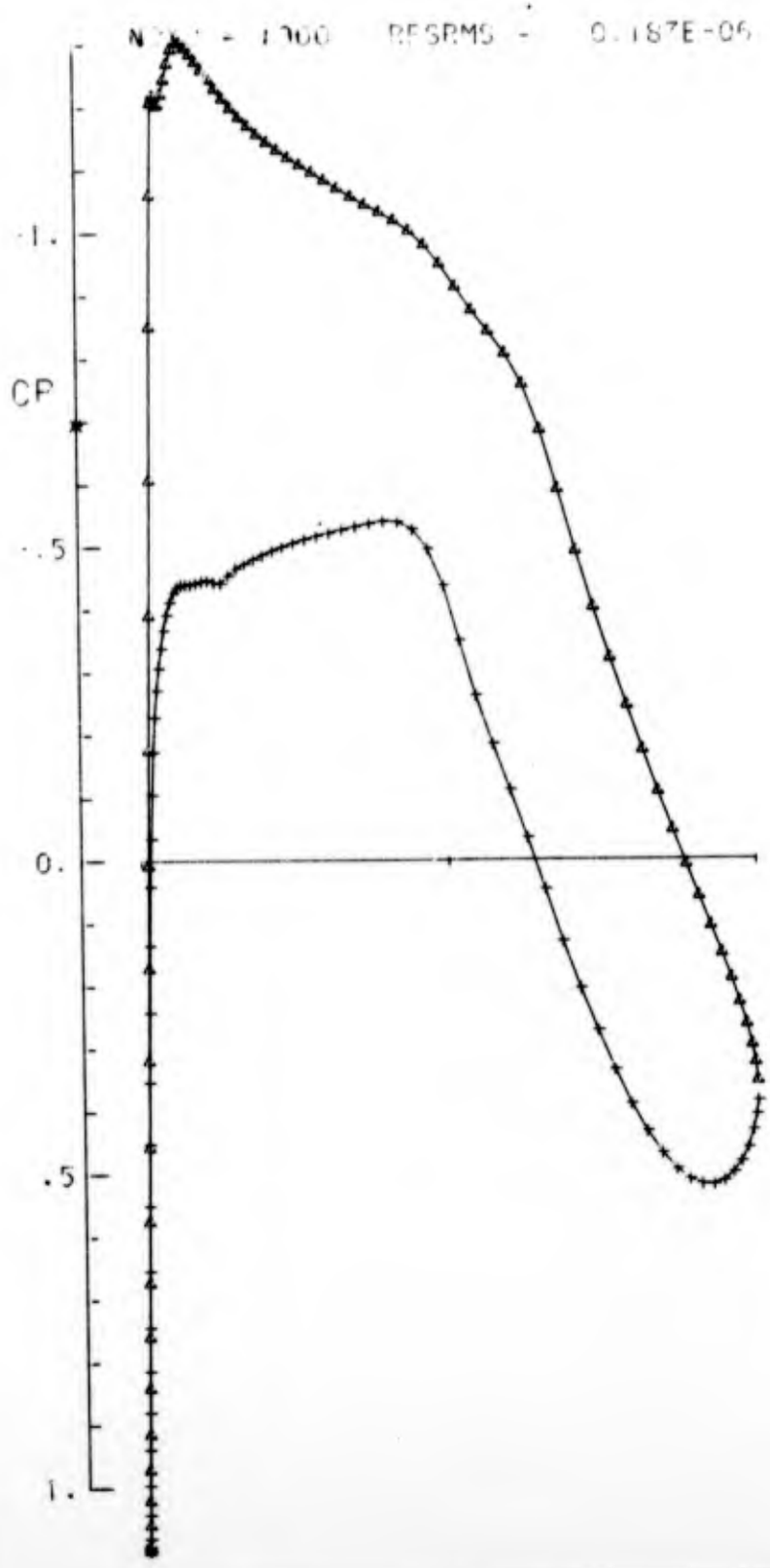
ON EXCEPT 1/5. OEFFICIENT 2nd Dif. filter and 2 × Coefficient 4th dif. filter

NORO NLRMESH3 NO2 .01 .02

CELLS 160X32
RESAE 0.151E-05
DRAG 0.198E-03
RESMX 0.894E-05 134 4



F.F.A.	AR 211		A.Rizzi	07-8-11
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



		07-1-15	07-1-16	07-1-17	07-1-18	07-1-19	07-1-20	07-1-21	07-1-22	07-1-23	07-1-24	07-1-25	TEST CASE 07 CONTRIBUTOR 2
07-2-1	07-2-2	07-2-3	07-2-4	07-2-5	07-2-6	07-2-7	07-2-8	07-2-9	07-2-10	07-2-11	07-2-12	07-2-13	07-2-14
07-2-15	07-2-16	07-2-17	07-2-18	07-2-19	07-2-20	07-2-21	TEST CASE 07 CONTRIBUTOR 3	07-3-1	07-3-2	07-3-3	07-3-4	07-3-5	07-3-6
07-3-7	07-3-8	07-3-9	07-3-10	07-3-11	07-3-12	07-3-13	07-3-14	07-3-15	07-3-16	07-3-17	07-3-18	TEST CASE 07 CONTRIBUTOR 6	07-6-1
07-6-2	07-6-3	07-6-4	07-6-5	07-6-6	07-6-7	07-6-8	07-6-9	07-6-10	07-6-11	07-6-12	07-6-13	07-6-14	07-6-15
07-6-16	07-6-17	07-6-18	07-6-19	07-6-20	07-6-21	07-6-22	07-6-23	TEST CASE 07 CONTRIBUTOR 8	07-8-1	07-8-2	07-8-3	07-8-4	07-8-5
← 07-8-6 →		X	07-8-7	← 07-8-8 →		X	07-8-9	← 07-8-10 →		07-8-11	X	X	CONTINUED

FICHE Nº 11

F.F.A.

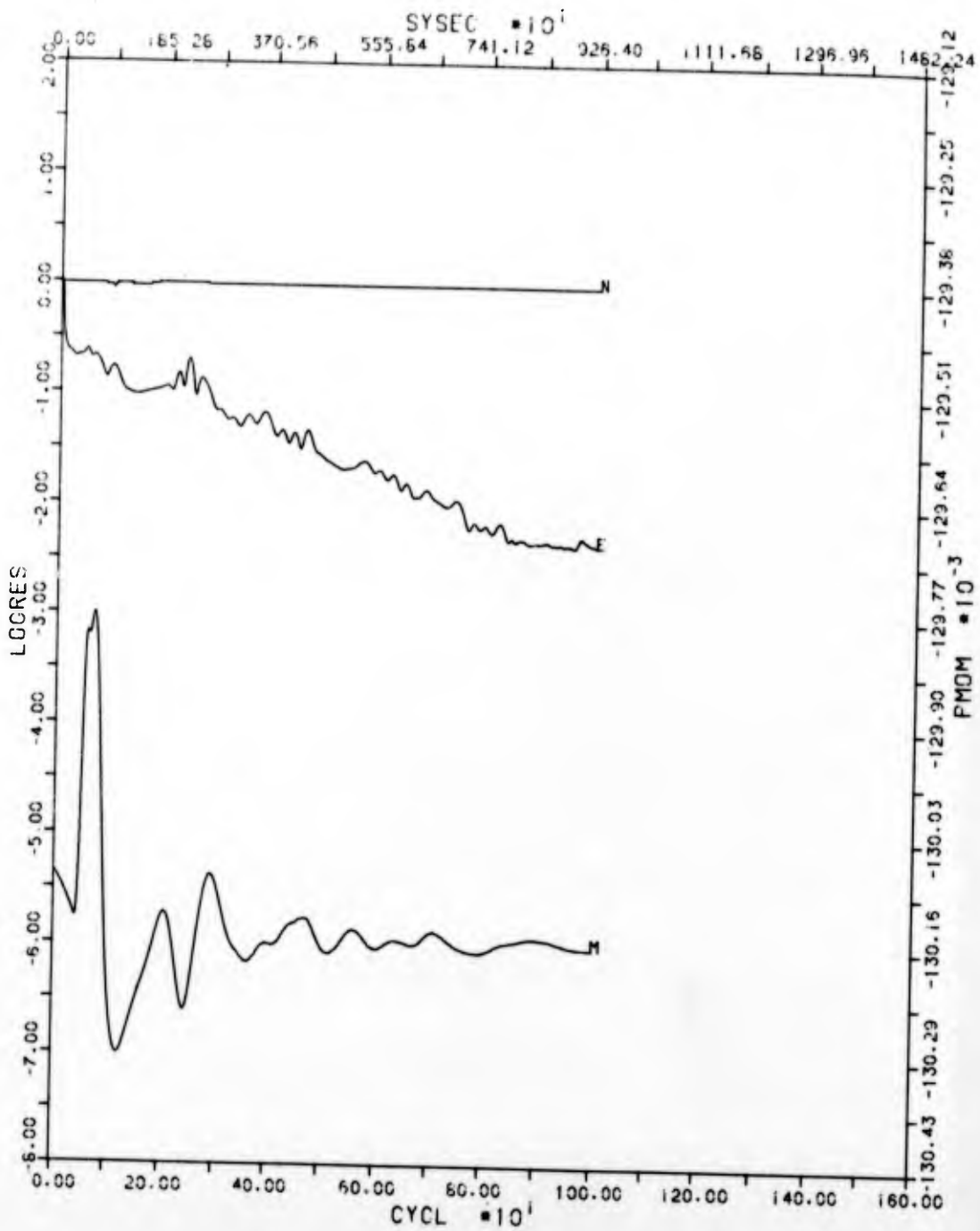
SOLUTION 28/6 after 2000 cycles (i.e. continued additional 1000 cycs)

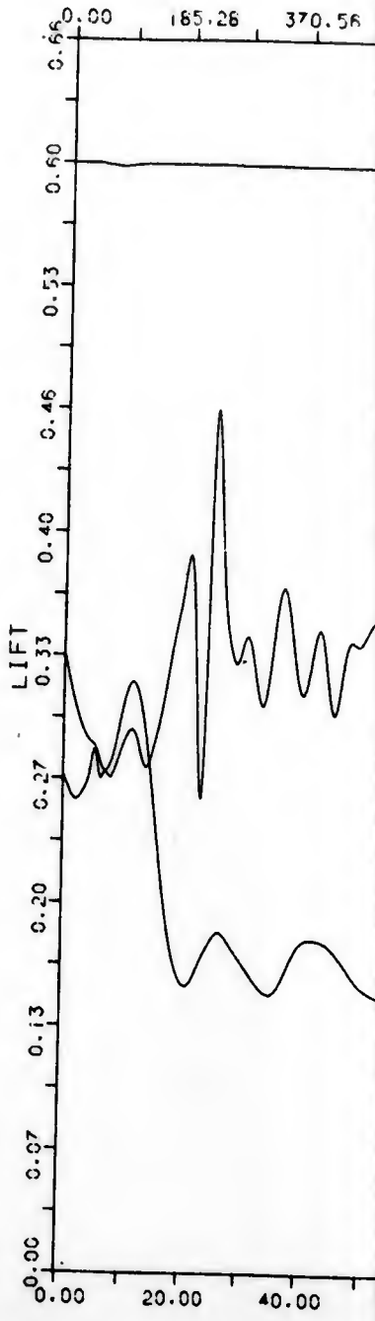
29/6 V07 NONISO VOR IN/OUT TOQO UNORO NLRMESH3 .01 .02 10

C_M PITCH	-0.130	Γ CCIRC	0.297		
MACH	0.721	ALPHA	-0.194		
RATE	0.995	start RESAS$_{rms}$	0.421E-04	end RESAE$_{rms}$	0.187E-06
NSUP	517	C_L LIFT	0.596E+00	C_D DRAG	0.258E-03
CYCL	1000	SYSEC	0.926E+04	RESMX$_{max}$	0.113E-05

CELLS 160X32

30





F.F.A.	AR 211		A.Rizzi	07-8-12
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

ter 2000 cycles (i.e. continued additional 1000 cycs)

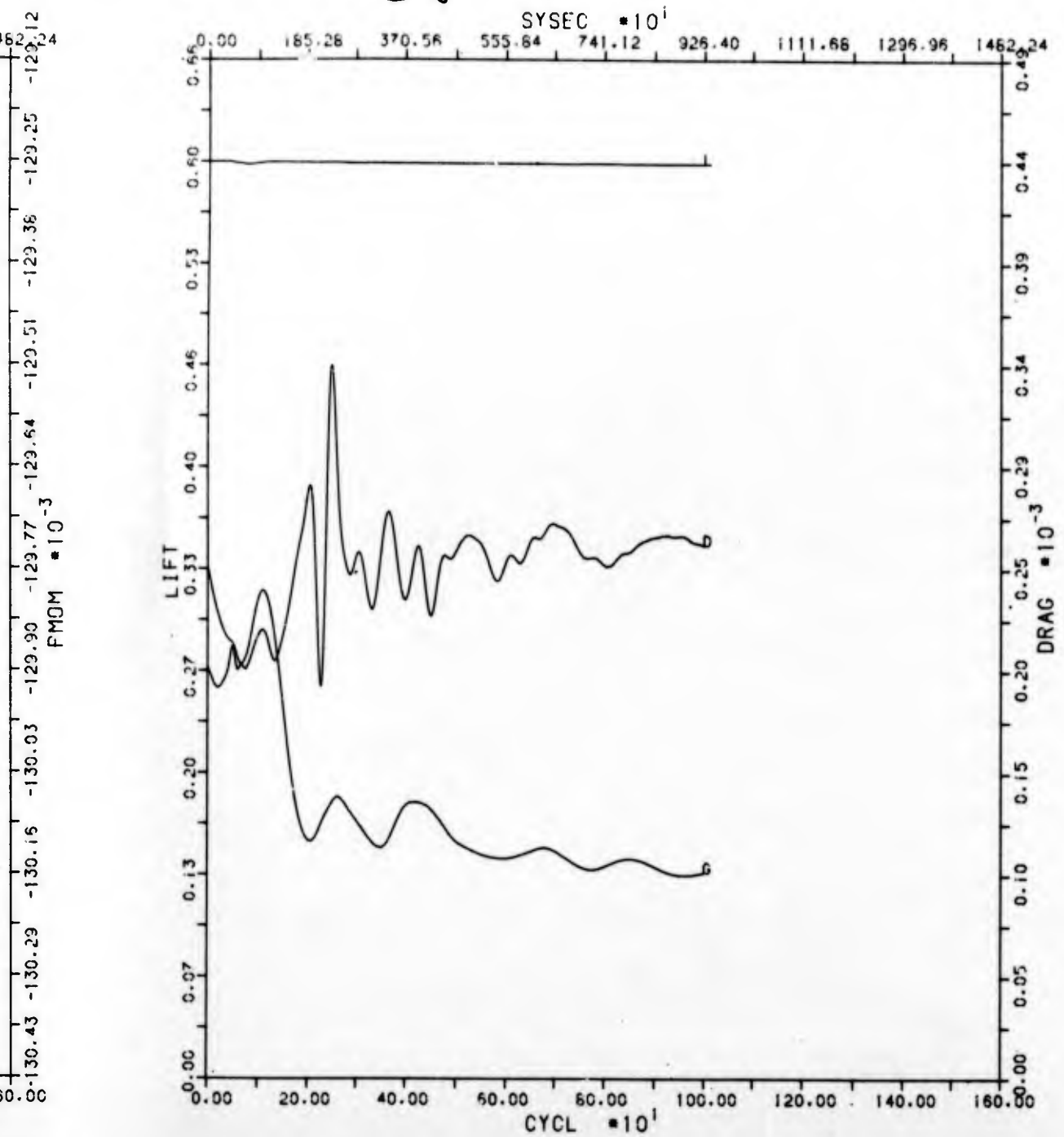
RO NLRMESH3 .01 .02 1000 EX

CELLS 160X32

end RESAE$_{rms}$ 0.187E-06

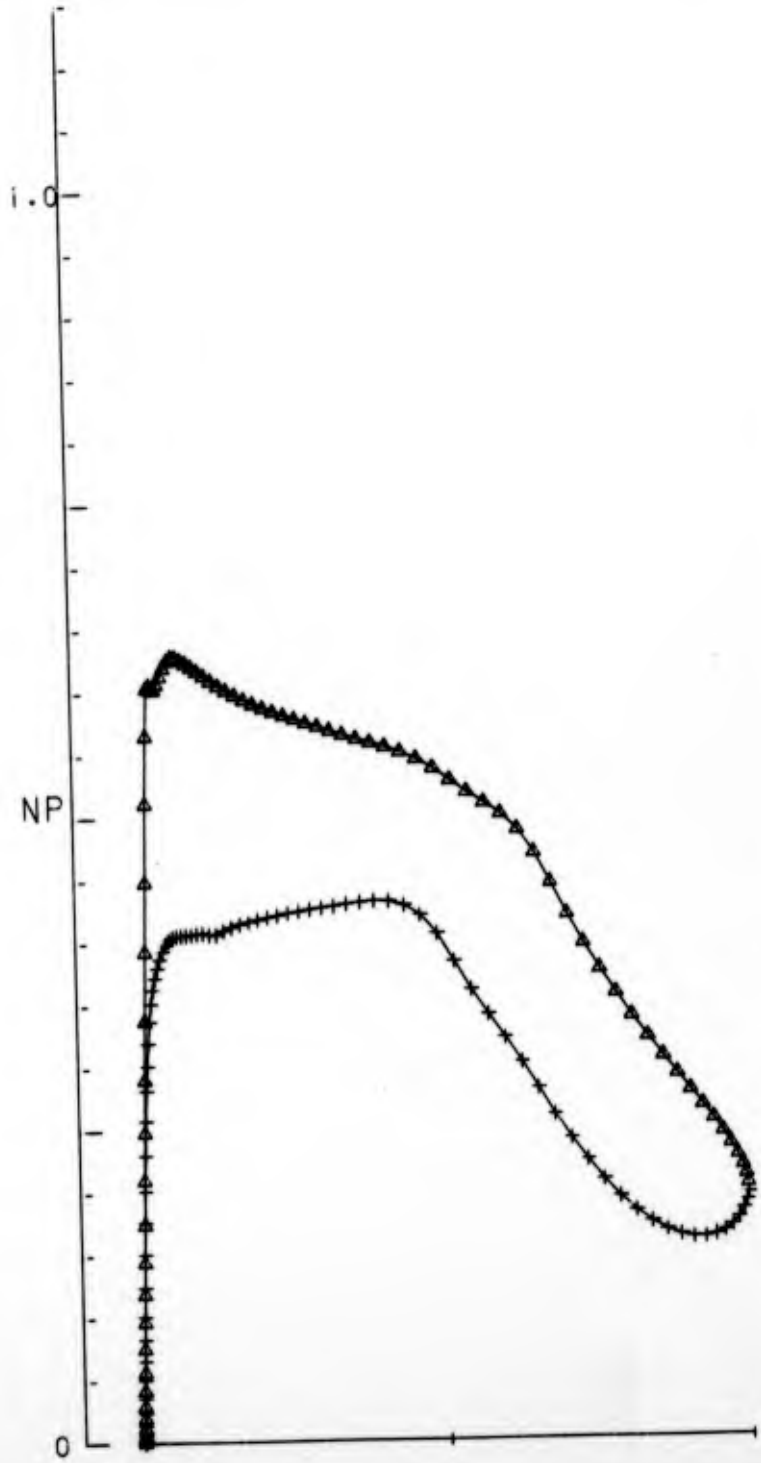
C_D DRAG 0.258E-03

RESMX$_{max}$ 0.113E-05 30 i

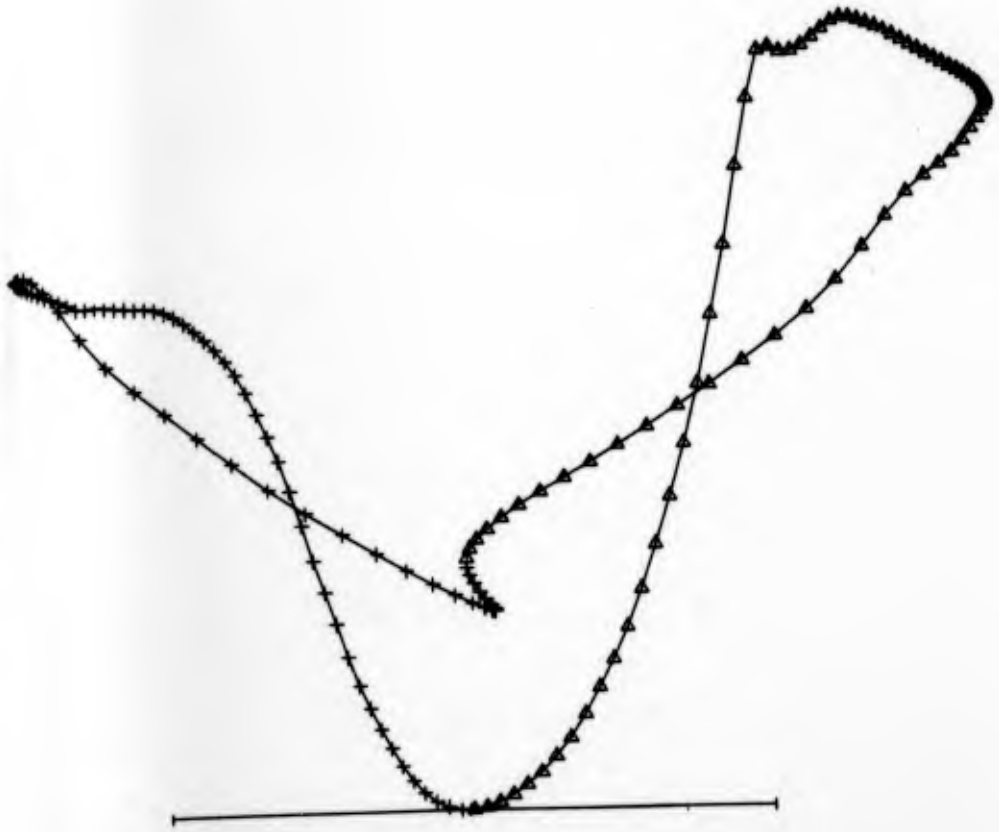


F.F.A.

SOLUTION AFTER 200 cycles
28/6 VO7 NONISO VOR IN/OUT TOQO UNORO NLRMESH 3 N/2 .01.02
P 1 PRES 1-P/PIINF

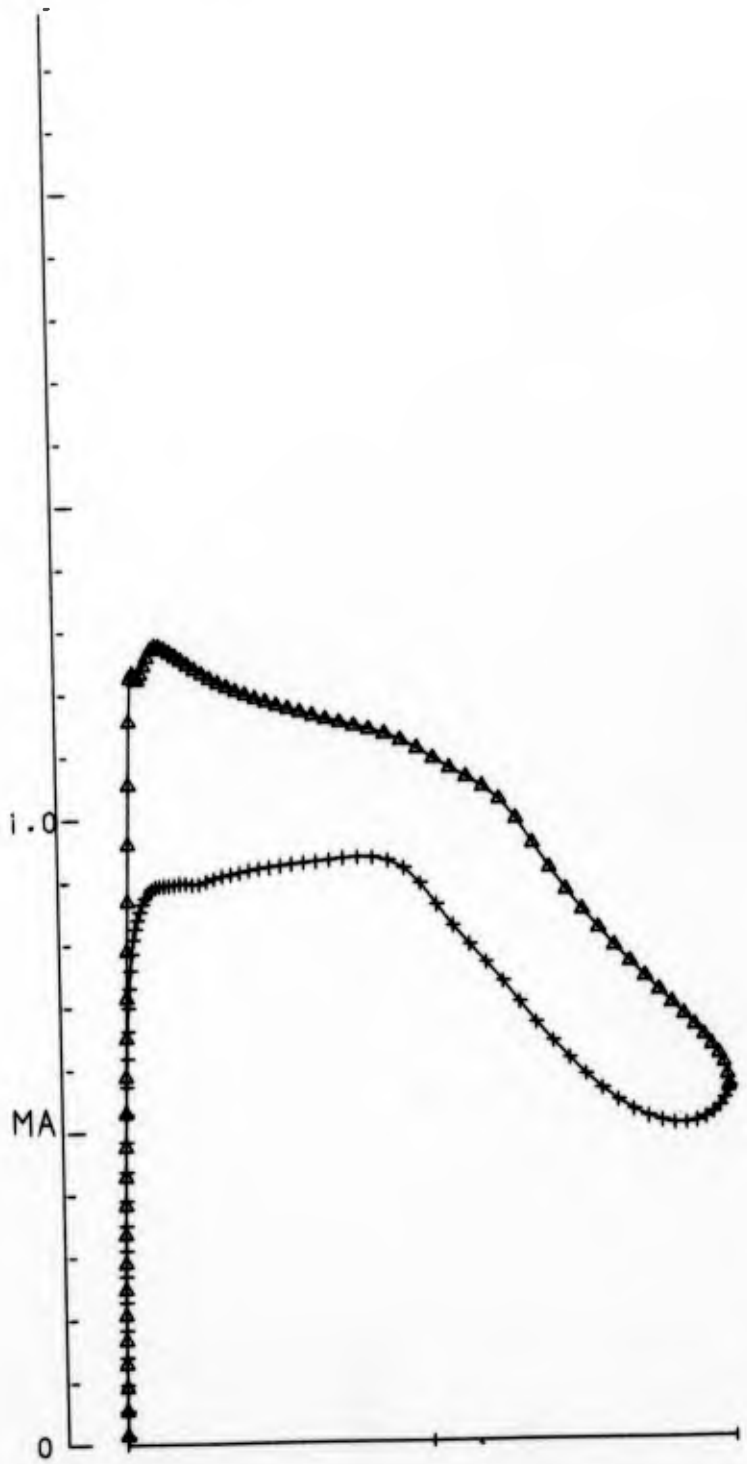


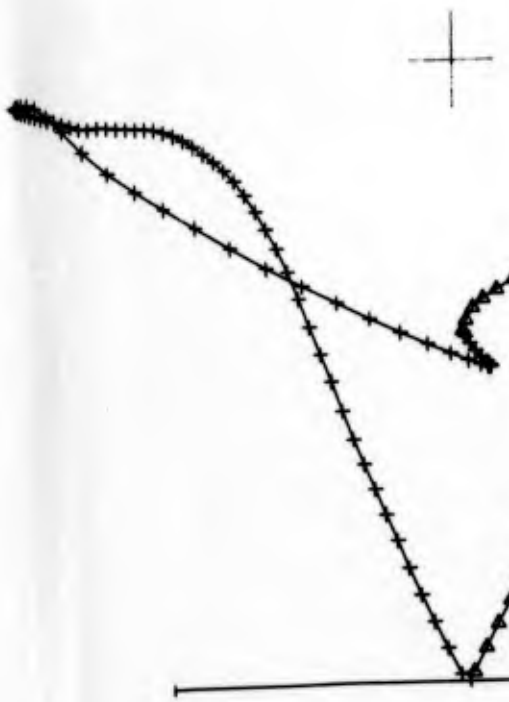
F.F.A.	AR 211		A.Rizzi	07-8-13
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



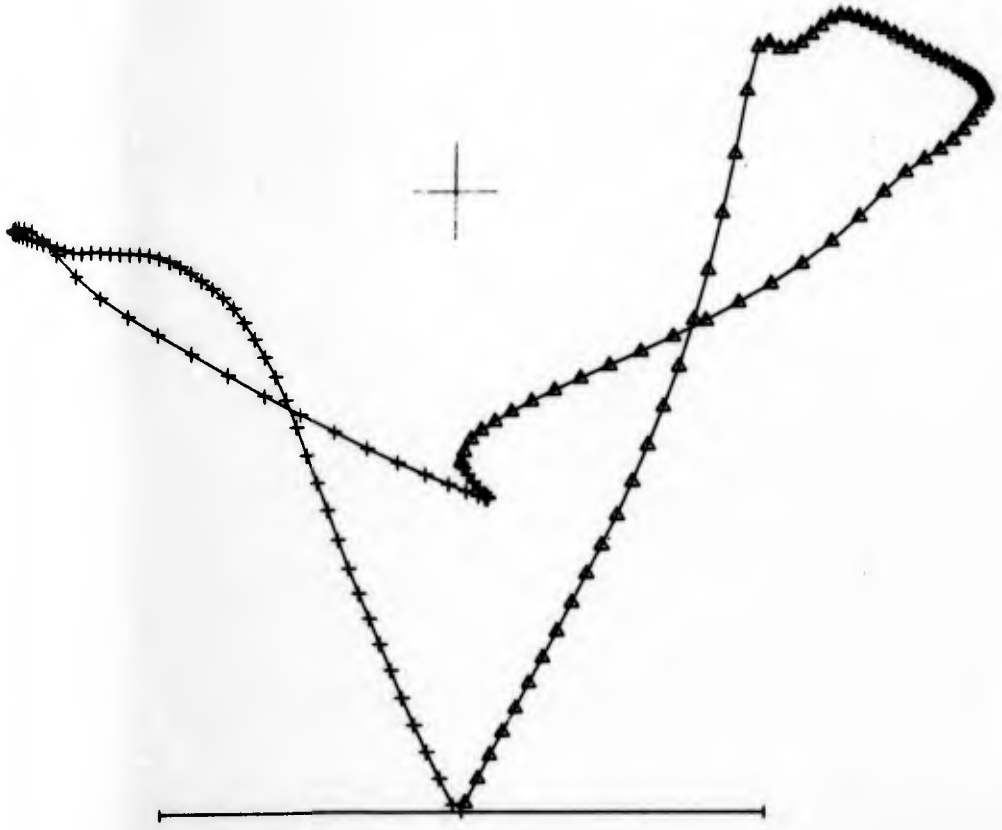
F.F.A.

P 2 MACH



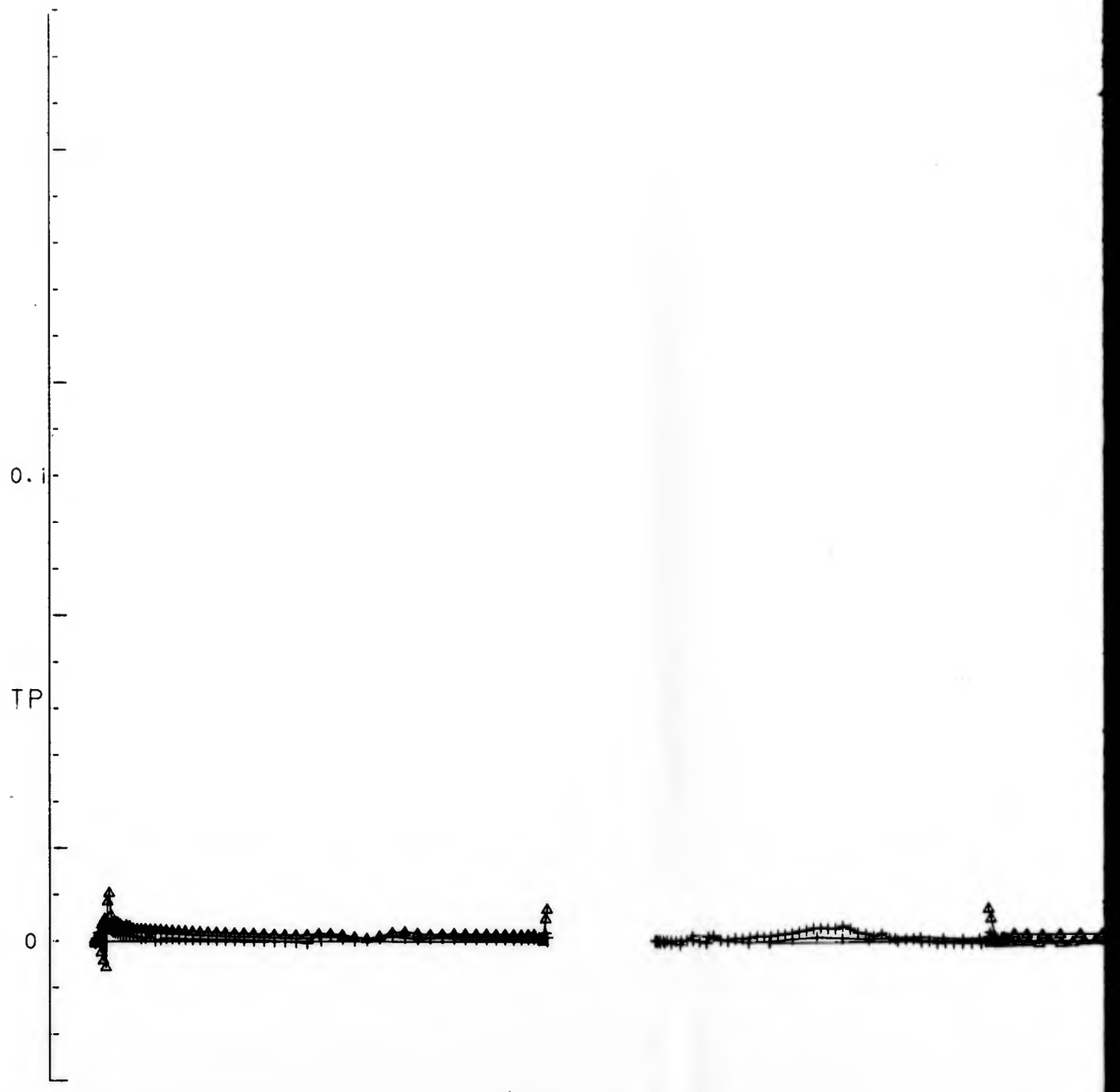


F.F.A.	AR 211		A.Rizzi	07-8-14
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



F.F.A.

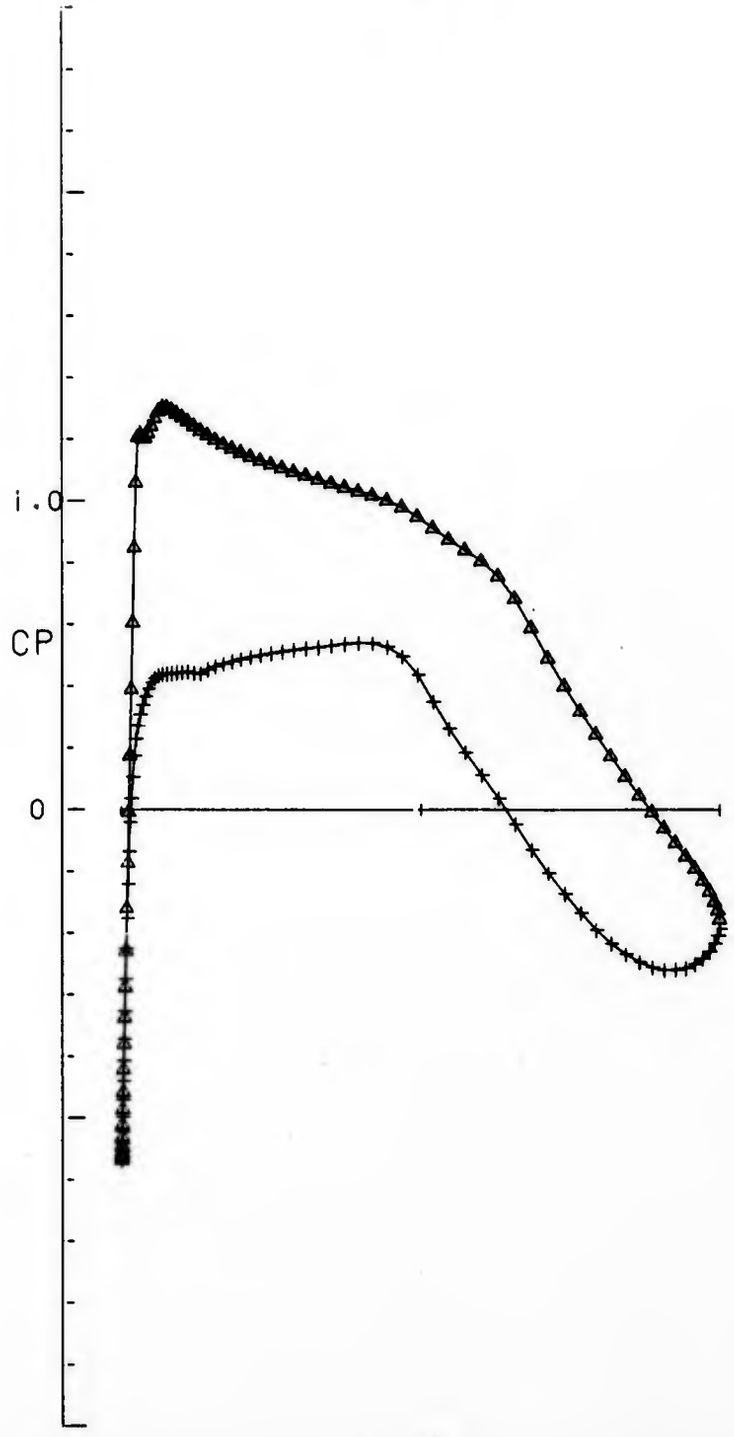
P 3 TOTP 1-PI/PIINF

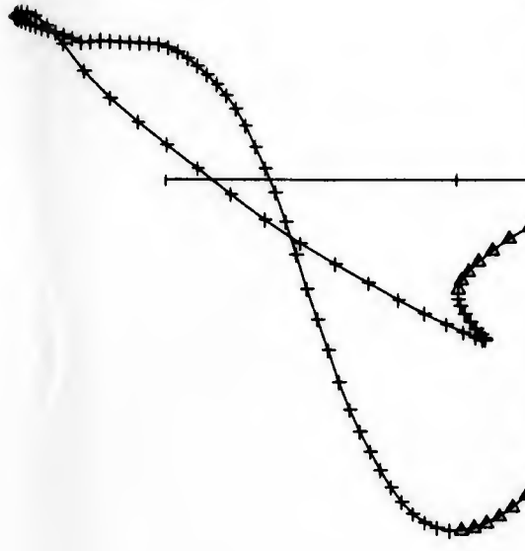


F.F.A.	AR 211		A.Rizzi	07-8-15
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

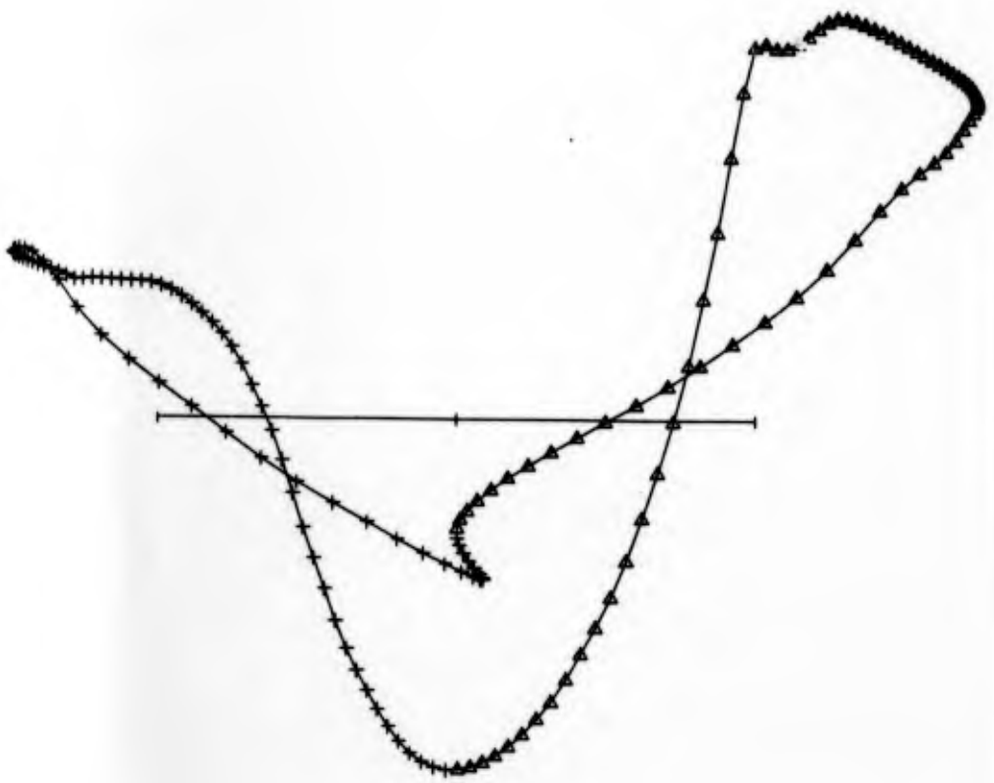
F.F.A.

P 4 COEP C_p



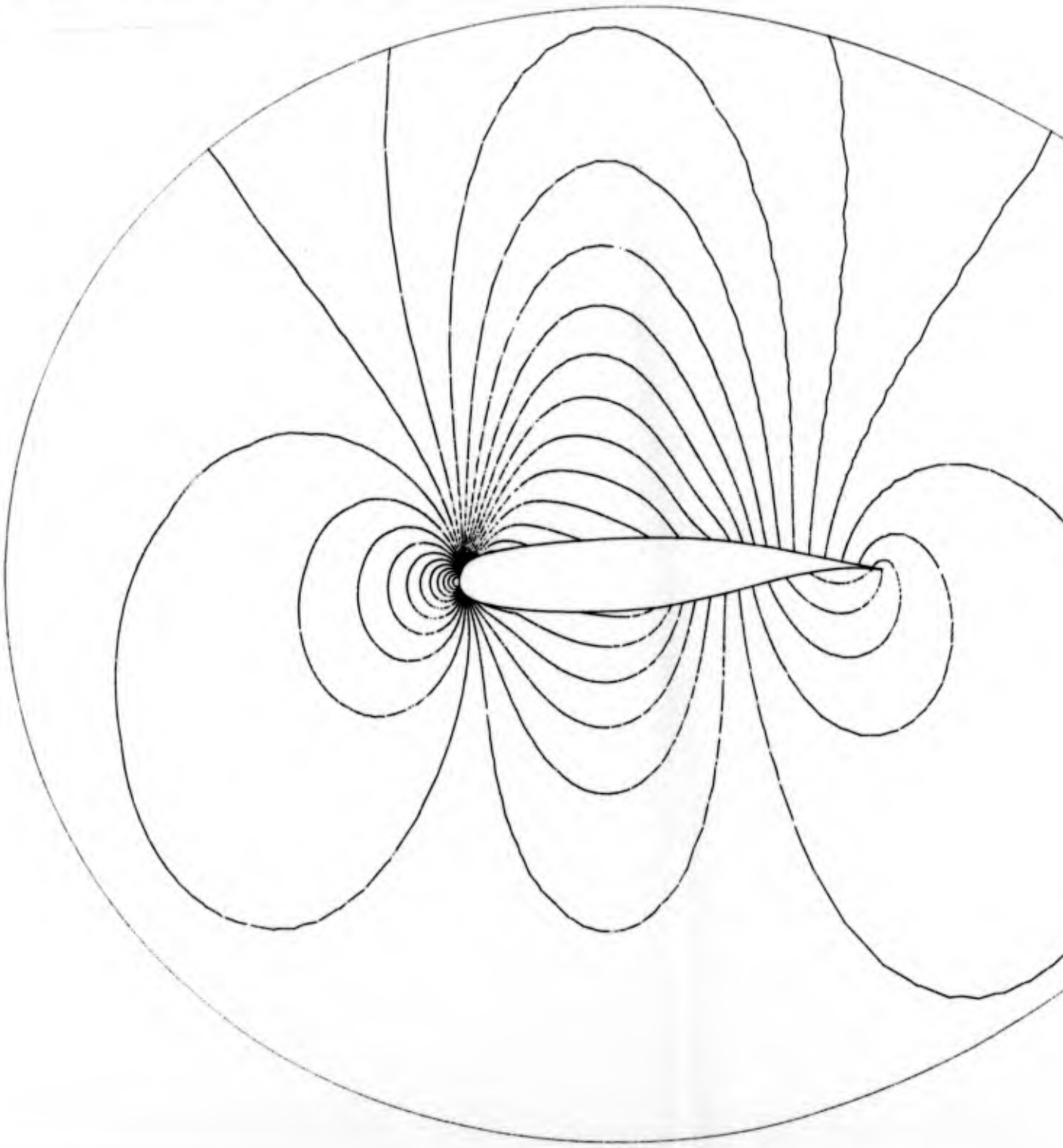


F.F.A.	AR 211		A.Rizzi	07-8-16
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

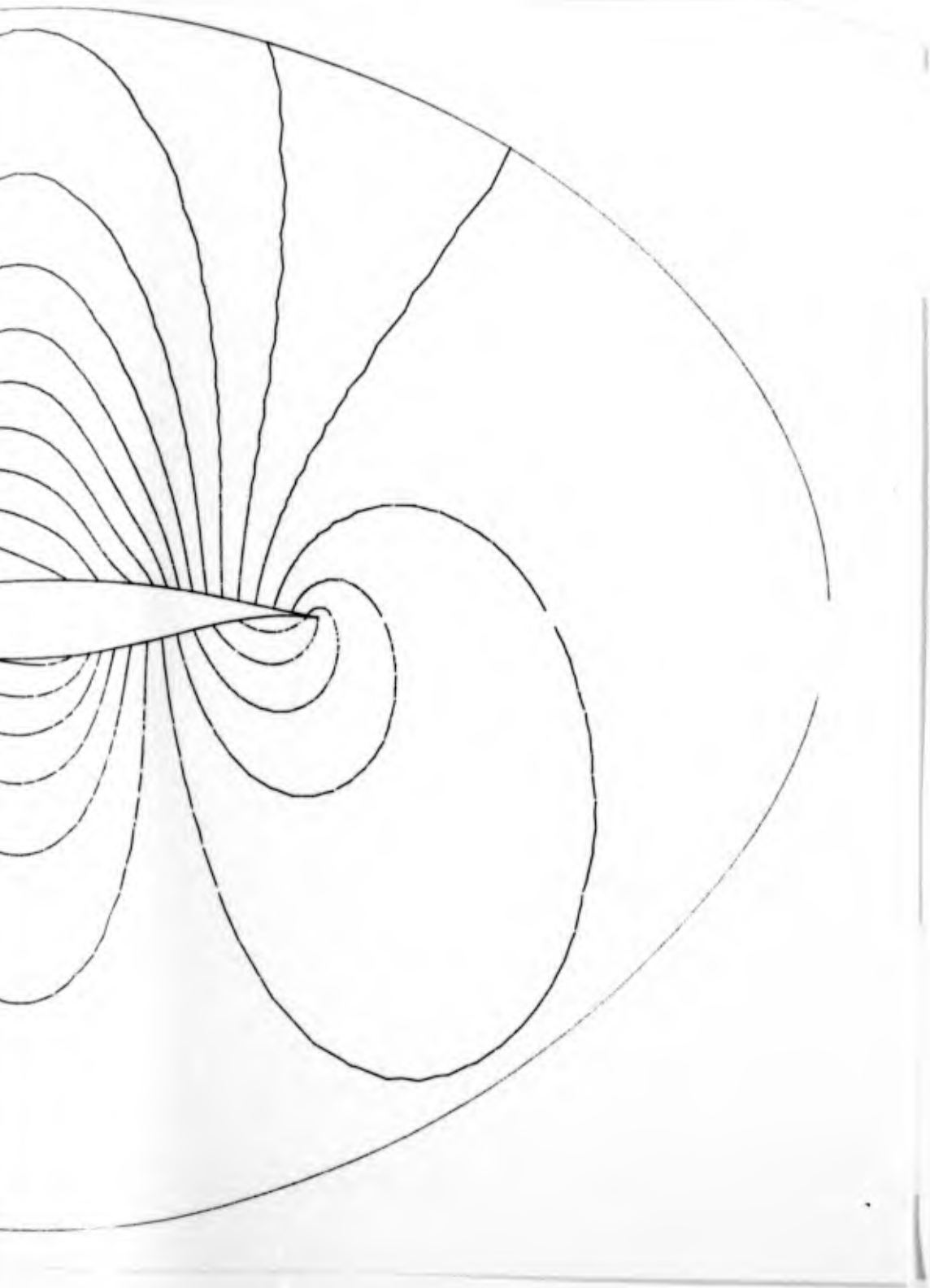


F.F.A.

P 5 PRES 1-P/PHNF INC = .025 min = .025 max = .625

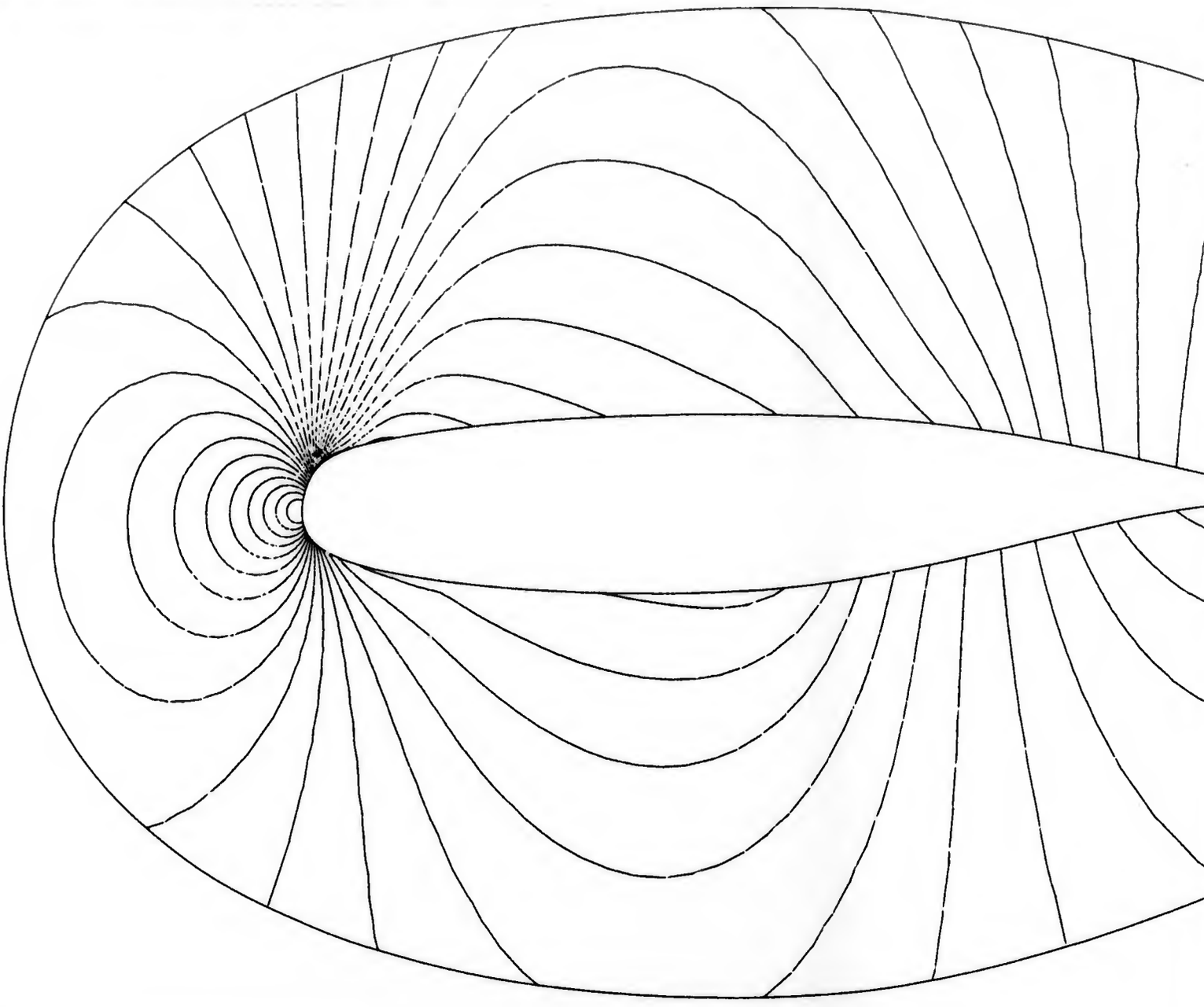


F.F.A.	AR 211		A.Rizzi	07-8-17
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

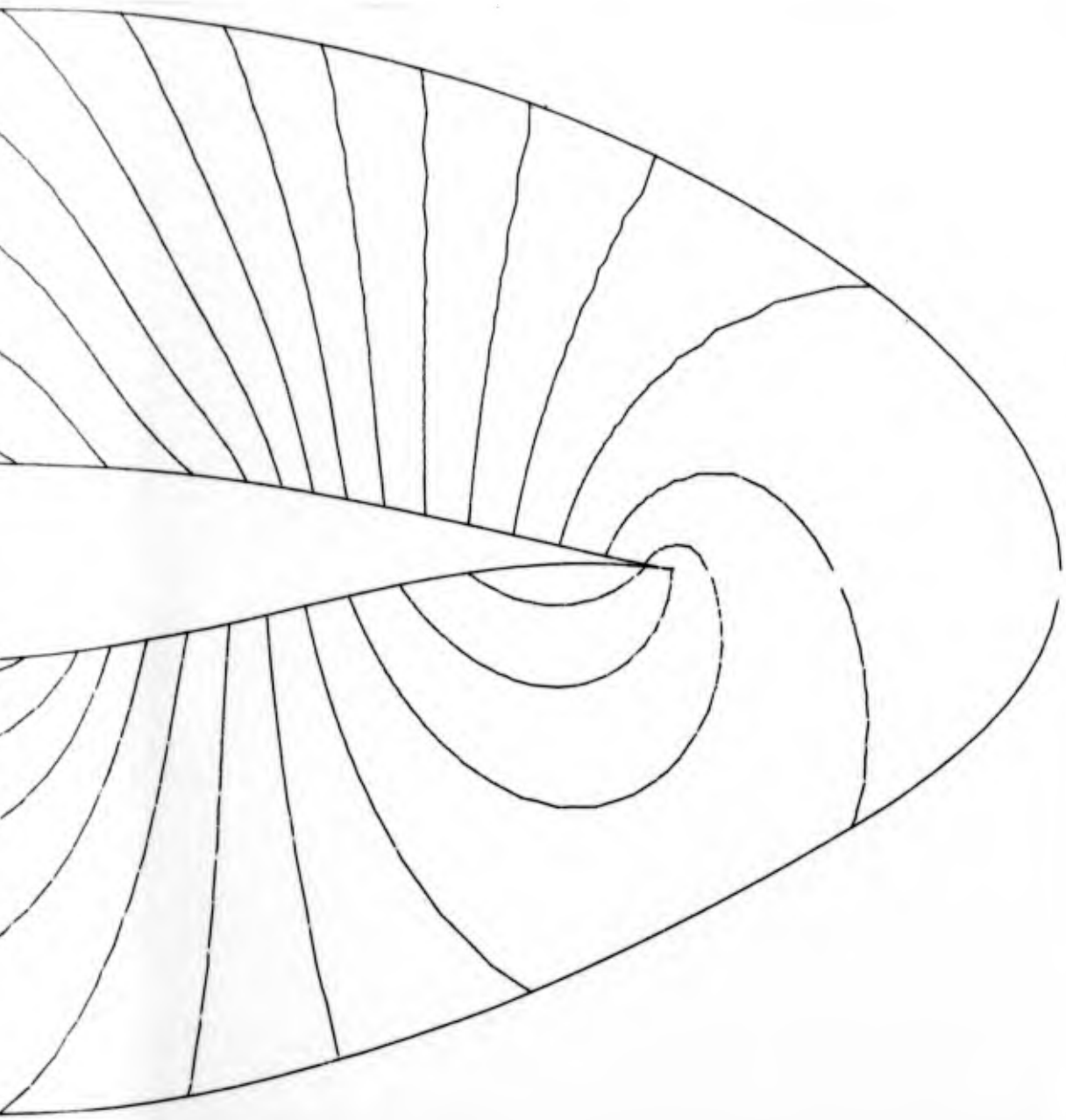


F.F.A.

P 6 PRES 1-P/PIINF INC = .025 min = .025 max = .625

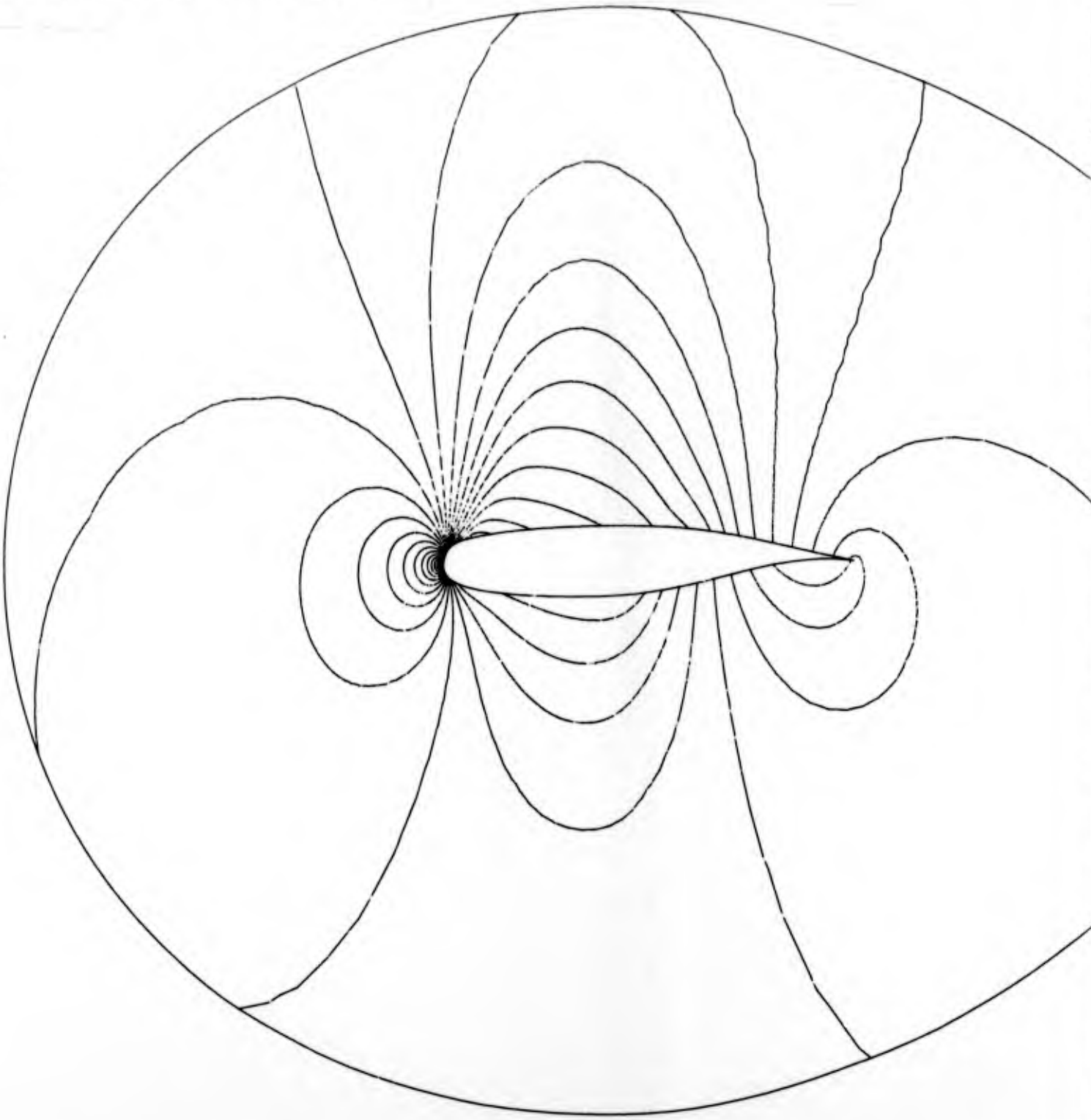


F.F.A.	AR 211		A.Rizzi	07-8-18
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

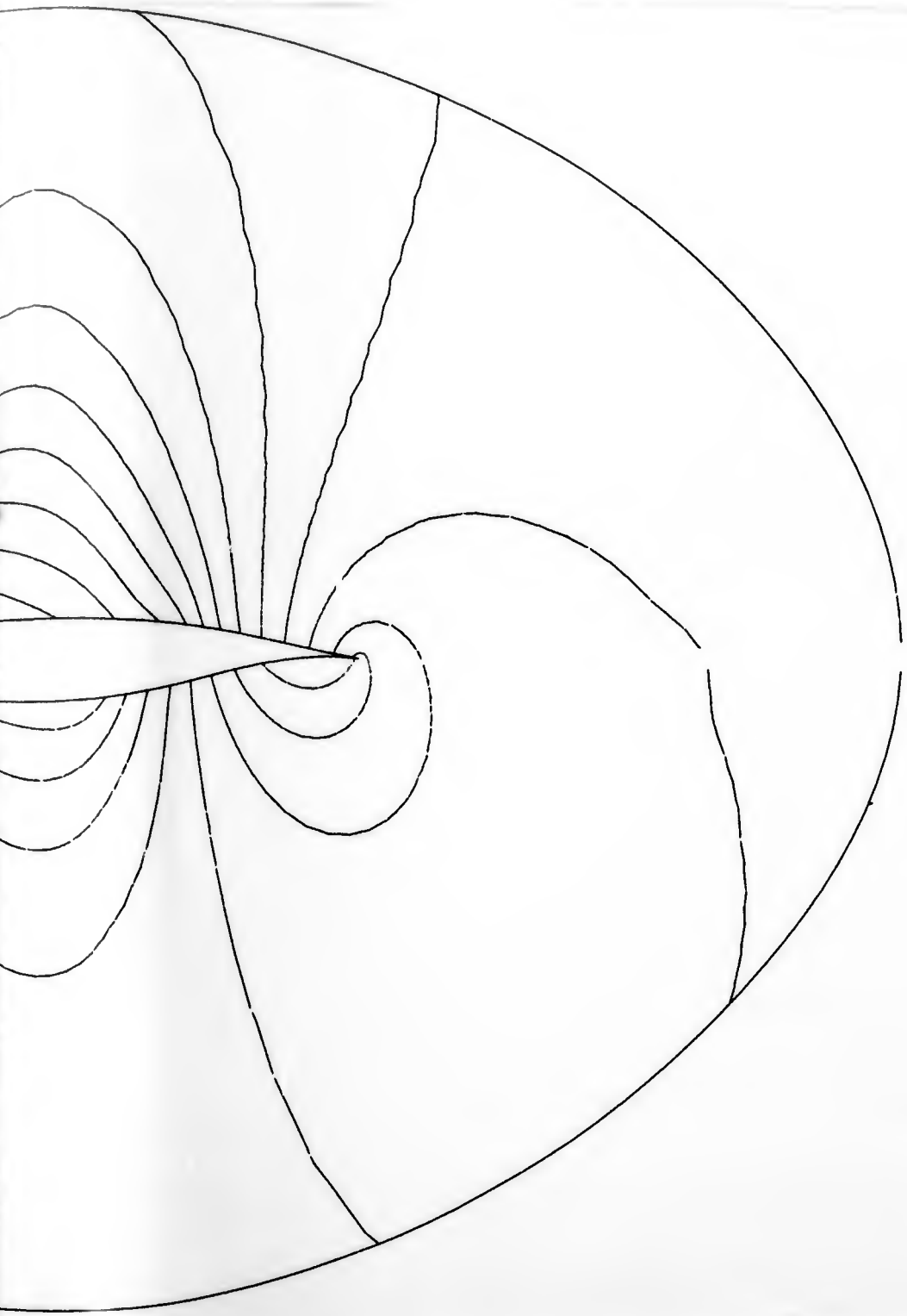


F.F.A.	AE
	NU

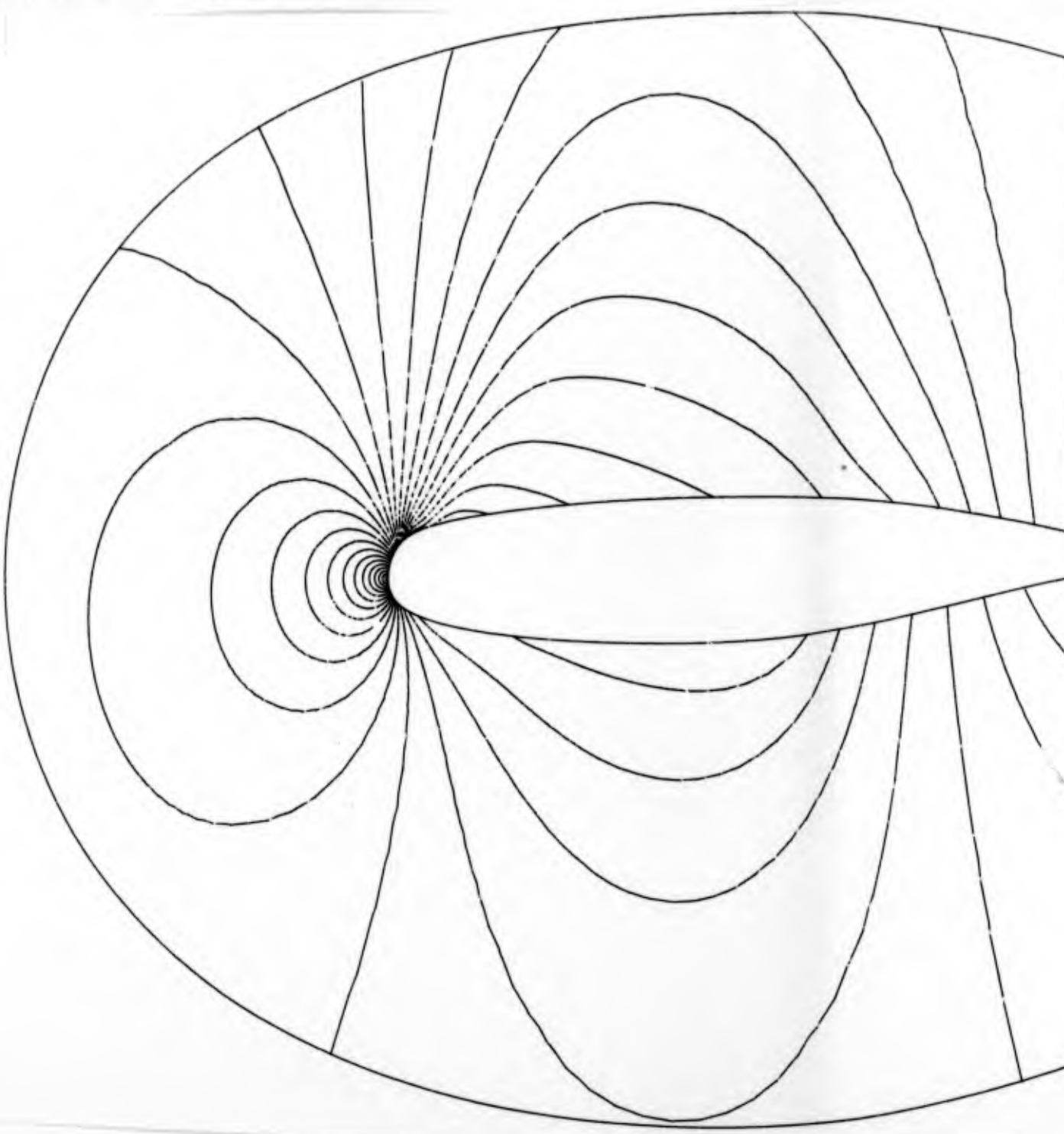
P 7 MACH INC = .05 min = .05 max = 1.25



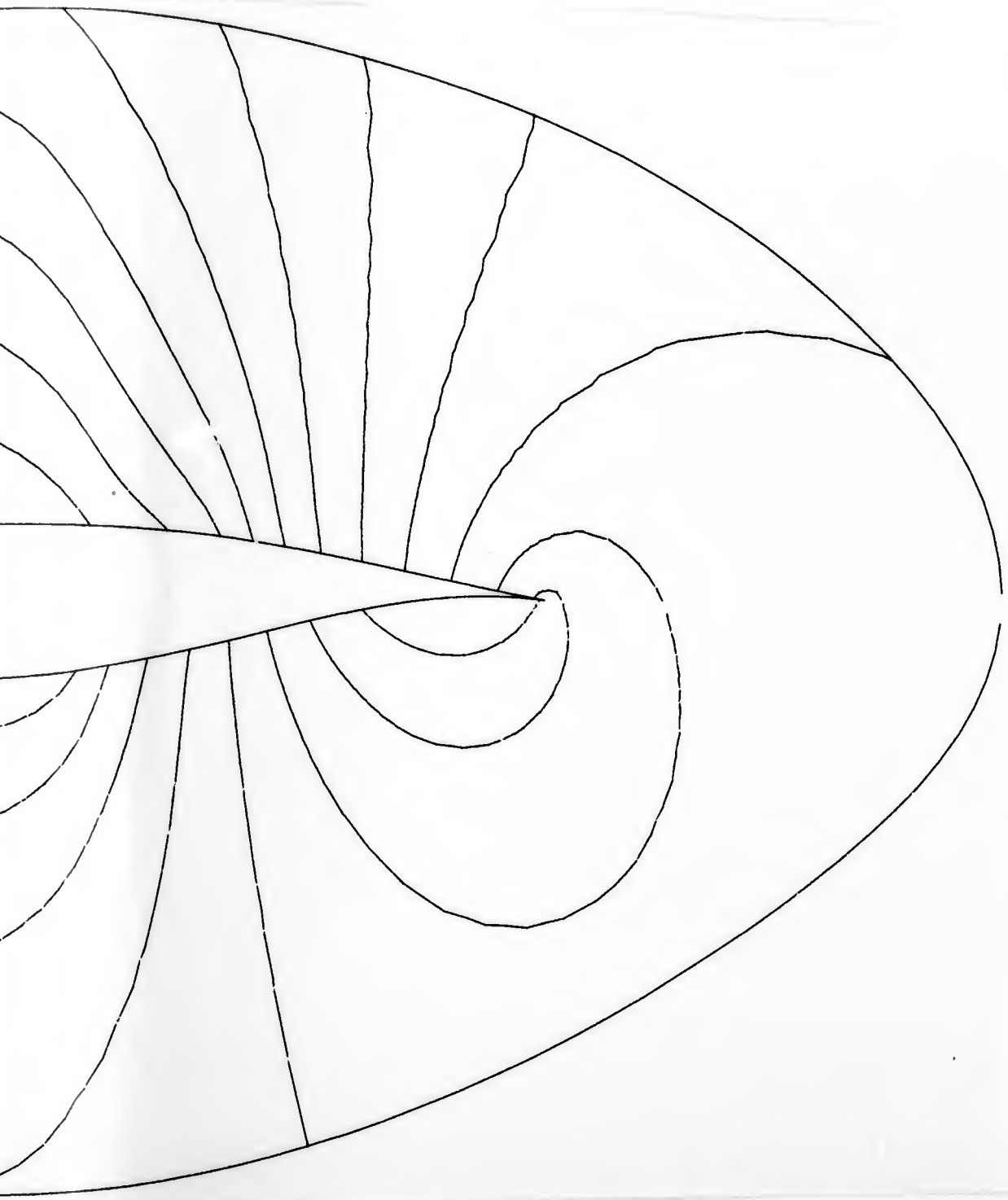
F.F.A.	AR 211		A.Rizzi	07-8-19
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



P 8 MACH INC = .05 min = .05 max = 1.25

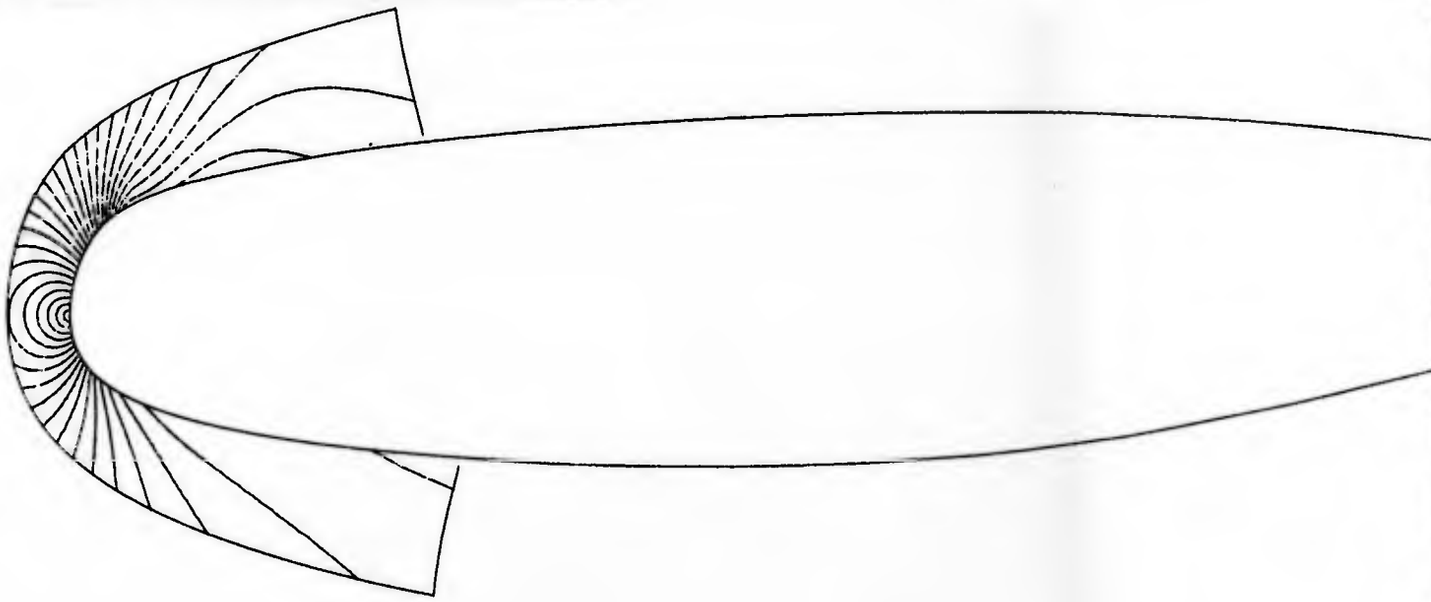


F.F.A.	AR 211		A.Rizzi	07-8-20
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

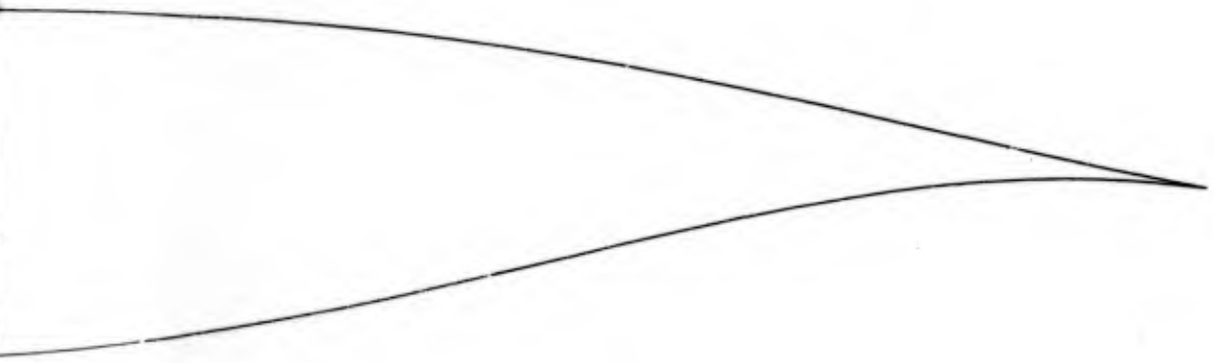


F.F.A.

P 9 MACH INC = .05 min = .05 max = 1.25

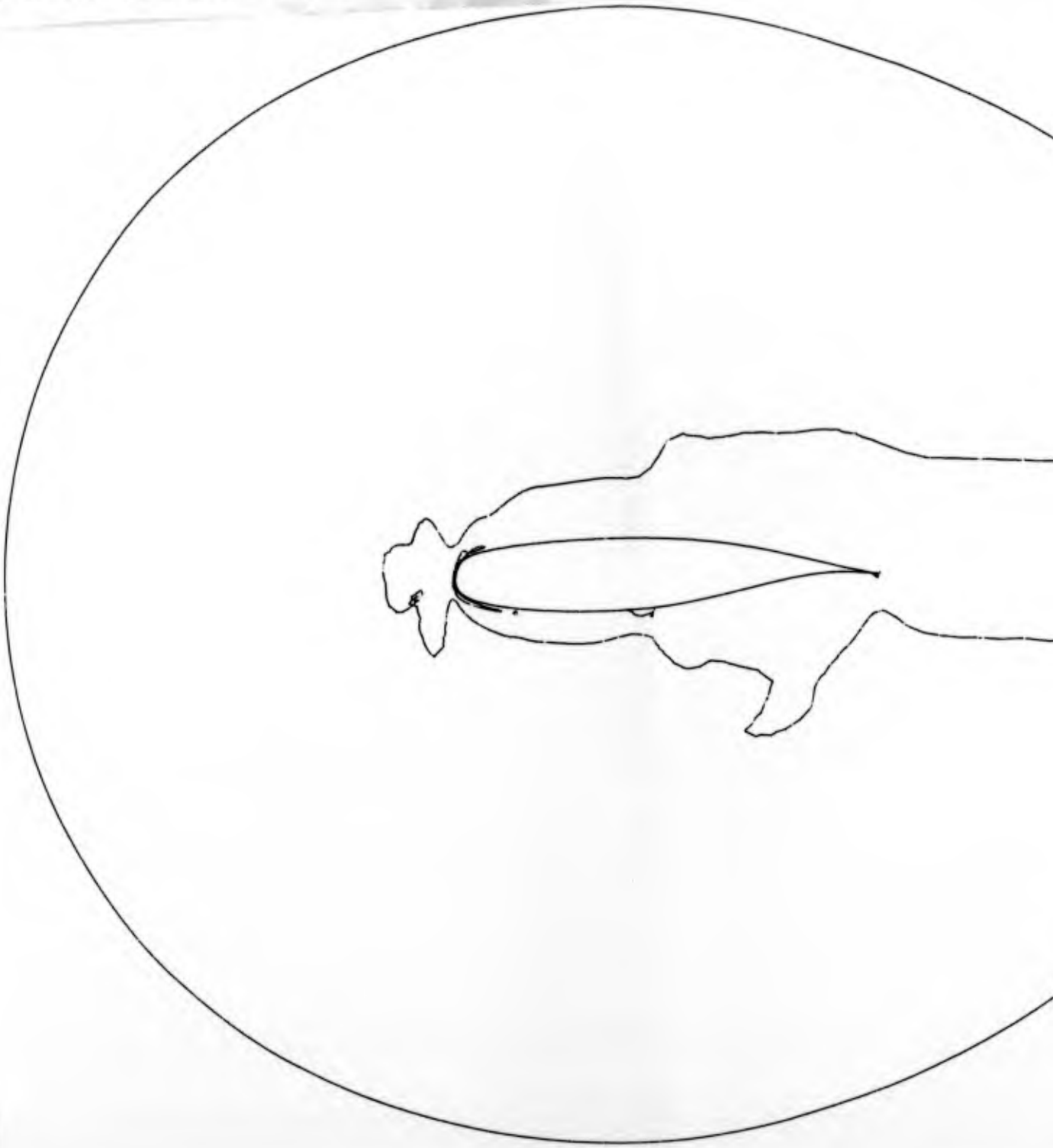


F.F.A.	AR 211		A.Rizzi	07-8-21
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

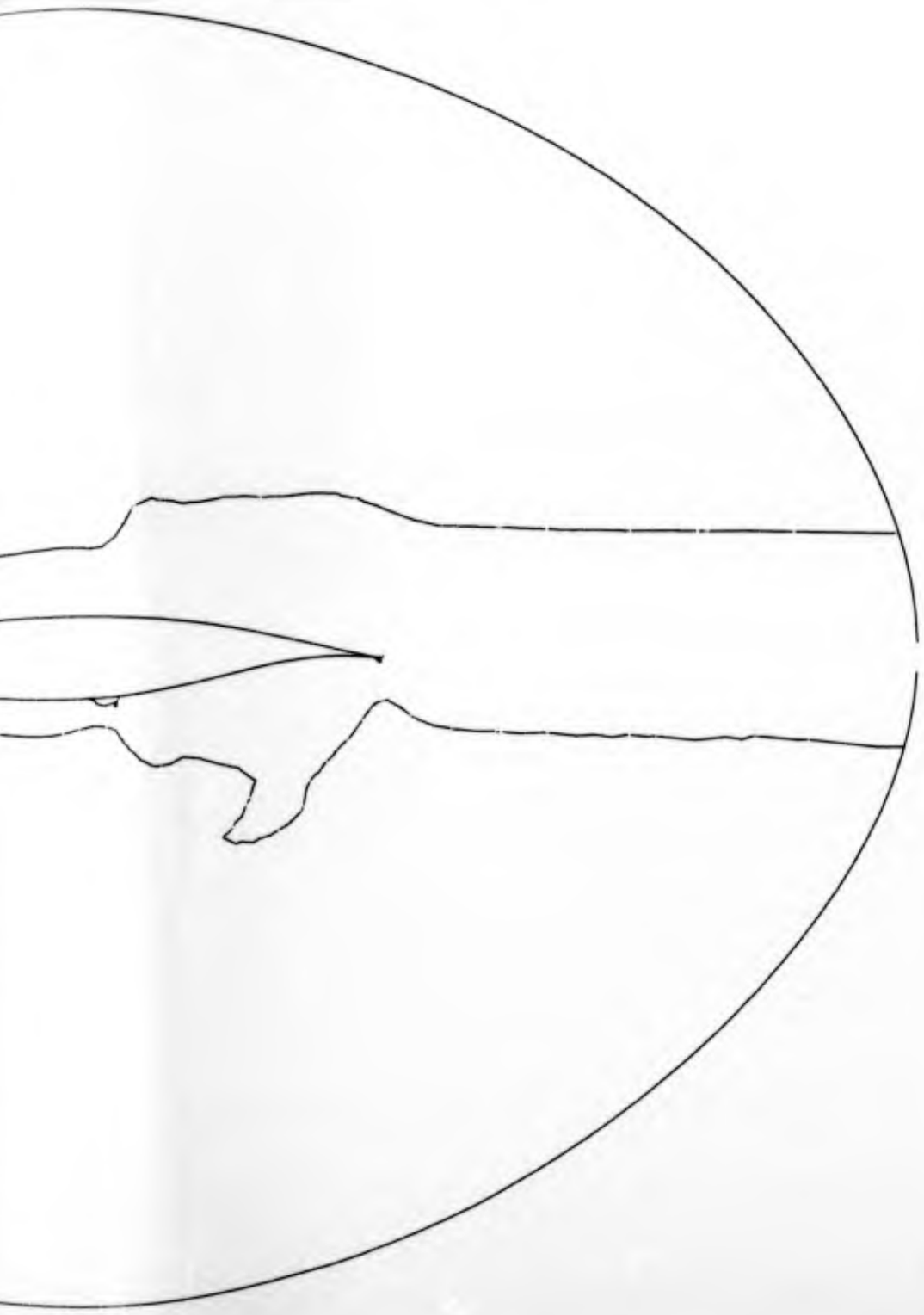


F.F.A.

P 10 TOTP 1-PI/PIINF INC = .005 min = −.005 max = .01

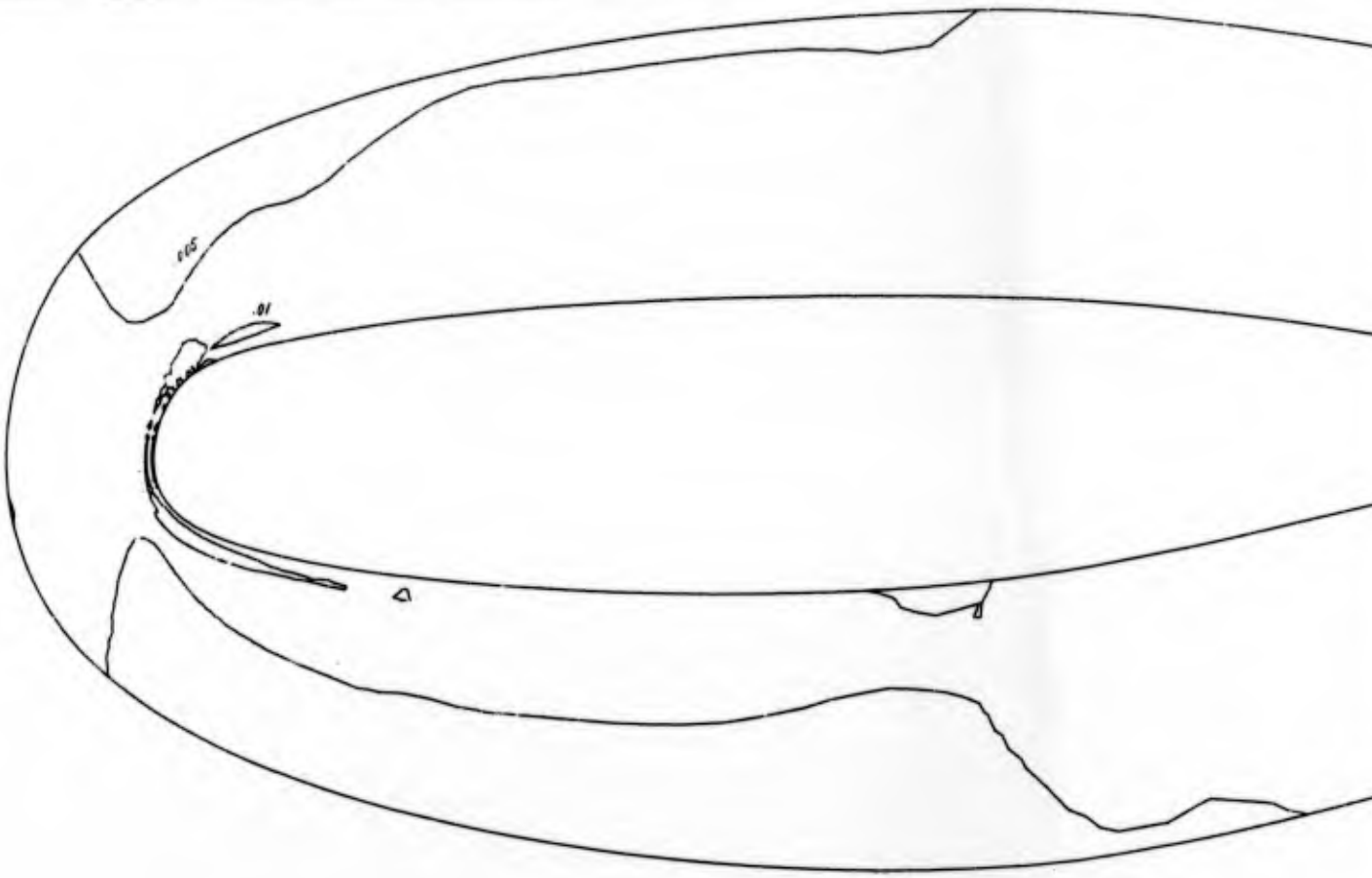


F.F.A.	AR 211		A.Rizzi	07-8-22
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

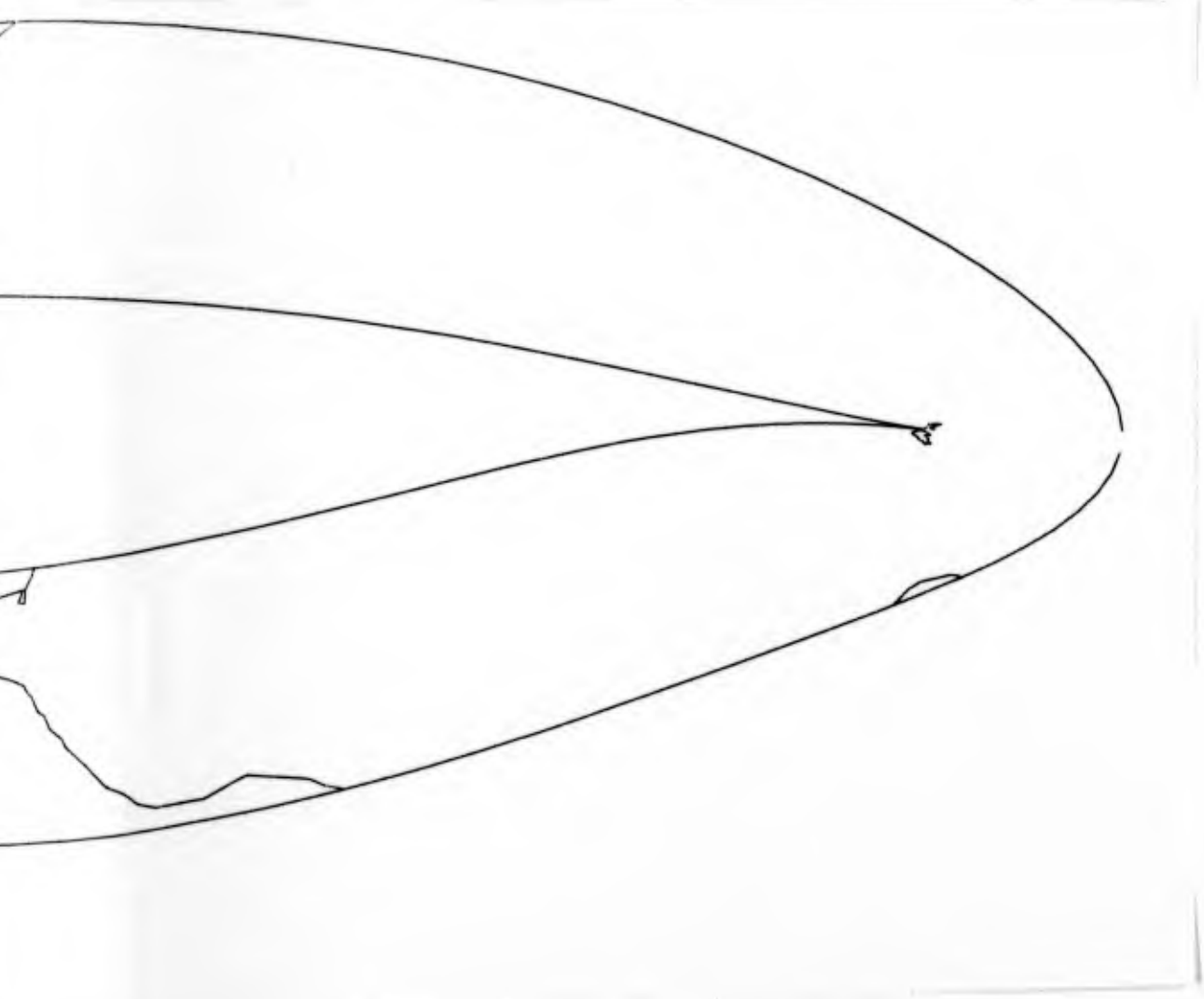


FFA.

P 11 TOTP 1-PI/PIINF INC = .005 min = −005 max = .01



F.F.A.	AR 211		A.Rizzi	07-8-23
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

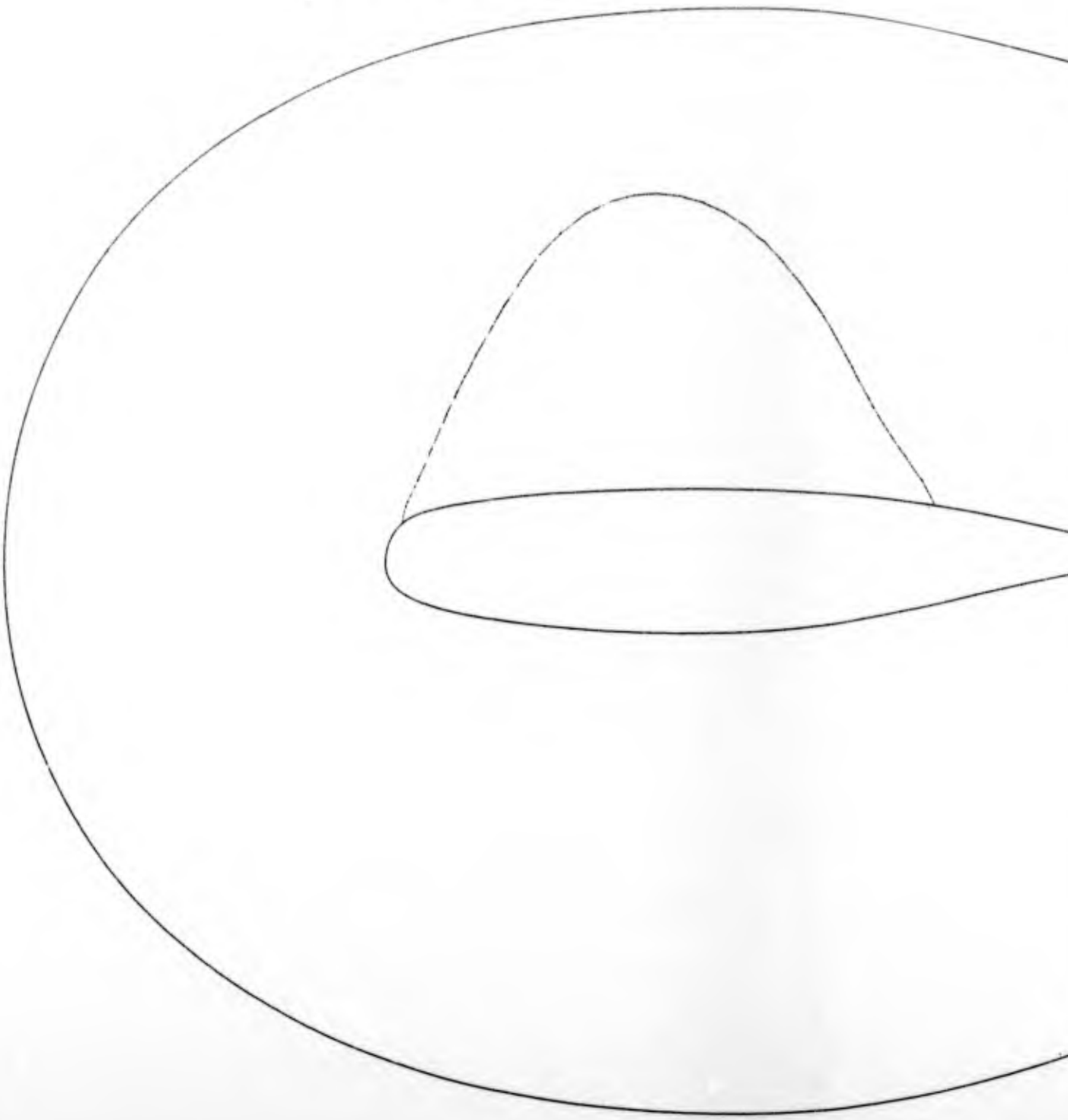


F.F.

22/6 V07 NONISO VOR IN/OUT TOCO UNORD NLRMESH3 NO. .02

P MACH

SONIC LINE AFTER 1000 cycles in fine mesh

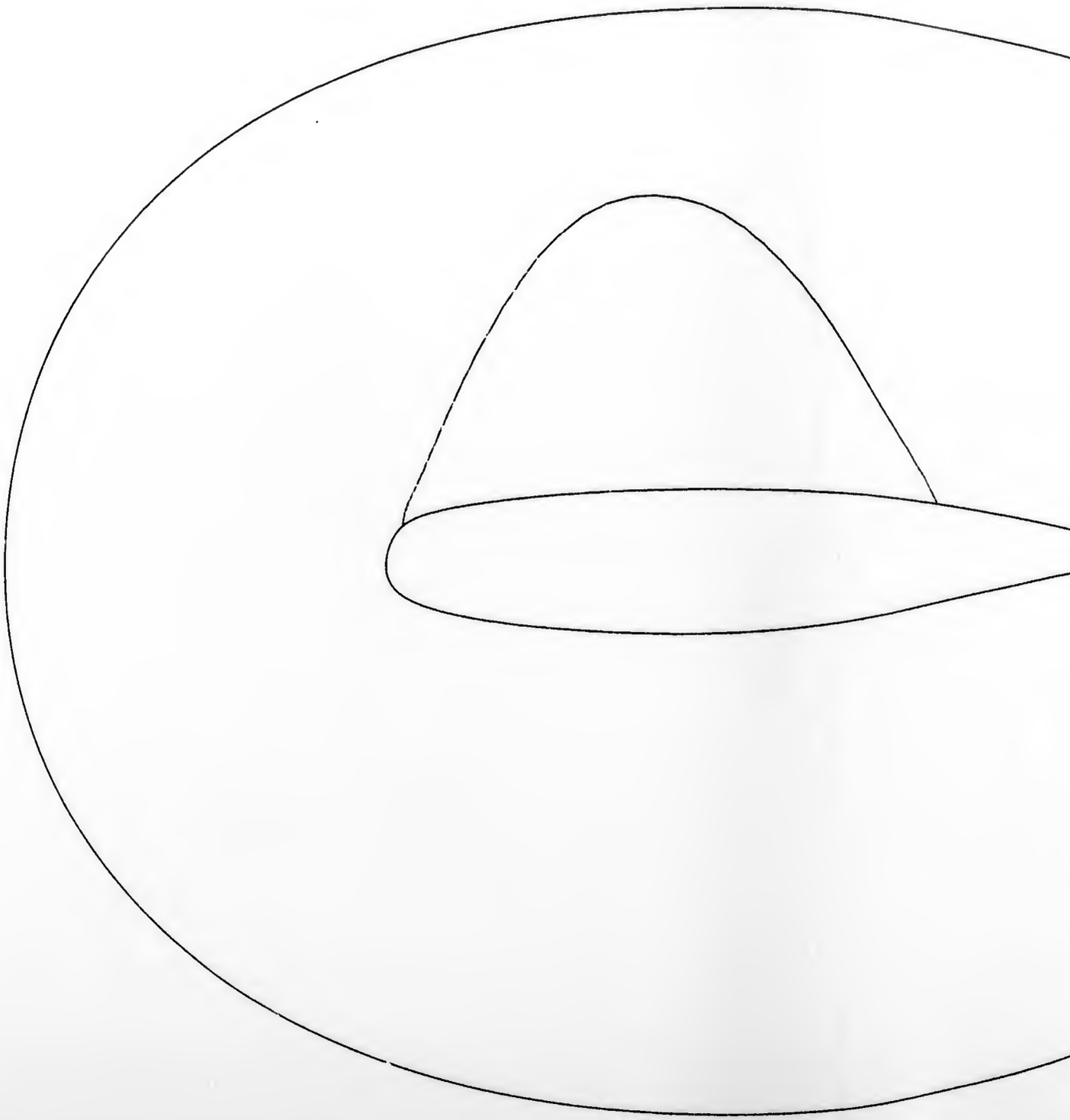


F.F.A.	AR 211		A.Rizzi	07-8-24
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

MESH3 NO2 .01 .02

28/6 V07 NONISO VOR IN/OUT TOQO UNORO NLRMESH3 N02 .01 .02

P 1 MACH SONIC LINE AFTER 2000 cycles



F.F.A.	AR 211		A.Rizzi	07-8-25
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

RMESH3 NO2 .01 .02

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 07

NLR 7301: MACH = 0.720957, ALPHA = −0.194

Contributor No 9

W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-1
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

N	X/C(%)	Z/C(%)	1-P/PIINF	CP	MACH	1-PI/PIINF
2	1.Ø15117	Ø.ØØØØ15	Ø.186418	Ø.412585	Ø.547994	Ø.ØØ2172
3	1.Ø14674	Ø.ØØØØ75	Ø.189420	Ø.4ØØ92Ø	Ø.554577	Ø.ØØ1Ø79
4	1.Ø13796	Ø.ØØØ194	Ø.188761	Ø.4Ø3481	Ø.554641	Ø.ØØØ222
5	1.Ø12485	Ø.ØØØ37Ø	Ø.187Ø96	Ø.4Ø9951	Ø.551606	Ø.ØØØ386
6	1.Ø1Ø739	Ø.ØØØ599	Ø.184662	Ø.419404	Ø.547433	Ø.ØØØ424
7	1.ØØ8563	Ø.ØØØ877	Ø.181953	Ø.429936	Ø.542862	Ø.ØØØ4ØØ
8	1.ØØ5956	Ø.ØØ1195	Ø.179314	Ø.44Ø182	Ø.538298	Ø.ØØØ443
9	1.ØØ2918	Ø.ØØ1546	Ø.176622	Ø.45Ø642	Ø.533Ø8Ø	Ø.ØØØ353
1Ø	Ø.999452	Ø.ØØ1922	Ø.174118	Ø.46Ø367	Ø.529464	Ø.ØØØ378
11	Ø.995569	Ø.ØØ2312	Ø.171937	Ø.468843	Ø.525591	Ø.ØØØ45Ø
12	Ø.991244	Ø.ØØ27Ø7	Ø.169811	Ø.477Ø98	Ø.522Ø13	Ø.ØØØ374
13	Ø.986598	Ø.ØØ3Ø98	Ø.167767	Ø.485Ø42	Ø.518486	Ø.ØØØ348
14	Ø.981356	Ø.ØØ3475	Ø.165890	Ø.492333	Ø.515171	Ø.ØØØ374
15	Ø.975792	Ø.ØØ3826	Ø.164160	Ø.499Ø53	Ø.512158	Ø.ØØØ361
16	Ø.969822	Ø.ØØ4140	Ø.162593	Ø.5Ø5141	Ø.5Ø9426	Ø.ØØØ343
17	Ø.963452	Ø.ØØ44Ø3	Ø.161231	Ø.51Ø432	Ø.5Ø7Ø21	Ø.ØØØ346
18	Ø.956688	Ø.ØØ4602	Ø.16ØØ94	Ø.514851	Ø.5Ø5Ø2Ø	Ø.ØØØ341
19	Ø.949539	Ø.ØØ4725	Ø.159211	Ø.518279	Ø.5Ø3465	Ø.ØØØ335
2Ø	Ø.942Ø12	Ø.ØØ4758	Ø.158612	Ø.52Ø6Ø9	Ø.5Ø24Ø3	Ø.ØØØ334
21	Ø.934116	Ø.ØØ4687	Ø.158316	Ø.521757	Ø.5Ø1886	Ø.ØØØ332
22	Ø.925861	Ø.ØØ4581	Ø.158345	Ø.521644	Ø.5Ø1936	Ø.ØØØ329
23	Ø.917257	Ø.ØØ4187	Ø.158714	Ø.52Ø21Ø	Ø.5Ø2595	Ø.ØØØ326
24	Ø.9Ø8316	Ø.ØØ3735	Ø.159448	Ø.517359	Ø.5Ø3899	Ø.ØØØ325
25	Ø.899Ø5Ø	Ø.ØØ3133	Ø.16Ø572	Ø.512993	Ø.5Ø5889	Ø.ØØØ326
26	Ø.889471	Ø.ØØ2374	Ø.162Ø98	Ø.5Ø7Ø65	Ø.5Ø859Ø	Ø.ØØØ32Ø
27	Ø.879592	Ø.ØØ145Ø	Ø.164Ø58	Ø.499451	Ø.512Ø37	Ø.ØØØ32Ø
28	Ø.869427	Ø.ØØØ356	Ø.166481	Ø.49ØØ37	Ø.516274	Ø.ØØØ325
29	Ø.858990	-Ø.ØØØ911	Ø.169386	Ø.478752	Ø.521335	Ø.ØØØ329
3Ø	Ø.848296	-Ø.ØØ2351	Ø.172789	Ø.465533	Ø.527218	Ø.ØØØ341
31	Ø.837358	-Ø.ØØ3962	Ø.176659	Ø.45Ø498	Ø.533887	Ø.ØØØ341
32	Ø.826191	-Ø.ØØ574Ø	Ø.18Ø954	Ø.433811	Ø.541263	Ø.ØØØ323
33	Ø.814812	-Ø.ØØ7679	Ø.185715	Ø.415313	Ø.549356	Ø.ØØØ329
34	Ø.8Ø3234	-Ø.ØØ9772	Ø.191ØØ4	Ø.394769	Ø.558249	Ø.ØØØ344
35	Ø.791472	-Ø.Ø12Ø1Ø	Ø.196861	Ø.372Ø15	Ø.568Ø24	Ø.ØØØ362
36	Ø.779541	-Ø.Ø14388	Ø.2Ø3275	Ø.347Ø97	Ø.578655	Ø.ØØØ372
37	Ø.767455	-Ø.Ø16868	Ø.21Ø2ØØ	Ø.32Ø192	Ø.59ØØ44	Ø.ØØØ383
38	Ø.755229	-Ø.Ø19456	Ø.217573	Ø.291552	Ø.6Ø2Ø64	Ø.ØØØ395
39	Ø.742876	-Ø.Ø22126	Ø.225271	Ø.261646	Ø.614556	Ø.ØØØ378
4Ø	Ø.73Ø411	-Ø.Ø24858	Ø.233238	Ø.23Ø692	Ø.627377	Ø.ØØØ366
41	Ø.717847	-Ø.Ø27638	Ø.241475	Ø.198695	Ø.64Ø53Ø	Ø.ØØØ362
42	Ø.7Ø5196	-Ø.Ø3Ø45Ø	Ø.25ØØ56	Ø.165358	Ø.654124	Ø.ØØØ372
43	Ø.692473	-Ø.Ø33279	Ø.259Ø48	Ø.13Ø426	Ø.668275	Ø.ØØØ39Ø
44	Ø.679689	-Ø.Ø36111	Ø.268515	Ø.Ø93646	Ø.683Ø68	Ø.ØØØ425
45	Ø.666857	-Ø.Ø38928	Ø.278372	Ø.Ø55361	Ø.698428	Ø.ØØØ436
46	Ø.653998	-Ø.Ø417Ø9	Ø.288477	Ø.Ø16Ø97	Ø.714Ø85	Ø.ØØØ457
47	Ø.641ØØØ	-Ø.Ø44436	Ø.298554	-Ø.Ø23Ø52	Ø.729701	Ø.ØØØ43Ø
48	Ø.628198	-Ø.Ø47Ø91	Ø.3Ø8372	-Ø.Ø61194	Ø.744888	Ø.ØØØ394
49	Ø.615296	-Ø.Ø49668	Ø.317825	-Ø.Ø97919	Ø.759453	Ø.ØØØ37Ø
5Ø	Ø.6Ø2407	-Ø.Ø52137	Ø.326929	-Ø.133286	Ø.773468	Ø.ØØØ357
51	Ø.589548	-Ø.Ø54516	Ø.335773	-Ø.167642	Ø.787Ø61	Ø.ØØØ339
52	Ø.576788	-Ø.Ø56796	Ø.344531	-Ø.2Ø1669	Ø.8ØØ523	Ø.ØØØ324
53	Ø.563921	-Ø.Ø58975	Ø.353465	-Ø.236377	Ø.814226	Ø.ØØØ347
54	Ø.551198	-Ø.Ø61Ø58	Ø.362868	-Ø.272986	Ø.828541	Ø.ØØØ493
55	Ø.538525	-Ø.Ø63Ø18	Ø.372615	-Ø.31Ø771	Ø.843382	Ø.ØØØ671
56	Ø.525937	-Ø.Ø64875	Ø.381923	-Ø.346932	Ø.858278	Ø.ØØØ119
57	Ø.513435	-Ø.Ø66573	Ø.388622	-Ø.372958	Ø.869995	-Ø.ØØ1317
58	Ø.5Ø1Ø28	-Ø.Ø68179	Ø.4Ø5355	-Ø.437964	Ø.89Ø358	Ø.ØØ4699
59	Ø.488725	-Ø.Ø69671	Ø.414382	-Ø.472721	Ø.91Ø731	-Ø.ØØ2235
6Ø	Ø.476537	-Ø.Ø7Ø959	Ø.421497	-Ø.5ØØ672	Ø.919284	Ø.ØØØ743
61	Ø.464472	-Ø.Ø72Ø88	Ø.426281	-Ø.518945	Ø.927168	Ø.ØØØ21Ø
62	Ø.452537	-Ø.Ø73Ø69	Ø.429444	-Ø.531545	Ø.932279	Ø.ØØØ198
63	Ø.44Ø741	-Ø.Ø73915	Ø.431515	-Ø.539591	Ø.935487	Ø.ØØØ261
64	Ø.429898	-Ø.Ø74637	Ø.432653	-Ø.544Ø14	Ø.937276	Ø.ØØØ273
65	Ø.417591	-Ø.Ø75247	Ø.433183	-Ø.545759	Ø.937982	Ø.ØØØ276
66	Ø.4Ø6251	-Ø.Ø75754	Ø.433Ø62	-Ø.545681	Ø.937983	Ø.ØØØ292
67	Ø.395Ø74	-Ø.Ø76167	Ø.432681	-Ø.544121	Ø.937294	Ø.ØØØ3Ø2
68	Ø.384Ø66	-Ø.Ø76494	Ø.432Ø92	-Ø.541832	Ø.936352	Ø.ØØØ314
69	Ø.373232	-Ø.Ø76742	Ø.431382	-Ø.539Ø73	Ø.935229	Ø.ØØØ314
7Ø	Ø.362575	-Ø.Ø76919	Ø.43Ø642	-Ø.536199	Ø.934Ø52	Ø.ØØØ327
71	Ø.352181	-Ø.Ø77Ø29	Ø.429935	-Ø.533454	Ø.932927	Ø.ØØØ34Ø
72	Ø.341811	-Ø.Ø77Ø77	Ø.429385	-Ø.531Ø84	Ø.931918	Ø.ØØØ355
73	Ø.33171Ø	-Ø.Ø77Ø69	Ø.428729	-Ø.528768	Ø.931Ø11	Ø.ØØØ354
74	Ø.321799	-Ø.Ø77ØØ8	Ø.428189	-Ø.526671	Ø.93Ø157	Ø.ØØØ36Ø
75	Ø.312Ø81	-Ø.Ø76896	Ø.427667	-Ø.524644	Ø.929333	Ø.ØØØ36Ø
76	Ø.3Ø2558	-Ø.Ø76737	Ø.427158	-Ø.522633	Ø.928513	Ø.ØØØ365
77	Ø.293231	-Ø.Ø76534	Ø.426629	-Ø.52Ø61Ø	Ø.927687	Ø.ØØØ372
78	Ø.284181	-Ø.Ø76289	Ø.426Ø74	-Ø.518452	Ø.926818	Ø.ØØØ368
79	Ø.275178	-Ø.Ø76ØØ5	Ø.425482	-Ø.516154	Ø.925885	Ø.ØØØ371
8Ø	Ø.266437	-Ø.Ø75684	Ø.424876	-Ø.513798	Ø.924922	Ø.ØØØ379

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-2
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

81	Ø.257ØØ2	-Ø.ØØ5329	Ø.424247	-Ø.511355	Ø.923936	Ø.ØØØ378
82	Ø.249566	-Ø.ØØ4942	Ø.423611	-Ø.5ØØ883	Ø.922929	Ø.ØØØ386
83	Ø.241427	-Ø.ØØ4525	Ø.422972	-Ø.5ØØ4Ø2	Ø.921922	Ø.ØØØ388
84	Ø.233486	-Ø.ØØ4ØØØ	Ø.422ØØ8	-Ø.5Ø3825	Ø.92ØØ77	Ø.ØØØ392
85	Ø.225741	-Ø.ØØ361Ø	Ø.421673	-Ø.5Ø1355	Ø.919849	Ø.ØØØ424
86	Ø.218196	-Ø.ØØ3115	Ø.42ØØ64	-Ø.498215	Ø.918654	Ø.ØØØ344
87	Ø.21ØØ32	-Ø.ØØ2597	Ø.42ØØØ5	-Ø.495265	Ø.917379	Ø.ØØØ437
88	Ø.2Ø3665	-Ø.ØØ2ØØ9	Ø.419292	-Ø.492ØØ5	Ø.916154	Ø.ØØØ381
89	Ø.196687	-Ø.ØØ15Ø2	Ø.418503	-Ø.489ØØ1	Ø.914880	Ø.ØØØ422
9Ø	Ø.189895	-Ø.ØØ9Ø28	Ø.417714	-Ø.485974	Ø.913647	Ø.ØØØ418
91	Ø.183288	-Ø.ØØ9338	Ø.416878	-Ø.482729	Ø.912352	Ø.ØØØ4Ø3
92	Ø.176861	-Ø.ØØ8733	Ø.416Ø14	-Ø.479373	Ø.91Ø998	Ø.ØØØ4Ø3
93	Ø.17ØØ13	-Ø.ØØ8115	Ø.415ØØ1	-Ø.476213	Ø.9Ø97Ø6	Ø.ØØØ425
94	Ø.164539	-Ø.ØØ7486	Ø.414455	-Ø.473316	Ø.9Ø8531	Ø.ØØØ434
95	Ø.158638	-Ø.ØØ6845	Ø.413752	-Ø.47Ø585	Ø.9Ø7414	Ø.ØØØ452
96	Ø.152ØØ4	-Ø.ØØ6195	Ø.413ØØ3	-Ø.467673	Ø.9Ø6221	Ø.ØØØ476
97	Ø.147335	-Ø.ØØ6536	Ø.412Ø14	-Ø.463832	Ø.9Ø4678	Ø.ØØØ473
98	Ø.141926	-Ø.ØØ5868	Ø.41ØØ28	-Ø.458Ø58	Ø.9Ø244Ø	Ø.ØØØ382
99	Ø.136674	-Ø.ØØ5192	Ø.4Ø8499	-Ø.45Ø177	Ø.899441	Ø.ØØØ2ØØ
1ØØ	Ø.131573	-Ø.ØØ451Ø	Ø.4Ø6564	-Ø.442657	Ø.896437	Ø.ØØØ186
1Ø1	Ø.126619	-Ø.ØØ3828	Ø.4Ø6216	-Ø.441Ø8	Ø.895493	Ø.ØØØ622
1Ø2	Ø.121805	-Ø.ØØ3148	Ø.4Ø753Ø	-Ø.446413	Ø.897423	Ø.ØØØ75Ø
1Ø3	Ø.117127	-Ø.ØØ2468	Ø.4Ø9Ø62	-Ø.452363	Ø.9ØØØ26	Ø.ØØØ52Ø
1Ø4	Ø.112584	-Ø.ØØ1781	Ø.4Ø9795	-Ø.455212	Ø.9Ø13ØØ	Ø.ØØØ377
1Ø5	Ø.1Ø8169	-Ø.ØØ1Ø84	Ø.4Ø973Ø	-Ø.454958	Ø.9Ø12Ø9	Ø.ØØØ367
1Ø6	Ø.1Ø3879	-Ø.ØØØ38Ø	Ø.4Ø935Ø	-Ø.453484	Ø.9ØØ856	Ø.ØØØ422
1Ø7	Ø.Ø99708	-Ø.ØØ9668	Ø.4Ø8994	-Ø.452Ø99	Ø.899978	Ø.ØØØ456
1Ø8	Ø.Ø9565Ø	-Ø.ØØ895Ø	Ø.4Ø8692	-Ø.45Ø927	Ø.899528	Ø.ØØØ44Ø
1Ø9	Ø.Ø91699	-Ø.ØØ8224	Ø.4Ø8457	-Ø.45ØØ15	Ø.899138	Ø.ØØØ46Ø
11Ø	Ø.Ø878Ø5Ø	-Ø.ØØ7491	Ø.4Ø8284	-Ø.449343	Ø.898862	Ø.ØØØ466
111	Ø.Ø84Ø97	-Ø.ØØ6749	Ø.4Ø8Ø96	-Ø.448613	Ø.898596	Ø.ØØØ442
112	Ø.Ø8Ø434	-Ø.ØØ5998	Ø.4Ø7896	-Ø.447834	Ø.898283	Ø.ØØØ436
113	Ø.Ø76856	-Ø.ØØ5235	Ø.4Ø7743	-Ø.447241	Ø.898Ø36	Ø.ØØØ445
114	Ø.Ø73357	-Ø.ØØ546Ø	Ø.4Ø7755	-Ø.447287	Ø.898ØØ1	Ø.ØØØ5Ø3
115	Ø.Ø6993Ø	-Ø.ØØ3671	Ø.4Ø7885	-Ø.447791	Ø.898169	Ø.ØØØ541
116	Ø.Ø66571	-Ø.ØØ2864	Ø.4Ø7853	-Ø.447668	Ø.898133	Ø.ØØØ528
117	Ø.Ø63274	-Ø.ØØ2Ø38	Ø.4Ø7434	-Ø.446Ø39	Ø.897478	Ø.ØØØ527
118	Ø.Ø6ØØ33	-Ø.ØØ1188	Ø.4Ø65Ø3	-Ø.442424	Ø.896Ø31	Ø.ØØØ523
119	Ø.Ø56844	-Ø.ØØØ312	Ø.4Ø5Ø64	-Ø.436832	Ø.893775	Ø.ØØØ537
12Ø	Ø.Ø537Ø2	-Ø.ØØ94Ø7	Ø.4Ø3197	-Ø.429578	Ø.89ØØ22	Ø.ØØØ585
121	Ø.ØØ5Ø6Ø1	-Ø.ØØ847Ø	Ø.4ØØ995	-Ø.421Ø26	Ø.887317	Ø.ØØØ671
122	Ø.ØØ7537	-Ø.ØØ7496	Ø.398348	-Ø.41Ø74Ø	Ø.883179	Ø.ØØØ7Ø4
123	Ø.ØØ45Ø8	-Ø.ØØ6482	Ø.395Ø16	-Ø.397798	Ø.878ØØ5	Ø.ØØØ695
124	Ø.ØØ1511	-Ø.ØØ5423	Ø.391ØØ7	-Ø.382224	Ø.871717	Ø.ØØØ768
125	Ø.ØØ8544	-Ø.ØØ4314	Ø.386496	-Ø.364698	Ø.864601	Ø.ØØØ9Ø3
126	Ø.ØØ56Ø8	-Ø.ØØ315Ø	Ø.381438	-Ø.345Ø17	Ø.856663	Ø.ØØ1Ø12
127	Ø.ØØ27Ø5	-Ø.ØØ1924	Ø.375824	-Ø.323236	Ø.847751	Ø.ØØ1272
128	Ø.ØØ984Ø	-Ø.ØØØ632	Ø.369465	-Ø.298533	Ø.837641	Ø.ØØ1581
129	Ø.ØØ7Ø22	-Ø.ØØ9264	Ø.361638	-Ø.268127	Ø.825354	Ø.ØØ1Ø9
13Ø	Ø.ØØ4265	-Ø.ØØ7815	Ø.351519	-Ø.228814	Ø.8Ø9643	Ø.ØØ1942
131	Ø.ØØ1584	-Ø.ØØ6276	Ø.338126	-Ø.176787	Ø.789185	Ø.ØØ18Ø1
132	Ø.ØØ8997	-Ø.ØØ4642	Ø.322Ø18	-Ø.114207	Ø.763984	Ø.ØØ2Ø5
133	Ø.ØØ652Ø	-Ø.ØØ2912	Ø.3Ø4446	-Ø.Ø45944	Ø.736Ø4Ø	Ø.ØØ2987
134	Ø.ØØ4173	-Ø.ØØ1Ø84	Ø.283ØØ1	Ø.Ø37378	Ø.7Ø3825	Ø.ØØ2Ø43
135	Ø.ØØ1993	-Ø.ØØ9152	Ø.253562	Ø.151738	Ø.66Ø137	-Ø.ØØØØ33
136	Ø.ØØ999Ø	-Ø.ØØ7123	Ø.223826	Ø.267268	Ø.61Ø598	Ø.ØØ1678
137	Ø.ØØ8166	-Ø.ØØ5ØØ8	Ø.192Ø52	Ø.39Ø696	Ø.559887	Ø.ØØØ43Ø
138	Ø.ØØ6529	-Ø.ØØ2815	Ø.161Ø34	Ø.511198	Ø.5Ø6219	Ø.ØØØ654
139	Ø.ØØ5Ø88	-Ø.ØØØ552	Ø.127643	Ø.64Ø919	Ø.447688	-Ø.ØØØ995
14Ø	Ø.ØØ3834	-Ø.ØØ8232	Ø.Ø99748	Ø.749288	Ø.389Ø77	Ø.ØØØ689
141	Ø.ØØ2746	-Ø.ØØ5871	Ø.Ø75911	Ø.841894	Ø.336341	Ø.ØØØ645
142	Ø.ØØ1847	-Ø.ØØ347Ø	Ø.Ø53238	Ø.929976	Ø.281447	-Ø.ØØØ3Ø3
143	Ø.ØØ1154	-Ø.ØØ1Ø37	Ø.Ø33914	1.ØØ5Ø45	Ø.223222	-Ø.ØØØ2Ø1
144	Ø.ØØØ651	-Ø.ØØØ584	Ø.Ø19328	1.Ø61741	Ø.166781	Ø.ØØØ94
145	Ø.ØØØ3Ø8	-Ø.ØØ6123	Ø.ØØ9395	1.1ØØ298	Ø.114637	Ø.ØØØ253
146	Ø.ØØØ1Ø2	-Ø.ØØ3663	Ø.ØØ3369	1.123759	Ø.Ø66915	Ø.ØØØ242
147	Ø.ØØØØ18	-Ø.ØØ1218	Ø.ØØØ8Ø6	1.133665	Ø.Ø2793Ø	Ø.ØØØ262
148	Ø.ØØØØ44	Ø.ØØ1231	Ø.ØØ1188	1.132182	Ø.Ø36275	Ø.ØØØ271
149	Ø.ØØØ172	Ø.ØØ3657	Ø.ØØ4154	1.12Ø659	Ø.Ø74637	Ø.ØØØ266
15Ø	Ø.ØØØ396	Ø.ØØ6Ø65	Ø.ØØ9449	1.1ØØØ9Ø	Ø.114864	Ø.ØØØ273
151	Ø.ØØØ711	Ø.ØØ8454	Ø.Ø16869	1.Ø71264	Ø.154715	Ø.ØØØ3ØØ
152	Ø.ØØ1118	Ø.Ø1Ø822	Ø.Ø26212	1.Ø34966	Ø.194232	Ø.ØØØ255
153	Ø.ØØ1591	Ø.Ø13167	Ø.Ø37576	Ø.99Ø82Ø	Ø.233563	Ø.ØØ3322
154	Ø.ØØ215Ø	Ø.Ø15489	Ø.Ø5Ø839	Ø.939295	Ø.272846	Ø.ØØØ45Ø
155	Ø.ØØ2785	Ø.Ø17786	Ø.Ø66Ø88	Ø.88ØØ52	Ø.314Ø4	-Ø.ØØØ1Ø2
156	Ø.ØØ35Ø6	Ø.Ø2ØØ57	Ø.Ø84411	Ø.8Ø8869	Ø.356611	Ø.ØØØ284
157	Ø.ØØ4321	Ø.Ø22299	Ø.1Ø3358	Ø.735262	Ø.397Ø74	Ø.ØØØ438
158	Ø.ØØ5225	Ø.Ø24589	Ø.123669	Ø.656358	Ø.437551	Ø.ØØØ499
159	Ø.ØØ6218	Ø.Ø26688	Ø.146Ø3	Ø.569Ø3	Ø.479ØØØ	Ø.ØØØ336
16Ø	Ø.ØØ7278	Ø.Ø28834	Ø.171396	Ø.47Ø942	Ø.524918	Ø.ØØØ265

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-3
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

161	0.008435	0.030942	0.199093	0.363343	0.571735	0.000366
162	0.009687	0.033011	0.228592	0.248741	0.619847	0.000426
163	0.011036	0.035035	0.259747	0.127708	0.669063	0.000654
164	0.012485	0.037012	0.292706	-0.000334	0.719959	0.001074
165	0.014034	0.038937	0.328787	-0.140503	0.776654	0.000025
166	0.015694	0.040804	0.368502	-0.294793	0.836675	0.001048
167	0.017472	0.042604	0.408299	-0.449399	0.897547	0.001912
168	0.019370	0.044333	0.450923	-0.614989	0.966212	0.000363
169	0.021403	0.045977	0.495494	-0.788145	1.037245	0.002067
170	0.023576	0.047526	0.535964	-0.945363	1.104372	0.003828
171	0.025882	0.048977	0.572459	-1.087144	1.171906	0.000296
172	0.028321	0.050320	0.598913	-1.189913	1.216405	0.006264
173	0.030855	0.051571	0.604723	-1.212486	1.225887	0.008354
174	0.033424	0.052759	0.602651	-1.204434	1.225173	0.004094
175	0.036016	0.053892	0.601415	-1.199636	1.225689	0.000317
176	0.038635	0.054971	0.601791	-1.201096	1.227671	-0.001357
177	0.041281	0.055997	0.603550	-1.207930	1.231072	-0.001425
178	0.043954	0.056972	0.606017	-1.217513	1.235313	-0.000795
179	0.046653	0.057899	0.608852	-1.228527	1.240212	-0.000073
180	0.049378	0.058782	0.611902	-1.240375	1.245741	0.000404
181	0.052128	0.059623	0.615044	-1.252579	1.251664	0.000640
182	0.054903	0.060426	0.618069	-1.264332	1.257502	0.000730
183	0.057705	0.061194	0.620848	-1.275130	1.262989	0.000688
184	0.060533	0.061930	0.623345	-1.284829	1.268000	0.000570
185	0.063390	0.062636	0.625463	-1.293058	1.272270	0.000469
186	0.066276	0.063317	0.627090	-1.299380	1.275568	0.000383
187	0.069193	0.063974	0.628132	-1.303427	1.277707	0.000295
188	0.072143	0.064612	0.628473	-1.304751	1.278424	0.000246
189	0.075127	0.065234	0.628061	-1.303149	1.277579	0.000277
190	0.078147	0.065842	0.627123	-1.299507	1.275755	0.000219
191	0.081206	0.066439	0.626064	-1.295392	1.273705	0.000143
192	0.084307	0.067026	0.625039	-1.291411	1.271675	0.000137
193	0.087454	0.067604	0.624044	-1.287547	1.269624	0.000248
194	0.090650	0.068174	0.623010	-1.283527	1.267462	0.000403
195	0.093898	0.068737	0.621908	-1.279249	1.265169	0.000565
196	0.097202	0.069293	0.620743	-1.274721	1.262774	0.000700
197	0.100564	0.069843	0.619551	-1.270089	1.260365	0.000786
198	0.103989	0.070388	0.618338	-1.265378	1.257928	0.000865
199	0.107478	0.070928	0.617071	-1.260455	1.255387	0.000947
200	0.111035	0.071464	0.615762	-1.255369	1.252780	0.001017
201	0.114662	0.071995	0.614450	-1.250273	1.250195	0.001059
202	0.118364	0.072523	0.613145	-1.245206	1.247623	0.001108
203	0.122142	0.073047	0.611829	-1.240089	1.245026	0.001168
204	0.126000	0.073568	0.610516	-1.234990	1.242455	0.001208
205	0.129940	0.074085	0.609225	-1.229974	1.239942	0.001238
206	0.133965	0.074599	0.607923	-1.224916	1.237402	0.001283
207	0.138078	0.075110	0.606579	-1.219696	1.234788	0.001326
208	0.142281	0.075617	0.605193	-1.214311	1.232102	0.001364
209	0.146578	0.076121	0.603779	-1.208818	1.229372	0.001401
210	0.150969	0.076622	0.602362	-1.203315	1.226645	0.001433
211	0.155459	0.077119	0.600961	-1.197870	1.223950	0.001470
212	0.160049	0.077612	0.599582	-1.192512	1.221308	0.001500
213	0.164743	0.078101	0.598220	-1.187223	1.218700	0.001538
214	0.169541	0.078585	0.596864	-1.181954	1.216114	0.001569
215	0.174447	0.079065	0.595527	-1.176759	1.213580	0.001585
216	0.179463	0.079539	0.594209	-1.171638	1.211087	0.001602
217	0.184591	0.080007	0.592905	-1.166572	1.208627	0.001616
218	0.189832	0.080470	0.591623	-1.161592	1.206223	0.001620
219	0.195189	0.080926	0.590361	-1.156693	1.203857	0.001627
220	0.200665	0.081375	0.589102	-1.151799	1.201494	0.001643
221	0.206260	0.081817	0.587849	-1.146933	1.199160	0.001647
222	0.211976	0.082250	0.586620	-1.142155	1.196868	0.001651
223	0.217815	0.082676	0.585409	-1.137450	1.194619	0.001655
224	0.223779	0.083092	0.584219	-1.132832	1.192413	0.001658
225	0.229870	0.083498	0.583036	-1.128234	1.190216	0.001671
226	0.236088	0.083893	0.581857	-1.123652	1.188042	0.001670
227	0.242435	0.084278	0.580691	-1.119123	1.185887	0.001677
228	0.248912	0.084651	0.579524	-1.114592	1.183743	0.001677
229	0.255520	0.085011	0.578366	-1.110090	1.181612	0.001682
230	0.262260	0.085358	0.577206	-1.105585	1.179485	0.001685
231	0.269133	0.085691	0.576059	-1.101130	1.177391	0.001679
232	0.276140	0.086009	0.574927	-1.096729	1.175324	0.001678
233	0.283281	0.086312	0.573797	-1.092341	1.173262	0.001682
234	0.290557	0.086598	0.572666	-1.087946	1.171207	0.001675
235	0.297968	0.086866	0.571534	-1.083549	1.169155	0.001670
236	0.305514	0.087116	0.570380	-1.079067	1.167061	0.001670
237	0.313196	0.087346	0.569191	-1.074449	1.164909	0.001668
238	0.321012	0.087556	0.567970	-1.069703	1.162704	0.001665
239	0.328964	0.087745	0.566715	-1.064842	1.160457	0.001651
240	0.337050	0.087912	0.565428	-1.059829	1.158126	0.001658

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-4
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

241	0.345269	0.088055	0.564084	-1.054607	1.155712	0.001653
242	0.353622	0.088175	0.562717	-1.049295	1.153266	0.001645
243	0.362106	0.088268	0.561326	-1.043894	1.150774	0.001646
244	0.370722	0.088335	0.559919	-1.038425	1.148259	0.001645
245	0.379467	0.088375	0.558546	-1.033093	1.145794	0.001665
246	0.388340	0.088385	0.557215	-1.027922	1.143573	0.001473
247	0.397339	0.088364	0.555826	-1.022525	1.140821	0.001829
248	0.406463	0.088312	0.554189	-1.016168	1.138136	0.001555
249	0.415709	0.088229	0.553005	-1.011565	1.136016	0.001582
250	0.425075	0.088111	0.551722	-1.006582	1.133727	0.001607
251	0.434558	0.087957	0.550421	-1.001527	1.131432	0.001606
252	0.444156	0.087767	0.549062	-0.996250	1.129054	0.001585
253	0.453865	0.087538	0.547626	-0.990669	1.126530	0.001582
254	0.463683	0.087270	0.546062	-0.984595	1.123784	0.001581
255	0.473606	0.086960	0.544361	-0.977987	1.120815	0.001568
256	0.483630	0.086608	0.542522	-0.970840	1.117614	0.001551
257	0.493752	0.086209	0.540504	-0.963003	1.114106	0.001536
258	0.503966	0.085764	0.538244	-0.954223	1.110189	0.001519
259	0.514270	0.085270	0.535662	-0.944191	1.105705	0.001527
260	0.524657	0.084724	0.532682	-0.932616	1.100542	0.001544
261	0.535124	0.084124	0.529340	-0.919631	1.094767	0.001568
262	0.545665	0.083468	0.525789	-0.905834	1.088653	0.001599
263	0.556274	0.082752	0.522315	-0.892340	1.082719	0.001599
264	0.566945	0.081972	0.519272	-0.880517	1.077599	0.001527
265	0.577674	0.081126	0.516900	-0.871302	1.073610	0.001481
266	0.588452	0.080209	0.515082	-0.864239	1.070719	0.001253
267	0.599274	0.079218	0.513315	-0.857377	1.067738	0.001250
268	0.610132	0.078146	0.510364	-0.845910	1.062754	0.001262
269	0.621019	0.076993	0.505289	-0.826195	1.054125	0.001397
270	0.631928	0.075753	0.497472	-0.795828	1.040929	0.001587
271	0.642851	0.074426	0.487248	-0.756108	1.023912	0.001720
272	0.653779	0.073012	0.475790	-0.711594	1.005169	0.001697
273	0.664704	0.071513	0.464515	-0.667792	0.987020	0.001537
274	0.675620	0.069932	0.454351	-0.628307	0.970797	0.001389
275	0.686517	0.068273	0.445346	-0.593322	0.956445	0.001350
276	0.697387	0.066541	0.437000	-0.560902	0.943168	0.001372
277	0.708222	0.064743	0.428772	-0.528937	0.930090	0.001452
278	0.719013	0.062882	0.420343	-0.496189	0.916796	0.001486
279	0.729753	0.060964	0.411753	-0.462817	0.903323	0.001503
280	0.740432	0.058996	0.403131	-0.429323	0.889874	0.001494
281	0.751041	0.056982	0.394634	-0.396314	0.876676	0.001477
282	0.761574	0.054929	0.386345	-0.364112	0.863827	0.001473
283	0.772019	0.052845	0.378268	-0.332734	0.851333	0.001474
284	0.782370	0.050735	0.370399	-0.302160	0.839183	0.001474
285	0.792617	0.048607	0.362732	-0.272376	0.827362	0.001480
286	0.802751	0.046467	0.355271	-0.243390	0.815881	0.001475
287	0.812764	0.044321	0.348033	-0.215271	0.804746	0.001478
288	0.822647	0.042176	0.341011	-0.187993	0.793949	0.001480
289	0.832390	0.040038	0.334212	-0.161581	0.783502	0.001474
290	0.841985	0.037913	0.327643	-0.136061	0.773400	0.001475
291	0.851422	0.035807	0.321289	-0.111377	0.763625	0.001475
292	0.860693	0.033725	0.315147	-0.087516	0.754171	0.001473
293	0.869787	0.031673	0.309214	-0.064466	0.745025	0.001476
294	0.878697	0.029656	0.303480	-0.042189	0.736178	0.001475
295	0.887411	0.027679	0.297945	-0.020687	0.727631	0.001469
296	0.895922	0.025746	0.292604	0.000063	0.719358	0.001477
297	0.904219	0.023862	0.287434	0.020149	0.711342	0.001476
298	0.912294	0.022031	0.282438	0.039558	0.703584	0.001473
299	0.920135	0.020256	0.277603	0.058341	0.696054	0.001481
300	0.927735	0.018541	0.272918	0.076543	0.688743	0.001481
301	0.935083	0.016890	0.268389	0.094136	0.681670	0.001476
302	0.942170	0.015306	0.264018	0.111116	0.674820	0.001474
303	0.948987	0.013792	0.259785	0.127562	0.668169	0.001473
304	0.955523	0.012349	0.255664	0.143569	0.661677	0.001476
305	0.961770	0.010980	0.251638	0.159210	0.655309	0.001484
306	0.967719	0.009687	0.247695	0.174529	0.649054	0.001493
307	0.973359	0.008473	0.243862	0.189420	0.642976	0.001481
308	0.978682	0.007339	0.240194	0.203672	0.637141	0.001475
309	0.983679	0.006287	0.236688	0.217292	0.631543	0.001471
310	0.988341	0.005318	0.233328	0.230344	0.626164	0.001469
311	0.992659	0.004431	0.230096	0.242900	0.620971	0.001468
312	0.996625	0.003627	0.226967	0.255055	0.615938	0.001462
313	1.000229	0.002906	0.223925	0.266872	0.611042	0.001446
314	1.003464	0.002266	0.220919	0.278553	0.606165	0.001448
315	1.006322	0.001707	0.217844	0.290498	0.601193	0.001427
316	1.008795	0.001228	0.214634	0.302968	0.595939	0.001439
317	1.010874	0.000828	0.211150	0.316502	0.590197	0.001467
318	1.012553	0.000507	0.207226	0.331747	0.583151	0.001307
319	1.013826	0.000265	0.202701	0.349325	0.576835	0.001032
320	1.014684	0.000103	0.197477	0.369620	0.567008	0.001888
321	1.015118	0.000021	0.188343	0.405105	0.551610	0.001917

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-5
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

NLR 7301 M=0.721, ALPHA=-0.194
RESULTS AT FAR-FIELD BOUNDARY (J=65)

I	X/C(%)	Z/C(%)	RHO	U	V	P
2	44.198776	-4.224165	1.000032	0.852934	-0.004323	1.000057
3	44.054855	-5.507944	1.000035	0.852907	-0.004320	1.000068
4	43.873230	-6.786684	1.000039	0.852883	-0.004320	1.000076
5	43.654114	-8.059116	1.000044	0.852863	-0.004319	1.000087
6	43.397781	-9.323985	1.000049	0.852842	-0.004319	1.000096
7	43.104553	-10.580049	1.000053	0.852819	-0.004319	1.000106
8	42.774796	-11.826078	1.000057	0.852796	-0.004320	1.000115
9	42.408905	-13.060868	1.000061	0.852772	-0.004320	1.000126
10	42.007370	-14.283227	1.000064	0.852747	-0.004321	1.000135
11	41.570694	-15.491988	1.000068	0.852720	-0.004321	1.000145
12	41.099426	-16.686005	1.000071	0.852692	-0.004321	1.000154
13	40.594147	-17.864166	1.000073	0.852664	-0.004321	1.000164
14	40.055527	-19.025391	1.000075	0.852636	-0.004320	1.000174
15	39.484238	-20.168594	1.000078	0.852606	-0.004318	1.000183
16	38.880997	-21.292786	1.000080	0.852576	-0.004316	1.000193
17	38.246567	-22.396957	1.000083	0.852545	-0.004314	1.000202
18	37.581757	-23.480133	1.000085	0.852514	-0.004310	1.000213
19	36.887390	-24.541428	1.000088	0.852482	-0.004306	1.000223
20	36.164352	-25.579941	1.000090	0.852450	-0.004301	1.000233
21	35.413498	-26.594833	1.000093	0.852418	-0.004295	1.000243
22	34.635803	-27.585297	1.000095	0.852386	-0.004288	1.000255
23	33.832184	-28.550598	1.000099	0.852352	-0.004280	1.000266
24	33.003616	-29.489975	1.000102	0.852320	-0.004272	1.000278
25	32.151123	-30.402802	1.000106	0.852287	-0.004262	1.000289
26	31.275696	-31.288406	1.000110	0.852254	-0.004251	1.000300
27	30.378387	-32.146240	1.000114	0.852221	-0.004239	1.000313
28	29.460236	-32.975723	1.000119	0.852188	-0.004226	1.000326
29	28.522324	-33.776398	1.000124	0.852155	-0.004211	1.000339
30	27.565720	-34.547775	1.000129	0.852123	-0.004195	1.000352
31	26.591507	-35.289490	1.000134	0.852090	-0.004178	1.000366
32	25.600784	-36.001144	1.000141	0.852058	-0.004159	1.000380
33	24.594650	-36.682449	1.000147	0.852026	-0.004139	1.000394
34	23.574203	-37.333130	1.000154	0.851995	-0.004117	1.000407
35	22.540543	-37.952957	1.000160	0.851965	-0.004093	1.000422
36	21.494781	-38.541748	1.000167	0.851936	-0.004067	1.000436
37	20.438019	-39.099365	1.000175	0.851906	-0.004040	1.000450
38	19.371338	-39.625732	1.000181	0.851879	-0.004011	1.000463
39	18.295822	-40.120773	1.000189	0.851853	-0.003980	1.000478
40	17.212585	-40.584503	1.000196	0.851828	-0.003947	1.000491
41	16.122665	-41.016953	1.000204	0.851804	-0.003912	1.000504
42	15.027136	-41.418182	1.000212	0.851783	-0.003875	1.000518
43	13.927039	-41.788330	1.000219	0.851763	-0.003836	1.000530
44	12.823407	-42.127548	1.000227	0.851746	-0.003795	1.000543
45	11.717255	-42.436020	1.000235	0.851730	-0.003753	1.000554
46	10.609577	-42.713989	1.000242	0.851717	-0.003708	1.000565
47	9.501350	-42.961685	1.000251	0.851706	-0.003662	1.000575
48	8.393530	-43.179443	1.000258	0.851699	-0.003614	1.000586
49	7.287051	-43.367584	1.000267	0.851694	-0.003564	1.000595
50	6.182825	-43.526459	1.000276	0.851692	-0.003512	1.000605
51	5.081738	-43.656479	1.000286	0.851693	-0.003459	1.000614
52	3.984653	-43.758072	1.000297	0.851697	-0.003404	1.000624
53	2.892404	-43.831696	1.000308	0.851706	-0.003347	1.000633
54	1.805797	-43.877823	1.000318	0.851722	-0.003289	1.000640
55	0.725613	-43.896957	1.000336	0.851736	-0.003229	1.000654
56	-0.347399	-43.889618	1.000383	0.851721	-0.003170	1.000706
57	-1.412516	-43.856323	1.000395	0.851692	-0.003147	1.000724
58	-2.469048	-43.797684	1.000409	0.851687	-0.003113	1.000740
59	-3.516332	-43.714264	1.000414	0.851683	-0.003080	1.000746
60	-4.553731	-43.606613	1.000419	0.851685	-0.003047	1.000749
61	-5.580645	-43.475372	1.000420	0.851690	-0.003015	1.000750
62	-6.596501	-43.321167	1.000420	0.851698	-0.002983	1.000748
63	-7.600763	-43.144653	1.000419	0.851707	-0.002952	1.000744
64	-8.592920	-42.946457	1.000417	0.851719	-0.002921	1.000739
65	-9.572495	-42.727264	1.000414	0.851732	-0.002892	1.000733
66	-10.539043	-42.487732	1.000410	0.851746	-0.002863	1.000726
67	-11.492147	-42.228531	1.000405	0.851763	-0.002835	1.000717
68	-12.431421	-41.950333	1.000401	0.851780	-0.002807	1.000709
69	-13.356509	-41.653824	1.000395	0.851798	-0.002781	1.000699
70	-14.267083	-41.339676	1.000389	0.851817	-0.002756	1.000689
71	-15.162848	-41.008575	1.000383	0.851836	-0.002731	1.000678
72	-16.043518	-40.661194	1.000377	0.851857	-0.002708	1.000667
73	-16.908890	-40.298218	1.000371	0.851876	-0.002685	1.000655
74	-17.758713	-39.920303	1.000363	0.851898	-0.002664	1.000643
75	-18.592804	-39.528107	1.000357	0.851919	-0.002643	1.000631
76	-19.411011	-39.122330	1.000350	0.851940	-0.002623	1.000619
77	-20.213181	-38.703583	1.000343	0.851961	-0.002604	1.000607
78	-20.999222	-38.272537	1.000337	0.851982	-0.002586	1.000595
79	-21.769028	-37.829834	1.000329	0.852004	-0.002569	1.000583
80	-22.522537	-37.376099	1.000322	0.852025	-0.002553	1.000570

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-6
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

81	-23.259705	-36.911957	1.000316	0.852046	-0.002537	1.000559
82	-23.980499	-36.438004	1.000309	0.852067	-0.002522	1.000546
83	-24.684921	-35.954865	1.000302	0.852088	-0.002508	1.000535
84	-25.373001	-35.463120	1.000296	0.852109	-0.002494	1.000524
85	-26.044769	-34.963333	1.000289	0.852129	-0.002481	1.000512
86	-26.700256	-34.456070	1.000282	0.852149	-0.002468	1.000501
87	-27.339569	-33.941895	1.000276	0.852170	-0.002457	1.000489
88	-27.962769	-33.421341	1.000270	0.852189	-0.002445	1.000479
89	-28.569962	-32.894928	1.000264	0.852208	-0.002434	1.000467
90	-29.161270	-32.363174	1.000257	0.852227	-0.002424	1.000457
91	-29.736816	-31.826569	1.000252	0.852246	-0.002414	1.000446
92	-30.296768	-31.285583	1.000246	0.852264	-0.002405	1.000437
93	-30.841248	-30.740692	1.000240	0.852282	-0.002396	1.000426
94	-31.370453	-30.192352	1.000235	0.852300	-0.002387	1.000417
95	-31.884537	-29.640976	1.000230	0.852317	-0.002379	1.000407
96	-32.383698	-29.087006	1.000224	0.852335	-0.002371	1.000398
97	-32.868149	-28.530823	1.000219	0.852351	-0.002363	1.000388
98	-33.338074	-27.972839	1.000214	0.852369	-0.002356	1.000379
99	-33.793686	-27.413422	1.000209	0.852385	-0.002349	1.000370
100	-34.235214	-26.852921	1.000204	0.852401	-0.002343	1.000361
101	-34.662872	-26.291672	1.000199	0.852417	-0.002336	1.000353
102	-35.076935	-25.730026	1.000195	0.852432	-0.002330	1.000344
103	-35.477585	-25.168274	1.000191	0.852447	-0.002324	1.000336
104	-35.865097	-24.606735	1.000186	0.852462	-0.002319	1.000328
105	-36.239685	-24.045654	1.000181	0.852477	-0.002313	1.000319
106	-36.601624	-23.485306	1.000177	0.852491	-0.002308	1.000312
107	-36.951141	-22.925964	1.000173	0.852506	-0.002303	1.000304
108	-37.288498	-22.367844	1.000169	0.852520	-0.002298	1.000297
109	-37.613953	-21.811172	1.000165	0.852534	-0.002294	1.000289
110	-37.927750	-21.256165	1.000161	0.852547	-0.002289	1.000282
111	-38.230133	-20.703018	1.000157	0.852560	-0.002285	1.000275
112	-38.521393	-20.151901	1.000154	0.852574	-0.002281	1.000268
113	-38.801743	-19.602982	1.000150	0.852587	-0.002277	1.000261
114	-39.071457	-19.056427	1.000146	0.852600	-0.002273	1.000254
115	-39.330780	-18.512375	1.000142	0.852612	-0.002270	1.000247
116	-39.579956	-17.970947	1.000138	0.852625	-0.002266	1.000240
117	-39.819229	-17.432266	1.000134	0.852638	-0.002263	1.000235
118	-40.048859	-16.896423	1.000132	0.852649	-0.002260	1.000228
119	-40.269058	-16.363525	1.000128	0.852662	-0.002257	1.000221
120	-40.480072	-15.833661	1.000125	0.852673	-0.002254	1.000216
121	-40.682144	-15.306881	1.000121	0.852685	-0.002251	1.000209
122	-40.875488	-14.783254	1.000118	0.852696	-0.002249	1.000203
123	-41.060333	-14.262828	1.000114	0.852708	-0.002246	1.000197
124	-41.236893	-13.745642	1.000112	0.852719	-0.002244	1.000191
125	-41.405380	-13.231725	1.000109	0.852730	-0.002241	1.000185
126	-41.565979	-12.721095	1.000106	0.852741	-0.002239	1.000179
127	-41.718918	-12.213762	1.000102	0.852752	-0.002237	1.000174
128	-41.864349	-11.709726	1.000099	0.852763	-0.002235	1.000168
129	-42.002457	-11.208979	1.000096	0.852773	-0.002233	1.000163
130	-42.133423	-10.711502	1.000093	0.852784	-0.002231	1.000157
131	-42.257370	-10.217270	1.000091	0.852794	-0.002229	1.000152
132	-42.374466	-9.726253	1.000088	0.852804	-0.002227	1.000146
133	-42.484848	-9.238414	1.000085	0.852815	-0.002226	1.000141
134	-42.588654	-8.753711	1.000082	0.852825	-0.002224	1.000135
135	-42.685989	-8.272089	1.000079	0.852835	-0.002223	1.000131
136	-42.776993	-7.793502	1.000076	0.852845	-0.002221	1.000126
137	-42.861816	-7.317897	1.000073	0.852855	-0.002220	1.000120
138	-42.940582	-6.845215	1.000072	0.852864	-0.002218	1.000115
139	-43.013428	-6.375391	1.000069	0.852874	-0.002217	1.000111
140	-43.080490	-5.908360	1.000066	0.852883	-0.002216	1.000105
141	-43.141937	-5.444055	1.000063	0.852893	-0.002215	1.000100
142	-43.197861	-4.982390	1.000061	0.852902	-0.002214	1.000095
143	-43.248337	-4.523283	1.000058	0.852912	-0.002213	1.000091
144	-43.293503	-4.066648	1.000055	0.852921	-0.002212	1.000086
145	-43.333496	-3.612401	1.000053	0.852930	-0.002211	1.000081
146	-43.368469	-3.160448	1.000051	0.852939	-0.002210	1.000076
147	-43.398529	-2.710691	1.000048	0.852949	-0.002210	1.000072
148	-43.423752	-2.263027	1.000046	0.852957	-0.002209	1.000067
149	-43.444260	-1.817351	1.000043	0.852967	-0.002208	1.000062
150	-43.460129	-1.373551	1.000041	0.852975	-0.002208	1.000057
151	-43.471405	-0.931517	1.000038	0.852985	-0.002207	1.000052
152	-43.478165	-0.491133	1.000035	0.852994	-0.002207	1.000049
153	-43.480484	-0.052281	1.000033	0.853003	-0.002206	1.000044
154	-43.478378	0.385156	1.000031	0.853012	-0.002206	1.000039
155	-43.471924	0.821299	1.000029	0.853020	-0.002206	1.000034
156	-43.461121	1.256269	1.000026	0.853029	-0.002205	1.000030
157	-43.445969	1.690186	1.000024	0.853038	-0.002205	1.000026
158	-43.426529	2.123175	1.000021	0.853047	-0.002205	1.000021
159	-43.402786	2.555358	1.000019	0.853055	-0.002205	1.000016
160	-43.374771	2.986858	1.000016	0.853065	-0.002205	1.000011

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-7
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

161	-43.342484	3.417800	1.000014	0.853073	-0.002205	1.000007
162	-43.305893	3.848303	1.000011	0.853082	-0.002205	1.000003
163	-43.264984	4.278490	1.000010	0.853091	-0.002205	0.999998
164	-43.219742	4.708482	1.000007	0.853100	-0.002205	0.999994
165	-43.170151	5.138398	1.000004	0.853109	-0.002205	0.999989
166	-43.116135	5.568357	1.000002	0.853118	-0.002205	0.999985
167	-43.057693	5.998474	1.000000	0.853126	-0.002206	0.999980
168	-42.994736	6.428864	0.999997	0.853135	-0.002206	0.999975
169	-42.927216	6.859634	0.999995	0.853144	-0.002206	0.999970
170	-42.855057	7.290896	0.999992	0.853154	-0.002207	0.999966
171	-42.778229	7.722759	0.999990	0.853162	-0.002207	0.999961
172	-42.696640	8.155329	0.999987	0.853172	-0.002208	0.999956
173	-42.610306	8.588720	0.999985	0.853181	-0.002208	0.999951
174	-42.519257	9.023059	0.999982	0.853190	-0.002209	0.999947
175	-42.423401	9.458450	0.999980	0.853200	-0.002210	0.999942
176	-42.322693	9.894995	0.999977	0.853209	-0.002210	0.999937
177	-42.216995	10.332787	0.999974	0.853218	-0.002211	0.999932
178	-42.106247	10.771921	0.999972	0.853228	-0.002212	0.999927
179	-41.990341	11.212485	0.999969	0.853238	-0.002213	0.999922
180	-41.869156	11.654567	0.999966	0.853248	-0.002214	0.999917
181	-41.742584	12.098244	0.999964	0.853258	-0.002215	0.999912
182	-41.610519	12.543594	0.999961	0.853267	-0.002216	0.999907
183	-41.472824	12.990687	0.999958	0.853277	-0.002217	0.999901
184	-41.329376	13.439590	0.999955	0.853287	-0.002219	0.999896
185	-41.180023	13.890360	0.999953	0.853298	-0.002220	0.999891
186	-41.024658	14.343054	0.999950	0.853308	-0.002222	0.999886
187	-40.863098	14.797719	0.999947	0.853318	-0.002223	0.999880
188	-40.695206	15.254396	0.999944	0.853329	-0.002225	0.999875
189	-40.520828	15.713122	0.999941	0.853339	-0.002226	0.999869
190	-40.339783	16.173920	0.999938	0.853350	-0.002228	0.999864
191	-40.151932	16.636810	0.999935	0.853362	-0.002230	0.999858
192	-39.957092	17.101822	0.999932	0.853373	-0.002232	0.999852
193	-39.755066	17.568954	0.999929	0.853384	-0.002234	0.999846
194	-39.545685	18.038177	0.999926	0.853395	-0.002236	0.999840
195	-39.328751	18.509521	0.999923	0.853407	-0.002239	0.999834
196	-39.104095	18.982941	0.999919	0.853418	-0.002241	0.999828
197	-38.871490	19.458405	0.999916	0.853430	-0.002244	0.999822
198	-38.630768	19.935883	0.999913	0.853442	-0.002246	0.999816
199	-38.381714	20.415329	0.999909	0.853454	-0.002249	0.999809
200	-38.124115	20.896683	0.999906	0.853466	-0.002252	0.999803
201	-37.857773	21.379868	0.999902	0.853479	-0.002255	0.999796
202	-37.582458	21.864838	0.999899	0.853492	-0.002258	0.999790
203	-37.297989	22.351471	0.999895	0.853504	-0.002261	0.999783
204	-37.004135	22.839676	0.999891	0.853518	-0.002265	0.999776
205	-36.700668	23.329361	0.999888	0.853531	-0.002268	0.999769
206	-36.387390	23.820389	0.999884	0.853544	-0.002272	0.999762
207	-36.064056	24.312637	0.999880	0.853558	-0.002276	0.999755
208	-35.730469	24.805954	0.999876	0.853573	-0.002280	0.999747
209	-35.386398	25.300186	0.999872	0.853587	-0.002284	0.999740
210	-35.031616	25.795166	0.999868	0.853601	-0.002289	0.999732
211	-34.665909	26.290695	0.999864	0.853616	-0.002294	0.999724
212	-34.289047	26.786606	0.999859	0.853631	-0.002299	0.999716
213	-33.900818	27.282684	0.999855	0.853646	-0.002304	0.999708
214	-33.501022	27.778702	0.999850	0.853661	-0.002309	0.999700
215	-33.089401	28.274429	0.999846	0.853677	-0.002315	0.999691
216	-32.665787	28.769623	0.999841	0.853694	-0.002321	0.999683
217	-32.229935	29.264023	0.999836	0.853710	-0.002327	0.999674
218	-31.781662	29.757355	0.999831	0.853727	-0.002333	0.999665
219	-31.320755	30.249313	0.999826	0.853744	-0.002340	0.999656
220	-30.847041	30.739624	0.999821	0.853761	-0.002347	0.999646
221	-30.360260	31.227951	0.999816	0.853779	-0.002355	0.999637
222	-29.860291	31.713959	0.999810	0.853797	-0.002363	0.999627
223	-29.346939	32.197327	0.999805	0.853815	-0.002371	0.999617
224	-28.820023	32.677673	0.999799	0.853834	-0.002380	0.999607
225	-28.279388	33.154633	0.999793	0.853853	-0.002389	0.999596
226	-27.724869	33.627823	0.999787	0.853872	-0.002398	0.999586
227	-27.156326	34.096848	0.999781	0.853892	-0.002409	0.999575
228	-26.573608	34.561264	0.999775	0.853912	-0.002419	0.999564
229	-25.976608	35.020676	0.999769	0.853933	-0.002430	0.999552
230	-25.365189	35.474625	0.999762	0.853953	-0.002442	0.999541
231	-24.739273	35.922653	0.999756	0.853974	-0.002454	0.999529
232	-24.098755	36.364288	0.999749	0.853996	-0.002467	0.999517
233	-23.443558	36.799042	0.999742	0.854017	-0.002481	0.999505
234	-22.773636	37.226440	0.999735	0.854039	-0.002495	0.999492
235	-22.088913	37.645950	0.999728	0.854061	-0.002510	0.999480
236	-21.389389	38.057083	0.999721	0.854084	-0.002526	0.999467
237	-20.675034	38.459274	0.999713	0.854106	-0.002543	0.999454
238	-19.945847	38.852005	0.999706	0.854128	-0.002560	0.999441
239	-19.201859	39.234695	0.999698	0.854151	-0.002579	0.999428
240	-18.443100	39.606812	0.999691	0.854174	-0.002598	0.999415

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-8
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

241	-17.669632	39.967758	0.999683	0.854196	-0.002618	0.999402
242	-16.881546	40.316971	0.999676	0.854219	-0.002640	0.999389
243	-16.078949	40.653854	0.999668	0.854241	-0.002662	0.999376
244	-15.261941	40.977798	0.999661	0.854263	-0.002685	0.999364
245	-14.430678	41.288223	0.999654	0.854285	-0.002710	0.999351
246	-13.585332	41.584503	0.999647	0.854305	-0.002735	0.999339
247	-12.726094	41.866013	0.999640	0.854326	-0.002762	0.999327
248	-11.853182	42.132156	0.999633	0.854345	-0.002789	0.999316
249	-10.966839	42.382309	0.999627	0.854365	-0.002818	0.999305
250	-10.067333	42.615845	0.999621	0.854382	-0.002848	0.999295
251	-9.154959	42.832123	0.999616	0.854398	-0.002878	0.999286
252	-8.230037	43.030533	0.999612	0.854413	-0.002910	0.999277
253	-7.292915	43.210464	0.999608	0.854427	-0.002942	0.999270
254	-6.343972	43.371277	0.999605	0.854438	-0.002976	0.999265
255	-5.383608	43.512344	0.999603	0.854448	-0.003010	0.999260
256	-4.412256	43.633087	0.999602	0.854454	-0.003044	0.999258
257	-3.430377	43.732880	0.999603	0.854459	-0.003079	0.999258
258	-2.438459	43.811111	0.999607	0.854460	-0.003114	0.999261
259	-1.437019	43.867218	0.999611	0.854455	-0.003150	0.999266
260	-0.426605	43.900604	0.999626	0.854449	-0.003187	0.999282
261	0.592210	43.910706	0.999633	0.854418	-0.003211	0.999298
262	1.618820	43.896973	0.999684	0.854405	-0.003274	0.999351
263	2.652595	43.858856	0.999705	0.854420	-0.003339	0.999369
264	3.692871	43.795822	0.999718	0.854435	-0.003402	0.999378
265	4.738960	43.707382	0.999732	0.854444	-0.003463	0.999390
266	5.790146	43.593033	0.999745	0.854446	-0.003521	0.999403
267	6.845682	43.452316	0.999758	0.854446	-0.003578	0.999415
268	7.904798	43.284775	0.999769	0.854442	-0.003633	0.999427
269	8.966694	43.089996	0.999780	0.854435	-0.003686	0.999439
270	10.030549	42.867584	0.999790	0.854424	-0.003736	0.999452
271	11.095512	42.617142	0.999800	0.854411	-0.003785	0.999465
272	12.160713	42.338364	0.999810	0.854395	-0.003831	0.999479
273	13.225256	42.030899	0.999820	0.854377	-0.003876	0.999493
274	14.288225	41.694504	0.999829	0.854356	-0.003918	0.999508
275	15.348682	41.328903	0.999839	0.854333	-0.003957	0.999523
276	16.405670	40.933899	0.999848	0.854308	-0.003995	0.999539
277	17.458221	40.509308	0.999857	0.854281	-0.004030	0.999554
278	18.505325	40.054977	0.999867	0.854252	-0.004063	0.999570
279	19.546005	39.570816	0.999875	0.854223	-0.004094	0.999586
280	20.579224	39.056732	0.999884	0.854192	-0.004122	0.999603
281	21.603943	38.512711	0.999892	0.854160	-0.004149	0.999619
282	22.619125	37.938751	0.999901	0.854128	-0.004173	0.999635
283	23.623718	37.334930	0.999908	0.854095	-0.004196	0.999650
284	24.616653	36.701294	0.999916	0.854060	-0.004217	0.999666
285	25.596878	36.038025	0.999923	0.854026	-0.004236	0.999681
286	26.563324	35.345276	0.999929	0.853992	-0.004253	0.999696
287	27.514923	34.623260	0.999935	0.853957	-0.004269	0.999711
288	28.450577	33.872269	0.999941	0.853922	-0.004283	0.999725
289	29.369263	33.092590	0.999946	0.853887	-0.004296	0.999739
290	30.269867	32.284592	0.999951	0.853852	-0.004307	0.999752
291	31.151382	31.448669	0.999956	0.853817	-0.004318	0.999765
292	32.012711	30.585266	0.999960	0.853782	-0.004327	0.999778
293	32.852859	29.694870	0.999963	0.853747	-0.004335	0.999790
294	33.670776	28.778000	0.999967	0.853713	-0.004341	0.999802
295	34.465454	27.835266	0.999969	0.853679	-0.004347	0.999813
296	35.235916	26.867264	0.999972	0.853644	-0.004352	0.999824
297	35.981155	25.874664	0.999974	0.853611	-0.004356	0.999834
298	36.700256	24.858170	0.999976	0.853577	-0.004359	0.999844
299	37.392273	23.818558	0.999978	0.853544	-0.004361	0.999854
300	38.056290	22.756592	0.999980	0.853511	-0.004363	0.999864
301	38.691452	21.673111	0.999981	0.853479	-0.004364	0.999873
302	39.296890	20.568985	0.999983	0.853447	-0.004364	0.999882
303	39.871811	19.445114	0.999984	0.853416	-0.004363	0.999891
304	40.415421	18.302475	0.999985	0.853386	-0.004362	0.999900
305	40.926987	17.142014	0.999987	0.853356	-0.004360	0.999909
306	41.405777	15.964776	0.999989	0.853327	-0.004358	0.999918
307	41.851135	14.771782	0.999991	0.853299	-0.004356	0.999927
308	42.262436	13.564120	0.999993	0.853271	-0.004353	0.999936
309	42.639084	12.342896	0.999996	0.853246	-0.004350	0.999945
310	42.980545	11.109244	0.999999	0.853221	-0.004346	0.999954
311	43.286301	9.864322	1.000003	0.853198	-0.004343	0.999963
312	43.555908	8.609307	1.000006	0.853176	-0.004341	0.999973
313	43.788971	7.345405	1.000010	0.853156	-0.004338	0.999982
314	43.985123	6.073832	1.000016	0.853140	-0.004336	0.999991
315	44.144043	4.795825	1.000022	0.853127	-0.004335	1.000000
316	44.265472	3.512634	1.000025	0.853104	-0.004338	1.000009
317	44.349213	2.225522	1.000022	0.853061	-0.004340	1.000015
318	44.395096	0.935760	1.000015	0.853007	-0.004338	1.000023
319	44.403030	-0.355373	1.000013	0.852967	-0.004331	1.000031
320	44.372940	-1.646595	1.000019	0.852955	-0.004324	1.000039
321	44.304840	-2.936621	1.000030	0.852958	-0.004322	1.000050
322	34.363541	-2.631125	1.000032	0.852934	-0.004323	1.000057

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-9
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

C_L = 0.594

C_D = 0.0005

C_M = - 0.132

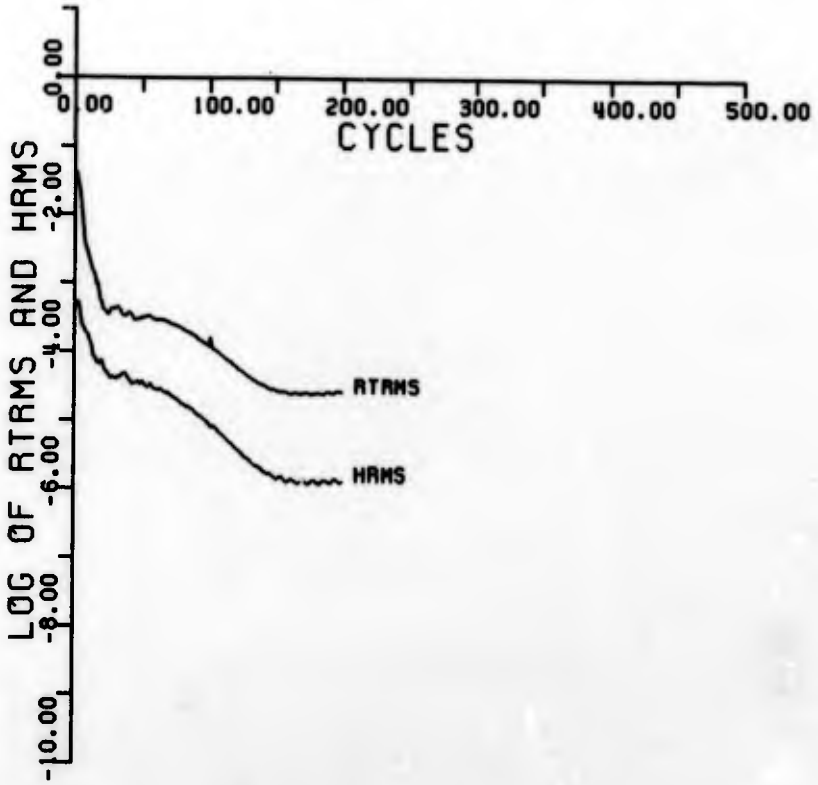


FIG. : CONVERGENCE BEHAVIOUR (DR/DT AND H)

NLR 7301 M=0.7210, ALPHA=-0.1940

GRID SEQUENCE :40×8->80×16->160×32->320×64

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-10
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

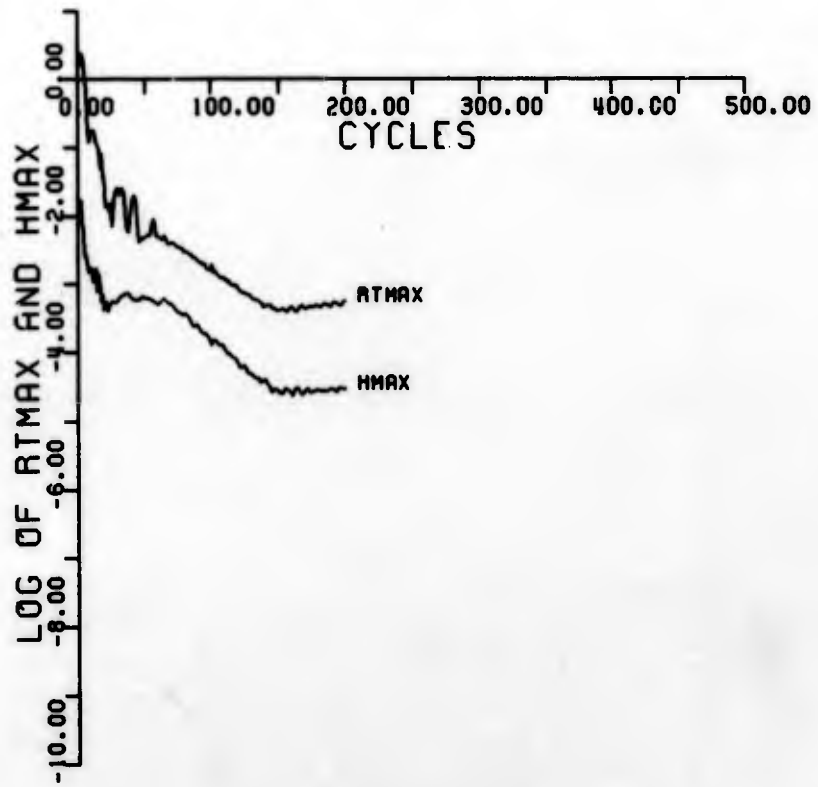


FIG. : CONVERGENCE BEHAVIOUR (DR/DT AND H)

NLR 7301 M=0.7210, ALPHA=-0.1940

GRID SEQUENCE : 40×8->80×16->160×32->320×64

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-11
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

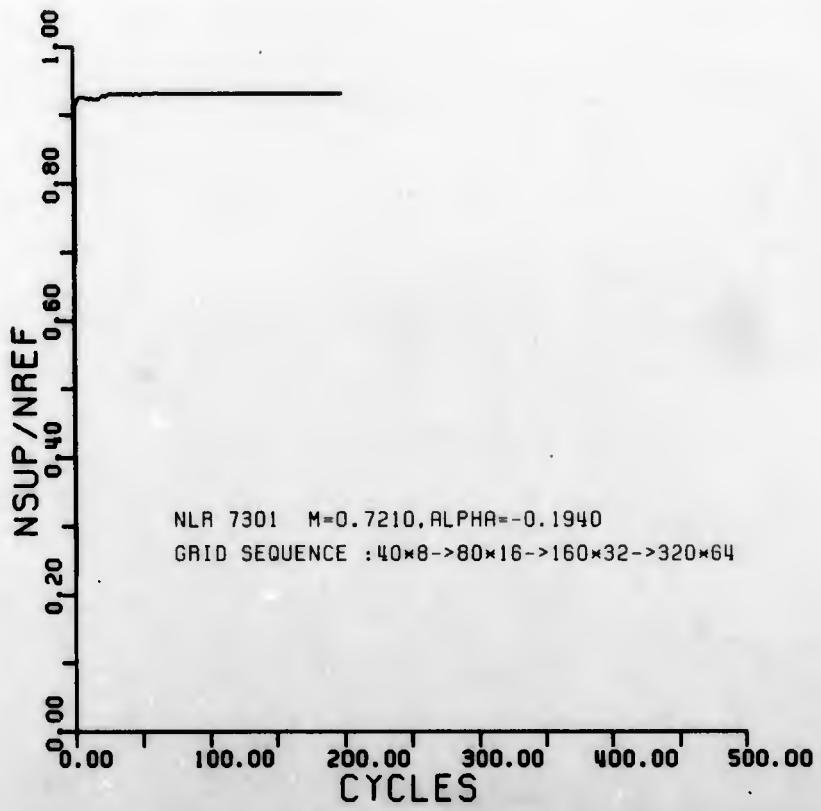


FIG. : CONVERGENCE BEHAVIOUR (NSUP/NREF), NREF=2000

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-12
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

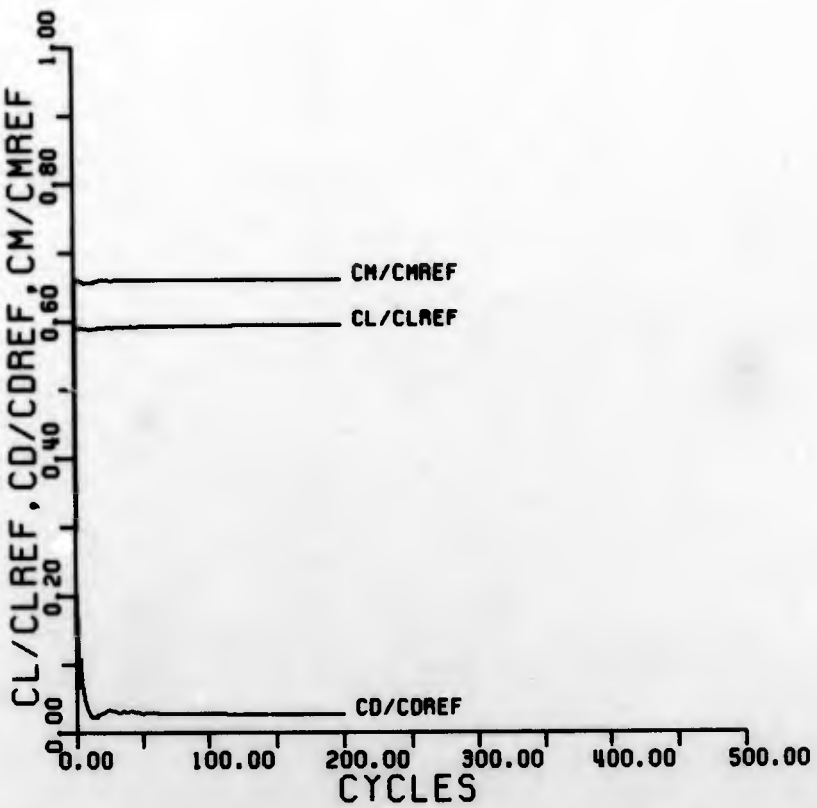


FIG. : CONVERGENCE BEHAVIOUR (CL,CD,CM)/REF

NLR 7301 M=0.7210,ALPHA=-0.194

REF-VALUES:CLREF=1.0,CDREF=0.02,CMREF=-0.20

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-13
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

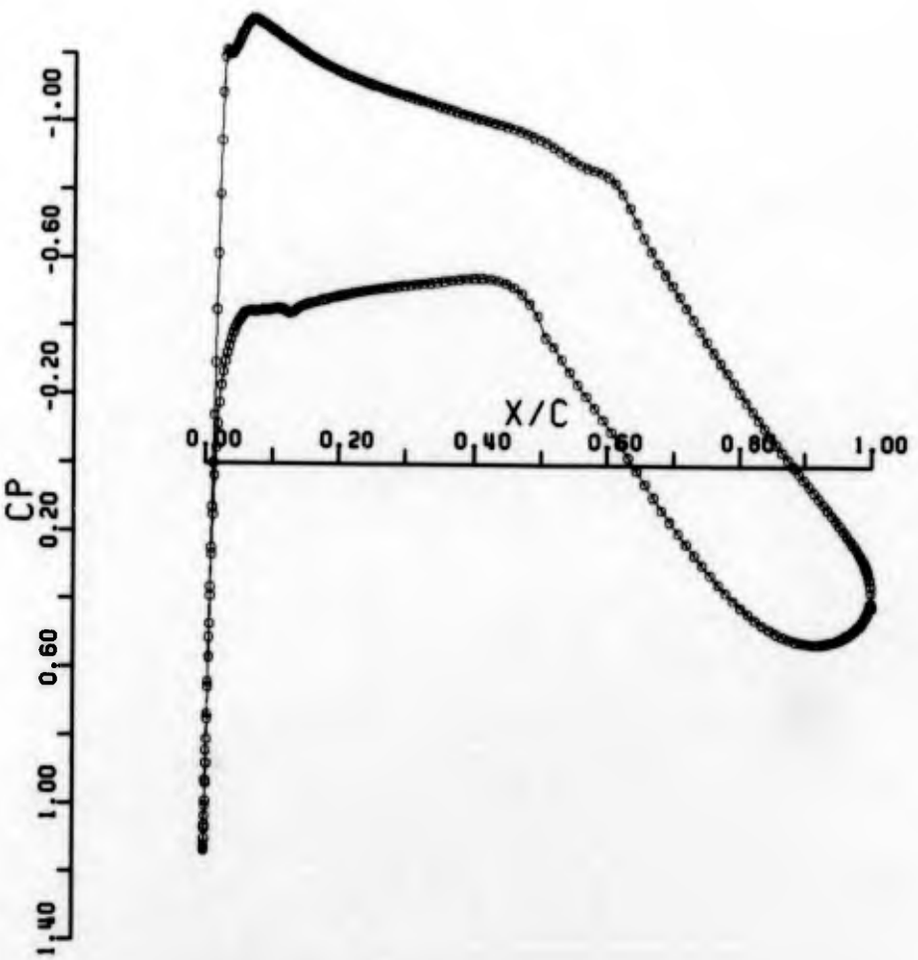


FIG. : CP(X/C) ON NLR 7301

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-14
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

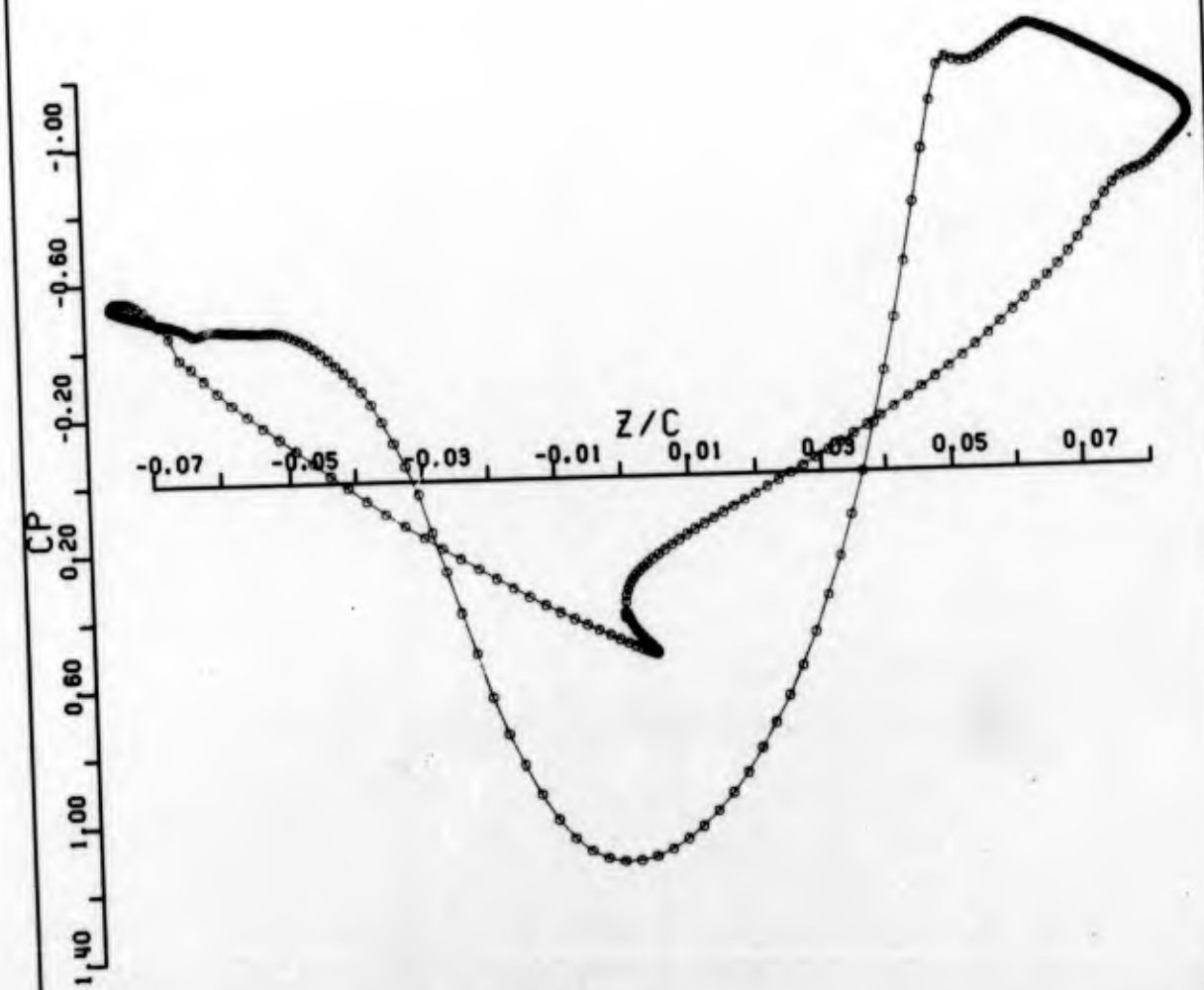


FIG. : CP(Z/C) ON NLR 7301

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-15
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

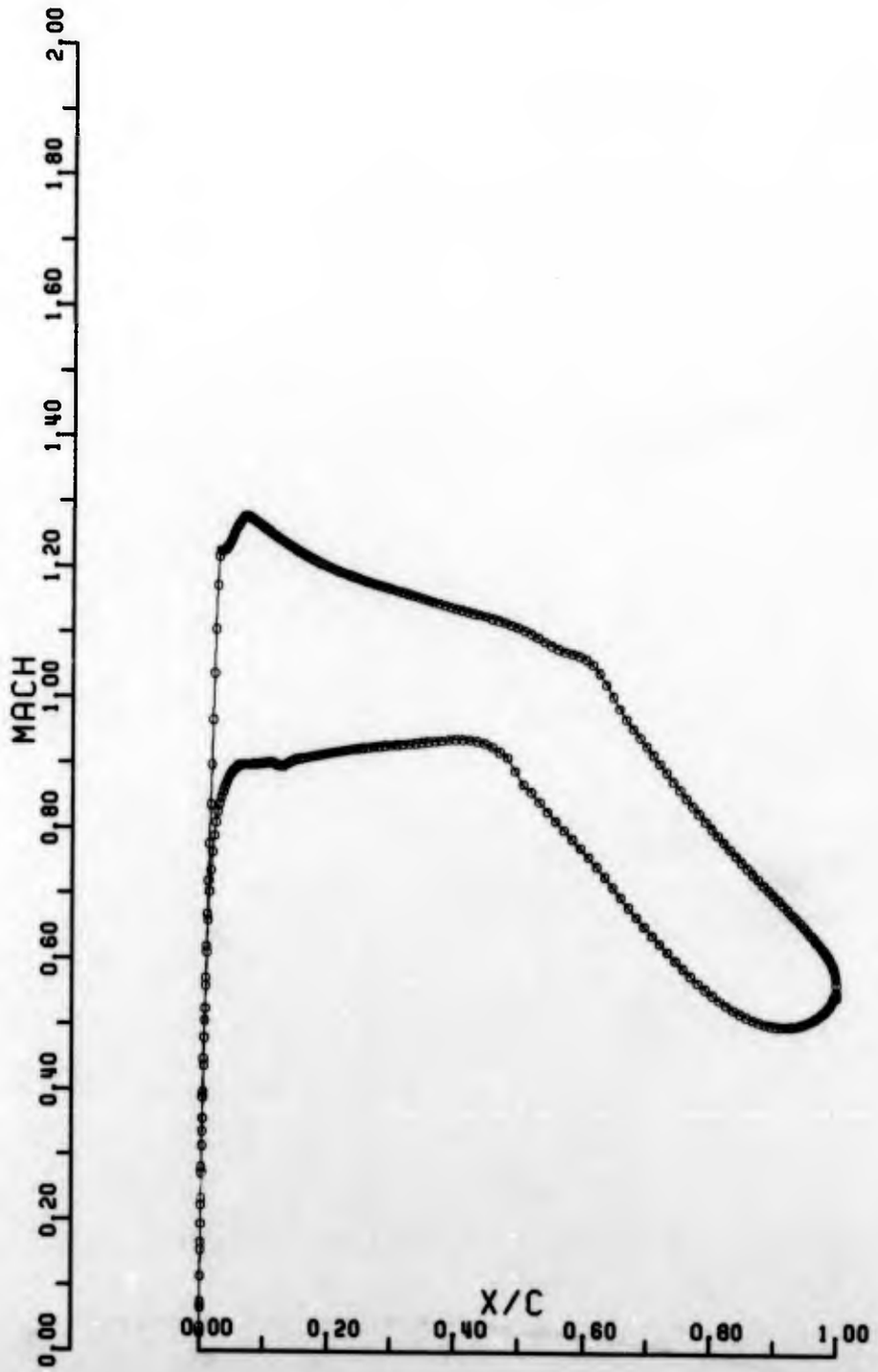


FIG. : MACH(X/C) ON NLR 7301

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-16
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

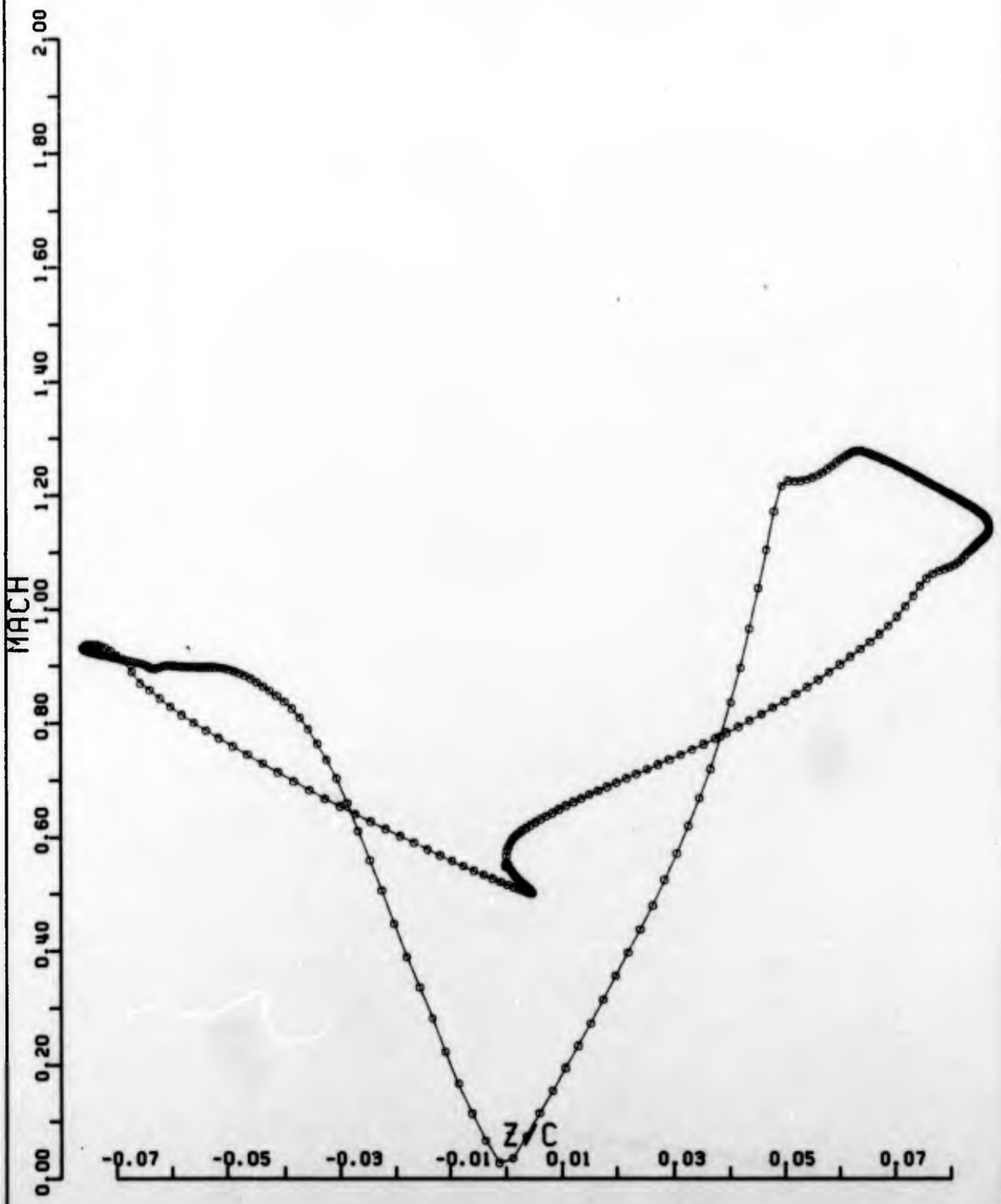


FIG. : MACH(Z/C) ON NLR 7301

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-17
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

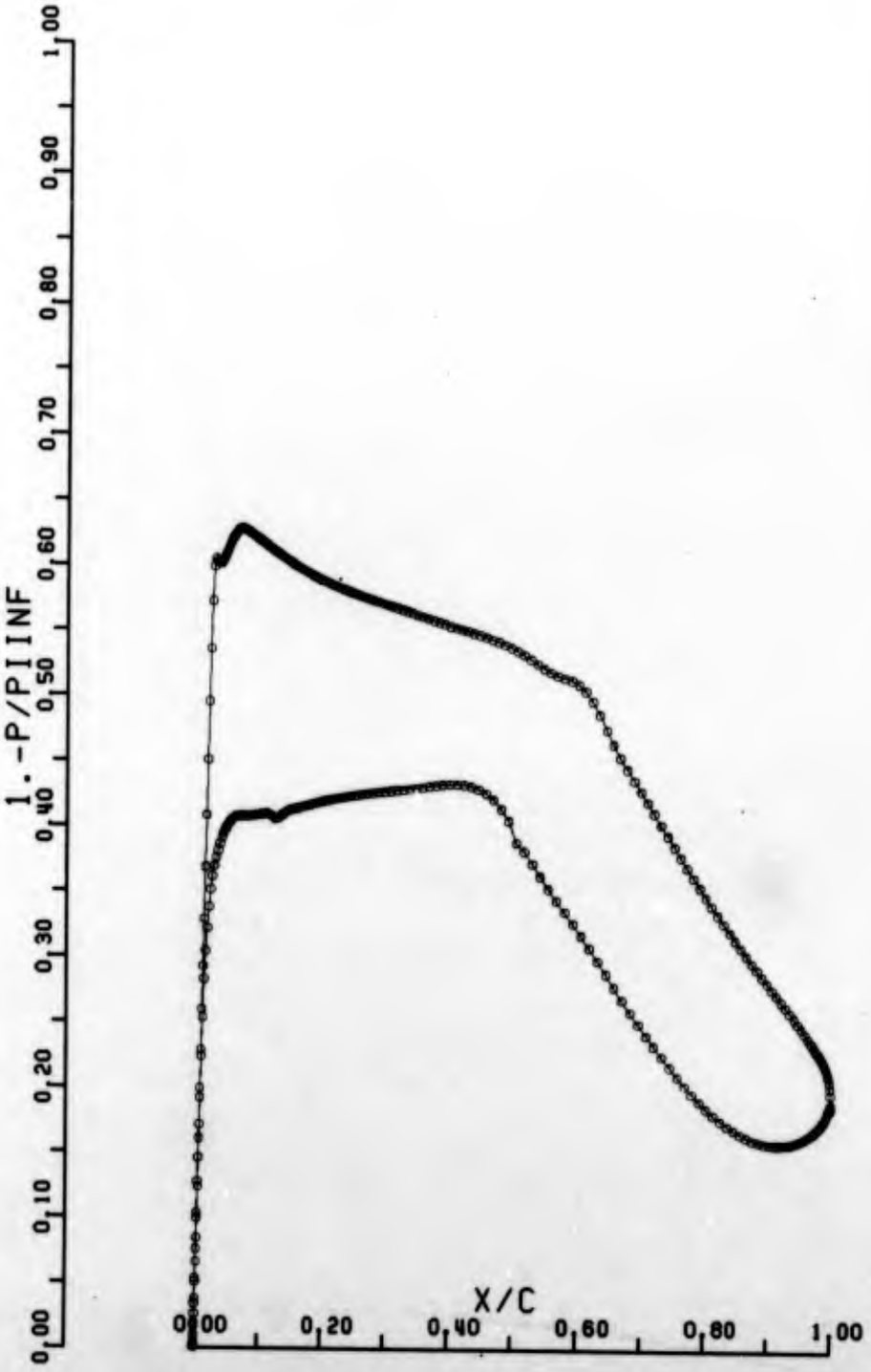


FIG. : 1.-P/PIINF VS. X/C ON NLR 7301

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-18
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

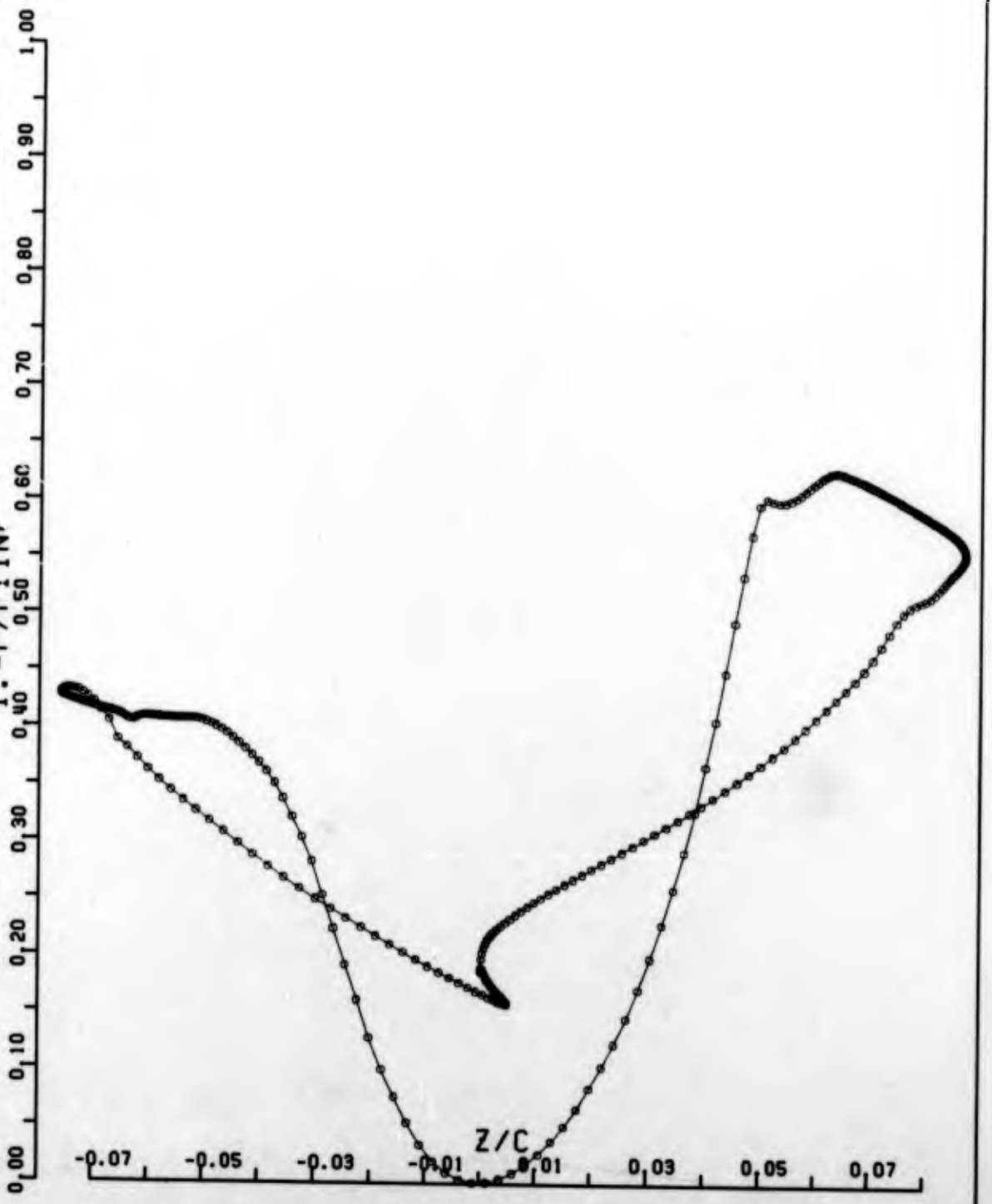


FIG. : 1.-P/PIINF VS. Z/C ON NLR 7301

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-19
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

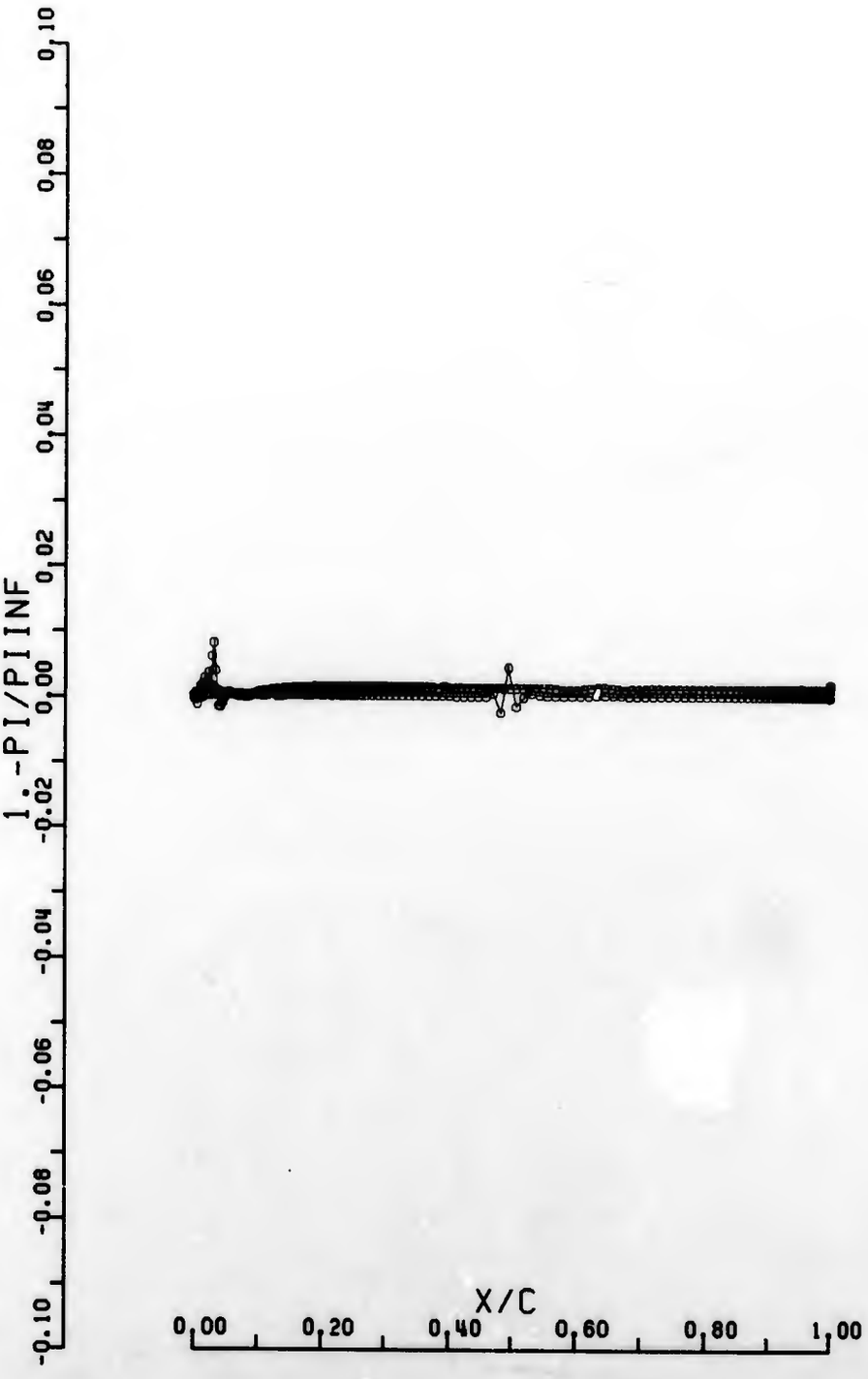


FIG. : 1.-PI/PIINF VS. X/C ON NLR 7301

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-20
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

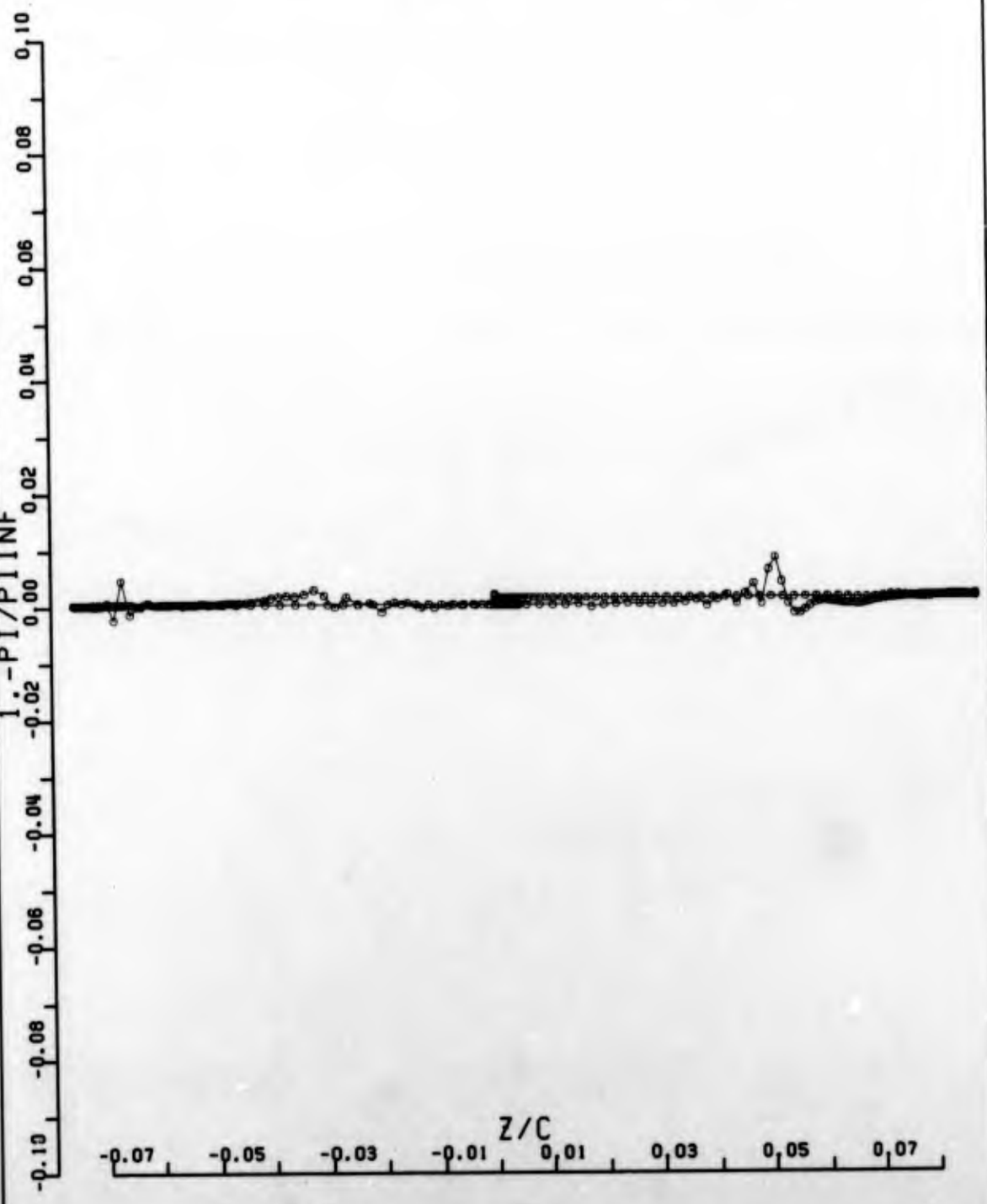
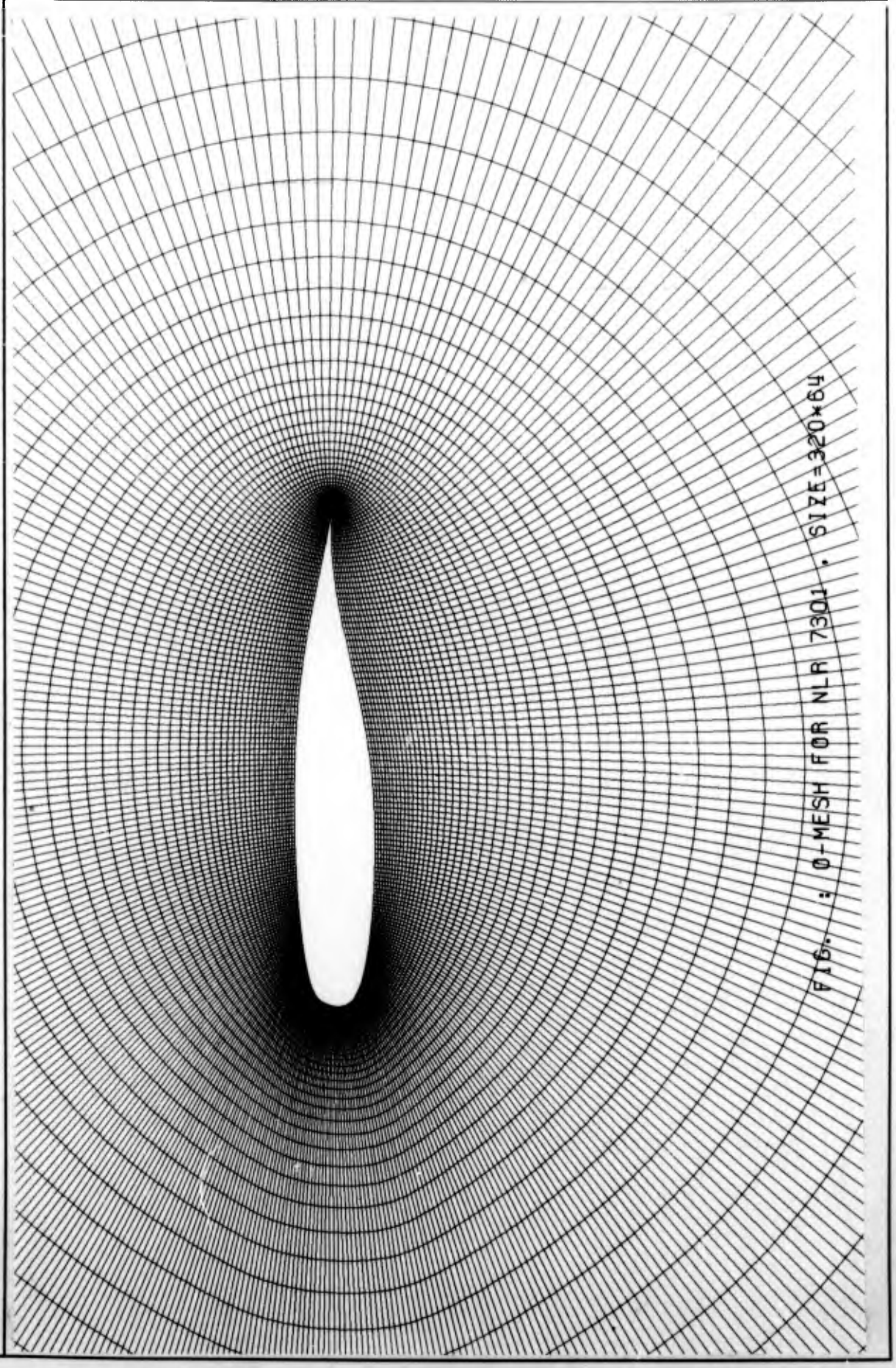
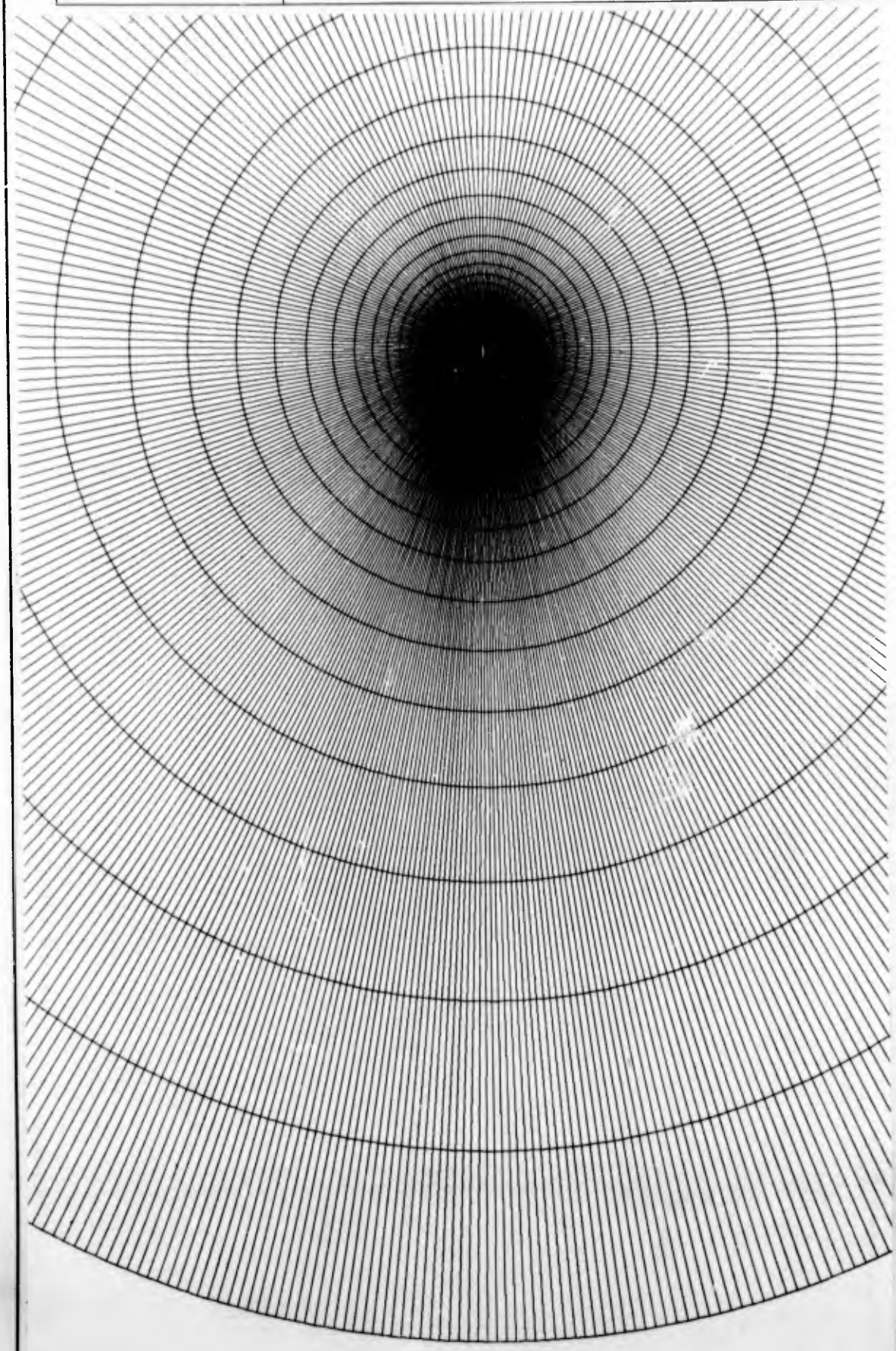


FIG. : 1.-PI/PIINF VS. Z/C ON NLR 7301

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-21
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-22
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-23
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

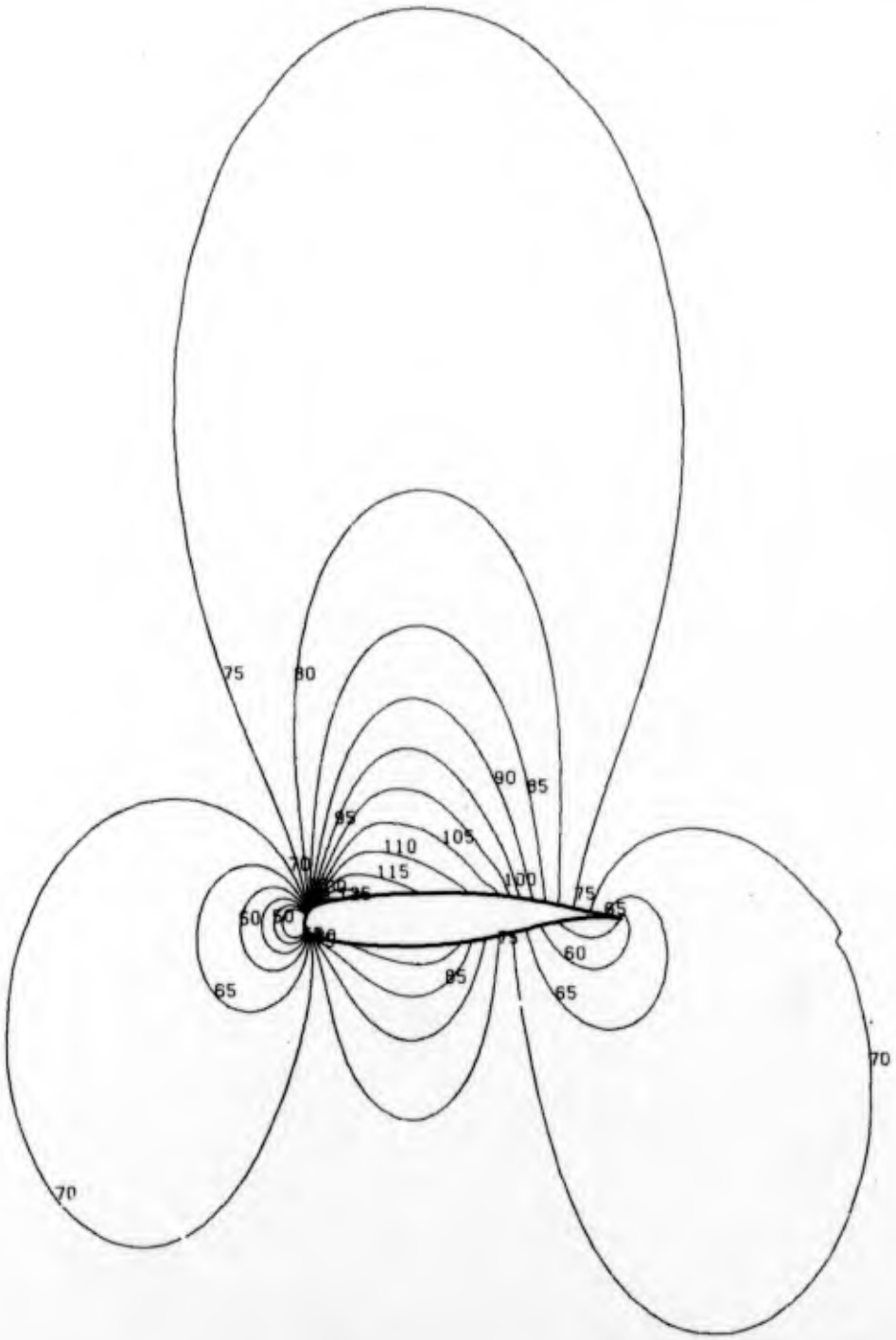


FIG. : ISO-MACH (DELTA = 0.050)

**** VALUES OF CURVE PARAMETER = 100*MACH ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-24
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

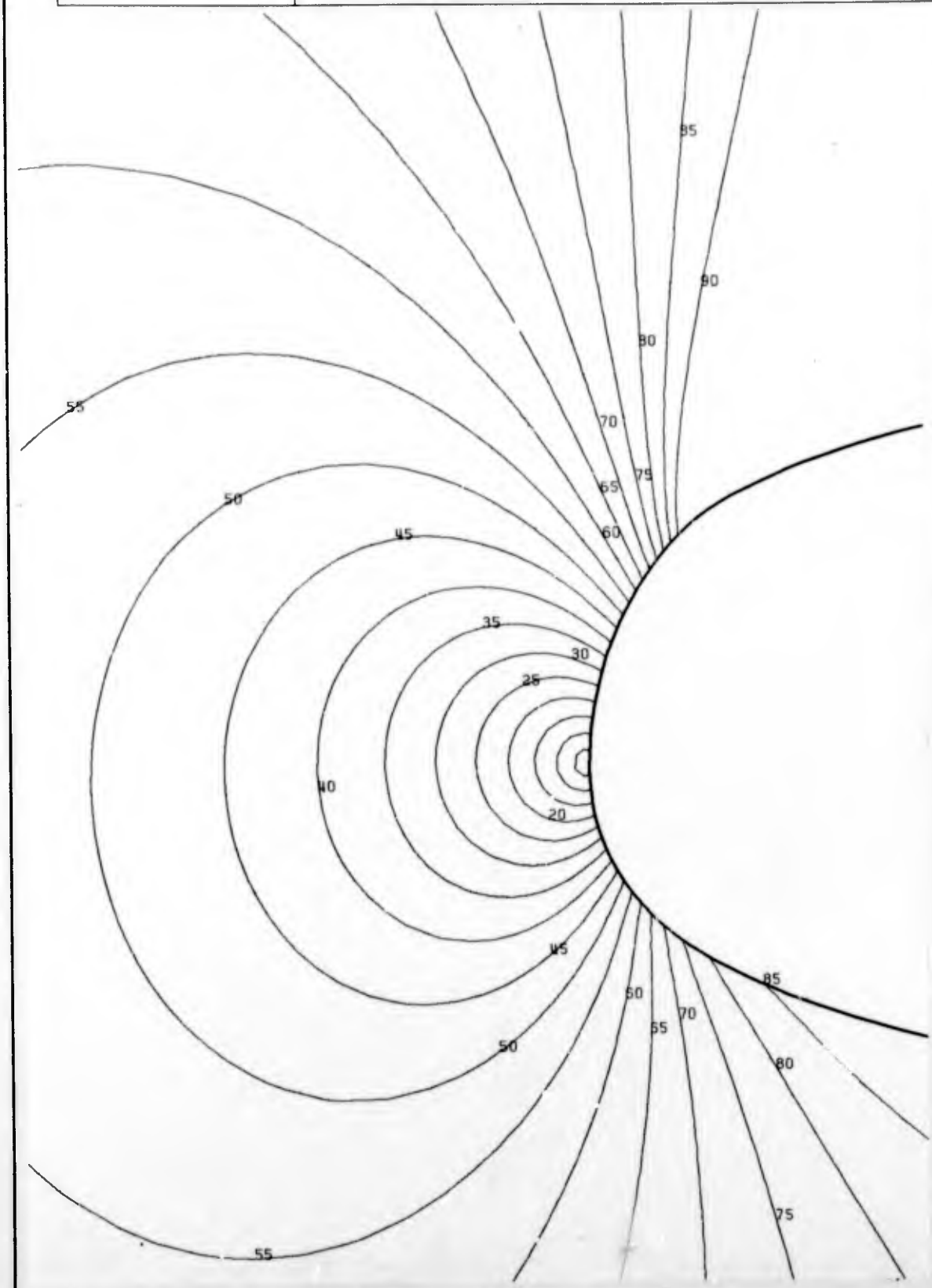
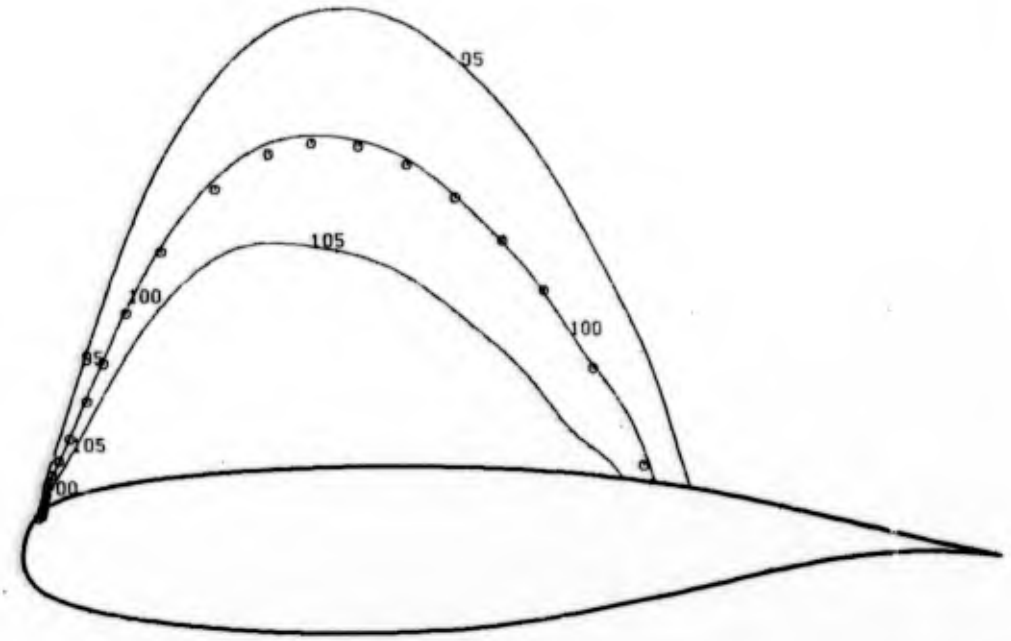


FIG. : ISO-MACH (DELTA = 0.050)

*** VALUES OF CURVE PARAMETER = 100*MACH ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-25
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			



000 DESIGN SONIC LINE (HODOGRAPH METHOD)

FIG. : ISO-MACH (DELTA = 0.050)

*** VALUES OF CURVE PARAMETER = 100*MACH ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-26
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

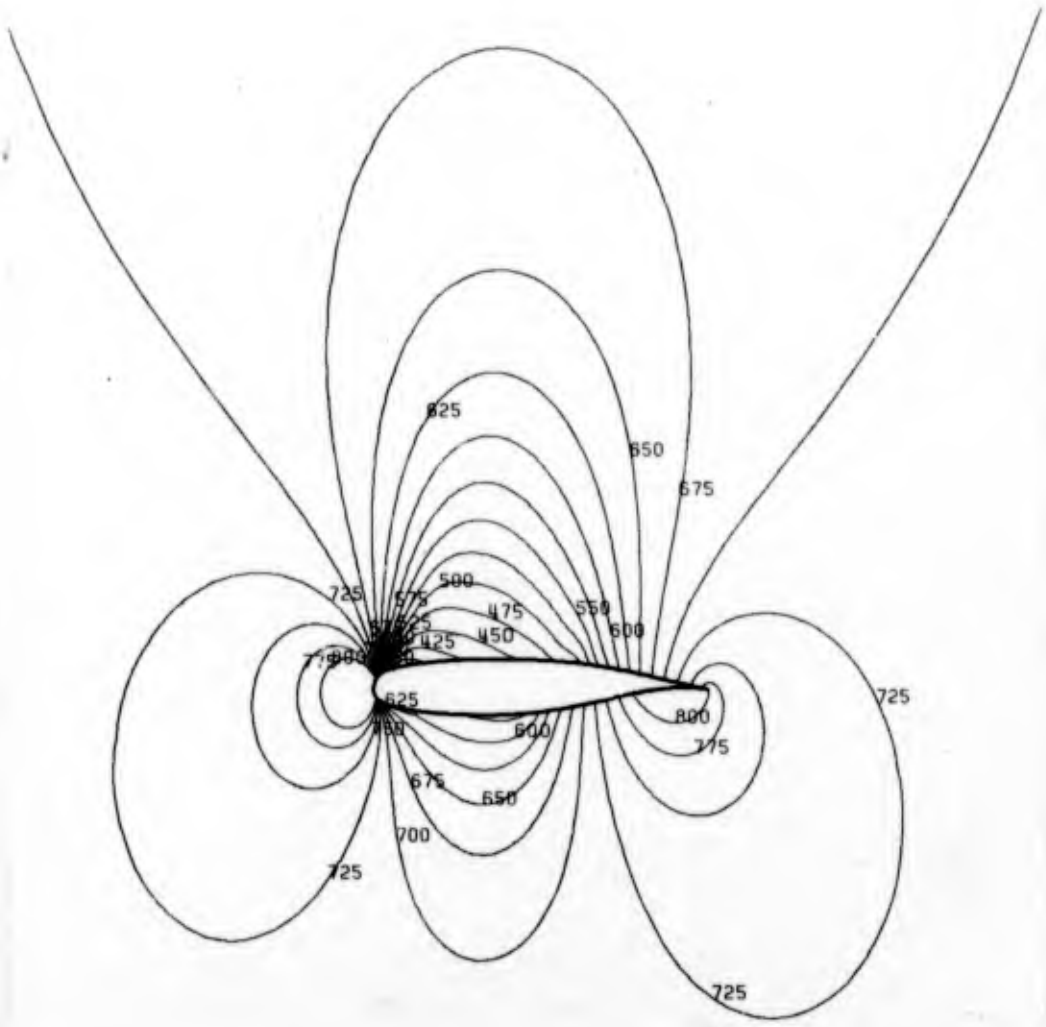


FIG. : ISO-P/PIINF (DELTA = 0.025)

**** VALUES OF CURVE PARAMETER = 1000*P/PIINF ****

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-27
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

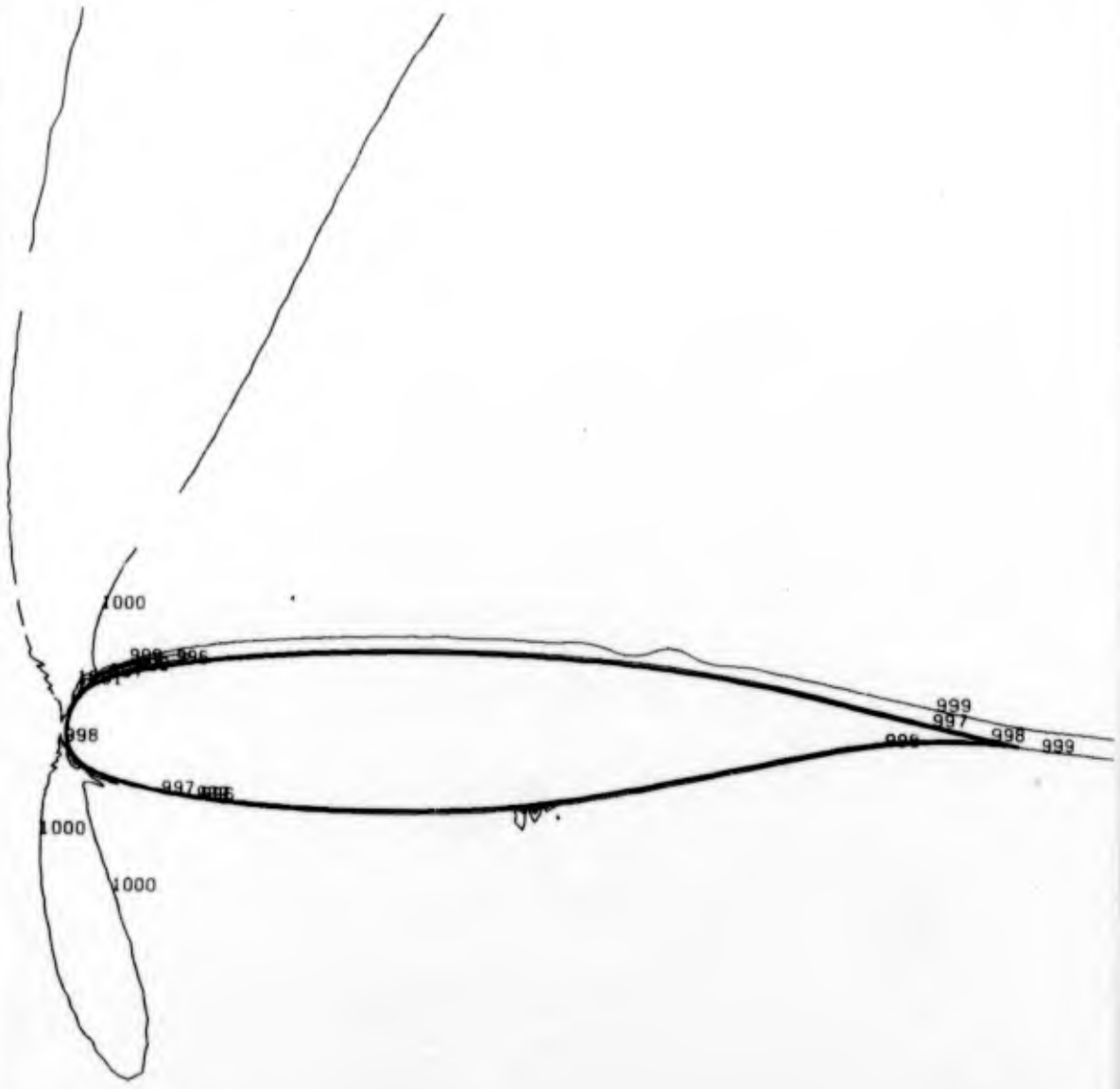


FIG. : ISO-PI/PIINF (DELTA = 0.0010)

××× VALUES OF CURVE PARAMETER = 1000×PI/PIINF ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	07-9-28
	NLR 7301: MACH = 0.720957, ALPHA = −0.194			

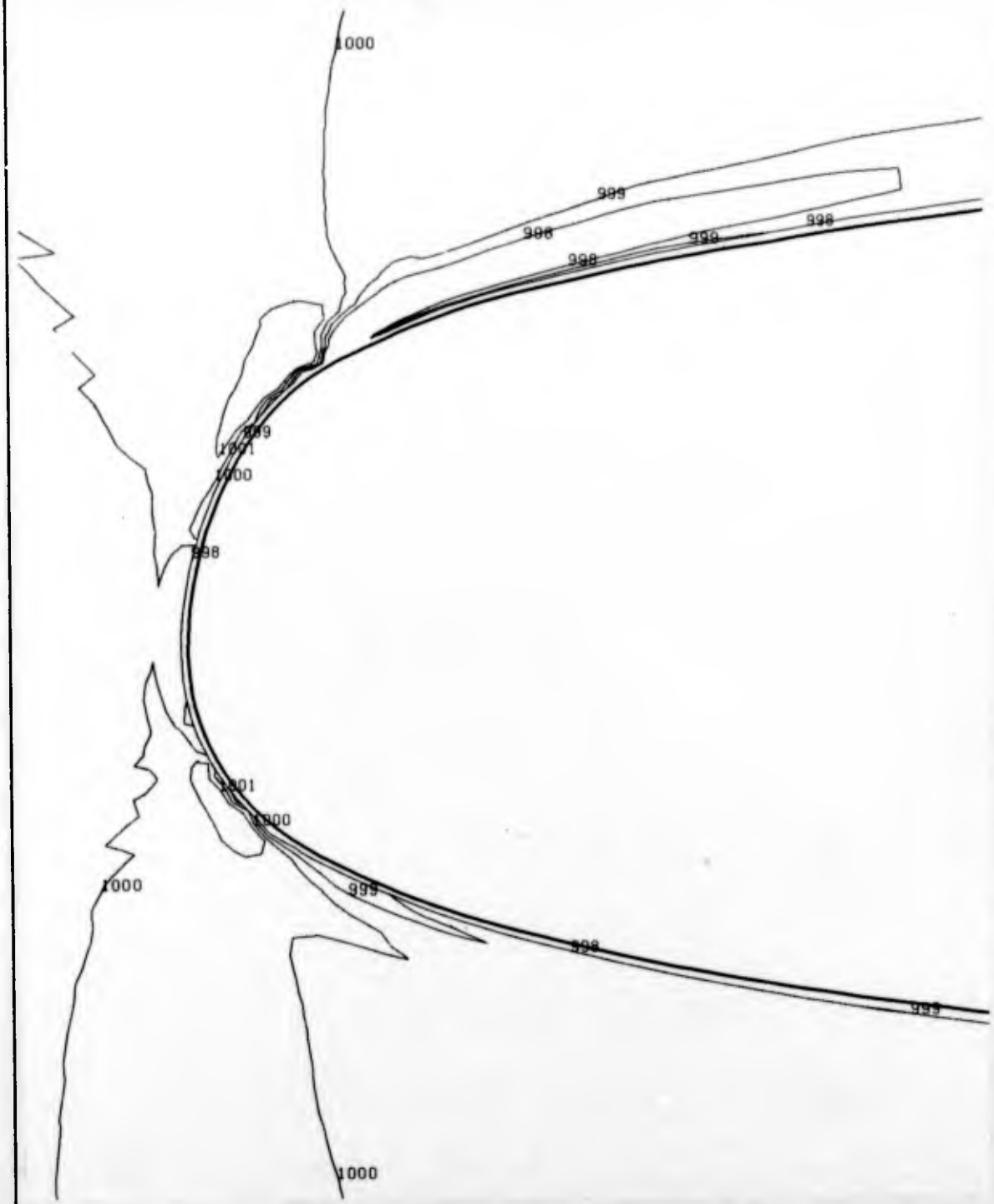


FIG. : ISO-PI/PIINF (DELTA = 0.0010)

*** VALUES OF CURVE PARAMETER = 1000*PI/PIINF ***

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 08

CHIOCCHIA-NOCILLA profile:

MACH = 0.769041, ALPHA = 0

Contributor No 7

A.Eberle

(M.B.B.,F.R.G.)

The scheme for solving the four equations for (ρ, ρu, ρw, e) is an eigenvalue-matrix-flux difference-split finite volume method which employs the cell center rule rather than the cell interface rule, since the latter seems to work only with a constant global time step.

The code used for the test cases works as follows:

The first predictor is classic first order:
The flux difference pieces aligned with the three eigenvalues are either backward or forward differenced depending on the sign of the characteristic slopes.

At the second predictor stage a second first order solution is computed with all flux difference directions reversed.

The corrector forms the arithmetic mean of both solutions. Thus second order accuracy and perfect conservation is obtained. To reduce wiggles a fourth step is added which adds (subtracts) and subtracts (adds) the eigenvalue split flux differences multiplied by a factor proportional to the second difference of the Mach number square depending on the sign of the characteristics to any pair of two adjacent cells. The effect is viscosity like and conservation is automatically guaranteed.

Boundary conditions

A characteristic post correction procedure is used at all far field boundaries, i.e.: first all quantities are computed using the interior point algorithm, then simple formulas relating the tangential and normal momentum as well as the specific energy to the density variation are used to adapt the flow quantities to the prescribed boundary conditions:

$M_\infty < 1$: inflow: $H = H_\infty$, $e = e_\infty$, $\alpha = \alpha_\infty$

outflow: $p = p_\infty$

$M_\infty > 1$: inflow: everything given

outflow: one sided differences

...

Convergence

Initial guess: parallel flow.
Each sample calculation was accompanied by quite a large number of interruptions since they had to be performed on a cockpit simulation computer which was not adapted for numerical problems. So I cannot give convergence plots. I stopped time stepping when the largest absolute residual of the solution vector (summed) was less than 0.0001.

Mesh:

C-type: ca. 150 x 25

In all cases 120 points along airfoil surface.

The exact number of grid points can be read from the print out.

Results:

	$\alpha°$	M
NACA0012	1.25	0.8
	1.0	0.85
	0	0.95
	0	1.2
	7.0	1.2
RAE2822	3.0	0.75
CHIOGGIA	0	0.769

M.B.B.	AR 211		A.Eberle	08-7-3
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

CHIOGGIA (E-SPLITTING)

M=0.769 AL=0.000 LU= 15 LO= 145 K= 24 N= 158

X,Z,1-P/PIINF,M,1-PI/PIINF,TI/TIINF-1,CP ALONG AIRFOIL

X	Z	1-P/PIINF	M	1-PI/PIINF	TI/TIINF-1	CP
0.9997	0.0000	0.2388	0.6286	0.0067	-0.0013	0.3035
0.9985	-0.0001	0.2420	0.6321	0.0080	-0.0016	0.2921
0.9962	-0.0002	0.2435	0.6353	0.0073	-0.0014	0.2869
0.9927	-0.0003	0.2469	0.6401	0.0079	-0.0016	0.2745
0.9881	-0.0005	0.2468	0.6406	0.0073	-0.0014	0.2750
0.9823	-0.0007	0.2444	0.6381	0.0061	-0.0010	0.2838
0.9754	-0.0011	0.2467	0.6393	0.0082	-0.0016	0.2755
0.9674	-0.0015	0.2479	0.6430	0.0069	-0.0012	0.2710
0.9583	-0.0022	0.2498	0.6452	0.0075	-0.0014	0.2643
0.9481	-0.0030	0.2523	0.6496	0.0071	-0.0013	0.2555
0.9369	-0.0039	0.2551	0.6541	0.0072	-0.0013	0.2452
0.9246	-0.0050	0.2584	0.6594	0.0071	-0.0013	0.2335
0.9114	-0.0064	0.2621	0.6653	0.0070	-0.0013	0.2204
0.8972	-0.0079	0.2662	0.6719	0.0069	-0.0012	0.2057
0.8820	-0.0096	0.2709	0.6794	0.0069	-0.0012	0.1889
0.8660	-0.0115	0.2761	0.6877	0.0068	-0.0012	0.1703
0.8492	-0.0136	0.2818	0.6967	0.0067	-0.0012	0.1500
0.8315	-0.0160	0.2882	0.7068	0.0067	-0.0012	0.1270
0.8130	-0.0185	0.2959	0.7183	0.0070	-0.0013	0.0997
0.7938	-0.0212	0.3040	0.7307	0.0073	-0.0013	0.0707
0.7739	-0.0241	0.3128	0.7445	0.0072	-0.0013	0.0392
0.7534	-0.0272	0.3221	0.7593	0.0068	-0.0012	0.0061
0.7323	-0.0304	0.3337	0.7772	0.0068	-0.0012	-0.0353
0.7106	-0.0337	0.3459	0.7964	0.0065	-0.0011	-0.0790
0.6885	-0.0372	0.3620	0.8212	0.0065	-0.0011	-0.1363
0.6659	-0.0407	0.3774	0.8452	0.0064	-0.0011	-0.1917
0.6429	-0.0442	0.4446	0.9440	0.0139	-0.0030	-0.4315
0.6196	-0.0474	0.5068	1.0533	0.0055	-0.0012	-0.6539
0.5960	-0.0496	0.4897	1.0258	0.0041	-0.0010	-0.5926
0.5722	-0.0513	0.4777	1.0047	0.0058	-0.0010	-0.5497
0.5482	-0.0527	0.4812	1.0104	0.0058	-0.0010	-0.5623
0.5241	-0.0539	0.4900	1.0245	0.0064	-0.0011	-0.5937
0.5000	-0.0547	0.5033	1.0466	0.0063	-0.0011	-0.6412
0.4759	-0.0553	0.5070	1.0528	0.0064	-0.0011	-0.6544
0.4518	-0.0555	0.5070	1.0528	0.0064	-0.0011	-0.6544
0.4278	-0.0555	0.5034	1.0468	0.0065	-0.0011	-0.6418
0.4040	-0.0553	0.4977	1.0370	0.0066	-0.0011	-0.6211
0.3804	-0.0547	0.4914	1.0265	0.0067	-0.0011	-0.5987
0.3571	-0.0539	0.4842	1.0146	0.0067	-0.0011	-0.5731
0.3341	-0.0528	0.4762	1.0014	0.0068	-0.0011	-0.5444
0.3115	-0.0515	0.4676	0.9873	0.0069	-0.0011	-0.5136
0.2894	-0.0500	0.4584	0.9724	0.0070	-0.0011	-0.4809
0.2677	-0.0482	0.4487	0.9567	0.0071	-0.0012	-0.4463
0.2466	-0.0463	0.4385	0.9404	0.0071	-0.0012	-0.4099

M.B.B.	AR 211		A.Eberle	08-7-4
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

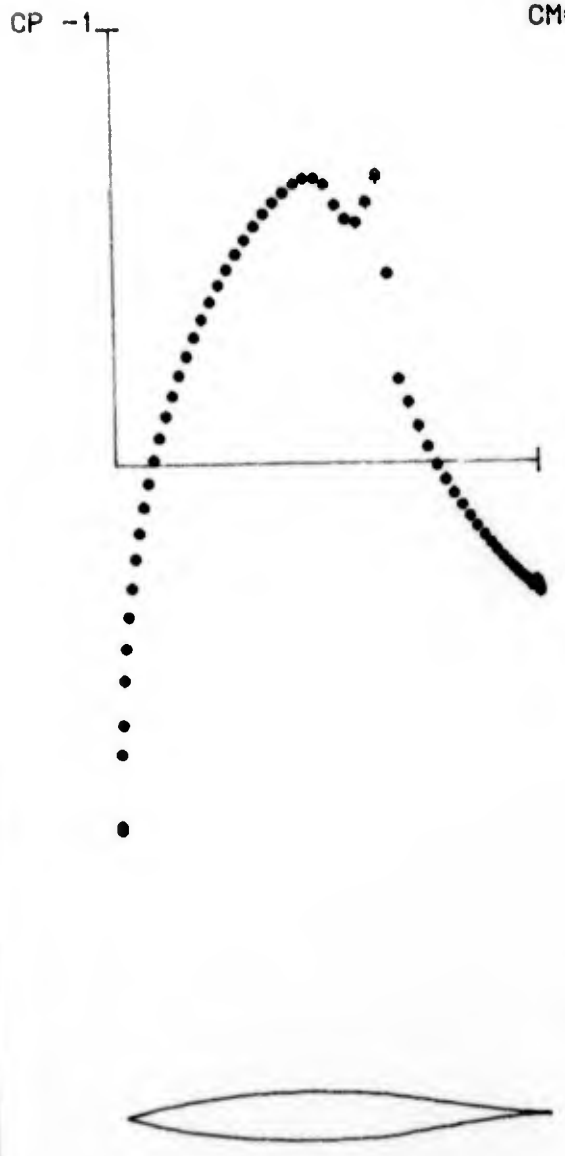
x	z	1-P/PIINF	M	1-PI/PIINF	TI/TIINF-1	CP
0.2261	-0.0441	0.4280	0.9236	0.0072	-0.0012	-0.3723
0.2062	-0.0418	0.4169	0.9060	0.0073	-0.0012	-0.3325
0.1870	-0.0393	0.4055	0.8880	0.0075	-0.0012	-0.2919
0.1685	-0.0367	0.3934	0.8690	0.0076	-0.0013	-0.2487
0.1508	-0.0340	0.3812	0.8499	0.0077	-0.0013	-0.2051
0.1340	-0.0313	0.3682	0.8295	0.0078	-0.0013	-0.1586
0.1180	-0.0284	0.3551	0.8091	0.0080	-0.0014	-0.1118
0.1028	-0.0256	0.3410	0.7872	0.0081	-0.0015	-0.0616
0.0886	-0.0227	0.3270	0.7652	0.0084	-0.0016	-0.0115
0.0754	-0.0199	0.3118	0.7414	0.0086	-0.0016	0.0430
0.0631	-0.0172	0.2967	0.7174	0.0090	-0.0018	0.0969
0.0519	-0.0145	0.2799	0.6907	0.0094	-0.0019	0.1567
0.0417	-0.0120	0.2636	0.6641	0.0102	-0.0022	0.2149
0.0326	-0.0096	0.2448	0.6335	0.0105	-0.0024	0.2822
0.0246	-0.0074	0.2264	0.6025	0.0113	-0.0027	0.3480
0.0177	-0.0055	0.2061	0.5668	0.0127	-0.0032	0.4205
0.0119	-0.0037	0.1875	0.5310	0.0154	-0.0043	0.4870
0.0073	-0.0023	0.1585	0.4778	0.0162	-0.0044	0.5905
0.0038	-0.0012	0.1413	0.4312	0.0243	-0.0079	0.6520
0.0015	-0.0005	0.0968	0.3357	0.0235	-0.0064	0.8110
0.0003	-0.0001	0.1022	0.2073	0.0749	-0.0449	0.7914
0.0003	0.0001	0.1022	0.2075	0.0749	-0.0449	0.7914
0.0015	0.0005	0.0968	0.3357	0.0235	-0.0064	0.8110
0.0038	0.0012	0.1413	0.4311	0.0243	-0.0079	0.6519
0.0073	0.0023	0.1585	0.4778	0.0161	-0.0044	0.5906
0.0119	0.0037	0.1871	0.5312	0.0148	-0.0041	0.4885
0.0177	0.0055	0.2071	0.5668	0.0140	-0.0036	0.4167
0.0246	0.0074	0.2269	0.6023	0.0121	-0.0030	0.3461
0.0326	0.0096	0.2447	0.6335	0.0104	-0.0023	0.2824
0.0417	0.0120	0.2636	0.6641	0.0100	-0.0022	0.2151
0.0519	0.0145	0.2800	0.6907	0.0094	-0.0019	0.1566
0.0631	0.0172	0.2967	0.7174	0.0091	-0.0018	0.0967
0.0754	0.0199	0.3118	0.7413	0.0086	-0.0016	0.0429
0.0886	0.0227	0.3270	0.7652	0.0084	-0.0016	-0.0115
0.1028	0.0256	0.3410	0.7872	0.0081	-0.0014	-0.0615
0.1180	0.0284	0.3550	0.8091	0.0079	-0.0014	-0.1117
0.1340	0.0313	0.3681	0.8295	0.0077	-0.0013	-0.1584
0.1508	0.0340	0.3812	0.8499	0.0076	-0.0013	-0.2049
0.1685	0.0367	0.3934	0.8690	0.0075	-0.0012	-0.2485
0.1870	0.0393	0.4054	0.8879	0.0074	-0.0012	-0.2917
0.2062	0.0418	0.4168	0.9059	0.0073	-0.0012	-0.3324
0.2261	0.0441	0.4280	0.9236	0.0072	-0.0012	-0.3722
0.2466	0.0463	0.4385	0.9404	0.0071	-0.0011	-0.4098
0.2677	0.0482	0.4487	0.9567	0.0071	-0.0011	-0.4462
0.2894	0.0500	0.4584	0.9723	0.0070	-0.0011	-0.4808
0.3115	0.0515	0.4675	0.9872	0.0069	-0.0011	-0.5135
0.3341	0.0528	0.4762	1.0014	0.0068	-0.0011	-0.5443
0.3571	0.0539	0.4842	1.0146	0.0067	-0.0011	-0.5729
0.3804	0.0547	0.4913	1.0265	0.0066	-0.0011	-0.5986
0.4040	0.0553	0.4976	1.0370	0.0066	-0.0011	-0.6210
0.4278	0.0555	0.5034	1.0467	0.0065	-0.0011	-0.6416
0.4518	0.0555	0.5069	1.0527	0.0064	-0.0011	-0.6542

M.B.B.	AR 211		A.Eberle	08-7-5
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

X	Z	1-P/PIINF	M	1-PI/PIINF	TI/TIINF-1	CP
0,4759	0,0553	0,5069	1,0527	0,0064	-0,0011	-0,6542
0,5000	0,0547	0,5032	1,0465	0,0062	-0,0011	-0,6408
0,5241	0,0539	0,4893	1,0234	0,0062	-0,0011	-0,5911
0,5482	0,0527	0,4802	1,0090	0,0057	-0,0010	-0,5589
0,5722	0,0513	0,4783	1,0052	0,0063	-0,0012	-0,5519
0,5960	0,0496	0,4917	1,0283	0,0051	-0,0013	-0,5998
0,6196	0,0474	0,5097	1,0578	0,0060	-0,0014	-0,6643
0,6429	0,0442	0,4449	0,9446	0,0139	-0,0029	-0,4328
0,6659	0,0407	0,3768	0,8443	0,0064	-0,0010	-0,1893
0,6885	0,0372	0,3626	0,8215	0,0072	-0,0012	-0,1388
0,7106	0,0337	0,3473	0,7973	0,0077	-0,0014	-0,0838
0,7323	0,0304	0,3337	0,7768	0,0072	-0,0013	-0,0355
0,7534	0,0272	0,3216	0,7586	0,0067	-0,0011	0,0078
0,7739	0,0241	0,3122	0,7441	0,0067	-0,0011	0,0415
0,7938	0,0212	0,3034	0,7303	0,0067	-0,0011	0,0730
0,8130	0,0185	0,2960	0,7183	0,0072	-0,0013	0,0994
0,8315	0,0160	0,2890	0,7070	0,0075	-0,0014	0,1243
0,8492	0,0136	0,2824	0,6969	0,0074	-0,0013	0,1479
0,8660	0,0115	0,2766	0,6881	0,0070	-0,0012	0,1687
0,8820	0,0096	0,2715	0,6807	0,0066	-0,0011	0,1868
0,8972	0,0079	0,2667	0,6739	0,0060	-0,0010	0,2038
0,9114	0,0064	0,2626	0,6675	0,0059	-0,0010	0,2186
0,9246	0,0050	0,2589	0,6613	0,0061	-0,0011	0,2317
0,9369	0,0039	0,2557	0,6554	0,0069	-0,0013	0,2432
0,9481	0,0030	0,2525	0,6497	0,0074	-0,0015	0,2545
0,9583	0,0022	0,2497	0,6440	0,0083	-0,0017	0,2648
0,9674	0,0015	0,2474	0,6405	0,0082	-0,0017	0,2729
0,9754	0,0011	0,2464	0,6364	0,0102	-0,0022	0,2766
0,9823	0,0007	0,2440	0,6350	0,0082	-0,0016	0,2850
0,9881	0,0005	0,2465	0,6375	0,0094	-0,0020	0,2762
0,9927	0,0003	0,2467	0,6372	0,0100	-0,0021	0,2752
0,9962	0,0002	0,2434	0,6326	0,0094	-0,0020	0,2871
0,9985	0,0001	0,2418	0,6296	0,0097	-0,0021	0,2928
0,9997	0,0000	0,2395	0,6270	0,0088	-0,0018	0,3011

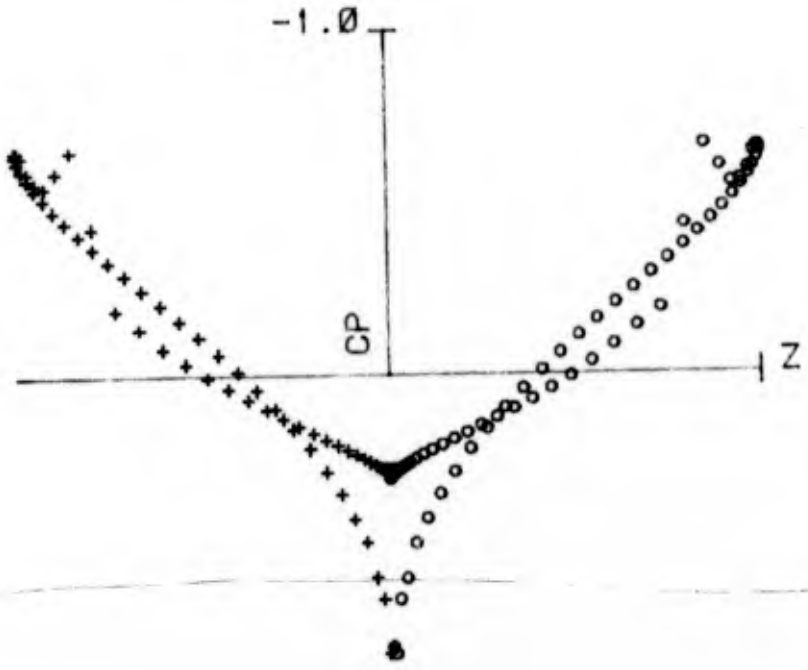
M.B.B.	AR 211		A.Eberle	08-7-6
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

MA= 0.769
AL= 0.000E+00 DEGREE
CL= 0.5224E-03
CD= 0.2984E-02
CM=-0.3810E-03



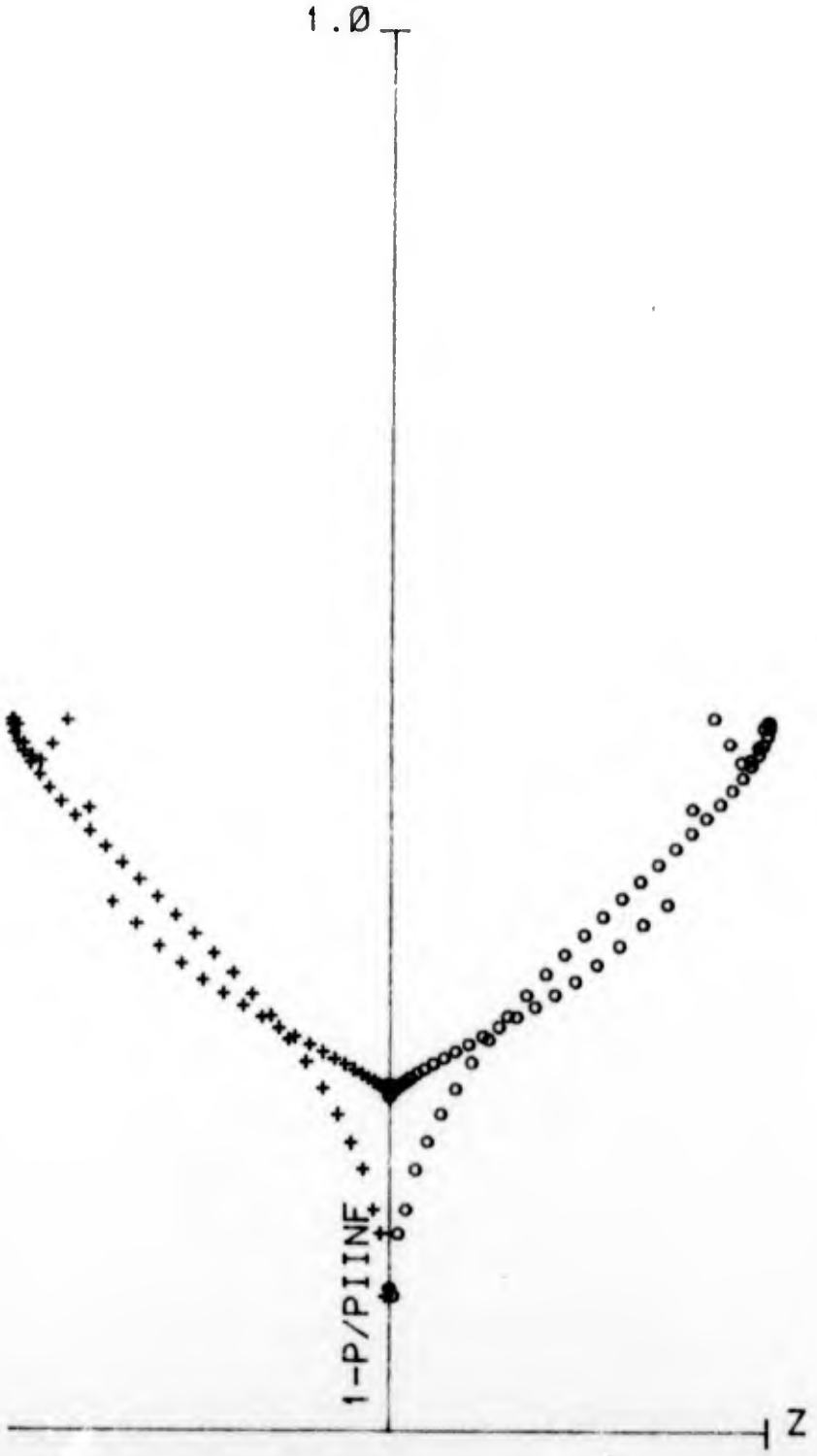
CHIOGGIA (E-SPLITTING)

M.B.B.	AR 211		A.Eberle	08-7-7
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

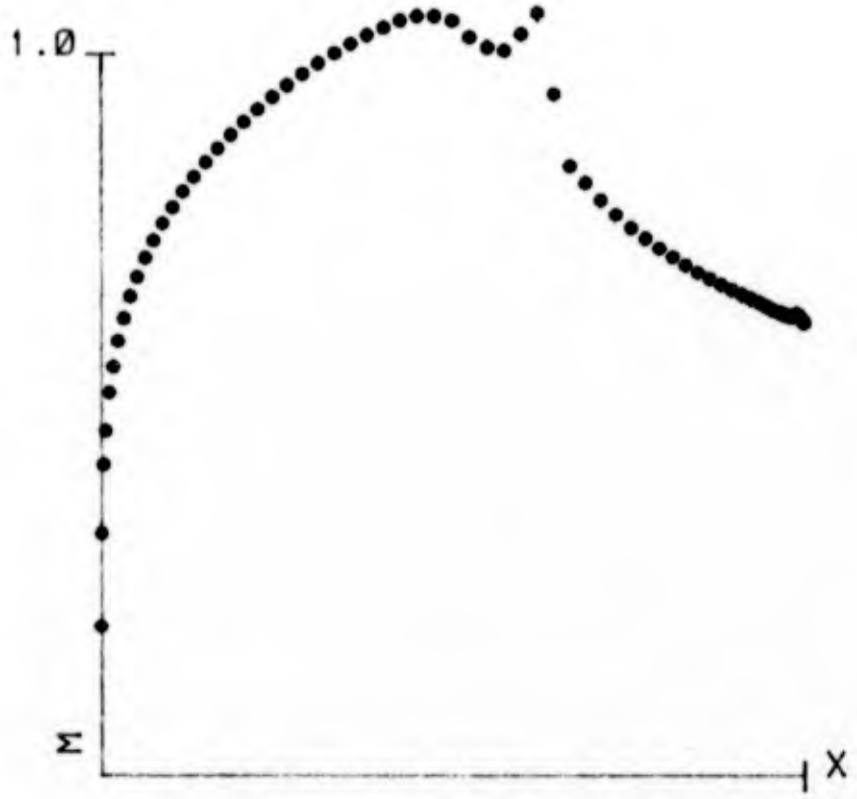


M.B.B.	AR 211		A.Eberle	08-7-8
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

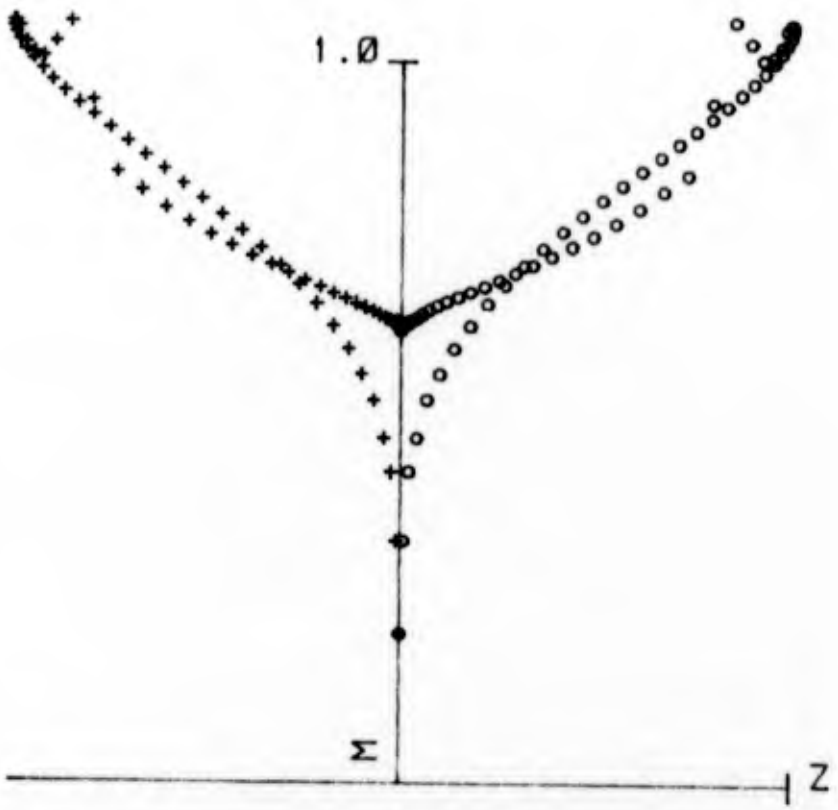
M.B.B.	AR 211		A.Eberle	08-7-9
	CHIOCCHIA-NOCILLA PROFILE: MACH = [illegible].769041, ALPHA = 0			



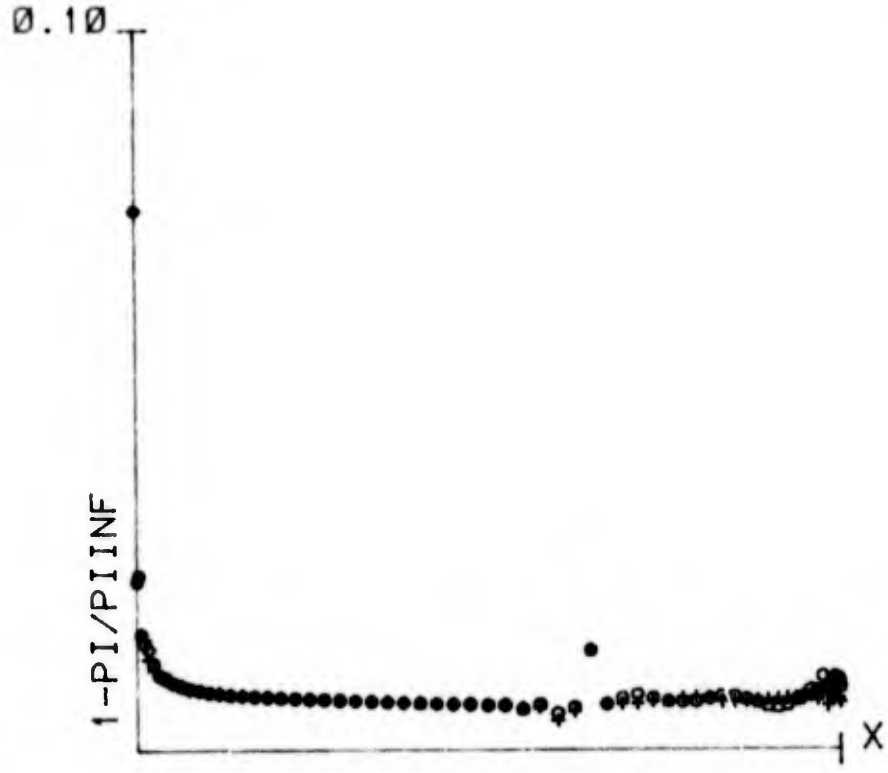
M.B.B.	AR 211		A.Eberle	08-7-10
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



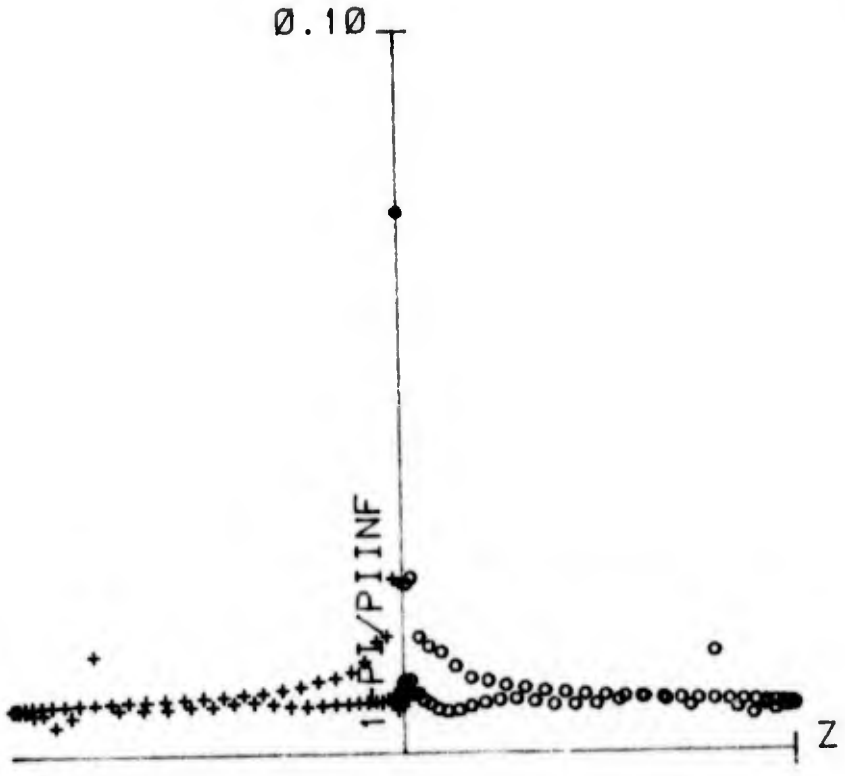
M.B.B.	AR 211		A.Eberle	08-7-11
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



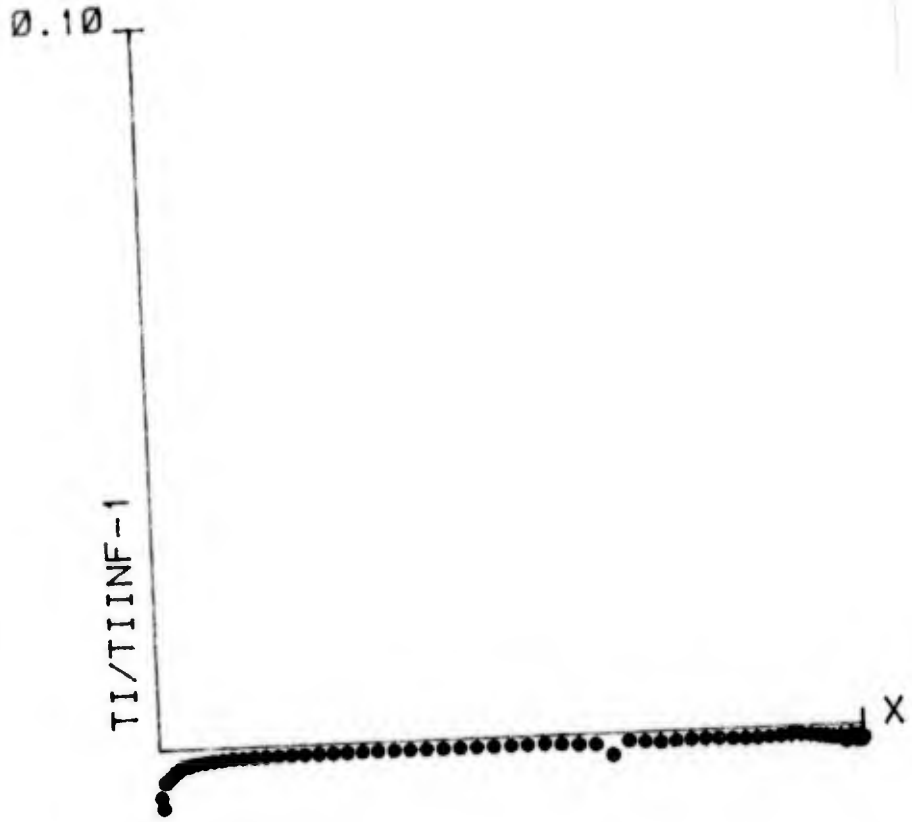
M.B.B.	AR 211		A.Eberle	08-7-12
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



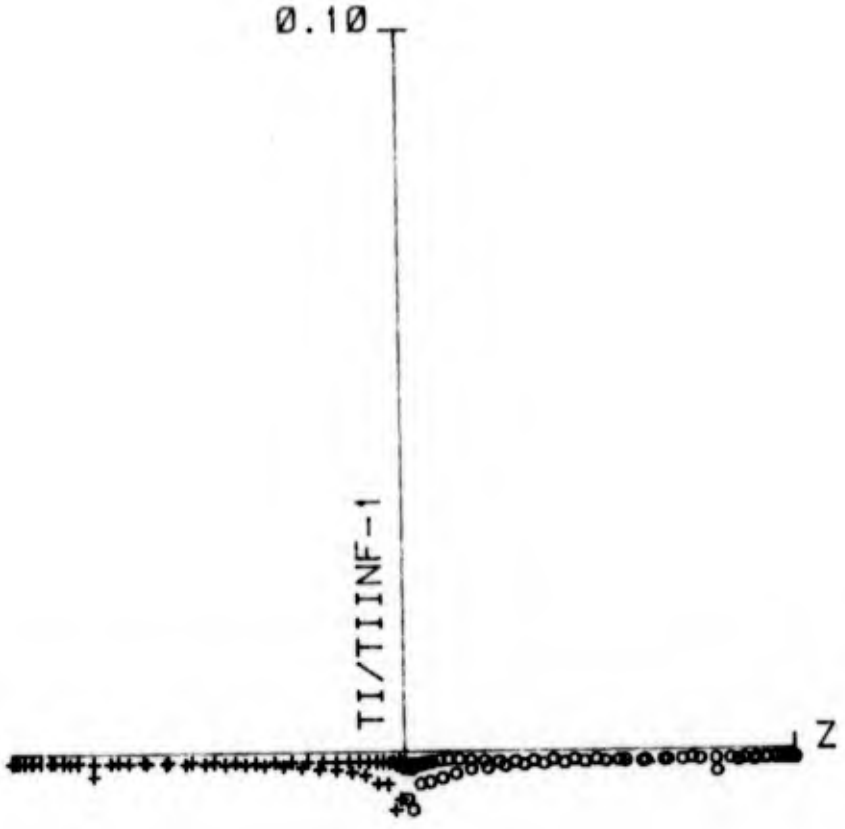
M.B.B.	AR 211		A.Eberle	08-7-13
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



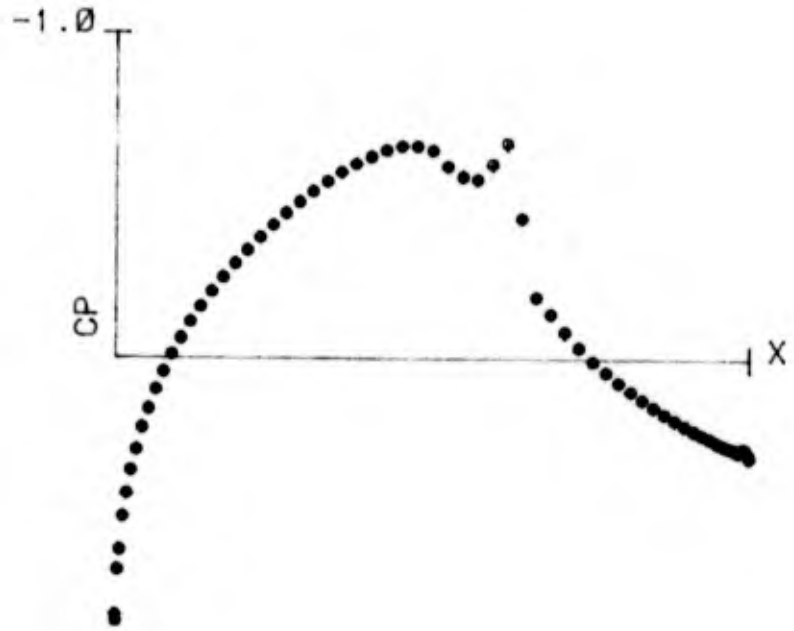
M.B.B.	AR 211		A.Eberle	08-7-14
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



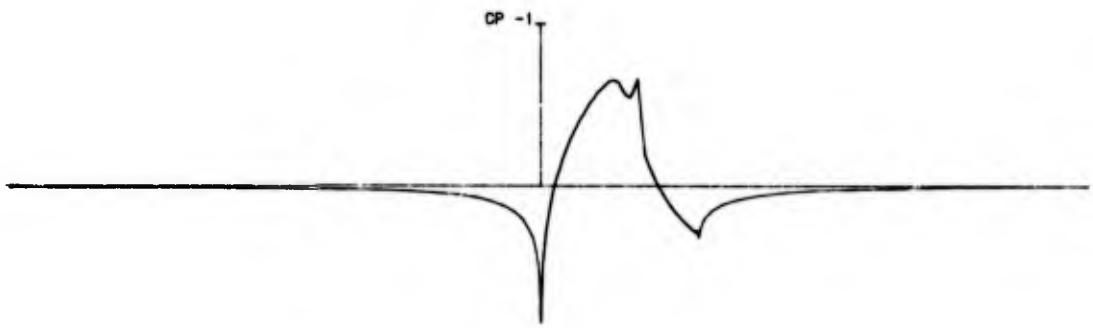
M.B.B.	AR 211		A.Eberle	08-7-15
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



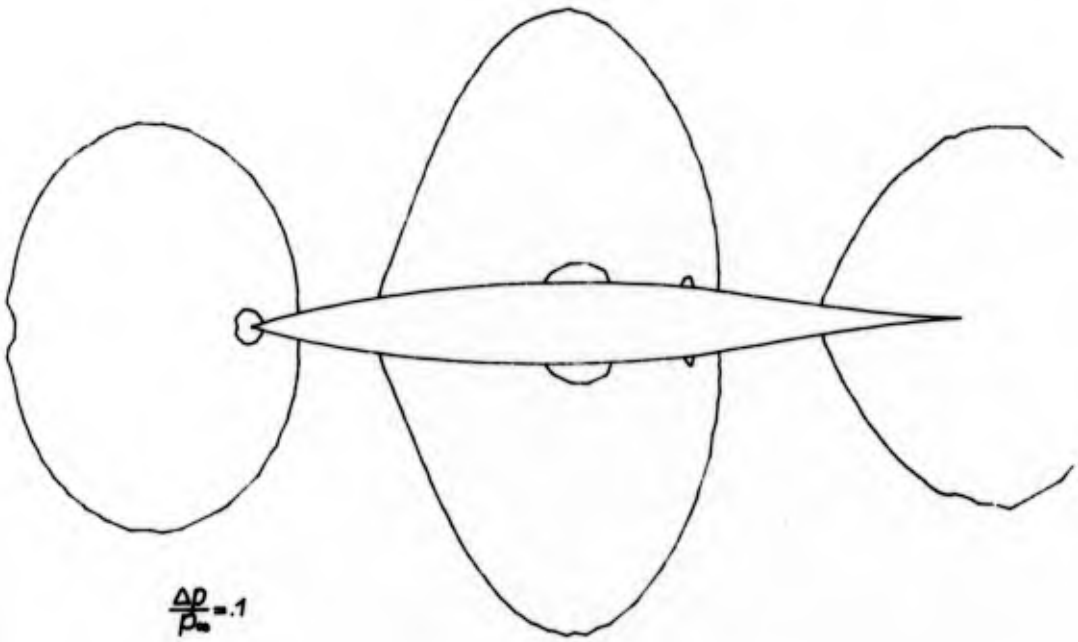
M.B.B.	AR 211		A.Eberle	08-7-16
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



M.B.B.	AR 211		A.Eberle	08-7-17
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

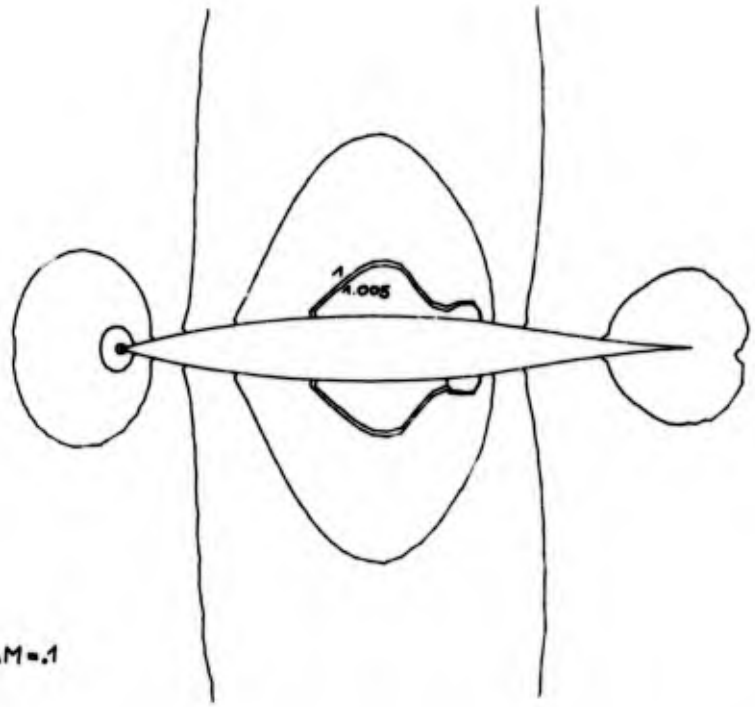


M.B.B.	AR 211		A.Eberle	08-7-18
	CHIOCCHIA-NOC LA PROFILE: MACH = 0.769041, ALPHA = 0			



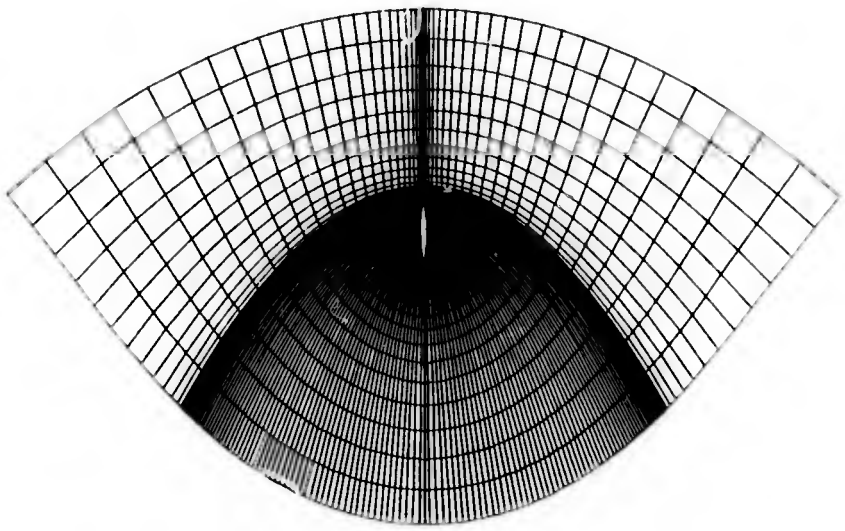
$\frac{\Delta\rho}{\rho_\infty} = .1$

M.B.B.	AR 211		A.Eberle	08-7-19
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

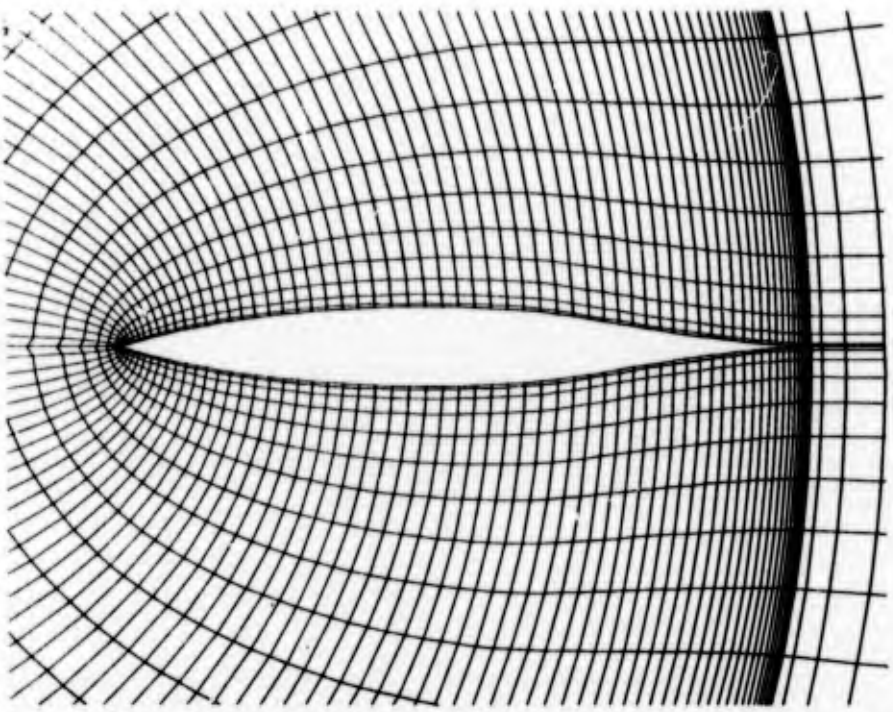


ΔM=.1

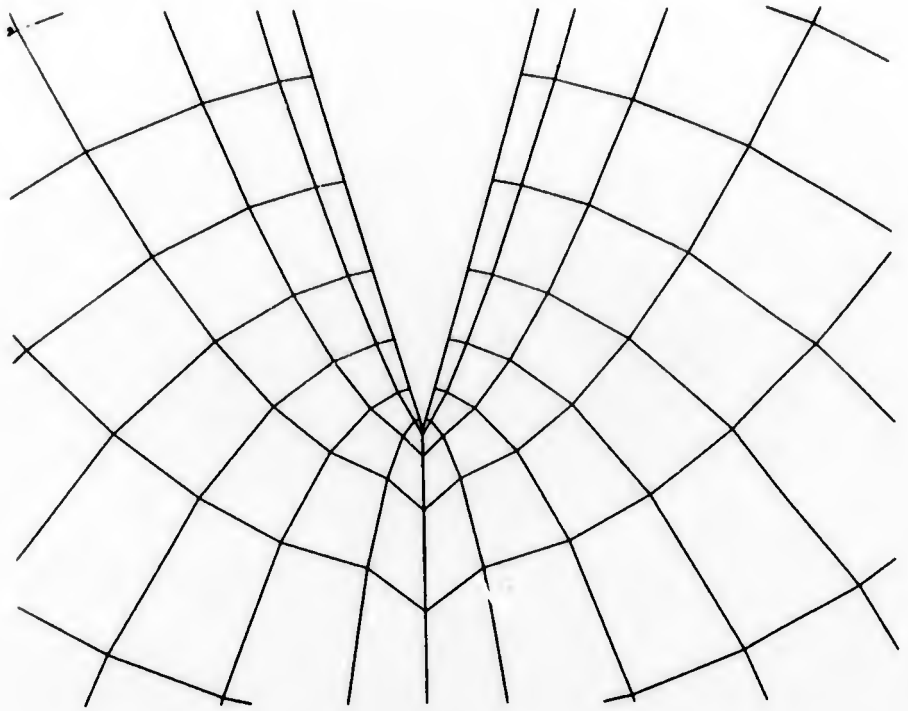
M.B.B.	AR 211		A.Eberle	08-7-20
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



M.B.B.	AR 211		A.Eberle	08-7-21
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



M.B.B.	AR 211		A.Eberle	08-7-22
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 08

CHIOCCHIA-NOCILLA profile:

MACH = 0.769041, ALPHA = 0

Contributor No 9

W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

SOLUTION N° 9.1

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-1
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

	X/C(%)	Z/C(%)	1-P/PIINF	CP	MACH	1-PI/PIIN
2	0.999925	-0.000000	0.228831	0.339222	0.615491	0.004224
3	0.999624	-0.000003	0.229527	0.336736	0.616516	0.004308
4	0.999022	-0.000012	0.230354	0.333780	0.617938	0.004239
5	0.998120	-0.000030	0.231421	0.329968	0.619640	0.004258
6	0.996918	-0.000061	0.232669	0.325510	0.621663	0.004250
7	0.995418	-0.000107	0.234058	0.320550	0.623911	0.004243
8	0.993622	-0.000171	0.235547	0.315230	0.626321	0.004233
9	0.991530	-0.000254	0.237093	0.309705	0.628820	0.004221
10	0.989145	-0.000358	0.238654	0.304130	0.631338	0.004212
11	0.986469	-0.000483	0.240186	0.298656	0.633800	0.004210
12	0.983505	-0.000631	0.241603	0.293595	0.636074	0.004204
13	0.980254	-0.000800	0.242667	0.289794	0.637833	0.004158
14	0.976721	-0.000993	0.243319	0.287464	0.638911	0.004127
15	0.972908	-0.001210	0.243729	0.285999	0.639576	0.004120
16	0.968818	-0.001456	0.244043	0.284877	0.640109	0.004094
17	0.964456	-0.001735	0.244456	0.283400	0.640788	0.004080
18	0.959826	-0.002052	0.245263	0.280518	0.642037	0.004111
19	0.954931	-0.002409	0.246464	0.276229	0.643966	0.004098
20	0.949777	-0.002808	0.247934	0.270976	0.646318	0.004091
21	0.944366	-0.003250	0.249518	0.265318	0.648862	0.004071
22	0.938706	-0.003733	0.251096	0.259680	0.651400	0.004047
23	0.932799	-0.004259	0.252705	0.253932	0.653963	0.004038
24	0.926652	-0.004830	0.254406	0.247857	0.656672	0.004030
25	0.920269	-0.005447	0.256253	0.241259	0.659600	0.004024
26	0.913657	-0.006109	0.258227	0.234205	0.662736	0.004016
27	0.906820	-0.006819	0.260299	0.226805	0.666022	0.004003
28	0.899765	-0.007575	0.262457	0.219096	0.669437	0.003995
29	0.892498	-0.008379	0.264713	0.211035	0.672999	0.003987
30	0.885023	-0.009230	0.267082	0.202573	0.676736	0.003978
31	0.877349	-0.010129	0.269583	0.193639	0.680672	0.003970
32	0.869480	-0.011075	0.272235	0.184163	0.684833	0.003971
33	0.861423	-0.012069	0.275003	0.174273	0.689185	0.003958
34	0.853185	-0.013108	0.277856	0.164081	0.693666	0.003944
35	0.844771	-0.014193	0.280856	0.153363	0.698345	0.003947
36	0.836189	-0.015323	0.284051	0.141952	0.703326	0.003948
37	0.827446	-0.016497	0.287381	0.130055	0.708532	0.003933
38	0.818547	-0.017713	0.290834	0.117719	0.713906	0.003933
39	0.809499	-0.018971	0.294446	0.104815	0.719519	0.003932
40	0.800310	-0.020269	0.298241	0.091259	0.725412	0.003927
41	0.790985	-0.021606	0.302240	0.076971	0.731611	0.003927
42	0.781532	-0.022980	0.306470	0.061860	0.738157	0.003928
43	0.771958	-0.024390	0.310921	0.045959	0.745042	0.003926
44	0.762268	-0.025832	0.315558	0.029395	0.752222	0.003913
45	0.752470	-0.027305	0.320479	0.011814	0.759798	0.003931
46	0.742571	-0.028807	0.325732	-0.006951	0.767898	0.003933
47	0.732577	-0.030336	0.331234	-0.026609	0.776408	0.003909
48	0.722495	-0.031888	0.337175	-0.047831	0.785497	0.003975
49	0.712331	-0.033461	0.343339	-0.069853	0.795089	0.003886
50	0.702092	-0.035053	0.350057	-0.093853	0.805414	0.003914
51	0.691784	-0.036659	0.358016	-0.122283	0.817465	0.004138
52	0.681414	-0.038278	0.366858	-0.153873	0.830859	0.004421
53	0.670988	-0.039905	0.372955	-0.175654	0.840583	0.004094
54	0.660513	-0.041535	0.379858	-0.200315	0.851779	0.003566
55	0.649994	-0.043165	0.412550	-0.317103	0.898346	0.008224
56	0.639439	-0.044789	0.464362	-0.502199	0.974874	0.015125
57	0.628851	-0.046399	0.520522	-0.702830	1.075275	0.006949
58	0.618233	-0.047733	0.510589	-0.667344	1.071877	-0.009423
59	0.607589	-0.048721	0.493308	-0.605607	1.033801	0.001854
60	0.596932	-0.049592	0.483512	-0.570613	1.019233	-0.000001
61	0.586270	-0.050397	0.475535	-0.542114	1.006419	-0.000254
62	0.575608	-0.051138	0.469045	-0.518929	0.995839	-0.000198
63	0.564952	-0.051817	0.465575	-0.506532	0.990386	-0.000378
64	0.554309	-0.052437	0.469309	-0.519873	0.995881	0.000252
65	0.543685	-0.052998	0.483759	-0.571495	1.018710	0.001096
66	0.533084	-0.053502	0.505143	-0.647886	1.054121	0.001105
67	0.522512	-0.053950	0.523436	-0.713239	1.085682	0.000307
68	0.511976	-0.054341	0.532042	-0.743981	1.101026	-0.000424
69	0.501479	-0.054678	0.532842	-0.746840	1.102460	-0.000493
70	0.491027	-0.054961	0.530565	-0.738707	1.098384	-0.000300
71	0.480625	-0.055190	0.527892	-0.729156	1.093643	-0.000113
72	0.470278	-0.055367	0.525532	-0.720726	1.089567	-0.000068
73	0.459990	-0.055493	0.523441	-0.713256	1.085992	-0.000064
74	0.449765	-0.055567	0.521331	-0.705720	1.082413	-0.000081
75	0.439609	-0.055591	0.519018	-0.697453	1.078439	-0.000092
76	0.429525	-0.055566	0.516463	-0.688327	1.074162	-0.000097
77	0.419517	-0.055492	0.513714	-0.678507	1.069514	-0.000093
78	0.409590	-0.055371	0.510833	-0.668214	1.064665	-0.000087
79	0.399746	-0.055205	0.507858	-0.657588	1.059654	-0.000084
80	0.389990	-0.054993	0.504796	-0.646647	1.054525	-0.000084

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-2
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

81	0.300324	-0.054737	0.501635	-0.635354	1.049248	-0.000082
82	0.378753	-0.054439	0.498371	-0.623696	1.043818	-0.000083
83	0.361279	-0.054098	0.495011	-0.611692	1.038243	-0.000083
84	0.351905	-0.053718	0.491563	-0.599374	1.032542	-0.000082
85	0.342635	-0.053298	0.488036	-0.586775	1.026731	-0.000082
86	0.333470	-0.052839	0.484443	-0.573939	1.020827	-0.000081
87	0.324413	-0.052344	0.480796	-0.560908	1.014853	-0.000080
88	0.315467	-0.051814	0.477102	-0.547713	1.008823	-0.000079
89	0.306634	-0.051249	0.473364	-0.534359	1.002741	-0.000079
90	0.297916	-0.050652	0.469575	-0.520821	0.996594	-0.000077
91	0.289315	-0.050023	0.465726	-0.507072	0.990271	-0.000075
92	0.280832	-0.049364	0.461815	-0.493101	0.984065	-0.000078
93	0.272471	-0.048676	0.457849	-0.478931	0.977690	-0.000079
94	0.264231	-0.047960	0.453840	-0.464610	0.971263	-0.000076
95	0.256116	-0.047219	0.449801	-0.450181	0.964807	-0.000077
96	0.248125	-0.046453	0.445740	-0.435674	0.958339	-0.000078
97	0.240260	-0.045664	0.441655	-0.421080	0.951840	-0.000076
98	0.232523	-0.044853	0.437537	-0.406369	0.945311	-0.000075
99	0.224914	-0.044022	0.433378	-0.391511	0.938734	-0.000078
100	0.217434	-0.043171	0.429172	-0.376494	0.932098	-0.000077
101	0.210084	-0.042303	0.424919	-0.361294	0.925407	-0.000079
102	0.202865	-0.041418	0.420628	-0.345965	0.918669	-0.000080
103	0.195777	-0.040518	0.416303	-0.330511	0.911892	-0.000078
104	0.188821	-0.039604	0.411948	-0.314952	0.905082	-0.000078
105	0.181997	-0.038678	0.407565	-0.299234	0.898243	-0.000079
106	0.175306	-0.037741	0.403153	-0.283536	0.891374	-0.000081
107	0.168747	-0.036794	0.398713	-0.267672	0.884471	-0.000080
108	0.162321	-0.035839	0.394242	-0.251701	0.877535	-0.000082
109	0.156028	-0.034876	0.389741	-0.235619	0.870560	-0.000083
110	0.149868	-0.033908	0.385208	-0.219426	0.863548	-0.000083
111	0.143840	-0.032934	0.380645	-0.203124	0.856499	-0.000085
112	0.137946	-0.031958	0.376052	-0.186715	0.849413	-0.000086
113	0.132183	-0.030978	0.371429	-0.170202	0.842289	-0.000089
114	0.126553	-0.029998	0.366778	-0.153587	0.835129	-0.000089
115	0.121055	-0.029018	0.362099	-0.136869	0.827931	-0.000093
116	0.115689	-0.028039	0.357388	-0.120041	0.820691	-0.000095
117	0.110453	-0.027062	0.352644	-0.103095	0.813405	-0.000096
118	0.105349	-0.026088	0.347865	-0.086022	0.806068	-0.000097
119	0.100374	-0.025119	0.343046	-0.068804	0.798671	-0.000101
120	0.095529	-0.024155	0.338180	-0.051421	0.791207	-0.000105
121	0.090814	-0.023198	0.333273	-0.033892	0.783678	-0.000106
122	0.086226	-0.022248	0.328332	-0.016241	0.776095	-0.000109
123	0.081767	-0.021307	0.323361	0.001518	0.768463	-0.000112
124	0.077434	-0.020375	0.318364	0.019368	0.760791	-0.000113
125	0.073228	-0.019454	0.313359	0.037251	0.753095	-0.000115
126	0.069148	-0.018545	0.308350	0.055144	0.745391	-0.000118
127	0.065193	-0.017648	0.303313	0.073139	0.737637	-0.000121
128	0.061362	-0.016764	0.298223	0.091324	0.729792	-0.000127
129	0.057655	-0.015894	0.293064	0.109754	0.721834	-0.000134
130	0.054071	-0.015038	0.287818	0.128494	0.713723	-0.000137
131	0.050609	-0.014197	0.282438	0.147714	0.705396	-0.000149
132	0.047268	-0.013372	0.276882	0.167562	0.696781	-0.000163
133	0.044048	-0.012564	0.271215	0.187806	0.687957	-0.000163
134	0.040948	-0.011775	0.265502	0.208217	0.679040	-0.000170
135	0.037966	-0.011005	0.259764	0.228643	0.670085	-0.000171
136	0.035103	-0.010257	0.254088	0.248990	0.661139	-0.000180
137	0.032356	-0.009530	0.248473	0.269052	0.652286	-0.000186
138	0.029727	-0.008828	0.243101	0.288241	0.643750	-0.000164
139	0.027213	-0.008148	0.237923	0.306740	0.635525	-0.000175
140	0.024814	-0.007492	0.232719	0.325330	0.627236	-0.000196
141	0.022530	-0.006857	0.227307	0.344666	0.618572	-0.000213
142	0.020361	-0.006243	0.221549	0.365235	0.609326	-0.000246
143	0.018305	-0.005651	0.215387	0.387248	0.599355	-0.000269
144	0.016362	-0.005078	0.208669	0.411249	0.588381	-0.000271
145	0.014533	-0.004527	0.200727	0.439620	0.575488	-0.000420
146	0.012815	-0.004000	0.191827	0.471416	0.560737	-0.000471
147	0.011207	-0.003503	0.183442	0.501372	0.546441	-0.000356
148	0.009709	-0.003040	0.176104	0.527585	0.533920	-0.000355
149	0.008319	-0.002612	0.169503	0.551167	0.522413	-0.000277
150	0.007038	-0.002216	0.161916	0.578272	0.509578	-0.000566
151	0.005865	-0.001852	0.154034	0.606429	0.495463	-0.000475
152	0.004800	-0.001525	0.147142	0.631052	0.482902	-0.000381
153	0.003842	-0.001232	0.140826	0.653614	0.471501	-0.000473
154	0.002991	-0.000971	0.134114	0.677592	0.459069	-0.000493
155	0.002248	-0.000739	0.125698	0.707657	0.443540	-0.000736
156	0.001611	-0.000537	0.114868	0.746347	0.423714	-0.001449
157	0.001082	-0.000366	0.109495	0.765543	0.409236	0.000623
158	0.000662	-0.000222	0.093505	0.822666	0.382351	-0.002658
159	0.000344	-0.000106	0.070165	0.900046	0.328415	-0.001949
160	0.000134	-0.000032	0.049742	0.979008	0.277354	-0.002418

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-3
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

161	0.000027	-0.000004	0.041451	1.000626	0.248059	-0.000749
162	0.000027	0.000004	0.041451	1.000626	0.248059	-0.000749
163	0.000134	0.000032	0.049742	0.979008	0.277354	-0.002418
164	0.000344	0.000106	0.070165	0.906046	0.328415	-0.001949
165	0.000660	0.000222	0.093505	0.822666	0.382351	-0.002698
166	0.001082	0.000366	0.109495	0.765543	0.409296	-0.000623
167	0.001611	0.000537	0.114868	0.746347	0.423714	-0.001449
168	0.002248	0.000739	0.125698	0.707657	0.443540	-0.000736
169	0.002991	0.000974	0.134114	0.677592	0.459069	-0.000493
170	0.003842	0.001232	0.140826	0.653614	0.471501	-0.000473
171	0.004808	0.001525	0.147142	0.631052	0.482902	-0.000381
172	0.005865	0.001852	0.154034	0.606429	0.495463	-0.000475
173	0.007038	0.002216	0.161916	0.578272	0.509578	-0.000566
174	0.008319	0.002612	0.169503	0.551167	0.522413	-0.000277
175	0.009709	0.003040	0.176104	0.527585	0.533920	-0.000355
176	0.011207	0.003503	0.183442	0.501372	0.546441	-0.000356
177	0.012815	0.004000	0.191827	0.471416	0.560737	-0.000471
178	0.014533	0.004527	0.200727	0.439620	0.575488	-0.000420
179	0.016362	0.005078	0.208669	0.411249	0.588381	-0.000271
180	0.018305	0.005651	0.215387	0.387240	0.599355	-0.000269
181	0.020361	0.006243	0.221549	0.365226	0.609326	-0.000246
182	0.022530	0.006857	0.227307	0.344666	0.618572	-0.000213
183	0.024814	0.007492	0.232719	0.325330	0.627236	-0.000196
184	0.027213	0.008148	0.237923	0.306740	0.635525	-0.000175
185	0.029727	0.008828	0.243101	0.288241	0.643750	-0.000164
186	0.032356	0.009530	0.248473	0.269052	0.652286	-0.000186
187	0.035103	0.010257	0.254088	0.248990	0.661139	-0.000180
188	0.037966	0.011005	0.259784	0.228643	0.670085	-0.000171
189	0.040948	0.011775	0.265502	0.208217	0.679040	-0.000170
190	0.044048	0.012564	0.271215	0.187906	0.687957	-0.000163
191	0.047268	0.013372	0.276882	0.167562	0.696781	-0.000163
192	0.050609	0.014197	0.282438	0.147714	0.705396	-0.000149
193	0.054071	0.015038	0.287818	0.128494	0.713723	-0.000137
194	0.057655	0.015894	0.293064	0.109754	0.721834	-0.000134
195	0.061362	0.016764	0.298223	0.091324	0.729792	-0.000127
196	0.065193	0.017648	0.303313	0.073139	0.737637	-0.000121
197	0.069148	0.018545	0.308350	0.055144	0.745391	-0.000118
198	0.073228	0.019454	0.313359	0.037251	0.753095	-0.000115
199	0.077434	0.020375	0.318364	0.019368	0.760791	-0.000113
200	0.081767	0.021307	0.323361	0.001518	0.768463	-0.000112
201	0.086226	0.022248	0.328332	-0.016241	0.776095	-0.000109
202	0.090814	0.023198	0.333273	-0.033892	0.783678	-0.000106
203	0.095529	0.024155	0.338180	-0.051421	0.791207	-0.000105
204	0.100374	0.025119	0.343046	-0.068804	0.798671	-0.000101
205	0.105349	0.026088	0.347865	-0.086022	0.806068	-0.000097
206	0.110453	0.027062	0.352644	-0.103095	0.813405	-0.000096
207	0.115689	0.028039	0.357388	-0.120041	0.820691	-0.000095
208	0.121055	0.029018	0.362099	-0.136869	0.827931	-0.000093
209	0.126553	0.029998	0.366778	-0.153587	0.835129	-0.000089
210	0.132183	0.030978	0.371429	-0.170202	0.842289	-0.000089
211	0.137946	0.031958	0.376052	-0.186715	0.849413	-0.000086
212	0.143840	0.032934	0.380645	-0.203124	0.856499	-0.000085
213	0.149868	0.033908	0.385208	-0.219426	0.863548	-0.000083
214	0.156028	0.034876	0.389741	-0.235619	0.870560	-0.000083
215	0.162321	0.035839	0.394242	-0.251701	0.877535	-0.000082
216	0.168747	0.036794	0.398713	-0.267672	0.884471	-0.000080
217	0.175306	0.037741	0.403153	-0.283535	0.891374	-0.000081
218	0.181997	0.038678	0.407565	-0.299294	0.898243	-0.000079
219	0.188821	0.039604	0.411948	-0.314952	0.905082	-0.000078
220	0.195777	0.040518	0.416303	-0.330511	0.911892	-0.000078
221	0.202865	0.041418	0.420628	-0.345963	0.918669	-0.000080
222	0.210084	0.042303	0.424919	-0.361294	0.925407	-0.000079
223	0.217434	0.043171	0.429172	-0.376484	0.932098	-0.000077
224	0.224914	0.044022	0.433378	-0.391511	0.938734	-0.000078
225	0.232523	0.044853	0.437537	-0.406369	0.945311	-0.000075
226	0.240260	0.045664	0.441655	-0.421080	0.951840	-0.000076
227	0.248125	0.046453	0.445740	-0.435674	0.958333	-0.000075
228	0.256116	0.047219	0.449801	-0.450181	0.964807	-0.000077
229	0.264231	0.047960	0.453840	-0.464610	0.971263	-0.000076
230	0.272471	0.048676	0.457849	-0.478931	0.977690	-0.000079
231	0.280832	0.049364	0.461815	-0.493101	0.984065	-0.000078
232	0.289315	0.050023	0.465726	-0.507072	0.990371	-0.000079
233	0.297916	0.050652	0.469575	-0.520821	0.996594	-0.000077
234	0.306634	0.051249	0.473364	-0.534359	1.002741	-0.000079
235	0.315467	0.051814	0.477102	-0.547713	1.008823	-0.000079
236	0.324413	0.052344	0.480796	-0.560908	1.014853	-0.000080
237	0.333470	0.052839	0.484443	-0.573939	1.020827	-0.000081
238	0.342635	0.053298	0.488036	-0.586775	1.026731	-0.000082
239	0.351905	0.053718	0.491563	-0.599374	1.032542	-0.000082
240	0.361279	0.054098	0.495011	-0.611692	1.038243	-0.000083
241	0.370753	0.054439	0.498371	-0.623696	1.043818	-0.000083
242	0.380324	0.054737	0.501635	-0.635354	1.049248	-0.000082
243	0.389990	0.054993	0.504796	-0.646647	1.054525	-0.000084

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-4
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

244	Ø.399746	Ø.Ø55205	Ø.5Ø7858	-Ø.657588	1.Ø59654	-Ø.ØØØØ84
245	Ø.4Ø9590	Ø.Ø55371	Ø.51Ø833	-Ø.668214	1.Ø64655	-Ø.ØØØØ87
246	Ø.419517	Ø.Ø55492	Ø.513714	-Ø.678507	1.Ø69514	-Ø.ØØØØ93
247	Ø.429525	Ø.Ø55566	Ø.516463	-Ø.688327	1.Ø74162	-Ø.ØØØØ97
248	Ø.439609	Ø.Ø55591	Ø.519Ø18	-Ø.697453	1.Ø78489	-Ø.ØØØØ92
249	Ø.449765	Ø.Ø55567	Ø.521331	-Ø.7Ø5728	1.Ø82413	-Ø.ØØØØ81
25Ø	Ø.459990	Ø.Ø55493	Ø.523441	-Ø.713256	1.Ø85992	-Ø.ØØØØ64
251	Ø.47Ø278	Ø.Ø55367	Ø.525532	-Ø.72Ø726	1.Ø89567	-Ø.ØØØØ68
252	Ø.48Ø625	Ø.Ø55190	Ø.527892	-Ø.729156	1.Ø93643	-Ø.ØØØ113
253	Ø.491Ø27	Ø.Ø54961	Ø.53Ø565	-Ø.738707	1.Ø98384	-Ø.ØØØ3ØØ
254	Ø.5Ø1479	Ø.Ø54678	Ø.532842	-Ø.746840	1.1Ø246Ø	-Ø.ØØØ493
255	Ø.511976	Ø.Ø54341	Ø.532Ø42	-Ø.743981	1.1Ø1Ø26	-Ø.ØØØ424
256	Ø.522512	Ø.Ø53950	Ø.523436	-Ø.713239	1.Ø85682	Ø.ØØØ3Ø7
257	Ø.533Ø84	Ø.Ø53502	Ø.5Ø5143	-Ø.647886	1.Ø54121	Ø.ØØ1Ø5
258	Ø.543685	Ø.Ø52998	Ø.483759	-Ø.571495	1.Ø18710	Ø.ØØ1Ø96
259	Ø.554389	Ø.Ø52437	Ø.469Ø89	-Ø.519873	Ø.995881	Ø.ØØØ252
26Ø	Ø.564952	Ø.Ø51817	Ø.465575	-Ø.5Ø6532	Ø.99Ø386	-Ø.ØØØ378
261	Ø.575608	Ø.Ø51138	Ø.469Ø45	-Ø.518929	Ø.995839	-Ø.ØØØ198
262	Ø.586278	Ø.Ø5Ø397	Ø.475535	-Ø.542114	1.ØØ6419	-Ø.ØØØ254
263	Ø.596932	Ø.Ø49592	Ø.483512	-Ø.57Ø613	1.Ø19233	-Ø.ØØØØØ1
264	Ø.6Ø7589	Ø.Ø48721	Ø.493Ø8	-Ø.6Ø5607	1.Ø338Ø1	Ø.ØØ1854
265	Ø.618233	Ø.Ø47733	Ø.51Ø589	-Ø.667344	1.Ø71877	-Ø.ØØ9423
266	Ø.628851	Ø.Ø46399	Ø.52Ø522	-Ø.7Ø2838	1.Ø75275	Ø.ØØ6949
267	Ø.639439	Ø.Ø44789	Ø.464362	-Ø.5Ø2199	Ø.974874	Ø.Ø15125
268	Ø.649994	Ø.Ø43165	Ø.412550	-Ø.317103	Ø.898346	Ø.ØØ8224
269	Ø.66Ø513	Ø.Ø41535	Ø.379858	-Ø.2ØØ315	Ø.851779	Ø.ØØ3566
27Ø	Ø.67Ø989	Ø.Ø39Ø5	Ø.372955	-Ø.175654	Ø.84Ø583	Ø.ØØ4Ø94
271	Ø.681414	Ø.Ø38278	Ø.366858	-Ø.153873	Ø.83Ø839	Ø.ØØ4421
272	Ø.691784	Ø.Ø36659	Ø.358Ø16	-Ø.122283	Ø.817465	Ø.ØØ4138
273	Ø.7Ø2Ø92	Ø.Ø35Ø53	Ø.35ØØ57	-Ø.Ø93853	Ø.8Ø5414	Ø.ØØ3914
274	Ø.712331	Ø.Ø33461	Ø.343339	-Ø.Ø69853	Ø.795Ø89	Ø.ØØ3886
275	Ø.722495	Ø.Ø31888	Ø.337175	-Ø.Ø47831	Ø.785497	Ø.ØØ3975
276	Ø.732577	Ø.Ø3Ø336	Ø.331234	-Ø.Ø26609	Ø.776Ø8	Ø.ØØ39Ø9
277	Ø.742571	Ø.Ø28Ø7	Ø.325732	-Ø.ØØ6951	Ø.767898	Ø.ØØ3933
278	Ø.752478	Ø.Ø27Ø5	Ø.32Ø479	Ø.Ø11814	Ø.759798	Ø.ØØ3931
279	Ø.762268	Ø.Ø25832	Ø.315558	Ø.Ø29395	Ø.752222	Ø.ØØ3913
28Ø	Ø.771958	Ø.Ø24398	Ø.31Ø921	Ø.Ø45959	Ø.745Ø42	Ø.ØØ3926
281	Ø.781532	Ø.Ø22988	Ø.3Ø6478	Ø.Ø61868	Ø.738157	Ø.ØØ3928
282	Ø.79Ø985	Ø.Ø216Ø6	Ø.3Ø224Ø	Ø.Ø76971	Ø.731611	Ø.ØØ3927
283	Ø.8ØØ31Ø	Ø.Ø2Ø269	Ø.298241	Ø.Ø91259	Ø.725412	Ø.ØØ3927
284	Ø.8Ø9499	Ø.Ø18971	Ø.294446	Ø.1Ø4815	Ø.719519	Ø.ØØ3932
285	Ø.818547	Ø.Ø17713	Ø.29Ø834	Ø.117719	Ø.7139.9	Ø.ØØ3933
286	Ø.827446	Ø.Ø16497	Ø.287381	Ø.13ØØ55	Ø.7Ø8532	Ø.ØØ3933
287	Ø.836189	Ø.Ø15323	Ø.284Ø51	Ø.141952	Ø.7Ø3326	Ø.ØØ3948
288	Ø.844771	Ø.Ø14193	Ø.28Ø856	Ø.153363	Ø.698345	Ø.ØØ3947
289	Ø.853185	Ø.Ø13Ø8	Ø.277856	Ø.164Ø81	Ø.693666	Ø.ØØ3944
29Ø	Ø.861423	Ø.Ø12Ø6S	Ø.275ØØ3	Ø.174273	Ø.689185	Ø.ØØ3958
291	Ø.869480	Ø.Ø11Ø75	Ø.272235	Ø.184163	Ø.684833	Ø.ØØ3971
292	Ø.877349	Ø.Ø1Ø129	Ø.269583	Ø.193639	Ø.68Ø672	Ø.ØØ397Ø
293	Ø.885Ø23	Ø.ØØ923Ø	Ø.267ØØ2	Ø.2Ø2573	Ø.676736	Ø.ØØ3978
294	Ø.892498	Ø.ØØ8379	Ø.264713	Ø.211Ø35	Ø.672999	Ø.ØØ3987
295	Ø.899765	Ø.ØØ7575	Ø.262457	Ø.219Ø96	Ø.669437	Ø.ØØ3995
296	Ø.9Ø6828	Ø.ØØ6819	Ø.26Ø299	Ø.226ØØ5	Ø.666Ø22	Ø.ØØ4ØØ3
297	Ø.913657	Ø.ØØ6109	Ø.258227	Ø.234Ø2Ø5	Ø.662736	Ø.ØØ4Ø16
298	Ø.92Ø269	Ø.ØØ5447	Ø.256253	Ø.241259	Ø.659600	Ø.ØØ4Ø24
299	Ø.926652	Ø.ØØ4838	Ø.254Ø86	Ø.247857	Ø.656672	Ø.ØØ4Ø3Ø
3ØØ	Ø.932799	Ø.ØØ4259	Ø.252705	Ø.253932	Ø.653963	Ø.ØØ4Ø38
3Ø1	Ø.938706	Ø.ØØ3733	Ø.251Ø96	Ø.259688	Ø.651488	Ø.ØØ4Ø47
3Ø2	Ø.944366	Ø.ØØ325Ø	Ø.249518	Ø.265318	Ø.648862	Ø.ØØ4Ø71
3Ø3	Ø.949777	Ø.ØØ2Ø8Ø8	Ø.247934	Ø.27Ø976	Ø.646318	Ø.ØØ4Ø91
3Ø4	Ø.954931	Ø.ØØ2489	Ø.246464	Ø.276229	Ø.643966	Ø.ØØ4Ø98
3Ø5	Ø.959826	Ø.ØØ2Ø52	Ø.245263	Ø.28Ø518	Ø.642Ø37	Ø.ØØ4111
3Ø6	Ø.964456	Ø.ØØ1735	Ø.244456	Ø.283ØØØ	Ø.64Ø788	Ø.ØØ4ØØØ
3Ø7	Ø.968818	Ø.ØØ1456	Ø.244Ø43	Ø.284Ø77	Ø.64Ø1Ø9	Ø.ØØ4Ø94
3Ø8	Ø.972Ø08	Ø.ØØ1218	Ø.243729	Ø.285999	Ø.639576	Ø.ØØ412Ø
3Ø9	Ø.976721	Ø.ØØØ993	Ø.243319	Ø.287464	Ø.638911	Ø.ØØ4127
31Ø	Ø.98Ø254	Ø.ØØØ8ØØ	Ø.242667	Ø.289794	Ø.637Ø33	Ø.ØØ4159
311	Ø.983585	Ø.ØØØ631	Ø.241ØØ3	Ø.293595	Ø.636Ø74	Ø.ØØ42Ø4
312	Ø.986469	Ø.ØØØ483	Ø.24Ø186	Ø.298656	Ø.633ØØØ	Ø.ØØ421Ø
313	Ø.988145	Ø.ØØØ358	Ø.238654	Ø.3Ø413Ø	Ø.631336	Ø.ØØ4212
314	Ø.991538	Ø.ØØØ254	Ø.237Ø93	Ø.3Ø97Ø5	Ø.628Ø2Ø	Ø.ØØ4221
315	Ø.993622	Ø.ØØØ171	Ø.235547	Ø.315232	Ø.626321	Ø.ØØ4233
316	Ø.995418	Ø.ØØØ1Ø7	Ø.234Ø58	Ø.32Ø55Ø	Ø.623911	Ø.ØØ4243
317	Ø.996918	Ø.ØØØØ61	Ø.232669	Ø.325518	Ø.621663	Ø.ØØ4258
318	Ø.998128	Ø.ØØØØ3Ø	Ø.231421	Ø.329968	Ø.619648	Ø.ØØ4258
319	Ø.999Ø22	Ø.ØØØØ12	Ø.23Ø354	Ø.333788	Ø.617938	Ø.ØØ4239
32Ø	Ø.999624	Ø.ØØØØØ3	Ø.229527	Ø.336736	Ø.616516	Ø.ØØ43Ø8
321	Ø.999925	Ø.ØØØØØØ	Ø.228831	Ø.339222	Ø.615491	Ø.ØØ4224

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-5
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

$$C_L = 0.651 \cdot 10^{-13}$$

$$C_D = 0.431 \cdot 10^{-3}$$

$$C_M = -0.215 \cdot 10^{-13}$$

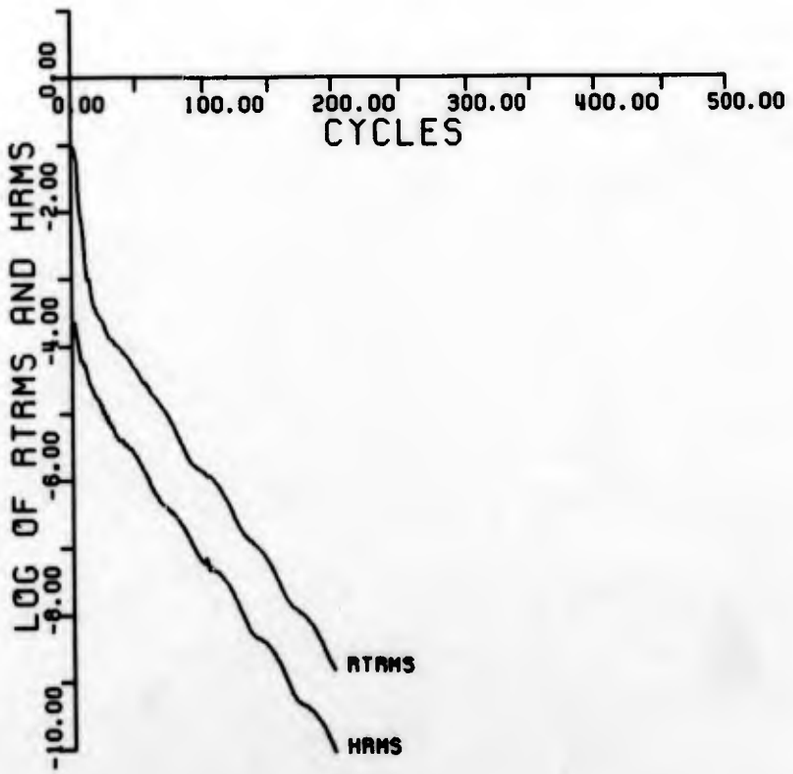


FIG. : CONVERGENCE BEHAVIOUR (DR/DT AND H)

CHIOCCHIA M=0.7690, ALPHA=0.0

GRID SEQUENCE : 40×8->80×16->160×32->320×64

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-6
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

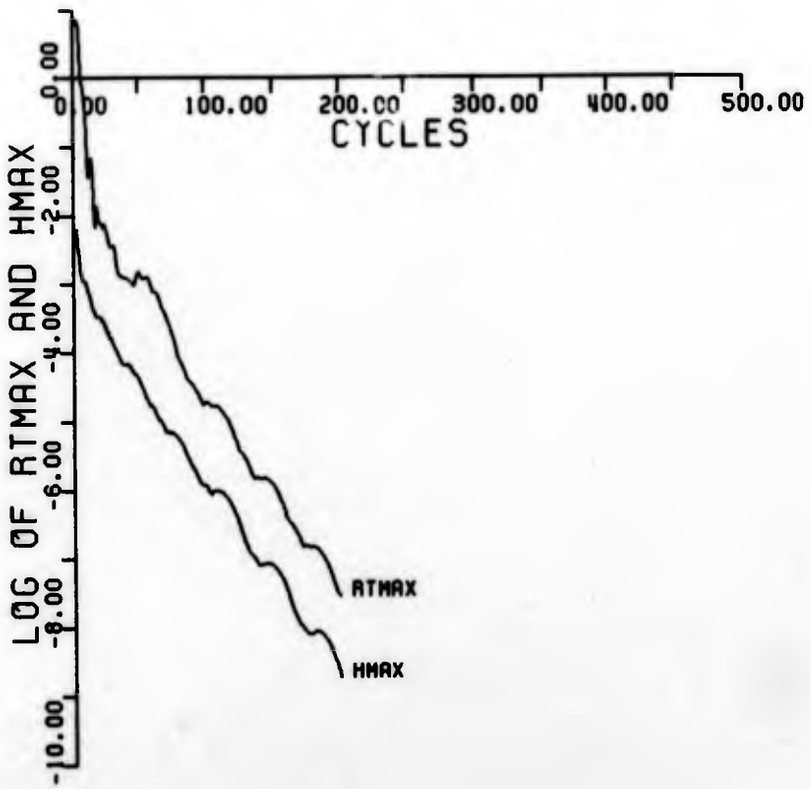


FIG. : CONVERGENCE BEHAVIOUR (DR/DT AND H)

CHIOCCHIA M=0.7690,ALPHA=0.0

GRID SEQUENCE :40×8->80×16->160×32->320×64

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-7
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

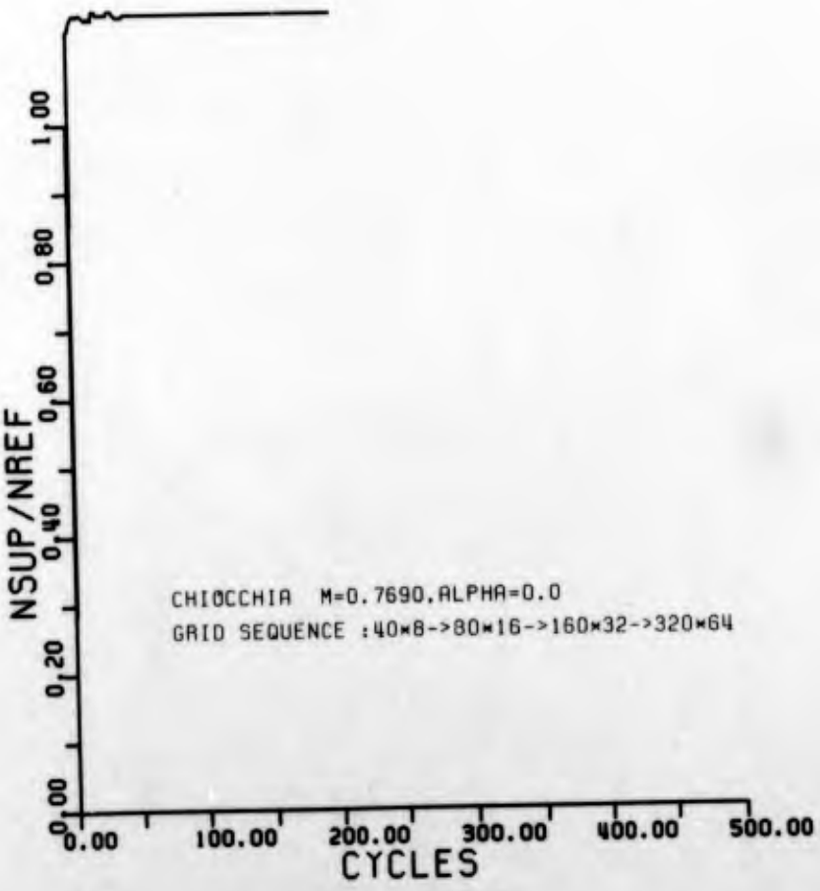


FIG. : CONVERGENCE BEHAVIOUR (NSUP/NREF), NREF=500

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-8
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

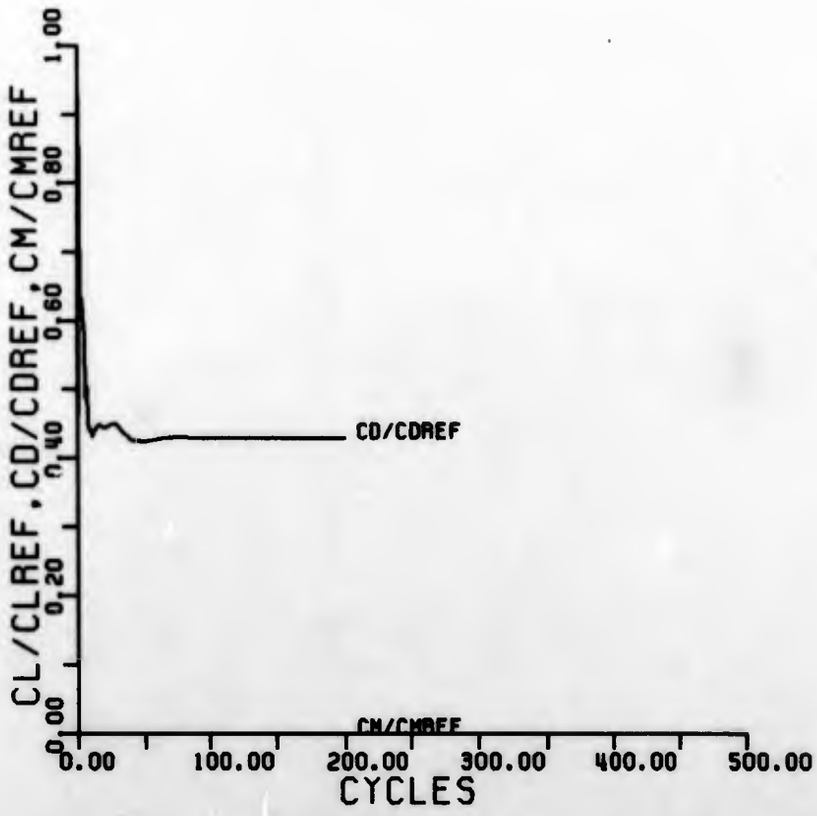


FIG. : CONVERGENCE BEHAVIOUR (CL,CD,CM)/REF

CHIOCCHIA M=0.7690,ALPHA=0.0

REF-VALUES:CLREF=1.0,CDREF=0.001,CMREF=-0.20

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-9
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

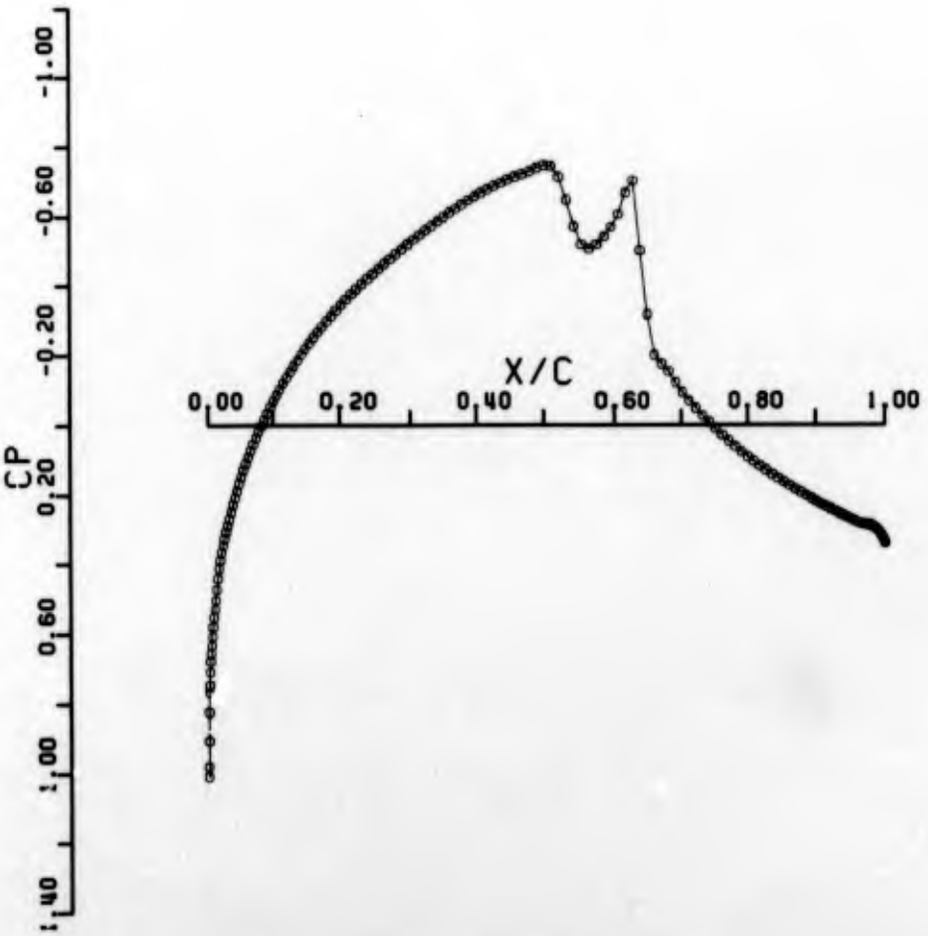


FIG. : CP(X/C) ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-10
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

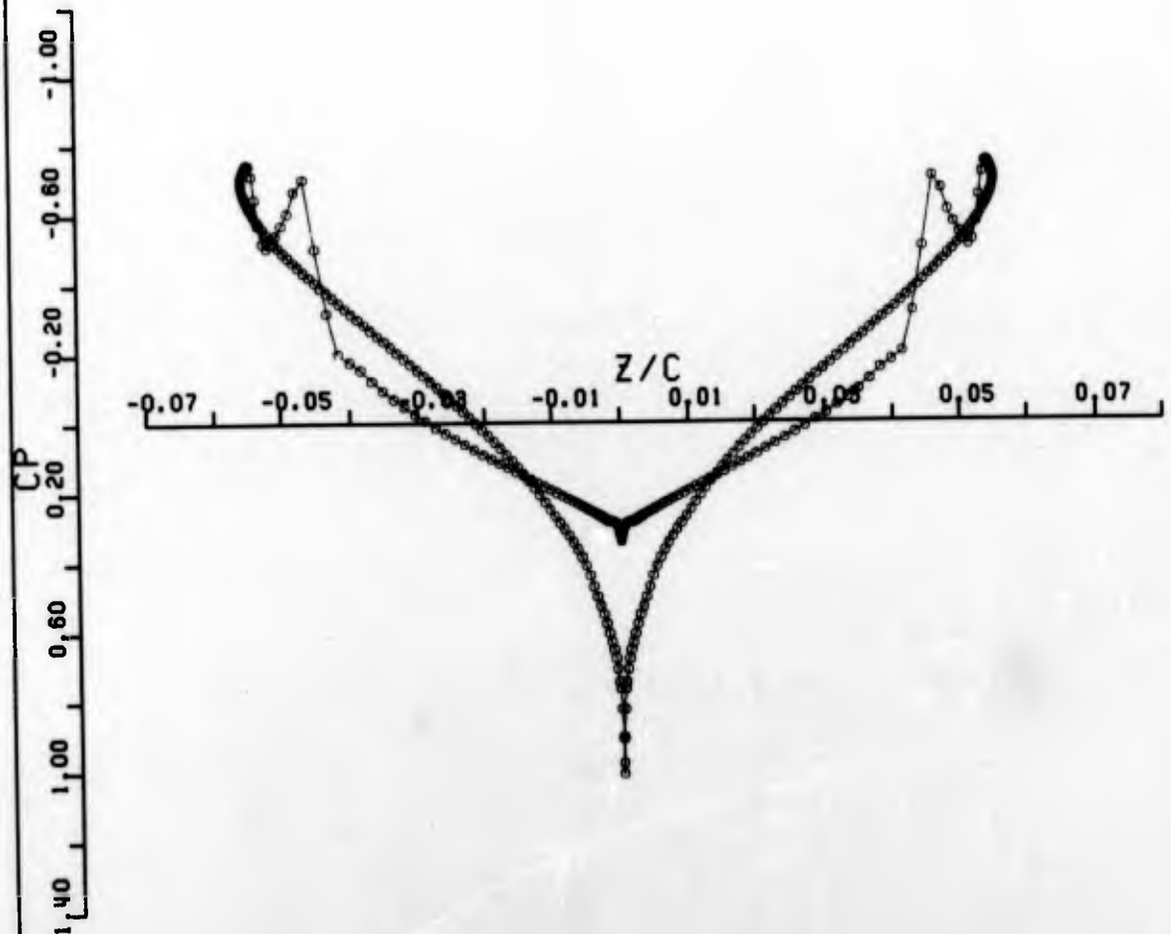


FIG. : CP(Z/C) ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-11
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

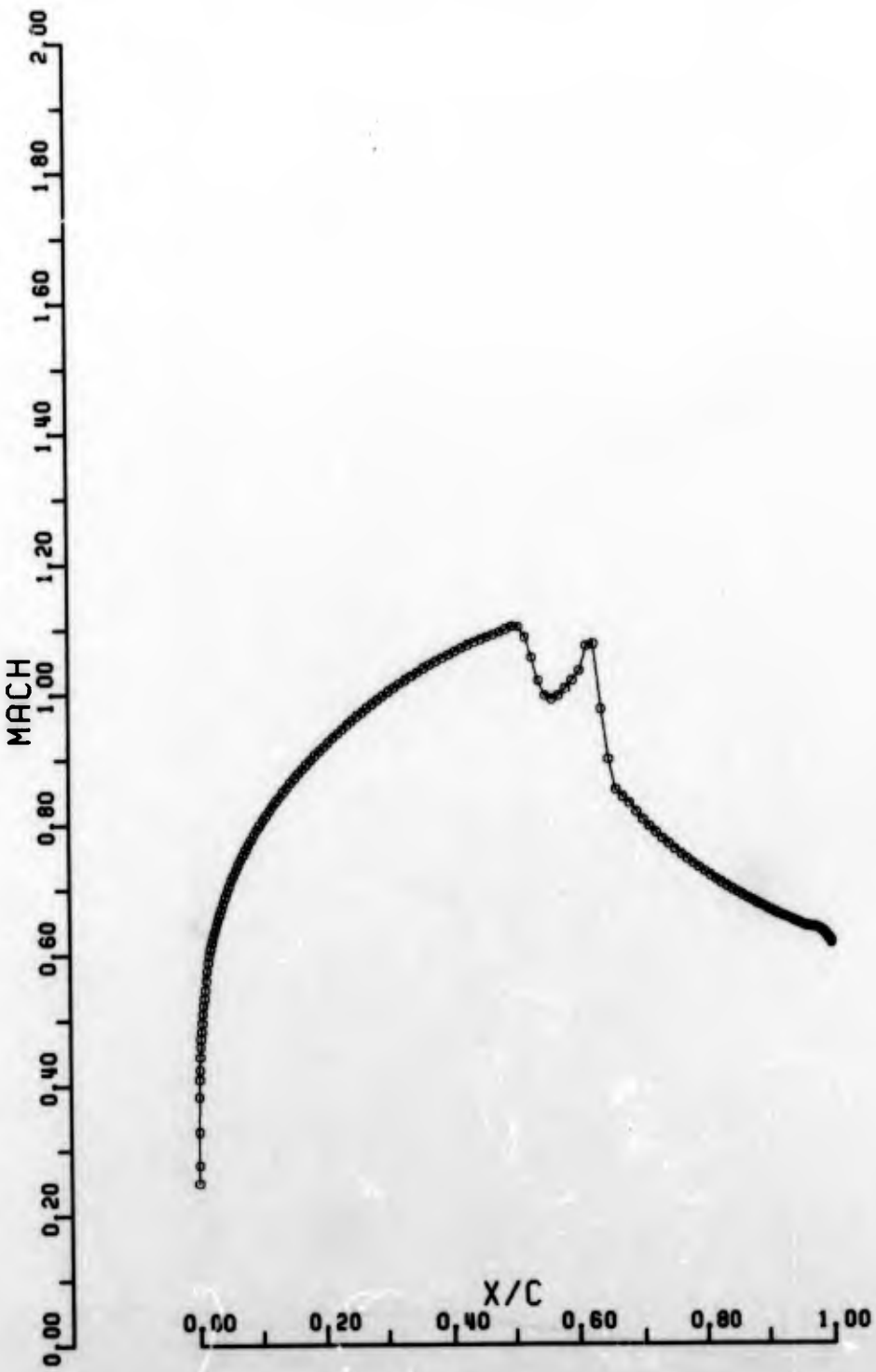


FIG. : MACH(X/C) ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-12
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

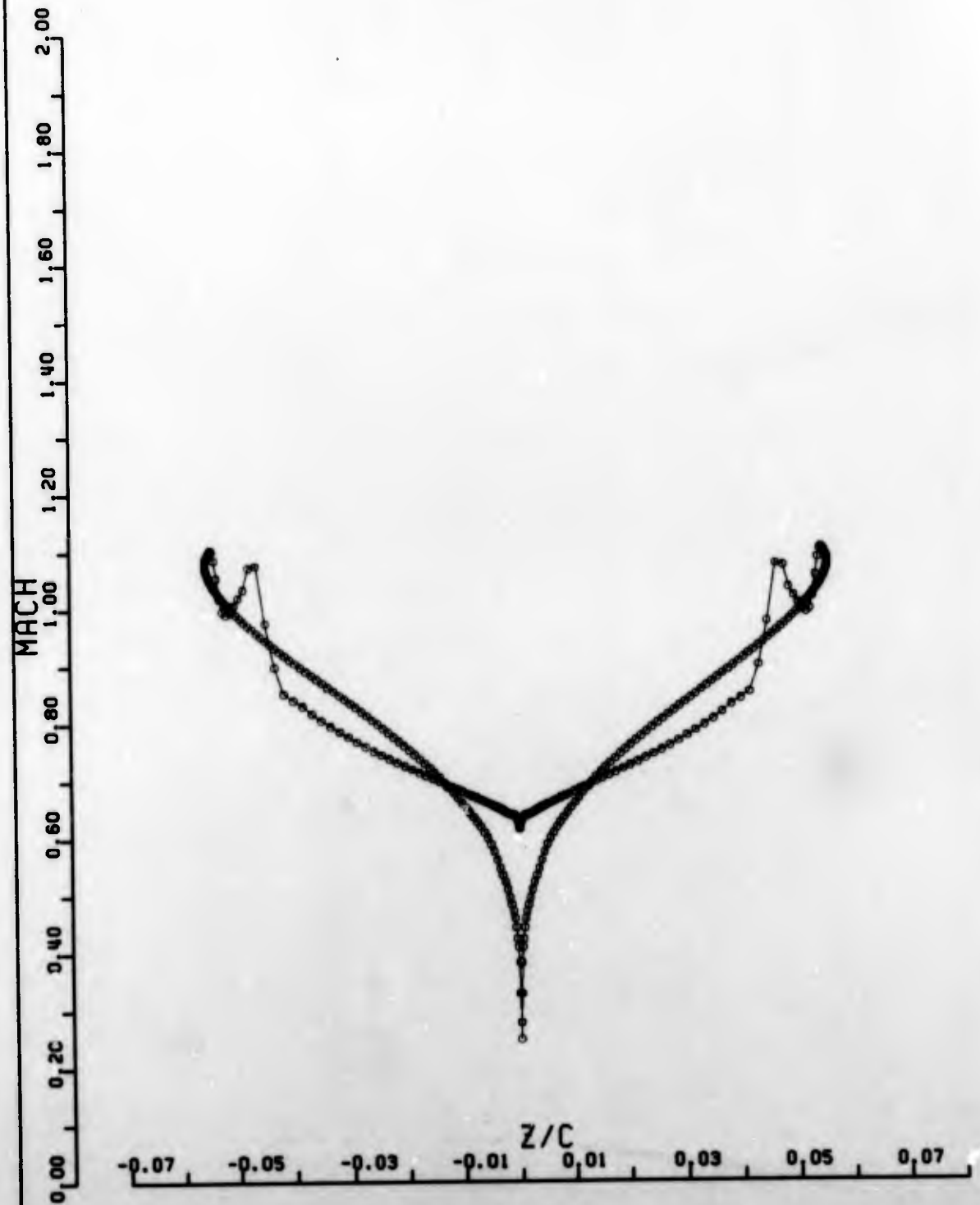


FIG. : MACH(Z/C) ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-13
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

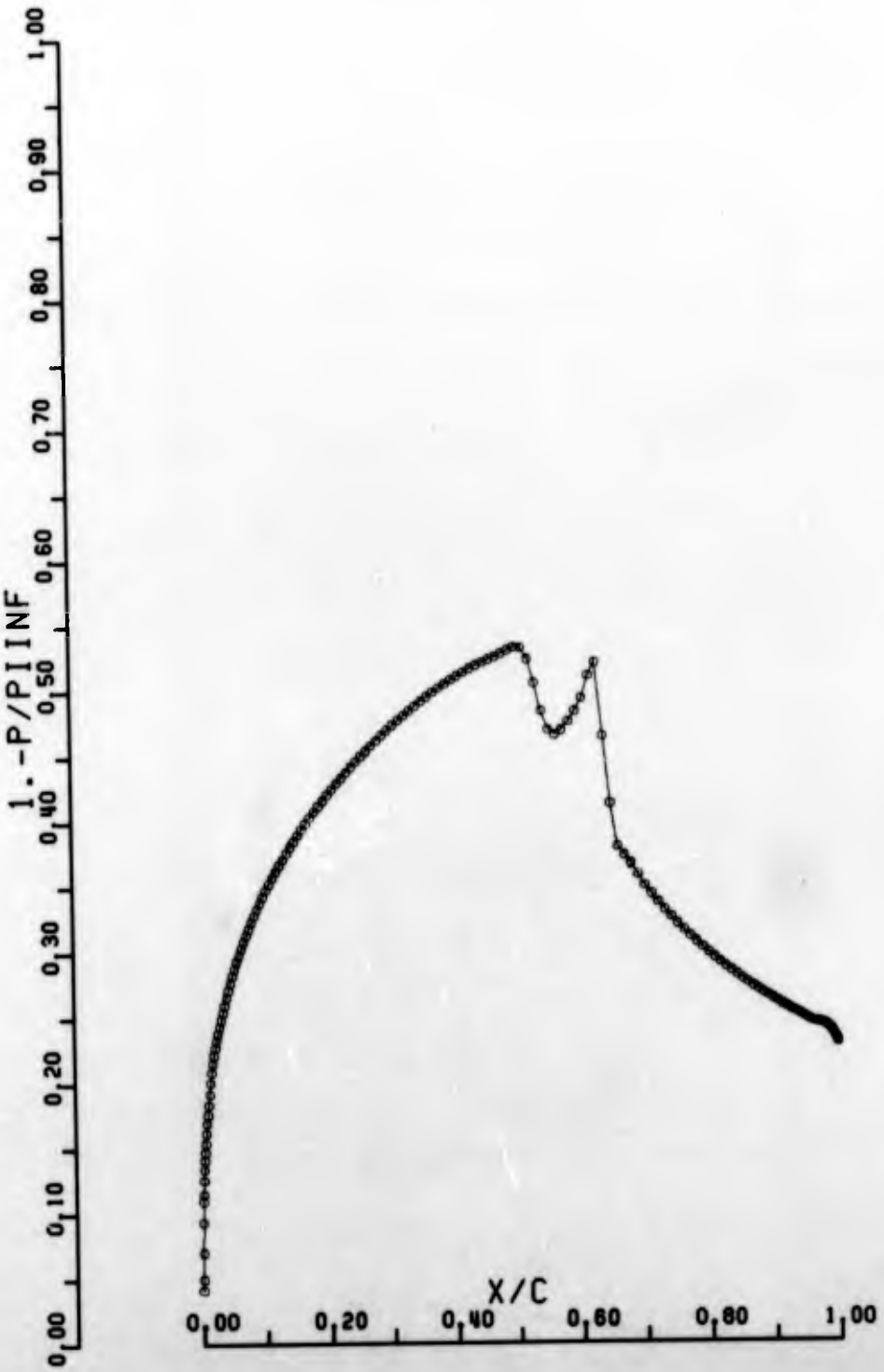


FIG. : 1.-P/PIINF VS. X/C ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-14
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

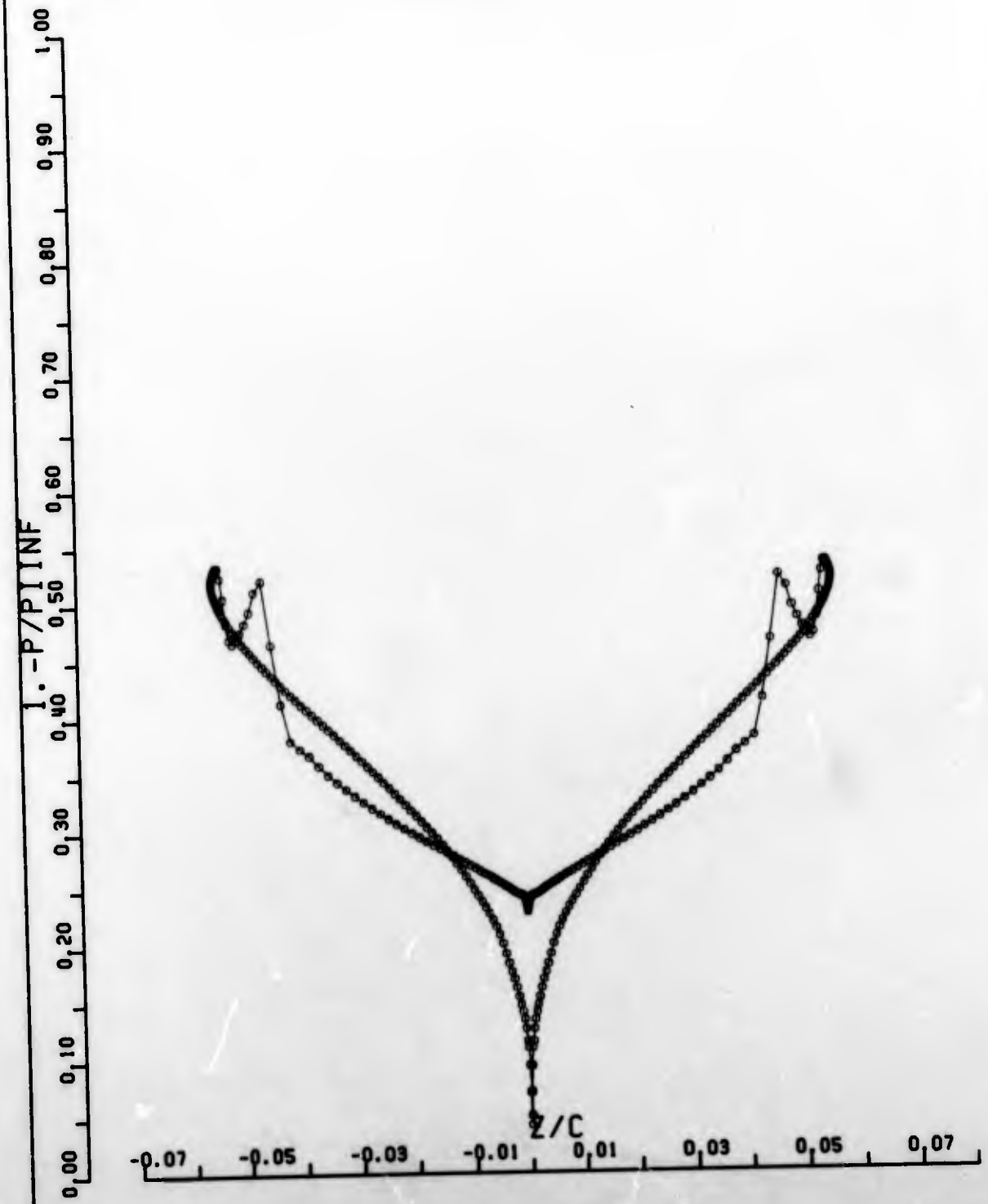


FIG. : 1.-P/PIINF VS. Z/C ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-15
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

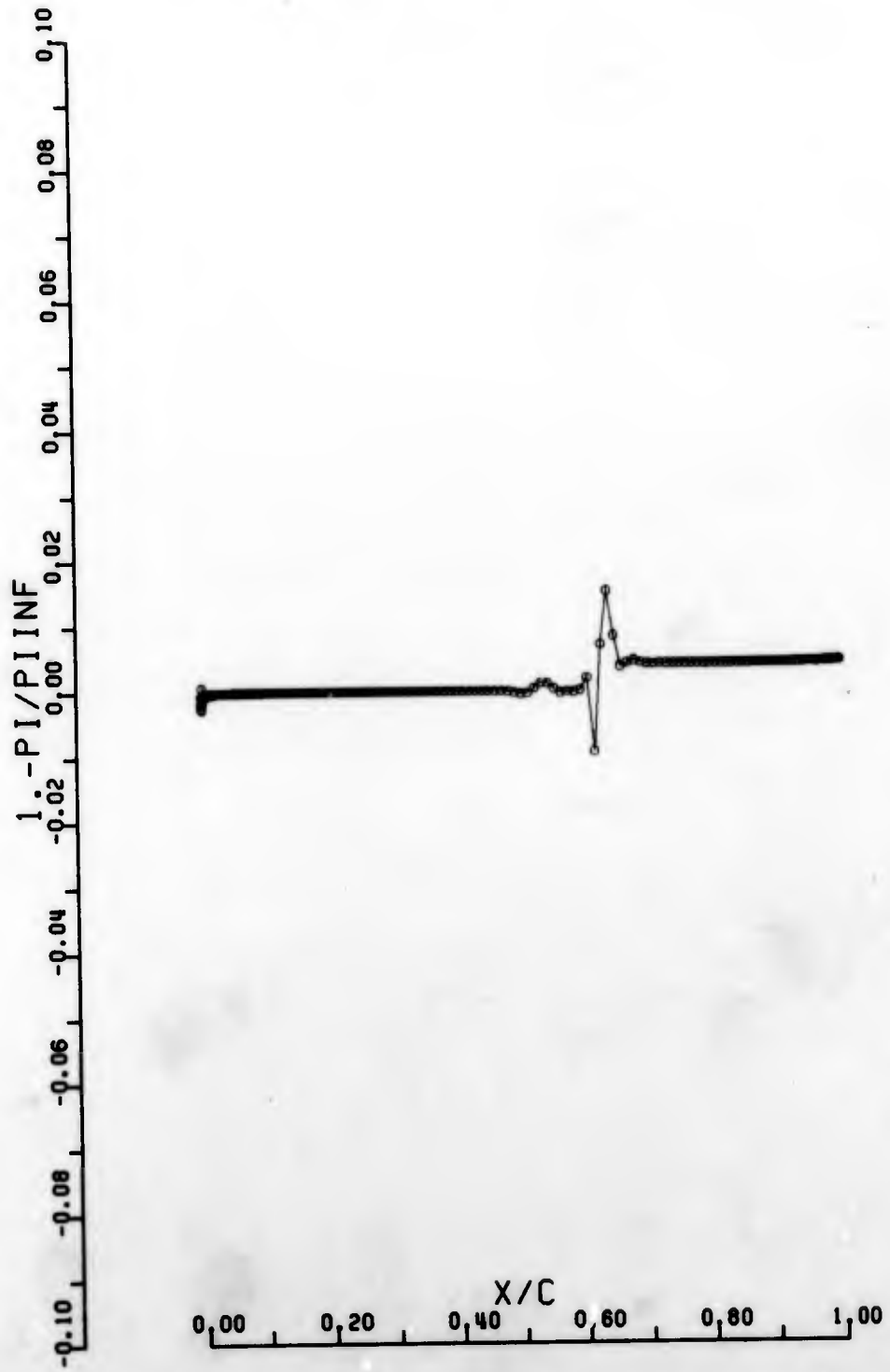
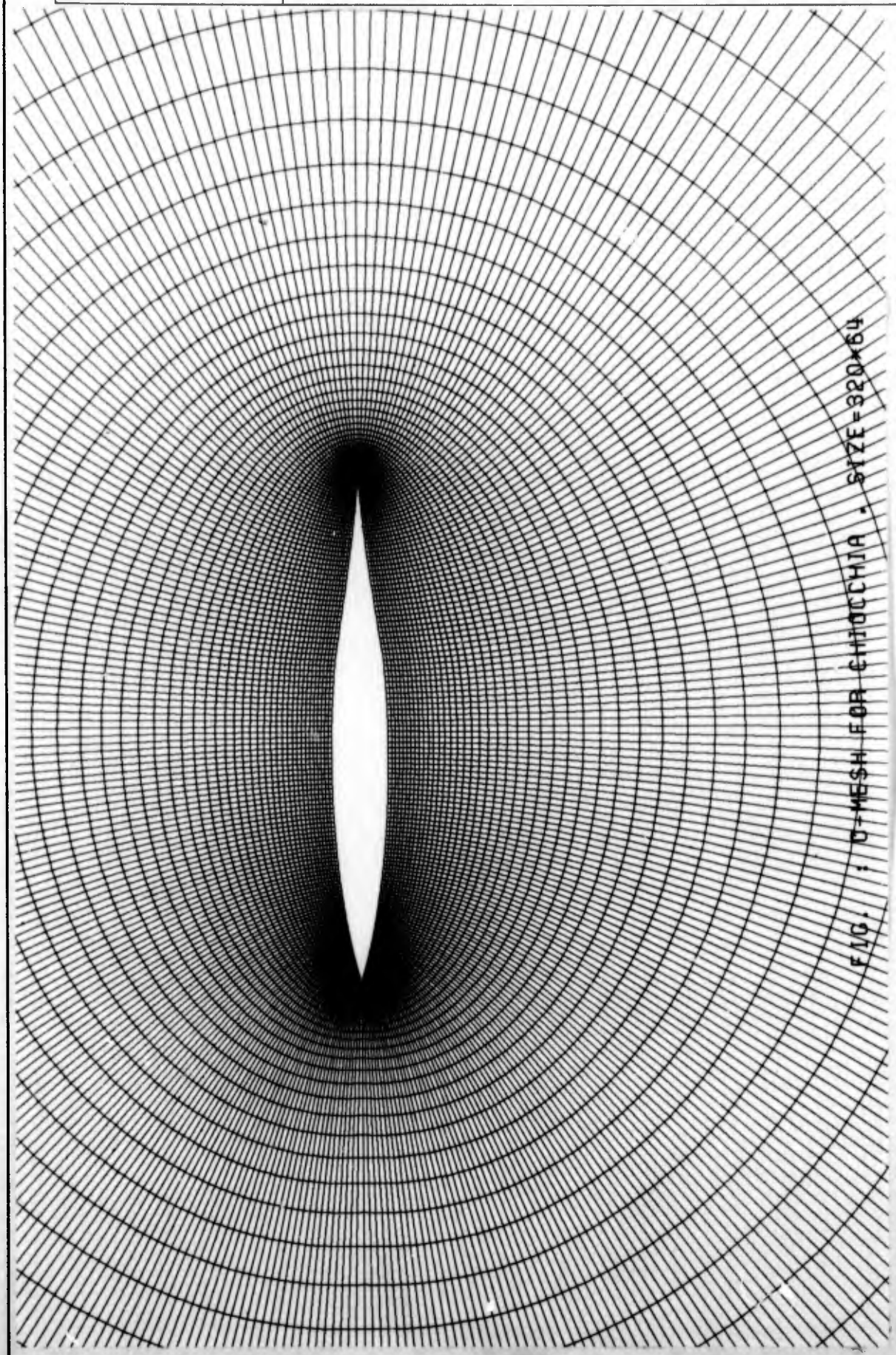


FIG. : 1.-PI/PIINF VS. X/C ON CHIOCCHIA

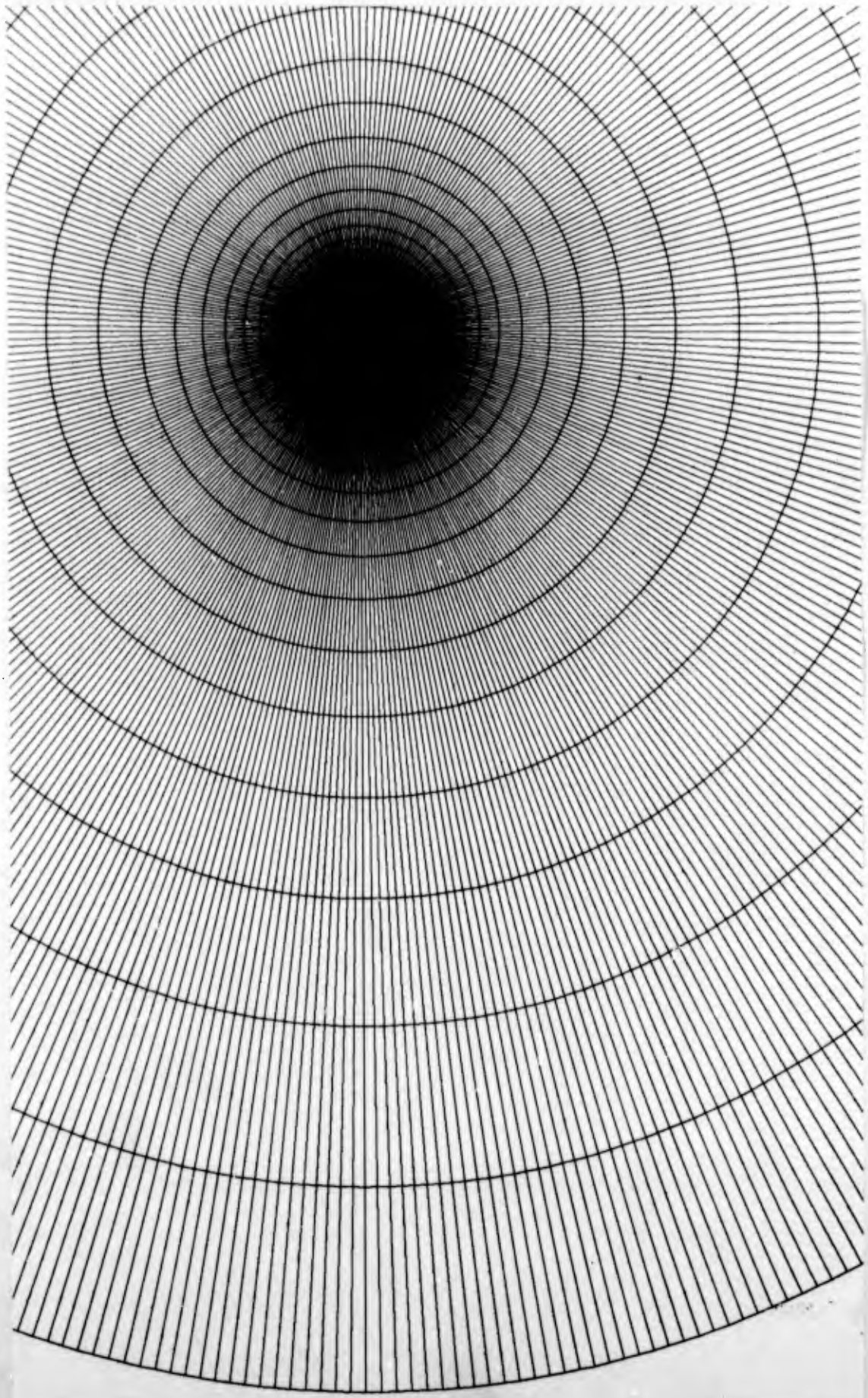
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-16
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

FIG. : 1.-PI/PIINF VS. Z/C ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-17
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-18
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-19
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

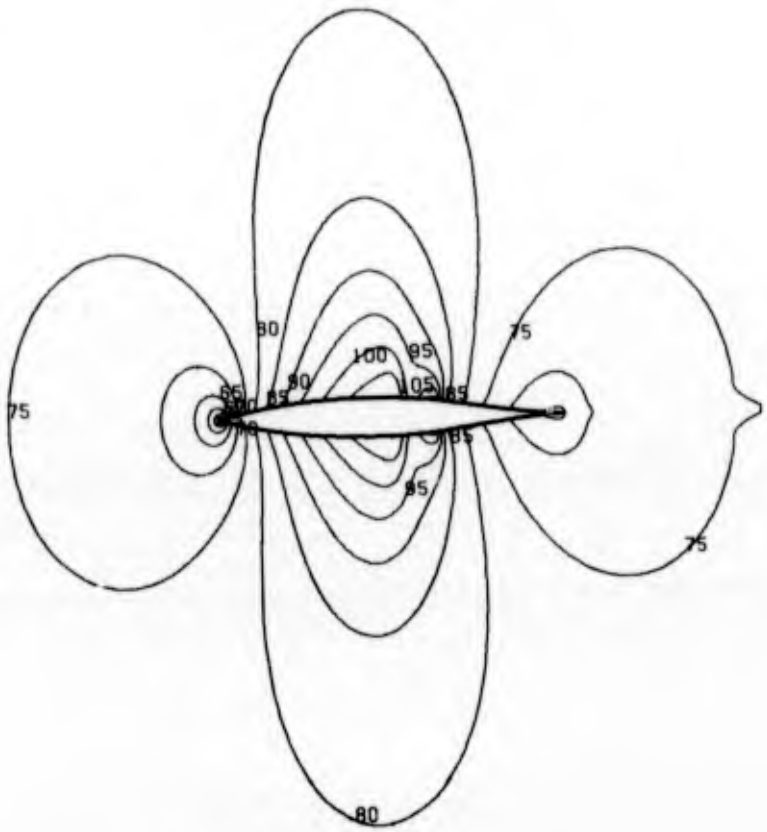


FIG. : ISO-MACH (DELTA = 0.050)

*** VALUES OF CURVE PARAMETER = 100*MACH ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-20
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

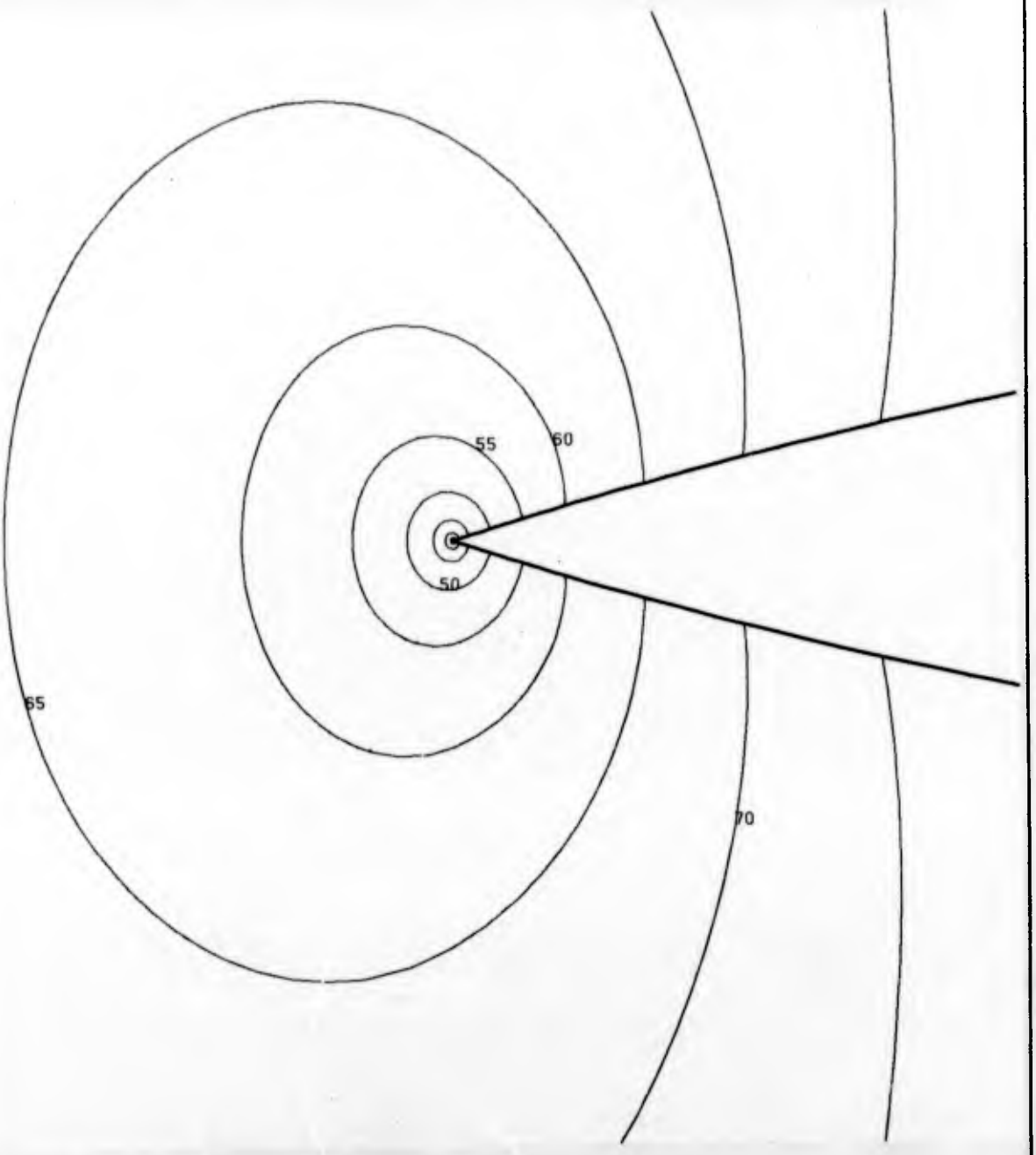


FIG. : ISO-MACH (DELTA = 0.050)

××× VALUES OF CURVE PARAMETER = 100×MACH ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-21
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

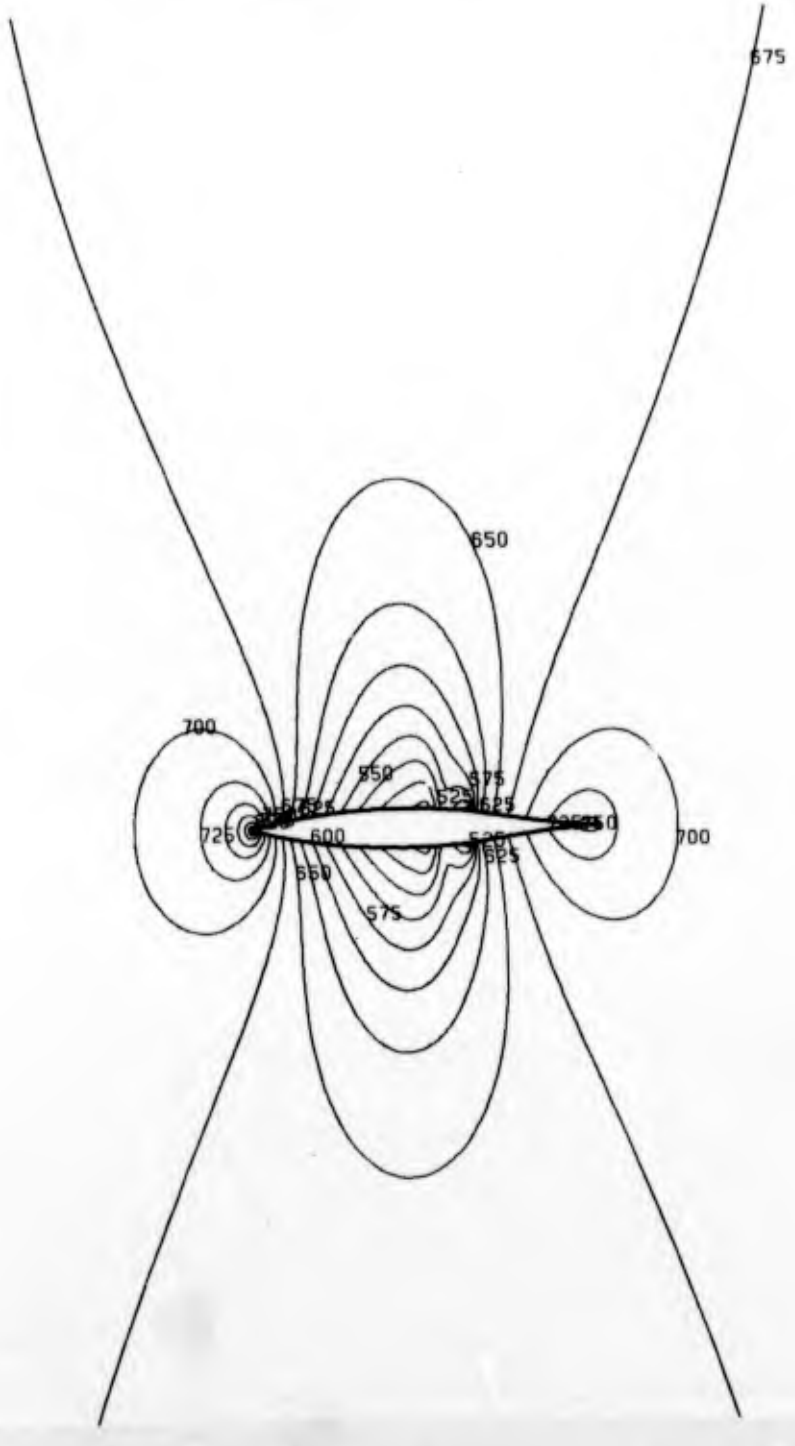


FIG. : ISO-P/PIINF (DELTA = 0.025)

*** VALUES OF CURVE PARAMETER = 1000*P/PIINF ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-22
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

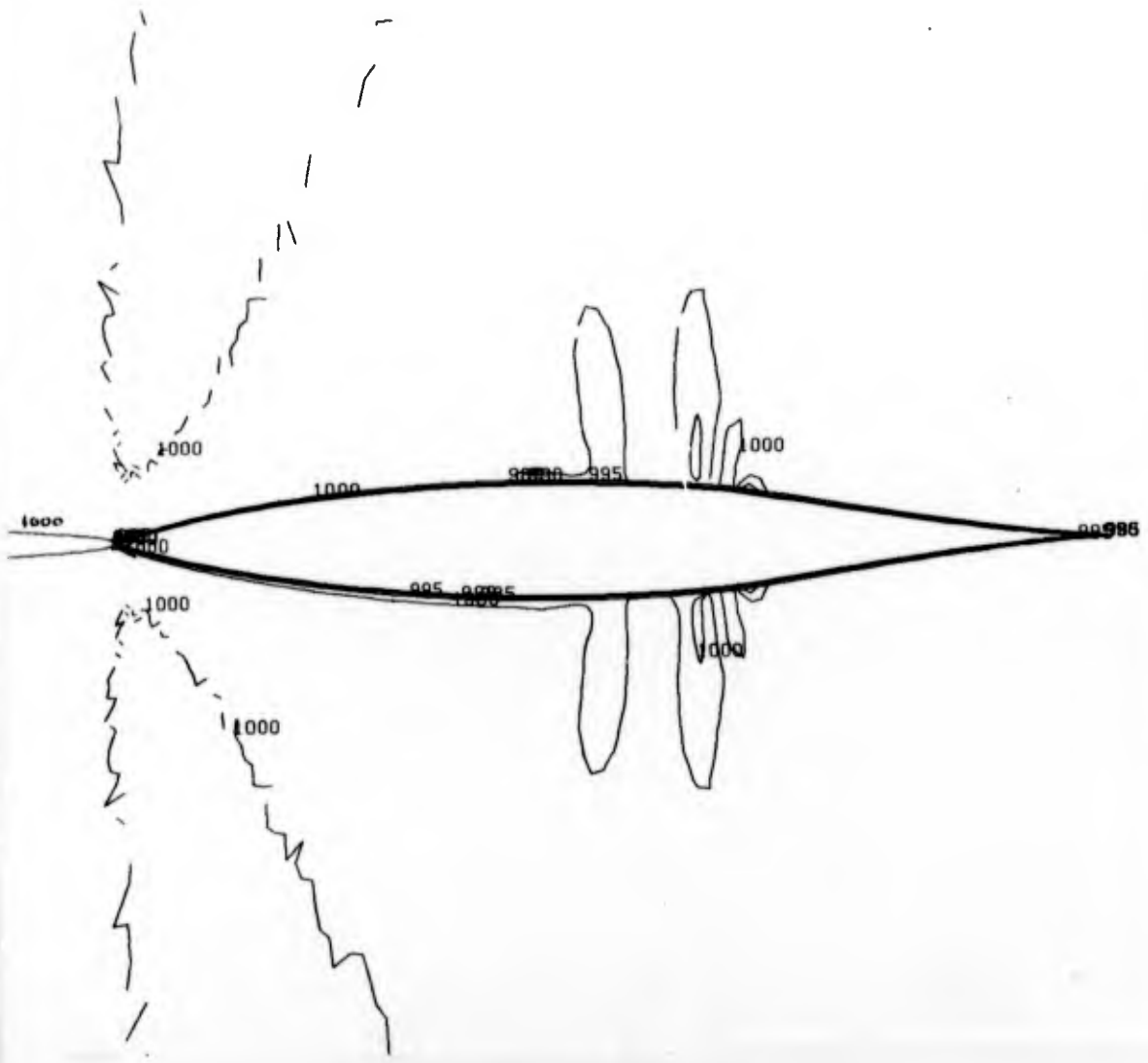


FIG. : ISO-PI/PIINF (DELTA = 0.0050)

××× VALUES OF CURVE PARAMETER = 1000×PI/PIINF ×××

SOLUTION N° 9.2

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-23
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

N	X/C(%)	Z/C(%)	1-P/PIINF	CP	MACH	1-PI/PIINF
2	0.999925	-0.000000	0.234073	0.348658	0.62.164	0.000472
3	0.999624	-0.000003	0.234781	0.346193	0.622294	0.000557
4	0.999022	-0.000012	0.235621	0.343266	0.623642	0.000492
5	0.998120	-0.000030	0.236704	0.339496	0.625358	0.000518
6	0.996918	-0.000061	0.237969	0.335092	0.627398	0.000518
7	0.995418	-0.000107	0.239376	0.330193	0.629670	0.000513
8	0.993622	-0.000171	0.240883	0.324947	0.632098	0.000508
9	0.991530	-0.000254	0.242446	0.319504	0.634618	0.000503
10	0.989145	-0.000358	0.244022	0.314016	0.637150	0.000501
11	0.986469	-0.000483	0.245567	0.308635	0.639626	0.000501
12	0.983505	-0.000631	0.246993	0.303672	0.641907	0.000501
13	0.980254	-0.000800	0.248058	0.299962	0.643658	0.000459
14	0.976721	-0.000993	0.248703	0.297713	0.644722	0.000431
15	0.972908	-0.001210	0.249099	0.296338	0.645358	0.000430
16	0.968818	-0.001456	0.249396	0.295303	0.645860	0.000407
17	0.964456	-0.001735	0.249794	0.293919	0.646507	0.000397
18	0.959826	-0.002052	0.250589	0.291149	0.647733	0.000432
19	0.954931	-0.002409	0.251783	0.286993	0.649644	0.000426
20	0.949777	-0.002808	0.253248	0.281890	0.651981	0.000423
21	0.944366	-0.003250	0.254826	0.276196	0.654507	0.000410
22	0.938706	-0.003733	0.256397	0.270926	0.657035	0.000384
23	0.932799	-0.004259	0.257997	0.265355	0.659576	0.000382
24	0.926652	-0.004830	0.259687	0.259470	0.662262	0.000376
25	0.920269	-0.005447	0.261523	0.253078	0.665170	0.000377
26	0.913657	-0.006109	0.263486	0.246244	0.668284	0.000368
27	0.906820	-0.006819	0.265543	0.239079	0.671546	0.000360
28	0.899765	-0.007575	0.267684	0.231626	0.674934	0.000350
29	0.892498	-0.008379	0.269921	0.223837	0.678464	0.000346
30	0.885023	-0.009230	0.272267	0.215668	0.682164	0.000338
31	0.877349	-0.010129	0.274742	0.207050	0.686061	0.000332
32	0.869480	-0.011075	0.277364	0.197921	0.690177	0.000332
33	0.861423	-0.012069	0.280097	0.188406	0.694472	0.000323
34	0.853185	-0.013108	0.282906	0.178623	0.698889	0.000306
35	0.844771	-0.014193	0.285856	0.168351	0.703498	0.000310
36	0.836189	-0.015323	0.288991	0.157436	0.708391	0.000311
37	0.827446	-0.016497	0.292252	0.146081	0.713495	0.000294
38	0.818547	-0.017713	0.295622	0.134348	0.718750	0.000286
39	0.809499	-0.018971	0.299136	0.122113	0.724219	0.000284
40	0.800310	-0.020269	0.302813	0.109308	0.729943	0.000278
41	0.790985	-0.021606	0.306674	0.095863	0.735937	0.000277
42	0.781532	-0.022980	0.310737	0.081716	0.742242	0.000274
43	0.771958	-0.024390	0.315008	0.066914	0.748833	0.000270
44	0.762268	-0.025832	0.319390	0.051586	0.755668	0.000249
45	0.752470	-0.027305	0.324031	0.035427	0.762832	0.000264
46	0.742571	-0.028807	0.328922	0.018399	0.770398	0.000258
47	0.732577	-0.030336	0.333955	0.000873	0.778222	0.000214
48	0.722495	-0.031888	0.339303	-0.018061	0.786556	0.000278
49	0.712331	-0.033461	0.345103	-0.037945	0.795426	0.000230
50	0.702092	-0.035053	0.351009	-0.058506	0.804531	0.000247
51	0.691784	-0.036659	0.356993	-0.079343	0.813827	0.000200
52	0.681414	-0.038278	0.363275	-0.101218	0.823601	0.000140
53	0.670988	-0.039905	0.370771	-0.127317	0.834927	0.000422
54	0.660513	-0.041535	0.379280	-0.156947	0.847623	0.000936
55	0.649994	-0.043165	0.384543	-0.175273	0.855682	0.000758
56	0.639439	-0.044789	0.401486	-0.234265	0.879247	0.010071
57	0.628851	-0.046399	0.481658	-0.513421	1.001443	0.017163
58	0.618233	-0.047733	0.551025	-0.754953	1.131578	0.002762
59	0.607589	-0.048721	0.588285	-0.884691	1.195247	0.007772
60	0.596932	-0.049592	0.591142	-0.894641	1.210419	-0.005062
61	0.586270	-0.050397	0.587366	-0.881493	1.197681	0.002400
62	0.575608	-0.051138	0.583589	-0.868340	1.193748	-0.001592
63	0.564952	-0.051817	0.580169	-0.856433	1.185884	0.000440
64	0.554309	-0.052437	0.577261	-0.846306	1.181109	-0.000283
65	0.543685	-0.052998	0.574713	-0.837435	1.176215	0.000029
66	0.533084	-0.053502	0.571930	-0.827745	1.171317	-0.000183
67	0.522512	-0.053950	0.569005	-0.817210	1.165771	-0.000100
68	0.511976	-0.054341	0.565755	-0.806243	1.160104	-0.000115
69	0.501479	-0.054678	0.562556	-0.795105	1.154346	-0.000099
70	0.491027	-0.054961	0.559291	-0.783738	1.148518	-0.000108
71	0.480625	-0.055190	0.555979	-0.772205	1.142615	-0.000097
72	0.470278	-0.055367	0.552620	-0.760509	1.136664	-0.000098
73	0.459990	-0.055493	0.549196	-0.748584	1.130625	-0.000098
74	0.449765	-0.055567	0.545693	-0.736387	1.124476	-0.000100
75	0.439609	-0.055591	0.542121	-0.723950	1.118231	-0.000098
76	0.429525	-0.055566	0.538493	-0.711318	1.111917	-0.000096
77	0.419517	-0.055492	0.534823	-0.698540	1.105560	-0.000094
78	0.409590	-0.055371	0.531125	-0.685663	1.099179	-0.000091
79	0.399746	-0.055205	0.527404	-0.672706	1.092789	-0.000090
80	0.389990	-0.054993	0.523646	-0.659623	1.086364	-0.000089

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-24
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

81	0.380324	-0.054737	0.519036	-0.646356	1.079877	-0.000089
82	0.370753	-0.054439	0.515969	-0.632889	1.073321	-0.000090
83	0.361279	-0.054098	0.512049	-0.619241	1.066704	-0.000090
84	0.351905	-0.053718	0.508083	-0.605431	1.060035	-0.000089
85	0.342635	-0.053298	0.504076	-0.591479	1.053327	-0.000090
86	0.333470	-0.052839	0.500034	-0.577407	1.046587	-0.000089
87	0.324413	-0.052344	0.495966	-0.563241	1.039828	-0.000084
88	0.315467	-0.051814	0.491874	-0.548993	1.033058	-0.000085
89	0.306634	-0.051249	0.487755	-0.534651	1.026270	-0.000085
90	0.297916	-0.050652	0.483599	-0.520100	1.019445	-0.000084
91	0.289315	-0.050023	0.479398	-0.505552	1.012574	-0.000087
92	0.280832	-0.049364	0.475148	-0.490756	1.005649	-0.000085
93	0.272471	-0.048676	0.470859	-0.475821	0.998682	-0.000085
94	0.264231	-0.047960	0.466544	-0.460794	0.991697	-0.000084
95	0.256116	-0.047219	0.462213	-0.445715	0.984711	-0.000085
96	0.248125	-0.046453	0.457874	-0.430607	0.977733	-0.000083
97	0.240260	-0.045664	0.453522	-0.415454	0.970759	-0.000083
98	0.232523	-0.044853	0.449146	-0.400215	0.963767	-0.000082
99	0.224914	-0.044022	0.444735	-0.384858	0.956741	-0.000085
100	0.217434	-0.043171	0.440284	-0.369359	0.949672	-0.000087
101	0.210084	-0.042303	0.435794	-0.353724	0.942559	-0.000085
102	0.202865	-0.041418	0.431271	-0.337976	0.935415	-0.000085
103	0.195777	-0.040518	0.426721	-0.322132	0.928246	-0.000088
104	0.188821	-0.039604	0.422147	-0.306208	0.921059	-0.000087
105	0.181997	-0.038678	0.417552	-0.290208	0.913854	-0.000088
106	0.175306	-0.037741	0.412934	-0.274129	0.906631	-0.000087
107	0.168747	-0.036794	0.408293	-0.257967	0.899386	-0.000089
108	0.162321	-0.035839	0.403625	-0.241716	0.892117	-0.000090
109	0.156028	-0.034876	0.398932	-0.225373	0.884820	-0.000091
110	0.149868	-0.033908	0.394211	-0.208935	0.877494	-0.000091
111	0.143840	-0.032934	0.389464	-0.192405	0.870140	-0.000093
112	0.137946	-0.031958	0.384690	-0.175783	0.862756	-0.000095
113	0.132183	-0.030978	0.379891	-0.159072	0.855344	-0.000096
114	0.126553	-0.029998	0.375066	-0.142273	0.847902	-0.000097
115	0.121055	-0.029018	0.370216	-0.125385	0.840431	-0.000098
116	0.115689	-0.028039	0.365338	-0.108399	0.832922	-0.000100
117	0.110453	-0.027062	0.360429	-0.091308	0.825374	-0.000101
118	0.105349	-0.026088	0.355487	-0.074101	0.817782	-0.000105
119	0.100374	-0.025119	0.350507	-0.056759	0.810134	-0.000108
120	0.095529	-0.024155	0.345482	-0.039263	0.802422	-0.000111
121	0.090814	-0.023198	0.340418	-0.021632	0.794652	-0.000112
122	0.086226	-0.022248	0.335322	-0.003888	0.786833	-0.000115
123	0.081767	-0.021307	0.330190	0.013955	0.778967	-0.000114
124	0.077434	-0.020375	0.325051	0.031876	0.771068	-0.000124
125	0.073228	-0.019454	0.319898	0.049820	0.763155	-0.000123
126	0.069148	-0.018545	0.314743	0.067768	0.755234	-0.000123
127	0.065193	-0.017648	0.309562	0.085808	0.747270	-0.000129
128	0.061362	-0.016764	0.304328	0.104032	0.739216	-0.000134
129	0.057655	-0.015894	0.299027	0.122491	0.731048	-0.000140
130	0.054071	-0.015038	0.293639	0.141252	0.722734	-0.000145
131	0.050609	-0.014197	0.288113	0.160491	0.714201	-0.000158
132	0.047268	-0.013372	0.282410	0.180343	0.705379	-0.000173
133	0.044048	-0.012564	0.276596	0.200594	0.696346	-0.000173
134	0.040948	-0.011775	0.270736	0.220998	0.687227	-0.000180
135	0.037966	-0.011005	0.264874	0.241409	0.678070	-0.000180
136	0.035103	-0.010257	0.259037	0.261734	0.668934	-0.000191
137	0.032356	-0.009530	0.253286	0.281760	0.659892	-0.000194
138	0.029727	-0.008828	0.247786	0.300910	0.651185	-0.000174
139	0.027213	-0.008148	0.242485	0.319369	0.642791	-0.000180
140	0.024814	-0.007492	0.237159	0.337914	0.634340	-0.000203
141	0.022530	-0.006857	0.231620	0.357199	0.625510	-0.000222
142	0.020361	-0.006243	0.225730	0.377707	0.616090	-0.000257
143	0.018305	-0.005651	0.219429	0.399648	0.605934	-0.000280
144	0.016362	-0.005078	0.212557	0.423574	0.594758	-0.000280
145	0.014533	-0.004527	0.204440	0.451840	0.581637	-0.000431
146	0.012815	-0.004000	0.195348	0.483497	0.566638	-0.000487
147	0.011207	-0.003503	0.186785	0.513313	0.552115	-0.000366
148	0.009709	-0.003040	0.179296	0.539388	0.539396	-0.000364
149	0.008319	-0.002612	0.172557	0.562854	0.527714	-0.000284
150	0.007038	-0.002216	0.164817	0.589804	0.514688	-0.000581
151	0.005865	-0.001852	0.156778	0.617794	0.500373	-0.000484
152	0.004800	-0.001525	0.149748	0.642273	0.487640	-0.000392
153	0.003842	-0.001232	0.143310	0.664691	0.476082	-0.000484
154	0.002991	-0.000971	0.136468	0.688513	0.463483	-0.000505
155	0.002248	-0.000739	0.127884	0.718404	0.447743	-0.000757
156	0.001611	-0.000537	0.116864	0.756774	0.427677	-0.001472
157	0.001082	-0.000366	0.111364	0.775924	0.413078	0.000618
158	0.000660	-0.000222	0.095100	0.832556	0.385801	-0.002740
159	0.000344	-0.000106	0.071346	0.915266	0.331288	-0.001976
160	0.000134	-0.000032	0.050573	0.987597	0.279729	-0.002453

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-25
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

161	0.000027	-0.000004	0.042144	1.016946	0.250980	-0.000760
162	0.000027	0.000004	0.042144	1.016946	0.250980	-0.000760
163	0.000134	0.000032	0.050573	0.987597	0.279729	-0.002453
164	0.000344	0.000106	0.071346	0.915266	0.331288	-0.001976
165	0.000660	0.000222	0.095100	0.832556	0.385801	-0.002740
166	0.001082	0.000366	0.111364	0.775924	0.413078	0.000618
167	0.001611	0.000537	0.116864	0.756774	0.427677	-0.001472
168	0.002248	0.000739	0.127884	0.718404	0.447743	-0.000757
169	0.002991	0.000971	0.136468	0.688513	0.463483	-0.000505
170	0.003842	0.001232	0.143310	0.664691	0.476082	-0.000484
171	0.004800	0.001525	0.149748	0.642273	0.487640	-0.000392
172	0.005865	0.001852	0.156778	0.617794	0.500373	-0.000484
173	0.007038	0.002216	0.164817	0.589804	0.514688	-0.000581
174	0.008319	0.002612	0.172557	0.562854	0.527714	-0.000284
175	0.009709	0.003040	0.179296	0.539388	0.539396	-0.000364
176	0.011207	0.003503	0.186785	0.513313	0.552115	-0.000368
177	0.012815	0.004000	0.195348	0.483497	0.566638	-0.000487
178	0.014533	0.004527	0.201440	0.461840	0.581637	-0.000431
179	0.016362	0.005078	0.212557	0.423574	0.594758	-0.000280
180	0.018305	0.005651	0.219429	0.399648	0.605934	-0.000280
181	0.020361	0.006243	0.225720	0.377707	0.616090	-0.000257
182	0.022530	0.006857	0.231624	0.357199	0.625510	-0.000222
183	0.024814	0.007492	0.237159	0.337914	0.634340	-0.000203
184	0.027213	0.008148	0.242485	0.319369	0.642791	-0.000180
185	0.029727	0.008828	0.247706	0.301910	0.651185	-0.000174
186	0.032356	0.009530	0.253206	0.281150	0.659892	-0.000194
187	0.035103	0.010257	0.259037	0.261734	0.668934	-0.000191
188	0.037966	0.011005	0.264874	0.241409	0.678070	-0.000180
189	0.040948	0.011775	0.270736	0.220998	0.687227	-0.000180
190	0.044048	0.012564	0.276596	0.200594	0.696346	-0.000173
191	0.047268	0.013372	0.282410	0.180349	0.705379	-0.000173
192	0.050609	0.014197	0.288113	0.160491	0.714201	-0.000158
193	0.054071	0.015038	0.293639	0.141252	0.722734	-0.000145
194	0.057655	0.015894	0.299027	0.122491	0.731048	-0.000140
195	0.061362	0.016764	0.304328	0.104032	0.739216	-0.000134
196	0.065193	0.017648	0.309552	0.085808	0.747270	-0.000129
197	0.069148	0.018545	0.314743	0.067768	0.755234	-0.000123
198	0.073228	0.019454	0.319898	0.049820	0.763155	-0.000123
199	0.077434	0.020375	0.325051	0.031876	0.771060	-0.000120
200	0.081767	0.021307	0.330198	0.013955	0.778967	-0.000114
201	0.086226	0.022248	0.335322	-0.003888	0.786833	-0.000115
202	0.090814	0.023198	0.340418	-0.021632	0.794652	-0.000112
203	0.095529	0.024155	0.345482	-0.039263	0.802422	-0.000111
204	0.100374	0.025119	0.350507	-0.056759	0.810134	-0.000108
205	0.105349	0.026088	0.355487	-0.074101	0.817782	-0.000105
206	0.110453	0.027062	0.360429	-0.091308	0.825374	-0.000101
207	0.115689	0.028039	0.365338	-0.108399	0.832922	-0.000100
208	0.121055	0.029018	0.370216	-0.125385	0.840431	-0.000098
209	0.126553	0.029998	0.375066	-0.142273	0.847902	-0.000097
210	0.132183	0.030978	0.379891	-0.159072	0.855344	-0.000096
211	0.137946	0.031958	0.384690	-0.175783	0.862756	-0.000095
212	0.143840	0.032934	0.389464	-0.192405	0.870140	-0.000093
213	0.149868	0.033908	0.394211	-0.208935	0.877494	-0.000091
214	0.156028	0.034876	0.398932	-0.225373	0.884820	-0.000091
215	0.162321	0.035839	0.403625	-0.241716	0.892117	-0.000090
216	0.168747	0.036794	0.408293	-0.257967	0.899386	-0.000089
217	0.175306	0.037741	0.412934	-0.274129	0.906631	-0.000087
218	0.181997	0.038678	0.417552	-0.290208	0.913854	-0.000088
219	0.188821	0.039604	0.422147	-0.306208	0.921059	-0.000087
220	0.195777	0.040518	0.426721	-0.322132	0.928246	-0.000088
221	0.202865	0.041418	0.431271	-0.337976	0.935415	-0.000085
222	0.210084	0.042303	0.435794	-0.353724	0.942559	-0.000085
223	0.217434	0.043171	0.440284	-0.369359	0.949672	-0.000087
224	0.224914	0.044022	0.444735	-0.384858	0.956741	-0.000085
225	0.232523	0.044853	0.449146	-0.400215	0.963767	-0.000082
226	0.240260	0.045664	0.453522	-0.415454	0.970759	-0.000083
227	0.248125	0.046453	0.457874	-0.430607	0.977733	-0.000083
228	0.256116	0.047219	0.462213	-0.445715	0.984711	-0.000085
229	0.264231	0.047960	0.466544	-0.460794	0.991697	-0.000084
230	0.272471	0.048676	0.470859	-0.475821	0.998682	-0.000085
231	0.280832	0.049364	0.475148	-0.490756	1.005649	-0.000085
232	0.289315	0.050023	0.479398	-0.505552	1.012574	-0.000087
233	0.297916	0.050652	0.483599	-0.520180	1.019445	-0.000084
234	0.306634	0.051249	0.487755	-0.534651	1.026270	-0.000085
235	0.315467	0.051814	0.491874	-0.548993	1.033058	-0.000085
236	0.324413	0.052344	0.495966	-0.563241	1.039828	-0.000084
237	0.333470	0.052839	0.500034	-0.577407	1.046587	-0.000089
238	0.342635	0.053298	0.504076	-0.591479	1.053327	-0.000090
239	0.351905	0.053718	0.508083	-0.605431	1.060035	-0.000089
240	0.361279	0.054098	0.512049	-0.619241	1.066704	-0.000090

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-26
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

241	0.370753	0.054439	0.515969	-0.632889	1.073321	-0.000094
242	0.380324	0.054737	0.519836	-0.645356	1.079877	-0.000089
243	0.389990	0.054993	0.523646	-0.659623	1.086364	-0.000089
244	0.399746	0.055205	0.527404	-0.672786	1.092789	-0.000090
245	0.409590	0.055371	0.531125	-0.685663	1.099179	-0.000091
246	0.419517	0.055492	0.534823	-0.698540	1.105560	-0.000094
247	0.429525	0.055566	0.538493	-0.711318	1.111917	-0.000096
248	0.439609	0.055591	0.542121	-0.723950	1.118231	-0.000098
249	0.449765	0.055567	0.545693	-0.736387	1.124476	-0.000100
250	0.459990	0.055492	0.549196	-0.748584	1.130625	-0.000098
251	0.470278	0.055367	0.552620	-0.760509	1.136664	-0.000098
252	0.480625	0.055190	0.555979	-0.772205	1.142615	-0.000097
253	0.491027	0.054961	0.559291	-0.783738	1.148518	-0.000100
254	0.501479	0.054678	0.562556	-0.795105	1.154346	-0.000099
255	0.511976	0.054341	0.565755	-0.806243	1.160104	-0.000115
256	0.522512	0.053950	0.568905	-0.817210	1.165771	-0.000100
257	0.533084	0.053502	0.571938	-0.827745	1.171317	-0.000183
258	0.543685	0.052998	0.574713	-0.837435	1.176215	0.000029
259	0.554309	0.052437	0.577261	-0.846206	1.181109	-0.000283
260	0.564952	0.051817	0.580169	-0.856433	1.185864	0.000440
261	0.575608	0.051138	0.583589	-0.868340	1.193748	-0.001592
262	0.586270	0.050397	0.587366	-0.881493	1.197681	0.002400
263	0.596932	0.049592	0.591142	-0.894641	1.210419	-0.005062
264	0.607589	0.048721	0.588285	-0.884691	1.195247	0.007772
265	0.618233	0.047733	0.551025	-0.754952	1.131578	0.002762
266	0.628851	0.046399	0.481658	-0.513421	1.001443	0.017163
267	0.639439	0.044789	0.401486	-0.234265	0.879247	0.010071
268	0.649994	0.043165	0.384543	-0.175270	0.855682	0.007058
269	0.660513	0.041535	0.379280	-0.156947	0.847623	0.006936
270	0.670988	0.039905	0.378771	-0.127317	0.834927	0.006422
271	0.681414	0.038278	0.363275	-0.101218	0.823601	0.006140
272	0.691784	0.036659	0.356993	-0.079343	0.813827	0.006200
273	0.702092	0.035053	0.351009	-0.058506	0.804531	0.006247
274	0.712331	0.033461	0.345103	-0.037945	0.795426	0.006230
275	0.722495	0.031888	0.339393	-0.018061	0.786556	0.006278
276	0.732577	0.030336	0.333955	0.000873	0.778222	0.006214
277	0.742571	0.028807	0.328922	0.018399	0.770398	0.006258
278	0.752470	0.027305	0.324031	0.035427	0.762832	0.006264
279	0.762268	0.025832	0.319390	0.051586	0.755668	0.006249
280	0.771958	0.024390	0.314988	0.066914	0.748833	0.006270
281	0.781532	0.022980	0.310737	0.081716	0.742242	0.006274
282	0.790985	0.021606	0.306674	0.095863	0.735937	0.006277
283	0.800310	0.020269	0.302813	0.109308	0.729943	0.006278
284	0.809499	0.018971	0.299136	0.122113	0.724219	0.006284
285	0.818547	0.017713	0.295622	0.134348	0.718750	0.006286
286	0.827446	0.016497	0.292252	0.146081	0.713495	0.006294
287	0.836189	0.015323	0.288991	0.157436	0.708391	0.006311
288	0.844771	0.014193	0.285856	0.168351	0.703498	0.006310
289	0.853185	0.013108	0.282906	0.178623	0.698889	0.006306
290	0.861423	0.012069	0.280097	0.188406	0.694472	0.006323
291	0.869480	0.011075	0.277364	0.197921	0.690177	0.006332
292	0.877349	0.010129	0.274742	0.207050	0.686061	0.006332
293	0.885023	0.009230	0.272267	0.215668	0.682164	0.006338
294	0.892498	0.008379	0.269921	0.223837	0.678464	0.006346
295	0.899765	0.007575	0.267684	0.231626	0.674934	0.006350
296	0.906820	0.006819	0.265543	0.239079	0.671546	0.006360
297	0.913657	0.006109	0.263486	0.246244	0.668284	0.006368
298	0.920269	0.005447	0.261523	0.253078	0.665170	0.006377
299	0.926652	0.004830	0.259687	0.259470	0.662262	0.006376
300	0.932799	0.004259	0.257997	0.265355	0.659576	0.006382
301	0.938706	0.003733	0.256397	0.270926	0.657035	0.006384
302	0.944366	0.003250	0.254826	0.276396	0.654507	0.006410
303	0.949777	0.002808	0.253248	0.281890	0.651981	0.006423
304	0.954931	0.002409	0.251783	0.286993	0.649644	0.006426
305	0.959826	0.002052	0.250589	0.291149	0.647733	0.006432
306	0.964456	0.001735	0.249794	0.293919	0.646507	0.006397
307	0.968818	0.001456	0.249396	0.295303	0.645860	0.006407
308	0.972908	0.001210	0.249099	0.296338	0.645358	0.006430
309	0.976721	0.000993	0.248703	0.297718	0.644722	0.006431
310	0.980254	0.000800	0.248058	0.299962	0.643658	0.006459
311	0.983505	0.000631	0.246993	0.303672	0.641907	0.006501
312	0.986469	0.000483	0.245567	0.308635	0.639626	0.006501
313	0.989145	0.000358	0.244022	0.314016	0.637150	0.006501
314	0.991530	0.000254	0.242446	0.319504	0.634618	0.006503
315	0.993622	0.000171	0.240883	0.324947	0.632098	0.006508
316	0.995418	0.000107	0.239376	0.330193	0.629670	0.006513
317	0.996918	0.000061	0.237969	0.335092	0.627398	0.006518
318	0.998120	0.000030	0.236704	0.339495	0.625358	0.006518
319	0.999022	0.000012	0.235621	0.343266	0.623642	0.006492
320	0.999624	0.000003	0.234781	0.346193	0.622204	0.006557
321	0.999925	0.000000	0.234073	0.348658	0.621164	0.006472

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-27
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

$$C_L = 0.651 \cdot 10^{-13}$$

$$C_D = 0.131 \cdot 10^{-2}$$

$$C_M = -0.245 \cdot 10^{-13}$$

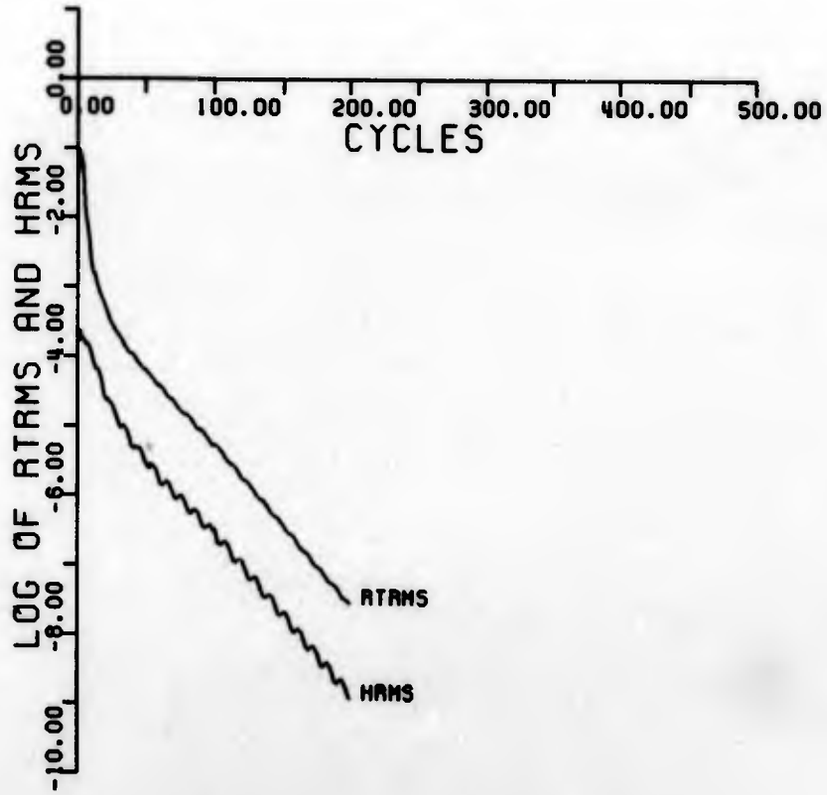


FIG. : CONVERGENCE BEHAVIOUR (DR/DT AND H)

CHIOCCHIA M=0.7850, ALPHA=0.0

GRID SEQUENCE :40×8->80×16->160×32->320×64

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-28
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

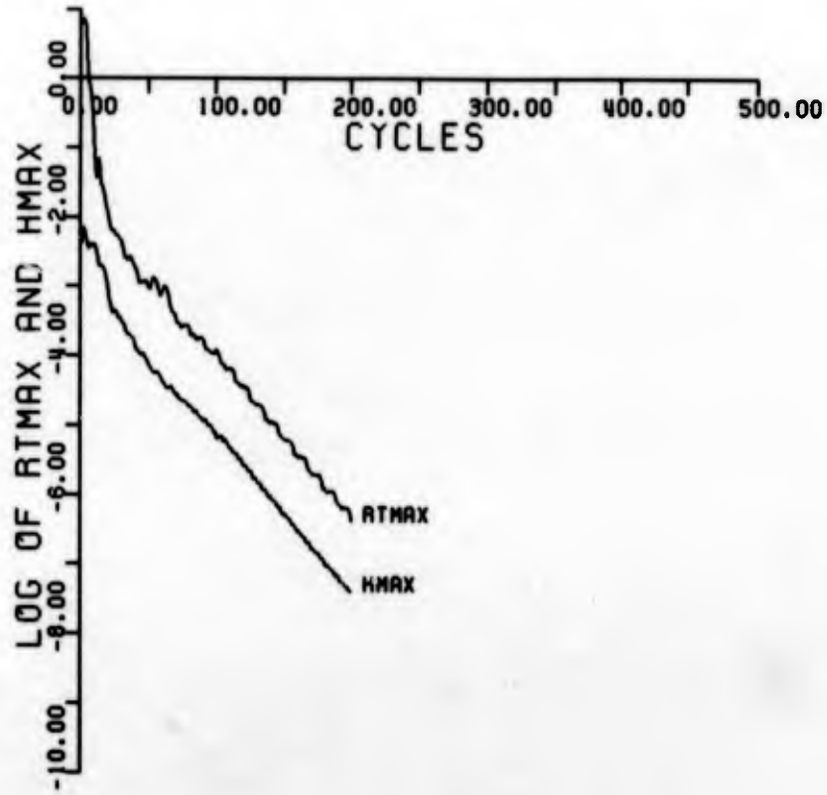


FIG. : CONVERGENCE BEHAVIOUR (DR/DT AND H)

CHIOCCHIA M=0.7850,ALPHA=0.0

GRID SEQUENCE :40×8->80×16->160×32->320×64

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-29
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

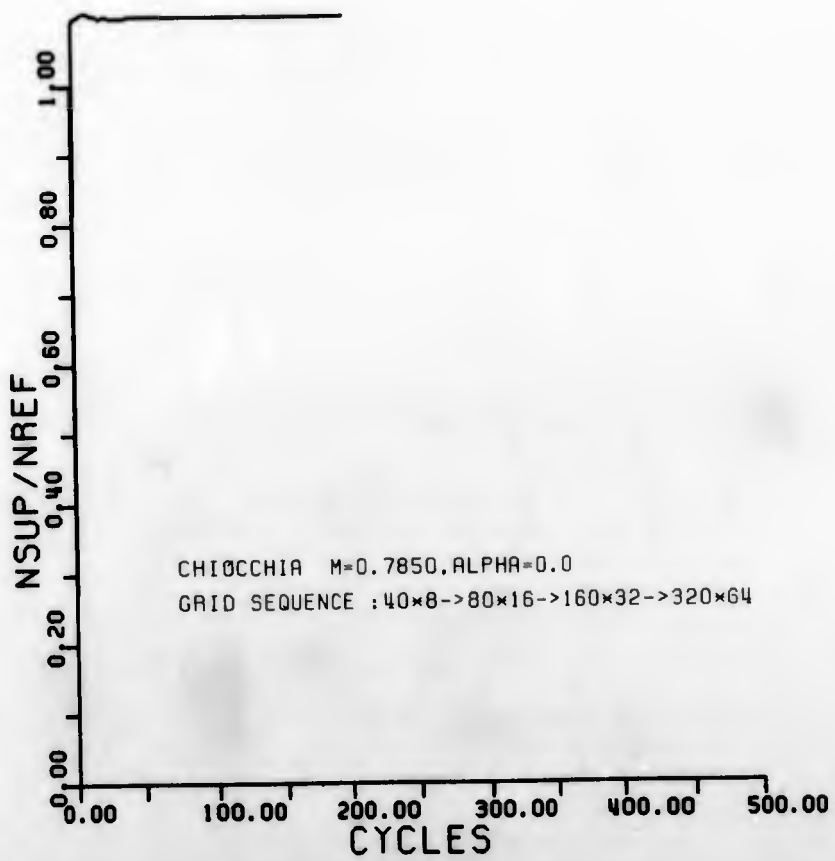


FIG. : CONVERGENCE BEHAVIOUR (NSUP/NREF), NREF=1000

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-30
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

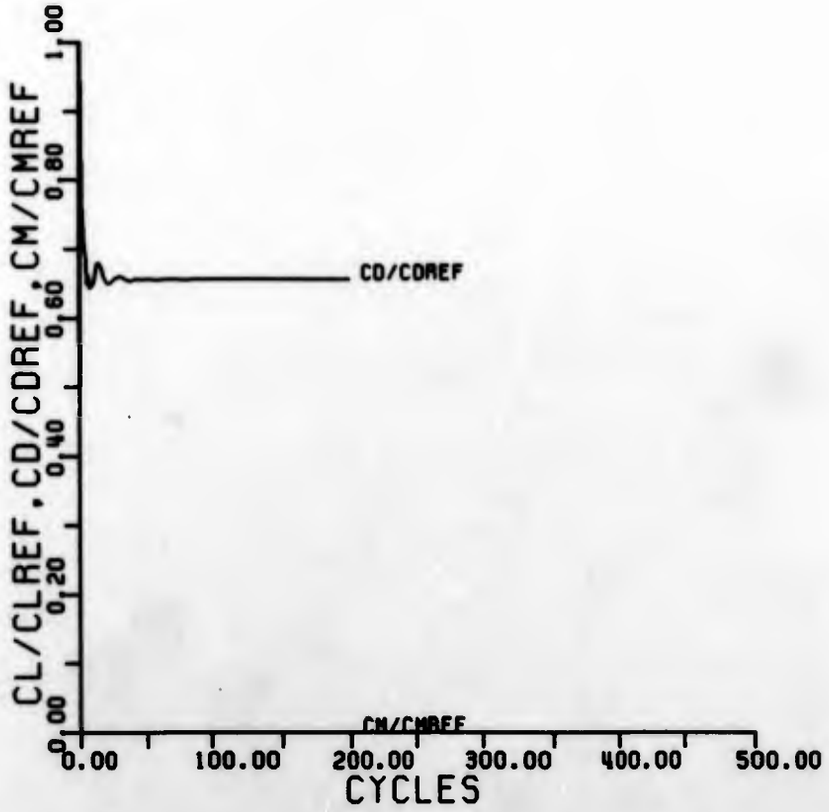


FIG. : CONVERGENCE BEHAVIOUR (CL,CD,CM)/REF

CHIOCCHIA M=0.7850,ALPHA=0.0

REF-VALUES:CLREF=1.0,CDREF=0.002,CMREF=-0.20

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-31
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

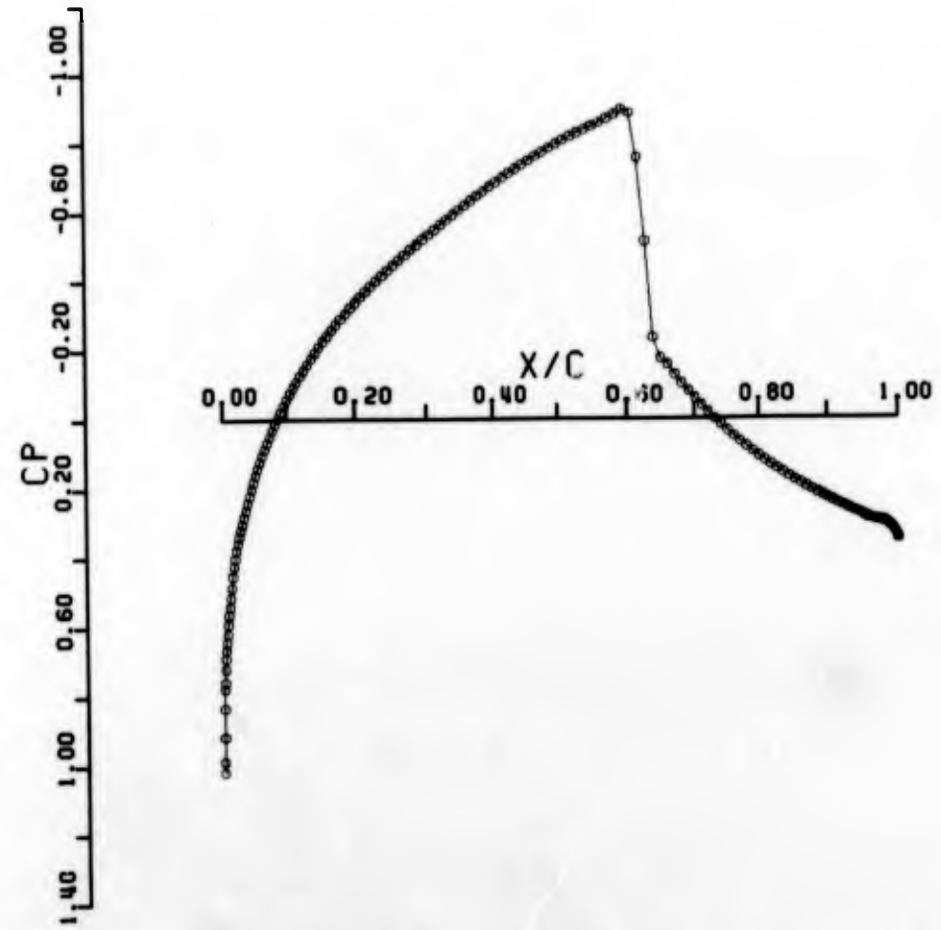


FIG. : CP(X/C) ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-32
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

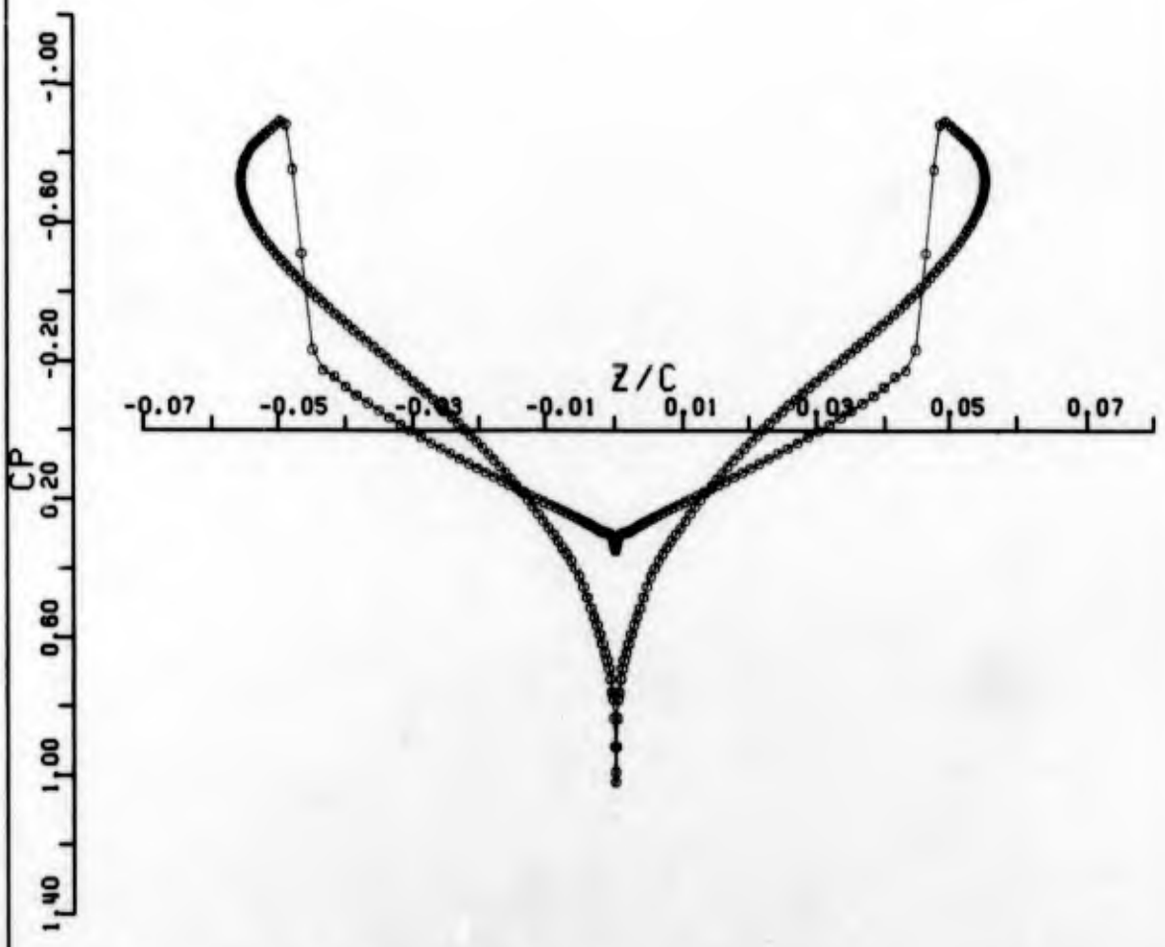


FIG. : CP(Z/C) ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-33
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

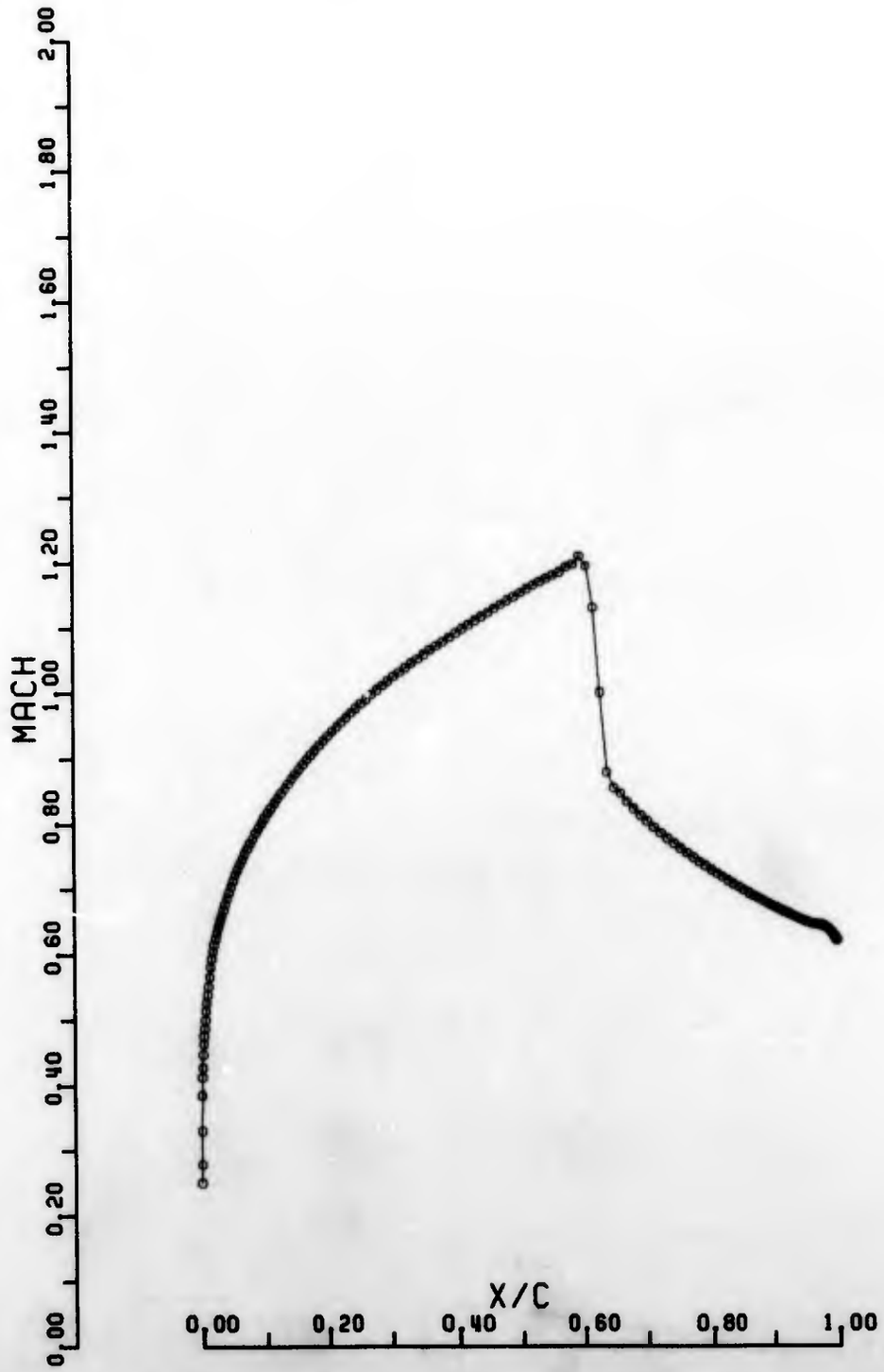


FIG. : MACH(X/C) ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-34
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

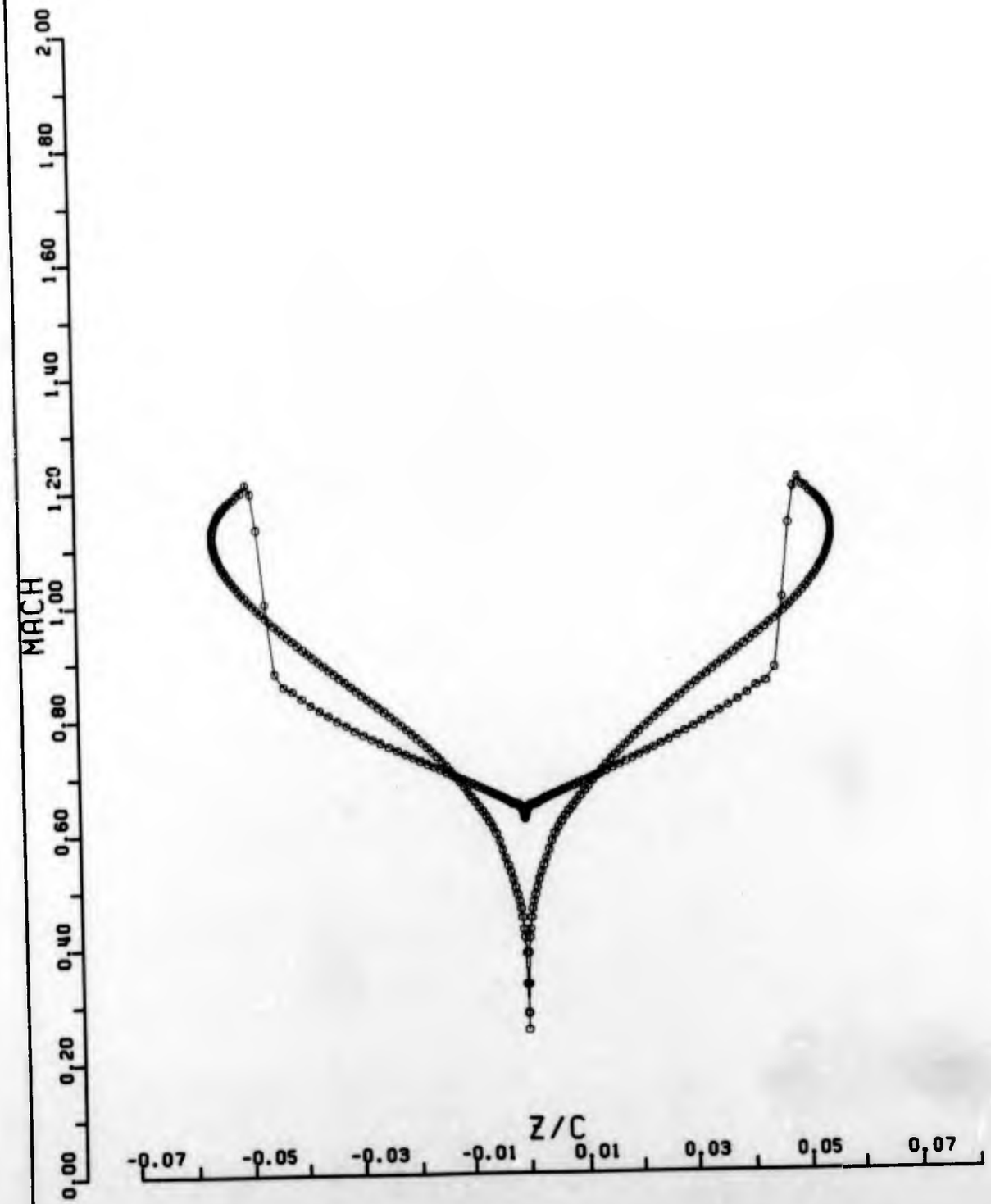


FIG. : MACH(Z/C) ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-35
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

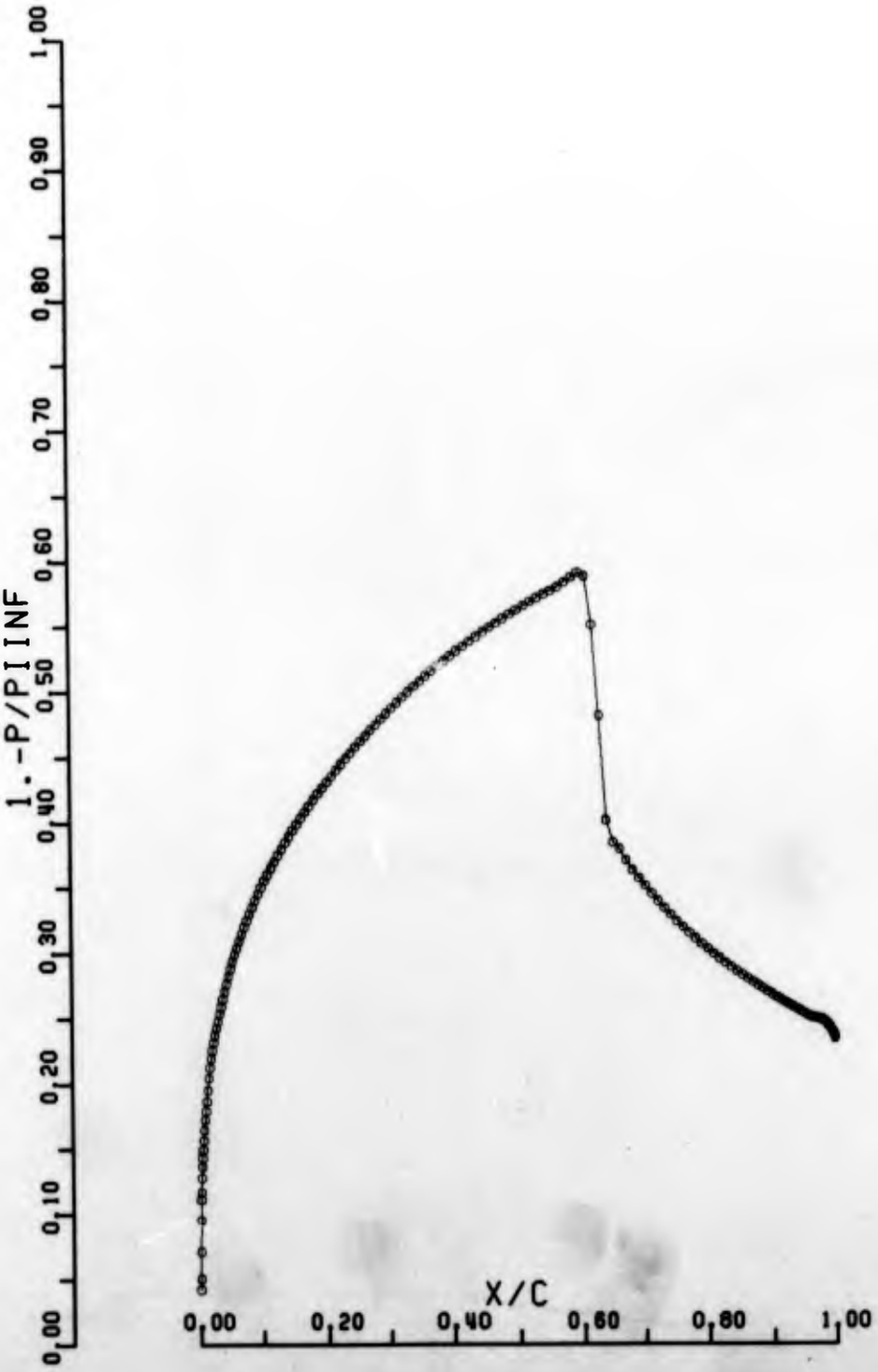


FIG. : 1.-P/PIINF VS. X/C ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-36
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

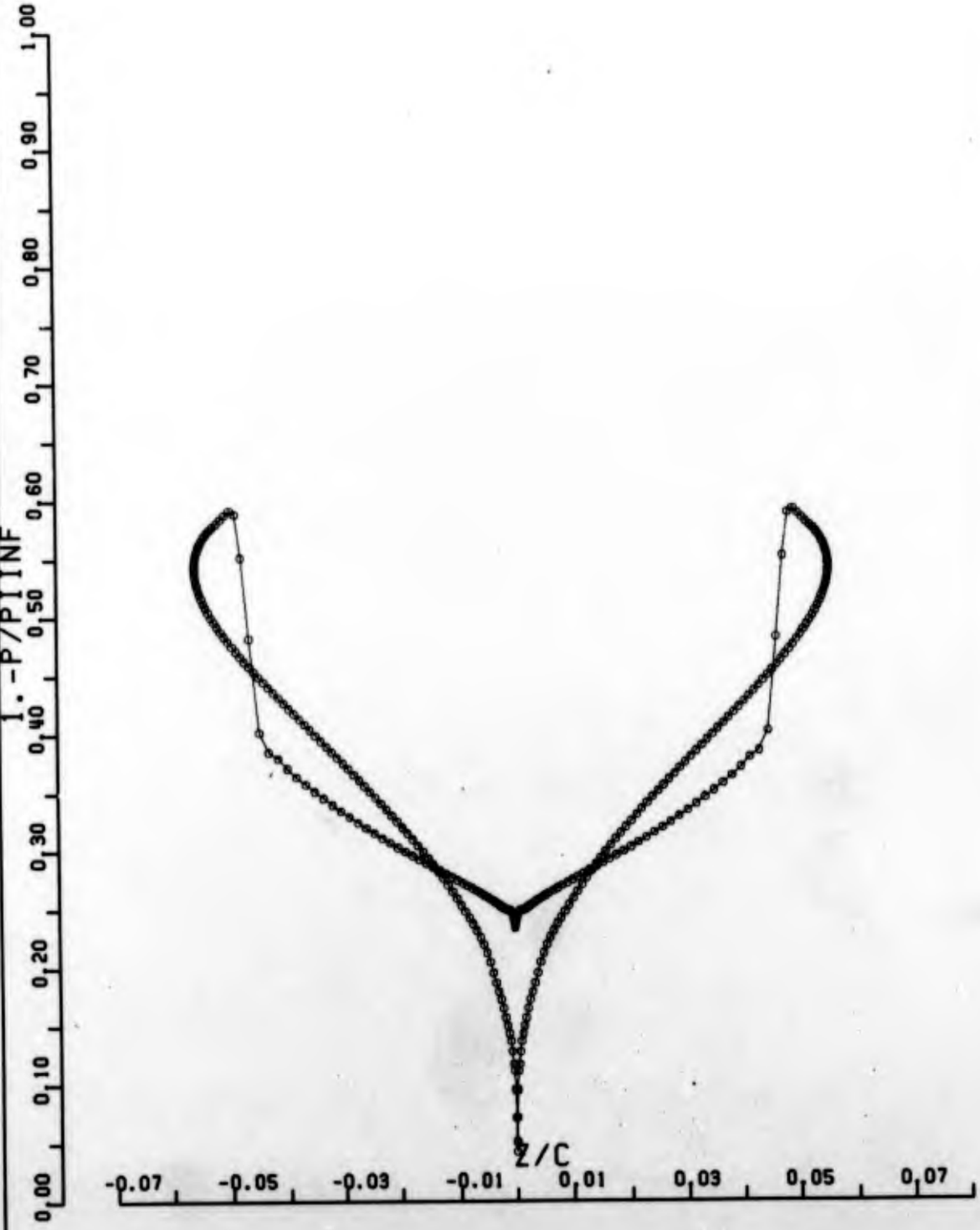


FIG. : 1.-P/PIINF VS. Z/C ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-37
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

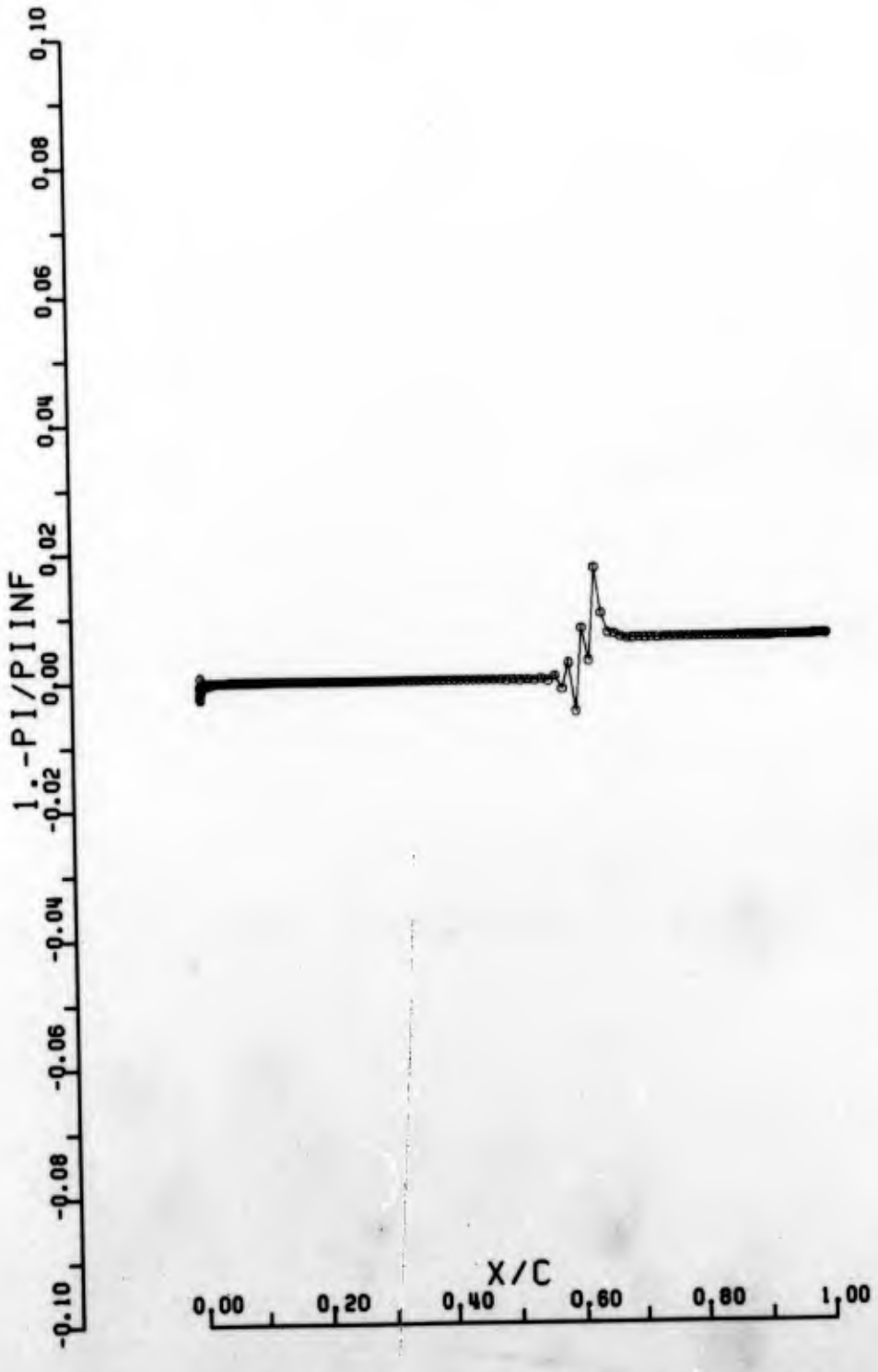


FIG. : 1.-PI/PIINF VS. X/C ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-38
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

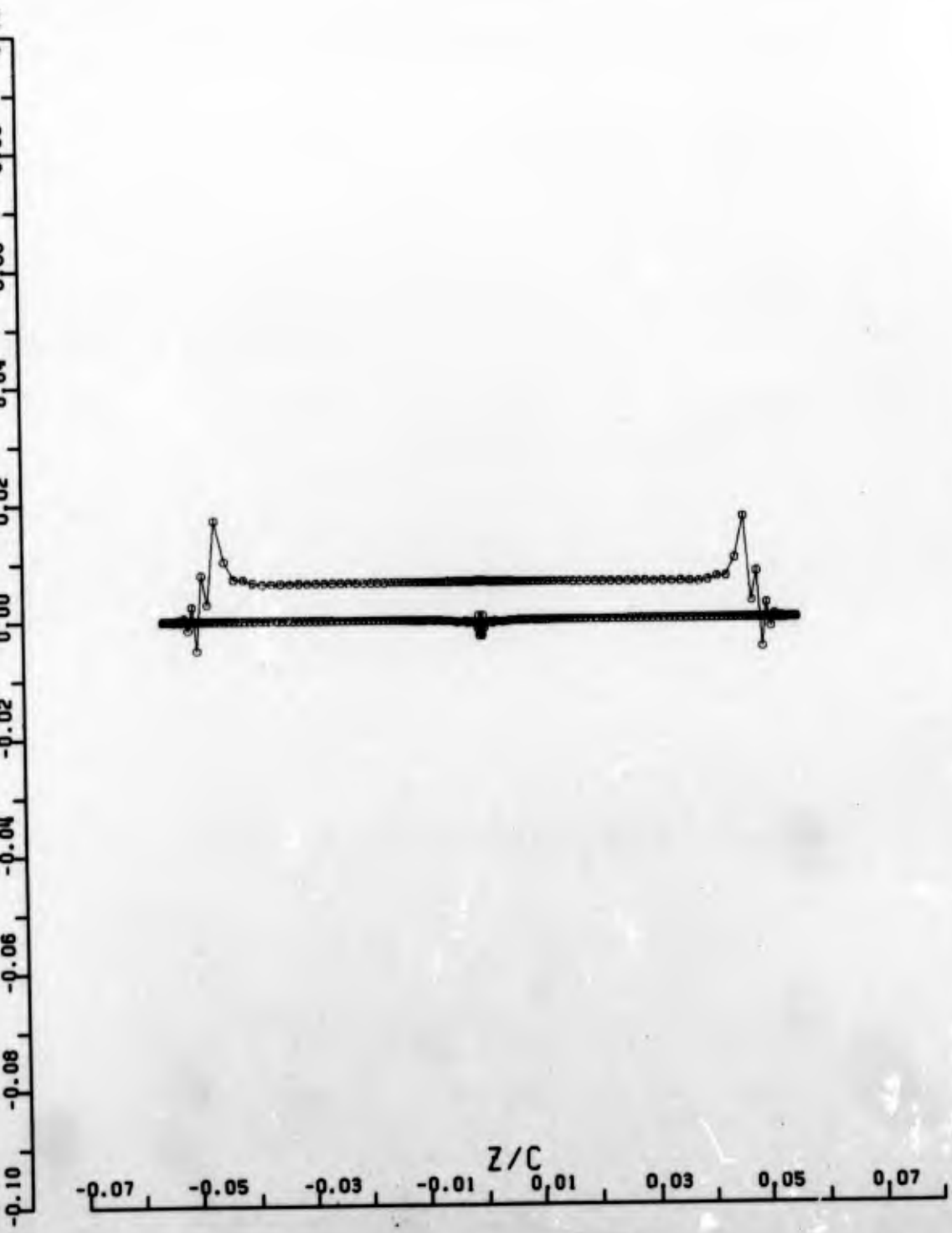


FIG. : 1.-PI/PIINF VS. Z/C ON CHIOCCHIA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-39
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

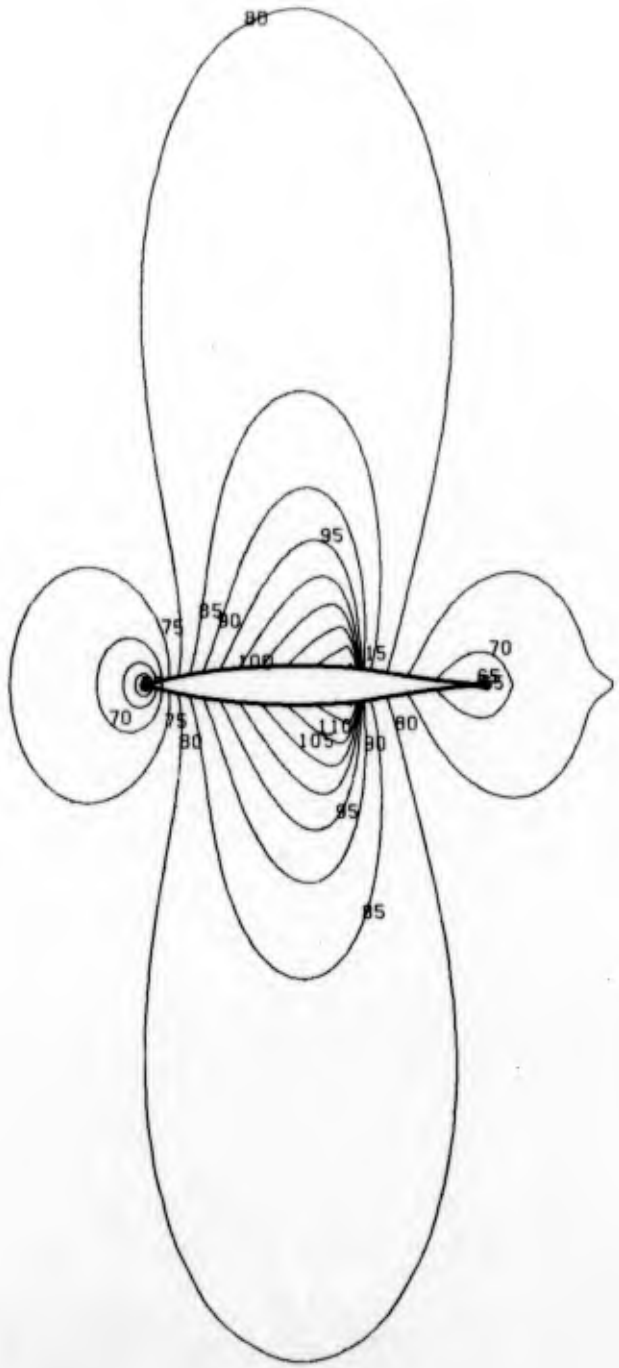


FIG. : ISO-MACH (DELTA = 0.050)

××× VALUES OF CURVE PARAMETER = 100×MACH ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-40
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

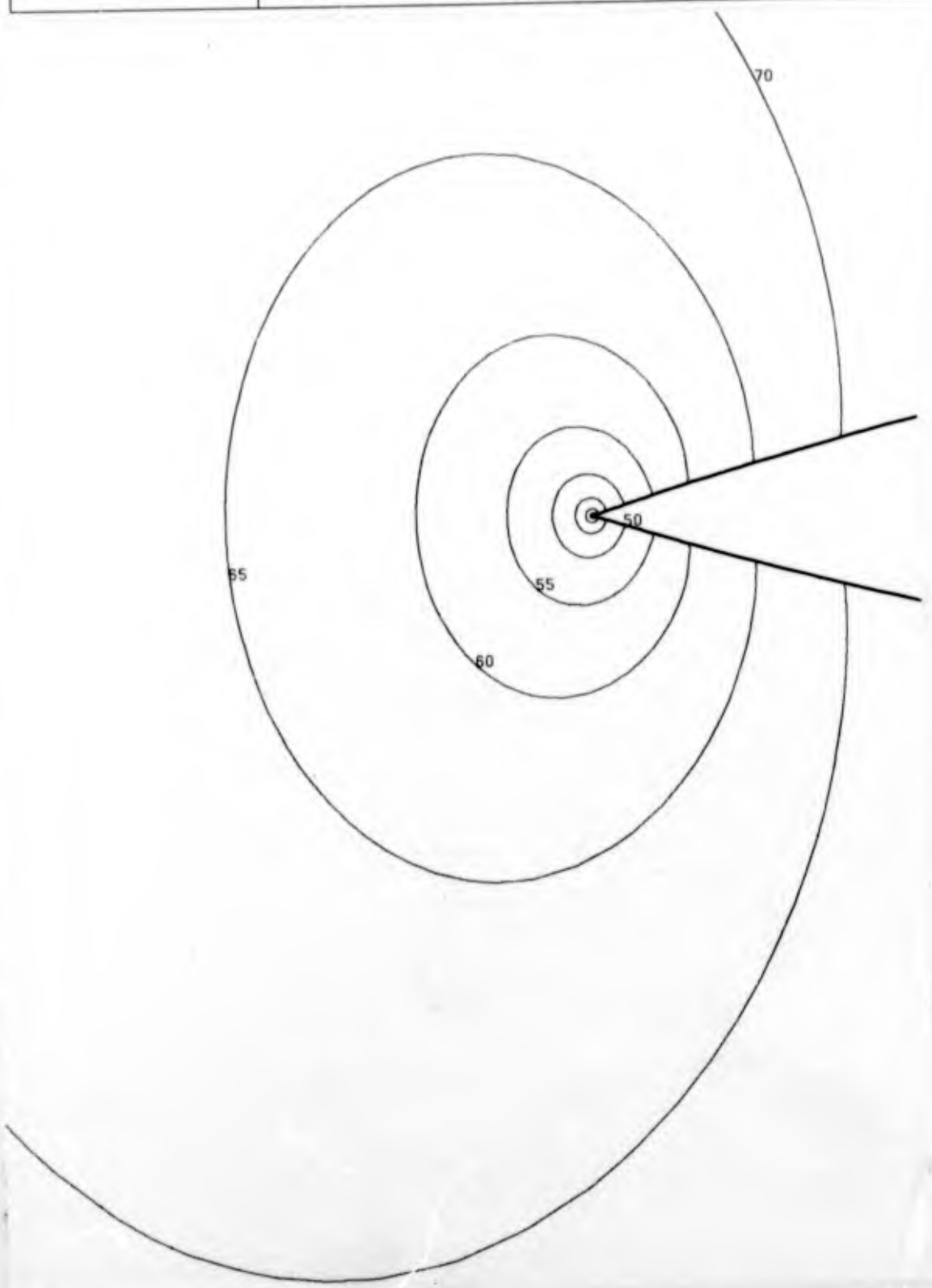


FIG. : ISO-MACH (DELTA = 0.050)

*** VALUES OF CURVE PARAMETER = 100*MACH ***

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-41
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

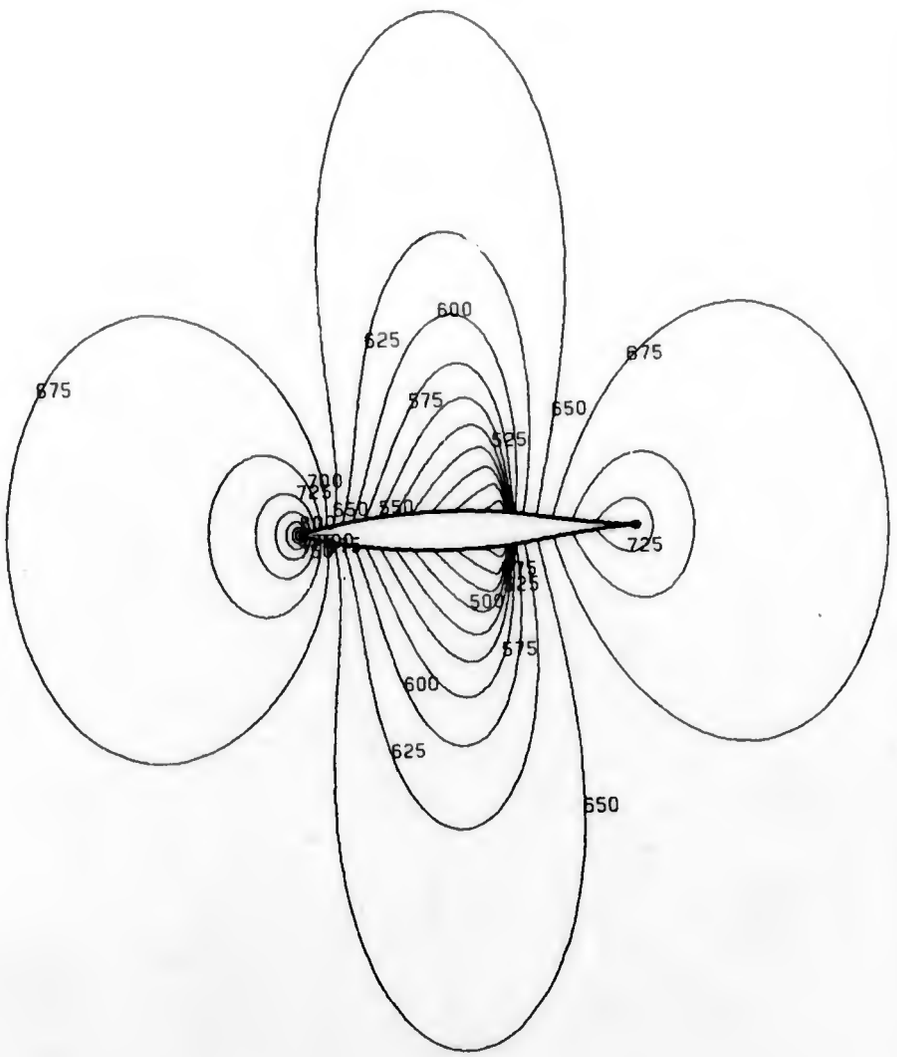


FIG. : ISO-P/PIINF (DELTA = 0.025)

××× VALUES OF CURVE PARAMEJER = 1000×P/PIINF ×××

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	08-9-42
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.785, ALPHA = 0			

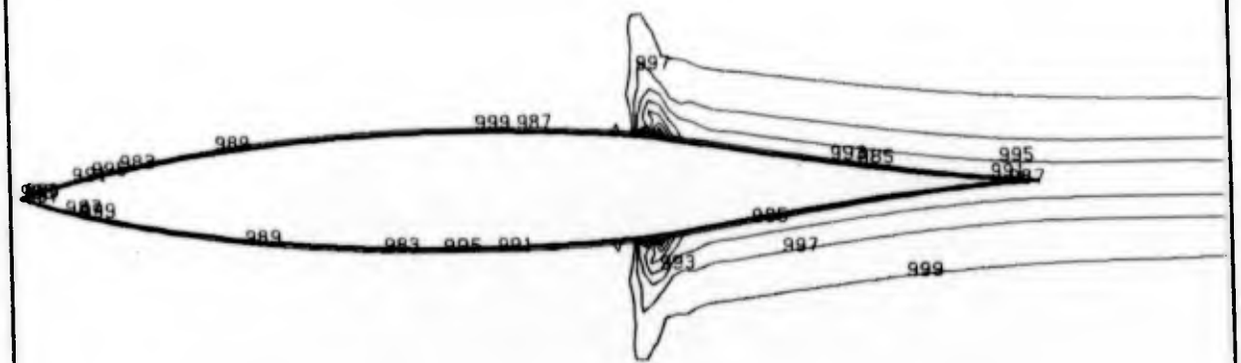


FIG. : ISO-PI/PIINF (DELTA = 0.0020)

*** VALUES OF CURVE PARAMETER = 1000*PI/PIINF ***

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 08

CHIOCCHIA-NOCILLA profile:

MACH = 0.769041, ALPHA = 0

Contributor No 11

A.Dadone

(University of Bari, Italy)

	AR 211		A.Dadone	08-11-1
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

COMPUTATION OF CHIOCCHIA AIRFOIL FLOW THROUGH A PERTURBATION IMPLICIT LAMBDA SCHEME

by Andrea Dadone
Professor - Istituto di Macchine, Università di Bari, Italy

The "Implicit Lambda Scheme" (1;2) takes use of characteristic-type variables so that windward differences are used and then the direction of wave propagation phenomena is correctly accounted for. However, when computing a compressible flow around an airfoil or inside a cascade by means of a rather coarse mesh, inaccurate results and, in particular, too many spurious total pressure losses are usually obtained around the leading and trailing edges, where the numerical method is not able to accurately model the large gradients present in the flow field(of course, local grid refinements are an adeguate but expensive remedy). This problem can be solved through a "perturbation formulation".

The "Perturbation Implicit Lambda Scheme" (3) can be considered an extension of the "Implicit Lambda Scheme"; it takes use of new characteristic-type variables, which are the difference between the original variable and its steady state value, corresponding to a suitable "incompressible flow solution". In this way the perturbative solution does not present large gradients around the stagnation points and accurate results can be obtained, provided that the "incompressible flow problem" has been computed accurately. Being this scheme a completely new technique, many aspects still need deeper investigations for a better understanding of its peculiarities.

The governing equations are:

$$\delta C_t+\delta D_t+G\{\lambda_{C1}\delta C_\psi+\lambda_{D1}\delta D_\psi+\lambda_{C2}(\delta C_\phi+\delta D_\phi)\} = -2G\{(\Phi_1\delta v_2+\Phi_2\delta v_1)\ \delta v_2 +k_1\delta v_1+k_2\delta v_2+k_3\ \}$$

$$\delta E_t+\delta F_t+G\{\lambda_{E1}(\delta E_\psi+\delta F_\psi)+\lambda_{E2}\delta E_\phi+\lambda_{F2}\delta F_\phi\} = 2G\{(\Phi_2\delta v_1+\Phi_1\delta v_2)\,\delta v_1 + k_4\delta v_2+k_5\}$$

$$\delta C_t-\delta D_t+\delta E_t-\delta F_t+2G\{\lambda_{C1}\delta C_\psi-\lambda_{D1}\delta D_\psi+\lambda_{E2}\delta E_\phi-\lambda_{F2}\delta F_\phi\} = 4G\{(\Phi_1\delta v_1 - \Phi_2\delta v_2)\delta A+k_6\delta v_1+k_7\delta v_2+k_8\}$$

$$\delta C-\delta D-\delta E+\delta F = 0$$

where: C, D, E, F are the four original bicharacteristic variables and λ_{Zi} (Z=C,D,E,F; i=1,2) are the i-components of the slope of the associated characteristic lines; v_i (i=1,2) are the i-components of the velocity; G, Φ_1, Φ_2 are coefficients depending on the conformal mapping, while the coefficients k_j (j=1÷8) depend on the "incompressible solution"; ϕ, ψ and t are the orthogonal curvilinear coordinates and time, while the corresponding subscripts indicate partial derivatives; finally, δ represents the perturbation with respect to the"incompressible" solution.

The governing equations are then written in incremental form and linearized in time, by neglecting terms of order Δt^2; the Douglas and Gunn ADI procedure is finally applied to the resulting linear system of equations.

For the present computation a potential flow net (ϕ, ψ) is used with the leading and trailing edges,together with the profile discontinuity, imbedded in mesh intervals; moreover, the body meshpoint downstream of the profile discontinuity is interpolated between the nearest body meshpoints taking into account the usual oblique shock relations. The calculation is started with the "incompressible solution", i.e. no perturbation inside the flow field is initially assumed.

The boundary conditions, described in details in Ref. 2, are here used:

- at the inlet boundary, the total temperature is assumed to be equal to the freestream total temperature and the velocity vector is assumed to be tangent to the incompressible

flow streamline;

- at the outlet boundary, the pressure decay law of the "incompressible flow" is imposed and the pressure level is prescribed at one of the outlet boundary gridpoints;
- the incompressible farfield streamline is supposed to remain a streamline in compressible flow conditions.

The inlet boundary is 37% of a chord upstream of the leading edge, the outlet boundary 126% downstream of the trailing edge, the incompressible farfield streamline 127% from the airfoil axis.

The isobar and isomach lines are obtained through a linear interpolation between meshpoints values; so, the isobar and isomach lines next to the leading or trailing edges are a little misplaced because of the imbedding of such edges in a mesh (a better description of isobar and isomach patterns in these regions can be obtained by taking into account the perturbative nature of the formulation and the "incompressible solution").

References

1. A. Dadone, M. Napolitano,"An Implicit Lambda Scheme",AIAA paper n. 82-0972, AIAA/ASME 3rd Joint Conference,St. Louis, Mi.,june 7-11,1982.
2. A. Dadone, M. Napolitano,"Efficient Transonic Flow Solutions to the Euler Equations",AIAA paper n. 83-0258,AIAA 21st Aerospace Sciences Meeting, Reno,Nv.,january 10-13,1983.
3. A. Dadone, M. Napolitano, "A Perturbation Implicit Lambda Scheme", to be published.

	AR 211		A.Dadone	08-11-4
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

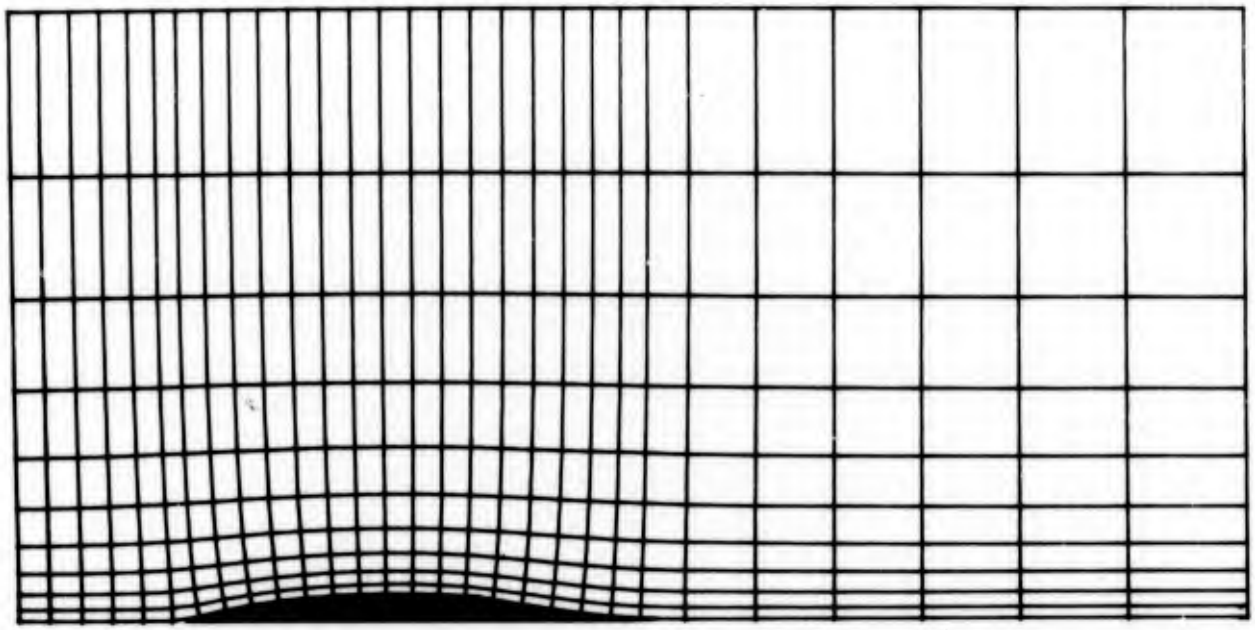
CHIOCCHIA AIRFOIL MACH = 0.769 RESULTS ON THE AIRFOIL SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
7	.028270	.008410	.244560	.283034	.647092	-.001027
8	.084820	.021880	.326146	-.008430	.772220	.000390
9	.141360	.032450	.384349	-.216356	.860231	.002001
10	.197900	.040720	.425036	-.361706	.923852	.001837
11	.254440	.047030	.458360	-.480755	.977092	.001546
12	.310990	.051520	.486795	-.582339	1.023472	.001357
13	.367540	.054300	.510709	-.667769	1.063437	.001136
14	.424080	.055520	.531344	-.741488	1.098710	.000955
15	.480620	.055180	.548751	-.803674	1.129132	.000796
16	.537170	.053310	.560945	-.847235	1.150902	.000613
17	.593700	.049850	.571305	-.884244	1.169634	.000517
18	.653480	.042630	.372987	-.175764	.838902	.005865
19	.716490	.032820	.340199	-.058631	.783750	.010210
20	.779480	.023280	.305197	.066411	.730177	.009459
21	.842470	.014490	.280476	.154724	.691377	.009561
22	.905460	.006970	.260786	.225066	.660051	.009715
23	.968480	.001510	.246918	.274609	.639862	.008082

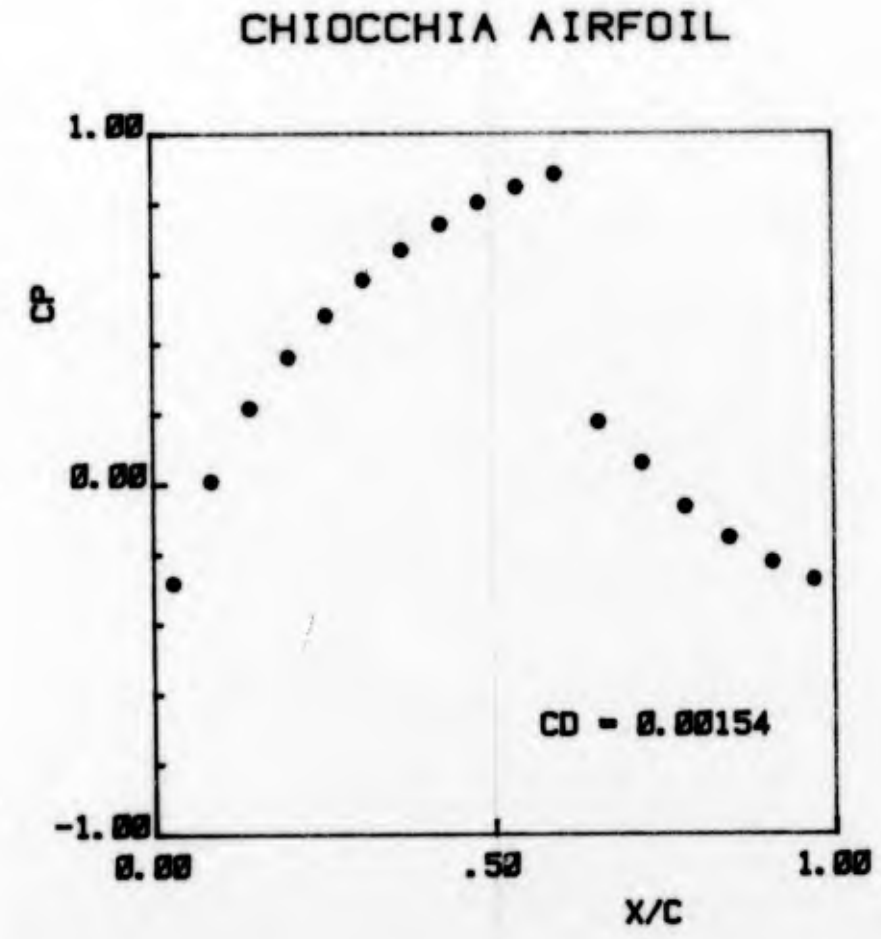
	AR 211		A.Dadone	08-11-5
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

COMPUTATIONAL MESH FOR CHIOCCHIA AIRFOIL

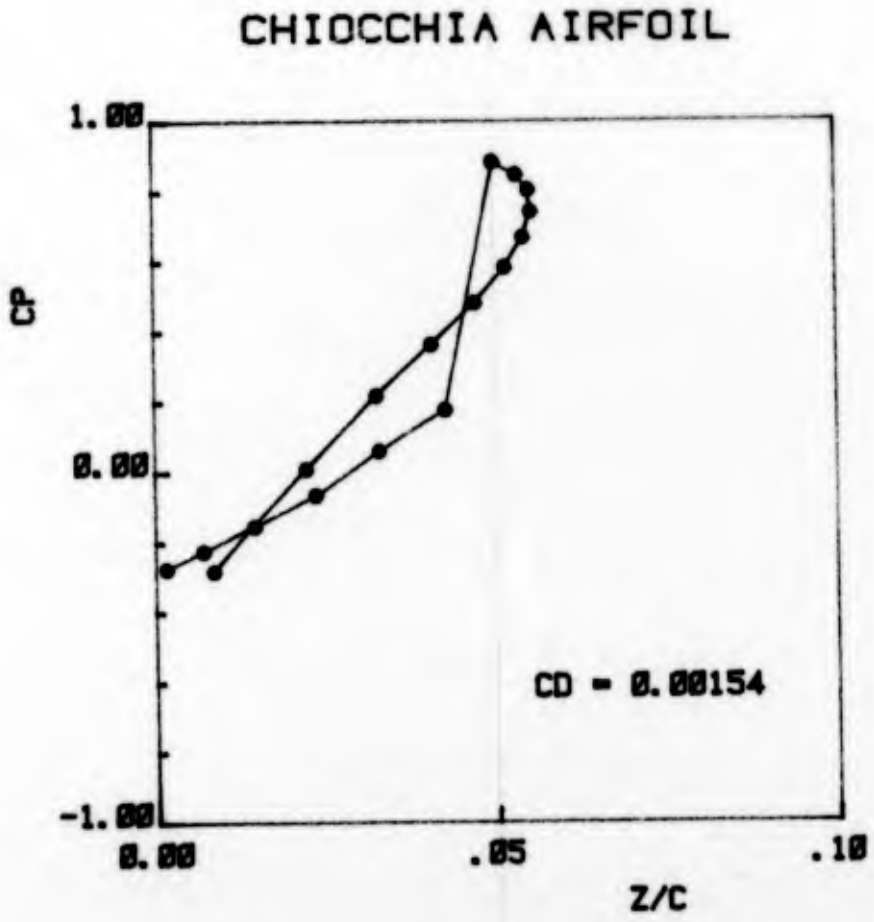
(10x20 CELLS - 17 MESHPOINTS ON THE AIRFOIL)



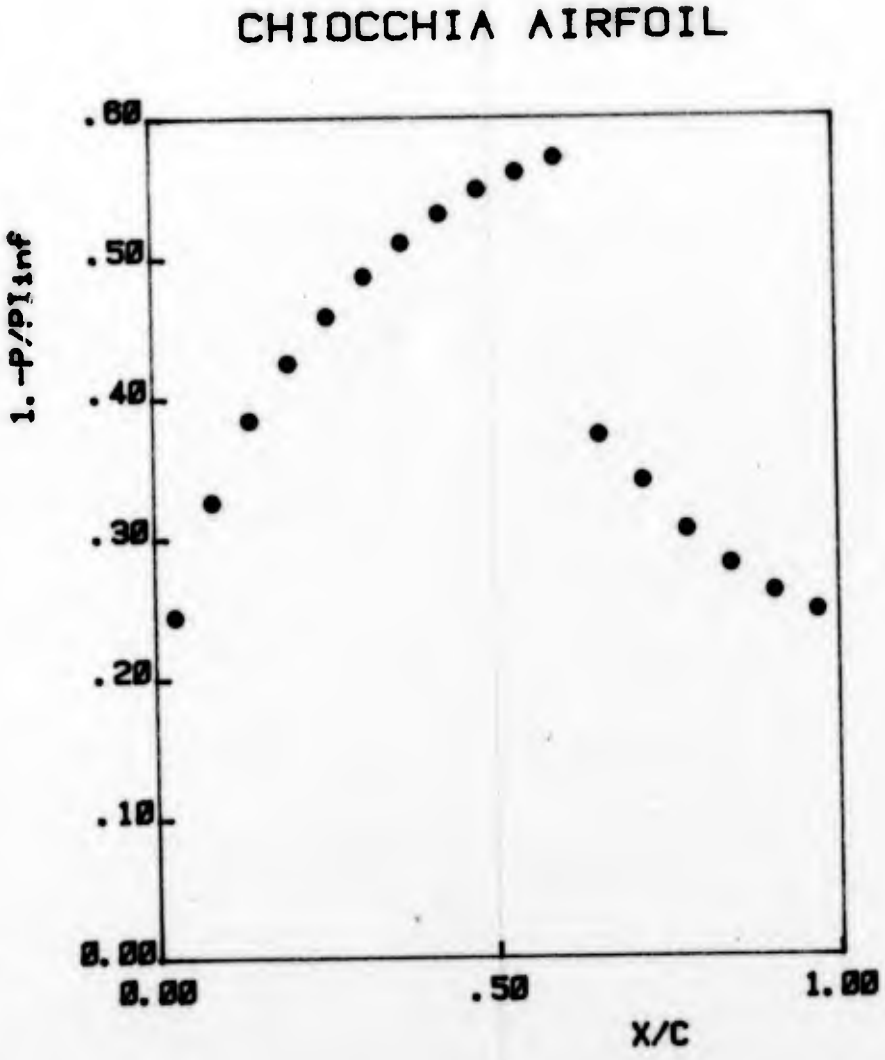
	AR 211		A.Dadone	08-11-6
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



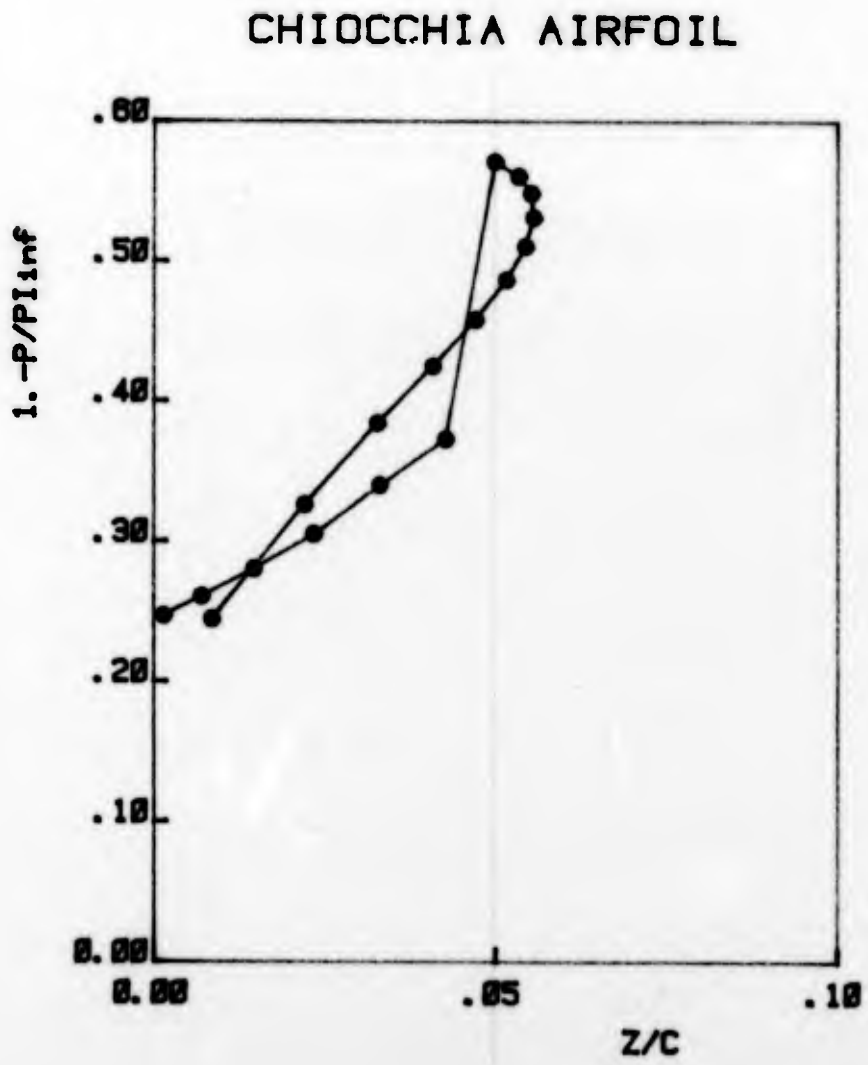
	AR 211		A.Dadone	08-11-7
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



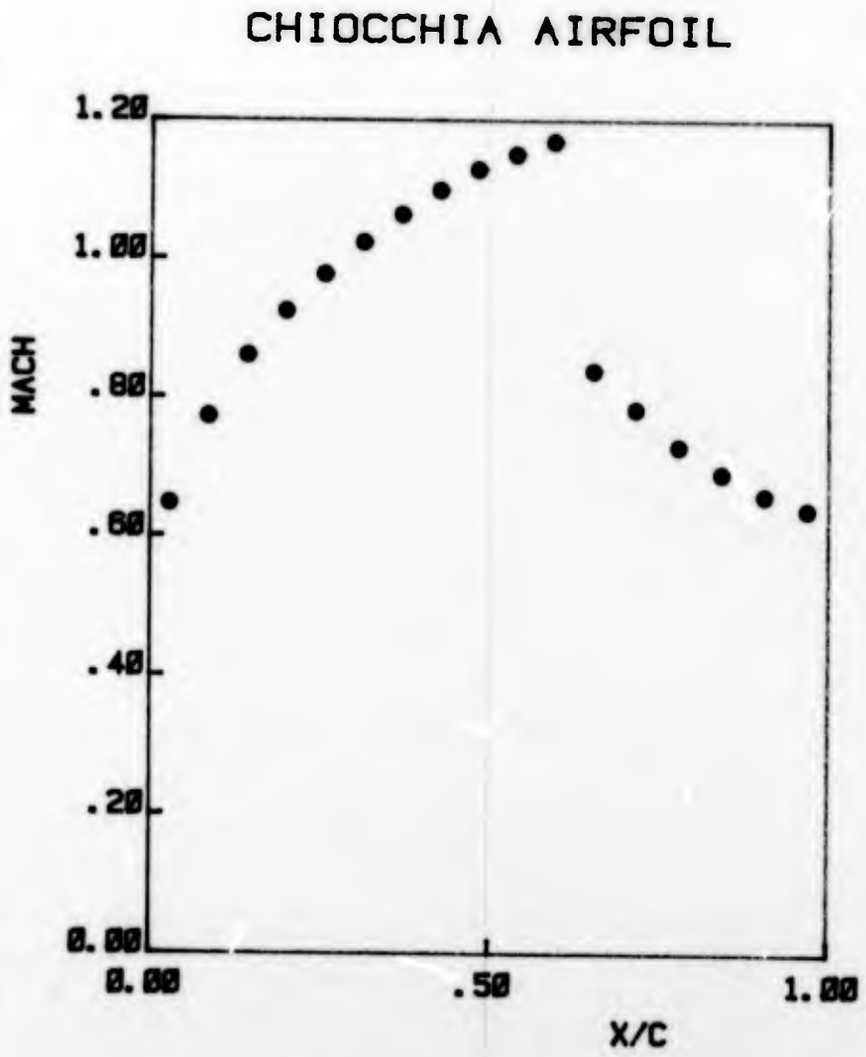
	AR 211		A.Dadone	08-11-8
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



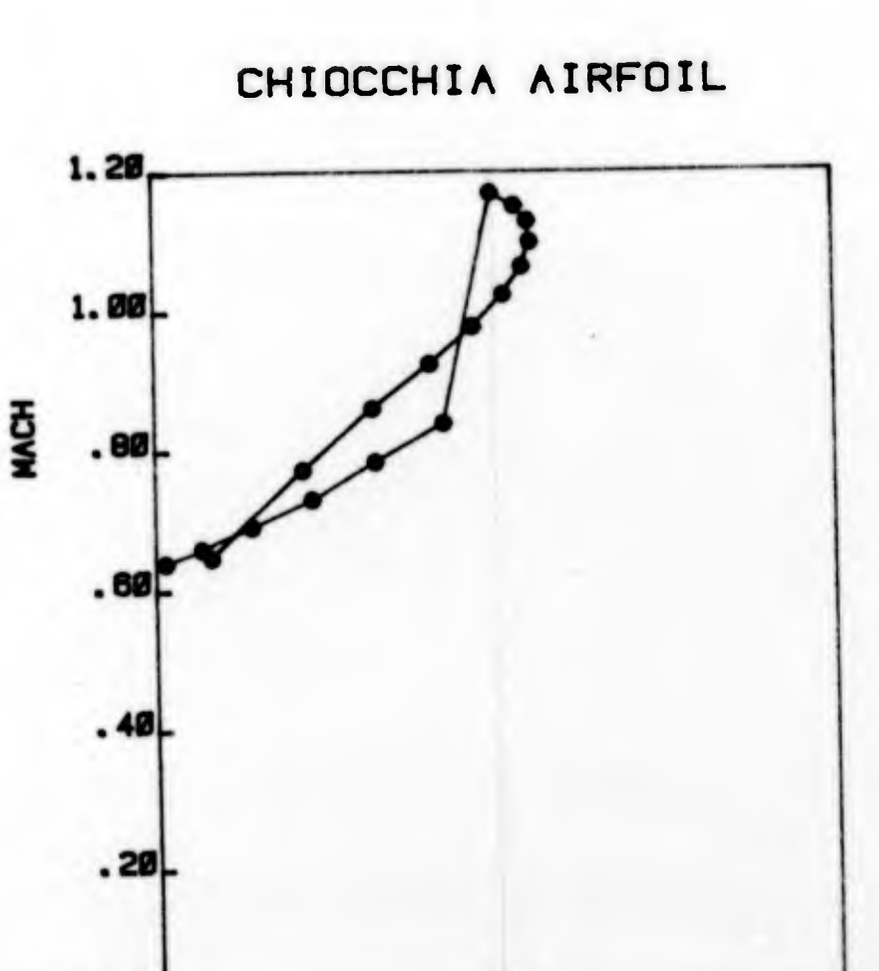
	AR 211		A.Dadone	08-11-9
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



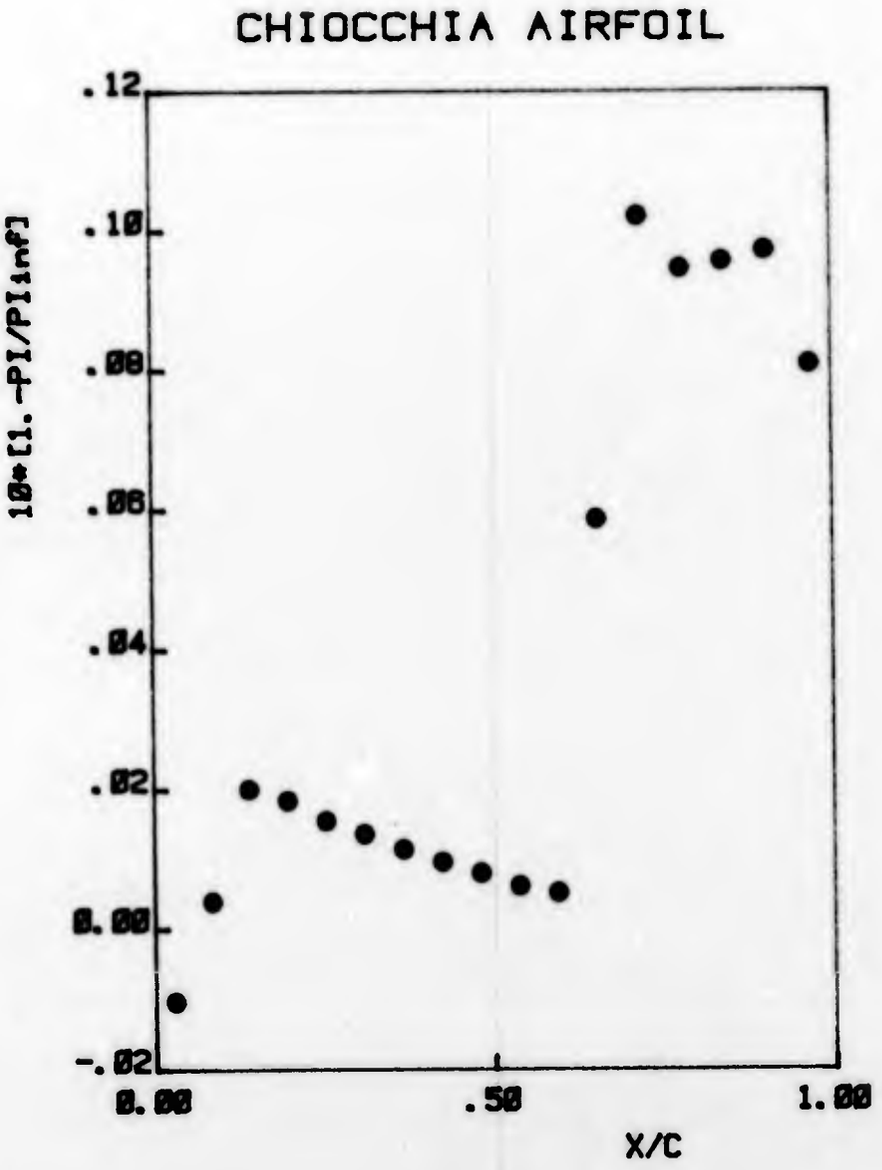
	AR 211		A.Dadone	08-11-10
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



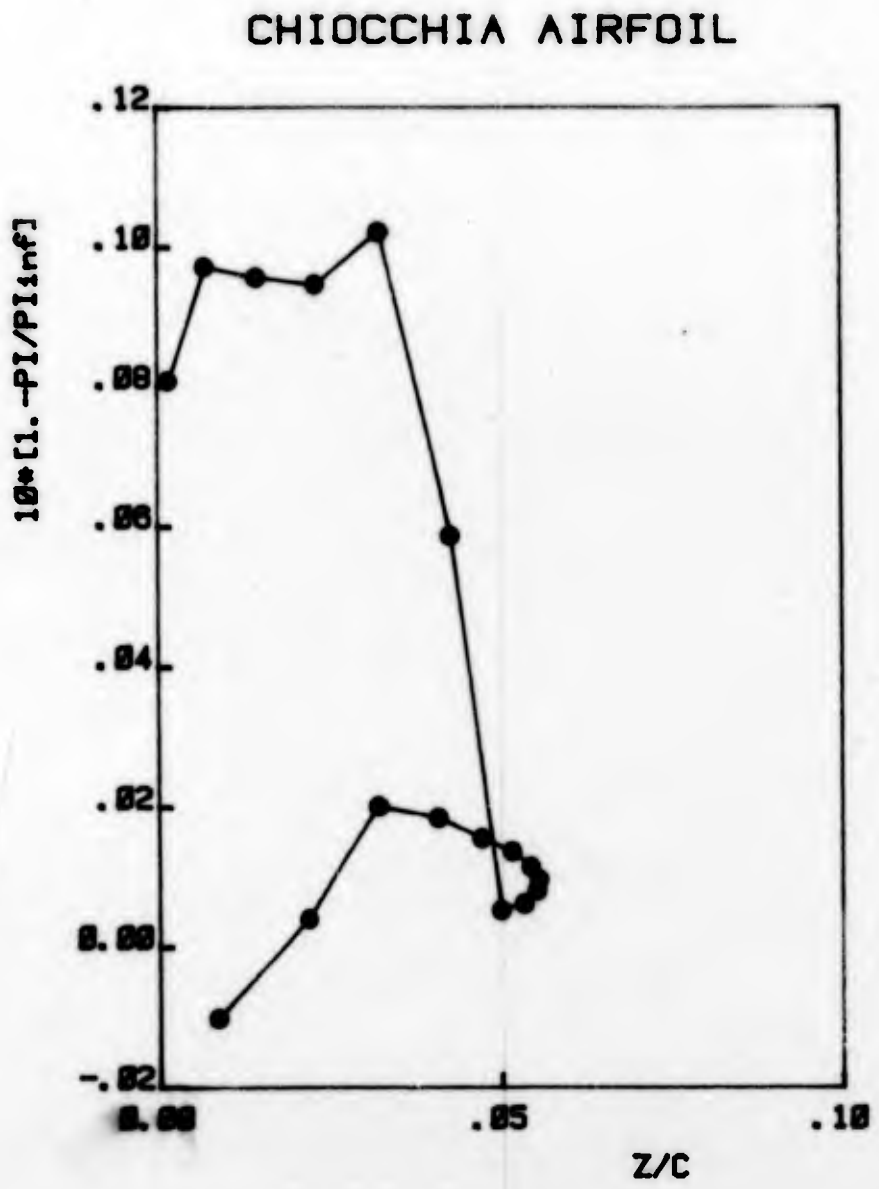
	AR 211		A.Dadone	08-11-11
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



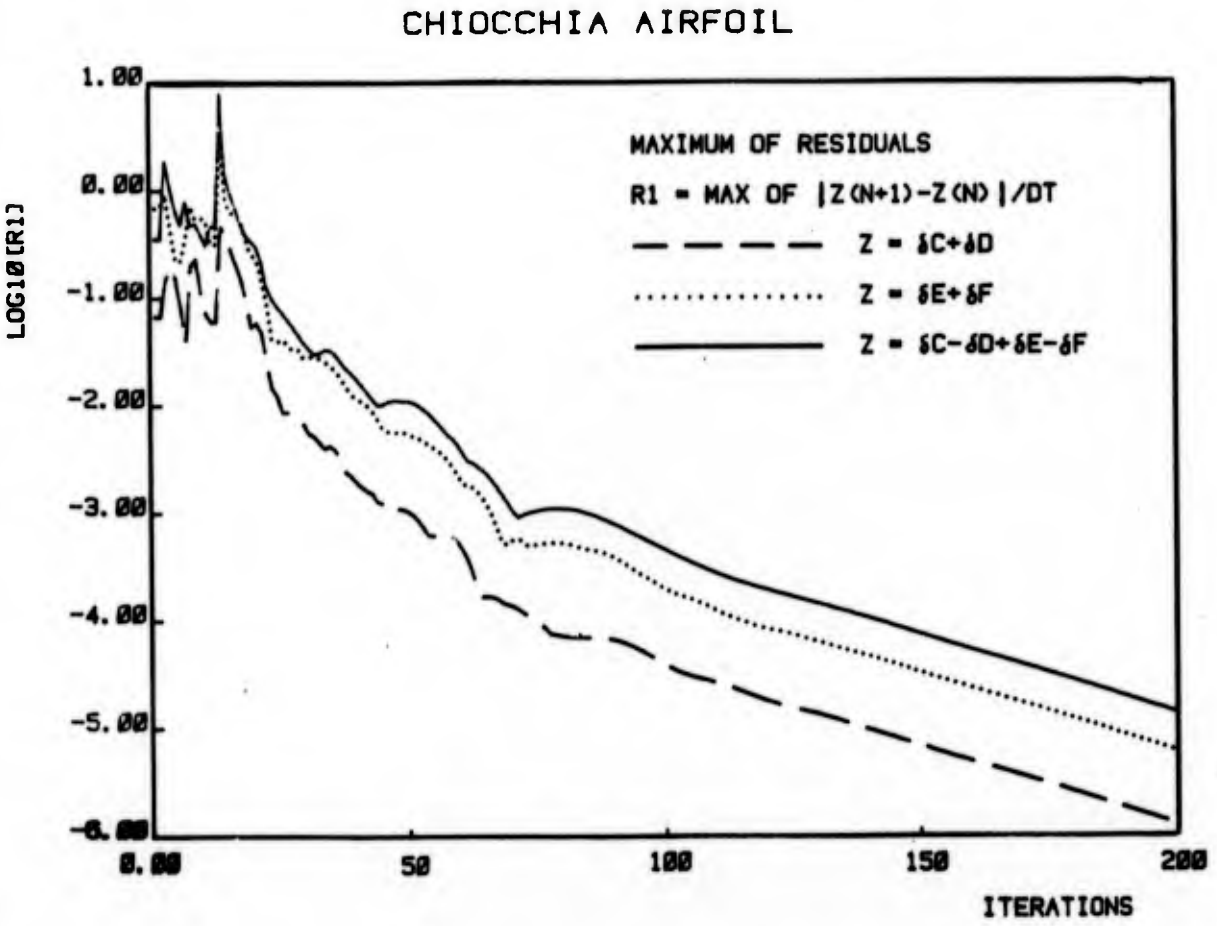
	AR 211		A.Dadone	08-11-12
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



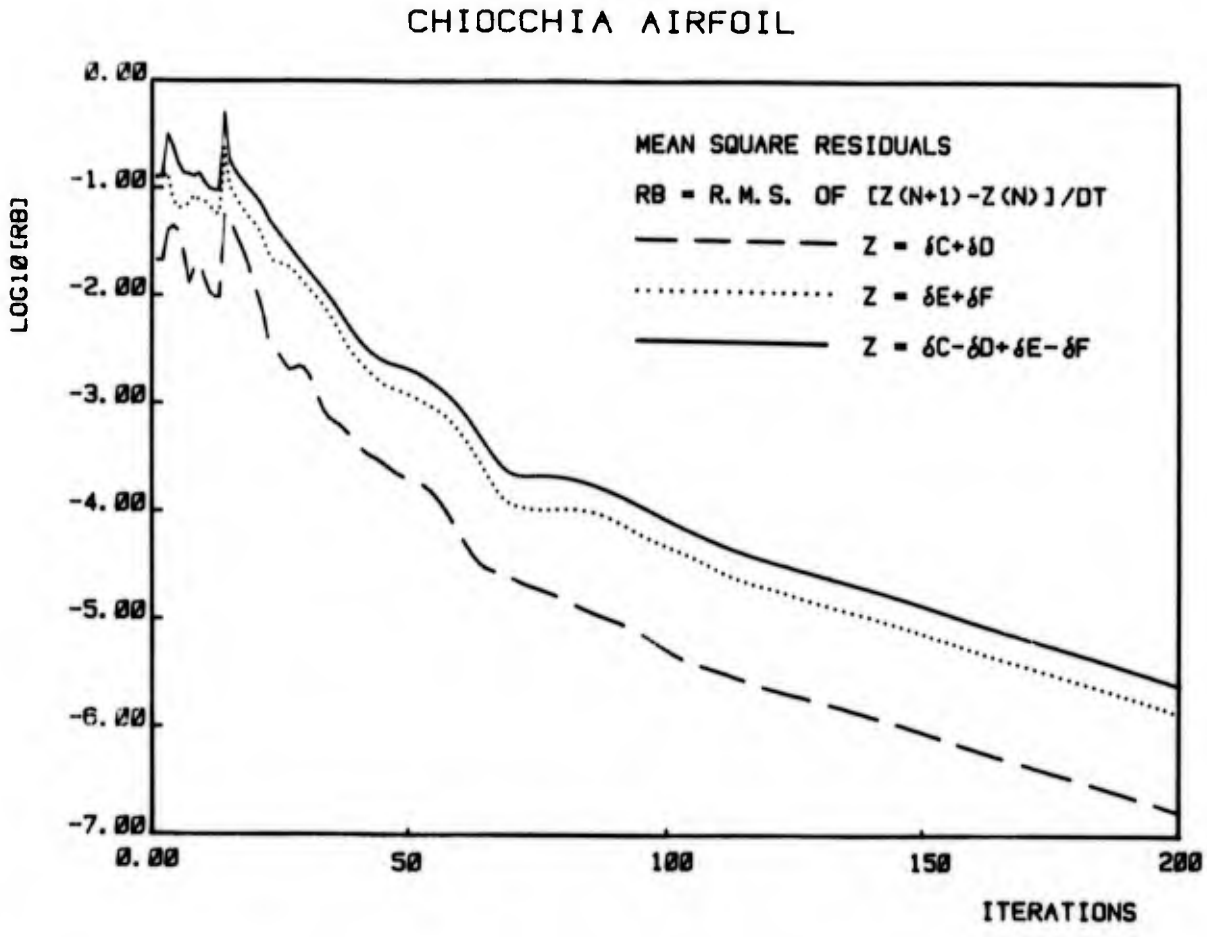
	AR 211		A.Dadone	08-11-13
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



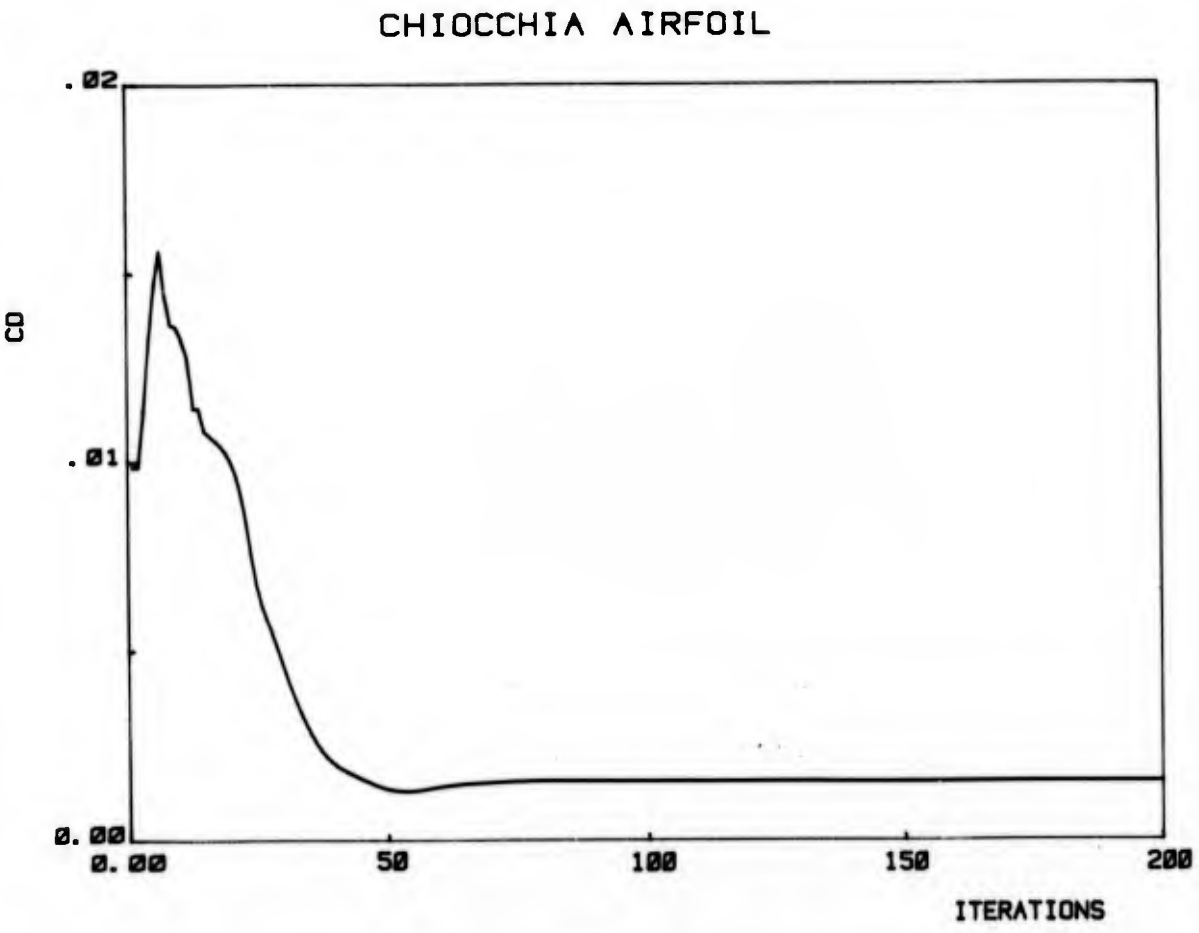
	AR 211		A.Dadone	08-11-14
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



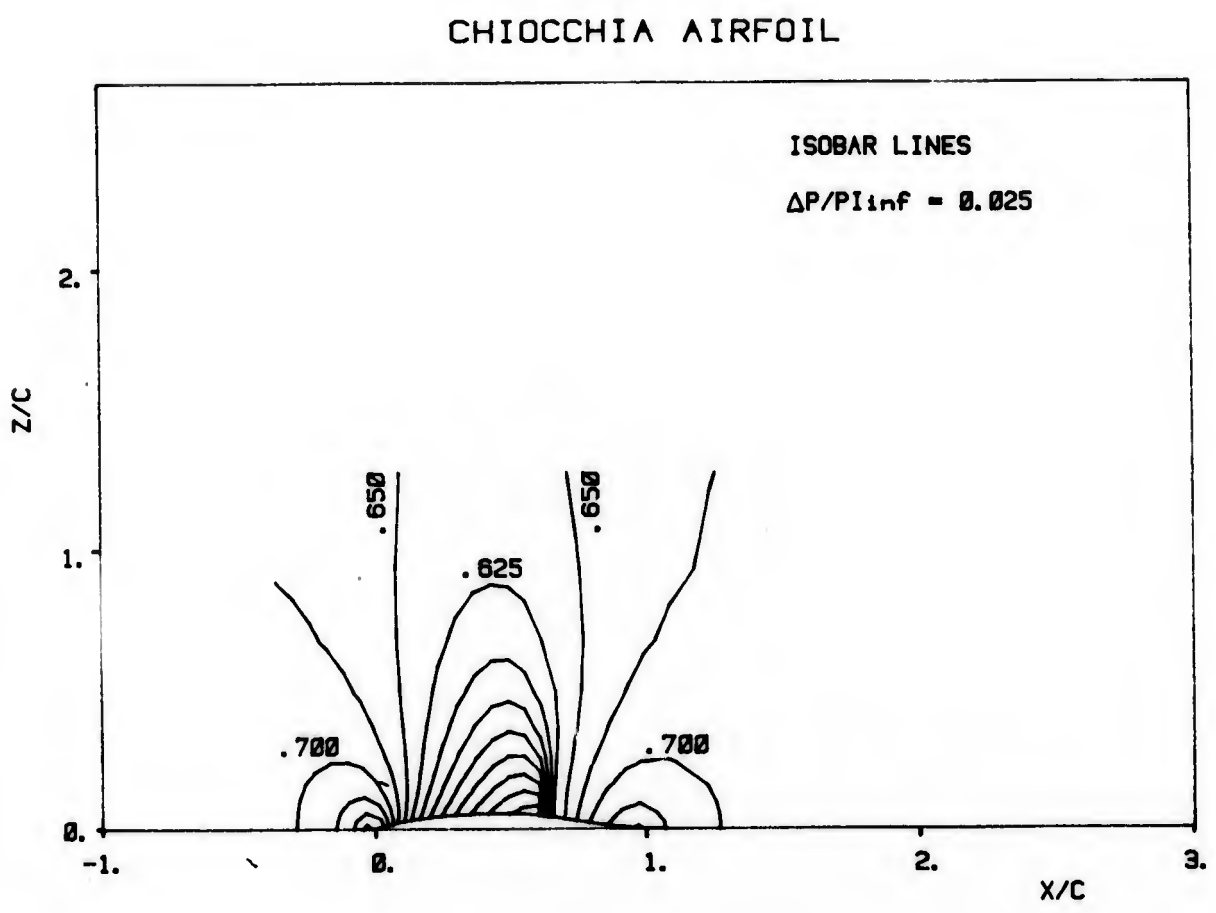
	AR 211		A.Dadone	08-11-15
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



	AR 211		A.Dadone	08-11-16
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

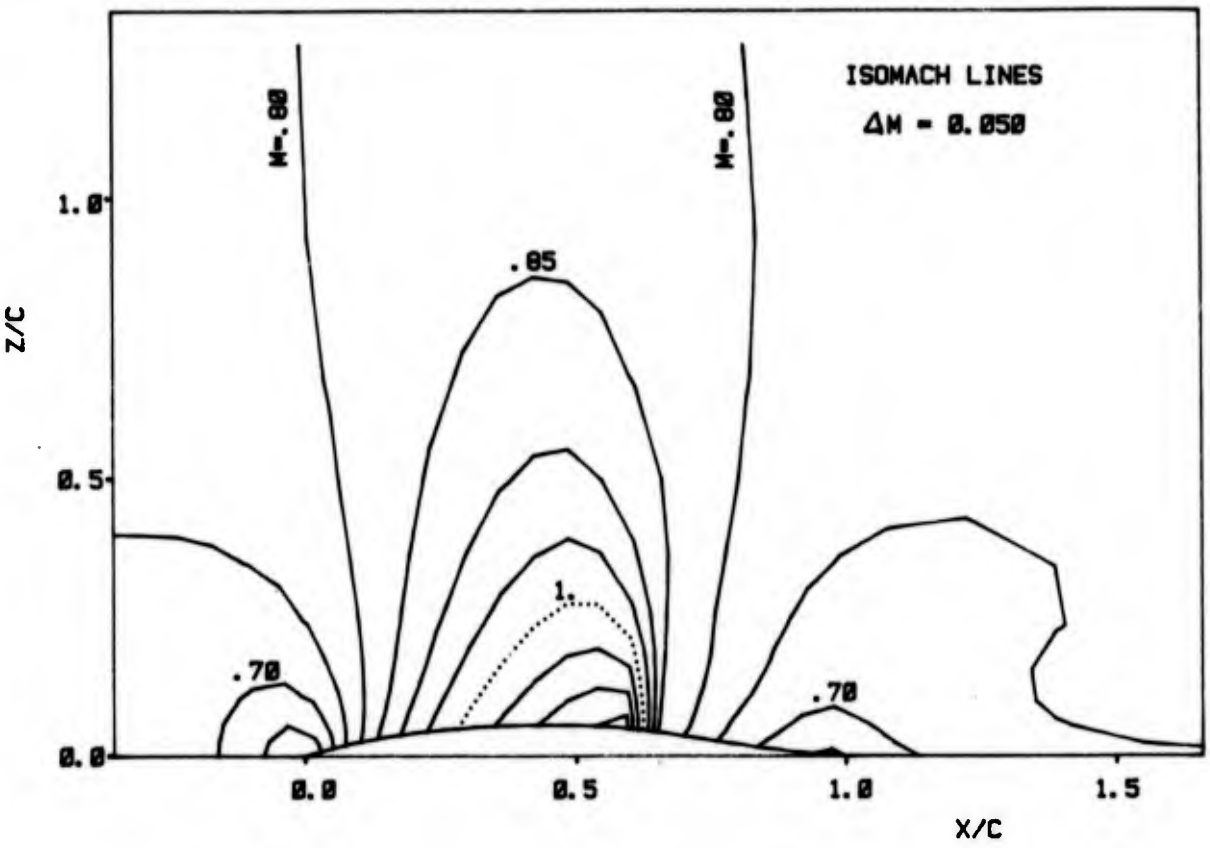


	AR 211		A.Dadone	08-11-17
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



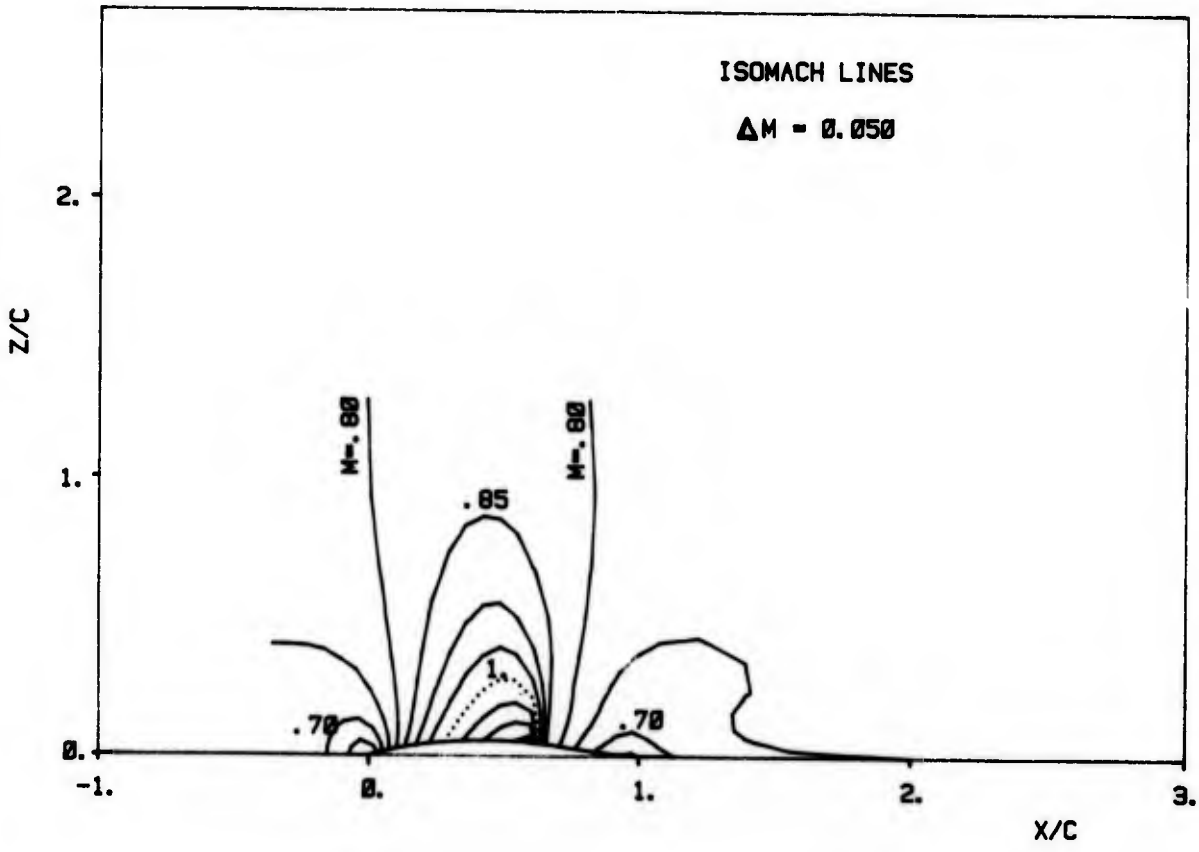
	AR 211		A.Dadone	08-11-18
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

CHIOCCHIA AIRFOIL

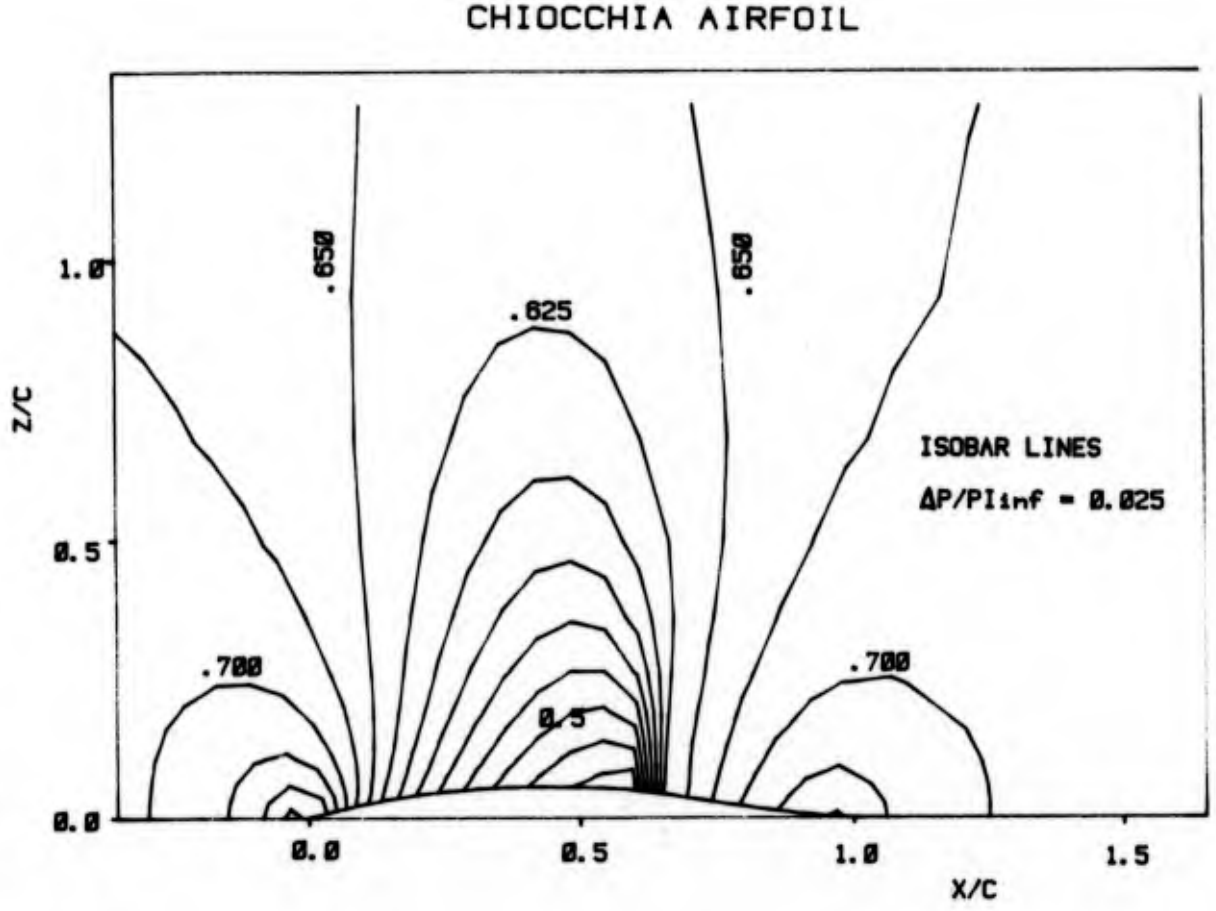


	AR 211		A.Dadone	08-11-19
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			

CHIOCCHIA AIRFOIL



	AR 211		A.Dadone	08-11-20
	CHIOCCHIA-NOCILLA PROFILE: MACH = 0.769041, ALPHA = 0			



AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 09

HOBSON 1 cascade:

MACH = 0.476, ALPHA = 43.544

Contributor No 12

G.Meauze and A Lesain

(O.N.E.R.A., France)

BLADE CASCADE COMPUTATION - HOBSON 1 and 2

---oooOooo---

DESCRIPTION OF THE METHOD

The computation uses a 2-D time marching method for EULER equations with the assomption of constant enthalpy in absolute axes or constant rothalpy in moving axes. It is derived from a more general method proposed by VIVIAND and VEUILLOT (ref. 1) and applied by SOVRANO (ref 2) to the case of a rotating cascade placed between two axisymmetric surfaces the mean radius and the width of which vary along the blade chord.

The system of equations is numerically solved using the time marching method with the MAC-CORMACK type predictor-corrector steps.

As described in ref. 1, the method can be applied to any kind of curvilinear meshes. The boundary conditions are taken into account by means of compatibility relations, as given also in ref. 1, with the exception of the condition of periodicity that is imposed at each predictor and corrector step, in a way that is conform to the general method used.

Near orthogonal grids are used, as shown on the test cases given below. There exists, however, a difficulty prescribing the periodicity condition, since in these near orthogonal mesh systems there are no corresponding points on the limiting stream lines. It is therefore necessary to use spline functions for interpolations.

The boundary conditions prescribed in the case of the computations, the results of which are given below are the following :

- upstream stagnation conditions are given,
- upstream flow angle is given,
- downstream static pressure is imposed,
- a Kutta-Joukovski condition is simulated at the subsonic trailing edge by prescribing the flow direction immediately donwnstream of this trailing edge. This direction is chosen to minimize the pressure difference between blade pressure and suction sides near this trailing edge.

For each case a table summarizes the mean cascade characteristics, obtained by taking a mean value of the various parameters along a line parallel to the cascade front. The results of the computation are compared to their theoretical values.

Contributors : A. LESAIN, G. MEAUZE.

[1] Viviand H. et Veuillot J.-P. : Méthodes pseudo-instationnaires pour le calcul d'écoulements transsoniques.
ONERA Publication n° 1978-4.(English version ESA.TT 561 1978)

[2] Sovrano R. : Calcul de l'écoulement transsonique dans un compresseur centrifuge par une méthode pseudo-instationnaire.
ONERA T.P. n° 1980-42.

HOBSON 1

	Mean calculated value	Assigned value	Theoretical value
Inlet Mach Number	0,485		0,476
Inlet angle	43,54°	43,54°	43,54°
Exit Mach Number	0,475		0,476
Exit angle	-42,25°		-43,54°
Total pressure ratio	0,994		1
Static over total pressure ratio	0,8565	0,8563	0,8563

O.N.E.R.A.	AR 211		G.Meauze A.Lesain	09-12-3
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			

CASCADE HOBSON-1 .RESULTS ON THE SUCTION SIDE :

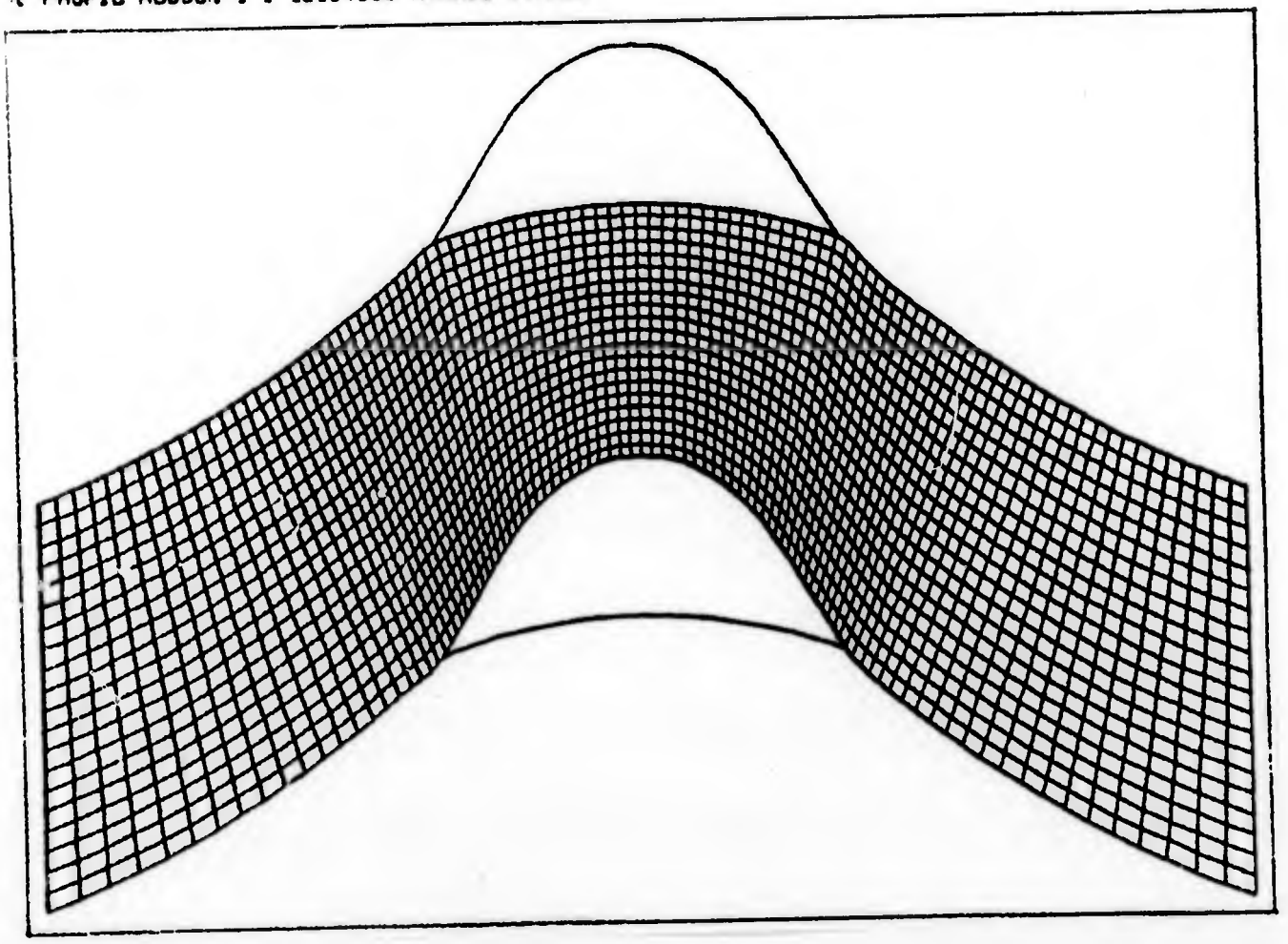
I	X/C	Y/C	1-P/PIINF	CP	MACH	1-PI/PIINF
23	.004043	.007098	.036960	.782472	.300360	-.025242
24	.018907	.032226	.108886	.247709	.398631	.005763
25	.032401	.055004	.099840	.314964	.399400	-.004748
26	.045848	.077660	.119496	.168825	.432426	-.001246
27	.059626	.100811	.130200	.089248	.454559	-.002239
28	.073411	.123893	.143151	-.007045	.477196	-.001385
29	.087177	.146834	.153296	-.082470	.495139	-.001136
30	.101024	.169765	.163615	-.159189	.513005	-.000872
31	.114985	.192658	.175237	-.245600	.533021	-.000774
32	.129064	.215464	.189418	-.351030	.556848	-.000589
33	.143235	.238205	.206362	-.477005	.584568	-.000257
34	.157572	.260851	.226922	-.629868	.617679	.000005
35	.172272	.283258	.253307	-.826038	.659526	.000142
36	.187569	.305270	.286734	-1.074558	.711487	.000362
37	.203706	.326669	.323999	-1.351622	.768816	.000491
38	.220890	.347245	.357812	-1.603018	.820243	.001018
39	.239228	.366792	.383678	-1.795327	.860041	.001112
40	.258683	.385229	.406598	-1.965730	.895614	.001130
41	.279117	.402571	.428168	-2.126100	.929248	.001327
42	.300492	.418741	.449619	-2.285587	.963389	.001203
43	.322765	.433647	.471605	-2.449050	.998014	.002099
44	.345860	.447246	.498156	-2.646452	1.043305	.000101
45	.369744	.459406	.524194	-2.840040	1.083052	.005116
46	.394463	.469762	.577749	-3.238213	1.189326	-.009821
47	.420096	.477583	.679972	-3.998228	1.378169	.012309
48	.446491	.482191	.728240	-4.357087	1.486235	.022016
49	.473212	.484315	.736945	-4.421812	1.510342	.019726
50	.500000	.485055	.748302	-4.506246	1.533056	.030507
51	.526788	.484315	.758689	-4.583473	1.573186	.014165
52	.553509	.482191	.706073	-4.192279	1.428026	.026829
53	.579904	.477583	.663979	-3.879323	1.338449	.018616
54	.605537	.469762	.655359	-3.815233	1.309613	.032497
55	.630256	.459406	.541389	-2.967882	1.081307	.043122
56	.654140	.447246	.472614	-2.456549	.965947	.040140
57	.677235	.433647	.467915	-2.421616	.957240	.041121
58	.699508	.418741	.450564	-2.292610	.929296	.040389
59	.720883	.402571	.426024	-2.110163	.890581	.039060
60	.741317	.385229	.405644	-1.958636	.857863	.038908
61	.760772	.366792	.382690	-1.787977	.821437	.038555
62	.779110	.347245	.357023	-1.597150	.780452	.038547
63	.796294	.326669	.325518	-1.362913	.731426	.037318
64	.812431	.305270	.289049	-1.091772	.675908	.034522
65	.827728	.283258	.255534	-.842593	.623915	.032157
66	.842428	.260851	.228347	-.640464	.579792	.030991
67	.856765	.238205	.206993	-.481698	.543705	.030406
68	.870936	.215464	.189929	-.354630	.513960	.029985
69	.885015	.192658	.175533	-.247802	.488420	.029450
70	.898976	.169765	.163568	-.158845	.466098	.029310
71	.912823	.146834	.152743	-.078361	.445655	.028988
72	.926589	.123893	.142540	-.002504	.424900	.029196
73	.940374	.100811	.130298	.088518	.402504	.027608
74	.954152	.077660	.119813	.166467	.377490	.028843
75	.967599	.055004	.104939	.277059	.352904	.024448
76	.981093	.032226	.100873	.307286	.329694	.030580
77	.995957	.007098	.081000	.455037	.292058	.024948

CASCADE HOBSON-1 .RESULTS ON THE PRESSURE SIDE :

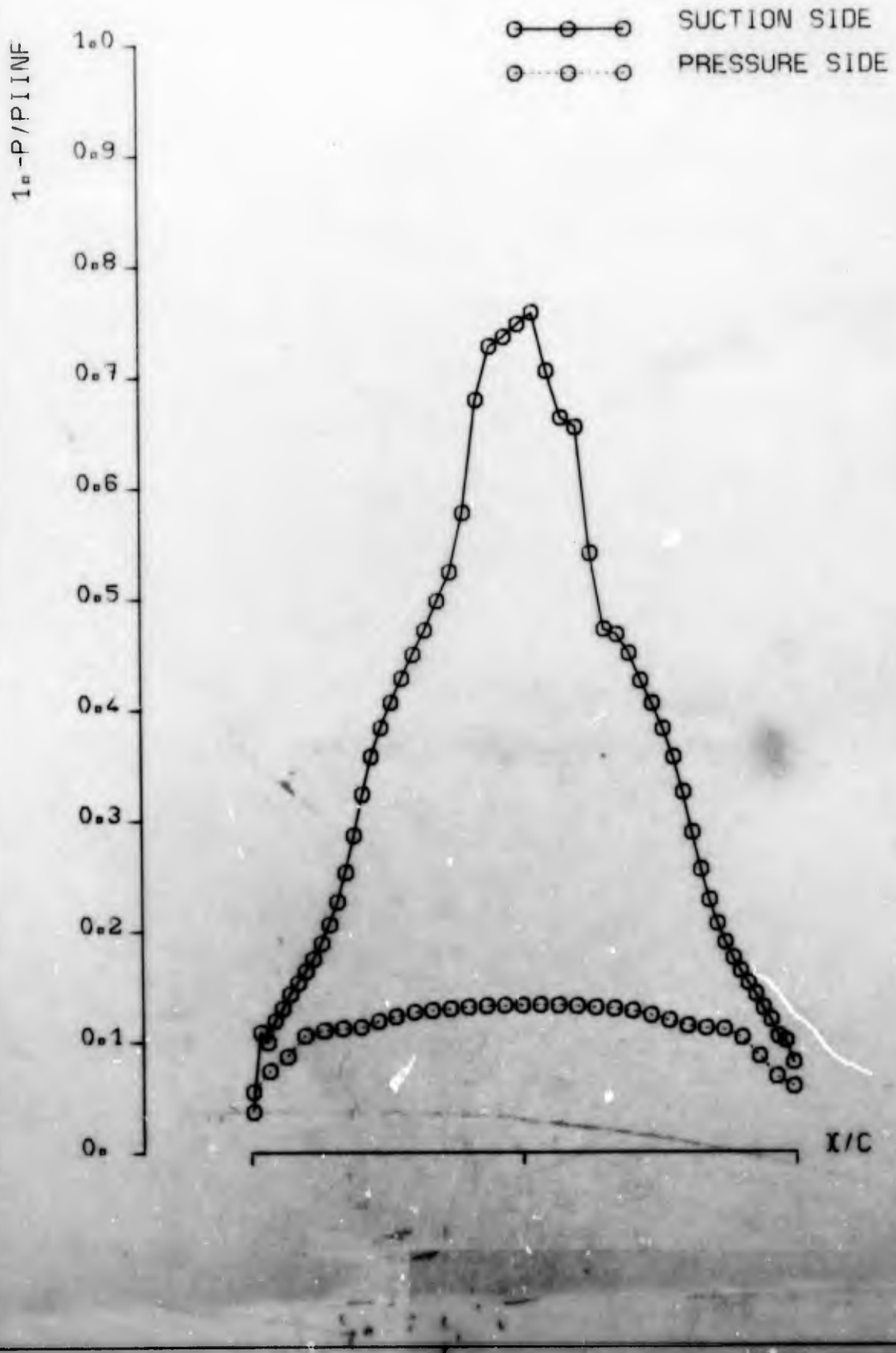
I	X/C	Y/C	1-P/PIINF	CP	MACH	1-PI/PIINF
35	.004353	.001832	.054764	.650099	.292762	-.003172
36	.035314	.013828	.073874	.508020	.322610	.004628
37	.067329	.024668	.086863	.411446	.356193	.003161
38	.099736	.034258	.105995	.269201	.391918	.006124
39	.132389	.042916	.110344	.236873	.404602	.004155
40	.165207	.050942	.112202	.223055	.409634	.003473
41	.198181	.058300	.113378	.214311	.414086	.002319
42	.231322	.064860	.118790	.174079	.423820	.002924
43	.264610	.070636	.122809	.144192	.432166	.002673
44	.298005	.075749	.126562	.116291	.439166	.002846
45	.331476	.080342	.128209	.104047	.442809	.002569
46	.365045	.084151	.129755	.092556	.445841	.002530
47	.398759	.086322	.131189	.081889	.448712	.002451
48	.432495	.088134	.132202	.074359	.450580	.002487
49	.466128	.090014	.132622	.071235	.451127	.002640
50	.500000	.090889	.132822	.069748	.451296	.002767
51	.533772	.090014	.133043	.068108	.451580	.002849
52	.567505	.088134	.132914	.069069	.451294	.002873
53	.601241	.086322	.132273	.073834	.449737	.003077
54	.634955	.084151	.130934	.083789	.447011	.003180
55	.668524	.080342	.129618	.093568	.444429	.003217
56	.701995	.075749	.127576	.108750	.440309	.003330
57	.735390	.070636	.123889	.136167	.433248	.003270
58	.768678	.064860	.119001	.172506	.423952	.003088
59	.801819	.058300	.114372	.206923	.415560	.002613
60	.834793	.050942	.112162	.223355	.411371	.002465
61	.867611	.042916	.111100	.231252	.408170	.003044
62	.900264	.034258	.103588	.287100	.389933	.004498
63	.932671	.024668	.086609	.413334	.353688	.004094
64	.964686	.013828	.068225	.550018	.315562	.001642
65	.995647	.001832	.059056	.618192	.296925	-.000306

O.N.E.R.A.	AR 211		G.Meauze A.Lesain	09-12-5
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			

[PROFIL HOBSON-1] 18.07.83 ANGLES DONNES

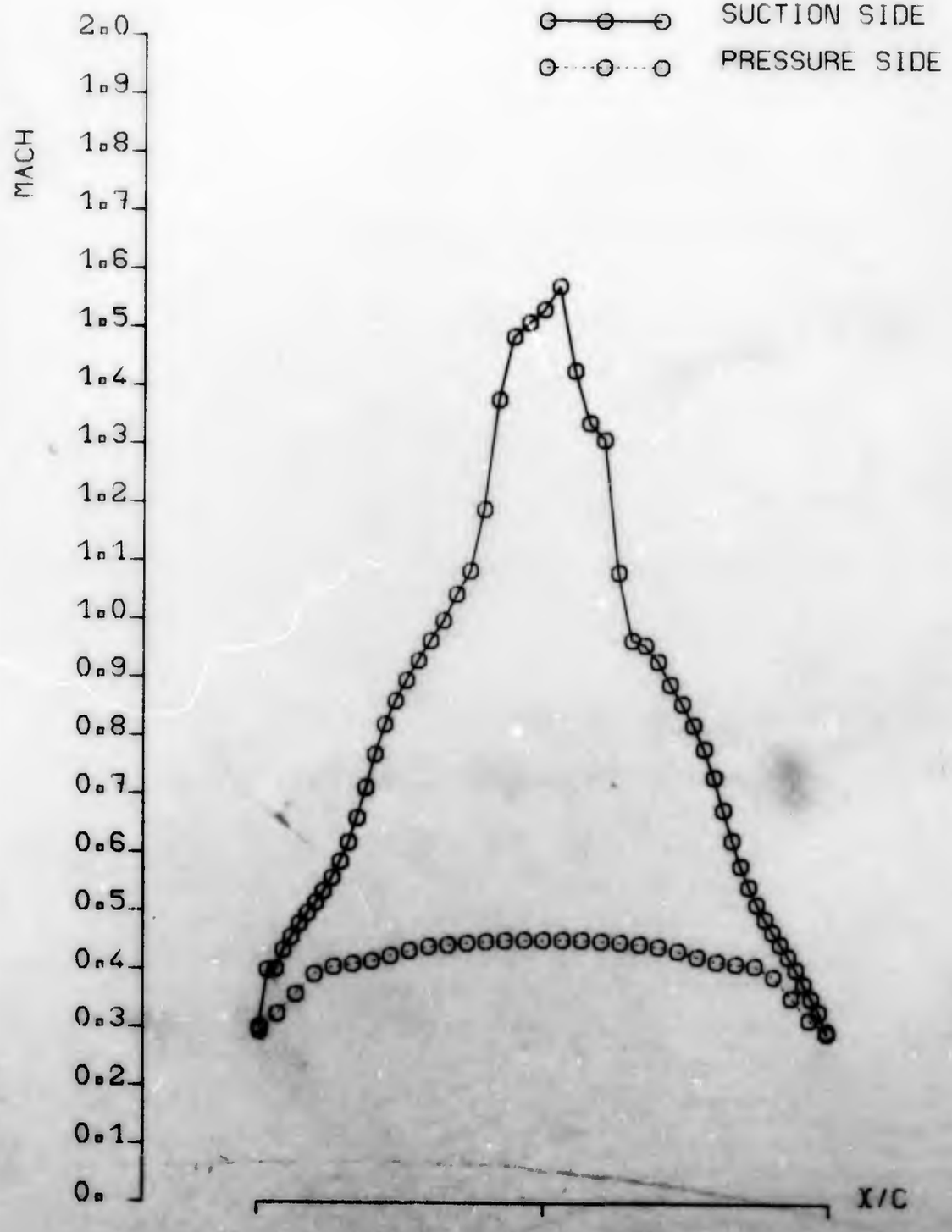


O.N.E.R.A.	AR 211		G.Meauze A.Lesain	09-12-6
	HOBSON I CASCADE: MACH = 0.476, ALPHA = 43.544			



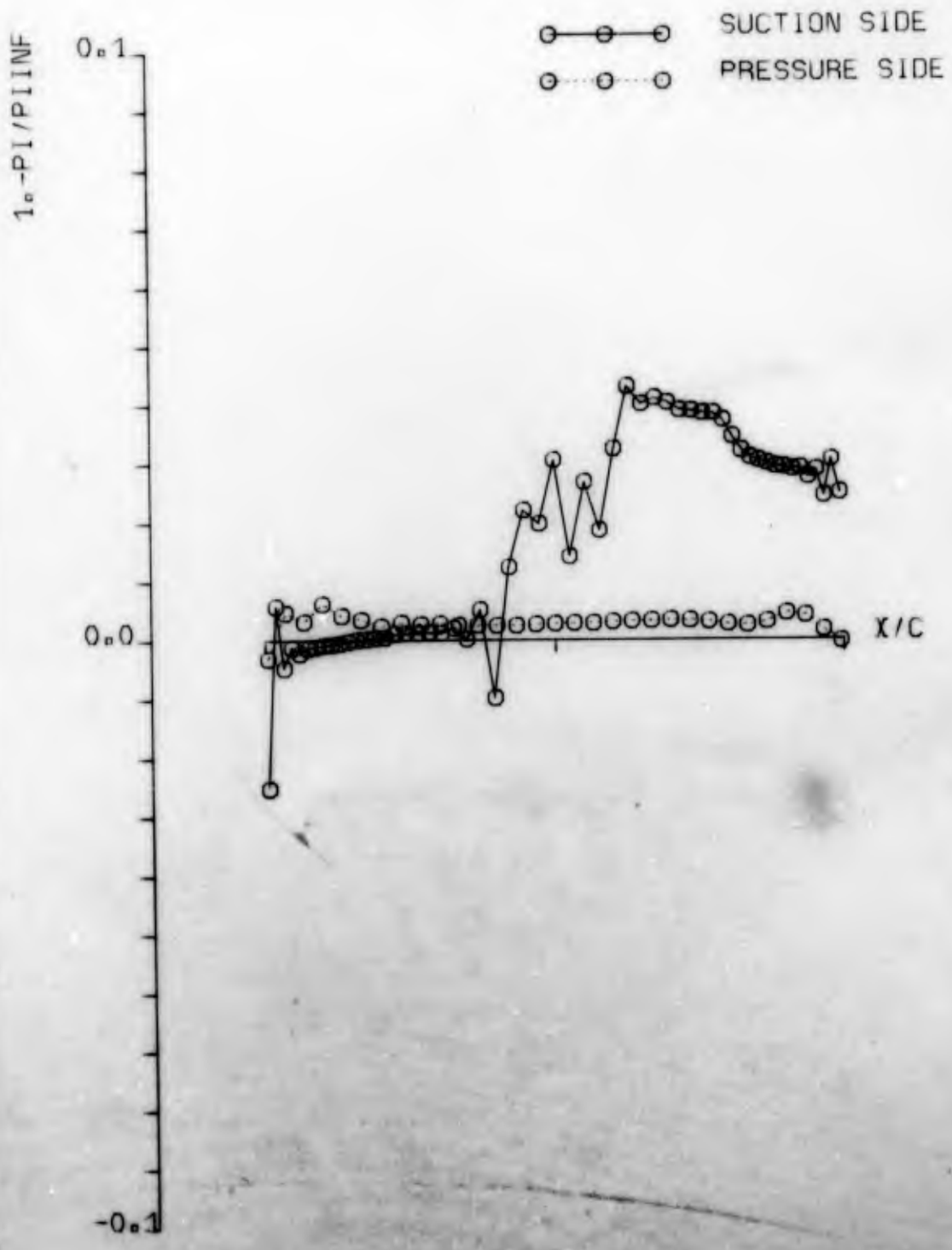
EI-LESN1

O.N.E.R.A.	AR 211		G.Meauze A.Lesain	09-12-7
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



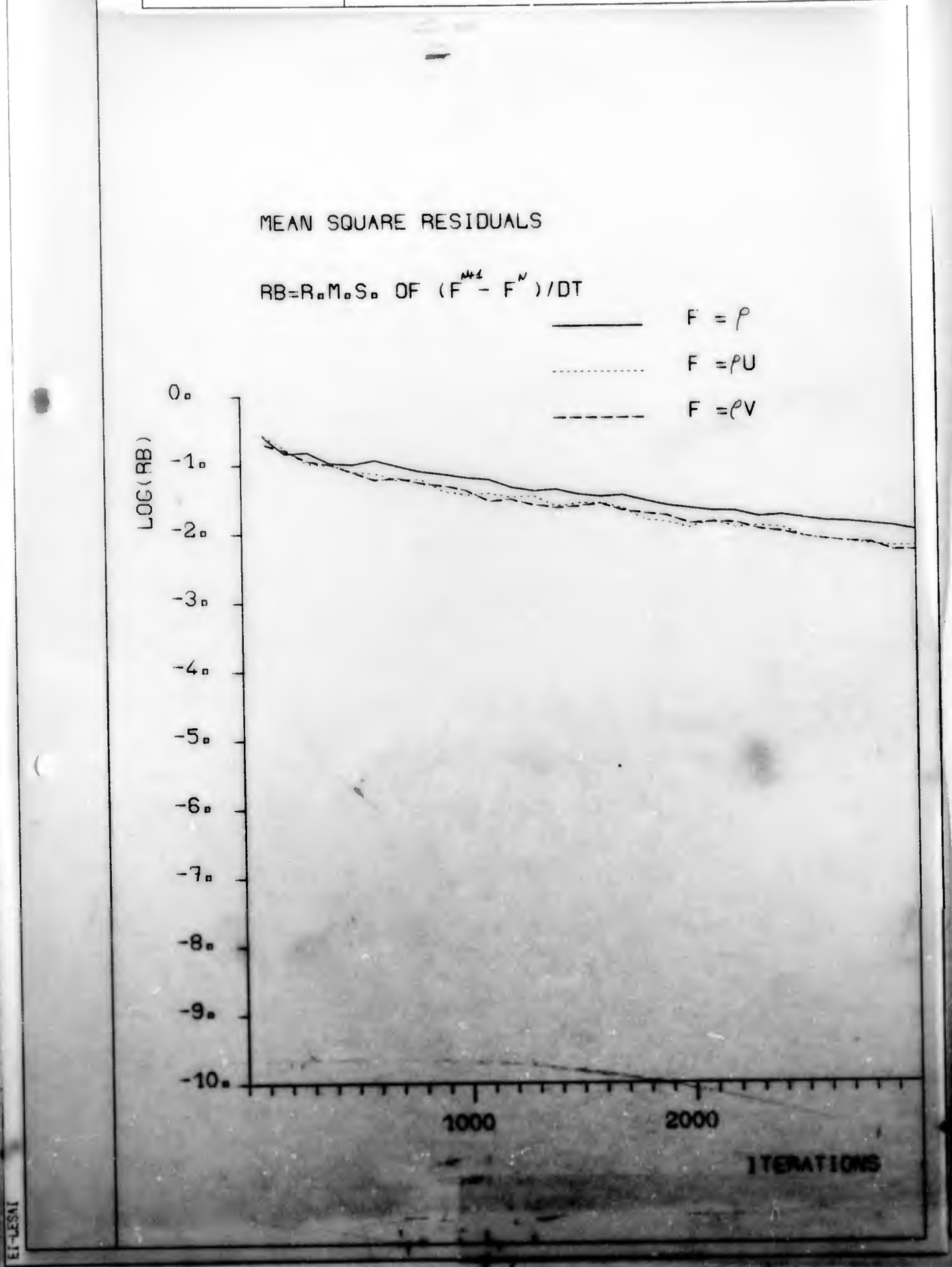
EI-LESAI

O.N.E.R.A.	AR 211		G.Meauze A.Lesain	09-12-8
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			

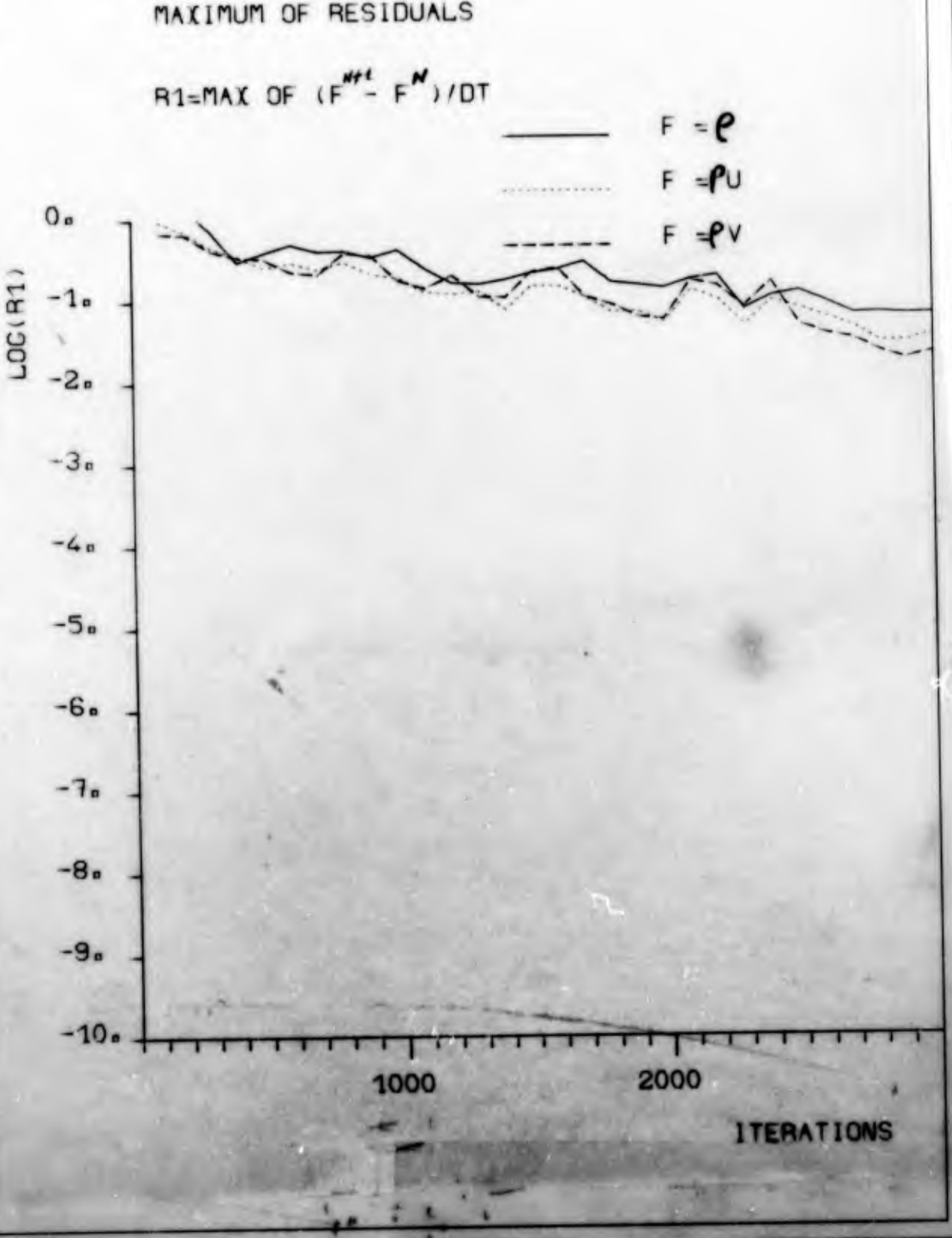


ET-LESAT

O.N.E.R.A.	AR 211		G.Meauze A.Lesain	09-12-9
	HOBSON I CASCADE: MACH = 0.476, ALPHA = 43.544			

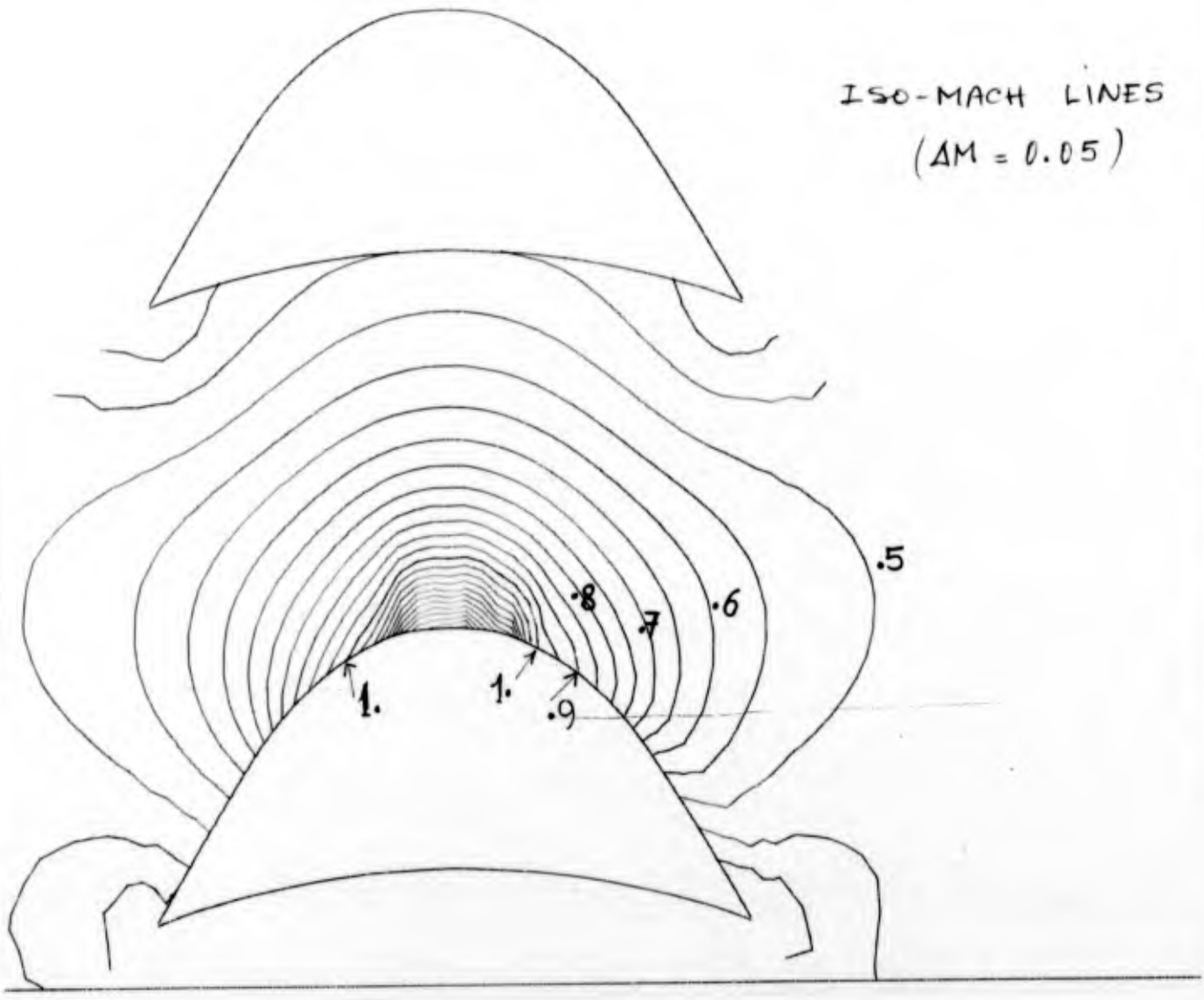


O.N.E.R.A.	AR 211		G.Meauze A.Lesain	09-12-10
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



EI-LESAI

O.N.E.R.A.	AR 211		G.Meauze A.Lesain	09-12-11
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 09

HOBSON 1 cascade:

MACH = 0.476, ALPHA = 43.544

Contributor No 13

B.Fortunato

(University of Bari, Italy)

	AR 211		B.Fortunato	09-13-1
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			

The calculation of two-dimensional transonic flow in the Hobson cascade is presented.

The employed method is the time dependent "Lambda Scheme" /1,2/ which is based on the flow bicharacteristics and takes correctly into account the physical domain of influence.

The numerical algorithm is explicit, second order accurate in space and time, similar to the Mac-Cormack scheme.

The integration flow field, shown in figure 1, is formed by the channel between the blades, with two symmetric extensions upstream and downstream, parallel to the corrisponding undisturbed velocities.

The following equations, obtained combining the compatibility equations along the four bicharacteristics, pertain to the internal mesh points:

$$u_t = -\frac{1}{2}\{(u+a)\,C_\zeta + (B+a\eta_x)\,C_\eta + (u-a)\,D_\zeta + (B-a\eta_x)\,D_\eta\} \quad (1)$$

$$v_t = -\frac{1}{2}\{u\,E_\zeta + (B+a\eta_y)\,E_\eta + u\,F_\zeta + (B-a\eta_y)\,F_\eta\} \quad (2)$$

$$(\log p)_t = -\frac{1}{2}\,\frac{\gamma}{a}\{(u+a)\,C_\zeta + (u+a)\,\eta_x\,C_\eta - (u-a)\,D_\zeta - (u-a)\,\eta_x D_\eta + (v+a)\,\eta_y\,E_\eta - (v-a)\,\eta_y\,F_\eta\} \quad (3)$$

where

$$B = u\,\eta_x + v\,\eta_y \quad (4)$$

and C,D,E,F are the Riemann variables defined as:

$$C = u + \frac{2}{\gamma-1}a\ ;\ D = u - \frac{2}{\gamma-1}a\ ;\ E = v + \frac{2}{\gamma-1}a\ ;\ F = v - \frac{2}{\gamma-1}a \quad (5a,b,c,d)$$

Windward space derivatives are used consistently with the direction of wave propagation.

In the nodes on the permeable walls the periodicity conditions are imposed.

On the cascade walls the classical tangency condition is applied.

At the inlet and outlet sections the discontinuity surfaces proposed by Pandolfi /3/ are used. According to this model, at the

inlet, the velocity direction and the total temperature are supposed to be equal to the free stream values; moreover the equation of propagation along the D bicharacteristic is used. At the outlet discontinuity surface the propagation equation of the C wave is used together with the governing equation (2) ; the total temperature and the mass flow rate are imposed to be equal to the values at downstream infinity, where the direction of velocity and the static pressure are also prescribed.

The flow is initially supposed at rest; then it is gradually accelerated decreasing the downstream static pressure up to its final value, corresponding to the undisturbed isentropic Mach number (M=0.476).

The computational grid used for the present test case is formed by 24x9 meshes.

Ref. /2/ provides a detailed description of the method employed for the present calculations.

Simbology

a	non dimensional speed of sound
p	" " static pressure
t	" " time
u	" " velocity along x
v	" " " " y
x,y	" " Cartesian coordinates
γ	specific heat ratio
η,ζ	computational coordinate defined in /2/

Bibliography

1. Zannetti L.,Colasurdo G.,"A Finite Difference Method Based on The Bicharacteristics For Solving Multidimensional Hyperbolic Flows",Istituto di Macchine e Motori per Aeromobili, Politecnico di Torino, Report n. PP 217, May 1979.
2. Dadone A.,Fortunato B.,"Calcolo Del Flusso Transonico In Una Schiera Di HOBSON", XXXVI Congresso Nazionale A.T.I., Viareggio, October 1981.
3. Pandolfi M.,"Computation Of The Unsteady Flow In Axial Flow Compressor",A.I.A.A. 8th Fluid and Plasma Dynamic Conference, Hartford Connecticut, June 1975.

CASCADE HOBSON 1 - MACH=0.476

RESULTS ON THE UPPER SURFACE

N	X/C	Z/C	1-P/PIINF	CP	MACH	1-PI/PIINF
8	.045455	.077112	.087989	.410076	.395963	-.016090
9	.136364	.227815	.173804	-.221778	.538221	-.006217
10	.227273	.354098	.311363	-1.234622	.744073	.005468
11	.318182	.430639	.475301	-2.441696	.991367	.016707
12	.409091	.473883	.608856	-3.425057	1.231466	.011460
13	.500000	.486000	.654001	-3.757461	1.333502	-.003659
14	.590909	.473884	.581519	-3.223778	1.186616	.002707
15	.681818	.430640	.472860	-2.423724	.989528	.014236
16	.772727	.354095	.365443	-1.632814	.813556	.019526
17	.863636	.227795	.258733	-.847108	.639000	.024339
18	.954545	.077120	.168713	-.184293	.475971	.029248

RESULTS ON THE LOWER SURFACE

8	.045455	.017281	.068873	.550826	.359953	-.018348
9	.136364	.043718	.098321	.334002	.402327	-.008047
10	.227273	.064541	.113663	.221033	.427692	-.005112
11	.318182	.079021	.120270	.172388	.441792	-.005903
12	.409091	.086814	.125129	.136616	.448945	-.004649
13	.500000	.090899	.124076	.144364	.449895	-.006435
14	.590909	.086815	.124449	.141622	.448964	-.005441
15	.681818	.079021	.120813	.168390	.441944	-.005373
16	.772727	.064537	.115356	.208567	.431452	-.005382
17	.863636	.043716	.110501	.244321	.417533	-.002862
18	.954545	.017276	.106987	.270189	.397095	.004470

	AR 211		B.Fortunato	09-13-4
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			

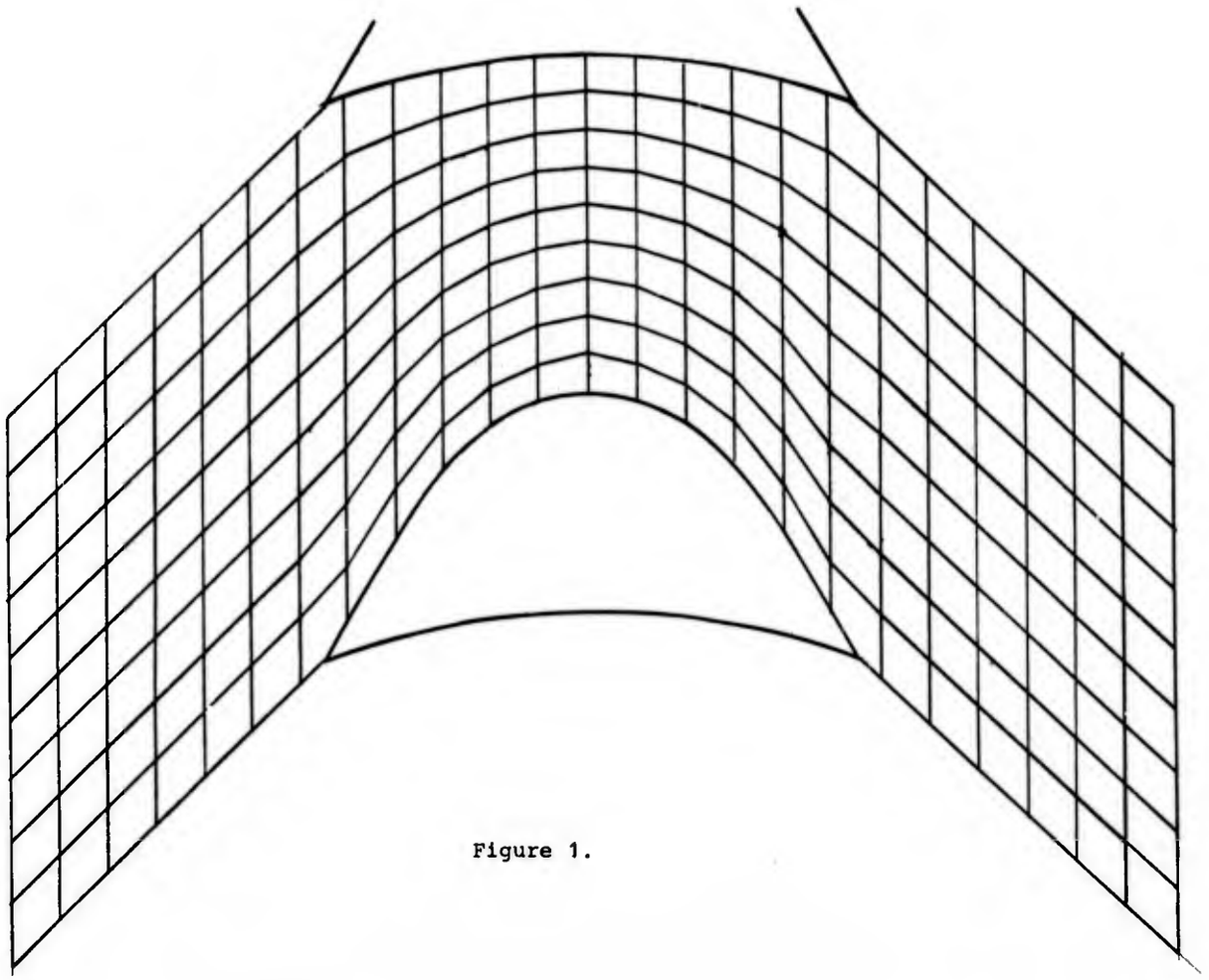
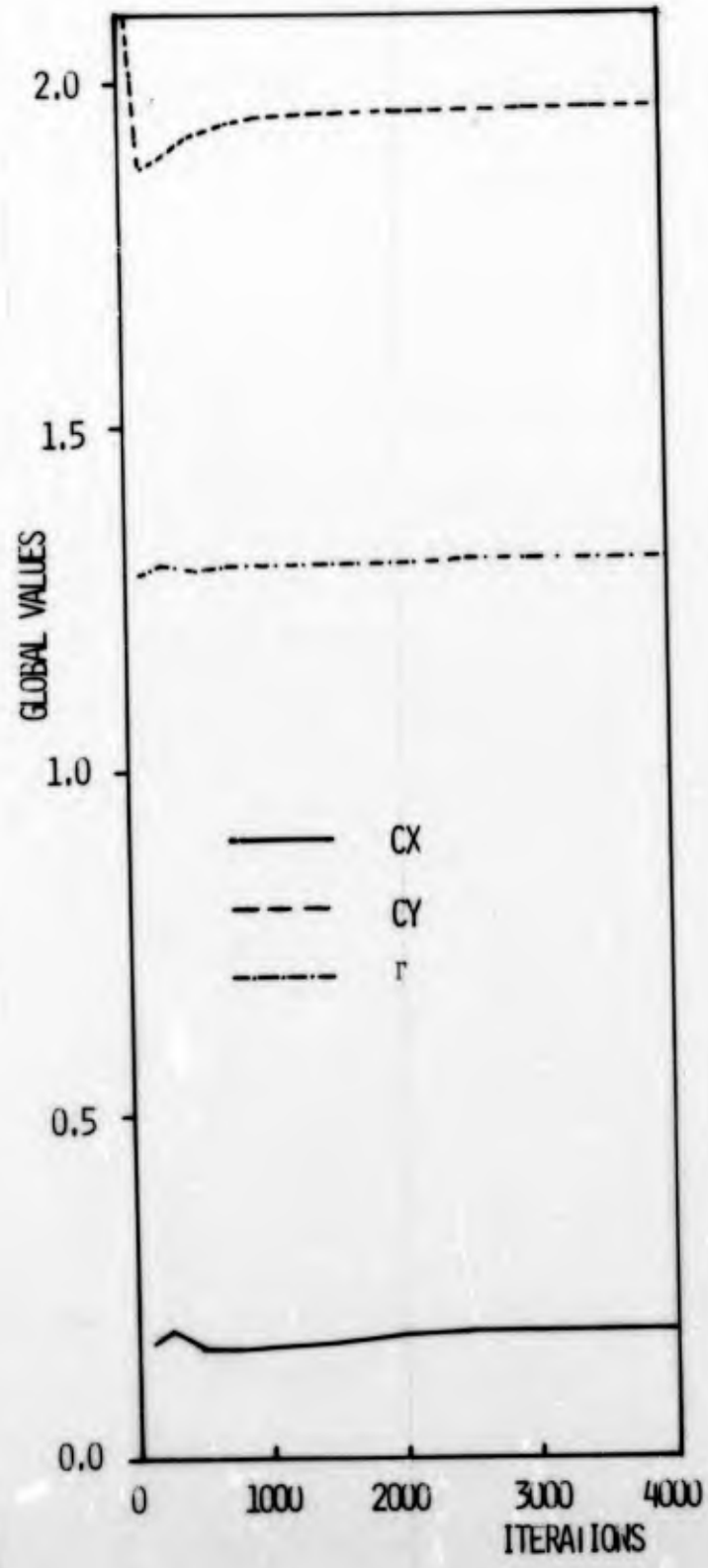
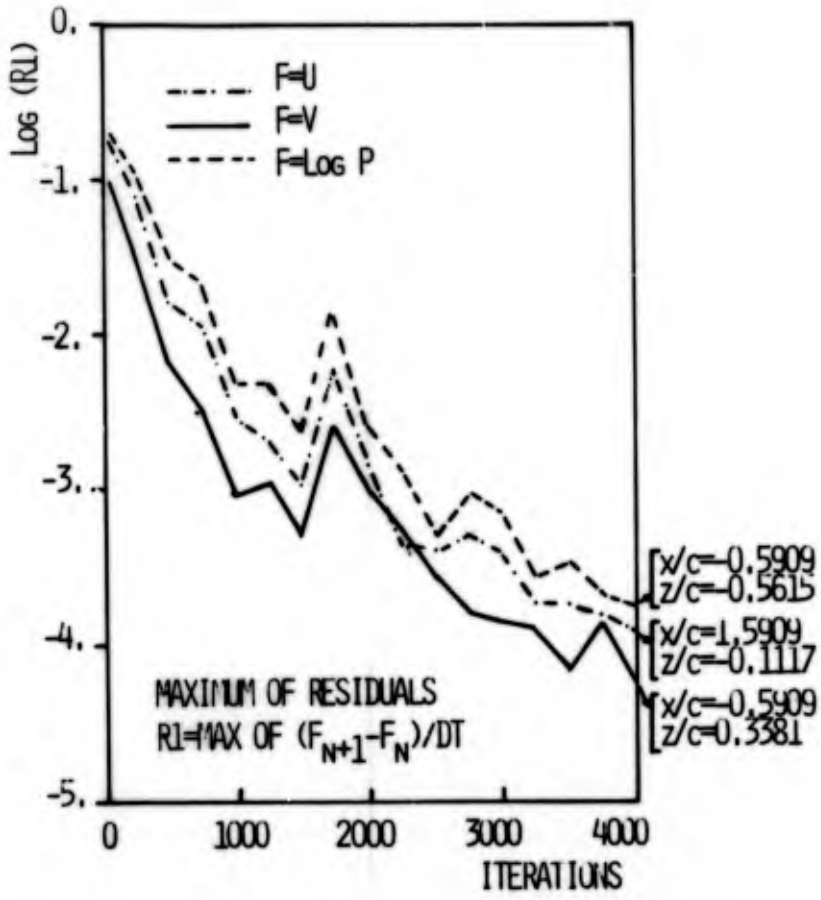


Figure 1.

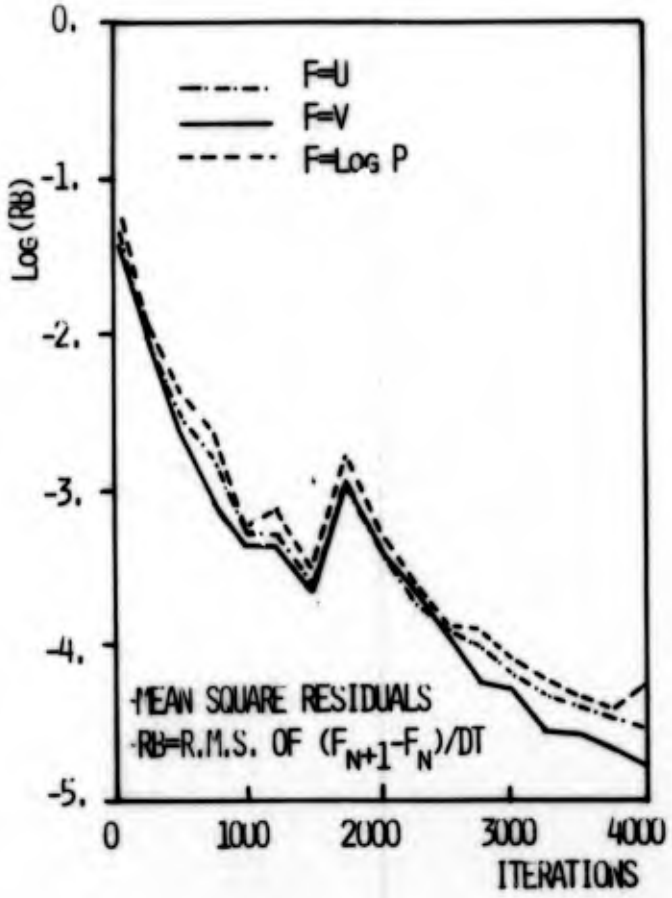
	AR 211		B.Fortunato	09-13-5
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



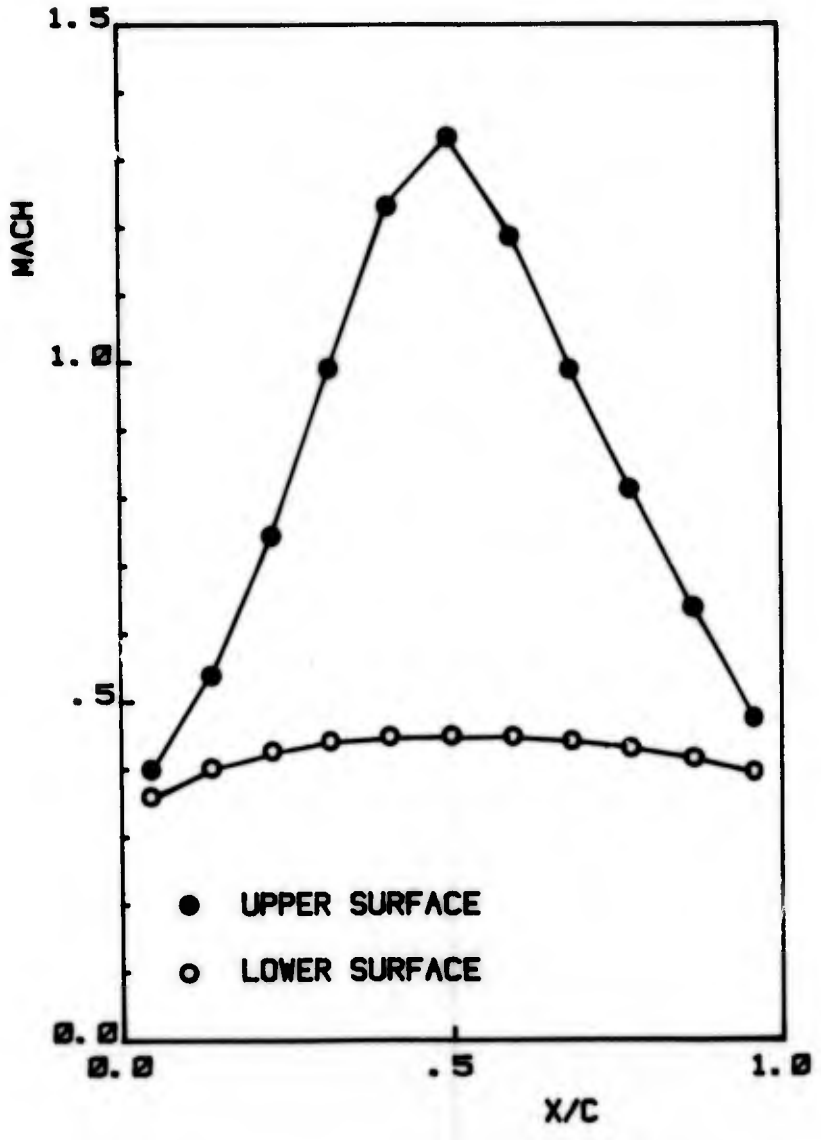
	AR 211		B.Fortunato	09-13-6
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



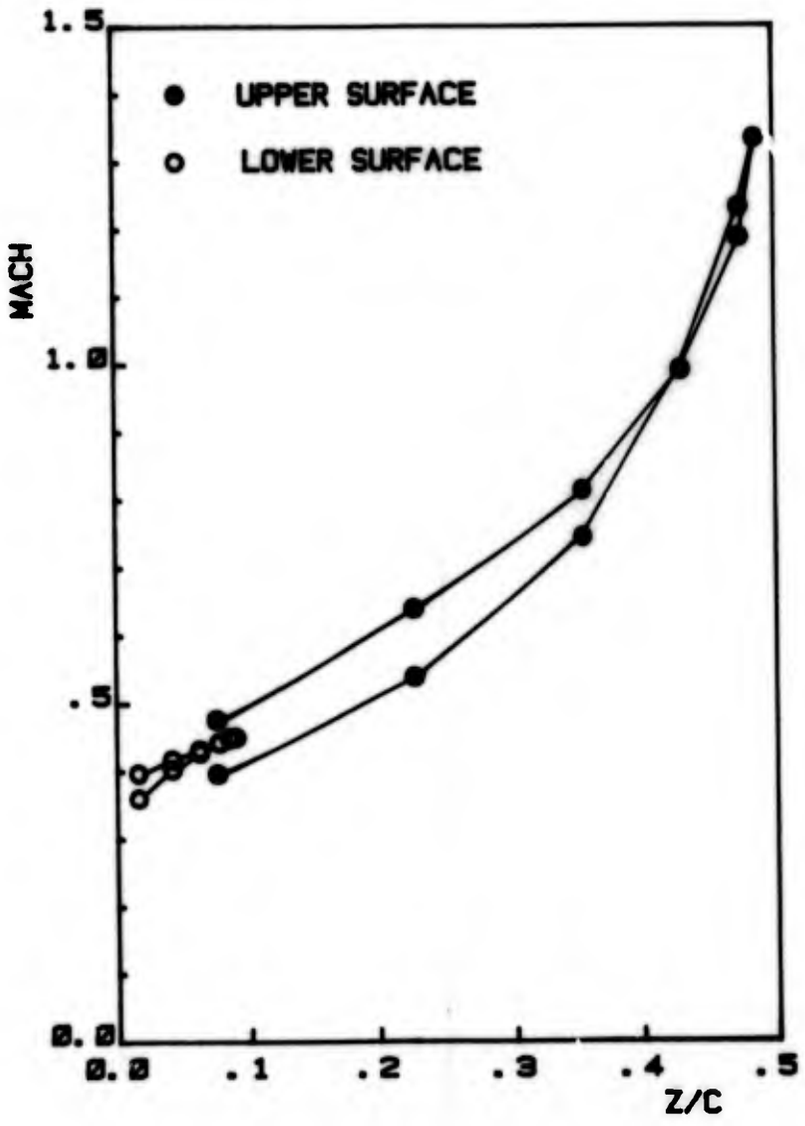
	AR 211		B.Fortunato	09-13-7
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



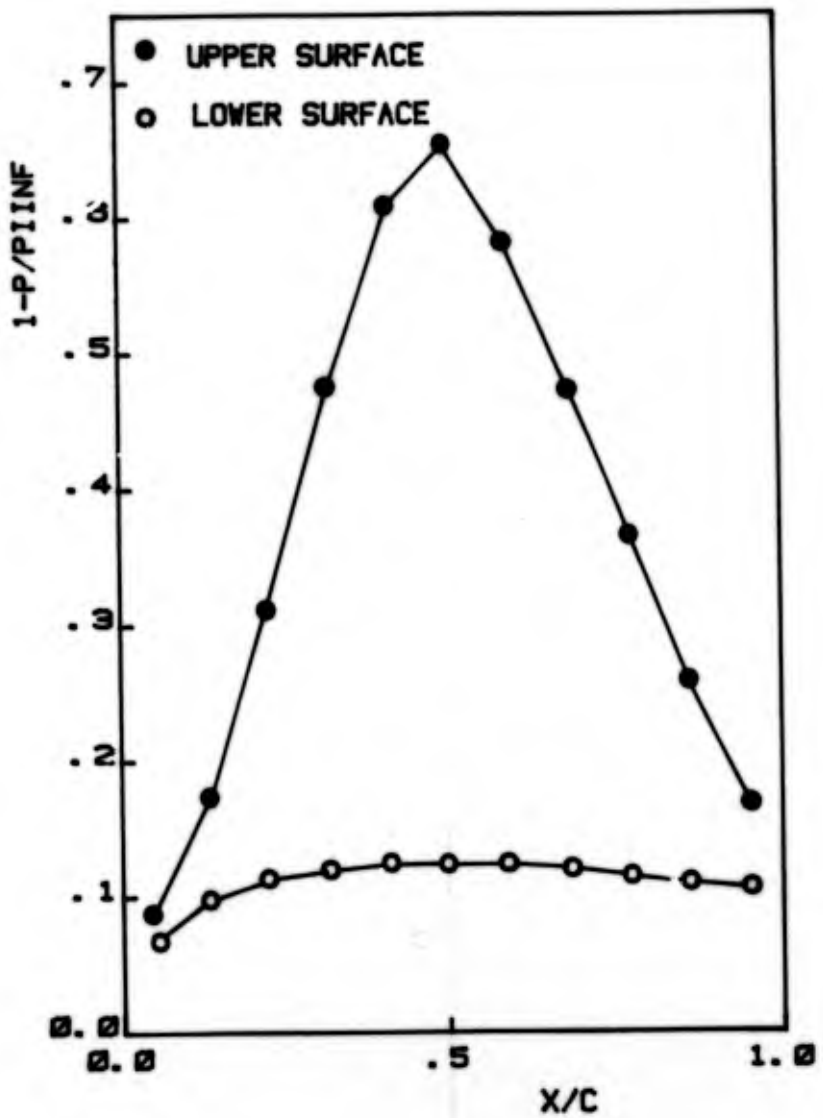
	AR 211		B.Fortunato	09-13-8
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



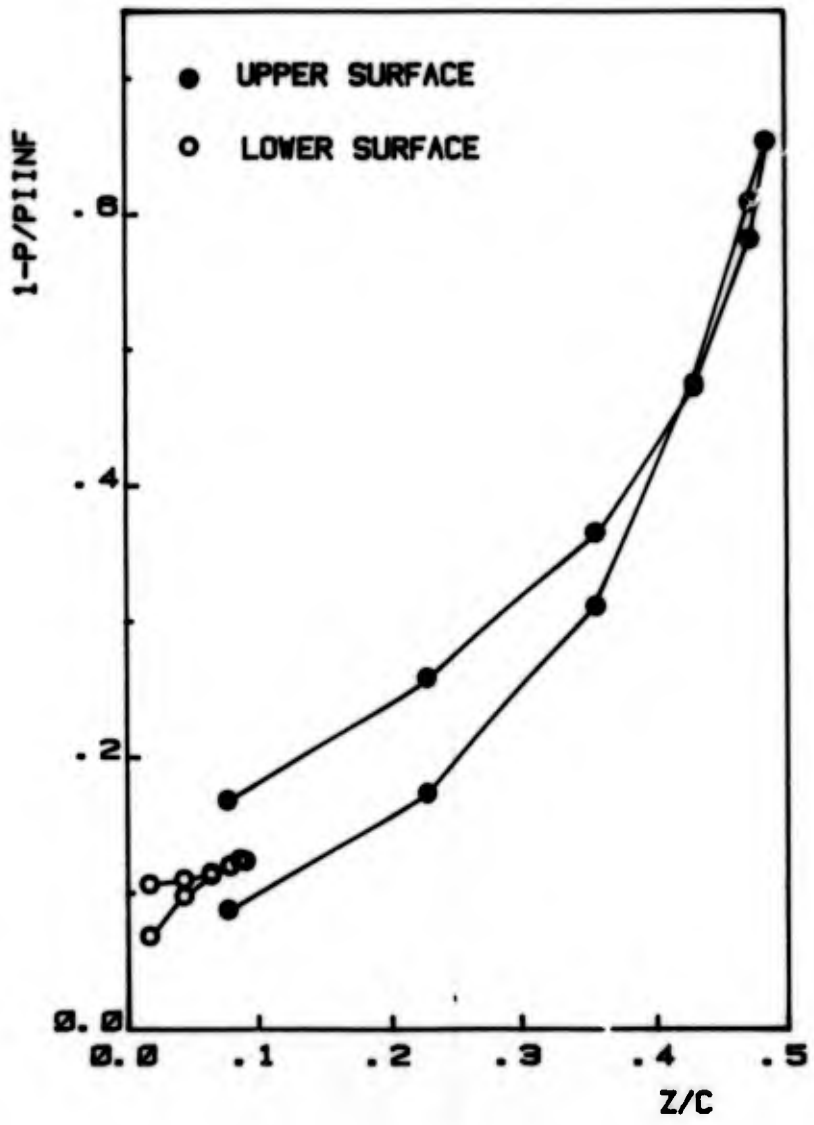
	AR 211		B.Fortunato	09-13-9
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



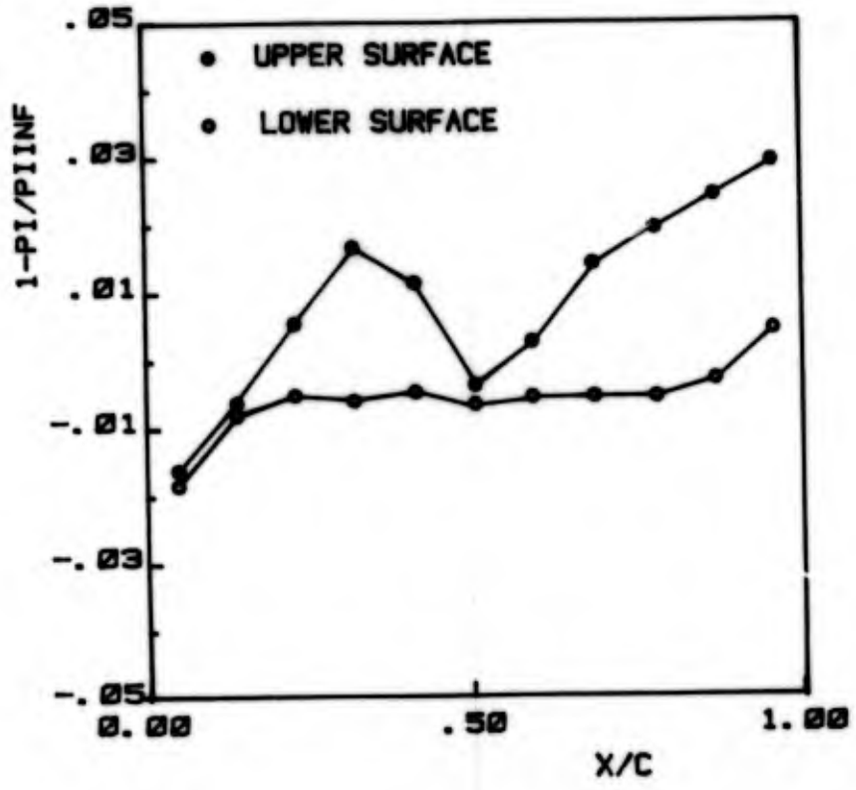
	AR 211		B.Fortunato	09-13-10
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



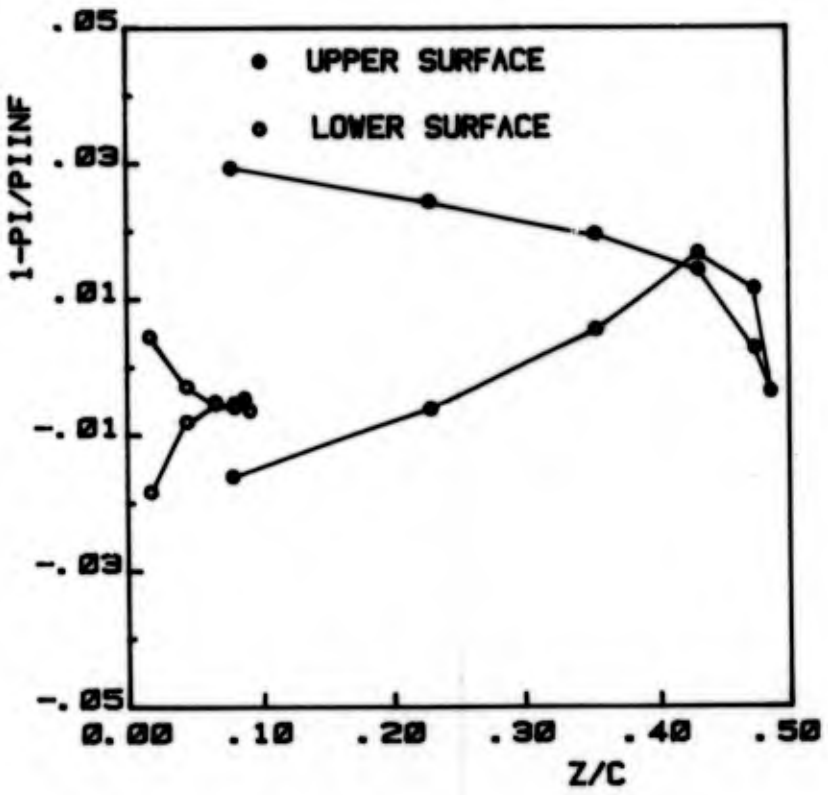
	AR 211		B.Fortunato	09-13-11
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



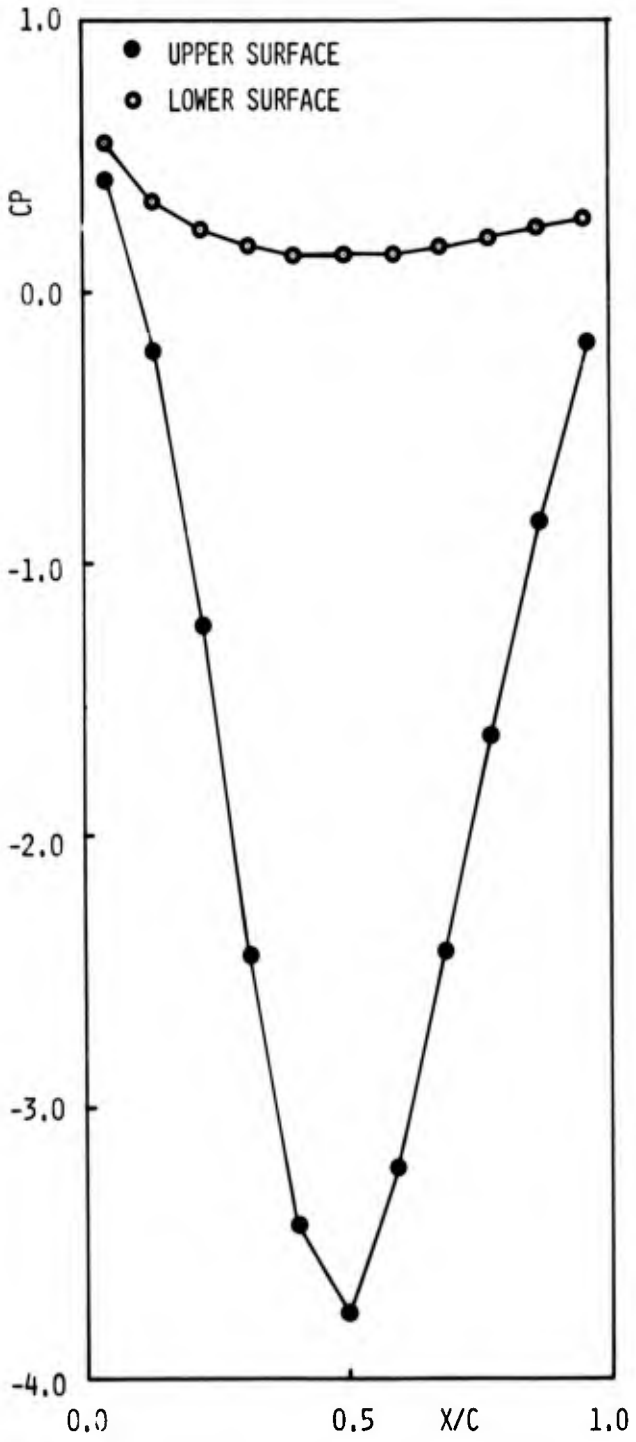
	AR 211		B.Fortunato	09-13-12
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



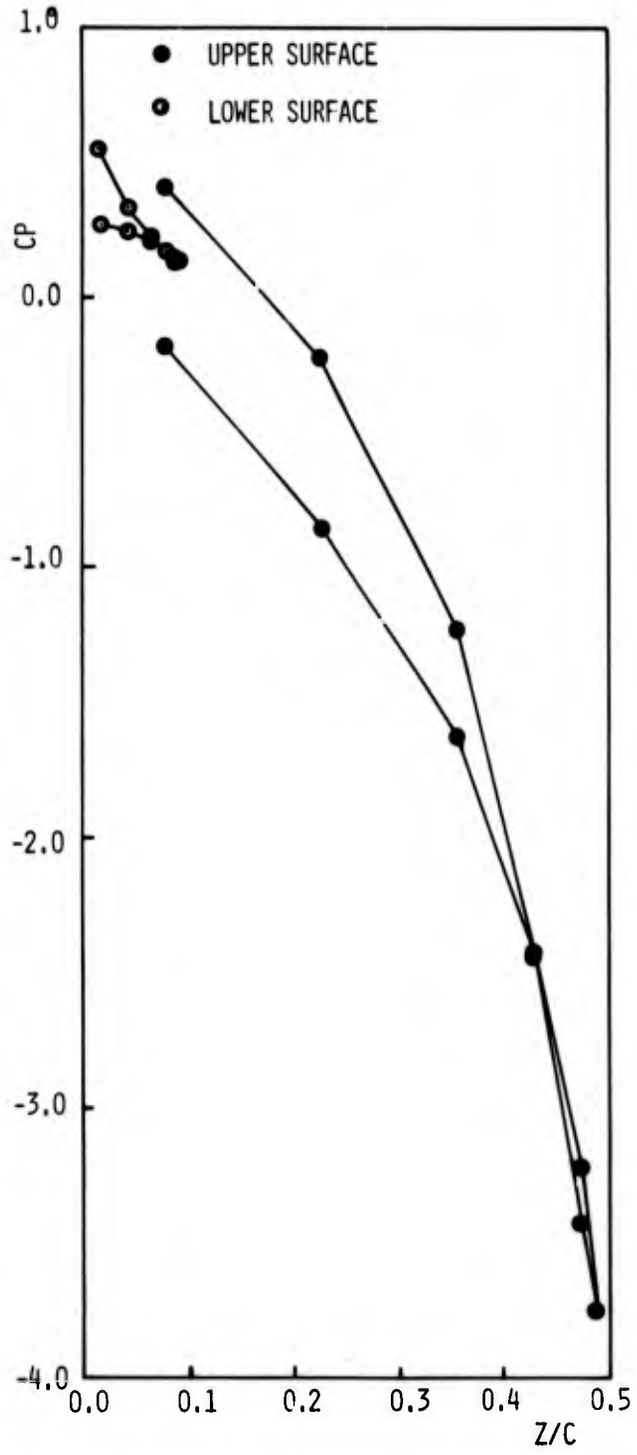
	AR 211		B.Fortunato	09-13-13
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



	AR 211		B.Fortunato	09-13-14
	HOBSON 1 CASCADE: MACH = 0.476, ALPHA = 43.544			



	AR 211		B.Fortunato	09-13-15
	HOBSON 1 ...SCADE: MACH = 0.476, ALPHA = 43.544			



AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 10

HOBSON 2 cascade:

MACH = 0.575, ALPHA = 46.123

Contributor No 12

G.Meauze and A Lesain

(O.N.E.R.A., France)

HOBSON 2

	Mean calculated value	Assigned value	Theoretical value
Inlet Mach Number	0,575		0,575
Inlet angle	46,13°	46,123°	46,123°
Exit Mach Number	0,572		0,575
Exit angle	-46,06°		-46,123°
Total pressure ratio	0,999		1
Static over total pressure ratio	0,7992	0,7992	0,7992

O.N.E.R.A.	AR 211		G.Meauze A.Lesain	10-12-2
	HOBSON 2 CASCADE: MACH = 0.575, ALPHA = 46.123			

CASCADE HOBSON-2 .RESULTS ON THE SUCTION SIDE :

I	X/C	Y/C	1-P/PIINF	CP	MACH	1-PI/PIINF
26	.004115	.006269	.104589	.519480	.442447	-.024233
27	.019628	.029205	.191991	.046620	.559974	.000290
28	.034331	.050793	.195244	.029024	.573593	-.005847
29	.049190	.072368	.219339	-.101336	.610449	-.003984
30	.064445	.093994	.238313	-.203989	.641884	-.004935
31	.080043	.115259	.260089	-.321803	.675637	-.004570
32	.096100	.136151	.280188	-.430542	.706965	-.004704
33	.112716	.156633	.300818	-.542154	.738720	-.004719
34	.129947	.176595	.322290	-.658020	.771770	-.004895
35	.147856	.195947	.345056	-.781494	.806676	-.005017
36	.166529	.214566	.367239	-.901505	.840606	-.005010
37	.186056	.232288	.387455	-1.010881	.871801	-.005151
38	.206491	.248954	.405983	-1.111116	.900503	-.005212
39	.227750	.264553	.421934	-1.197415	.925418	-.005286
40	.249798	.279017	.436875	-1.278250	.948919	-.005326
41	.272569	.292311	.452767	-1.364231	.974195	-.005414
42	.295975	.304457	.472042	-1.468510	1.005245	-.005532
43	.320063	.315174	.493684	-1.585597	1.040590	-.005533
44	.344742	.324467	.514718	-1.699396	1.075667	-.005555
45	.369816	.332615	.536277	-1.816036	1.112387	-.005489
46	.395370	.339125	.552462	-1.903599	1.140601	-.005452
47	.421246	.344179	.564706	-1.969838	1.162256	-.005303
48	.447370	.347771	.575583	-2.028686	1.181770	-.005114
49	.473642	.349991	.584132	-2.074941	1.197648	-.005377
50	.500000	.350695	.588050	-2.096134	1.204477	-.004822
51	.526358	.349991	.590714	-2.110549	1.210109	-.005708
52	.552630	.347771	.579747	-2.051218	1.190305	-.006320
53	.578754	.344179	.554879	-1.916674	1.144900	-.005490
54	.604630	.339125	.538774	-1.829542	1.116394	-.005096
55	.630184	.332615	.532368	-1.794885	1.105438	-.005224
56	.655258	.324467	.516332	-1.708129	1.077616	-.004604
57	.679937	.315174	.492101	-1.577032	1.036751	-.004055
58	.704025	.304457	.469571	-1.455142	.999662	-.003668
59	.727431	.292311	.449230	-1.345081	.966743	-.003329
60	.750202	.279017	.436045	-1.273757	.944865	-.002231
61	.772250	.264553	.423188	-1.204200	.923754	-.001261
62	.793509	.248954	.406888	-1.116014	.897856	-.000805
63	.813944	.232288	.388050	-1.014096	.868401	-.000570
64	.833471	.214566	.367766	-.904355	.836913	-.000364
65	.852144	.195947	.346646	-.790092	.804229	-.000133
66	.870053	.176595	.324618	-.670919	.770405	-.000123
67	.887284	.156633	.303388	-.556061	.737607	.000012
68	.903900	.136151	.283005	-.445781	.705905	.000181
69	.919957	.115259	.262456	-.334610	.673612	.000399
70	.935555	.093994	.241122	-.219185	.640449	-.000039
71	.950810	.072368	.220387	-.107005	.606383	.000591
72	.965669	.050793	.198044	.013873	.572164	-.001270
73	.980372	.029205	.180705	.107677	.536392	.003486
74	.995885	.006269	.147159	.289169	.493351	-.007203

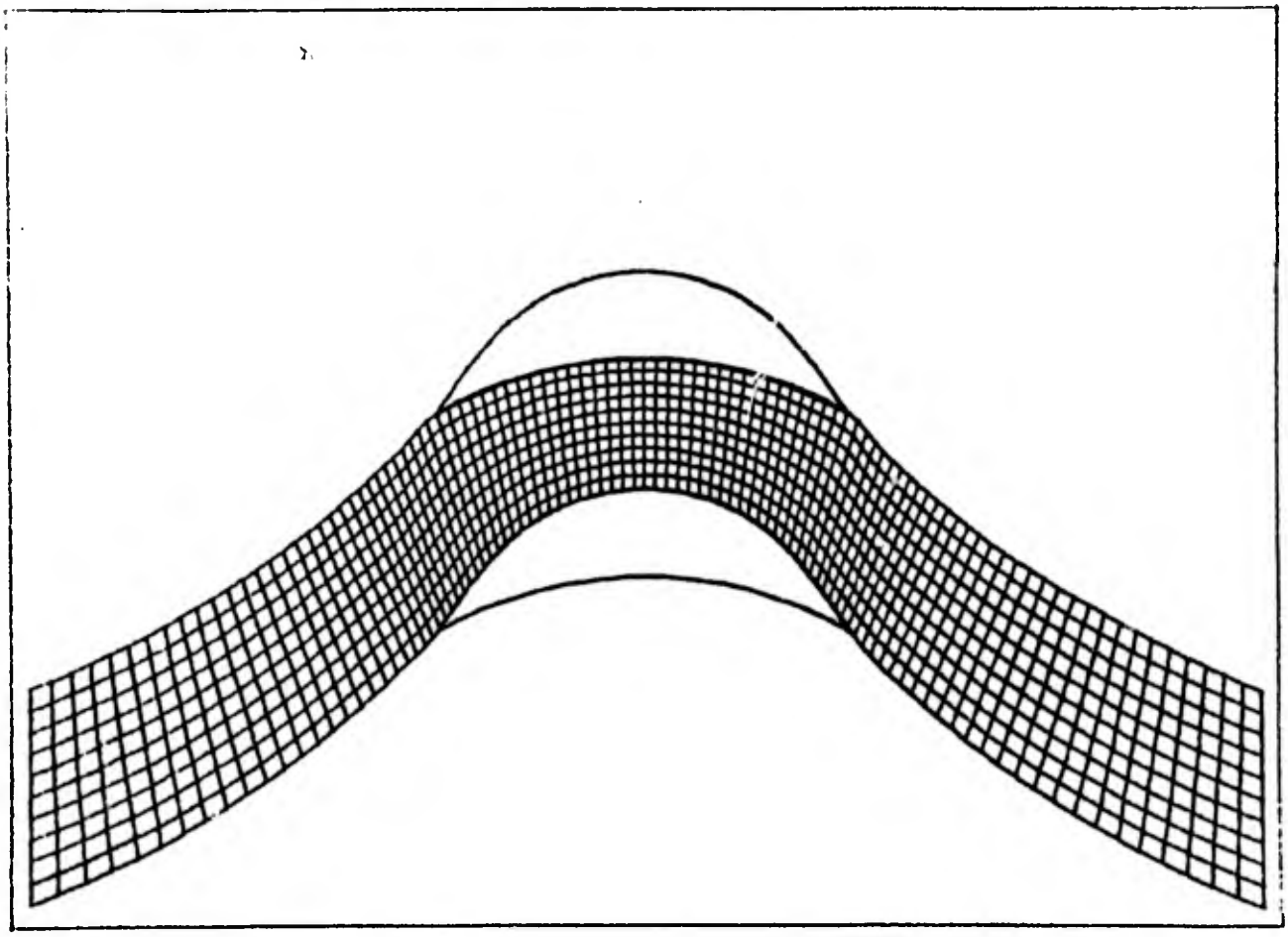
O.N.E.R.A.	AR 211		G.Meauze A.Lesain	10-12-3
	HOBSON 2 CASCADE: MACH = 0.575, ALPHA = 46.123			

CASCADE HOBSON-2 .RESULTS ON THE PRESSURE SIDE :

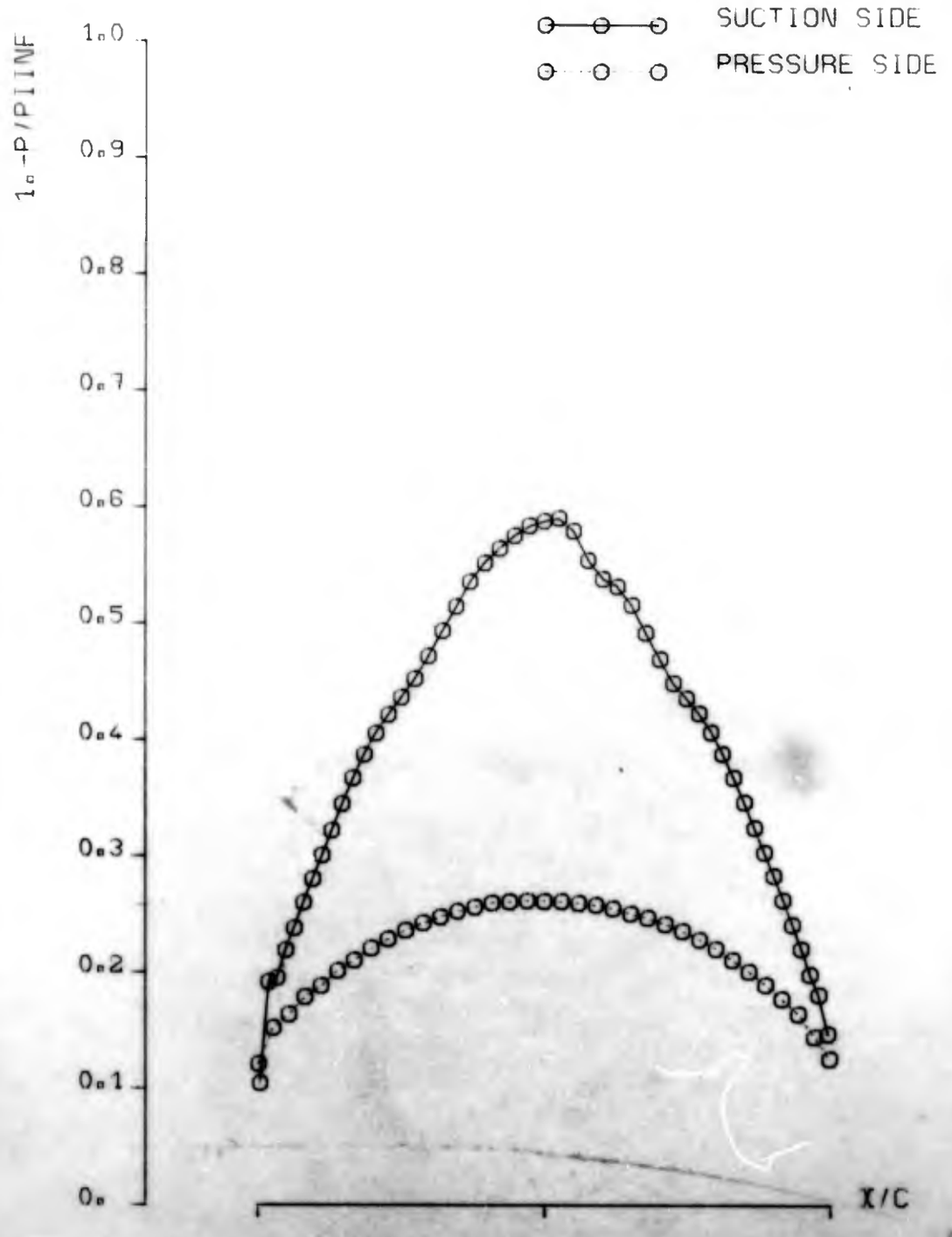
I	X/C	Y/C	1-P/PIINF	CP	MACH	1-PI/PIINF
33	.001472	.001356	.121005	.430667	.444357	-.006603
34	.027288	.015853	.152106	.262405	.484507	.004408
35	.054737	.030165	.163840	.198925	.509103	.002048
36	.082577	.043183	.178750	.118259	.534324	.002570
37	.110831	.055335	.188136	.067477	.552402	.001083
38	.139440	.066710	.201232	-.003375	.573424	.001764
39	.168314	.077343	.210288	-.052371	.589298	.001066
40	.197491	.087112	.220674	-.108562	.605898	.001343
41	.226926	.096077	.228551	-.151178	.619014	.001041
42	.256562	.104352	.236065	-.191827	.631087	.001029
43	.286457	.111633	.242553	-.226930	.641520	.000961
44	.316578	.117917	.247978	-.256282	.650262	.000853
45	.346861	.123366	.252537	-.280944	.657525	.000808
46	.377290	.127927	.256406	-.301877	.663747	.000705
47	.407850	.131508	.259842	-.320468	.668888	.000932
48	.438506	.134154	.260724	-.325241	.670604	.000649
49	.469235	.135715	.261929	-.331758	.672270	.000843
50	.500000	.136242	.261320	-.328462	.671585	.000609
51	.530765	.135715	.261201	-.327818	.671203	.000777
52	.561494	.134154	.259709	-.319750	.668913	.000732
53	.592150	.131508	.258046	-.310750	.666088	.000911
54	.622710	.127927	.255029	-.294430	.661046	.001158
55	.653139	.123366	.250865	-.271899	.654426	.001194
56	.683422	.117917	.247071	-.251371	.647881	.001642
57	.713543	.111633	.241780	-.222749	.639204	.001859
58	.743438	.104352	.235756	-.190155	.629170	.002189
59	.773074	.096077	.228451	-.150636	.617373	.002229
60	.802509	.087112	.220477	-.107493	.604059	.002539
61	.831686	.077343	.210730	-.054761	.588212	.002461
62	.860560	.066710	.200568	.000218	.571294	.002534
63	.889149	.055335	.189305	.061155	.552343	.002563
64	.917423	.043183	.177060	.127401	.531898	.002228
65	.945263	.030165	.164494	.195383	.508488	.003245
66	.972712	.015853	.144666	.302659	.471490	.004003
67	.998528	.001356	.125914	.404108	.443820	-.000660

O.N.E.R.A.	AR 211		G.Meauze A.Lesain	10-12-4
	HOBSON 2 CASCADE: MACH = 0.575, ALPHA = 46.123			

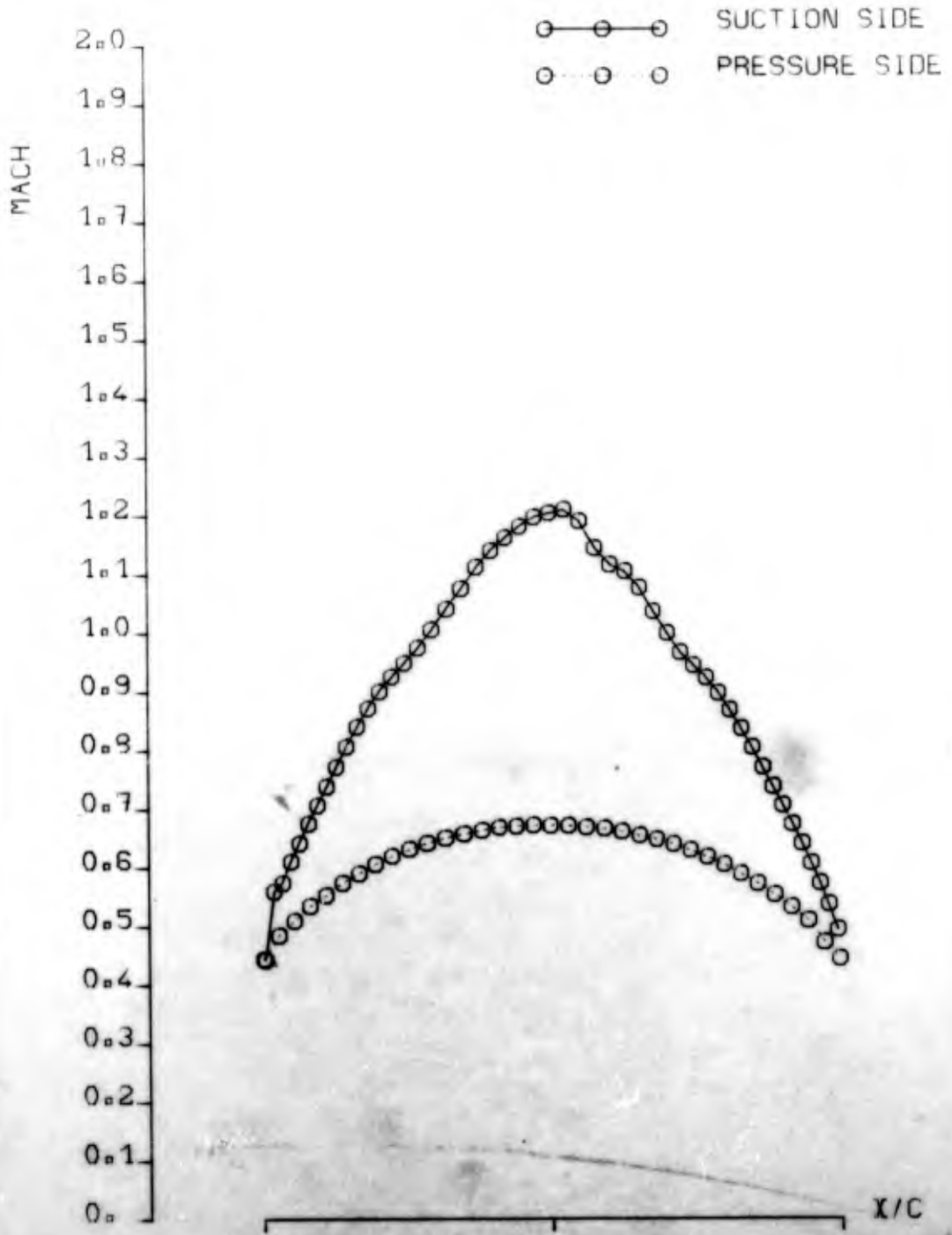
[PROFIL HOBSON-2] 02.08.82 ANGLES DONNES



O.N.E.R.A.	AR 211		G.Meauze A.Lesain	10-12-5
	HOBSON 2 CASCADE: MACH = 0.575, ALPHA = 46.123			

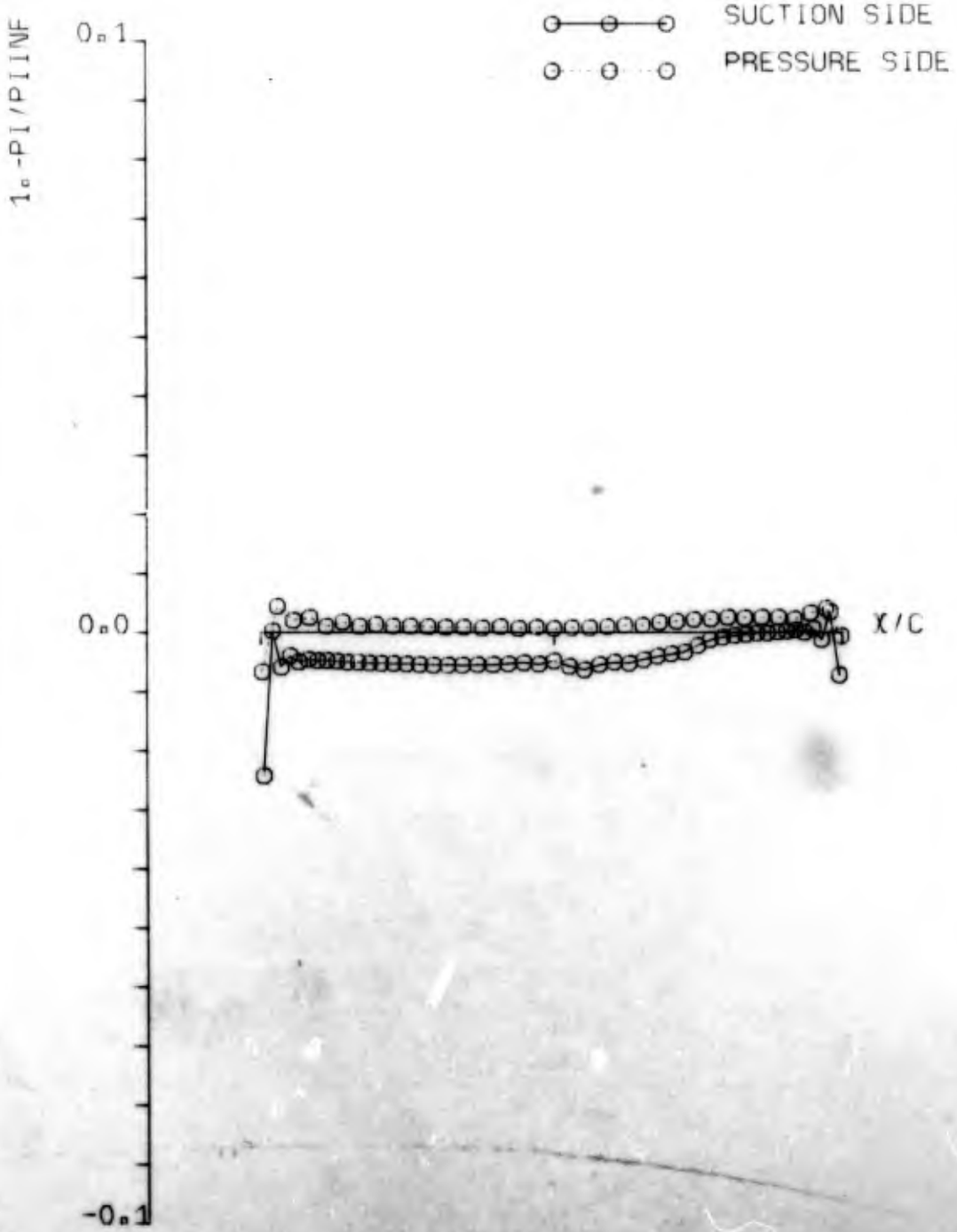


O.N.E.R.A.	AR 211		G.Meauze A.Lesain	10-12-6
	HOBSON 2 CASCADE: MACH = 0.575, ALPHA = 46.123			

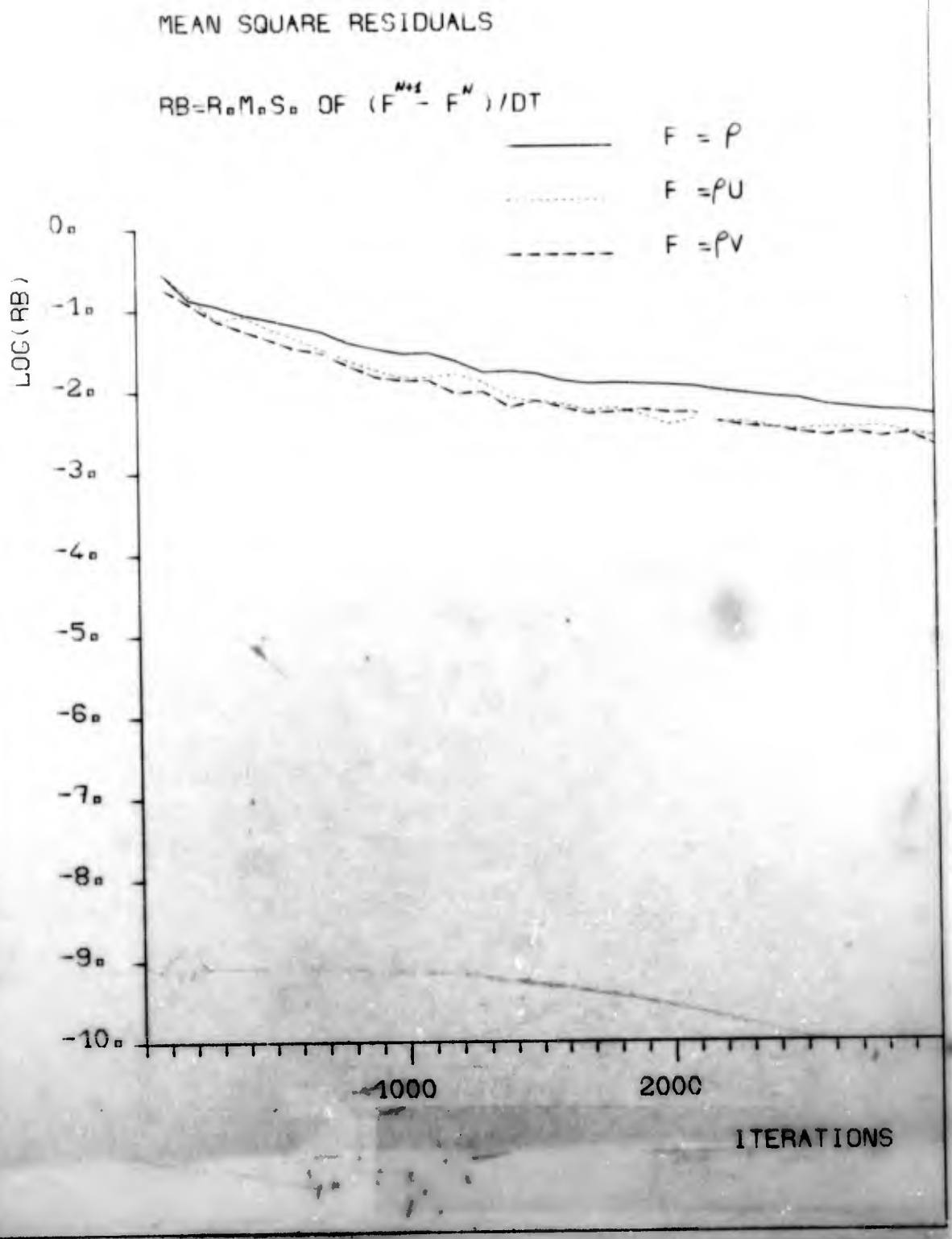


ET-LESAI

O.N.E.R.A.	AR 211		G.Meauze A.Lesain	10-12-7
	HOBSON 2 CASCADE: MACH = 0.575, ALPHA = 46.123			

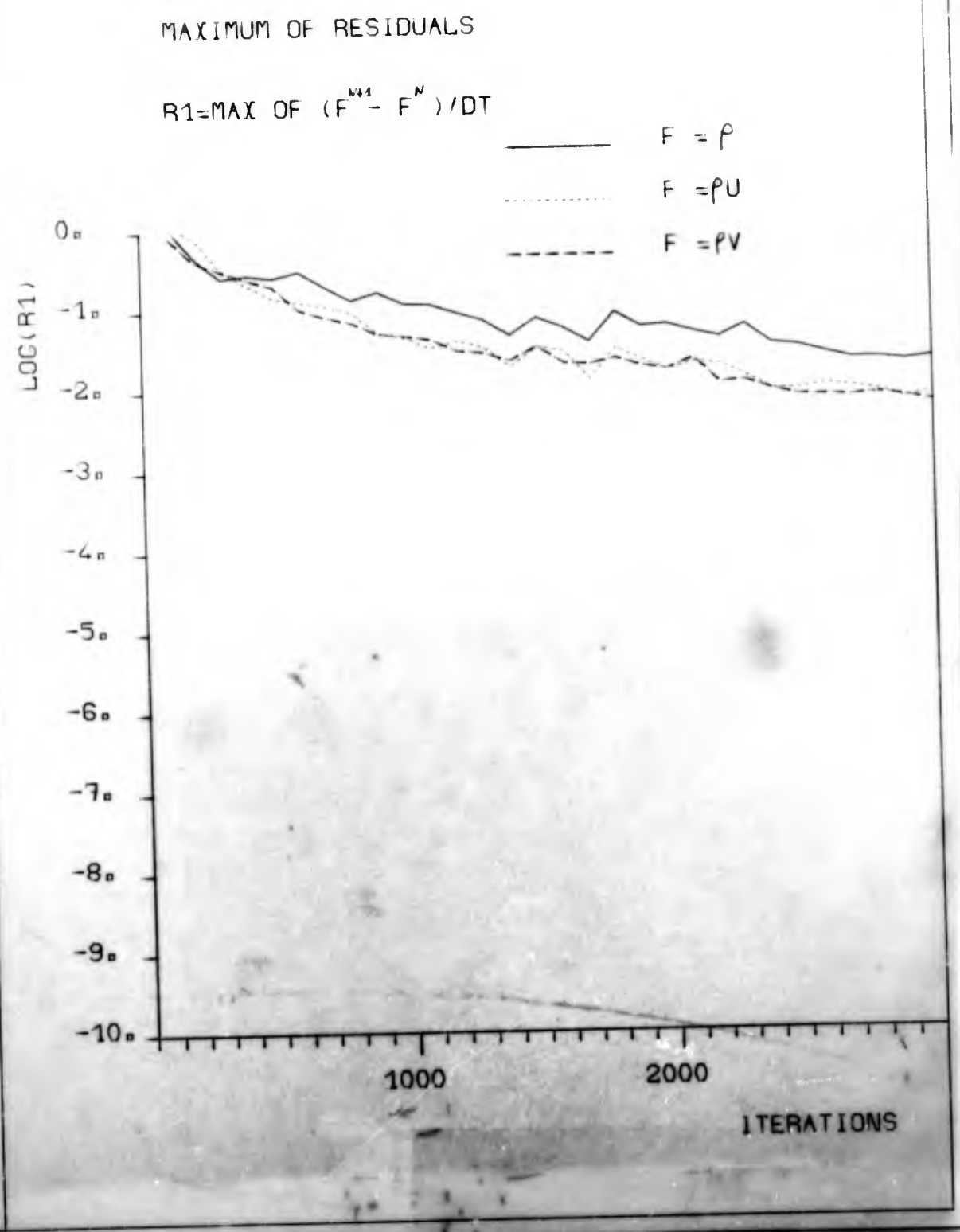


O.N.E.R.A.	AR 211		G.Meauze A.Lesain	10-12-8
	HOBSON 2 CASCADE: MACH = 0.575, ALPHA = 46.123			



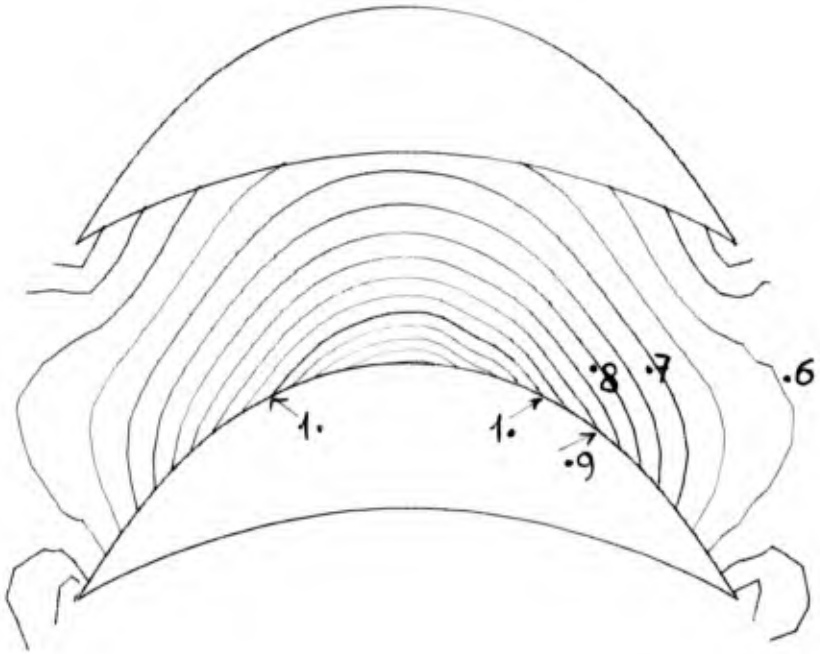
EI-LESAI

O.N.E.R.A.	AR 211		G.Meauze A.Lesain	10-12-9
	HOBSON 2 CASCADE: MACH = 0.575, ALPHA = 46.123			



O.N.E.R.A.	AR 211		G.Meauze A.Lesain	10-12-10
	HOBSON 2 CASCADE: MACH = 0.575, ALPHA = 46.123			

ISO-MACH LINES
($\Delta M = 0.05$)



AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 14

DILLNER WING: MACH = 1.50, ALPHA = 15

Contributor No 9

W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-1
	DILLNER WING: MACH = 1.50, ALPHA = 15			

K	IP	XC	YC	MACH	1-PI/PINF	1-P/PINF
1	1	1.00000	0.0	1.42323	0.01068	0.69915
1	2	0.99627	0.0	1.46422	0.04138	0.72505
1	3	0.98764	0.0	1.43998	0.00277	0.70388
1	4	0.97625	0.0	1.41403	0.03917	0.70398
1	5	0.96122	0.0	1.42214	0.01818	0.70097
1	6	0.94139	0.0	1.40735	0.02779	0.69764
1	7	0.91523	0.0	1.39774	0.02524	0.69271
1	8	0.88351	0.0	1.38412	0.02592	0.68700
1	9	0.85027	0.0	1.36974	0.02614	0.68072
1	10	0.81783	0.0	1.35519	0.02629	0.67424
1	11	0.78619	0.0	1.34116	0.02660	0.66796
1	12	0.75530	0.0	1.32712	0.02643	0.66142
1	13	0.72515	0.0	1.31362	0.02695	0.65528
1	14	0.69569	0.0	1.30051	0.02678	0.64899
1	15	0.66691	0.0	1.28797	0.02727	0.64315
1	16	0.63877	0.0	1.27621	0.02739	0.63748
1	17	0.61124	0.0	1.26462	0.02750	0.63183
1	18	0.58428	0.0	1.25408	0.02806	0.62681
1	19	0.55788	0.0	1.24442	0.02817	0.62202
1	20	0.53199	0.0	1.23577	0.02879	0.61790
1	21	0.50658	0.0	1.22799	0.02907	0.61406
1	22	0.48164	0.0	1.22099	0.02966	0.61071
1	23	0.45712	0.0	1.21494	0.03024	0.60784
1	24	0.43299	0.0	1.20953	0.03072	0.60524
1	25	0.40921	0.0	1.20516	0.03160	0.60333
1	26	0.38577	0.0	1.20173	0.03229	0.60184
1	27	0.36263	0.0	1.19858	0.03292	0.60046
1	28	0.33974	0.0	1.19622	0.03398	0.59967
1	29	0.31710	0.0	1.19438	0.03460	0.59897
1	30	0.29465	0.0	1.19307	0.03560	0.59870
1	31	0.27239	0.0	1.19237	0.03634	0.59864
1	32	0.25025	0.0	1.19217	0.03713	0.59887
1	33	0.22823	0.0	1.19252	0.03778	0.59932
1	34	0.20628	0.0	1.19326	0.03816	0.59986
1	35	0.18437	0.0	1.19459	0.03842	0.60066

TABULATED DATA INCONSISTENT WITH PLOTTED DATA

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-2
	DILLNER WING: MACH = 1.50, ALPHA = 15			

1	36	0.16247	0.0	1.19653	0.03824	0.60159
1	37	0.14056	0.0	1.19870	0.03718	0.60228
1	38	0.11939	0.0	1.20147	0.03581	0.60315
1	39	0.10039	0.0	1.20453	0.03335	0.60372
1	40	0.08401	0.0	1.20767	0.03038	0.60414
1	41	0.06988	0.0	1.21103	0.02691	0.60446
1	42	0.05770	0.0	1.21437	0.02281	0.60454
1	43	0.04719	0.0	1.21758	0.01842	0.60443
1	44	0.03813	0.0	1.22057	0.01368	0.60408
1	45	0.03032	0.0	1.22321	0.00871	0.60347
1	46	0.02358	0.0	1.22534	0.00341	0.60246
1	47	0.01777	0.0	1.22734	-0.00144	0.60159
1	48	0.01276	0.0	1.22843	-0.00780	0.59963
1	49	0.00843	0.0	1.23153	-0.00850	0.60099
1	50	0.00470	0.0	1.23769	-0.02957	0.59596
1	51	0.00149	0.0	1.24421	-0.06057	0.58738
1	52	0.0	0.0	1.24421	-0.06057	0.58738
1	53	0.00470	0.0	1.41768	0.52091	0.85316
1	54	0.00843	0.0	1.31107	0.47976	0.81505
1	55	0.01276	0.0	1.32246	0.47668	0.81683
1	56	0.01777	0.0	1.32314	0.45411	0.80911
1	57	0.02358	0.0	1.34763	0.44086	0.81097
1	58	0.03032	0.0	1.37231	0.41815	0.80992
1	59	0.03813	0.0	1.40451	0.39357	0.81064
1	60	0.04719	0.0	1.43918	0.36334	0.81074
1	61	0.05770	0.0	1.47425	0.32997	0.81057
1	62	0.06988	0.0	1.50490	0.29631	0.80967
1	63	0.08401	0.0	1.52714	0.26642	0.80790
1	64	0.10039	0.0	1.53917	0.24288	0.80518
1	65	0.11940	0.0	1.54377	0.22397	0.80166
1	66	0.14057	0.0	1.54590	0.20667	0.79787
1	67	0.16248	0.0	1.54904	0.19119	0.79487
1	68	0.18437	0.0	1.55223	0.17672	0.79217
1	69	0.20628	0.0	1.55501	0.16487	0.79004
1	70	0.22823	0.0	1.55652	0.15496	0.78802
1	71	0.25025	0.0	1.55743	0.14684	0.78627
1	72	0.27239	0.0	1.55829	0.14002	0.78483
1	73	0.29465	0.0	1.55962	0.13417	0.78379
1	74	0.31710	0.0	1.56199	0.12871	0.78318
1	75	0.33974	0.0	1.56559	0.12407	0.78318
1	76	0.36263	0.0	1.57047	0.11930	0.78356
1	77	0.38577	0.0	1.57698	0.11520	0.78463
1	78	0.40921	0.0	1.58414	0.11135	0.78596
1	79	0.43299	0.0	1.59268	0.10740	0.78771
1	80	0.45711	0.0	1.60275	0.10396	0.79005
1	81	0.48163	0.0	1.61357	0.10063	0.79262
1	82	0.50658	0.0	1.62539	0.09738	0.79550
1	83	0.53199	0.0	1.63782	0.09462	0.79864
1	84	0.55788	0.0	1.65079	0.09163	0.80185
1	85	0.58428	0.0	1.66446	0.08929	0.80536
1	86	0.61123	0.0	1.67863	0.08656	0.80889
1	87	0.63877	0.0	1.69370	0.08434	0.81272
1	88	0.66691	0.0	1.70824	0.08242	0.81640
1	89	0.69569	0.0	1.72305	0.08010	0.82001
1	90	0.72515	0.0	1.73782	0.07861	0.82371
1	91	0.75530	0.0	1.75215	0.07647	0.82710
1	92	0.78618	0.0	1.76648	0.07506	0.83057
1	93	0.81783	0.0	1.77973	0.07352	0.83369
1	94	0.85027	0.0	1.79349	0.07163	0.83681
1	95	0.88351	0.0	1.80666	0.07022	0.83982
1	96	0.91522	0.0	1.81800	0.07045	0.84262
1	97	0.94139	0.0	1.83601	0.06170	0.84546
1	98	0.96122	0.0	1.83635	0.07307	0.84742

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-3
	DILLNER WING: MACH = 1.50, ALPHA = 15			

1	99	0.97625	0.0	1.81042	0.06790	0.84034
1	100	0.98764	0.0	1.93910	0.03434	0.86434
1	101	0.99627	0.0	1.69726	0.13654	0.82434
1	102	1.00000	0.0	1.69726	0.13654	0.82434
2	1	1.00000	0.01350	1.44843	-0.01638	0.70182
2	2	0.99641	0.01350	1.48760	0.01239	0.72610
2	3	0.98810	0.01350	1.45757	-0.02253	0.70391
2	4	0.97713	0.01350	1.43586	0.01222	0.70496
2	5	0.96266	0.01350	1.44445	-0.00949	0.70215
2	6	0.94356	0.01350	1.42992	0.00061	0.69896
2	7	0.91837	0.01350	1.42103	-0.00232	0.69425
2	8	0.88784	0.01350	1.40835	-0.00161	0.68894
2	9	0.85582	0.01350	1.39515	-0.00135	0.68318
2	10	0.82459	0.01350	1.38171	-0.00113	0.67722
2	11	0.79412	0.01350	1.36873	-0.00057	0.67150
2	12	0.76438	0.01350	1.35565	-0.00047	0.66550
2	13	0.73534	0.01350	1.34294	0.00046	0.65988
2	14	0.70698	0.01350	1.33038	0.00080	0.65405
2	15	0.67927	0.01350	1.31812	0.00195	0.64859
2	16	0.65217	0.01350	1.30618	0.00298	0.64318
2	17	0.62566	0.01350	1.29386	0.00419	0.63759
2	18	0.59970	0.01350	1.28220	0.00598	0.63248
2	19	0.57428	0.01350	1.27141	0.00691	0.62744
2	20	0.54935	0.01350	1.26148	0.00814	0.62291
2	21	0.52489	0.01350	1.25234	0.00878	0.61852
2	22	0.50087	0.01350	1.24386	0.00946	0.61445
2	23	0.47726	0.01350	1.23628	0.00992	0.61074
2	24	0.45402	0.01350	1.22927	0.01003	0.60715
2	25	0.43112	0.01350	1.22325	0.01038	0.60416
2	26	0.40855	0.01350	1.21821	0.01043	0.60154
2	27	0.38627	0.01350	1.21338	0.01024	0.59893
2	28	0.36423	0.01350	1.20928	0.01047	0.59686
2	29	0.34243	0.01350	1.20569	0.01013	0.59482
2	30	0.32082	0.01350	1.20257	0.01011	0.59316
2	31	0.29937	0.01350	1.20007	0.00980	0.59170
2	32	0.27806	0.01350	1.19803	0.00950	0.59049
2	33	0.25685	0.01350	1.19650	0.00909	0.58950
2	34	0.23572	0.01350	1.19534	0.00847	0.58862
2	35	0.21462	0.01350	1.19469	0.00782	0.58801
2	36	0.19354	0.01350	1.19453	0.00696	0.58756
2	37	0.17244	0.01350	1.19447	0.00555	0.58695
2	38	0.15206	0.01350	1.19477	0.00437	0.58662
2	39	0.13376	0.01350	1.19509	0.00262	0.58606
2	40	0.11799	0.01350	1.19516	0.00123	0.58552
2	41	0.10438	0.01350	1.19537	0.00024	0.58523
2	42	0.09265	0.01350	1.19582	-0.00065	0.58510
2	43	0.08253	0.01350	1.19660	-0.00113	0.58532
2	44	0.07381	0.01350	1.19792	-0.00098	0.58610
2	45	0.06629	0.01350	1.19983	-0.00122	0.58703
2	46	0.05980	0.01350	1.20281	0.00047	0.58932
2	47	0.05420	0.01350	1.20703	-0.00063	0.59113
2	48	0.04938	0.01350	1.21266	0.00429	0.59614
2	49	0.04521	0.01350	1.22356	0.00319	0.60144
2	50	0.04162	0.01350	1.25651	-0.01785	0.61045
2	51	0.03852	0.01350	1.27948	-0.05640	0.60798
2	52	0.03709	0.01350	1.27948	-0.05640	0.60798
2	53	0.04162	0.01350	1.37739	0.59597	0.86895
2	54	0.04521	0.01350	1.40014	0.53753	0.85470
2	55	0.04938	0.01350	1.42334	0.54441	0.86148
2	56	0.05420	0.01350	1.44635	0.52327	0.85972
2	57	0.05980	0.01350	1.47768	0.50621	0.86108
2	58	0.06629	0.01350	1.51022	0.47407	0.85884
2	59	0.07381	0.01350	1.54286	0.44201	0.85720

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-4
	DILLNER WING: MACH = 1.50, ALPHA = 15			

2	60	0.08253	0.01350	1.57132	0.40760	0.85459
2	61	0.09265	0.01350	1.59404	0.37558	0.85179
2	62	0.10438	0.01350	1.60881	0.34722	0.84841
2	63	0.11798	0.01350	1.61588	0.32313	0.84446
2	64	0.13376	0.01350	1.61697	0.30180	0.83982
2	65	0.15206	0.01350	1.61479	0.28144	0.83461
2	66	0.17245	0.01350	1.61006	0.26272	0.82911
2	67	0.19354	0.01350	1.60002	0.25077	0.82373
2	68	0.21463	0.01350	1.58443	0.23991	0.81701
2	69	0.23572	0.01350	1.57209	0.22591	0.81021
2	70	0.25685	0.01350	1.56449	0.21035	0.80422
2	71	0.27806	0.01350	1.56078	0.19520	0.79937
2	72	0.29937	0.01350	1.56012	0.18140	0.79573
2	73	0.32082	0.01350	1.56189	0.16935	0.79327
2	74	0.34243	0.01350	1.56585	0.15880	0.79186
2	75	0.36423	0.01350	1.57153	0.15007	0.79145
2	76	0.38627	0.01350	1.57868	0.14214	0.79171
2	77	0.40855	0.01350	1.58712	0.13565	0.79273
2	78	0.43112	0.01350	1.59608	0.12981	0.79408
2	79	0.45402	0.01350	1.60623	0.12426	0.79586
2	80	0.47725	0.01350	1.61745	0.11958	0.79816
2	81	0.50086	0.01350	1.62904	0.11515	0.80061
2	82	0.52489	0.01350	1.64125	0.11095	0.80328
2	83	0.54935	0.01350	1.65367	0.10728	0.80610
2	84	0.57428	0.01350	1.66635	0.10345	0.80893
2	85	0.59970	0.01350	1.67940	0.10033	0.81199
2	86	0.62566	0.01350	1.69289	0.09676	0.81504
2	87	0.65217	0.01350	1.70701	0.09379	0.81834
2	88	0.67927	0.01350	1.72019	0.09120	0.82141
2	89	0.70698	0.01350	1.73345	0.08835	0.82441
2	90	0.73534	0.01350	1.74657	0.08647	0.82752
2	91	0.76438	0.01350	1.75934	0.08403	0.83038
2	92	0.79411	0.01350	1.77217	0.08253	0.83339
2	93	0.82458	0.01350	1.78414	0.08091	0.83612
2	94	0.85582	0.01350	1.79671	0.07919	0.83893
2	95	0.88783	0.01350	1.80885	0.07799	0.84169
2	96	0.91837	0.01350	1.81949	0.07808	0.84426
2	97	0.94356	0.01350	1.83470	0.07241	0.84692
2	98	0.96266	0.01350	1.83964	0.07724	0.84887
2	99	0.97713	0.01350	1.80699	0.08270	0.84205
2	100	0.98810	0.01350	1.93631	0.03622	0.86402
2	101	0.99641	0.01350	1.67900	0.15950	0.82425
2	102	1.00000	0.01350	1.67900	0.15950	0.82425
3	1	1.00000	0.03850	1.45496	-0.02356	0.70250
3	2	0.99667	0.03850	1.49053	0.00629	0.72558
3	3	0.98895	0.03850	1.46211	-0.02934	0.70387
3	4	0.97876	0.03850	1.44026	0.00542	0.70479
3	5	0.96532	0.03850	1.44862	-0.01607	0.70199
3	6	0.94759	0.03850	1.43421	-0.00597	0.69883
3	7	0.92420	0.03850	1.42500	-0.00835	0.69413
3	8	0.89584	0.03850	1.41195	-0.00696	0.68886
3	9	0.86610	0.03850	1.39825	-0.00558	0.68323
3	10	0.83710	0.03850	1.38444	-0.00403	0.67752
3	11	0.80880	0.03850	1.37120	-0.00187	0.67220
3	12	0.78119	0.03850	1.35804	-0.00002	0.66676
3	13	0.75422	0.03850	1.34538	0.00282	0.66182
3	14	0.72788	0.03850	1.33303	0.00517	0.65682
3	15	0.70215	0.03850	1.32115	0.00841	0.65231
3	16	0.67698	0.03850	1.30999	0.01129	0.64798
3	17	0.65236	0.03850	1.29888	0.01386	0.64354
3	18	0.62825	0.03850	1.28866	0.01655	0.63955
3	19	0.60464	0.03850	1.27929	0.01819	0.63557
3	20	0.58149	0.03850	1.27073	0.01990	0.63198

DORNIER JAMESON	AR 211		W.Schmidt A.Jameson	14-9-5
	DILLNER WING: MACH = 1.50, ALPHA = 15			

3	22	0.53647	0.03850	1.25543	0.02155	0.62499
3	23	0.51454	0.03850	1.24866	0.02191	0.62172
3	24	0.49296	0.03850	1.24218	0.02178	0.61840
3	25	0.47170	0.03850	1.23639	0.02182	0.61547
3	26	0.45074	0.03850	1.23140	0.02143	0.61276
3	27	0.43004	0.03850	1.22647	0.02066	0.60993
3	28	0.40958	0.03850	1.22203	0.02020	0.60745
3	29	0.38933	0.03850	1.21790	0.01913	0.60488
3	30	0.36926	0.03850	1.21405	0.01832	0.60255
3	31	0.34934	0.03850	1.21057	0.01725	0.60030
3	32	0.32956	0.03850	1.20739	0.01623	0.59821
3	33	0.30986	0.03850	1.20456	0.01520	0.59630
3	34	0.29023	0.03850	1.20180	0.01393	0.59432
3	35	0.27064	0.03850	1.19954	0.01318	0.59281
3	36	0.25106	0.03850	1.19758	0.01206	0.59131
3	37	0.23147	0.03850	1.19561	0.01094	0.58979
3	38	0.21254	0.03850	1.19412	0.01037	0.58876
3	39	0.19555	0.03850	1.19306	0.00958	0.58786
3	40	0.18090	0.03850	1.19216	0.00904	0.58716
3	41	0.16826	0.03850	1.19162	0.00883	0.58678
3	42	0.15737	0.03850	1.19154	0.00866	0.58666
3	43	0.14797	0.03850	1.19202	0.00863	0.58691
3	44	0.13987	0.03850	1.19333	0.00908	0.58780
3	45	0.13288	0.03850	1.19569	0.00867	0.58889
3	46	0.12686	0.03850	1.19971	0.00988	0.59155
3	47	0.12166	0.03850	1.20602	0.00737	0.59386
3	48	0.11718	0.03850	1.21349	0.01171	0.59958
3	49	0.11331	0.03850	1.22397	0.01412	0.60603
3	50	0.10998	0.03850	1.26691	-0.01565	0.61667
3	51	0.10710	0.03850	1.31156	-0.06538	0.62150
3	52	0.10577	0.03850	1.31156	-0.06538	0.62150
3	53	0.10998	0.03850	1.52657	0.48241	0.86435
3	54	0.11331	0.03850	1.65604	0.38673	0.86727
3	55	0.11718	0.03850	1.65998	0.45945	0.88370
3	56	0.12166	0.03850	1.69280	0.44349	0.88603
3	57	0.12686	0.03850	1.71197	0.44064	0.88871
3	58	0.13288	0.03850	1.73127	0.41628	0.88720
3	59	0.13987	0.03850	1.74204	0.39726	0.88540
3	60	0.14797	0.03850	1.75183	0.37288	0.88254
3	61	0.15737	0.03850	1.75863	0.35078	0.87965
3	62	0.16826	0.03850	1.76071	0.32930	0.87606
3	63	0.18090	0.03850	1.76077	0.31025	0.87255
3	64	0.19555	0.03850	1.75714	0.29436	0.86889
3	65	0.21254	0.03850	1.74959	0.28011	0.86470
3	66	0.23147	0.03850	1.73764	0.26911	0.86012
3	67	0.25106	0.03850	1.71963	0.26512	0.85547
3	68	0.27064	0.03850	1.69744	0.26512	0.85054
3	69	0.29023	0.03850	1.67545	0.26133	0.84472
3	70	0.30986	0.03850	1.65802	0.25236	0.83867
3	71	0.32956	0.03850	1.64492	0.24091	0.83295
3	72	0.34935	0.03850	1.63546	0.22880	0.82788
3	73	0.36926	0.03850	1.62928	0.21688	0.82360
3	74	0.38933	0.03850	1.62609	0.20541	0.82016
3	75	0.40958	0.03850	1.62541	0.19478	0.81757
3	76	0.43004	0.03850	1.62708	0.18443	0.81568
3	77	0.45074	0.03850	1.63050	0.17518	0.81454
3	78	0.47170	0.03850	1.63508	0.16646	0.81386
3	79	0.49296	0.03850	1.64131	0.15797	0.81370
3	80	0.51454	0.03850	1.64879	0.15035	0.81410
3	81	0.53647	0.03850	1.65687	0.14310	0.81477
3	82	0.55877	0.03850	1.66568	0.13627	0.81574
3	83	0.58149	0.03850	1.67492	0.13007	0.81698

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-6
	DILLNER WING: MACH = 1.50, ALPHA = 15			

3	84	0.60464	0.03850	1.68470	0.12385	0.81836
3	85	0.62825	0.03850	1.69509	0.11847	0.82008
3	86	0.65236	0.03850	1.70596	0.11289	0.82189
3	87	0.67698	0.03850	1.71749	0.10805	0.82401
3	88	0.70214	0.03850	1.72861	0.10354	0.82607
3	89	0.72788	0.03850	1.74019	0.09884	0.82820
3	90	0.75422	0.03850	1.75209	0.09520	0.83059
3	91	0.78119	0.03850	1.76412	0.09117	0.83293
3	92	0.80880	0.03850	1.77664	0.08830	0.83556
3	93	0.83709	0.03850	1.78879	0.08547	0.83808
3	94	0.86610	0.03850	1.80190	0.08284	0.84084
3	95	0.89583	0.03850	1.81477	0.08115	0.84366
3	96	0.92419	0.03850	1.82654	0.08045	0.84633
3	97	0.94759	0.03850	1.84109	0.07618	0.84903
3	98	0.96532	0.03850	1.84666	0.07947	0.85085
3	99	0.97876	0.03850	1.81719	0.08658	0.84516
3	100	0.98895	0.03850	1.94495	0.03786	0.86606
3	101	0.99667	0.03850	1.67535	0.16780	0.82503
3	102	1.00000	0.03850	1.67535	0.16780	0.82503
4	1	1.00000	0.06000	1.45322	-0.01568	0.70405
4	2	0.99689	0.06000	1.48571	0.01477	0.72602
4	3	0.98968	0.06000	1.45920	-0.02109	0.70501
4	4	0.98016	0.06000	1.43662	0.01362	0.70570
4	5	0.96761	0.06000	1.44466	-0.00705	0.70295
4	6	0.95105	0.06000	1.43067	0.00289	0.69997
4	7	0.92920	0.06000	1.42147	0.00103	0.69546
4	8	0.90272	0.06000	1.40866	0.00250	0.69035
4	9	0.87495	0.06000	1.39518	0.00378	0.68482
4	10	0.84786	0.06000	1.38171	0.00493	0.67917
4	11	0.82143	0.06000	1.36892	0.00641	0.67388
4	12	0.79564	0.06000	1.35636	0.00734	0.66844
4	13	0.77045	0.06000	1.34440	0.00901	0.66347
4	14	0.74585	0.06000	1.33285	0.00996	0.65839
4	15	0.72182	0.06000	1.32191	0.01155	0.65377
4	16	0.69832	0.06000	1.31178	0.01263	0.64932
4	17	0.67532	0.06000	1.30171	0.01343	0.64476
4	18	0.65281	0.06000	1.29242	0.01459	0.64067
4	19	0.63076	0.06000	1.28384	0.01503	0.63664
4	20	0.60913	0.06000	1.27598	0.01582	0.63305
4	21	0.58792	0.06000	1.26872	0.01605	0.62954
4	22	0.56708	0.06000	1.26184	0.01636	0.62622
4	23	0.54661	0.06000	1.25550	0.01649	0.62309
4	24	0.52645	0.06000	1.24937	0.01624	0.61989
4	25	0.50659	0.06000	1.24383	0.01624	0.61708
4	26	0.48702	0.06000	1.23897	0.01586	0.61445
4	27	0.46769	0.06000	1.23411	0.01514	0.61167
4	28	0.44858	0.06000	1.22960	0.01478	0.60921
4	29	0.42967	0.06000	1.22529	0.01383	0.60659
4	30	0.41092	0.06000	1.22111	0.01314	0.60415
4	31	0.39232	0.06000	1.21714	0.01222	0.60170
4	32	0.37384	0.06000	1.21332	0.01134	0.59934
4	33	0.35544	0.06000	1.20969	0.01049	0.59708
4	34	0.33711	0.06000	1.20596	0.00939	0.59466
4	35	0.31881	0.06000	1.20256	0.00885	0.59263
4	36	0.30053	0.06000	1.19938	0.00800	0.59059
4	37	0.28223	0.06000	1.19611	0.00717	0.58850
4	38	0.26455	0.06000	1.19339	0.00702	0.58698
4	39	0.24868	0.06000	1.19145	0.00682	0.58585
4	40	0.23500	0.06000	1.19014	0.00676	0.58512
4	41	0.22320	0.06000	1.18948	0.00694	0.58484
4	42	0.21302	0.06000	1.18951	0.00711	0.58493
4	43	0.20425	0.06000	1.19029	0.00725	0.58541
4	44	0.19668	0.06000	1.19202	0.00775	0.58655

CHART		08-9-15	08-9-16	08-9-17	08-9-18	08-9-19	08-9-20	08-9-21	08-9-22	08-9-23	08-9-24	08-9-25	08-9-26	FICHE Nº 13
08-9-27	08-9-28	08-9-29	08-9-30	08-9-31	08-9-32	08-9-33	08-9-34	08-9-35	08-9-36	08-9-37	08-9-38	08-9-39	08-9-40	
08-9-41	08-9-42	TEST CASE 08 CONTRIBUTOR 11	08-11-1	08-11-2	08-11-3	08-11-4	08-11-5	08-11-6	08-11-7	08-11-8	08-11-9	08-11-10	08-11-11	
08-11-12	~~08-11-13~~ 08-11-13	08-11-14	08-11-15	08-11-16	08-11-17	08-11-18	08-11-19	08-11-20	TEST CASE 09 CONTRIBUTOR 12	09-12-1	09-12-2	09-12-3	09-12-4	
09-12-5	09-12-6	09-12-7	09-12-8	09-12-9	09-12-10	09-12-11	TEST CASE 09 CONTRIBUTOR 13	09-13-1	09-13-2	09-13-3	09-13-4	09-13-5	09-13-6	
09-13-7	09-13-8	09-13-9	09-13-10	09-13-11	09-13-12	09-13-13	09-13-14	09-13-15	TEST CASE 10 CONTRIBUTOR 12	10-12-1	10-12-2	10-12-3	10-12-4	
10-12-5	10-12-6	10-12-7	10-12-8	10-12-9	10-12-10	TEST CASE 14 CONTRIBUTOR 9	14-9-1	14-9-2	14-9-3	14-9-4	14-9-5	14-9-6	CONTINUED	

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-7
	DILLNER WING: MACH = 1.50, ALPHA = 15			

4	46	0.18795	0.06000	1.19984	0.00801	0.59084
4	47	0.17968	0.06000	1.20769	0.00423	0.59347
4	48	0.17549	0.06000	1.21618	0.00736	0.59924
4	49	0.17188	0.06000	1.22266	0.01556	0.60592
4	50	0.16876	0.06000	1.26866	-0.01593	0.61747
4	51	0.16608	0.06000	1.34913	-0.10666	0.62664
4	52	0.16483	0.06000	1.34913	-0.10666	0.62664
4	53	0.16877	0.06000	1.78645	0.17967	0.85424
4	54	0.17188	0.06000	1.89006	0.20303	0.87922
4	55	0.17549	0.06000	1.84347	0.37173	0.89771
4	56	0.17968	0.06000	1.89454	0.32057	0.89774
4	57	0.18453	0.06000	1.86810	0.35615	0.89907
4	58	0.19016	0.06000	1.87786	0.33060	0.89663
4	59	0.19668	0.06000	1.88187	0.32179	0.89591
4	60	0.20425	0.06000	1.88885	0.30695	0.89477
4	61	0.21302	0.06000	1.89394	0.29872	0.89436
4	62	0.22320	0.06000	1.89650	0.29171	0.89372
4	63	0.23500	0.06000	1.89379	0.28602	0.89242
4	64	0.24868	0.06000	1.88843	0.27858	0.89040
4	65	0.26455	0.06000	1.87884	0.27215	0.88777
4	66	0.28223	0.06000	1.86415	0.26945	0.88477
4	67	0.30053	0.06000	1.84409	0.27104	0.88142
4	68	0.31882	0.06000	1.82212	0.27403	0.87786
4	69	0.33711	0.06000	1.80079	0.27315	0.87365
4	70	0.35544	0.06000	1.78172	0.26772	0.86895
4	71	0.37384	0.06000	1.76449	0.25956	0.86396
4	72	0.39232	0.06000	1.74909	0.24993	0.85893
4	73	0.41092	0.06000	1.73579	0.23954	0.85405
4	74	0.42967	0.06000	1.72462	0.22883	0.84947
4	75	0.44858	0.06000	1.71554	0.21824	0.84529
4	76	0.46769	0.06000	1.70825	0.20771	0.84147
4	77	0.48702	0.06000	1.70276	0.19759	0.83811
4	78	0.50659	0.06000	1.69945	0.18739	0.83523
4	79	0.52645	0.06000	1.69811	0.17744	0.83288
4	80	0.54660	0.06000	1.69831	0.16825	0.83106
4	81	0.56708	0.06000	1.69990	0.15941	0.82967
4	82	0.58792	0.06000	1.70299	0.15103	0.82878
4	83	0.60913	0.06000	1.70729	0.14336	0.82835
4	84	0.63076	0.06000	1.71284	0.13588	0.82830
4	85	0.65281	0.06000	1.71963	0.12933	0.82876
4	86	0.67532	0.06000	1.72749	0.12286	0.82953
4	87	0.69831	0.06000	1.73636	0.11739	0.83076
4	88	0.72182	0.06000	1.74528	0.11238	0.83208
4	89	0.74585	0.06000	1.75499	0.10733	0.83360
4	90	0.77045	0.06000	1.76534	0.10334	0.83547
4	91	0.79564	0.06000	1.77616	0.09900	0.83738
4	92	0.82143	0.06000	1.78776	0.09575	0.83965
4	93	0.84785	0.06000	1.79936	0.09243	0.84189
4	94	0.87494	0.06000	1.81214	0.08924	0.84441
4	95	0.90271	0.06000	1.82477	0.08697	0.84701
4	96	0.92920	0.06000	1.83671	0.08498	0.84946
4	97	0.95105	0.06000	1.85042	0.08046	0.85187
4	98	0.96761	0.06000	1.85525	0.08294	0.85336
4	99	0.98016	0.06000	1.83089	0.08835	0.84867
4	100	0.98968	0.06000	1.95571	0.03940	0.86849
4	101	0.99689	0.06000	1.67793	0.17126	0.82643
4	102	1.00000	0.06000	1.67793	0.17126	0.82643
5	1	1.00000	0.07864	1.45625	-0.00847	0.70742
5	2	0.99708	0.07864	1.48128	0.02325	0.72663
5	3	0.99031	0.07864	1.45441	-0.01327	0.70526
5	4	0.98138	0.07864	1.43201	0.02174	0.70621
5	5	0.96960	0.07864	1.44031	0.00070	0.70341

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-8
	DILLNER WING: MACH = 1.50, ALPHA = 15			

5	6	0.95405	0.07864	1.42663	0.01039	0.70051
5	7	0.93354	0.07864	1.41778	0.00846	0.69614
5	8	0.90868	0.07864	1.40562	0.00953	0.69121
5	9	0.88261	0.07864	1.39285	0.01042	0.68589
5	10	0.85719	0.07864	1.38021	0.01098	0.68045
5	11	0.83238	0.07864	1.36836	0.01174	0.67537
5	12	0.80817	0.07864	1.35686	0.01178	0.67015
5	13	0.78453	0.07864	1.34607	0.01237	0.66538
5	14	0.76144	0.07864	1.33570	0.01208	0.66046
5	15	0.73888	0.07864	1.32588	0.01230	0.65592
5	16	0.71682	0.07864	1.31670	0.01202	0.65146
5	17	0.69523	0.07864	1.30733	0.01155	0.64680
5	18	0.67410	0.07864	1.29850	0.01158	0.64254
5	19	0.65340	0.07864	1.29015	0.01105	0.63827
5	20	0.63310	0.07864	1.28236	0.01102	0.63442
5	21	0.61318	0.07864	1.27502	0.01060	0.63063
5	22	0.59363	0.07864	1.26795	0.01042	0.62703
5	23	0.57441	0.07864	1.26135	0.01023	0.62364
5	24	0.55549	0.07864	1.25488	0.00983	0.62022
5	25	0.53685	0.07864	1.24896	0.00983	0.61721
5	26	0.51847	0.07864	1.24368	0.00959	0.61442
5	27	0.50033	0.07864	1.23839	0.00916	0.61153
5	28	0.48239	0.07864	1.23347	0.00919	0.60899
5	29	0.46464	0.07864	1.22876	0.00870	0.60636
5	30	0.44704	0.07864	1.22421	0.00854	0.60392
5	31	0.42958	0.07864	1.21988	0.00816	0.60150
5	32	0.41223	0.07864	1.21571	0.00784	0.59918
5	33	0.39497	0.07864	1.21173	0.00754	0.59696
5	34	0.37776	0.07864	1.20768	0.00696	0.59458
5	35	0.36058	0.07864	1.20391	0.00690	0.59255
5	36	0.34342	0.07864	1.20041	0.00645	0.59050
5	37	0.32624	0.07864	1.19688	0.00585	0.58836
5	38	0.30965	0.07864	1.19388	0.00581	0.58674
5	39	0.29475	0.07864	1.19178	0.00567	0.58555
5	40	0.28190	0.07864	1.19051	0.00558	0.58483
5	41	0.27083	0.07864	1.19005	0.00569	0.58463
5	42	0.26128	0.07864	1.19044	0.00582	0.58489
5	43	0.25304	0.07864	1.19172	0.00589	0.58561
5	44	0.24594	0.07864	1.19399	0.00643	0.58705
5	45	0.23981	0.07864	1.19752	0.00605	0.58879
5	46	0.23453	0.07864	1.20305	0.00694	0.59211
5	47	0.22998	0.07864	1.21227	0.00248	0.59519
5	48	0.22605	0.07864	1.22236	0.00475	0.60144
5	49	0.22266	0.07864	1.22599	0.01763	0.60847
5	50	0.21973	0.07864	1.27201	-0.01315	0.62023
5	51	0.21721	0.07864	1.38284	-0.14266	0.63217
5	52	0.21604	0.07864	1.38284	-0.14266	0.63217
5	53	0.21973	0.07864	1.93574	-0.06161	0.85009
5	54	0.22266	0.07864	1.94258	0.16206	0.88292
5	55	0.22605	0.07864	1.94532	0.25495	0.89634
5	56	0.22998	0.07864	1.94529	0.23052	0.89294
5	57	0.23453	0.07864	1.93919	0.26224	0.89637
5	58	0.23981	0.07864	1.96103	0.23902	0.89667
5	59	0.24594	0.07864	1.96689	0.25513	0.89977
5	60	0.25304	0.07864	1.97703	0.25456	0.90127
5	61	0.26128	0.07864	1.98449	0.26021	0.90314
5	62	0.27083	0.07864	1.99091	0.26129	0.90425
5	63	0.28190	0.07864	1.99398	0.26258	0.90487
5	64	0.29475	0.07864	1.99359	0.26210	0.90475
5	65	0.30965	0.07864	1.98667	0.26340	0.90389
5	66	0.32625	0.07864	1.97441	0.26692	0.90251
5	67	0.34342	0.07864	1.95768	0.27096	0.90049
5	68	0.36059	0.07864	1.94016	0.27344	0.89810

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-9
	DILLNER WING: MACH = 1.50, ALPHA = 15			

5	70	0.39471	0.07864	1.90848	0.26859	0.89163
5	71	0.41223	0.07864	1.88965	0.25962	0.88773
5	72	0.42958	0.07864	1.87285	0.25149	0.88352
5	73	0.44704	0.07864	1.85657	0.24257	0.87913
5	74	0.46464	0.07864	1.84110	0.23321	0.87469
5	75	0.48239	0.07864	1.82656	0.22378	0.87029
5	76	0.50033	0.07864	1.81326	0.21450	0.86604
5	77	0.51847	0.07864	1.80131	0.20554	0.86201
5	78	0.53685	0.07864	1.79079	0.19676	0.85822
5	79	0.55548	0.07864	1.78170	0.18807	0.85469
5	80	0.57440	0.07864	1.77448	0.17955	0.85153
5	81	0.59362	0.07864	1.76947	0.17076	0.84879
5	82	0.61318	0.07864	1.76665	0.16209	0.84656
5	83	0.63310	0.07864	1.76554	0.15393	0.84480
5	84	0.65340	0.07864	1.76625	0.14589	0.84349
5	85	0.67410	0.07864	1.76864	0.13862	0.84274
5	86	0.69523	0.07864	1.77244	0.13138	0.84233
5	87	0.71681	0.07864	1.77742	0.12505	0.84238
5	88	0.73887	0.07864	1.78275	0.11913	0.84260
5	89	0.76144	0.07864	1.78905	0.11324	0.84306
5	90	0.78453	0.07864	1.79622	0.10833	0.84391
5	91	0.80817	0.07864	1.80420	0.10309	0.84490
5	92	0.83238	0.07864	1.81324	0.09895	0.84632
5	93	0.85718	0.07864	1.82271	0.09468	0.84782
5	94	0.88261	0.07864	1.83367	0.09066	0.84969
5	95	0.90868	0.07864	1.84476	0.08755	0.85173
5	96	0.93354	0.07864	1.85588	0.08451	0.85376
5	97	0.95405	0.07864	1.86836	0.08023	0.85587
5	98	0.96960	0.07864	1.87265	0.08255	0.85718
5	99	0.98138	0.07864	1.85240	0.08765	0.85348
5	100	0.99031	0.07864	1.97164	0.03934	0.87169
5	101	0.99708	0.07864	1.68549	0.17527	0.82922
5	102	1.00000	0.07864	1.68549	0.17527	0.82922
6	1	1.00000	0.09464	1.47086	-0.00799	0.71363
6	2	0.99724	0.09464	1.47807	0.02781	0.72665
6	3	0.99085	0.09464	1.45236	-0.01128	0.70497
6	4	0.98242	0.09464	1.43098	0.02528	0.70684
6	5	0.97130	0.09464	1.43961	0.00312	0.70383
6	6	0.95663	0.09464	1.42607	0.01274	0.70099
6	7	0.93727	0.09464	1.41775	0.01033	0.69670
6	8	0.91380	0.09464	1.40623	0.01079	0.69186
6	9	0.88920	0.09464	1.39407	0.01112	0.68665
6	10	0.86520	0.09464	1.38202	0.01121	0.68134
6	11	0.84178	0.09464	1.37079	0.01155	0.67641
6	12	0.81893	0.09464	1.35996	0.01124	0.67139
6	13	0.79661	0.09464	1.34987	0.01155	0.66686
6	14	0.77481	0.09464	1.34022	0.01104	0.66221
6	15	0.75352	0.09464	1.33106	0.01113	0.65795
6	16	0.73269	0.09464	1.32243	0.01077	0.65374
6	17	0.71232	0.09464	1.31348	0.01026	0.64930
6	18	0.69237	0.09464	1.30493	0.01025	0.64517
6	19	0.67283	0.09464	1.29671	0.00967	0.64098
6	20	0.65367	0.09464	1.28890	0.00959	0.63712
6	21	0.63487	0.09464	1.28140	0.00914	0.63326
6	22	0.61641	0.09464	1.27406	0.00894	0.62953
6	23	0.59827	0.09464	1.26708	0.00873	0.62596
6	24	0.58041	0.09464	1.26016	0.00835	0.62233
6	25	0.56282	0.09464	1.25371	0.00840	0.61908
6	26	0.54547	0.09464	1.24785	0.00827	0.61603
6	27	0.52834	0.09464	1.24196	0.00800	0.61291
6	28	0.51141	0.09464	1.23645	0.00822	0.61015
6	29	0.49465	0.09464	1.23117	0.00800	0.60733

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-10
	DILLNER WING: MACH = 1.50, ALPHA = 15			

6	30	0.47804	0.09464	1.22608	0.00814	0.60474
6	31	0.46156	0.09464	1.22128	0.00812	0.60222
6	32	0.44519	0.09464	1.21670	0.00818	0.59984
6	33	0.42889	0.09464	1.21238	0.00828	0.59761
6	34	0.41265	0.09464	1.20816	0.00818	0.59533
6	35	0.39643	0.09464	1.20418	0.00831	0.59328
6	36	0.38023	0.09464	1.20063	0.00844	0.59144
6	37	0.36402	0.09464	1.19724	0.00810	0.58949
6	38	0.34835	0.09464	1.19447	0.00823	0.58806
6	39	0.33429	0.09464	1.19266	0.00815	0.58705
6	40	0.32217	0.09464	1.19176	0.00799	0.58650
6	41	0.31171	0.09464	1.19176	0.00797	0.58649
6	42	0.30270	0.09464	1.19270	0.00794	0.58699
6	43	0.29492	0.09464	1.19463	0.00782	0.58798
6	44	0.28822	0.09464	1.19761	0.00821	0.58973
6	45	0.28244	0.09464	1.20187	0.00782	0.59184
6	46	0.27745	0.09464	1.20802	0.00889	0.59555
6	47	0.27315	0.09464	1.21830	0.00442	0.59917
6	48	0.26944	0.09464	1.23048	0.00526	0.60589
6	49	0.26624	0.09464	1.23485	0.01950	0.61377
6	50	0.26348	0.09464	1.28032	-0.01006	0.62560
6	51	0.26110	0.09464	1.39598	-0.13822	0.64030
6	52	0.26000	0.09464	1.39598	-0.13822	0.64030
6	53	0.26348	0.09464	1.96557	-0.08806	0.85330
6	54	0.26624	0.09464	1.92047	0.13728	0.87526
6	55	0.26944	0.09464	1.92788	0.17972	0.88275
6	56	0.27315	0.09464	1.92768	0.17087	0.88145
6	57	0.27745	0.09464	1.93726	0.20057	0.88738
6	58	0.28244	0.09464	1.95618	0.20289	0.89095
6	59	0.28822	0.09464	1.96832	0.23172	0.89685
6	60	0.29492	0.09464	1.99019	0.23652	0.90092
6	61	0.30270	0.09464	2.00745	0.24792	0.90499
6	62	0.31171	0.09464	2.02404	0.25267	0.90800
6	63	0.32217	0.09464	2.03705	0.25840	0.91053
6	64	0.33429	0.09464	2.04594	0.26203	0.91220
6	65	0.34836	0.09464	2.04833	0.26671	0.91308
6	66	0.36402	0.09464	2.04586	0.27174	0.91334
6	67	0.38023	0.09464	2.03921	0.27482	0.91281
6	68	0.39644	0.09464	2.03134	0.27515	0.91177
6	69	0.41265	0.09464	2.02251	0.27156	0.91011
6	70	0.42889	0.09464	2.01223	0.26618	0.90798
6	71	0.44519	0.09464	2.00019	0.25958	0.90540
6	72	0.46157	0.09464	1.98675	0.25221	0.90244
6	73	0.47805	0.09464	1.97238	0.24424	0.89917
6	74	0.49465	0.09464	1.95747	0.23591	0.89568
6	75	0.51141	0.09464	1.94222	0.22752	0.89201
6	76	0.52834	0.09464	1.92712	0.21927	0.88827
6	77	0.54547	0.09464	1.91234	0.21116	0.88450
6	78	0.56282	0.09464	1.89841	0.20337	0.88082
6	79	0.58040	0.09464	1.88527	0.19613	0.87727
6	80	0.59826	0.09464	1.87338	0.18916	0.87392
6	81	0.61641	0.09464	1.86285	0.18225	0.87076
6	82	0.63487	0.09464	1.85362	0.17545	0.86782
6	83	0.65367	0.09464	1.84618	0.16828	0.86514
6	84	0.67283	0.09464	1.84135	0.16045	0.86286
6	85	0.69237	0.09464	1.83843	0.15294	0.86101
6	86	0.71231	0.09464	1.83691	0.14543	0.85945
6	87	0.73269	0.09464	1.83653	0.13882	0.85828
6	88	0.75351	0.09464	1.83668	0.13263	0.85729
6	89	0.77481	0.09464	1.83808	0.12648	0.85659
6	90	0.79661	0.09464	1.84070	0.12124	0.85631
6	91	0.81893	0.09464	1.84452	0.11572	0.85625
6	92	0.84178	0.09464	1.84986	0.11122	0.85670

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-11
	DILLNER WING: MACH = 1.50, ALPHA = 15			

6	93	0.86519	0.09464	1.85620	0.10660	0.85736
6	94	0.88919	0.09464	1.86443	0.10234	0.85848
6	95	0.91380	0.09464	1.87316	0.09899	0.85985
6	96	0.93727	0.09464	1.88272	0.09520	0.86132
6	97	0.95663	0.09464	1.89352	0.09118	0.86300
6	98	0.97130	0.09464	1.89698	0.09225	0.86389
6	99	0.98242	0.09464	1.87932	0.09666	0.86081
6	100	0.99085	0.09464	1.99245	0.04910	0.87704
6	101	0.99724	0.09464	1.69779	0.18584	0.83451
6	102	1.00000	0.09464	1.69779	0.18584	0.83451
7	1	1.00000	0.10850	1.49028	-0.01391	0.71990
7	2	0.99739	0.10850	1.46850	0.02842	0.72304
7	3	0.99132	0.10850	1.45359	-0.01018	0.70581
7	4	0.98333	0.10850	1.43500	0.02184	0.70748
7	5	0.97278	0.10850	1.44171	0.00183	0.70434
7	6	0.95886	0.10850	1.42848	0.01066	0.70138
7	7	0.94050	0.10850	1.42071	0.00767	0.69716
7	8	0.91824	0.10850	1.40955	0.00771	0.69235
7	9	0.89490	0.10850	1.39777	0.00751	0.68714
7	10	0.87213	0.10850	1.38598	0.00714	0.68180
7	11	0.84992	0.10850	1.37498	0.00709	0.67684
7	12	0.82824	0.10850	1.36433	0.00644	0.67180
7	13	0.80708	0.10850	1.35444	0.00651	0.66727
7	14	0.78640	0.10850	1.34497	0.00584	0.66266
7	15	0.76620	0.10850	1.33602	0.00586	0.65847
7	16	0.74645	0.10850	1.32761	0.00547	0.65436
7	17	0.72712	0.10850	1.31888	0.00499	0.65002
7	18	0.70820	0.10850	1.31052	0.00503	0.64601
7	19	0.68966	0.10850	1.30246	0.00451	0.64191
7	20	0.67149	0.10850	1.29475	0.00450	0.63814
7	21	0.65366	0.10850	1.28729	0.00410	0.63431
7	22	0.63615	0.10850	1.27993	0.00395	0.63060
7	23	0.61894	0.10850	1.27285	0.00379	0.62700
7	24	0.60200	0.10850	1.26577	0.00342	0.62329
7	25	0.58531	0.10850	1.25909	0.00347	0.61992
7	26	0.56886	0.10850	1.25292	0.00332	0.61672
7	27	0.55261	0.10850	1.24670	0.00303	0.61341
7	28	0.53655	0.10850	1.24080	0.00321	0.61044
7	29	0.52066	0.10850	1.23513	0.00298	0.60741
7	30	0.50490	0.10850	1.22966	0.00310	0.60460
7	31	0.48927	0.10850	1.22448	0.00308	0.60189
7	32	0.47373	0.10850	1.21954	0.00316	0.59932
7	33	0.45828	0.10850	1.21490	0.00329	0.59691
7	34	0.44287	0.10850	1.21049	0.00334	0.59460
7	35	0.42749	0.10850	1.20638	0.00351	0.59248
7	36	0.41212	0.10850	1.20272	0.00368	0.59060
7	37	0.39674	0.10850	1.19938	0.00350	0.58874
7	38	0.38188	0.10850	1.19679	0.00377	0.58746
7	39	0.36854	0.10850	1.19527	0.00390	0.58669
7	40	0.35705	0.10850	1.19477	0.00390	0.58642
7	41	0.34713	0.10850	1.19525	0.00399	0.58672
7	42	0.33858	0.10850	1.19679	0.00410	0.58759
7	43	0.33120	0.10850	1.19943	0.00405	0.58898
7	44	0.32484	0.10850	1.20321	0.00452	0.59120
7	45	0.31936	0.10850	1.20835	0.00428	0.59384
7	46	0.31463	0.10850	1.21519	0.00578	0.59807
7	47	0.31055	0.10850	1.22606	0.00240	0.60244
7	48	0.30703	0.10850	1.24023	0.00211	0.60971
7	49	0.30400	0.10850	1.24849	0.01489	0.61892
7	50	0.30138	0.10850	1.29450	-0.01422	0.63121
7	51	0.29912	0.10850	1.38948	-0.10124	0.64879
7	52	0.29807	0.10850	1.38948	-0.10124	0.64879
7	53	0.30138	0.10850	1.90608	0.07058	0.86259

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-12
	DILLNER WING: MACH = 1.50, ALPHA = 15			

7	54	0.30400	0.10850	1.88348	0.12891	0.86664
7	55	0.30703	0.10850	1.87315	0.16822	0.87061
7	56	0.31055	0.10850	1.88299	0.16117	0.87148
7	57	0.31463	0.10850	1.89281	0.17916	0.87613
7	58	0.31936	0.10850	1.90542	0.19749	0.88123
7	59	0.32484	0.10850	1.92238	0.22282	0.88796
7	60	0.33120	0.10850	1.95143	0.23011	0.89389
7	61	0.33858	0.10850	1.97896	0.24077	0.89974
7	62	0.34713	0.10850	2.00658	0.24703	0.90475
7	63	0.35705	0.10850	2.03170	0.25375	0.90922
7	64	0.36854	0.10850	2.05382	0.25808	0.91280
7	65	0.38188	0.10850	2.07024	0.26231	0.91549
7	66	0.39674	0.10850	2.08282	0.26498	0.91744
7	67	0.41212	0.10850	2.09120	0.26459	0.91847
7	68	0.42749	0.10850	2.09678	0.26216	0.91891
7	69	0.44287	0.10850	2.09926	0.25736	0.91870
7	70	0.45828	0.10850	2.09860	0.25205	0.91803
7	71	0.47374	0.10850	2.09515	0.24600	0.91692
7	72	0.48927	0.10850	2.08925	0.23953	0.91543
7	73	0.50490	0.10850	2.08124	0.23273	0.91360
7	74	0.52066	0.10850	2.07134	0.22579	0.91146
7	75	0.53655	0.10850	2.05964	0.21881	0.90902
7	76	0.55261	0.10850	2.04668	0.21201	0.90635
7	77	0.56886	0.10850	2.03259	0.20529	0.90346
7	78	0.58531	0.10850	2.01781	0.19897	0.90042
7	79	0.60200	0.10850	2.00272	0.19291	0.89729
7	80	0.61894	0.10850	1.98770	0.18691	0.89408
7	81	0.63615	0.10850	1.97318	0.18081	0.89085
7	82	0.65366	0.10850	1.95939	0.17459	0.88764
7	83	0.67149	0.10850	1.94652	0.16845	0.88452
7	84	0.68966	0.10850	1.93387	0.16203	0.88133
7	85	0.70820	0.10850	1.92247	0.15483	0.87817
7	86	0.72712	0.10850	1.91318	0.14625	0.87516
7	87	0.74644	0.10850	1.90555	0.13784	0.87243
7	88	0.76620	0.10850	1.89920	0.12959	0.86994
7	89	0.78640	0.10850	1.89489	0.12136	0.86783
7	90	0.80708	0.10850	1.89261	0.11410	0.86627
7	91	0.82824	0.10850	1.89245	0.10666	0.86511
7	92	0.84992	0.10850	1.89455	0.10040	0.86461
7	93	0.87213	0.10850	1.89839	0.09409	0.86447
7	94	0.89489	0.10850	1.90474	0.08826	0.86493
7	95	0.91823	0.10850	1.91198	0.08374	0.86577
7	96	0.94049	0.10850	1.92080	0.07865	0.86685
7	97	0.95886	0.10850	1.93186	0.07357	0.86839
7	98	0.97278	0.10850	1.93465	0.07561	0.86924
7	99	0.98333	0.10850	1.91426	0.07946	0.86562
7	100	0.99132	0.10850	2.03209	0.03009	0.88208
7	101	0.99739	0.10850	1.73131	0.17275	0.84015
7	102	1.00000	0.10850	1.73131	0.17275	0.84015
8	1	1.00000	0.12400	1.53909	-0.02651	0.73584
8	2	0.99754	0.12400	1.46550	0.02648	0.72128
8	3	0.99185	0.12400	1.44947	-0.00770	0.70480
8	4	0.98434	0.12400	1.43968	0.01784	0.70823
8	5	0.97443	0.12400	1.44419	0.00068	0.70504
8	6	0.96136	0.12400	1.43117	0.00916	0.70207
8	7	0.94411	0.12400	1.42366	0.00614	0.69796
8	8	0.92320	0.12400	1.41264	0.00635	0.69327
8	9	0.90127	0.12400	1.40100	0.00625	0.68816
8	10	0.87989	0.12400	1.38929	0.00603	0.68292
8	11	0.85903	0.12400	1.37834	0.00615	0.67805
8	12	0.83866	0.12400	1.36773	0.00569	0.67310
8	13	0.81878	0.12400	1.35785	0.00596	0.66866
8	14	0.79936	0.12400	1.34842	0.00551	0.66415

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-13
	DILLNER WING: MACH = 1.50, ALPHA = 15			

8	15	0.78038	0.12400	1.33955	0.00575	0.66009
8	16	0.76183	0.12400	1.33127	0.00560	0.65613
8	17	0.74367	0.12400	1.32271	0.00534	0.65198
8	18	0.72590	0.12400	1.31456	0.00558	0.64816
8	19	0.70849	0.12400	1.30673	0.00527	0.64426
8	20	0.69142	0.12400	1.29925	0.00543	0.64068
8	21	0.67467	0.12400	1.29203	0.00521	0.63706
8	22	0.65822	0.12400	1.28490	0.00520	0.63353
8	23	0.64205	0.12400	1.27804	0.00514	0.63010
8	24	0.62614	0.12400	1.27115	0.00487	0.62655
8	25	0.61047	0.12400	1.26462	0.00494	0.62329
8	26	0.59501	0.12400	1.25854	0.00482	0.62016
8	27	0.57975	0.12400	1.25238	0.00451	0.61690
8	28	0.56466	0.12400	1.24651	0.00463	0.61394
8	29	0.54973	0.12400	1.24083	0.00431	0.61089
8	30	0.53493	0.12400	1.23534	0.00432	0.60804
8	31	0.52025	0.12400	1.23011	0.00415	0.60526
8	32	0.50566	0.12400	1.22513	0.00405	0.60261
8	33	0.49114	0.12400	1.22044	0.00397	0.60011
8	34	0.47666	0.12400	1.21598	0.00377	0.59768
8	35	0.46222	0.12400	1.21187	0.00374	0.59549
8	36	0.44778	0.12400	1.20825	0.00373	0.59356
8	37	0.43334	0.12400	1.20503	0.00331	0.59168
8	38	0.41938	0.12400	1.20260	0.00331	0.59038
8	39	0.40685	0.12400	1.20129	0.00328	0.58966
8	40	0.39605	0.12400	1.20109	0.00314	0.58950
8	41	0.38673	0.12400	1.20196	0.00309	0.58995
8	42	0.37870	0.12400	1.20396	0.00310	0.59102
8	43	0.37177	0.12400	1.20716	0.00294	0.59266
8	44	0.36580	0.12400	1.21164	0.00324	0.59517
8	45	0.36065	0.12400	1.21762	0.00290	0.59820
8	46	0.35620	0.12400	1.22523	0.00433	0.60277
8	47	0.35237	0.12400	1.23652	0.00197	0.60774
8	48	0.34907	0.12400	1.25193	0.00125	0.61541
8	49	0.34622	0.12400	1.26448	0.01150	0.62570
8	50	0.34376	0.12400	1.31271	-0.01921	0.63848
8	51	0.34164	0.12400	1.38297	-0.06209	0.65817
8	52	0.34065	0.12400	1.38297	-0.06209	0.65817
8	53	0.34376	0.12400	1.82414	0.24528	0.87341
8	54	0.34622	0.12400	1.87555	0.13621	0.86613
8	55	0.34907	0.12400	1.86254	0.17415	0.86942
8	56	0.35237	0.12400	1.86111	0.17948	0.86998
8	57	0.35620	0.12400	1.86646	0.18589	0.87205
8	58	0.36065	0.12400	1.86632	0.20364	0.87481
8	59	0.36580	0.12400	1.87930	0.22411	0.88045
8	60	0.37177	0.12400	1.90509	0.23306	0.88644
8	61	0.37870	0.12400	1.93530	0.24162	0.89283
8	62	0.38673	0.12400	1.96916	0.24782	0.89915
8	63	0.39605	0.12400	2.00457	0.25381	0.90531
8	64	0.40685	0.12400	2.04071	0.25709	0.91088
8	65	0.41938	0.12400	2.07508	0.25895	0.91575
8	66	0.43334	0.12400	2.10669	0.25845	0.91975
8	67	0.44779	0.12400	2.13240	0.25503	0.92256
8	68	0.46222	0.12400	2.15230	0.25102	0.92453
8	69	0.47666	0.12400	2.16640	0.24604	0.92568
8	70	0.49114	0.12400	2.17560	0.24139	0.92629
8	71	0.50566	0.12400	2.18071	0.23640	0.92640
8	72	0.52025	0.12400	2.18218	0.23136	0.92608
8	73	0.53494	0.12400	2.18036	0.22623	0.92538
8	74	0.54973	0.12400	2.17561	0.22109	0.92432
8	75	0.56466	0.12400	2.16812	0.21590	0.92292
8	76	0.57975	0.12400	2.15862	0.21091	0.92127
8	77	0.59501	0.12400	2.14723	0.20579	0.91933

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-14
	DILLNER WING: MACH = 1.50, ALPHA = 15			

8	78	0.61047	0.12400	2.13457	0.20092	0.91721
8	79	0.62614	0.12400	2.12106	0.19597	0.91492
8	80	0.64205	0.12400	2.10701	0.19089	0.91248
8	81	0.65822	0.12400	2.09281	0.18571	0.90995
8	82	0.67467	0.12400	2.07880	0.18026	0.90734
8	83	0.69142	0.12400	2.06511	0.17481	0.90471
8	84	0.70849	0.12400	2.05158	0.16972	0.90208
8	85	0.72590	0.12400	2.03837	0.16520	0.89950
8	86	0.74367	0.12400	2.02579	0.16024	0.89690
8	87	0.76182	0.12400	2.01476	0.15490	0.89445
8	88	0.78038	0.12400	2.00539	0.14905	0.89215
8	89	0.79936	0.12400	1.99819	0.14278	0.89013
8	90	0.81878	0.12400	1.99299	0.13695	0.88849
8	91	0.83866	0.12400	1.98985	0.13059	0.88712
8	92	0.85902	0.12400	1.98877	0.12502	0.88620
8	93	0.87988	0.12400	1.98940	0.11905	0.88554
8	94	0.90127	0.12400	1.99250	0.11321	0.88533
8	95	0.92319	0.12400	1.99614	0.10855	0.88538
8	96	0.94410	0.12400	2.00098	0.10309	0.88554
8	97	0.96136	0.12400	2.00822	0.09761	0.88614
8	98	0.97443	0.12400	2.00544	0.10063	0.88603
8	99	0.98434	0.12400	1.98362	0.10394	0.88253
8	100	0.99185	0.12400	2.09285	0.05499	0.89550
8	101	0.99754	0.12400	1.75959	0.20850	0.85349
8	102	1.00000	0.12400	1.75959	0.20850	0.85349
9	1	1.00000	0.14100	1.60190	-0.04582	0.75464
9	2	0.99772	0.14100	1.46760	0.02290	0.72110
9	3	0.99243	0.14100	1.44091	-0.00722	0.70131
9	4	0.98545	0.14100	1.44318	0.01642	0.70927
9	5	0.97624	0.14100	1.44728	-0.00205	0.70553
9	6	0.96409	0.14100	1.43305	0.00847	0.70266
9	7	0.94807	0.14100	1.42614	0.00450	0.69852
9	8	0.92864	0.14100	1.41494	0.00513	0.69389
9	9	0.90827	0.14100	1.40334	0.00515	0.68884
9	10	0.88840	0.14100	1.39167	0.00505	0.68366
9	11	0.86901	0.14100	1.38074	0.00530	0.67886
9	12	0.85009	0.14100	1.37016	0.00497	0.67397
9	13	0.83162	0.14100	1.36031	0.00535	0.66959
9	14	0.81357	0.14100	1.35091	0.00502	0.66514
9	15	0.79594	0.14100	1.34208	0.00534	0.66114
9	16	0.77870	0.14100	1.33386	0.00529	0.65725
9	17	0.76183	0.14100	1.32541	0.00513	0.65319
9	18	0.74532	0.14100	1.31740	0.00547	0.64948
9	19	0.72914	0.14100	1.30972	0.00526	0.64571
9	20	0.71328	0.14100	1.30243	0.00553	0.64227
9	21	0.69771	0.14100	1.29543	0.00541	0.63880
9	22	0.68243	0.14100	1.28854	0.00550	0.63545
9	23	0.66741	0.14100	1.28195	0.00556	0.63220
9	24	0.65262	0.14100	1.27533	0.00540	0.62884
9	25	0.63806	0.14100	1.26906	0.00557	0.62576
9	26	0.62370	0.14100	1.26321	0.00554	0.62280
9	27	0.60952	0.14100	1.25729	0.00532	0.61972
9	28	0.59550	0.14100	1.25165	0.00550	0.61691
9	29	0.58163	0.14100	1.24617	0.00525	0.61401
9	30	0.56788	0.14100	1.24088	0.00528	0.61129
9	31	0.55423	0.14100	1.23584	0.00515	0.60863
9	32	0.54068	0.14100	1.23102	0.00505	0.60609
9	33	0.52718	0.14100	1.22648	0.00494	0.60367
9	34	0.51374	0.14100	1.22226	0.00482	0.60141
9	35	0.50031	0.14100	1.21830	0.00457	0.59923
9	36	0.48690	0.14100	1.21488	0.00457	0.59742
9	37	0.47348	0.14100	1.21192	0.00407	0.59565
9	38	0.46051	0.14100	1.20981	0.00398	0.59450

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-15
	DILLNER WING: MACH = 1.50, ALPHA = 15			

9	39	0.44887	0.14100	1.20885	0.00390	0.59395
9	40	0.43883	0.14100	1.20906	0.00369	0.59398
9	41	0.43017	0.14100	1.21040	0.00354	0.59463
9	42	0.42271	0.14100	1.21293	0.00349	0.59595
9	43	0.41627	0.14100	1.21673	0.00325	0.59787
9	44	0.41072	0.14100	1.22192	0.00341	0.60067
9	45	0.40594	0.14100	1.22877	0.00290	0.60406
9	46	0.40181	0.14100	1.23730	0.00407	0.60896
9	47	0.39825	0.14100	1.24925	0.00225	0.61443
9	48	0.39518	0.14100	1.26567	0.00156	0.62254
9	49	0.39253	0.14100	1.28126	0.01020	0.63357
9	50	0.39024	0.14100	1.33271	-0.02212	0.64725
9	51	0.38827	0.14100	1.38777	-0.03738	0.66836
9	52	0.38736	0.14100	1.38777	-0.03738	0.66836
9	53	0.39025	0.14100	1.77222	0.35736	0.88331
9	54	0.39253	0.14100	1.86477	0.17455	0.86993
9	55	0.39518	0.14100	1.88152	0.18534	0.87490
9	56	0.39825	0.14100	1.87504	0.18672	0.87386
9	57	0.40181	0.14100	1.86473	0.20027	0.87398
9	58	0.40593	0.14100	1.85644	0.21519	0.87474
9	59	0.41072	0.14100	1.86296	0.23086	0.87847
9	60	0.41627	0.14100	1.88073	0.23824	0.88288
9	61	0.42271	0.14100	1.90563	0.24441	0.88821
9	62	0.43017	0.14100	1.93552	0.24947	0.89398
9	63	0.43883	0.14100	1.97050	0.25420	0.90021
9	64	0.44887	0.14100	2.01188	0.25650	0.90672
9	65	0.46051	0.14100	2.05742	0.25693	0.91316
9	66	0.47348	0.14100	2.10402	0.25446	0.91898
9	67	0.48690	0.14100	2.14505	0.24951	0.92351
9	68	0.50032	0.14100	2.17837	0.24515	0.92697
9	69	0.51374	0.14100	2.20440	0.24035	0.92944
9	70	0.52718	0.14100	2.22447	0.23584	0.93122
9	71	0.54068	0.14100	2.23947	0.23098	0.93239
9	72	0.55423	0.14100	2.24980	0.22617	0.93306
9	73	0.56788	0.14100	2.25600	0.22135	0.93329
9	74	0.58163	0.14100	2.25860	0.21657	0.93315
9	75	0.59550	0.14100	2.25780	0.21179	0.93266
9	76	0.60952	0.14100	2.25456	0.20721	0.93193
9	77	0.62370	0.14100	2.24885	0.20256	0.93091
9	78	0.63806	0.14100	2.24135	0.19828	0.92972
9	79	0.65262	0.14100	2.23248	0.19401	0.92836
9	80	0.66741	0.14100	2.22244	0.18971	0.92684
9	81	0.68243	0.14100	2.21171	0.18543	0.92520
9	82	0.69771	0.14100	2.20053	0.18103	0.92347
9	83	0.71328	0.14100	2.18899	0.17679	0.92167
9	84	0.72914	0.14100	2.17720	0.17301	0.91985
9	85	0.74532	0.14100	2.16543	0.16999	0.91806
9	86	0.76183	0.14100	2.15395	0.16726	0.91630
9	87	0.77869	0.14100	2.14333	0.16445	0.91461
9	88	0.79594	0.14100	2.13382	0.16095	0.91297
9	89	0.81357	0.14100	2.12588	0.15665	0.91143
9	90	0.83162	0.14100	2.11935	0.15228	0.91006
9	91	0.85009	0.14100	2.11432	0.14706	0.90879
9	92	0.86901	0.14100	2.11079	0.14225	0.90777
9	93	0.88839	0.14100	2.10860	0.13669	0.90685
9	94	0.90826	0.14100	2.10839	0.13118	0.90623
9	95	0.92863	0.14100	2.10803	0.12658	0.90568
9	96	0.94806	0.14100	2.10897	0.12053	0.90517
9	97	0.96409	0.14100	2.11278	0.11555	0.90519
9	98	0.97624	0.14100	2.10622	0.11807	0.90449
9	99	0.98545	0.14100	2.08750	0.12216	0.90211
9	100	0.99243	0.14100	2.18319	0.07465	0.91115
9	101	0.99772	0.14100	1.80396	0.24322	0.86909

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-16
	DILLNER WING: MACH = 1.50, ALPHA = 15			

9	102	1.00000	0.14100	1.80396	0.24322	0.86909
0	1	1.00000	0.15650	1.66354	-0.06939	0.77114
.0	2	0.99788	0.15650	1.46538	0.01845	0.71894
.0	3	0.99295	0.15650	1.43411	-0.01059	0.69740
.0	4	0.98646	0.15650	1.44649	0.01673	0.71073
.0	5	0.97789	0.15650	1.45044	-0.00601	0.70570
.0	6	0.96659	0.15650	1.43417	0.00817	0.70304
.0	7	0.95168	0.15650	1.42833	0.00253	0.69886
.0	8	0.93360	0.15650	1.41678	0.00371	0.69425
.0	9	0.91464	0.15650	1.40519	0.00369	0.68920
.0	10	0.89616	0.15650	1.39357	0.00358	0.68404
.0	11	0.87812	0.15650	1.38271	0.00385	0.67927
.0	12	0.86051	0.15650	1.37221	0.00350	0.67442
.0	13	0.84332	0.15650	1.36243	0.00386	0.67007
.0	14	0.82653	0.15650	1.35311	0.00349	0.66565
.0	15	0.81012	0.15650	1.34434	0.00378	0.66166
.0	16	0.79408	0.15650	1.33620	0.00368	0.65781
.0	17	0.77839	0.15650	1.32784	0.00348	0.65377
.0	18	0.76302	0.15650	1.31992	0.00376	0.65009
.0	19	0.74797	0.15650	1.31236	0.00351	0.64636
.0	20	0.73321	0.15650	1.30520	0.00373	0.64297
.0	21	0.71873	0.15650	1.29834	0.00357	0.63956
.0	22	0.70451	0.15650	1.29163	0.00363	0.63628
.0	23	0.69053	0.15650	1.28523	0.00366	0.63313
.0	24	0.67677	0.15650	1.27885	0.00349	0.62989
.0	25	0.66322	0.15650	1.27282	0.00365	0.62693
.0	26	0.64985	0.15650	1.26721	0.00362	0.62410
.0	27	0.63666	0.15650	1.26156	0.00342	0.62116
.0	28	0.62362	0.15650	1.25617	0.00361	0.61849
.0	29	0.61071	0.15650	1.25097	0.00339	0.61575
.0	30	0.59791	0.15650	1.24595	0.00344	0.61319
.0	31	0.58522	0.15650	1.24119	0.00334	0.61069
.0	32	0.57260	0.15650	1.23666	0.00328	0.60832
.0	33	0.56005	0.15650	1.23240	0.00320	0.60607
.0	34	0.54754	0.15650	1.22849	0.00314	0.60401
.0	35	0.53505	0.15650	1.22489	0.00295	0.60204
.0	36	0.52257	0.15650	1.22181	0.00300	0.60045
.0	37	0.51007	0.15650	1.21929	0.00259	0.59895
.0	38	0.49801	0.15650	1.21767	0.00254	0.59808
.0	39	0.48718	0.15650	1.21725	0.00251	0.59785
.0	40	0.47784	0.15650	1.21805	0.00233	0.59819
.0	41	0.46978	0.15650	1.22001	0.00216	0.59916
.0	42	0.46284	0.15650	1.22320	0.00212	0.60083
.0	43	0.45685	0.15650	1.22771	0.00188	0.60310
.0	44	0.45168	0.15650	1.23368	0.00201	0.60627
.0	45	0.44723	0.15650	1.24143	0.00142	0.61007
.0	46	0.44339	0.15650	1.25095	0.00243	0.61537
.0	47	0.44007	0.15650	1.26378	0.00085	0.62131
.0	48	0.43722	0.15650	1.28140	0.00009	0.62990
.0	49	0.43475	0.15650	1.29878	0.00847	0.64155
.0	50	0.43263	0.15650	1.35297	-0.02448	0.65620
.0	51	0.43079	0.15650	1.40374	-0.02897	0.67835
.0	52	0.42994	0.15650	1.40374	-0.02897	0.67835
.0	53	0.43263	0.15650	1.77067	0.39650	0.89016
.0	54	0.43475	0.15650	1.87368	0.19930	0.87555
.0	55	0.43722	0.15650	1.89960	0.19550	0.87986
.0	56	0.44007	0.15650	1.89237	0.19085	0.87781
.0	57	0.44339	0.15650	1.87625	0.21074	0.87781
.0	58	0.44723	0.15650	1.86581	0.22352	0.87784
.0	59	0.45168	0.15650	1.86966	0.23463	0.88030
.0	60	0.45685	0.15650	1.88179	0.23845	0.88311
.0	61	0.46284	0.15650	1.89902	0.24192	0.88669
.0	62	0.46978	0.15650	1.92004	0.24502	0.89077

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-17
	DILLNER WING: MACH = 1.50, ALPHA = 15			

10	63	0.47783	0.15650	1.94702	0.24835	0.89570
10	64	0.48718	0.15650	1.98227	0.24976	0.90144
10	65	0.49801	0.15650	2.02609	0.24962	0.90791
10	66	0.51008	0.15650	2.07553	0.24699	0.91445
10	67	0.52257	0.15650	2.12259	0.24250	0.92004
10	68	0.53505	0.15650	2.16369	0.23917	0.92468
10	69	0.54754	0.15650	2.19893	0.23518	0.92835
10	70	0.56005	0.15650	2.22892	0.23135	0.93130
10	71	0.57260	0.15650	2.25403	0.22710	0.93358
10	72	0.58522	0.15650	2.27453	0.22278	0.93532
10	73	0.59792	0.15650	2.29082	0.21831	0.93658
10	74	0.61071	0.15650	2.30338	0.21389	0.93746
10	75	0.62362	0.15650	2.31220	0.20953	0.93798
10	76	0.63666	0.15650	2.31796	0.20561	0.93823
10	77	0.64985	0.15650	2.32061	0.20169	0.93818
10	78	0.66322	0.15650	2.32089	0.19821	0.93794
10	79	0.67677	0.15650	2.31930	0.19471	0.93751
10	80	0.69053	0.15650	2.31596	0.19112	0.93691
10	81	0.70451	0.15650	2.31135	0.18747	0.93616
10	82	0.71873	0.15650	2.30572	0.18362	0.93529
10	83	0.73321	0.15650	2.29929	0.17970	0.93433
10	84	0.74797	0.15650	2.29226	0.17581	0.93328
10	85	0.76302	0.15650	2.28496	0.17198	0.93220
10	86	0.77838	0.15650	2.27751	0.16825	0.93110
10	87	0.79408	0.15650	2.27007	0.16466	0.92999
10	88	0.81012	0.15650	2.26278	0.16081	0.92886
10	89	0.82653	0.15650	2.25596	0.15670	0.92775
10	90	0.84332	0.15650	2.24959	0.15283	0.92669
10	91	0.86051	0.15650	2.24388	0.14837	0.92564
10	92	0.87811	0.15650	2.23895	0.14433	0.92471
10	93	0.89615	0.15650	2.23484	0.13941	0.92379
10	94	0.91464	0.15650	2.23200	0.13465	0.92302
10	95	0.93359	0.15650	2.22816	0.13087	0.92222
.0	96	0.95167	0.15650	2.22610	0.12427	0.92138
10	97	0.96659	0.15650	2.22715	0.12075	0.92119
.0	98	0.97789	0.15650	2.21841	0.12214	0.92023
.0	99	0.98646	0.15650	2.20401	0.12551	0.91873
10	100	0.99295	0.15650	2.29151	0.07961	0.92541
.0	101	0.99788	0.15650	1.86863	0.25557	0.88339
10	102	1.00000	0.15650	1.86863	0.25557	0.88339
.1	1	1.00000	0.17200	1.72434	-0.09813	0.78556
.1	2	0.99803	0.17200	1.46228	0.01460	0.71658
.1	3	0.99348	0.17200	1.42988	-0.01325	0.69477
.1	4	0.98747	0.17200	1.45004	0.01586	0.71193
.1	5	0.97954	0.17200	1.45301	-0.00914	0.70587
.1	6	0.96908	0.17200	1.43547	0.00727	0.70332
.1	7	0.95529	0.17200	1.43046	0.00032	0.69911
.1	8	0.93856	0.17200	1.41853	0.00198	0.69448
.1	9	0.92102	0.17200	1.40694	0.00191	0.68941
.1	10	0.90391	0.17200	1.39536	0.00179	0.68427
.1	11	0.88722	0.17200	1.38457	0.00207	0.67954
.1	12	0.87093	0.17200	1.37418	0.00172	0.67473
.1	13	0.85502	0.17200	1.36451	0.00206	0.67043
.1	14	0.83949	0.17200	1.35530	0.00167	0.66605
.1	15	0.82431	0.17200	1.34663	0.00193	0.66211
.1	16	0.80946	0.17200	1.33861	0.00179	0.65829
.1	17	0.79494	0.17200	1.33036	0.00156	0.65431
.1	18	0.78072	0.17200	1.32256	0.00178	0.65066
.1	19	0.76679	0.17200	1.31513	0.00148	0.64698
.1	20	0.75314	0.17200	1.30809	0.00164	0.64363
.1	21	0.73974	0.17200	1.30138	0.00143	0.64027
.1	22	0.72658	0.17200	1.29483	0.00142	0.63705
.1	23	0.71364	0.17200	1.28861	0.00139	0.63397

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-18
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.1	24	0.70091	0.17200	1.28246	0.00117	0.63083
.1	25	0.68837	0.17200	1.27665	0.00126	0.62796
.1	26	0.67601	0.17200	1.27129	0.00118	0.62523
.1	27	0.66380	0.17200	1.26591	0.00093	0.62243
.1	28	0.65173	0.17200	1.26082	0.00106	0.61989
.1	29	0.63979	0.17200	1.25594	0.00080	0.61729
.1	30	0.62795	0.17200	1.25125	0.00080	0.61489
.1	31	0.61620	0.17200	1.24684	0.00066	0.61257
.1	32	0.60453	0.17200	1.24269	0.00057	0.61039
.1	33	0.59291	0.17200	1.23883	0.00045	0.60834
.1	34	0.58133	0.17200	1.23533	0.00037	0.60648
.1	35	0.56978	0.17200	1.23220	0.00016	0.60477
.1	36	0.55823	0.17200	1.22963	0.00019	0.60343
.1	37	0.54667	0.17200	1.22767	-0.00019	0.60226
.1	38	0.53550	0.17200	1.22666	-0.00021	0.60171
.1	39	0.52548	0.17200	1.22685	-0.00012	0.60185
.1	40	0.51684	0.17200	1.22826	-0.00017	0.60257
.1	41	0.50939	0.17200	1.23086	-0.00020	0.60392
.1	42	0.50296	0.17200	1.23472	-0.00007	0.60599
.1	43	0.49742	0.17200	1.23992	-0.00015	0.60867
.1	44	0.49264	0.17200	1.24661	0.00013	0.61225
.1	45	0.48852	0.17200	1.25519	-0.00030	0.61649
.1	46	0.48496	0.17200	1.26556	0.00075	0.62218
.1	47	0.48190	0.17200	1.27921	-0.00050	0.62859
.1	48	0.47926	0.17200	1.29805	-0.00150	0.63759
.1	49	0.47697	0.17200	1.31649	0.00748	0.64976
.1	50	0.47501	0.17200	1.37205	-0.02529	0.66494
.1	51	0.47331	0.17200	1.42485	-0.02858	0.68793
.1	52	0.47253	0.17200	1.42485	-0.02858	0.68793
.1	53	0.47501	0.17200	1.80717	0.38333	0.89384
.1	54	0.47698	0.17200	1.90506	0.19086	0.88018
.1	55	0.47926	0.17200	1.91556	0.19908	0.88331
.1	56	0.48190	0.17200	1.90639	0.19409	0.88091
.1	57	0.48496	0.17200	1.89300	0.21369	0.88138
.1	58	0.48852	0.17200	1.88675	0.22378	0.88176
.1	59	0.49264	0.17200	1.88991	0.23184	0.88356
.1	60	0.49742	0.17200	1.89821	0.23306	0.88522
.1	61	0.50296	0.17200	1.90881	0.23461	0.88732
.1	62	0.50938	0.17200	1.92220	0.23597	0.88982
.1	63	0.51684	0.17200	1.94111	0.23775	0.89325
.1	64	0.52548	0.17200	1.96830	0.23763	0.89765
.1	65	0.53550	0.17200	2.00445	0.23608	0.90304
.1	66	0.54667	0.17200	2.04808	0.23245	0.90898
.1	67	0.55823	0.17200	2.09278	0.22774	0.91459
.1	68	0.56978	0.17200	2.13485	0.22466	0.91971
.1	69	0.58133	0.17200	2.17367	0.22130	0.92411
.1	70	0.59291	0.17200	2.20887	0.21829	0.92790
.1	71	0.60453	0.17200	2.24041	0.21510	0.93109
.1	72	0.61620	0.17200	2.26815	0.21210	0.93377
.1	73	0.62795	0.17200	2.29213	0.20930	0.93598
.1	74	0.63979	0.17200	2.31265	0.20678	0.93781
.1	75	0.65173	0.17200	2.32958	0.20439	0.93925
.1	76	0.66380	0.17200	2.34371	0.20228	0.94042
.1	77	0.67601	0.17200	2.35490	0.19978	0.94127
.1	78	0.68837	0.17200	2.36366	0.19740	0.94190
.1	79	0.70091	0.17200	2.37043	0.19480	0.94232
.1	80	0.71364	0.17200	2.37511	0.19214	0.94255
.1	81	0.72658	0.17200	2.37796	0.18973	0.94264
.1	82	0.73974	0.17200	2.37906	0.18762	0.94259
.1	83	0.75314	0.17200	2.37848	0.18617	0.94243
.1	84	0.76679	0.17200	2.37612	0.18582	0.94219
.1	85	0.78072	0.17200	2.37162	0.18675	0.94185
.1	86	0.79494	0.17200	2.36580	0.18816	0.94142

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-19
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.1	87	0.80946	0.17200	2.35968	0.18901	0.94092
.1	88	0.82430	0.17200	2.35433	0.18798	0.94035
.1	89	0.83949	0.17200	2.35017	0.18490	0.93973
.1	90	0.85502	0.17200	2.34687	0.18065	0.93911
.1	91	0.87093	0.17200	2.34420	0.17506	0.93843
.1	92	0.88722	0.17200	2.34197	0.16940	0.93780
.1	93	0.90391	0.17200	2.34004	0.16277	0.93711
.1	94	0.92102	0.17200	2.33853	0.15641	0.93648
.1	95	0.93855	0.17200	2.33480	0.15226	0.93580
.1	96	0.95528	0.17200	2.33309	0.14365	0.93497
.1	97	0.96908	0.17200	2.33413	0.13929	0.93475
.1	98	0.97954	0.17200	2.32304	0.14164	0.93378
.1	99	0.98747	0.17200	2.31685	0.13606	0.93271
.1	100	0.99348	0.17200	2.40176	0.09569	0.93832
.1	101	0.99803	0.17200	1.95019	0.25712	0.89742
.1	102	1.00000	0.17200	1.95019	0.25712	0.89742
.2	1	1.00000	0.18900	1.77974	-0.12384	0.79826
.2	2	0.99821	0.18900	1.46347	0.01468	0.71708
.2	3	0.99406	0.18900	1.42570	-0.01174	0.69341
.2	4	0.98858	0.18900	1.45277	0.01776	0.71361
.2	5	0.98136	0.18900	1.45515	-0.00850	0.70696
.2	6	0.97182	0.18900	1.43691	0.00933	0.70454
.2	7	0.95924	0.18900	1.43225	0.00157	0.70025
.2	8	0.94400	0.18900	1.42006	0.00355	0.69562
.2	9	0.92801	0.18900	1.40843	0.00343	0.69054
.2	10	0.91242	0.18900	1.39685	0.00333	0.68541
.2	11	0.89721	0.18900	1.38609	0.00363	0.68072
.2	12	0.88236	0.18900	1.37575	0.00329	0.67596
.2	13	0.86786	0.18900	1.36615	0.00365	0.67171
.2	14	0.85370	0.18900	1.35701	0.00330	0.66739
.2	15	0.83986	0.18900	1.34842	0.00359	0.66350
.2	16	0.82633	0.18900	1.34047	0.00348	0.65975
.2	17	0.81309	0.18900	1.33232	0.00327	0.65583
.2	18	0.80013	0.18900	1.32462	0.00352	0.65225
.2	19	0.78744	0.18900	1.31727	0.00325	0.64864
.2	20	0.77499	0.18900	1.31033	0.00343	0.64535
.2	21	0.76278	0.18900	1.30372	0.00325	0.64208
.2	22	0.75079	0.18900	1.29729	0.00328	0.63894
.2	23	0.73900	0.18900	1.29122	0.00328	0.63596
.2	24	0.72739	0.18900	1.28523	0.00310	0.63292
.2	25	0.71596	0.18900	1.27962	0.00321	0.63017
.2	26	0.70469	0.18900	1.27446	0.00316	0.62757
.2	27	0.69357	0.18900	1.26932	0.00296	0.62491
.2	28	0.68257	0.18900	1.26450	0.00311	0.62253
.2	29	0.67168	0.18900	1.25991	0.00288	0.62012
.2	30	0.66089	0.18900	1.25555	0.00291	0.61791
.2	31	0.65018	0.18900	1.25150	0.00280	0.61579
.2	32	0.63954	0.18900	1.24774	0.00273	0.61383
.2	33	0.62895	0.18900	1.24431	0.00262	0.61203
.2	34	0.61840	0.18900	1.24129	0.00255	0.61043
.2	35	0.60787	0.18900	1.23869	0.00234	0.60901
.2	36	0.59734	0.18900	1.23670	0.00234	0.60797
.2	37	0.58680	0.18900	1.23540	0.00195	0.60714
.2	38	0.57663	0.18900	1.23507	0.00188	0.60695
.2	39	0.56749	0.18900	1.23593	0.00197	0.60743
.2	40	0.55962	0.18900	1.23797	0.00194	0.60847
.2	41	0.55282	0.18900	1.24120	0.00189	0.61013
.2	42	0.54697	0.18900	1.24570	0.00203	0.61251
.2	43	0.54191	0.18900	1.25154	0.00195	0.61548
.2	44	0.53756	0.18900	1.25889	0.00221	0.61934
.2	45	0.53380	0.18900	1.26817	0.00179	0.62389
.2	46	0.53056	0.18900	1.27926	0.00273	0.62981
.2	47	0.52777	0.18900	1.29355	0.00168	0.63652

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-20
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.2	48	0.52536	0.18900	1.31339	0.00016	0.64567
.2	49	0.52328	0.18900	1.33259	0.00972	0.65818
.2	50	0.52149	0.18900	1.38832	-0.02268	0.67331
.2	51	0.51994	0.18900	1.44538	-0.02863	0.69690
.2	52	0.51922	0.18900	1.44538	-0.02863	0.69690
.2	53	0.52149	0.18900	1.85727	0.34495	0.89558
.2	54	0.52328	0.18900	1.94298	0.16502	0.88341
.2	55	0.52536	0.18900	1.92964	0.19755	0.88561
.2	56	0.52777	0.18900	1.91906	0.19507	0.88336
.2	57	0.53056	0.18900	1.91196	0.21045	0.88433
.2	58	0.53380	0.18900	1.90907	0.21982	0.88519
.2	59	0.53756	0.18900	1.91037	0.22752	0.88655
.2	60	0.54191	0.18900	1.91474	0.22845	0.88745
.2	61	0.54697	0.18900	1.91992	0.22958	0.88851
.2	62	0.55282	0.18900	1.92795	0.23066	0.89004
.2	63	0.55961	0.18900	1.94129	0.23168	0.89243
.2	64	0.56749	0.18900	1.96212	0.23060	0.89570
.2	65	0.57663	0.18900	1.99081	0.22814	0.89993
.2	66	0.58680	0.18900	2.02634	0.22426	0.90484
.2	67	0.59734	0.18900	2.06417	0.21983	0.90978
.2	68	0.60787	0.18900	2.10182	0.21706	0.91463
.2	69	0.61840	0.18900	2.13939	0.21377	0.91916
.2	70	0.62895	0.18900	2.17614	0.21058	0.92336
.2	71	0.63954	0.18900	2.21148	0.20712	0.92717
.2	72	0.65018	0.18900	2.24459	0.20390	0.93057
.2	73	0.66089	0.18900	2.27495	0.20096	0.93354
.2	74	0.67168	0.18900	2.30227	0.19855	0.93613
.2	75	0.68257	0.18900	2.32605	0.19682	0.93833
.2	76	0.69357	0.18900	2.34670	0.19616	0.94024
.2	77	0.70469	0.18900	2.36406	0.19581	0.94182
.2	78	0.71596	0.18900	2.37890	0.19575	0.94315
.2	79	0.72739	0.18900	2.39221	0.19489	0.94426
.2	80	0.73900	0.18900	2.40433	0.19268	0.94515
.2	81	0.75079	0.18900	2.41580	0.18895	0.94588
.2	82	0.76278	0.18900	2.42693	0.18333	0.94644
.2	83	0.77499	0.18900	2.43777	0.17599	0.94686
.2	84	0.78744	0.18900	2.44830	0.16710	0.94717
.2	85	0.80013	0.18900	2.45850	0.15670	0.94735
.2	86	0.81309	0.18900	2.46803	0.14527	0.94742
.2	87	0.82633	0.18900	2.47389	0.13724	0.94741
.2	88	0.83986	0.18900	2.47473	0.13476	0.94733
.2	89	0.85370	0.18900	2.47222	0.13589	0.94719
.2	90	0.86786	0.18900	2.46801	0.13878	0.94702
.2	91	0.88236	0.18900	2.46309	0.14155	0.94679
.2	92	0.89720	0.18900	2.45809	0.14440	0.94655
.2	93	0.91242	0.18900	2.45419	0.14461	0.94623
.2	94	0.92801	0.18900	2.45198	0.14274	0.94593
.2	95	0.94399	0.18900	2.44793	0.14238	0.94557
.2	96	0.95924	0.18900	2.44563	0.13721	0.94504
.2	97	0.97182	0.18900	2.44712	0.13443	0.94499
.2	98	0.98136	0.18900	2.43424	0.14038	0.94426
.2	99	0.98858	0.18900	2.43517	0.13322	0.94388
.2	100	0.99406	0.18900	2.51462	0.09548	0.94825
.2	101	0.99821	0.18900	2.04265	0.25311	0.91068
.2	102	1.00000	0.18900	2.04265	0.25311	0.91068
.3	1	1.00000	0.20490	1.83306	-0.15325	0.80920
.3	2	0.99837	0.20490	1.46378	0.01577	0.71752
.3	3	0.99460	0.20490	1.42031	-0.01379	0.69043
.3	4	0.98962	0.20490	1.45608	0.02069	0.71582
.3	5	0.98305	0.20490	1.45847	-0.01089	0.70765
.3	6	0.97438	0.20490	1.43733	0.01157	0.70538
.3	7	0.96295	0.20490	1.43387	0.00141	0.70089
.3	8	0.94908	0.20490	1.42105	0.00434	0.69629

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-21
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.3	9	0.93455	0.20490	1.40949	0.00394	0.69116
.3	10	0.92038	0.20490	1.39782	0.00385	0.68601
.3	11	0.90654	0.20490	1.38702	0.00413	0.68130
.3	12	0.89304	0.20490	1.37668	0.00377	0.67653
.3	13	0.87986	0.20490	1.36707	0.00412	0.67228
.3	14	0.86699	0.20490	1.35794	0.00376	0.66797
.3	15	0.85441	0.20490	1.34936	0.00403	0.66409
.3	16	0.84211	0.20490	1.34143	0.00392	0.66035
.3	17	0.83007	0.20490	1.33331	0.00372	0.65646
.3	18	0.81829	0.20490	1.32565	0.00397	0.65290
.3	19	0.80675	0.20490	1.31834	0.00371	0.64931
.3	20	0.79543	0.20490	1.31143	0.00390	0.64605
.3	21	0.78433	0.20490	1.30486	0.00374	0.64280
.3	22	0.77343	0.20490	1.29847	0.00378	0.63970
.3	23	0.76271	0.20490	1.29246	0.00381	0.63676
.3	24	0.75216	0.20490	1.28656	0.00365	0.63378
.3	25	0.74177	0.20490	1.28103	0.00379	0.63109
.3	26	0.73152	0.20490	1.27597	0.00378	0.62856
.3	27	0.72141	0.20490	1.27098	0.00361	0.62599
.3	28	0.71141	0.20490	1.26632	0.00380	0.62371
.3	29	0.70151	0.20490	1.26192	0.00363	0.62142
.3	30	0.69170	0.20490	1.25778	0.00371	0.61935
.3	31	0.68196	0.20490	1.25399	0.00366	0.61739
.3	32	0.67229	0.20490	1.25052	0.00364	0.61561
.3	33	0.66266	0.20490	1.24743	0.00361	0.61401
.3	34	0.65307	0.20490	1.24478	0.00360	0.61265
.3	35	0.64349	0.20490	1.24263	0.00349	0.61149
.3	36	0.63392	0.20490	1.24114	0.00356	0.61075
.3	37	0.62435	0.20490	1.24044	0.00330	0.61029
.3	38	0.61509	0.20490	1.24081	0.00332	0.61049
.3	39	0.60679	0.20490	1.24240	0.00346	0.61137
.3	40	0.59963	0.20490	1.24518	0.00342	0.61278
.3	41	0.59345	0.20490	1.24915	0.00334	0.61479
.3	42	0.58813	0.20490	1.25438	0.00343	0.61751
.3	43	0.58353	0.20490	1.26096	0.00329	0.62081
.3	44	0.57957	0.20490	1.26905	0.00346	0.62496
.3	45	0.57616	0.20490	1.27908	0.00298	0.62982
.3	46	0.57321	0.20490	1.29092	0.00375	0.63598
.3	47	0.57067	0.20490	1.30583	0.00283	0.64296
.3	48	0.56848	0.20490	1.32661	0.00087	0.65228
.3	49	0.56659	0.20490	1.34647	0.01065	0.66498
.3	50	0.56496	0.20490	1.40180	-0.02064	0.68008
.3	51	0.56356	0.20490	1.46307	-0.03058	0.70392
.3	52	0.56290	0.20490	1.46307	-0.03058	0.70392
.3	53	0.56496	0.20490	1.90144	0.30044	0.89583
.3	54	0.56659	0.20490	1.96900	0.14301	0.88507
.3	55	0.56848	0.20490	1.93753	0.19377	0.88647
.3	56	0.57067	0.20490	1.93076	0.19038	0.88479
.3	57	0.57321	0.20490	1.93080	0.20174	0.88641
.3	58	0.57616	0.20490	1.92804	0.21234	0.88744
.3	59	0.57957	0.20490	1.92649	0.22010	0.88828
.3	60	0.58353	0.20490	1.92656	0.22153	0.88850
.3	61	0.58813	0.20490	1.92786	0.22351	0.88900
.3	62	0.59345	0.20490	1.93191	0.22577	0.89002
.3	63	0.59963	0.20490	1.94090	0.22731	0.89175
.3	64	0.60679	0.20490	1.95621	0.22640	0.89417
.3	65	0.61509	0.20490	1.97788	0.22384	0.89733
.3	66	0.62435	0.20490	2.00494	0.22062	0.90115
.3	67	0.63392	0.20490	2.03422	0.21734	0.90516
.3	68	0.64349	0.20490	2.06418	0.21585	0.90932
.3	69	0.65307	0.20490	2.09517	0.21454	0.91346
.3	70	0.66266	0.20490	2.12696	0.21397	0.91759
.3	71	0.67229	0.20490	2.15931	0.21354	0.92161

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-22
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.3	72	0.68196	0.20490	2.19198	0.21267	0.92544
.3	73	0.69170	0.20490	2.22505	0.21041	0.92900
.3	74	0.70151	0.20490	2.25852	0.20635	0.93227
.3	75	0.71141	0.20490	2.29189	0.20005	0.93521
.3	76	0.72141	0.20490	2.32482	0.19216	0.93786
.3	77	0.73152	0.20490	2.35566	0.18377	0.94017
.3	78	0.74177	0.20490	2.38312	0.17722	0.94222
.3	79	0.75216	0.20490	2.40673	0.17318	0.94404
.3	80	0.76271	0.20490	2.42577	0.17251	0.94563
.3	81	0.77343	0.20490	2.43974	0.17622	0.94704
.3	82	0.78433	0.20490	2.44905	0.18375	0.94828
.3	83	0.79543	0.20490	2.45458	0.19414	0.94938
.3	84	0.80675	0.20490	2.45681	0.20691	0.95035
.3	85	0.81829	0.20490	2.45595	0.22161	0.95121
.3	86	0.83007	0.20490	2.45287	0.23711	0.95195
.3	87	0.84211	0.20490	2.45599	0.24310	0.95256
.3	88	0.85441	0.20490	2.46533	0.23944	0.95302
.3	89	0.86699	0.20490	2.47664	0.23155	0.95336
.3	90	0.87986	0.20490	2.48763	0.22254	0.95361
.3	91	0.89304	0.20490	2.49775	0.21274	0.95376
.3	92	0.90654	0.20490	2.50585	0.20467	0.95387
.3	93	0.92037	0.20490	2.51091	0.19919	0.95392
.3	94	0.93455	0.20490	2.51514	0.19497	0.95398
.3	95	0.94908	0.20490	2.51732	0.19287	0.95402
.3	96	0.96294	0.20490	2.52289	0.18159	0.95377
.3	97	0.97438	0.20490	2.53013	0.17861	0.95413
.3	98	0.98305	0.20490	2.52969	0.16925	0.95357
.3	99	0.98962	0.20490	2.53351	0.16502	0.95361
.3	100	0.99460	0.20490	2.62406	0.11258	0.95715
.3	101	0.99837	0.20490	2.16099	0.24471	0.92492
.3	102	1.00000	0.20490	2.16099	0.24471	0.92492
.4	1	1.00000	0.21840	1.86847	-0.17714	0.81557
.4	2	0.99851	0.21840	1.46216	0.01540	0.71676
.4	3	0.99506	0.21840	1.41558	-0.02085	0.68618
.4	4	0.99050	0.21840	1.46262	0.02209	0.71887
.4	5	0.98449	0.21840	1.46412	-0.01899	0.70769
.4	6	0.97656	0.21840	1.43758	0.01120	0.70538
.4	7	0.96609	0.21840	1.43653	-0.00321	0.70064
.4	8	0.95341	0.21840	1.42251	0.00137	0.69601
.4	9	0.94010	0.21840	1.41111	0.00047	0.69079
.4	10	0.92713	0.21840	1.39930	0.00044	0.68559
.4	11	0.91447	0.21840	1.38846	0.00070	0.68084
.4	12	0.90212	0.21840	1.37808	0.00029	0.67604
.4	13	0.89006	0.21840	1.36844	0.00061	0.67175
.4	14	0.87828	0.21840	1.35930	0.00021	0.66742
.4	15	0.86676	0.21840	1.35072	0.00045	0.66351
.4	16	0.85551	0.21840	1.34281	0.00030	0.65976
.4	17	0.84449	0.21840	1.33472	0.00007	0.65587
.4	18	0.83371	0.21840	1.32709	0.00027	0.65230
.4	19	0.82315	0.21840	1.31981	-0.00001	0.64871
.4	20	0.81279	0.21840	1.31294	0.00014	0.64545
.4	21	0.80263	0.21840	1.30641	-0.00006	0.64220
.4	22	0.79265	0.21840	1.30008	-0.00006	0.63910
.4	23	0.78284	0.21840	1.29412	-0.00007	0.63617
.4	24	0.77319	0.21840	1.28830	-0.00026	0.63321
.4	25	0.76368	0.21840	1.28286	-0.00016	0.63054
.4	26	0.75430	0.21840	1.27789	-0.00021	0.62803
.4	27	0.74505	0.21840	1.27301	-0.00040	0.62551
.4	28	0.73589	0.21840	1.26849	-0.00026	0.62328
.4	29	0.72684	0.21840	1.26425	-0.00044	0.62106
.4	30	0.71786	0.21840	1.26030	-0.00039	0.61907
.4	31	0.70895	0.21840	1.25672	-0.00046	0.61722
.4	32	0.70010	0.21840	1.25350	-0.00048	0.61556

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-23
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.4	33	0.69129	0.21840	1.25070	-0.00052	0.61410
.4	34	0.68251	0.21840	1.24838	-0.00052	0.61291
.4	35	0.67374	0.21840	1.24661	-0.00061	0.61196
.4	36	0.66499	0.21840	1.24556	-0.00050	0.61146
.4	37	0.65622	0.21840	1.24538	-0.00067	0.61130
.4	38	0.64775	0.21840	1.24634	-0.00055	0.61184
.4	39	0.64015	0.21840	1.24858	-0.00023	0.61312
.4	40	0.63360	0.21840	1.25201	-0.00007	0.61495
.4	41	0.62795	0.21840	1.25666	0.00002	0.61737
.4	42	0.62308	0.21840	1.26259	0.00033	0.62051
.4	43	0.61887	0.21840	1.26985	0.00040	0.62421
.4	44	0.61525	0.21840	1.27860	0.00080	0.62877
.4	45	0.61212	0.21840	1.28932	0.00053	0.63401
.4	46	0.60943	0.21840	1.30182	0.00151	0.64052
.4	47	0.60710	0.21840	1.31724	0.00098	0.64782
.4	48	0.60510	0.21840	1.33878	-0.00084	0.65747
.4	49	0.60337	0.21840	1.35917	0.00909	0.67031
.4	50	0.60188	0.21840	1.41399	-0.02002	0.68573
.4	51	0.60059	0.21840	1.47734	-0.03186	0.70957
.4	52	0.59999	0.21840	1.47734	-0.03186	0.70957
.4	53	0.60188	0.21840	1.92605	0.27426	0.89597
.4	54	0.60337	0.21840	1.97684	0.14064	0.88614
.4	55	0.60510	0.21840	1.94000	0.19525	0.88711
.4	56	0.60710	0.21840	1.94057	0.18691	0.88604
.4	57	0.60943	0.21840	1.94819	0.19339	0.88827
.4	58	0.61212	0.21840	1.94662	0.20069	0.88902
.4	59	0.61525	0.21840	1.94499	0.20447	0.88926
.4	60	0.61887	0.21840	1.94364	0.20396	0.88896
.4	61	0.62308	0.21840	1.94413	0.20562	0.88927
.4	62	0.62795	0.21840	1.94619	0.20881	0.89007
.4	63	0.63360	0.21840	1.95190	0.21182	0.89145
.4	64	0.64015	0.21840	1.96258	0.21229	0.89330
.4	65	0.64776	0.21840	1.97797	0.21086	0.89563
.4	66	0.65622	0.21840	1.99732	0.20886	0.89847
.4	67	0.66499	0.21840	2.01842	0.20670	0.90148
.4	68	0.67375	0.21840	2.04036	0.20598	0.90470
.4	69	0.68251	0.21840	2.06334	0.20570	0.90802
.4	70	0.69129	0.21840	2.08715	0.20655	0.91147
.4	71	0.70010	0.21840	2.11133	0.20853	0.91497
.4	72	0.70895	0.21840	2.13514	0.21257	0.91849
.4	73	0.71786	0.21840	2.15779	0.21958	0.92203
.4	74	0.72684	0.21840	2.17818	0.23030	0.92552
.4	75	0.73589	0.21840	2.19590	0.24354	0.92880
.4	76	0.74505	0.21840	2.21355	0.25604	0.93188
.4	77	0.75431	0.21840	2.23485	0.26257	0.93470
.4	78	0.76368	0.21840	2.26112	0.26179	0.93726
.4	79	0.77319	0.21840	2.29163	0.25426	0.93957
.4	80	0.78284	0.21840	2.32584	0.24067	0.94168
.4	81	0.79265	0.21840	2.36470	0.21910	0.94356
.4	82	0.80263	0.21840	2.40538	0.19241	0.94522
.4	83	0.81279	0.21840	2.44529	0.16436	0.94674
.4	84	0.82315	0.21840	2.48358	0.13621	0.94814
.4	85	0.83371	0.21840	2.52045	0.10848	0.94945
.4	86	0.84449	0.21840	2.55597	0.07998	0.95064
.4	87	0.85550	0.21840	2.57456	0.07489	0.95177
.4	88	0.86676	0.21840	2.58658	0.08004	0.95293
.4	89	0.87828	0.21840	2.59772	0.08596	0.95403
.4	90	0.89006	0.21840	2.60906	0.09107	0.95508
.4	91	0.90212	0.21840	2.62061	0.09466	0.95605
.4	92	0.91447	0.21840	2.63290	0.09680	0.95698
.4	93	0.92713	0.21840	2.64558	0.09642	0.95780
.4	94	0.94010	0.21840	2.65912	0.09357	0.95854
.4	95	0.95340	0.21840	2.66829	0.09821	0.95933

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-24
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.4	96	0.96609	0.21840	2.67579	0.09405	0.95961
.4	97	0.97656	0.21840	2.68460	0.09981	0.96041
.4	98	0.98449	0.21840	2.68105	0.10549	0.96044
.4	99	0.99050	0.21840	2.67742	0.09810	0.95989
.4	100	0.99506	0.21840	2.78717	0.05804	0.96460
.4	101	0.99851	0.21840	2.36788	0.13326	0.93767
.4	102	1.00000	0.21840	2.36788	0.13326	0.93767
.5	1	1.00000	0.23500	1.87271	-0.17233	0.81752
.5	2	0.99868	0.23500	1.46143	0.01968	0.71769
.5	3	0.99562	0.23500	1.41616	-0.01846	0.68718
.5	4	0.99158	0.23500	1.46930	0.02623	0.72273
.5	5	0.98626	0.23500	1.46921	-0.01785	0.71014
.5	6	0.97923	0.23500	1.44018	0.01495	0.70758
.5	7	0.96996	0.23500	1.43989	-0.00102	0.70272
.5	8	0.95872	0.23500	1.42523	0.00423	0.69805
.5	9	0.94693	0.23500	1.41382	0.00310	0.69278
5	10	0.93544	0.23500	1.40184	0.00316	0.68756
.5	11	0.92423	0.23500	1.39092	0.00341	0.68280
.5	12	0.91328	0.23500	1.38047	0.00300	0.67799
5	13	0.90259	0.23500	1.37075	0.00332	0.67370
.5	14	0.89215	0.23500	1.36156	0.00293	0.66936
.5	15	0.88195	0.23500	1.35295	0.00317	0.66547
.5	16	0.87198	0.23500	1.34504	0.00304	0.66174
.5	17	0.86222	0.23500	1.33698	0.00282	0.65788
.5	18	0.85267	0.23500	1.32938	0.00302	0.65435
.5	19	0.84331	0.23500	1.32215	0.00275	0.65080
.5	20	0.83414	0.23500	1.31533	0.00289	0.64758
.5	21	0.82513	0.23500	1.30886	0.00271	0.64438
.5	22	0.81629	0.23500	1.30260	0.00270	0.64133
.5	23	0.80760	0.23500	1.29673	0.00269	0.63845
.5	24	0.79905	0.23500	1.29102	0.00251	0.63557
.5	25	0.79062	0.23500	1.28569	0.00259	0.63296
.5	26	0.78232	0.23500	1.28083	0.00254	0.63053
.5	27	0.77411	0.23500	1.27611	0.00235	0.62810
.5	28	0.76601	0.23500	1.27176	0.00247	0.62596
.5	29	0.75798	0.23500	1.26771	0.00228	0.62384
.5	30	0.75003	0.23500	1.26399	0.00231	0.62197
.5	31	0.74213	0.23500	1.26066	0.00223	0.62025
.5	32	0.73429	0.23500	1.25773	0.00218	0.61874
.5	33	0.72648	0.23500	1.25525	0.00211	0.61745
.5	34	0.71871	0.23500	1.25329	0.00209	0.61644
.5	35	0.71094	0.23500	1.25194	0.00198	0.61570
.5	36	0.70318	0.23500	1.25136	0.00203	0.61542
.5	37	0.69542	0.23500	1.25171	0.00187	0.61554
.5	38	0.68791	0.23500	1.25324	0.00200	0.61638
.5	39	0.68118	0.23500	1.25606	0.00240	0.61797
.5	40	0.67537	0.23500	1.26005	0.00266	0.62011
.5	41	0.67037	0.23500	1.26528	0.00288	0.62284
.5	42	0.66605	0.23500	1.27179	0.00336	0.62630
.5	43	0.66233	0.23500	1.27962	0.00357	0.63031
.5	44	0.65911	0.23500	1.28894	0.00419	0.63516
.5	45	0.65635	0.23500	1.30022	0.00413	0.64069
.5	46	0.65396	0.23500	1.31327	0.00535	0.64745
.5	47	0.65190	0.23500	1.32913	0.00520	0.65498
.5	48	0.65012	0.23500	1.35126	0.00368	0.66485
.5	49	0.64859	0.23500	1.37224	0.01382	0.67780
.5	50	0.64727	0.23500	1.42675	-0.01349	0.69334
.5	51	0.64613	0.23500	1.48968	-0.02312	0.71711
.5	52	0.64560	0.23500	1.48968	-0.02312	0.71711
.5	53	0.64727	0.23500	1.93428	0.27901	0.89796
.5	54	0.64859	0.23500	1.97861	0.15496	0.88835
.5	55	0.65012	0.23500	1.94336	0.20743	0.88939
.5	56	0.65190	0.23500	1.94997	0.19473	0.88877

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-25
	DILLNER WING: MACH = 1.50, ALPHA = 15			

L5	57	0.65396	0.23500	1.96448	0.19379	0.89112
L5	58	0.65635	0.23500	1.96827	0.19111	0.89140
L5	59	0.65911	0.23500	1.97029	0.18618	0.89108
L5	60	0.66233	0.23500	1.97365	0.17860	0.89063
L5	61	0.66605	0.23500	1.97927	0.17369	0.89093
L5	62	0.67037	0.23500	1.98461	0.17213	0.89163
L5	63	0.67537	0.23500	1.99105	0.17274	0.89279
L5	64	0.68118	0.23500	2.00050	0.17152	0.89420
L5	65	0.68791	0.23500	2.01311	0.16907	0.89595
L5	66	0.69542	0.23500	2.02818	0.16641	0.89804
L5	67	0.70318	0.23500	2.04465	0.16310	0.90023
L5	68	0.71094	0.23500	2.06305	0.15892	0.90256
L5	69	0.71871	0.23500	2.08430	0.15223	0.90499
L5	70	0.72648	0.23500	2.10880	0.14284	0.90755
L5	71	0.73429	0.23500	2.13664	0.13023	0.91018
L5	72	0.74213	0.23500	2.16769	0.11443	0.91288
L5	73	0.75003	0.23500	2.20161	0.09540	0.91561
L5	74	0.75798	0.23500	2.23752	0.07418	0.91835
L5	75	0.76601	0.23500	2.27151	0.05649	0.92111
L5	76	0.77411	0.23500	2.29491	0.05535	0.92385
L5	77	0.78232	0.23500	2.30423	0.07538	0.92654
L5	78	0.79062	0.23500	2.30135	0.11288	0.92920
L5	79	0.79905	0.23500	2.29119	0.15907	0.93182
L5	80	0.80760	0.23500	2.27893	0.20526	0.93431
L5	81	0.81629	0.23500	2.265[illegible]	0.25007	0.93671
L5	82	0.82513	0.23500	2.25409	0.29022	0.93901
L5	83	0.83414	0.23500	2.24660	0.32329	0.94116
L5	84	0.84331	0.23500	2.24327	0.34991	0.94318
L5	85	0.85267	0.23500	2.24327	0.37119	0.94504
L5	86	0.86222	0.23500	2.24289	0.39266	0.94689
L5	87	0.87198	0.23500	2.26866	0.38824	0.94862
L5	88	0.88195	0.23500	2.29824	0.37799	0.95012
L5	89	0.89215	0.23500	2.32604	0.36888	0.95154
L5	90	0.90259	0.23500	2.35276	0.36085	0.95293
L5	91	0.91328	0.23500	2.37890	0.35311	0.95427
L5	92	0.92422	0.23500	2.40411	0.34683	0.95561
L5	93	0.93544	0.23500	2.42909	0.34075	0.95691
L5	94	0.94693	0.23500	2.45555	0.33295	0.95816
L5	95	0.95872	0.23500	2.47708	0.33427	0.95962
L5	96	0.96996	0.23500	2.50303	0.32040	0.96041
L5	97	0.97923	0.23500	2.54207	0.30153	0.96171
L5	98	0.98626	0.23500	2.54798	0.31104	0.96257
L5	99	0.99158	0.23500	2.57427	0.25896	0.96135
L5	100	0.99562	0.23500	2.71734	0.21715	0.96726
L5	101	0.99868	0.23500	2.36398	0.18180	0.94080
L5	102	1.00000	0.23500	2.36398	0.18180	0.94080
L6	1	1.00000	0.25500	1.81719	-0.12670	0.80900
L6	2	0.99888	0.25500	1.46499	0.02494	0.72064
L6	3	0.99630	0.25500	1.42411	-0.00680	0.69422
L6	4	0.99289	0.25500	1.47323	0.02861	0.72497
L6	5	0.98839	0.25500	1.47311	-0.00605	0.71510
L6	6	0.98245	0.25500	1.44697	0.01992	0.71186
L6	7	0.97461	0.25500	1.44452	0.00737	0.70715
L6	8	0.96512	0.25500	1.43017	0.01168	0.70240
L6	9	0.95516	0.25500	1.41854	0.01059	0.69712
L6	10	0.94545	0.25500	1.40632	0.01069	0.69187
L6	11	0.93597	0.25500	1.39524	0.01090	0.68710
L6	12	0.92672	0.25500	1.38464	0.01049	0.68227
L6	13	0.91769	0.25500	1.37478	0.01080	0.67796
L6	14	0.90887	0.25500	1.36546	0.01041	0.67362
L6	15	0.90026	0.25500	1.35673	0.01064	0.66971
L6	16	0.89183	0.25500	1.34876	0.01049	0.66599
L6	17	0.88358	0.25500	1.34066	0.01028	0.66216

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-26
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.6	18	0.87551	0.25500	1.33306	0.01046	0.65866
.6	19	0.86760	0.25500	1.32584	0.01019	0.65516
.6	20	0.85985	0.25500	1.31904	0.01033	0.65198
.6	21	0.85224	0.25500	1.31261	0.01014	0.64884
.6	22	0.84477	0.25500	1.30642	0.01014	0.64585
.6	23	0.83743	0.25500	1.30063	0.01012	0.64304
.6	24	0.83020	0.25500	1.29502	0.00995	0.64025
.6	25	0.82308	0.25500	1.28982	0.01002	0.63773
.6	26	0.81607	0.25500	1.28510	0.00997	0.63539
.6	27	0.80913	0.25500	1.28055	0.00979	0.63308
.6	28	0.80228	0.25500	1.27639	0.00990	0.63105
.6	29	0.79550	0.25500	1.27257	0.00973	0.62908
.6	30	0.78878	0.25500	1.26911	0.00976	0.62736
.6	31	0.78211	0.25500	1.26607	0.00968	0.62581
.6	32	0.77548	0.25500	1.26347	0.00965	0.62449
.6	33	0.76889	0.25500	1.26137	0.00958	0.62341
.6	34	0.76232	0.25500	1.25985	0.00956	0.62263
.6	35	0.75576	0.25500	1.25900	0.00947	0.62217
.6	36	0.74920	0.25500	1.25899	0.00952	0.62218
.6	37	0.74264	0.25500	1.26004	0.00938	0.62266
.6	38	0.73630	0.25500	1.26239	0.00942	0.62386
.6	39	0.73061	0.25500	1.26611	0.00968	0.62583
.6	40	0.72570	0.25500	1.27098	0.00977	0.62831
.6	41	0.72147	0.25500	1.27710	0.00976	0.63135
.6	42	0.71782	0.25500	1.28448	0.01006	0.63512
.6	43	0.71468	0.25500	1.29315	0.01011	0.63940
.6	44	0.71196	0.25500	1.30330	0.01059	0.64451
.6	45	0.70962	0.25500	1.31541	0.01041	0.65027
.6	46	0.70761	0.25500	1.32928	0.01149	0.65723
.6	47	0.70587	0.25500	1.34585	0.01135	0.66493
.6	48	0.70437	0.25500	1.36890	0.00976	0.67497
.6	49	0.70307	0.25500	1.39077	0.01976	0.68794
.6	50	0.70195	0.25500	1.44592	-0.00626	0.70372
.6	51	0.70099	0.25500	1.50866	-0.01390	0.72726
.6	52	0.70054	0.25500	1.50866	-0.01390	0.72726
.6	53	0.70195	0.25500	1.96145	0.27536	0.90167
.6	54	0.70307	0.25500	2.00969	0.14217	0.89201
.6	55	0.70437	0.25500	1.96919	0.20565	0.89350
.6	56	0.70587	0.25500	1.97692	0.19682	0.89360
.6	57	0.70761	0.25500	1.98641	0.19678	0.89515
.6	58	0.70962	0.25500	1.99155	0.18885	0.89496
.6	59	0.71196	0.25500	1.99546	0.17812	0.89422
.6	60	0.71468	0.25500	2.00452	0.16478	0.89400
.6	61	0.71782	0.25500	2.01540	0.15308	0.89432
.6	62	0.72147	0.25500	2.02535	0.14491	0.89494
.6	63	0.72570	0.25500	2.03454	0.13955	0.89579
.6	64	0.73061	0.25500	2.04490	0.13358	0.89675
.6	65	0.73630	0.25500	2.05629	0.12816	0.89793
.6	66	0.74264	0.25500	2.06732	0.12495	0.89930
.6	67	0.74920	0.25500	2.07807	0.12239	0.90069
.6	68	0.75576	0.25500	2.09107	0.11757	0.90215
.6	69	0.76232	0.25500	2.10908	0.10614	0.90363
.6	70	0.76889	0.25500	2.13414	0.08523	0.90516
.6	71	0.77548	0.25500	2.16736	0.05232	0.90673
.6	72	0.78211	0.25500	2.20992	0.00438	0.90832
.6	73	0.78878	0.25500	2.26330	-0.06321	0.90995
.6	74	0.79550	0.25500	2.33002	-0.15820	0.91163
.6	75	0.80228	0.25500	2.41242	-0.29151	0.91336
.6	76	0.80913	0.25500	2.50827	-0.46739	0.91521
.6	77	0.81607	0.25500	2.59587	-0.64273	0.91715
.6	78	0.82308	0.25500	2.66405	-0.78029	0.91918
.6	79	0.83020	0.25500	2.70869	-0.85725	0.92129
.6	80	0.83743	0.25500	2.72949	-0.86494	0.92345

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-27
	DILLNER WING: MACH = 1.50, ALPHA = 15			

L6	81	0.84477	0.25500	2.73089	-0.81541	0.92564
L6	82	0.85224	0.25500	2.71939	-0.73065	0.92785
L6	83	0.85985	0.25500	2.70120	-0.63196	0.93004
L6	84	0.86760	0.25500	2.68058	-0.53280	0.93217
L6	85	0.87551	0.25500	2.65819	-0.43587	0.93423
L6	86	0.88358	0.25500	2.64777	-0.37143	0.93616
L6	87	0.89183	0.25500	2.64225	-0.32097	0.93798
L6	88	0.90025	0.25500	2.64154	-0.28209	0.93974
L6	89	0.90887	0.25500	2.64378	-0.24909	0.94150
.6	90	0.91769	0.25500	2.64671	-0.21673	0.94327
L6	91	0.92672	0.25500	2.65119	-0.18742	0.94502
L6	92	0.93597	0.25500	2.66142	-0.16709	0.94681
L6	93	0.94545	0.25500	2.67577	-0.15233	0.94863
L6	94	0.95516	0.25500	2.70714	-0.16830	0.95037
L6	95	0.96512	0.25500	2.73271	-0.16335	0.95248
L6	96	0.97461	0.25500	2.73021	-0.12941	0.95369
L6	97	0.98245	0.25500	2.78629	-0.18041	0.95558
L6	98	0.98839	0.25500	2.78695	-0.08738	0.95913
L6	99	0.99289	0.25500	2.71396	-0.08418	0.95442
L6	100	0.99630	0.25500	2.86213	-0.11710	0.96255
L6	101	0.99888	0.25500	2.38425	0.06027	0.93412
L6	102	1.00000	0.25500	2.38425	0.06027	0.93412
.7	1	1.00000	0.27500	1.79487	-0.13186	0.80146
L7	2	0.99909	0.27500	1.46829	0.00265	0.71560
L7	3	0.99698	0.27500	1.44630	-0.02662	0.69789
.7	4	0.99419	0.27500	1.48812	0.00343	0.72383
L7	5	0.99052	0.27500	1.48622	-0.02603	0.71488
.7	6	0.98567	0.27500	1.46322	-0.00398	0.71162
.7	7	0.97927	0.27500	1.45907	-0.01477	0.70678
L7	8	0.97152	0.27500	1.44453	-0.01069	0.70183
L7	9	0.96339	0.27500	1.43265	-0.01171	0.69643
L7	10	0.95546	0.27500	1.42018	-0.01147	0.69108
.7	11	0.94772	0.27500	1.40893	-0.01120	0.68621
.7	12	0.94017	0.27500	1.39812	-0.01151	0.68130
L7	13	0.93280	0.27500	1.38807	-0.01111	0.67689
.7	14	0.92559	0.27500	1.37858	-0.01143	0.67247
.7	15	0.91856	0.27500	1.36970	-0.01112	0.66848
.7	16	0.91168	0.27500	1.36161	-0.01119	0.66470
.7	17	0.90494	0.27500	1.35349	-0.01132	0.66085
.7	18	0.89835	0.27500	1.34589	-0.01108	0.65735
.7	19	0.89190	0.27500	1.33871	-0.01126	0.65387
.7	20	0.88557	0.27500	1.33196	-0.01107	0.65071
.7	21	0.87936	0.27500	1.32563	-0.01117	0.64762
.7	22	0.87326	0.27500	1.31957	-0.01110	0.64470
.7	23	0.86726	0.27500	1.31395	-0.01105	0.64197
.7	24	0.86136	0.27500	1.30857	-0.01114	0.63930
L7	25	0.85555	0.27500	1.30361	-0.01101	0.63690
L7	26	0.84981	0.27500	1.29914	-0.01098	0.63470
.7	27	0.84416	0.27500	1.29491	-0.01106	0.63256
L7	28	0.83856	0.27500	1.29110	-0.01090	0.63072
.7	29	0.83302	0.27500	1.28769	-0.01098	0.62897
L7	30	0.82754	0.27500	1.28469	-0.01090	0.62749
.7	31	0.82209	0.27500	1.28216	-0.01091	0.62622
.7	32	0.81668	0.27500	1.28014	-0.01088	0.62521
L7	33	0.81129	0.27500	1.27868	-0.01087	0.62447
.7	34	0.80593	0.27500	1.27788	-0.01084	0.62408
.7	35	0.80057	0.27500	1.27785	-0.01086	0.62406
L7	36	0.79522	0.27500	1.27881	-0.01080	0.62456
L7	37	0.78986	0.27500	1.28101	-0.01092	0.62563
L7	38	0.78468	0.27500	1.28470	-0.01095	0.62748
L7	39	0.78004	0.27500	1.28980	-0.01069	0.63014
.7	40	0.77603	0.27500	1.29605	-0.01064	0.63328
L7	41	0.77258	0.27500	1.30357	-0.01076	0.63697

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-28
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.7	42	0.76960	0.27500	1.31242	-0.01058	0.64139
.7	43	0.76703	0.27500	1.32257	-0.01077	0.64627
.7	44	0.76481	0.27500	1.33421	-0.01054	0.65197
.7	45	0.76290	0.27500	1.34786	-0.01103	0.65830
.7	46	0.76126	0.27500	1.36326	-0.01040	0.66573
.7	47	0.75983	0.27500	1.38121	-0.01078	0.67388
.7	48	0.75861	0.27500	1.40621	-0.01323	0.68438
L7	49	0.75755	0.27500	1.42982	-0.00355	0.69767
.7	50	0.75664	0.27500	1.48683	-0.02926	0.71423
L7	51	0.75585	0.27500	1.55408	-0.04127	0.73786
L7	52	0.75549	0.27500	1.55408	-0.04127	0.73786
.7	53	0.75664	0.27500	2.08526	0.15740	0.90571
.7	54	0.75755	0.27500	2.13301	0.00699	0.89687
.7	55	0.75861	0.27500	2.06359	0.12194	0.89836
.7	56	0.75983	0.27500	2.04484	0.15165	0.89889
.7	57	0.76126	0.27500	2.01441	0.19697	0.89965
L7	58	0.76290	0.27500	1.99811	0.20718	0.89837
L7	59	0.76481	0.27500	1.99458	0.20853	0.89799
.7	60	0.76703	0.27500	1.98838	0.21739	0.89815
.7	61	0.76960	0.27500	1.97541	0.23751	0.89875
L7	62	0.77258	0.27500	1.96072	0.25960	0.89942
L7	63	0.77603	0.27500	1.94686	0.28001	0.90006
.7	64	0.78004	0.27500	1.93119	0.30235	0.90079
.7	65	0.78468	0.27500	1.90997	0.33030	0.90158
L7	66	0.78986	0.27500	1.87914	0.36659	0.90238
.7	67	0.79522	0.27500	1.83810	0.40896	0.90297
.7	68	0.80057	0.27500	1.79239	0.45083	0.90330
.7	69	0.80593	0.27500	1.74914	0.48691	0.90350
.7	70	0.81129	0.27500	1.71352	0.51486	0.90370
L7	71	0.81668	0.27500	1.68675	0.53524	0.90394
.7	72	0.82209	0.27500	1.66684	0.55037	0.90425
L7	73	0.82754	0.27500	1.65209	0.56196	0.90463
.7	74	0.83302	0.27500	1.64259	0.57029	0.90511
.7	75	0.83856	0.27500	1.64287	0.57275	0.90569
.7	76	0.84416	0.27500	1.66075	0.56434	0.90637
.7	77	0.84981	0.27500	1.69922	0.54247	0.90720
L7	78	0.85555	0.27500	1.75364	0.50831	0.90816
.7	79	0.86136	0.27500	1.81397	0.46734	0.90926
L7	80	0.86726	0.27500	1.87015	0.42736	0.91051
.7	81	0.87326	0.27500	1.91552	0.39532	0.91190
L7	82	0.87935	0.27500	1.94768	0.37531	0.91340
L7	83	0.88557	0.27500	1.96755	0.36772	0.91501
L7	84	0.89190	0.27500	1.97745	0.37054	0.91668
L7	85	0.89835	0.27500	1.97944	0.38182	0.91843
L7	86	0.90494	0.27500	1.97939	0.39501	0.92016
L7	87	0.91167	0.27500	1.97998	0.40818	0.92197
L7	88	0.91856	0.27500	1.98301	0.41961	0.92384
L7	89	0.92559	0.27500	1.99120	0.42726	0.92579
.7	90	0.93280	0.27500	2.00385	0.43202	0.92784
L7	91	0.94017	0.27500	2.01506	0.43847	0.92990
L7	92	0.94772	0.27500	2.02084	0.45086	0.93206
L7	93	0.95546	0.27500	2.01571	0.47362	0.93435
L7	94	0.96339	0.27500	2.00805	0.49856	0.93671
L7	95	0.97152	0.27500	2.01474	0.51522	0.93945
L7	96	0.97927	0.27500	1.99759	0.54178	0.94122
L7	97	0.98567	0.27500	2.07414	0.50750	0.94392
L7	98	0.99052	0.27500	2.09216	0.53888	0.94895
L7	99	0.99419	0.27500	2.04843	0.51157	0.94211
L7	100	0.99698	0.27500	2.16087	0.50194	0.95048
L7	101	0.99909	0.27500	1.73241	0.53367	0.91004
L7	102	1.00000	0.27500	1.73241	0.53367	0.91004
L8	1	1.00000	0.29650	1.71115	-0.05074	0.79068
L8	2	0.99931	0.29650	1.47438	0.04617	0.73038

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-29
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.8	3	0.99771	0.29650	1.46419	0.01411	0.71721
.8	4	0.99560	0.29650	1.49240	0.03997	0.73559
.8	5	0.99281	0.29650	1.49311	0.01597	0.72926
.8	6	0.98913	0.29650	1.47310	0.03316	0.72620
.8	7	0.98428	0.29650	1.46774	0.02524	0.72183
.8	8	0.97840	0.29650	1.45394	0.02839	0.71718
.8	9	0.97223	0.29650	1.44184	0.02779	0.71208
.8	10	0.96622	0.29650	1.42932	0.02808	0.70699
.8	11	0.96035	0.29650	1.41797	0.02843	0.70234
.8	12	0.95462	0.29650	1.40709	0.02821	0.69766
.8	13	0.94903	0.29650	1.39695	0.02863	0.69344
.8	14	0.94357	0.29650	1.38738	0.02839	0.68922
.8	15	0.93823	0.29650	1.37842	0.02873	0.68540
.8	16	0.93301	0.29650	1.37024	0.02872	0.68178
.8	17	0.92791	0.29650	1.36207	0.02865	0.67812
.8	18	0.92291	0.29650	1.35444	0.02892	0.67478
.8	19	0.91801	0.29650	1.34724	0.02877	0.67147
.8	20	0.91321	0.29650	1.34051	0.02896	0.66846
.8	21	0.90850	0.29650	1.33421	0.02885	0.66554
.8	22	0.90387	0.29650	1.32824	0.02886	0.66278
.8	23	0.89933	0.29650	1.32271	0.02886	0.66021
.8	24	0.89485	0.29650	1.31748	0.02870	0.65771
.8	25	0.89044	0.29650	1.31267	0.02871	0.65545
.8	26	0.88609	0.29650	1.30836	0.02863	0.65339
.8	27	0.88180	0.29650	1.30434	0.02843	0.65141
.8	28	0.87756	0.29650	1.30074	0.02843	0.64970
.8	29	0.87336	0.29650	1.29756	0.02820	0.64810
.8	30	0.86920	0.29650	1.29482	0.02810	0.64675
.8	31	0.86507	0.29650	1.29255	0.02792	0.64559
.8	32	0.86096	0.29650	1.29078	0.02778	0.64469
.8	33	0.85688	0.29650	1.28954	0.02765	0.64405
.8	34	0.85281	0.29650	1.28895	0.02754	0.64372
.8	35	0.84875	0.29650	1.28912	0.02738	0.64375
.8	36	0.84468	0.29650	1.29014	0.02736	0.64423
.8	37	0.84062	0.29650	1.29231	0.02730	0.64525
.8	38	0.83670	0.29650	1.29573	0.02740	0.64693
.8	39	0.83317	0.29650	1.30031	0.02804	0.64935
.8	40	0.83013	0.29650	1.30576	0.02873	0.65220
.8	41	0.82751	0.29650	1.31223	0.02949	0.65552
.8	42	0.82525	0.29650	1.31976	0.03075	0.65949
.8	43	0.82331	0.29650	1.32821	0.03201	0.66386
.8	44	0.82163	0.29650	1.33768	0.03378	0.66882
.8	45	0.82018	0.29650	1.34840	0.03601	0.67444
.8	46	0.81893	0.29650	1.36002	0.03936	0.68076
.8	47	0.81785	0.29650	1.37317	0.04495	0.68838
.8	48	0.81692	0.29650	1.38961	0.05013	0.69712
.8	49	0.81612	0.29650	1.40934	0.07127	0.71197
.8	50	0.81543	0.29650	1.44047	0.07279	0.72487
.8	51	0.81483	0.29650	1.50957	0.07162	0.75059
.8	52	0.81455	0.29650	1.50957	0.07162	0.75059
.8	53	0.81543	0.29650	2.03077	0.23626	0.90696
.8	54	0.81612	0.29650	2.11955	0.05410	0.89968
.8	55	0.81692	0.29650	2.10888	0.07675	0.90043
.8	56	0.81785	0.29650	2.16874	0.00245	0.90203
.8	57	0.81893	0.29650	2.12353	0.07745	0.90276
.8	58	0.82018	0.29650	2.10868	0.08302	0.90108
.8	59	0.82163	0.29650	2.12927	0.04132	0.89985
.8	60	0.82331	0.29650	2.17262	-0.02843	0.89961
.8	61	0.82525	0.29650	2.23059	-0.12315	0.89987
.8	62	0.82751	0.29650	2.31578	-0.28139	0.90002
.8	63	0.83013	0.29650	2.43215	-0.53472	0.90016
.8	64	0.83317	0.29650	2.55712	-0.86747	0.89998
.8	65	0.83670	0.29650	2.68439	-1.28961	0.89927

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-30
	DILLNER WING: MACH = 1.50, ALPHA = 15			

.8	66	0.84062	0.29650	2.83461	-1.91241	0.89820
.8	67	0.84469	0.29650	2.93159	-2.41900	0.89683
.8	68	0.84875	0.29650	2.92882	-2.43893	0.89579
.8	69	0.85281	0.29650	2.85443	-2.09101	0.89516
.8	70	0.85688	0.29650	2.74935	-1.63792	0.89497
.8	71	0.86096	0.29650	2.64057	-1.22908	0.89508
.8	72	0.86507	0.29650	2.54320	-0.91097	0.89542
.8	73	0.86920	0.29650	2.45489	-0.65771	0.89592
.8	74	0.87336	0.29650	2.37214	-0.44876	0.89650
.8	75	0.87756	0.29650	2.29333	-0.27317	0.89711
.8	76	0.88180	0.29650	2.22050	-0.12924	0.89773
.8	77	0.88609	0.29650	2.15813	-0.01775	0.89837
.8	78	0.89044	0.29650	2.10962	0.06280	0.89904
.8	79	0.89485	0.29650	2.07546	0.11793	0.89977
.8	80	0.89933	0.29650	2.05255	0.15605	0.90062
.8	81	0.90387	0.29650	2.03557	0.18581	0.90155
.8	82	0.90850	0.29650	2.01939	0.21451	0.90260
.8	83	0.91321	0.29650	2.00046	0.24633	0.90375
.8	84	0.91801	0.29650	1.97723	0.28223	0.90496
.8	85	0.92291	0.29650	1.94954	0.32185	0.90626
.8	86	0.92791	0.29650	1.91946	0.36170	0.90756
.8	87	0.93301	0.29650	1.89106	0.39840	0.90897
.8	88	0.93823	0.29650	1.86837	0.42832	0.91042
.8	89	0.94357	0.29650	1.85318	0.45108	0.91195
.8	90	0.94903	0.29650	1.84499	0.46863	0.91368
.8	91	0.95462	0.29650	1.84823	0.47712	0.91548
.8	92	0.96035	0.29650	1.85702	0.48288	0.91754
.8	93	0.96622	0.29650	1.87500	0.49266	0.92131
.8	94	0.97223	0.29650	1.93721	0.46775	0.92501
.8	95	0.97840	0.29650	1.99537	0.43963	0.92786
.8	96	0.98428	0.29650	2.00247	0.44715	0.92961
.8	97	0.98813	0.29650	2.07374	0.40007	0.93165
.8	98	0.99281	0.29650	2.09909	0.43529	0.93816
.8	99	0.99560	0.29650	2.04979	0.39442	0.92838
.8	100	0.99771	0.29650	2.18664	0.39536	0.94226
.8	101	0.99931	0.29650	1.77976	0.43532	0.89864
.8	102	1.00000	0.29650	1.77976	0.43532	0.89864
.9	1	1.00000	0.31300	1.66777	-0.07593	0.77119
.9	2	0.99948	0.31300	1.50793	0.00136	0.73108
.9	3	0.99827	0.31300	1.49615	-0.03278	0.71709
.9	4	0.99667	0.31300	1.50899	-0.00350	0.73018
.9	5	0.99457	0.31300	1.50731	-0.02794	0.72294
.9	6	0.99179	0.31300	1.48822	-0.01063	0.71997
.9	7	0.98812	0.31300	1.48268	-0.01882	0.71544
.9	8	0.98368	0.31300	1.46922	-0.01618	0.71062
.9	9	0.97902	0.31300	1.45764	-0.01770	0.70533
.9	10	0.97448	0.31300	1.44555	-0.01809	0.70008
.9	11	0.97004	0.31300	1.43457	-0.01834	0.69528
.9	12	0.96571	0.31300	1.42398	-0.01906	0.69044
.9	13	0.96149	0.31300	1.41413	-0.01909	0.68608
.9	14	0.95736	0.31300	1.40487	-0.01980	0.68173
.9	15	0.95333	0.31300	1.39623	-0.01994	0.67779
.9	16	0.94939	0.31300	1.38841	-0.02044	0.67407
.9	17	0.94553	0.31300	1.38068	-0.02102	0.67033
.9	18	0.94175	0.31300	1.37352	-0.02127	0.66693
.9	19	0.93805	0.31300	1.36682	-0.02193	0.66359
.9	20	0.93442	0.31300	1.36061	-0.02223	0.66057
.9	21	0.93087	0.31300	1.35484	-0.02279	0.65765
.9	22	0.92737	0.31300	1.34940	-0.02316	0.65493
.9	23	0.92393	0.31300	1.34439	-0.02348	0.65243
.9	24	0.92055	0.31300	1.33968	-0.02384	0.65004
.9	25	0.91722	0.31300	1.33539	-0.02395	0.64792
.9	26	0.91394	0.31300	1.33158	-0.02409	0.64602

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-31
	DILLNER WING: MACH = 1.50, ALPHA = 15			

19	27	0.91069	0.31300	1.32810	-0.02429	0.64425
19	28	0.90749	0.31300	1.32506	-0.02426	0.64278
19	29	0.90432	0.31300	1.32245	-0.02435	0.64146
19	30	0.90117	0.31300	1.32026	-0.02423	0.64043
19	31	0.89805	0.31300	1.31854	-0.02403	0.63965
19	32	0.89495	0.31300	1.31733	-0.02366	0.63918
19	33	0.89186	0.31300	1.31671	-0.02325	0.63902
19	34	0.88879	0.31300	1.31679	-0.02283	0.63920
19	35	0.88572	0.31300	1.31764	-0.02230	0.63981
19	36	0.88265	0.31300	1.31941	-0.02154	0.64095
19	37	0.87958	0.31300	1.32240	-0.02051	0.64278
19	38	0.87661	0.31300	1.32676	-0.01939	0.64530
19	39	0.87395	0.31300	1.33232	-0.01785	0.64854
19	40	0.87166	0.31300	1.33864	-0.01633	0.65210
19	41	0.86968	0.31300	1.34594	-0.01461	0.65618
19	42	0.86797	0.31300	1.35425	-0.01226	0.66090
19	43	0.86650	0.31300	1.36358	-0.00978	0.66609
19	44	0.86523	0.31300	1.37428	-0.00663	0.67206
19	45	0.86413	0.31300	1.38690	-0.00338	0.67884
19	46	0.86319	0.31300	1.40136	0.00110	0.68671
19	47	0.86237	0.31300	1.41883	0.00576	0.69576
19	48	0.86167	0.31300	1.44385	0.00908	0.70738
19	49	0.86107	0.31300	1.47077	0.02519	0.72302
.9	50	0.86054	0.31300	1.54035	0.00228	0.74372
19	51	0.86009	0.31300	1.58040	0.04605	0.76897
19	52	0.85988	0.31300	1.58040	0.04605	0.76897
.9	53	0.86054	0.31300	1.63758	0.69328	0.93176
.9	54	0.86107	0.31300	1.62414	0.63458	0.91705
.9	55	0.86167	0.31300	1.62567	0.63699	0.91779
.9	56	0.86237	0.31300	1.64019	0.61362	0.91437
.9	57	0.86319	0.31300	1.65050	0.60352	0.91349
.9	58	0.86413	0.31300	1.66861	0.58072	0.91095
.9	59	0.86523	0.31300	1.69032	0.55811	0.90916
19	60	0.86650	0.31300	1.71964	0.52852	0.90727
.9	61	0.86797	0.31300	1.75732	0.49169	0.90558
.9	62	0.86968	0.31300	1.81150	0.43718	0.90376
.9	63	0.87166	0.31300	1.88063	0.36171	0.90185
.9	64	0.87395	0.31300	1.94799	0.27663	0.89977
.9	65	0.87661	0.31300	2.01415	0.18117	0.89763
.9	66	0.87958	0.31300	2.09130	0.05894	0.89568
.9	67	0.88265	0.31300	2.17972	-0.09404	0.89438
.9	68	0.88572	0.31300	2.25879	-0.24416	0.89387
.9	69	0.88879	0.31300	2.30215	-0.33070	0.89394
.9	70	0.89186	0.31300	2.31380	-0.35156	0.89422
.9	71	0.89495	0.31300	2.30665	-0.33200	0.89458
.9	72	0.89805	0.31300	2.29222	-0.29697	0.89501
.9	73	0.90117	0.31300	2.27391	-0.25453	0.89549
.9	74	0.90432	0.31300	2.25287	-0.20810	0.89599
.9	75	0.90749	0.31300	2.22928	-0.15843	0.89651
.9	76	0.91069	0.31300	2.20302	-0.10625	0.89703
.9	77	0.91394	0.31300	2.17495	-0.05295	0.89759
.9	78	0.91722	0.31300	2.14691	-0.00229	0.89815
.9	79	0.92055	0.31300	2.12109	0.04288	0.89873
.9	80	0.92393	0.31300	2.09804	0.08258	0.89937
.9	81	0.92737	0.31300	2.07694	0.11798	0.90001
.9	82	0.93086	0.31300	2.05639	0.15153	0.90068
.9	83	0.93442	0.31300	2.03452	0.18558	0.90136
.9	84	0.93805	0.31300	2.01052	0.22070	0.90202
.9	85	0.94175	0.31300	1.98430	0.25721	0.90272
.9	86	0.94553	0.31300	1.95654	0.29346	0.90339
.9	87	0.94939	0.31300	1.92896	0.32820	0.90413
.9	88	0.95333	0.31300	1.90461	0.35789	0.90485
.9	89	0.95736	0.31300	1.88581	0.38149	0.90565

DORNIER JAMESON	AR 211		W.Schmidt A.Jameson	14-9-32
	DILLNER WING: MACH = 1.50, ALPHA = 15			

9	90	0.96149	0.31300	1.87015	0.40236	0.90661
9	91	0.96571	0.31300	1.85934	0.41893	0.90767
9	92	0.97004	0.31300	1.85997	0.42645	0.90895
.9	93	0.97447	0.31300	1.87828	0.41832	0.91023
.9	94	0.97902	0.31300	1.91531	0.39101	0.91124
9	95	0.98368	0.31300	1.96440	0.34983	0.91218
.9	96	0.98812	0.31300	1.98081	0.33865	0.91292
9	97	0.99179	0.31300	2.03778	0.28207	0.91349
.9	98	0.99457	0.31300	2.07364	0.30242	0.92051
9	99	0.99667	0.31300	1.97797	0.29456	0.90670
.9	100	0.99827	0.31300	2.12022	0.26700	0.92234
.9	101	0.99948	0.31300	1.79311	0.37334	0.88978
.9	102	1.00000	0.31300	1.79311	0.37334	0.88978
0	1	1.00000	0.32350	1.73796	-0.14287	0.78138
0	2	0.99959	0.32350	1.51531	-0.05874	0.71793
0	3	0.99862	0.32350	1.51398	-0.07757	0.71236
0	4	0.99736	0.32350	1.52769	-0.06458	0.72144
0	5	0.99568	0.32350	1.52032	-0.08169	0.71391
0	6	0.99348	0.32350	1.50648	-0.07103	0.71098
0	7	0.99057	0.32350	1.50037	-0.07940	0.70612
0	8	0.98704	0.32350	1.48686	-0.07776	0.70078
0	9	0.98334	0.32350	1.47485	-0.07929	0.69512
0	10	0.97973	0.32350	1.46280	-0.07981	0.68966
0	11	0.97621	0.32350	1.45174	-0.08015	0.68460
0	12	0.97277	0.32350	1.44096	-0.08074	0.67953
0	13	0.96942	0.32350	1.43091	-0.08065	0.67494
0	14	0.96614	0.32350	1.42141	-0.08120	0.67036
0	15	0.96294	0.32350	1.41257	-0.08125	0.66620
0	16	0.95981	0.32350	1.40452	-0.08166	0.66225
0	17	0.95674	0.32350	1.39665	-0.08221	0.65832
0	18	0.95374	0.32350	1.38944	-0.08257	0.65472
0	19	0.95080	0.32350	1.38278	-0.08345	0.65120
0	20	0.94792	0.32350	1.37672	-0.08418	0.64799
0	21	0.94510	0.32350	1.37119	-0.08529	0.64490
0	22	0.94232	0.32350	1.36612	-0.08640	0.64202
0	23	0.93959	0.32350	1.36156	-0.08757	0.63935
0	24	0.93691	0.32350	1.35737	-0.08888	0.63681
0	25	0.93426	0.32350	1.35365	-0.09007	0.63453
0	26	0.93165	0.32350	1.35041	-0.09135	0.63245
0	27	0.92908	0.32350	1.34752	-0.09275	0.63051
0	28	0.92653	0.32350	1.34512	-0.09401	0.62885
0	29	0.92401	0.32350	1.34320	-0.09539	0.62739
0	30	0.92152	0.32350	1.34172	-0.09663	0.62621
0	31	0.91904	0.32350	1.34070	-0.09778	0.62529
0	32	0.91658	0.32350	1.34014	-0.09876	0.62467
0	33	0.91412	0.32350	1.33993	-0.09951	0.62430
0	34	0.91168	0.32350	1.34013	-0.09990	0.62427
0	35	0.90924	0.32350	1.34091	-0.09991	0.62467
0	36	0.90681	0.32350	1.34256	-0.09965	0.62562
0	37	0.90437	0.32350	1.34536	-0.09923	0.62721
0	38	0.90201	0.32350	1.34923	-0.09829	0.62951
0	39	0.89990	0.32350	1.35386	-0.09619	0.63259
0	40	0.89808	0.32350	1.35885	-0.09394	0.63587
0	41	0.89651	0.32350	1.36464	-0.09137	0.63964
0	42	0.89515	0.32350	1.37141	-0.08826	0.64404
0	43	0.89398	0.32350	1.37918	-0.08519	0.64887
0	44	0.89297	0.32350	1.38828	-0.08192	0.65437
0	45	0.89210	0.32350	1.39917	-0.07870	0.66063
0	46	0.89135	0.32350	1.41181	-0.07552	0.66761
0	47	0.89071	0.32350	1.42708	-0.07136	0.67598
0	48	0.89015	0.32350	1.44940	-0.07147	0.68609
0	49	0.88967	0.32350	1.47479	-0.05630	0.70159
0	50	0.88925	0.32350	1.54653	-0.08619	0.72351

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-33
	DILLNER WING: MACH = 1.50, ALPHA = 15			

20	51	0.88890	0.32350	1.60053	-0.05259	0.75255
20	52	0.88873	0.32350	1.60053	-0.05259	0.75255
20	53	0.88925	0.32350	1.57018	0.74973	0.93847
20	54	0.88967	0.32350	1.53840	0.71597	0.92683
20	55	0.89015	0.32350	1.54689	0.70859	0.92586
20	56	0.89071	0.32350	1.54953	0.69518	0.92275
20	57	0.89135	0.32350	1.56268	0.68624	0.92200
20	58	0.89210	0.32350	1.57751	0.67371	0.92064
20	59	0.89297	0.32350	1.58866	0.66378	0.91956
20	60	0.89398	0.32350	1.59498	0.65438	0.91808
20	61	0.89515	0.32350	1.60143	0.64439	0.91651
20	62	0.89651	0.32350	1.61409	0.63021	0.91480
20	63	0.89808	0.32350	1.63430	0.61080	0.91298
20	64	0.89990	0.32350	1.65694	0.58824	0.91100
20	65	0.90202	0.32350	1.67908	0.56455	0.90896
20	66	0.90437	0.32350	1.70266	0.53791	0.90676
20	67	0.90681	0.32350	1.73201	0.50689	0.90482
20	68	0.90925	0.32350	1.76526	0.47376	0.90343
20	69	0.91168	0.32350	1.79459	0.44454	0.90252
20	70	0.91412	0.32350	1.81579	0.42288	0.90196
20	71	0.91658	0.32350	1.82924	0.40893	0.90163
20	72	0.91904	0.32350	1.83774	0.40024	0.90148
20	73	0.92152	0.32350	1.84357	0.39492	0.90149
20	74	0.92401	0.32350	1.84790	0.39167	0.90162
20	75	0.92653	0.32350	1.85095	0.39035	0.90187
20	76	0.92908	0.32350	1.85186	0.39151	0.90219
20	77	0.93165	0.32350	1.85009	0.39595	0.90264
20	78	0.93426	0.32350	1.84594	0.40285	0.90314
20	79	0.93691	0.32350	1.84030	0.41128	0.90368
20	80	0.93959	0.32350	1.83347	0.42093	0.90426
20	81	0.94232	0.32350	1.82559	0.43125	0.90482
20	82	0.94510	0.32350	1.81665	0.44244	0.90540
20	83	0.94792	0.32350	1.80606	0.45495	0.90602
20	84	0.95080	0.32350	1.79379	0.46858	0.90663
20	85	0.95374	0.32350	1.77986	0.48348	0.90730
20	86	0.95674	0.32350	1.76483	0.49875	0.90795
20	87	0.95981	0.32350	1.74961	0.51409	0.90868
20	88	0.96294	0.32350	1.73594	0.52774	0.90938
20	89	0.96614	0.32350	1.72563	0.53891	0.91013
20	90	0.96942	0.32350	1.71711	0.54919	0.91100
20	91	0.97277	0.32350	1.71077	0.55798	0.91189
20	92	0.97621	0.32350	1.71062	0.56288	0.91285
20	93	0.97973	0.32350	1.71928	0.56099	0.91361
20	94	0.98334	0.32350	1.73693	0.55198	0.91416
20	95	0.98704	0.32350	1.76348	0.53484	0.91440
20	96	0.99057	0.32350	1.76960	0.53039	0.91439
20	97	0.99348	0.32350	1.80462	0.49615	0.91293
20	98	0.99568	0.32350	1.83193	0.49964	0.91707
20	99	0.99736	0.32350	1.76468	0.49005	0.90633
20	100	0.99862	0.32350	1.88080	0.44974	0.91541
20	101	0.99959	0.32350	1.60396	0.52405	0.88868
20	102	1.00000	0.32350	1.60396	0.52405	0.88868
21	1	1.00000	0.33450	1.73796	-0.14287	0.78138
21	2	0.99970	0.33450	1.51531	-0.05874	0.71793
21	3	0.99900	0.33450	1.51398	-0.07757	0.71236
21	4	0.99807	0.33450	1.52769	-0.06458	0.72144
21	5	0.99686	0.33450	1.52032	-0.08169	0.71391
21	6	0.99525	0.33450	1.50648	-0.07103	0.71098
21	7	0.99313	0.33450	1.50037	-0.07940	0.70612
21	8	0.99056	0.33450	1.48686	-0.07776	0.70078
21	9	0.98786	0.33450	1.47485	-0.07929	0.69512
21	10	0.98524	0.33450	1.46280	-0.07981	0.68966
21	11	0.98267	0.33450	1.45174	-0.08015	0.68460

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-34
	DILLNER WING: MACH = 1.50, ALPHA = 15			

21	12	0.98017	0.33450	1.44096	-0.08074	0.67953
21	13	0.97772	0.33450	1.43091	-0.08065	0.67494
21	14	0.97534	0.33450	1.42141	-0.08120	0.67036
21	15	0.97300	0.33450	1.41257	-0.08125	0.66620
21	16	0.97072	0.33450	1.40452	-0.08166	0.66225
21	17	0.96849	0.33450	1.39665	-0.08221	0.65832
21	18	0.96631	0.33450	1.38944	-0.08257	0.65472
21	19	0.96417	0.33450	1.38278	-0.08345	0.65120
21	20	0.96207	0.33450	1.37672	-0.08418	0.64799
21	21	0.96001	0.33450	1.37119	-0.08529	0.64490
21	22	0.95799	0.33450	1.36612	-0.08640	0.64202
21	23	0.95600	0.33450	1.36156	-0.08757	0.63935
21	24	0.95404	0.33450	1.35737	-0.08888	0.63681
21	25	0.95212	0.33450	1.35365	-0.09007	0.63453
21	26	0.95022	0.33450	1.35041	-0.09135	0.63245
21	27	0.94834	0.33450	1.34752	-0.09275	0.63051
21	28	0.94649	0.33450	1.34512	-0.09401	0.62885
21	29	0.94465	0.33450	1.34320	-0.09539	0.62739
21	30	0.94283	0.33450	1.34172	-0.09663	0.62621
21	31	0.94103	0.33450	1.34070	-0.09778	0.62529
21	32	0.93923	0.33450	1.34014	-0.09876	0.62467
21	33	0.93745	0.33450	1.33993	-0.09951	0.62430
21	34	0.93567	0.33450	1.34013	-0.09990	0.62427
21	35	0.93389	0.33450	1.34091	-0.09991	0.62467
21	36	0.93212	0.33450	1.34256	-0.09965	0.62562
21	37	0.93034	0.33450	1.34536	-0.09923	0.62721
21	38	0.92863	0.33450	1.34923	-0.09829	0.62951
21	39	0.92709	0.33450	1.35386	-0.09619	0.63259
21	40	0.92576	0.33450	1.35885	-0.09394	0.63587
21	41	0.92461	0.33450	1.36464	-0.09137	0.63964
21	42	0.92363	0.33450	1.37141	-0.08826	0.64404
21	43	0.92278	0.33450	1.37918	-0.08519	0.64887
21	44	0.92204	0.33450	1.38828	-0.08192	0.65437
21	45	0.92141	0.33450	1.39917	-0.07870	0.66063
21	46	0.92086	0.33450	1.41181	-0.07552	0.66761
21	47	0.92039	0.33450	1.42708	-0.07136	0.67598
21	48	0.91998	0.33450	1.44940	-0.07147	0.68609
21	49	0.91963	0.33450	1.47479	-0.05630	0.70159
21	50	0.91933	0.33450	1.54653	-0.08619	0.72351
21	51	0.91907	0.33450	1.60053	-0.05259	0.75255
21	52	0.91895	0.33450	1.60053	-0.05259	0.75255
21	53	0.91933	0.33450	1.57018	0.74973	0.93847
21	54	0.91963	0.33450	1.53840	0.71597	0.92683
21	55	0.91998	0.33450	1.54689	0.70859	0.92586
21	56	0.92039	0.33450	1.54953	0.69518	0.92275
21	57	0.92086	0.33450	1.56268	0.68624	0.92200
21	58	0.92141	0.33450	1.57751	0.67371	0.92064
21	59	0.92204	0.33450	1.58866	0.66378	0.91956
21	60	0.92278	0.33450	1.59498	0.65438	0.91808
21	61	0.92363	0.33450	1.60143	0.64439	0.91651
21	62	0.92461	0.33450	1.61409	0.63021	0.91480
21	63	0.92576	0.33450	1.63430	0.61080	0.91298
21	64	0.92709	0.33450	1.65694	0.58824	0.91100
21	65	0.92863	0.33450	1.67908	0.56455	0.90896
21	66	0.93034	0.33450	1.70266	0.53791	0.90676
21	67	0.93212	0.33450	1.73201	0.50689	0.90482
21	68	0.93389	0.33450	1.76526	0.47376	0.90343
21	69	0.93567	0.33450	1.79459	0.44454	0.90252
21	70	0.93745	0.33450	1.81579	0.42288	0.90196
21	71	0.93923	0.33450	1.82924	0.40893	0.90163
21	72	0.94103	0.33450	1.83774	0.40024	0.90148
21	73	0.94283	0.33450	1.84357	0.39492	0.90149
21	74	0.94465	0.33450	1.84790	0.39167	0.90162

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-35
	DILLNER WING: MACH = 1.50, ALPHA = 15			

21	75	0.94649	0.33450	1.85095	0.39035	0.90187
21	76	0.94834	0.33450	1.85186	0.39151	0.90219
21	77	0.95022	0.33450	1.85009	0.39595	0.90264
21	78	0.95212	0.33450	1.84594	0.40285	0.90314
21	79	0.95404	0.33450	1.84030	0.41128	0.90368
21	80	0.95600	0.33450	1.83347	0.42093	0.90426
21	81	0.95799	0.33450	1.82559	0.43125	0.90482
21	82	0.96001	0.33450	1.81665	0.44244	0.90540
21	83	0.96207	0.33450	1.80606	0.45495	0.90602
21	84	0.96417	0.33450	1.79379	0.46858	0.90663
21	85	0.96631	0.33450	1.77986	0.48348	0.90730
21	86	0.96849	0.33450	1.76483	0.49875	0.90795
21	87	0.97072	0.33450	1.74961	0.51409	0.90868
21	88	0.97300	0.33450	1.73594	0.52774	0.90938
21	89	0.97534	0.33450	1.72563	0.53891	0.91013
21	90	0.97772	0.33450	1.71711	0.54919	0.91100
21	91	0.98017	0.33450	1.71077	0.55798	0.91189
21	92	0.98267	0.33450	1.71062	0.56288	0.91285
21	93	0.98523	0.33450	1.71928	0.56099	0.91361
21	94	0.98786	0.33450	1.73693	0.55198	0.91416
21	95	0.99056	0.33450	1.76348	0.53484	0.91440
21	96	0.99313	0.33450	1.76960	0.53039	0.91439
21	97	0.99525	0.33450	1.80462	0.49615	0.91293
21	98	0.99686	0.33450	1.83193	0.49964	0.91707
21	99	0.99807	0.33450	1.76468	0.49005	0.90633
21	100	0.99900	0.33450	1.88080	0.44974	0.91541
21	101	0.99970	0.33450	1.60396	0.52405	0.88868
21	102	1.00000	0.33450	1.60396	0.52405	0.88868
22	1	1.00000	0.34000	1.73796	-0.14287	0.78138
22	2	0.99975	0.34000	1.51531	-0.05874	0.71793
22	3	0.99918	0.34000	1.51398	-0.07757	0.71236
22	4	0.99843	0.34000	1.52769	-0.06458	0.72144
22	5	0.99744	0.34000	1.52032	-0.08169	0.71391
22	6	0.99614	0.34000	1.50648	-0.07103	0.71098
22	7	0.99441	0.34000	1.50037	-0.07940	0.70612
22	8	0.99232	0.34000	1.48686	-0.07776	0.70078
22	9	0.99013	0.34000	1.47485	-0.07929	0.69512
22	10	0.98799	0.34000	1.46280	-0.07981	0.68966
22	11	0.98590	0.34000	1.45174	-0.08015	0.68460
22	12	0.98386	0.34000	1.44096	-0.08074	0.67953
22	13	0.98188	0.34000	1.43091	-0.08065	0.67494
22	14	0.97993	0.34000	1.42141	-0.08120	0.67036
22	15	0.97804	0.34000	1.41257	-0.08125	0.66620
22	16	0.97618	0.34000	1.40452	-0.08166	0.66225
22	17	0.97436	0.34000	1.39665	-0.08221	0.65832
22	18	0.97259	0.34000	1.38944	-0.08257	0.65472
22	19	0.97085	0.34000	1.38278	-0.08345	0.65120
22	20	0.96914	0.34000	1.37672	-0.08418	0.64799
22	21	0.96746	0.34000	1.37119	-0.08529	0.64490
22	22	0.96582	0.34000	1.36612	-0.08640	0.64202
22	23	0.96420	0.34000	1.36156	-0.08757	0.63935
22	24	0.96261	0.34000	1.35737	-0.08888	0.63681
22	25	0.96104	0.34000	1.35365	-0.09007	0.63453
22	26	0.95950	0.34000	1.35041	-0.09135	0.63245
22	27	0.95797	0.34000	1.34752	-0.09275	0.63051
22	28	0.95646	0.34000	1.34512	-0.09401	0.62885
22	29	0.95497	0.34000	1.34320	-0.09539	0.62739
22	30	0.95349	0.34000	1.34172	-0.09663	0.62621
22	31	0.95202	0.34000	1.34070	-0.09778	0.62529
22	32	0.95056	0.34000	1.34014	-0.09876	0.62467
22	33	0.94911	0.34000	1.33993	-0.09951	0.62430
22	34	0.94766	0.34000	1.34013	-0.09990	0.62427
22	35	0.94622	0.34000	1.34091	-0.09991	0.62467

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-36
	DILLNER WING: MACH = 1.50, ALPHA = 15			

'2	36	0.94477	0.34000	1.34256	-0.09965	0.62562
'2	37	0.94333	0.34000	1.34536	-0.09923	0.62721
'2	38	0.94193	0.34000	1.34923	-0.09829	0.62951
'2	39	0.94068	0.34000	1.35386	-0.09619	0.63259
'2	40	0.93960	0.34000	1.35885	-0.09394	0.63587
'2	41	0.93867	0.34000	1.36464	-0.09137	0.63964
'2	42	0.93786	0.34000	1.37141	-0.08826	0.64404
'2	43	0.93717	0.34000	1.37918	-0.08519	0.64887
'2	44	0.93657	0.34000	1.38828	-0.08192	0.65437
'2	45	0.93606	0.34000	1.39917	-0.07870	0.66063
'2	46	0.93561	0.34000	1.41181	-0.07552	0.66761
'2	47	0.93523	0.34000	1.42708	-0.07136	0.67598
'2	48	0.93490	0.34000	1.44940	-0.07147	0.68609
'2	49	0.93462	0.34000	1.47479	-0.05630	0.70159
'2	50	0.93437	0.34000	1.54653	-0.08619	0.72351
'2	51	0.93416	0.34000	1.60053	-0.05259	0.75255
'2	52	0.93406	0.34000	1.60053	-0.05259	0.75255
'2	53	0.93437	0.34000	1.57018	0.74973	0.93847
'2	54	0.93462	0.34000	1.53840	0.71597	0.92683
'2	55	0.93490	0.34000	1.54689	0.70859	0.92586
'2	56	0.93523	0.34000	1.54953	0.69518	0.92275
'2	57	0.93561	0.34000	1.56268	0.68624	0.92200
'2	58	0.93606	0.34000	1.57751	0.67371	0.92064
'2	59	0.93657	0.34000	1.58866	0.66378	0.91956
'2	60	0.93717	0.34000	1.59498	0.65438	0.91808
'2	61	0.93786	0.34000	1.60143	0.64439	0.91651
'2	62	0.93867	0.34000	1.61409	0.63021	0.91480
'2	63	0.93960	0.34000	1.63430	0.61080	0.91298
'2	64	0.94068	0.34000	1.65694	0.58824	0.91100
'2	65	0.94193	0.34000	1.67908	0.56455	0.90896
'2	66	0.94333	0.34000	1.70266	0.53791	0.90676
'2	67	0.94477	0.34000	1.73201	0.50689	0.90482
'2	68	0.94622	0.34000	1.76526	0.47376	0.90343
'2	69	0.94766	0.34000	1.79459	0.44454	0.90252
'2	70	0.94911	0.34000	1.81579	0.42288	0.90196
'2	71	0.95056	0.34000	1.82924	0.40893	0.90163
'2	72	0.95202	0.34000	1.83774	0.40024	0.90148
'2	73	0.95349	0.34000	1.84357	0.39492	0.90149
'2	74	0.95497	0.34000	1.84790	0.39167	0.90162
'2	75	0.95646	0.34000	1.85095	0.39035	0.90187
'2	76	0.95797	0.34000	1.85186	0.39151	0.90219
'2	77	0.95950	0.34000	1.85009	0.39595	0.90264
'2	78	0.96104	0.34000	1.84594	0.40285	0.90314
'2	79	0.96261	0.34000	1.84030	0.41128	0.90368
'2	80	0.96420	0.34000	1.83347	0.42093	0.90426
'2	81	0.96582	0.34000	1.82559	0.43125	0.90482
'2	82	0.96746	0.34000	1.81665	0.44244	0.90540
'2	83	0.96914	0.34000	1.80606	0.45495	0.90602
'2	84	0.97085	0.34000	1.79379	0.46858	0.90663
'2	85	0.97259	0.34000	1.77986	0.48348	0.90730
'2	86	0.97436	0.34000	1.76483	0.49875	0.90795
'2	87	0.97618	0.34000	1.74961	0.51409	0.90868
'2	88	0.97804	0.34000	1.73594	0.52774	0.90938
'2	89	0.97993	0.34000	1.72563	0.53891	0.91013
'2	90	0.98188	0.34000	1.71711	0.54919	0.91100
'2	91	0.98386	0.34000	1.71077	0.55798	0.91189
'2	92	0.98590	0.34000	1.71062	0.56288	0.91285
'2	93	0.98799	0.34000	1.71928	0.56099	0.91361
'2	94	0.99013	0.34000	1.73693	0.55198	0.91416
'2	95	0.99232	0.34000	1.76348	0.53484	0.91440
'2	96	0.99441	0.34000	1.76960	0.53039	0.91439
'2	97	0.99614	0.34000	1.80462	0.49615	0.91293
'2	98	0.99744	0.34000	1.83193	0.49964	0.91707

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-37
	DILLNER WING: MACH = 1.50, ALPHA = 15			

22	99	0.99843	0.34000	1.76468	0.49005	0.90633
22	100	0.99918	0.34000	1.88080	0.44974	0.91541
22	101	0.99975	0.34000	1.60396	0.52405	0.88868
22	102	1.00000	0.34000	1.60396	0.52405	0.88868
23	1	1.00000	0.36399	1.65777	0.06034	0.79716
23	2	1.00000	0.36399	1.65085	0.05564	0.79402
23	3	1.00000	0.36399	1.65422	0.05352	0.79459
23	4	1.00000	0.36399	1.65623	0.05270	0.79503
23	5	1.00000	0.36399	1.65685	0.05079	0.79481
23	6	1.00000	0.36399	1.65609	0.05114	0.79465
23	7	1.00000	0.36399	1.65379	0.05279	0.79430
23	8	1.00000	0.36399	1.65073	0.05465	0.79376
23	9	1.00000	0.36399	1.64699	0.05634	0.79298
23	10	1.00000	0.36399	1.64303	0.05792	0.79210
23	11	1.00000	0.36399	1.63879	0.05973	0.79118
23	12	1.00000	0.36399	1.63442	0.06166	0.79025
23	13	1.00000	0.36399	1.62997	0.06362	0.78929
23	14	1.00000	0.36399	1.62545	0.06561	0.78832
23	15	1.00000	0.36399	1.62077	0.06773	0.78732
23	16	1.00000	0.36399	1.61588	0.06999	0.78629
23	17	1.00000	0.36399	1.61094	0.07224	0.78524
23	18	1.00000	0.36399	1.60600	0.07434	0.78415
23	19	1.00000	0.36399	1.60123	0.07611	0.78303
23	20	1.00000	0.36399	1.59674	0.07742	0.78189
23	21	1.00000	0.36399	1.59255	0.07829	0.78074
23	22	1.00000	0.36399	1.58865	0.07882	0.77960
23	23	1.00000	0.36399	1.58507	0.07914	0.77851
23	24	1.00000	0.36399	1.58171	0.07911	0.77740
23	25	1.00000	0.36399	1.57834	0.07876	0.77621
23	26	1.00000	0.36399	1.57493	0.07804	0.77490
23	27	1.00000	0.36399	1.57161	0.07676	0.77348
23	28	1.00000	0.36399	1.56846	0.07480	0.77195
23	29	1.00000	0.36399	1.56524	0.07259	0.77032
23	30	1.00000	0.36399	1.56225	0.07014	0.76870
23	31	1.00000	0.36399	1.55963	0.06773	0.76720
23	32	1.00000	0.36399	1.55736	0.06558	0.76589
23	33	1.00000	0.36399	1.55493	0.06375	0.76459
23	34	1.00000	0.36399	1.55233	0.06239	0.76335
23	35	1.00000	0.36399	1.54986	0.06146	0.76225
23	36	1.00000	0.36399	1.54791	0.06038	0.76130
23	37	1.00000	0.36399	1.54600	0.05928	0.76035
23	38	1.00000	0.36399	1.54365	0.05864	0.75936
23	39	1.00000	0.36399	1.54123	0.05802	0.75835
23	40	1.00000	0.36399	1.53911	0.05684	0.75730
23	41	1.00000	0.36399	1.53756	0.05477	0.75621
23	42	1.00000	0.36399	1.53642	0.05178	0.75503
23	43	1.00000	0.36399	1.53494	0.04849	0.75365
23	44	1.00000	0.36399	1.53264	0.04549	0.75204
23	45	1.00000	0.36399	1.52972	0.04270	0.75025
23	46	1.00000	0.36399	1.52659	0.03966	0.74831
23	47	1.00000	0.36399	1.52336	0.03604	0.74617
23	48	1.00000	0.36399	1.51970	0.03071	0.74341
23	49	1.00000	0.36399	1.51380	0.02518	0.73972
23	50	1.00000	0.36399	1.50124	0.02646	0.73528
23	51	1.00000	0.36399	1.50124	0.02646	0.73528
23	52	1.00000	0.36399	1.50455	0.02178	0.73528
23	53	1.00000	0.36399	1.50860	0.03250	0.73972
23	54	1.00000	0.36399	1.51225	0.04116	0.74341
23	55	1.00000	0.36399	1.51315	0.05025	0.74617
23	56	1.00000	0.36399	1.51384	0.05732	0.74831
23	57	1.00000	0.36399	1.51522	0.06270	0.75025
23	58	1.00000	0.36399	1.51748	0.06634	0.75204
23	59	1.00000	0.36399	1.52016	0.06877	0.75365

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	14-9-38
	DILLNER WING: MACH = 1.50, ALPHA = 15			

3	60	1.00000	0.36399	1.52277	0.07047	0.75503
3	61	1.00000	0.36399	1.52484	0.07215	0.75621
3	62	1.00000	0.36399	1.52649	0.07406	0.75730
3	63	1.00000	0.36399	1.52777	0.07635	0.75835
3	64	1.00000	0.36399	1.52879	0.07886	0.75936
3	65	1.00000	0.36399	1.52969	0.08145	0.76035
3	66	1.00000	0.36399	1.53036	0.08419	0.76130
3	67	1.00000	0.36399	1.53091	0.08712	0.76225
3	68	1.00000	0.36399	1.53205	0.08981	0.76335
3	69	1.00000	0.36399	1.53411	0.09185	0.76459
3	70	1.00000	0.36399	1.53681	0.09329	0.76589
3	71	1.00000	0.36399	1.53998	0.09421	0.76720
3	72	1.00000	0.36399	1.54381	0.09495	0.76870
3	73	1.00000	0.36399	1.54796	0.09582	0.77032
3	74	1.00000	0.36399	1.55195	0.09697	0.77195
3	75	1.00000	0.36399	1.55559	0.09825	0.77348
3	76	1.00000	0.36399	1.55861	0.09990	0.77490
3	77	1.00000	0.36399	1.56122	0.10168	0.77621
3	78	1.00000	0.36399	1.56360	0.10334	0.77740
3	79	1.00000	0.36399	1.56596	0.10471	0.77851
3	80	1.00000	0.36399	1.56845	0.10586	0.77960
3	81	1.00000	0.36399	1.57135	0.10668	0.78074
3	82	1.00000	0.36399	1.57447	0.10728	0.78189
3	83	1.00000	0.36399	1.57769	0.10772	0.78303
3	84	1.00000	0.36399	1.58100	0.10795	0.78415
3	85	1.00000	0.36399	1.58449	0.10787	0.78524
3	86	1.00000	0.36399	1.58825	0.10732	0.78629
3	87	1.00000	0.36399	1.59230	0.10628	0.78732
3	88	1.00000	0.36399	1.59659	0.10480	0.78832
3	89	1.00000	0.36399	1.60109	0.10294	0.78929
3	90	1.00000	0.36399	1.60575	0.10082	0.79025
3	91	1.00000	0.36399	1.61052	0.09848	0.79118
3	92	1.00000	0.36399	1.61547	0.09582	0.79210
3	93	1.00000	0.36399	1.62050	0.09288	0.79298
3	94	1.00000	0.36399	1.62530	0.08985	0.79376
3	95	1.00000	0.36399	1.63029	0.08546	0.79430
3	96	1.00000	0.36399	1.63348	0.08267	0.79465
3	97	1.00000	0.36399	1.63620	0.07964	0.79481
3	98	1.00000	0.36399	1.63780	0.07844	0.79503
3	99	1.00000	0.36399	1.63464	0.08080	0.79459
3	100	1.00000	0.36399	1.63455	0.07834	0.79402
3	101	1.00000	0.36399	1.63038	0.08426	0.79406
3	102	1.00000	0.36399	1.63038	0.08426	0.79406

WING CONTOUR **

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 15

DILLNER WING: MACH = 0.70, ALPHA = 15

Contributor No 9

W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-1
	DILLNER WING: MACH = 0.70, ALPHA = 15			

TABULATED DATA INCONSISTENT WITH PLOTTED DATA

K	IP	XC	YC	MACH	1-PI/PINF	1-P/PINF
1	1	1.00000	0.0	0.58860	-0.00657	0.20382
1	2	0.99627	0.0	0.58077	0.00367	0.20718
1	3	0.98764	0.0	0.61632	-0.00868	0.21936
1	4	0.97625	0.0	0.63376	0.00025	0.23714
1	5	0.96122	0.0	0.65224	-0.00189	0.24716
1	6	0.94139	0.0	0.66492	-0.00068	0.25612
1	7	0.91523	0.0	0.67466	-0.00066	0.26234
1	8	0.88351	0.0	0.68020	-0.00079	0.26578
1	9	0.85027	0.0	0.68205	-0.00064	0.26709
1	10	0.81783	0.0	0.68143	-0.00058	0.26673
1	11	0.78619	0.0	0.67931	-0.00038	0.26552
1	12	0.75530	0.0	0.67609	-0.00052	0.26336
1	13	0.72515	0.0	0.67235	-0.00026	0.26117
1	14	0.69569	0.0	0.66829	-0.00043	0.25845
1	15	0.66691	0.0	0.66409	-0.00026	0.25591
1	16	0.63877	0.0	0.65994	-0.00024	0.25328
1	17	0.61124	0.0	0.65557	-0.00034	0.25043
1	18	0.58428	0.0	0.65124	-0.00016	0.24783
1	19	0.55788	0.0	0.64692	-0.00027	0.24502
1	20	0.53199	0.0	0.64258	-0.00011	0.24241
1	21	0.50658	0.0	0.63819	-0.00015	0.23962
1	22	0.48164	0.0	0.63364	-0.00005	0.23683
1	23	0.45712	0.0	0.62900	0.00007	0.23402
1	24	0.43299	0.0	0.62414	0.00007	0.23099
1	25	0.40921	0.0	0.61920	0.00032	0.22811
1	26	0.38577	0.0	0.61426	0.00051	0.22519
1	27	0.36263	0.0	0.60909	0.00064	0.22210
1	28	0.33974	0.0	0.60394	0.00109	0.21927
1	29	0.31710	0.0	0.59883	0.00133	0.21632
1	30	0.29465	0.0	0.59379	0.00183	0.21363
1	31	0.27239	0.0	0.58895	0.00229	0.21104
1	32	0.25025	0.0	0.58432	0.00286	0.20868
1	33	0.22823	0.0	0.57998	0.00351	0.20658
1	34	0.20628	0.0	0.57594	0.00419	0.20468
1	35	0.18437	0.0	0.57224	0.00501	0.20312
1	36	0.16247	0.0	0.56895	0.00594	0.20189
1	37	0.14056	0.0	0.56599	0.00673	0.20076
1	38	0.11939	0.0	0.56354	0.00781	0.20018
1	39	0.10039	0.0	0.56179	0.00882	0.19996
1	40	0.08401	0.0	0.56081	0.00975	0.20012
1	41	0.06988	0.0	0.56062	0.01058	0.20069
1	42	0.05770	0.0	0.56127	0.01112	0.20151
1	43	0.04719	0.0	0.56288	0.01134	0.20264
1	44	0.03813	0.0	0.56575	0.01081	0.20390
1	45	0.03032	0.0	0.57001	0.00923	0.20517
1	46	0.02358	0.0	0.57545	0.00667	0.20637
1	47	0.01777	0.0	0.58002	0.00424	0.20718
1	48	0.01276	0.0	0.58087	0.00502	0.20831
1	49	0.00843	0.0	0.57665	0.01074	0.21034
1	50	0.00470	0.0	0.59194	0.00235	0.21292
1	51	0.00149	0.0	0.67921	-0.06190	0.22029
1	52	0.0	0.0	0.67921	-0.06190	0.22029
1	53	0.00470	0.0	0.84530	0.03620	0.39612
1	54	0.00843	0.0	0.80105	0.10074	0.41068
1	55	0.01276	0.0	0.79040	0.12826	0.42267
1	56	0.01777	0.0	0.79208	0.13385	0.42732
1	57	0.02358	0.0	0.79169	0.13509	0.42791
1	58	0.03032	0.0	0.79038	0.12993	0.42376

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-2
	DILLNER WING: MACH = 0.70, ALPHA = 15			

1	59	0.03813	0.0	0.78893	0.11951	0.41603
1	60	0.04719	0.0	0.78752	0.10463	0.40534
1	61	0.05770	0.0	0.78662	0.08706	0.39313
1	62	0.06988	0.0	0.78665	0.06906	0.38119
1	63	0.08401	0.0	0.78670	0.05433	0.37143
1	64	0.10039	0.0	0.78363	0.04607	0.36403
1	65	0.11940	0.0	0.77714	0.04279	0.35779
1	66	0.14057	0.0	0.77051	0.04177	0.35297
1	67	0.16248	0.0	0.76636	0.04166	0.35031
1	68	0.18437	0.0	0.76509	0.04082	0.34895
1	69	0.20628	0.0	0.76628	0.03992	0.34908
1	70	0.22823	0.0	0.76898	0.03867	0.34992
1	71	0.25025	0.0	0.77253	0.03740	0.35129
1	72	0.27239	0.0	0.77642	0.03615	0.35289
1	73	0.29465	0.0	0.78026	0.03502	0.35454
1	74	0.31710	0.0	0.78383	0.03389	0.35603
1	75	0.33974	0.0	0.78693	0.03307	0.35744
1	76	0.36263	0.0	0.78952	0.03206	0.35840
1	77	0.38577	0.0	0.79168	0.03142	0.35934
1	78	0.40921	0.0	0.79322	0.03072	0.35985
1	79	0.43299	0.0	0.79453	0.02993	0.36015
1	80	0.45711	0.0	0.79567	0.02937	0.36051
1	81	0.48163	0.0	0.79653	0.02867	0.36059
1	82	0.50658	0.0	0.79729	0.02796	0.36060
1	83	0.53199	0.0	0.79786	0.02736	0.36057
1	84	0.55788	0.0	0.79828	0.02651	0.36027
1	85	0.58428	0.0	0.79851	0.02595	0.36005
1	86	0.61123	0.0	0.79838	0.02503	0.35937
1	87	0.63877	0.0	0.79776	0.02443	0.35858
1	88	0.66691	0.0	0.79605	0.02370	0.35701
1	89	0.69569	0.0	0.79336	0.02279	0.35470
1	90	0.72515	0.0	0.78923	0.02228	0.35174
1	91	0.75530	0.0	0.78326	0.02130	0.34728
1	92	0.78618	0.0	0.77511	0.02077	0.34172
1	93	0.81783	0.0	0.76407	0.01987	0.33407
1	94	0.85027	0.0	0.74989	0.01910	0.32451
1	95	0.88351	0.0	0.73176	0.01844	0.31250
1	96	0.91522	0.0	0.70954	0.01797	0.29806
1	97	0.94139	0.0	0.68510	0.01712	0.28201
1	98	0.96122	0.0	0.66133	0.01587	0.26618
1	99	0.97625	0.0	0.63635	0.01652	0.25115
1	100	0.98764	0.0	0.61084	0.01171	0.23178
1	101	0.99627	0.0	0.57508	0.01749	0.21480
1	102	1.00000	0.0	0.57508	0.01749	0.21480
2	1	1.00000	0.01350	0.60107	-0.01690	0.20341
2	2	0.99641	0.01350	0.59533	-0.00530	0.20896
2	3	0.98810	0.01350	0.62727	-0.01611	0.22053
2	4	0.97713	0.01350	0.64373	-0.00830	0.23694
2	5	0.96266	0.01350	0.66129	-0.01048	0.24650
2	6	0.94356	0.01350	0.67395	-0.00955	0.25533
2	7	0.91837	0.01350	0.68431	-0.00984	0.26181
2	8	0.88784	0.01350	0.69082	-0.01042	0.26559
2	9	0.85582	0.01350	0.69372	-0.01067	0.26730
2	10	0.82459	0.01350	0.69416	-0.01096	0.26738
2	11	0.79412	0.01350	0.69313	-0.01110	0.26660
2	12	0.76438	0.01350	0.69095	-0.01160	0.26483
2	13	0.73534	0.01350	0.68817	-0.01166	0.26298
2	14	0.70698	0.01350	0.68501	-0.01217	0.26056
2	15	0.67927	0.01350	0.68166	-0.01232	0.25827
2	16	0.65217	0.01350	0.67834	-0.01259	0.25593
2	17	0.62566	0.01350	0.67477	-0.01300	0.25332

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-3
	DILLNER WING: MACH = 0.70, ALPHA = 15			

2	18	0.59970	0.01350	0.67120	-0.01305	0.25097
2	19	0.57428	0.01350	0.66763	-0.01338	0.24842
2	20	0.54935	0.01350	0.66400	-0.01337	0.24610
2	21	0.52489	0.01350	0.66027	-0.01346	0.24363
2	22	0.50087	0.01350	0.65628	-0.01333	0.24116
2	23	0.47726	0.01350	0.65204	-0.01299	0.23869
2	24	0.45402	0.01350	0.64729	-0.01260	0.23595
2	25	0.43112	0.01350	0.64208	-0.01175	0.23327
2	26	0.40855	0.01350	0.63656	-0.01078	0.23050
2	27	0.38627	0.01350	0.63070	-0.00994	0.22743
2	28	0.36423	0.01350	0.62472	-0.00886	0.22449
2	29	0.34243	0.01350	0.61863	-0.00808	0.22127
2	30	0.32082	0.01350	0.61250	-0.00718	0.21813
2	31	0.29937	0.01350	0.60645	-0.00643	0.21495
2	32	0.27806	0.01350	0.60054	-0.00575	0.21182
2	33	0.25685	0.01350	0.59485	-0.00513	0.20880
2	34	0.23572	0.01350	0.58942	-0.00461	0.20588
2	35	0.21462	0.01350	0.58431	-0.00405	0.20319
2	36	0.19354	0.01350	0.57955	-0.00347	0.20076
2	37	0.17244	0.01350	0.57516	-0.00308	0.19841
2	38	0.15206	0.01350	0.57136	-0.00244	0.19662
2	39	0.13376	0.01350	0.56839	-0.00190	0.19527
2	40	0.11799	0.01350	0.56634	-0.00141	0.19442
2	41	0.10438	0.01350	0.56521	-0.00094	0.19412
2	42	0.09265	0.01350	0.56503	-0.00054	0.19434
2	43	0.08253	0.01350	0.56585	-0.00031	0.19502
2	44	0.07381	0.01350	0.56784	0.00020	0.19662
2	45	0.06629	0.01350	0.57144	-0.00051	0.19822
2	46	0.05980	0.01350	0.57756	-0.00031	0.20207
2	47	0.05420	0.01350	0.58682	-0.00526	0.20377
2	48	0.04938	0.01350	0.59262	-0.00095	0.21072
2	49	0.04521	0.01350	0.58696	0.00751	0.21397
2	50	0.04162	0.01350	0.61409	-0.00409	0.22151
2	51	0.03852	0.01350	0.75000	-0.10966	0.23592
2	52	0.03709	0.01350	0.75000	-0.10966	0.23592
2	53	0.04162	0.01350	0.90451	0.07937	0.45832
2	54	0.04521	0.01350	0.91683	0.09539	0.47487
2	55	0.04938	0.01350	0.92347	0.08694	0.47383
2	56	0.05420	0.01350	0.92192	0.08779	0.47342
2	57	0.05980	0.01350	0.92301	0.08898	0.47474
2	58	0.06629	0.01350	0.92432	0.08753	0.47467
2	59	0.07381	0.01350	0.92237	0.08501	0.47208
2	60	0.08253	0.01350	0.91703	0.08213	0.46730
2	61	0.09265	0.01350	0.90746	0.08001	0.46044
2	62	0.10438	0.01350	0.89190	0.07909	0.45071
2	63	0.11798	0.01350	0.86889	0.08072	0.43806
2	64	0.13376	0.01350	0.83749	0.07927	0.41844
2	65	0.15206	0.01350	0.81049	0.07088	0.39682
2	66	0.17245	0.01350	0.79374	0.06228	0.38101
2	67	0.19354	0.01350	0.78567	0.05640	0.37217
2	68	0.21463	0.01350	0.78341	0.05173	0.36767
2	69	0.23572	0.01350	0.78431	0.04822	0.36588
2	70	0.25685	0.01350	0.78672	0.04524	0.36539
2	71	0.27806	0.01350	0.78975	0.04261	0.36554
2	72	0.29937	0.01350	0.79283	0.04022	0.36588
2	73	0.32082	0.01350	0.79556	0.03806	0.36616
2	74	0.34243	0.01350	0.79779	0.03605	0.36623
2	75	0.36423	0.01350	0.79951	0.03435	0.36620
2	76	0.38627	0.01350	0.80087	0.03254	0.36587
2	77	0.40855	0.01350	0.80172	0.03132	0.36561
2	78	0.43112	0.01350	0.80191	0.03028	0.36505

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-4
	DILLNER WING: MACH = 0.70, ALPHA = 15			

2	79	0.45402	0.01350	0.80185	0.02949	0.36449
2	80	0.47725	0.01350	0.80160	0.02917	0.36412
2	81	0.50086	0.01350	0.80110	0.02886	0.36361
2	82	0.52489	0.01350	0.80056	0.02869	0.36315
2	83	0.54935	0.01350	0.79986	0.02869	0.36271
2	84	0.57428	0.01350	0.79905	0.02847	0.36205
2	85	0.59970	0.01350	0.79803	0.02854	0.36146
2	86	0.62566	0.01350	0.79666	0.02820	0.36036
2	87	0.65217	0.01350	0.79470	0.02817	0.35910
2	88	0.67927	0.01350	0.79164	0.02792	0.35700
2	89	0.70698	0.01350	0.78762	0.02748	0.35416
2	90	0.73534	0.01350	0.78219	0.02738	0.35066
2	91	0.76438	0.01350	0.77499	0.02678	0.34569
2	92	0.79411	0.01350	0.76572	0.02663	0.33971
2	93	0.82458	0.01350	0.75378	0.02605	0.33176
2	94	0.85582	0.01350	0.73905	0.02551	0.32206
2	95	0.88783	0.01350	0.72055	0.02516	0.31013
2	96	0.91837	0.01350	0.69791	0.02494	0.29574
2	97	0.94356	0.01350	0.67322	0.02414	0.27973
2	98	0.96266	0.01350	0.64943	0.02277	0.26396
2	99	0.97713	0.01350	0.62360	0.02407	0.24912
2	100	0.98810	0.01350	0.59876	0.01727	0.22879
2	101	0.99641	0.01350	0.56046	0.02608	0.21311
2	102	1.00000	0.01350	0.56046	0.02608	0.21311
3	1	1.00000	0.03850	0.60708	-0.02262	0.20272
3	2	0.99667	0.03850	0.60149	-0.01029	0.20885
3	3	0.98895	0.03850	0.63398	-0.02145	0.22073
3	4	0.97876	0.03850	0.65051	-0.01367	0.23720
3	5	0.96532	0.03850	0.66788	-0.01598	0.24666
3	6	0.94759	0.03850	0.68041	-0.01521	0.25534
3	7	0.92420	0.03850	0.69070	-0.01566	0.26172
3	8	0.89584	0.03850	0.69723	-0.01642	0.26542
3	9	0.86610	0.03850	0.70020	-0.01677	0.26711
3	10	0.83710	0.03850	0.70074	-0.01711	0.26722
3	11	0.80880	0.03850	0.69982	-0.01724	0.26653
3	12	0.78119	0.03850	0.69773	-0.01767	0.26484
3	13	0.75422	0.03850	0.69498	-0.01761	0.26309
3	14	0.72788	0.03850	0.69177	-0.01793	0.26076
3	15	0.70215	0.03850	0.68825	-0.01780	0.25855
3	16	0.67698	0.03850	0.68465	-0.01768	0.25629
3	17	0.65236	0.03850	0.68069	-0.01758	0.25379
3	18	0.62825	0.03850	0.67659	-0.01695	0.25159
3	19	0.60464	0.03850	0.67237	-0.01642	0.24924
3	20	0.58149	0.03850	0.66802	-0.01534	0.24723
3	21	0.55877	0.03850	0.66354	-0.01415	0.24521
3	22	0.53647	0.03850	0.65880	-0.01255	0.24336
3	23	0.51454	0.03850	0.65389	-0.01057	0.24170
3	24	0.49296	0.03850	0.64871	-0.00845	0.23999
3	25	0.47170	0.03850	0.64341	-0.00592	0.23853
3	26	0.45074	0.03850	0.63818	-0.00339	0.23714
3	27	0.43004	0.03850	0.63291	-0.00110	0.23557
3	28	0.40958	0.03850	0.62771	0.00130	0.23416
3	29	0.38933	0.03850	0.62259	0.00326	0.23248
3	30	0.36926	0.03850	0.61753	0.00516	0.23081
3	31	0.34934	0.03850	0.61260	0.00671	0.22897
3	32	0.32956	0.03850	0.60778	0.00801	0.22703
3	33	0.30986	0.03850	0.60312	0.00909	0.22502
3	34	0.29023	0.03850	0.59855	0.00981	0.22280
3	35	0.27064	0.03850	0.59418	0.01056	0.22074
3	36	0.25106	0.03850	0.59004	0.01102	0.21860
3	37	0.23147	0.03850	0.58614	0.01122	0.21641

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-5
	DILLNER WING: MACH = 0.70, ALPHA = 15			

3	38	0.21254	0.03850	0.58268	0.01155	0.21459
3	39	0.19555	0.03850	0.57996	0.01187	0.21322
3	40	0.18090	0.03850	0.57812	0.01209	0.21229
3	41	0.16826	0.03850	0.57719	0.01221	0.21184
3	42	0.15737	0.03850	0.57718	0.01229	0.21189
3	43	0.14797	0.03850	0.57807	0.01213	0.21230
3	44	0.13987	0.03850	0.57988	0.01247	0.21365
3	45	0.13288	0.03850	0.58309	0.01153	0.21482
3	46	0.12686	0.03850	0.58866	0.01194	0.21850
3	47	0.12166	0.03850	0.59906	0.00580	0.21997
3	48	0.11718	0.03850	0.60815	0.00771	0.22702
3	49	0.11331	0.03850	0.60515	0.01560	0.23134
3	50	0.10998	0.03850	0.63008	0.00129	0.23564
3	51	0.10710	0.03850	0.74525	-0.07607	0.25573
3	52	0.10577	0.03850	0.74525	-0.07607	0.25573
3	53	0.10998	0.03850	0.89603	0.06238	0.44323
3	54	0.11331	0.03850	0.93077	0.05020	0.45707
3	55	0.11718	0.03850	0.95200	0.04700	0.46803
3	56	0.12166	0.03850	0.96327	0.05936	0.48159
3	57	0.12686	0.03850	0.97663	0.06891	0.49464
3	58	0.13288	0.03850	0.98704	0.07670	0.50484
3	59	0.13987	0.03850	0.99255	0.08354	0.51163
3	60	0.14797	0.03850	0.99438	0.08955	0.51587
3	61	0.15737	0.03850	0.99150	0.09482	0.51706
3	62	0.16826	0.03850	0.98089	0.09989	0.51384
3	63	0.18090	0.03850	0.96085	0.10488	0.50532
3	64	0.19555	0.03850	0.93203	0.10744	0.49050
3	65	0.21254	0.03850	0.90019	0.10399	0.47034
3	66	0.23147	0.03850	0.87265	0.09738	0.45043
3	67	0.25106	0.03850	0.85254	0.09000	0.43410
3	68	0.27064	0.03850	0.83906	0.08280	0.42160
3	69	0.29023	0.03850	0.82996	0.07569	0.41165
3	70	0.30986	0.03850	0.82393	0.06891	0.40369
3	71	0.32956	0.03850	0.81961	0.06280	0.39714
3	72	0.34935	0.03850	0.81622	0.05723	0.39148
3	73	0.36926	0.03850	0.81343	0.05214	0.38647
3	74	0.38933	0.03850	0.81109	0.04744	0.38198
3	75	0.40958	0.03850	0.80917	0.04327	0.37808
3	76	0.43004	0.03850	0.80769	0.03923	0.37452
3	77	0.45074	0.03850	0.80662	0.03580	0.37162
3	78	0.47170	0.03850	0.80579	0.03277	0.36912
3	79	0.49296	0.03850	0.80523	0.03028	0.36715
3	80	0.51454	0.03850	0.80479	0.02857	0.36575
3	81	0.53647	0.03850	0.80428	0.02726	0.36458
3	82	0.55877	0.03850	0.80370	0.02647	0.36369
3	83	0.58149	0.03850	0.80284	0.02617	0.36294
3	84	0.60464	0.03850	0.80166	0.02595	0.36206
3	85	0.62825	0.03850	0.80007	0.02620	0.36121
3	86	0.65236	0.03850	0.79792	0.02620	0.35985
3	87	0.67698	0.03850	0.79505	0.02656	0.35826
3	88	0.70214	0.03850	0.79108	0.02672	0.35585
3	89	0.72788	0.03850	0.78614	0.02672	0.35272
3	90	0.75422	0.03850	0.77986	0.02704	0.34895
3	91	0.78119	0.03850	0.77191	0.02689	0.34381
3	92	0.80880	0.03850	0.76200	0.02719	0.33774
3	93	0.83709	0.03850	0.74958	0.02710	0.32982
3	94	0.86610	0.03850	0.73449	0.02706	0.32026
3	95	0.89583	0.03850	0.71566	0.02727	0.30855
3	96	0.92419	0.03850	0.69271	0.02754	0.29437
3	97	0.94759	0.03850	0.66778	0.02708	0.27852
3	98	0.96532	0.03850	0.64377	0.02594	0.26287
3	99	0.97876	0.03850	0.61775	0.02752	0.24823

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-6
	DILLNER WING: MACH = 0.70, ALPHA = 15			

3	100	0.98895	0.03850	0.59314	0.02075	0.22814
3	101	0.99667	0.03850	0.55492	0.03029	0.21332
3	102	1.00000	0.03850	0.55492	0.03029	0.21332
4	1	1.00000	0.06000	0.60809	-0.02466	0.20177
4	2	0.99689	0.06000	0.60253	-0.01225	0.20796
4	3	0.98968	0.06000	0.63609	-0.02402	0.22012
4	4	0.98016	0.06000	0.65270	-0.01577	0.23703
4	5	0.96761	0.06000	0.67001	-0.01794	0.24659
4	6	0.95105	0.06000	0.68229	-0.01688	0.25535
4	7	0.92920	0.06000	0.69220	-0.01690	0.26179
4	8	0.90272	0.06000	0.69834	-0.01716	0.26561
4	9	0.87495	0.06000	0.70095	-0.01699	0.26745
4	10	0.84786	0.06000	0.70119	-0.01681	0.26773
4	11	0.82143	0.06000	0.69999	-0.01645	0.26720
4	12	0.79564	0.06000	0.69761	-0.01639	0.26569
4	13	0.77045	0.06000	0.69454	-0.01583	0.26409
4	14	0.74585	0.06000	0.69098	-0.01564	0.26191
4	15	0.72182	0.06000	0.68706	-0.01503	0.25980
4	16	0.69832	0.06000	0.68301	-0.01444	0.25760
4	17	0.67532	0.06000	0.67856	-0.01392	0.25509
4	18	0.65281	0.06000	0.67393	-0.01294	0.25281
4	19	0.63076	0.06000	0.66913	-0.01215	0.25031
4	20	0.60913	0.06000	0.66419	-0.01091	0.24804
4	21	0.58792	0.06000	0.65912	-0.00969	0.24570
4	22	0.56708	0.06000	0.65389	-0.00821	0.24347
4	23	0.54661	0.06000	0.64864	-0.00652	0.24139
4	24	0.52645	0.06000	0.64334	-0.00489	0.23927
4	25	0.50659	0.06000	0.63816	-0.00300	0.23743
4	26	0.48702	0.06000	0.63326	-0.00116	0.23575
4	27	0.46769	0.06000	0.62846	0.00047	0.23399
4	28	0.44858	0.06000	0.62386	0.00231	0.23254
4	29	0.42967	0.06000	0.61947	0.00381	0.23097
4	30	0.41092	0.06000	0.61525	0.00536	0.22956
4	31	0.39232	0.06000	0.61124	0.00670	0.22813
4	32	0.37384	0.06000	0.60739	0.00791	0.22671
4	33	0.35544	0.06000	0.60372	0.00901	0.22533
4	34	0.33711	0.06000	0.60017	0.00983	0.22380
4	35	0.31881	0.06000	0.59681	0.01031	0.22245
4	36	0.30053	0.06000	0.59369	0.01134	0.22107
4	37	0.28223	0.06000	0.59079	0.01174	0.21962
4	38	0.26455	0.06000	0.58832	0.01226	0.21854
4	39	0.24868	0.06000	0.58655	0.01276	0.21788
4	40	0.23500	0.06000	0.58560	0.01312	0.21759
4	41	0.22320	0.06000	0.58553	0.01339	0.21776
4	42	0.21302	0.06000	0.58634	0.01365	0.21845
4	43	0.20425	0.06000	0.58803	0.01366	0.21948
4	44	0.19668	0.06000	0.59050	0.01422	0.22141
4	45	0.19016	0.06000	0.59409	0.01375	0.22320
4	46	0.18453	0.06000	0.59934	0.01484	0.22724
4	47	0.17968	0.06000	0.60926	0.00992	0.22942
4	48	0.17549	0.06000	0.61966	0.01061	0.23634
4	49	0.17188	0.06000	0.62108	0.01634	0.24163
4	50	0.16876	0.06000	0.64452	0.00092	0.24441
4	51	0.16608	0.06000	0.72725	-0.04495	0.26505
4	52	0.16483	0.06000	0.72725	-0.04495	0.26505
4	53	0.16877	0.06000	0.86886	0.06223	0.42674
4	54	0.17188	0.06000	0.90119	0.05528	0.44214
4	55	0.17549	0.06000	0.92592	0.04526	0.45130
4	56	0.17968	0.06000	0.93691	0.06113	0.46698
4	57	0.18453	0.06000	0.95338	0.07284	0.48327
4	58	0.19016	0.06000	0.97291	0.08315	0.50024
4	59	0.19668	0.06000	0.99174	0.09123	0.51527

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-7
	DILLNER WING: MACH = 0.70, ALPHA = 15			

4	60	0.20425	0.06000	1.00870	0.09910	0.52889
4	61	0.21302	0.06000	1.02203	0.10545	0.53951
4	62	0.22320	0.06000	1.02808	0.11075	0.54550
4	63	0.23500	0.06000	1.02474	0.11417	0.54545
4	64	0.24868	0.06000	1.01168	0.11410	0.53835
4	65	0.26455	0.06000	0.99015	0.10998	0.52440
4	66	0.28223	0.06000	0.96481	0.10387	0.50699
4	67	0.30053	0.06000	0.93993	0.09611	0.48857
4	68	0.31882	0.06000	0.91798	0.08841	0.47149
4	69	0.33711	0.06000	0.89893	0.08053	0.45572
4	70	0.35544	0.06000	0.88233	0.07297	0.44136
4	71	0.37384	0.06000	0.86821	0.06575	0.42850
4	72	0.39232	0.06000	0.85627	0.05919	0.41722
4	73	0.41092	0.06000	0.84630	0.05328	0.40744
4	74	0.42967	0.06000	0.83815	0.04798	0.39908
4	75	0.44858	0.06000	0.83162	0.04336	0.39210
4	76	0.46769	0.06000	0.82653	0.03922	0.38630
4	77	0.48702	0.06000	0.82264	0.03579	0.38167
4	78	0.50659	0.06000	0.81965	0.03284	0.37789
4	79	0.52645	0.06000	0.81732	0.03039	0.37485
4	80	0.54660	0.06000	0.81535	0.02859	0.37244
4	81	0.56708	0.06000	0.81350	0.02713	0.37033
4	82	0.58792	0.06000	0.81167	0.02608	0.36849
4	83	0.60913	0.06000	0.80964	0.02542	0.36677
4	84	0.63076	0.06000	0.80736	0.02483	0.36494
4	85	0.65281	0.06000	0.80473	0.02465	0.36315
4	86	0.67532	0.06000	0.80161	0.02430	0.36094
4	87	0.69831	0.06000	0.79784	0.02436	0.35859
4	88	0.72182	0.06000	0.79308	0.02434	0.35554
4	89	0.74585	0.06000	0.78741	0.02426	0.35189
4	90	0.77045	0.06000	0.78045	0.02457	0.34768
4	91	0.79564	0.06000	0.77191	0.02449	0.34219
4	92	0.82143	0.06000	0.76151	0.02488	0.33586
4	93	0.84785	0.06000	0.74876	0.02490	0.32779
4	94	0.87494	0.06000	0.73343	0.02503	0.31817
4	95	0.90271	0.06000	0.71440	0.02549	0.30650
4	96	0.92920	0.06000	0.69133	0.02602	0.29240
4	97	0.95105	0.06000	0.66636	0.02569	0.27662
4	98	0.96761	0.06000	0.64236	0.02469	0.26105
4	99	0.98016	0.06000	0.61655	0.02632	0.24658
4	100	0.98968	0.06000	0.59209	0.01997	0.22690
4	101	0.99689	0.06000	0.55495	0.02939	0.21261
4	102	1.00000	0.06000	0.55495	0.02939	0.21261
5	1	1.00000	0.07864	0.60529	-0.02261	0.20159
5	2	0.99708	0.07864	0.59958	-0.01021	0.20773
5	3	0.99031	0.07864	0.63385	-0.02269	0.21969
5	4	0.98138	0.07864	0.65033	-0.01390	0.23691
5	5	0.96960	0.07864	0.66755	-0.01592	0.24649
5	6	0.95405	0.07864	0.67957	-0.01458	0.25526
5	7	0.93354	0.07864	0.68906	-0.01423	0.26168
5	8	0.90868	0.07864	0.69471	-0.01406	0.26549
5	9	0.88261	0.07864	0.69687	-0.01343	0.26735
5	10	0.85719	0.07864	0.69673	-0.01281	0.26770
5	11	0.83238	0.07864	0.69520	-0.01204	0.26726
5	12	0.80817	0.07864	0.69252	-0.01158	0.26585
5	13	0.78453	0.07864	0.68915	-0.01063	0.26437
5	14	0.76144	0.07864	0.68530	-0.01005	0.26229
5	15	0.73888	0.07864	0.68111	-0.00905	0.26032
5	16	0.71682	0.07864	0.67683	-0.00811	0.25825
5	17	0.69523	0.07864	0.67220	-0.00729	0.25588
5	18	0.67410	0.07864	0.66745	-0.00607	0.25373
5	19	0.65340	0.07864	0.66263	-0.00515	0.25134
5	20	0.63310	0.07864	0.65776	-0.00393	0.24914

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-8
	DILLNER WING: MACH = 0.70, ALPHA = 15			

5	21	0.61318	0.07864	0.65289	-0.00289	0.24682
5	22	0.59363	0.07864	0.64797	-0.00180	0.24453
5	23	0.57441	0.07864	0.64314	-0.00069	0.24232
5	24	0.55549	0.07864	0.63834	0.00020	0.23998
5	25	0.53685	0.07864	0.63370	0.00124	0.23785
5	26	0.51847	0.07864	0.62931	0.00216	0.23582
5	27	0.50033	0.07864	0.62500	0.00288	0.23369
5	28	0.48239	0.07864	0.62088	0.00384	0.23187
5	29	0.46464	0.07864	0.61693	0.00453	0.22996
5	30	0.44704	0.07864	0.61314	0.00537	0.22827
5	31	0.42958	0.07864	0.60956	0.00610	0.22664
5	32	0.41223	0.07864	0.60615	0.00684	0.22512
5	33	0.39497	0.07864	0.60295	0.00760	0.22375
5	34	0.37770	0.07864	0.59990	0.00820	0.22237
5	35	0.36058	0.07864	0.59710	0.00898	0.22128
5	36	0.34342	0.07864	0.59462	0.00962	0.22027
5	37	0.32624	0.07864	0.59245	0.01007	0.21931
5	38	0.30965	0.07864	0.59082	0.01068	0.21880
5	39	0.29475	0.07864	0.58996	0.01127	0.21875
5	40	0.28190	0.07864	0.58993	0.01168	0.21906
5	41	0.27083	0.07864	0.59078	0.01203	0.21985
5	42	0.26128	0.07864	0.59253	0.01238	0.22118
5	43	0.25304	0.07864	0.59522	0.01249	0.22289
5	44	0.24594	0.07864	0.59872	0.01308	0.22548
5	45	0.23981	0.07864	0.60325	0.01290	0.22808
5	46	0.23453	0.07864	0.60899	0.01439	0.23273
5	47	0.22998	0.07864	0.61869	0.01088	0.23595
5	48	0.22605	0.07864	0.62980	0.01159	0.24334
5	49	0.22266	0.07864	0.63501	0.01591	0.24986
5	50	0.21973	0.07864	0.66085	-0.00115	0.25318
5	51	0.21721	0.07864	0.72463	-0.02820	0.27509
5	52	0.21604	0.07864	0.72463	-0.02820	0.27509
5	53	0.21973	0.07864	0.86655	0.06601	0.42765
5	54	0.22266	0.07864	0.88653	0.07094	0.44265
5	55	0.22605	0.07864	0.90206	0.05730	0.44386
5	56	0.22998	0.07864	0.90816	0.07005	0.45502
5	57	0.23453	0.07864	0.92046	0.07954	0.46780
5	58	0.23981	0.07864	0.94060	0.08803	0.48437
5	59	0.24594	0.07864	0.96454	0.09387	0.50134
5	60	0.25304	0.07864	0.98957	0.10056	0.51905
5	61	0.26128	0.07864	1.01461	0.10554	0.53549
5	62	0.27083	0.07864	1.03628	0.10898	0.54902
5	63	0.28190	0.07864	1.05215	0.11031	0.55819
5	64	0.29475	0.07864	1.05945	0.10860	0.56124
5	65	0.30965	0.07864	1.05588	0.10389	0.55701
5	66	0.32625	0.07864	1.04269	0.09766	0.54679
5	67	0.34342	0.07864	1.02294	0.08994	0.53202
5	68	0.36059	0.07864	1.00056	0.08301	0.51589
5	69	0.37776	0.07864	0.97770	0.07616	0.49918
5	70	0.39497	0.07864	0.95543	0.07037	0.48309
5	71	0.41223	0.07864	0.93472	0.06470	0.46770
5	72	0.42958	0.07864	0.91631	0.05920	0.45356
5	73	0.44704	0.07864	0.90034	0.05399	0.44087
5	74	0.46464	0.07864	0.88673	0.04920	0.42972
5	75	0.48239	0.07864	0.87513	0.04490	0.42000
5	76	0.50033	0.07864	0.86529	0.04107	0.41159
5	77	0.51847	0.07864	0.85685	0.03775	0.40429
5	78	0.53685	0.07864	0.84959	0.03479	0.39792
5	79	0.55548	0.07864	0.84326	0.03219	0.39232
5	80	0.57440	0.07864	0.83759	0.03002	0.38740
5	81	0.59362	0.07864	0.83242	0.02808	0.38290
5	82	0.61318	0.07864	0.82765	0.02642	0.37883
5	83	0.63310	0.07864	0.82314	0.02506	0.37510

DORNIER JAMESON	AR 211		W.Schmidt A.Jameson	15-9-9
	DILLNER WING: MACH = 0.70, ALPHA = 15			

5	84	0.65340	0.07864	0.81878	0.02378	0.37152
5	85	0.67410	0.07864	0.81440	0.02294	0.36819
5	86	0.69523	0.07864	0.80982	0.02205	0.36470
5	87	0.71681	0.07864	0.80481	0.02165	0.36124
5	88	0.73887	0.07864	0.79899	0.02127	0.35728
5	89	0.76144	0.07864	0.79235	0.02094	0.35283
5	90	0.78453	0.07864	0.78452	0.02106	0.34792
5	91	0.80817	0.07864	0.77523	0.02086	0.34186
5	92	0.83238	0.07864	0.76422	0.02117	0.33506
5	93	0.85718	0.07864	0.75105	0.02116	0.32666
5	94	0.88261	0.07864	0.73543	0.02133	0.31686
5	95	0.90868	0.07864	0.71624	0.02193	0.30512
5	96	0.93354	0.07864	0.69314	0.02272	0.29114
5	97	0.95495	0.07864	0.66828	0.02272	0.27560
5	98	0.96960	0.07864	0.64440	0.02212	0.26036
5	99	0.98138	0.07864	0.61890	0.02403	0.24624
5	100	0.99031	0.07864	0.59451	0.01837	0.22709
5	101	0.99708	0.07864	0.55849	0.02772	0.21330
5	102	1.00000	0.07864	0.55849	0.02772	0.21330
6	1	1.00000	0.09464	0.59976	-0.01537	0.20379
6	2	0.99724	0.09464	0.59346	-0.00501	0.20804
6	3	0.99085	0.09464	0.62811	-0.01795	0.21965
6	4	0.98242	0.09464	0.64442	-0.00877	0.23701
6	5	0.97130	0.09464	0.66164	-0.01065	0.24660
6	6	0.95663	0.09464	0.67345	-0.00911	0.25534
6	7	0.93727	0.09464	0.68263	-0.00852	0.26169
6	8	0.91380	0.09464	0.68795	-0.00809	0.26544
6	9	0.88920	0.09464	0.68982	-0.00724	0.26726
6	10	0.86520	0.09464	0.68950	-0.00646	0.26762
6	11	0.84178	0.09464	0.68786	-0.00556	0.26722
6	12	0.81893	0.09464	0.68511	-0.00500	0.26586
6	13	0.79661	0.09464	0.68174	-0.00398	0.26444
6	14	0.77481	0.09464	0.67791	-0.00337	0.26243
6	15	0.75352	0.09464	0.67379	-0.00239	0.26052
6	16	0.73269	0.09464	0.66962	-0.00149	0.25851
6	17	0.71232	0.09464	0.66518	-0.00074	0.25623
6	18	0.69237	0.09464	0.66068	0.00035	0.25419
6	19	0.67283	0.09464	0.65621	0.00112	0.25194
6	20	0.65367	0.09464	0.65178	0.00216	0.24991
6	21	0.63487	0.09464	0.64744	0.00294	0.24777
6	22	0.61641	0.09464	0.64314	0.00377	0.24569
6	23	0.59827	0.09464	0.63897	0.00455	0.24368
6	24	0.58041	0.09464	0.63485	0.00509	0.24152
6	25	0.56282	0.09464	0.63086	0.00576	0.23954
6	26	0.54547	0.09464	0.62708	0.00629	0.23760
6	27	0.52834	0.09464	0.62331	0.00661	0.23551
6	28	0.51141	0.09464	0.61966	0.00716	0.23367
6	29	0.49465	0.09464	0.61613	0.00742	0.23170
6	30	0.47804	0.09464	0.61270	0.00783	0.22990
6	31	0.46156	0.09464	0.60941	0.00814	0.22813
6	32	0.44519	0.09464	0.60627	0.00848	0.22647
6	33	0.42889	0.09464	0.60332	0.00887	0.22497
6	34	0.41265	0.09464	0.60055	0.00916	0.22351
6	35	0.39643	0.09464	0.59801	0.00956	0.22228
6	36	0.38023	0.09464	0.59586	0.01003	0.22135
6	37	0.36402	0.09464	0.59413	0.01028	0.22049
6	38	0.34835	0.09464	0.59304	0.01071	0.22018
6	39	0.33429	0.09464	0.59283	0.01116	0.22040
6	40	0.32217	0.09464	0.59352	0.01143	0.22103
6	41	0.31171	0.09464	0.59512	0.01164	0.22216
6	42	0.30270	0.09464	0.59769	0.01186	0.22389
6	43	0.29492	0.09464	0.60127	0.01184	0.22605
6	44	0.28822	0.09464	0.60578	0.01223	0.22910

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-10
	DILLNER WING: MACH = 0.70, ALPHA = 15			

6	45	0.28244	0.09464	0.61139	0.01191	0.23227
6	46	0.27745	0.09464	0.61801	0.01333	0.23742
6	47	0.27315	0.09464	0.62808	0.01044	0.24140
6	48	0.26944	0.09464	0.63995	0.01102	0.24920
6	49	0.26624	0.09464	0.64735	0.01522	0.25698
6	50	0.26348	0.09464	0.67591	-0.00465	0.26020
6	51	0.26110	0.09464	0.73450	-0.02311	0.28521
6	52	0.26000	0.09464	0.73450	-0.02311	0.28521
6	53	0.26348	0.09464	0.87769	0.07059	0.43714
6	54	0.26624	0.09464	0.88947	0.07731	0.44821
6	55	0.26944	0.09464	0.89552	0.06697	0.44565
6	56	0.27315	0.09464	0.89784	0.07595	0.45236
6	57	0.27745	0.09464	0.90471	0.08246	0.46026
6	58	0.28244	0.09464	0.91897	0.08891	0.47235
6	59	0.28822	0.09464	0.93869	0.09235	0.48572
6	60	0.29492	0.09464	0.96186	0.09705	0.50157
6	61	0.30270	0.09464	0.98861	0.10086	0.51867
6	62	0.31171	0.09464	1.01682	0.10366	0.53573
6	63	0.32217	0.09464	1.04453	0.10499	0.55145
6	64	0.33429	0.09464	1.06821	0.10396	0.56362
6	65	0.34836	0.09464	1.08315	0.10061	0.56991
6	66	0.36402	0.09464	1.08688	0.09583	0.56961
6	67	0.38023	0.09464	1.07940	0.08948	0.56259
6	68	0.39644	0.09464	1.06422	0.08438	0.55192
6	69	0.41265	0.09464	1.04462	0.07925	0.53861
6	70	0.42889	0.09464	1.02298	0.07515	0.52444
6	71	0.44519	0.09464	1.00115	0.07109	0.50994
6	72	0.46157	0.09464	0.98022	0.06695	0.49566
6	73	0.47805	0.09464	0.96073	0.06271	0.48195
6	74	0.49465	0.09464	0.94294	0.05866	0.46916
6	75	0.51141	0.09464	0.92656	0.05485	0.45720
6	76	0.52834	0.09464	0.91161	0.05136	0.44616
6	77	0.54547	0.09464	0.89793	0.04808	0.43590
6	78	0.56282	0.09464	0.88558	0.04504	0.42653
6	79	0.58040	0.09464	0.87446	0.04222	0.41797
6	80	0.59826	0.09464	0.86443	0.03970	0.41022
6	81	0.61641	0.09464	0.85543	0.03743	0.40321
6	82	0.63487	0.09464	0.84732	0.03545	0.39692
6	83	0.65367	0.09464	0.83993	0.03378	0.39124
6	84	0.67283	0.09464	0.83310	0.03225	0.38598
6	85	0.69237	0.09464	0.82658	0.03112	0.38115
6	86	0.71231	0.09464	0.82008	0.02998	0.37633
6	87	0.73269	0.09464	0.81335	0.02928	0.37162
6	88	0.75351	0.09464	0.80602	0.02858	0.36654
6	89	0.77481	0.09464	0.79803	0.02792	0.36105
6	90	0.79661	0.09464	0.78905	0.02765	0.35518
6	91	0.81893	0.09464	0.77882	0.02709	0.34832
6	92	0.84178	0.09464	0.76708	0.02700	0.34082
6	93	0.86519	0.09464	0.75340	0.02660	0.33189
6	94	0.88919	0.09464	0.73743	0.02640	0.32166
6	95	0.91380	0.09464	0.71800	0.02661	0.30956
6	96	0.93727	0.09464	0.69484	0.02695	0.29527
6	97	0.95663	0.09464	0.67009	0.02646	0.27949
6	98	0.97130	0.09464	0.64641	0.02543	0.26410
6	99	0.98242	0.09464	0.62128	0.02682	0.24983
6	100	0.99085	0.09464	0.59711	0.02118	0.23086
6	101	0.99724	0.09464	0.56273	0.02930	0.21704
6	102	1.00000	0.09464	0.56273	0.02930	0.21704

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-11
	DILLNER WING: MACH = 0.70, ALPHA = 15			

7	1	1.00000	0.10850	0.59117	-0.01064	0.20219
7	2	0.99739	0.10850	0.58572	0.00071	0.20782
7	3	0.99132	0.10850	0.62156	-0.01207	0.22002
7	4	0.98333	0.10850	0.63757	-0.00217	0.23769
7	5	0.97278	0.10850	0.65497	-0.00417	0.24718
7	6	0.95886	0.10850	0.66649	-0.00241	0.25584
7	7	0.94050	0.10850	0.67547	-0.00179	0.26202
7	8	0.91824	0.10850	0.68061	-0.00132	0.26567
7	9	0.89490	0.10850	0.68243	-0.00049	0.26743
7	10	0.87213	0.10850	0.68218	0.00018	0.26777
7	11	0.84992	0.10850	0.68069	0.00093	0.26736
7	12	0.82824	0.10850	0.67816	0.00130	0.26602
7	13	0.80708	0.10850	0.67506	0.00206	0.26460
7	14	0.78640	0.10850	0.67156	0.00237	0.26261
7	15	0.76620	0.10850	0.66781	0.00299	0.26068
7	16	0.74645	0.10850	0.66405	0.00347	0.25866
7	17	0.72712	0.10850	0.66004	0.00376	0.25633
7	18	0.70820	0.10850	0.65602	0.00434	0.25422
7	19	0.68966	0.10850	0.65203	0.00457	0.25189
7	20	0.67149	0.10850	0.64811	0.00505	0.24978
7	21	0.65366	0.10850	0.64428	0.00529	0.24756
7	22	0.63615	0.10850	0.64049	0.00559	0.24542
7	23	0.61894	0.10850	0.63683	0.00590	0.24337
7	24	0.60200	0.10850	0.63320	0.00602	0.24119
7	25	0.58531	0.10850	0.62968	0.00631	0.23922
7	26	0.56886	0.10850	0.62635	0.00652	0.23732
7	27	0.55261	0.10850	0.62301	0.00656	0.23528
7	28	0.53655	0.10850	0.61977	0.00683	0.23349
7	29	0.52066	0.10850	0.61662	0.00686	0.23157
7	30	0.50490	0.10850	0.61356	0.00703	0.22981
7	31	0.48927	0.10850	0.61063	0.00712	0.22808
7	32	0.47373	0.10850	0.60783	0.00722	0.22644
7	33	0.45828	0.10850	0.60520	0.00734	0.22492
7	34	0.44287	0.10850	0.60277	0.00744	0.22352
7	35	0.42749	0.10850	0.60061	0.00755	0.22229
7	36	0.41212	0.10850	0.59884	0.00770	0.22133
7	37	0.39674	0.10850	0.59754	0.00770	0.22053
7	38	0.38188	0.10850	0.59697	0.00788	0.22033
7	39	0.36854	0.10850	0.59731	0.00816	0.22075
7	40	0.35705	0.10850	0.59859	0.00831	0.22165
7	41	0.34713	0.10850	0.60081	0.00843	0.22310
7	42	0.33858	0.10850	0.60402	0.00863	0.22522
7	43	0.33120	0.10850	0.60830	0.00858	0.22778
7	44	0.32484	0.10850	0.61360	0.00891	0.23130
7	45	0.31936	0.10850	0.62012	0.00848	0.23497
7	46	0.31463	0.10850	0.62753	0.00989	0.24064
7	47	0.31055	0.10850	0.63815	0.00728	0.24524
7	48	0.30703	0.10850	0.65090	0.00761	0.25346
7	49	0.30400	0.10850	0.65929	0.01223	0.26219
7	50	0.30138	0.10850	0.68867	-0.00877	0.26541
7	51	0.29912	0.10850	0.74645	-0.02426	0.29236
7	52	0.29807	0.10850	0.74645	-0.02426	0.29236
7	53	0.30138	0.10850	0.88951	0.07048	0.44415
7	54	0.30400	0.10850	0.89661	0.07762	0.45263
7	55	0.30703	0.10850	0.89811	0.07001	0.44901
7	56	0.31055	0.10850	0.89891	0.07709	0.45367
7	57	0.31463	0.10850	0.90280	0.08096	0.45826
7	58	0.31936	0.10850	0.91161	0.08577	0.46624
7	59	0.32484	0.10850	0.92565	0.08713	0.47521
7	60	0.33120	0.10850	0.94389	0.08886	0.48674
7	61	0.33858	0.10850	0.96690	0.08959	0.50033

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-12
	DILLNER WING: MACH = 0.70, ALPHA = 15			

7	62	0.34713	0.10850	0.99394	0.08972	0.51571
7	63	0.35705	0.10850	1.02436	0.08934	0.53250
7	64	0.36854	0.10850	1.05577	0.08784	0.54901
7	65	0.38188	0.10850	1.08383	0.08501	0.56282
7	66	0.39674	0.10850	1.10412	0.08105	0.57180
7	67	0.41212	0.10850	1.11276	0.07558	0.57386
7	68	0.42749	0.10850	1.11084	0.07137	0.57089
7	69	0.44287	0.10850	1.10104	0.06665	0.56343
7	70	0.45828	0.10850	1.08587	0.06256	0.55321
7	71	0.47374	0.10850	1.06763	0.05818	0.54100
7	72	0.48927	0.10850	1.04776	0.05376	0.52762
7	73	0.50490	0.10850	1.02717	0.04934	0.51359
7	74	0.52066	0.10850	1.00645	0.04484	0.49920
7	75	0.53655	0.10850	0.98624	0.04043	0.48491
7	76	0.55261	0.10850	0.96698	0.03654	0.47126
7	77	0.56886	0.10850	0.94887	0.03284	0.45823
7	78	0.58531	0.10850	0.93221	0.02960	0.44618
7	79	0.60200	0.10850	0.91699	0.02672	0.43511
7	80	0.61894	0.10850	0.90314	0.02419	0.42501
7	81	0.63615	0.10850	0.89061	0.02203	0.41587
7	82	0.65366	0.10850	0.87922	0.02020	0.40759
7	83	0.67149	0.10850	0.86874	0.01870	0.40005
7	84	0.68966	0.10850	0.85898	0.01739	0.39304
7	85	0.70820	0.10850	0.84963	0.01645	0.38651
7	86	0.72712	0.10850	0.84046	0.01556	0.38010
7	87	0.74644	0.10850	0.83122	0.01508	0.37388
7	88	0.76620	0.10850	0.82162	0.01464	0.36745
7	89	0.78640	0.10850	0.81160	0.01426	0.36078
7	90	0.80708	0.10850	0.80083	0.01427	0.35387
7	91	0.82824	0.10850	0.78906	0.01405	0.34617
7	92	0.84992	0.10850	0.77605	0.01431	0.33799
7	93	0.87213	0.10850	0.76138	0.01428	0.32855
7	94	0.89489	0.10850	0.74464	0.01450	0.31798
7	95	0.91823	0.10850	0.72464	0.01515	0.30566
7	96	0.94049	0.10850	0.70119	0.01594	0.29132
7	97	0.95886	0.10850	0.67639	0.01597	0.27568
7	98	0.97278	0.10850	0.65292	0.01528	0.26049
7	99	0.98333	0.10850	0.62808	0.01712	0.24652
7	100	0.99132	0.10850	0.60440	0.01206	0.22812
7	101	0.99739	0.10850	0.57124	0.02000	0.21453
7	102	1.00000	0.10850	0.57124	0.02000	0.21453
8	1	1.00000	0.12400	0.58892	-0.00229	0.20740
8	2	0.99754	0.12400	0.58322	0.00681	0.21116
8	3	0.99185	0.12400	0.61841	-0.00629	0.22251
8	4	0.98434	0.12400	0.63367	0.00375	0.23975
8	5	0.97443	0.12400	0.65075	0.00160	0.24885
8	6	0.96136	0.12400	0.66184	0.00325	0.25709
8	7	0.94411	0.12400	0.67045	0.00368	0.26287
8	8	0.92320	0.12400	0.67539	0.00394	0.26620
8	9	0.90127	0.12400	0.67718	0.00452	0.26776
8	10	0.87989	0.12400	0.67703	0.00498	0.26800
8	11	0.85903	0.12400	0.67575	0.00549	0.26757
8	12	0.83866	0.12400	0.67349	0.00565	0.26625
8	13	0.81878	0.12400	0.67072	0.00619	0.26489
8	14	0.79936	0.12400	0.66758	0.00627	0.26297
8	15	0.78038	0.12400	0.66423	0.00666	0.26114
8	16	0.76183	0.12400	0.66088	0.00690	0.25921
8	17	0.74367	0.12400	0.65730	0.00695	0.25699
8	18	0.72590	0.12400	0.65370	0.00728	0.25497
8	19	0.70849	0.12400	0.65012	0.00727	0.25272
8	20	0.69142	0.12400	0.64660	0.00750	0.25069
8	21	0.67467	0.12400	0.64314	0.00753	0.24855
8	22	0.65822	0.12400	0.63969	0.00763	0.24647

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-13
	DILLNER WING: MACH = 0.70, ALPHA = 15			

8	23	0.64205	0.12400	0.63635	0.00777	0.24449
8	24	0.62614	0.12400	0.63302	0.00775	0.24240
8	25	0.61047	0.12400	0.62979	0.00792	0.24053
8	26	0.59501	0.12400	0.62674	0.00804	0.23873
8	27	0.57975	0.12400	0.62370	0.00802	0.23683
8	28	0.56466	0.12400	0.62076	0.00825	0.23519
8	29	0.54973	0.12400	0.61793	0.00825	0.23345
8	30	0.53493	0.12400	0.61520	0.00839	0.23188
8	31	0.52025	0.12400	0.61262	0.00846	0.23035
8	32	0.50566	0.12400	0.61020	0.00855	0.22893
8	33	0.49114	0.12400	0.60797	0.00864	0.22763
8	34	0.47666	0.12400	0.60597	0.00866	0.22643
8	35	0.46222	0.12400	0.60427	0.00873	0.22544
8	36	0.44778	0.12400	0.60301	0.00884	0.22476
8	37	0.43334	0.12400	0.60228	0.00872	0.22422
8	38	0.41938	0.12400	0.60229	0.00876	0.22426
8	39	0.40685	0.12400	0.60320	0.00891	0.22493
8	40	0.39605	0.12400	0.60503	0.00893	0.22606
8	41	0.38673	0.12400	0.60778	0.00892	0.22774
8	42	0.37870	0.12400	0.61151	0.00904	0.23011
8	43	0.37177	0.12400	0.61629	0.00889	0.23294
8	44	0.36580	0.12400	0.62214	0.00913	0.23672
8	45	0.36065	0.12400	0.62928	0.00855	0.24069
8	46	0.35620	0.12400	0.63721	0.00985	0.24661
8	47	0.35237	0.12400	0.64820	0.00728	0.25152
8	48	0.34907	0.12400	0.66157	0.00736	0.25998
8	49	0.34622	0.12400	0.67048	0.01176	0.26887
8	50	0.34376	0.12400	0.69885	-0.00821	0.27241
8	51	0.34164	0.12400	0.75477	-0.02305	0.29873
8	52	0.34065	0.12400	0.75477	-0.02305	0.29873
8	53	0.34376	0.12400	0.89931	0.06520	0.44687
8	54	0.34622	0.12400	0.90368	0.07398	0.45466
8	55	0.34907	0.12400	0.90345	0.06695	0.45039
8	56	0.35237	0.12400	0.90343	0.07325	0.45409
8	57	0.35620	0.12400	0.90572	0.07486	0.45639
8	58	0.36065	0.12400	0.91096	0.07803	0.46134
8	59	0.36580	0.12400	0.92045	0.07800	0.46691
8	60	0.37177	0.12400	0.93395	0.07803	0.47484
8	61	0.37870	0.12400	0.95191	0.07740	0.48495
8	62	0.38673	0.12400	0.97418	0.07677	0.49749
8	63	0.39605	0.12400	1.00104	0.07625	0.51259
8	64	0.40685	0.12400	1.03220	0.07552	0.52981
8	65	0.41938	0.12400	1.06588	0.07464	0.54806
8	66	0.43334	0.12400	1.09792	0.07302	0.56472
8	67	0.44779	0.12400	1.12222	0.06958	0.57615
8	68	0.46222	0.12400	1.13646	0.06712	0.58258
8	69	0.47666	0.12400	1.14142	0.06353	0.58360
8	70	0.49114	0.12400	1.13857	0.06024	0.58063
8	71	0.50566	0.12400	1.12980	0.05668	0.57435
8	72	0.52025	0.12400	1.11652	0.05344	0.56570
8	73	0.53494	0.12400	1.10012	0.05067	0.55544
8	74	0.54973	0.12400	1.08153	0.04831	0.54400
8	75	0.56466	0.12400	1.06170	0.04587	0.53164
8	76	0.57975	0.12400	1.04171	0.04367	0.51911
8	77	0.59501	0.12400	1.02202	0.04120	0.50642
8	78	0.61047	0.12400	1.00308	0.03900	0.49415
8	79	0.62614	0.12400	0.98509	0.03685	0.48230
8	80	0.64205	0.12400	0.96802	0.03474	0.47090
8	81	0.65822	0.12400	0.95188	0.03282	0.46004
8	82	0.67467	0.12400	0.93655	0.03098	0.44963
8	83	0.69142	0.12400	0.92193	0.02926	0.43964

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-14
	DILLNER WING: MACH = 0.70, ALPHA = 15			

8	84	0.70849	0.12400	0.90789	0.02762	0.42998
8	85	0.72590	0.12400	0.89425	0.02616	0.42061
8	86	0.74367	0.12400	0.88093	0.02468	0.41138
8	87	0.76182	0.12400	0.86777	0.02345	0.40234
8	88	0.78038	0.12400	0.85456	0.02226	0.39326
8	89	0.79936	0.12400	0.84116	0.02115	0.38406
8	90	0.81878	0.12400	0.82729	0.02039	0.37476
8	91	0.83866	0.12400	0.81275	0.01946	0.36488
8	92	0.85902	0.12400	0.79729	0.01897	0.35469
8	93	0.87988	0.12400	0.78052	0.01825	0.34349
8	94	0.90127	0.12400	0.76194	0.01786	0.33135
8	95	0.92319	0.12400	0.74034	0.01789	0.31759
8	96	0.94410	0.12400	0.71568	0.01805	0.30201
8	97	0.96136	0.12400	0.69005	0.01755	0.28544
8	98	0.97443	0.12400	0.66602	0.01641	0.26951
8	99	0.98434	0.12400	0.64069	0.01792	0.25490
8	100	0.99185	0.12400	0.61648	0.01264	0.23595
8	101	0.99754	0.12400	0.58387	0.01990	0.22193
8	102	1.00000	0.12400	0.58387	0.01990	0.22193
9	1	1.00000	0.14100	0.59280	0.00329	0.21417
9	2	0.99772	0.14100	0.58697	0.01123	0.21692
9	3	0.99243	0.14100	0.62065	-0.00251	0.22682
9	4	0.98545	0.14100	0.63440	0.00766	0.24319
9	5	0.97624	0.14100	0.65061	0.00527	0.25152
9	6	0.96409	0.14100	0.66083	0.00677	0.25908
9	7	0.94807	0.14100	0.66873	0.00700	0.26423
9	8	0.92864	0.14100	0.67323	0.00706	0.26713
9	9	0.90827	0.14100	0.67486	0.00741	0.26842
9	10	0.88840	0.14100	0.67471	0.00762	0.26848
9	11	0.86901	0.14100	0.67353	0.00792	0.26795
9	12	0.85009	0.14100	0.67145	0.00785	0.26659
9	13	0.83162	0.14100	0.66888	0.00819	0.26521
9	14	0.81357	0.14100	0.66598	0.00808	0.26330
9	15	0.79594	0.14100	0.66286	0.00828	0.26148
9	16	0.77870	0.14100	0.65976	0.00835	0.25958
9	17	0.76183	0.14100	0.65642	0.00824	0.25741
9	18	0.74532	0.14100	0.65307	0.00844	0.25544
9	19	0.72914	0.14100	0.64973	0.00831	0.25326
9	20	0.71328	0.14100	0.64643	0.00843	0.25128
9	21	0.69771	0.14100	0.64318	0.00837	0.24921
9	22	0.68243	0.14100	0.63992	0.00840	0.24719
9	23	0.66741	0.14100	0.63675	0.00845	0.24526
9	24	0.65262	0.14100	0.63359	0.00837	0.24323
9	25	0.63806	0.14100	0.63054	0.00847	0.24141
9	26	0.62370	0.14100	0.62765	0.00853	0.23967
9	27	0.60952	0.14100	0.62479	0.00847	0.23785
9	28	0.59550	0.14100	0.62204	0.00865	0.23629
9	29	0.58163	0.14100	0.61942	0.00862	0.23466
9	30	0.56788	0.14100	0.61693	0.00874	0.23321
9	31	0.55423	0.14100	0.61460	0.00881	0.23183
9	32	0.54068	0.14100	0.61246	0.00889	0.23058
9	33	0.52718	0.14100	0.61055	0.00898	0.22948
9	34	0.51374	0.14100	0.60892	0.00908	0.22856
9	35	0.50031	0.14100	0.60763	0.00910	0.22779
9	36	0.48690	0.14100	0.60682	0.00925	0.22740
9	37	0.47348	0.14100	0.60661	0.00917	0.22721
9	38	0.46051	0.14100	0.60720	0.00923	0.22762
9	39	0.44887	0.14100	0.60870	0.00942	0.22869
9	40	0.43883	0.14100	0.61109	0.00947	0.23019
9	41	0.43017	0.14100	0.61439	0.00945	0.23220
9	42	0.42271	0.14100	0.61863	0.00960	0.23492
9	43	0.41627	0.14100	0.62389	0.00945	0.23805
9	44	0.41072	0.14100	0.63019	0.00967	0.24212

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-15
	DILLNER WING: MACH = 0.70, ALPHA = 15			

9	45	0.40594	0.14100	0.63781	0.00904	0.24636
9	46	0.40181	0.14100	0.64611	0.01031	0.25250
9	47	0.39825	0.14100	0.65732	0.00777	0.25761
9	48	0.39518	0.14100	0.67104	0.00782	0.26630
9	49	0.39253	0.14100	0.68035	0.01146	0.27487
9	50	0.39024	0.14100	0.70695	-0.00613	0.27915
9	51	0.38827	0.14100	0.75979	-0.02123	0.30330
9	52	0.38736	0.14100	0.75979	-0.02123	0.30330
9	53	0.39025	0.14100	0.90634	0.05718	0.44638
9	54	0.39253	0.14100	0.90908	0.06827	0.45452
9	55	0.39518	0.14100	0.90774	0.06180	0.44993
9	56	0.39825	0.14100	0.90689	0.06850	0.45335
9	57	0.40181	0.14100	0.90815	0.06893	0.45436
9	58	0.40593	0.14100	0.91137	0.07141	0.45772
9	59	0.41072	0.14100	0.91788	0.07104	0.46136
9	60	0.41627	0.14100	0.92772	0.07072	0.46699
9	61	0.42271	0.14100	0.94121	0.06987	0.47447
9	62	0.43017	0.14100	0.95842	0.06926	0.48422
9	63	0.43883	0.14100	0.98006	0.06894	0.49663
9	64	0.44887	0.14100	1.00659	0.06846	0.51166
9	65	0.46051	0.14100	1.03814	0.06819	0.52943
9	66	0.47348	0.14100	1.07290	0.06772	0.54856
9	67	0.48690	0.14100	1.10507	0.06572	0.56518
9	68	0.50032	0.14100	1.13110	0.06459	0.57860
9	69	0.51374	0.14100	1.14997	0.06219	0.58751
9	70	0.52718	0.14100	1.16104	0.06005	0.59236
9	71	0.54068	0.14100	1.16481	0.05760	0.59328
9	72	0.55423	0.14100	1.16204	0.05544	0.59089
9	73	0.56788	0.14100	1.15402	0.05361	0.58587
9	74	0.58163	0.14100	1.14211	0.05206	0.57886
9	75	0.59550	0.14100	1.12728	0.05030	0.57010
9	76	0.60952	0.14100	1.11068	0.04873	0.56035
9	77	0.62370	0.14100	1.09286	0.04666	0.54954
9	78	0.63806	0.14100	1.07440	0.04478	0.53830
9	79	0.65262	0.14100	1.05580	0.04278	0.52675
9	80	0.66741	0.14100	1.03712	0.04064	0.51492
9	81	0.68243	0.14100	1.01857	0.03862	0.50307
9	82	0.69771	0.14100	1.00023	0.03657	0.49117
9	83	0.71328	0.14100	0.98213	0.03455	0.47929
9	84	0.72914	0.14100	0.96429	0.03261	0.46747
9	85	0.74532	0.14100	0.94671	0.03067	0.45569
9	86	0.76183	0.14100	0.92949	0.02866	0.44397
9	87	0.77869	0.14100	0.91242	0.02684	0.43234
9	88	0.79594	0.14100	0.89539	0.02511	0.42070
9	89	0.81357	0.14100	0.87830	0.02351	0.40902
9	90	0.83162	0.14100	0.86095	0.02224	0.39729
9	91	0.85009	0.14100	0.84318	0.02088	0.38517
9	92	0.86901	0.14100	0.82478	0.01992	0.37285
9	93	0.88839	0.14100	0.80539	0.01877	0.35974
9	94	0.90826	0.14100	0.78441	0.01808	0.34587
9	95	0.92863	0.14100	0.76064	0.01777	0.33046
9	96	0.94806	0.14100	0.73432	0.01765	0.31358
9	97	0.96409	0.14100	0.70757	0.01717	0.29624
9	98	0.97624	0.14100	0.68261	0.01618	0.27976
9	99	0.98545	0.14100	0.65626	0.01814	0.26471
9	100	0.99243	0.14100	0.63115	0.01286	0.24515
9	101	0.99772	0.14100	0.59877	0.02016	0.23106
9	102	1.00000	0.14100	0.59877	0.02016	0.23106
.0	1	1.00000	0.15650	0.60360	0.00470	0.22189
.0	2	0.99788	0.15650	0.59734	0.01243	0.22413
.0	3	0.99295	0.15650	0.62883	-0.00153	0.23270
.0	4	0.98646	0.15650	0.64045	0.00886	0.24787

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-16
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.0	5	0.97789	0.15650	0.65517	0.00621	0.25509
.0	6	0.96659	0.15650	0.66380	0.00772	0.26166
.0	7	0.95168	0.15650	0.67043	0.00782	0.26592
.0	8	0.93360	0.15650	0.67405	0.00778	0.26818
.0	9	0.91464	0.15650	0.67519	0.00798	0.26905
.0	10	0.89616	0.15650	0.67480	0.00804	0.26885
.0	11	0.87812	0.15650	0.67352	0.00820	0.26815
.0	12	0.86051	0.15650	0.67142	0.00801	0.26668
.0	13	0.84332	0.15650	0.66889	0.00822	0.26524
.0	14	0.82653	0.15650	0.66606	0.00799	0.26329
.0	15	0.81012	0.15650	0.66302	0.00809	0.26144
.0	16	0.79408	0.15650	0.66001	0.00806	0.25952
.0	17	0.77839	0.15650	0.65676	0.00788	0.25734
.0	18	0.76302	0.15650	0.65349	0.00799	0.25538
.0	19	0.74797	0.15650	0.65025	0.00781	0.25321
.0	20	0.73321	0.15650	0.64704	0.00788	0.25125
.0	21	0.71873	0.15650	0.64389	0.00777	0.24920
.0	22	0.70451	0.15650	0.64074	0.00774	0.24721
.0	23	0.69053	0.15650	0.63770	0.00775	0.24532
.0	24	0.67677	0.15650	0.63467	0.00763	0.24333
.0	25	0.66322	0.15650	0.63174	0.00767	0.24155
.0	26	0.64985	0.15650	0.62900	0.00767	0.23985
.0	27	0.63666	0.15650	0.62629	0.00755	0.23807
.0	28	0.62362	0.15650	0.62371	0.00765	0.23655
.0	29	0.61071	0.15650	0.62127	0.00756	0.23498
.0	30	0.59791	0.15650	0.61898	0.00761	0.23360
.0	31	0.58522	0.15650	0.61687	0.00760	0.23229
.0	32	0.57260	0.15650	0.61498	0.00761	0.23113
.0	33	0.56005	0.15650	0.61333	0.00762	0.23013
.0	34	0.54754	0.15650	0.61200	0.00767	0.22935
.0	35	0.53505	0.15650	0.61105	0.00765	0.22875
.0	36	0.52257	0.15650	0.61062	0.00775	0.22857
.0	37	0.51007	0.15650	0.61084	0.00767	0.22864
.0	38	0.49801	0.15650	0.61193	0.00772	0.22935
.0	39	0.48718	0.15650	0.61396	0.00792	0.23075
.0	40	0.47784	0.15650	0.61686	0.00798	0.23258
.0	41	0.46978	0.15650	0.62066	0.00797	0.23492
.0	42	0.46284	0.15650	0.62537	0.00815	0.23797
.0	43	0.45685	0.15650	0.63107	0.00802	0.24140
.0	44	0.45168	0.15650	0.63778	0.00829	0.24578
.0	45	0.44723	0.15650	0.64580	0.00766	0.25030
.0	46	0.44339	0.15650	0.65440	0.00897	0.25668
.0	47	0.44007	0.15650	0.66572	0.00650	0.26196
.0	48	0.43722	0.15650	0.67957	0.00669	0.27088
.0	49	0.43475	0.15650	0.68919	0.00954	0.27907
.0	50	0.43263	0.15650	0.71404	-0.00566	0.28409
.0	51	0.43079	0.15650	0.76361	-0.02093	0.30605
.0	52	0.42994	0.15650	0.76361	-0.02093	0.30605
.0	53	0.43263	0.15650	0.91114	0.04881	0.44438
.0	54	0.43475	0.15650	0.91240	0.06206	0.45288
.0	55	0.43722	0.15650	0.90975	0.05640	0.44798
.0	56	0.44007	0.15650	0.90810	0.06381	0.45132
.0	57	0.44339	0.15650	0.90873	0.06352	0.45153
.0	58	0.44723	0.15650	0.91081	0.06580	0.45411
.0	59	0.45168	0.15650	0.91541	0.06543	0.45663
.0	60	0.45685	0.15650	0.92262	0.06514	0.46076
.0	61	0.46284	0.15650	0.93270	0.06421	0.46623
.0	62	0.46978	0.15650	0.94573	0.06346	0.47352
.0	63	0.47783	0.15650	0.96244	0.06297	0.48310
.0	64	0.48718	0.15650	0.98358	0.06237	0.49514
.0	65	0.49801	0.15650	1.00982	0.06194	0.51010
.0	66	0.51008	0.15650	1.04078	0.06138	0.52748
.0	67	0.52257	0.15650	1.07269	0.05980	0.54461

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-17
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.0	68	0.53505	0.15650	1.10229	0.05949	0.56076
.0	69	0.54754	0.15650	1.12832	0.05825	0.57426
.0	70	0.56005	0.15650	1.14922	0.05735	0.58498
.0	71	0.57260	0.15650	1.16443	0.05600	0.59239
.0	72	0.58522	0.15650	1.17351	0.05465	0.59654
.0	73	0.59792	0.15650	1.17678	0.05313	0.59759
.0	74	0.61071	0.15650	1.17497	0.05154	0.59597
.0	75	0.62362	0.15650	1.16864	0.04957	0.59182
.0	76	0.63666	0.15650	1.15888	0.04781	0.58592
.0	77	0.64985	0.15650	1.14622	0.04552	0.57817
.0	78	0.66322	0.15650	1.13135	0.04352	0.56925
.0	79	0.67677	0.15650	1.11502	0.04144	0.55937
.0	80	0.69053	0.15650	1.09743	0.03923	0.54858
.0	81	0.70451	0.15650	1.07895	0.03722	0.53722
.0	82	0.71873	0.15650	1.05987	0.03518	0.52533
.0	83	0.73321	0.15650	1.04037	0.03320	0.51306
.0	84	0.74797	0.15650	1.02067	0.03132	0.50053
.0	85	0.76302	0.15650	1.00087	0.02938	0.48776
.0	86	0.77838	0.15650	0.98107	0.02746	0.47483
.0	87	0.79408	0.15650	0.96108	0.02570	0.46171
.0	88	0.81012	0.15650	0.94098	0.02407	0.44845
.0	89	0.82653	0.15650	0.92077	0.02253	0.43504
.0	90	0.84332	0.15650	0.90036	0.02125	0.42153
.0	91	0.86051	0.15650	0.87961	0.01994	0.40769
.0	92	0.87811	0.15650	0.85833	0.01900	0.39362
.0	93	0.89615	0.15650	0.83617	0.01790	0.37883
.0	94	0.91464	0.15650	0.81241	0.01738	0.36331
.0	95	0.93359	0.15650	0.78585	0.01719	0.34619
.0	96	0.95167	0.15650	0.75700	0.01698	0.32759
.0	97	0.96659	0.15650	0.72818	0.01634	0.30875
.0	98	0.97789	0.15650	0.70159	0.01501	0.29090
.0	99	0.98646	0.15650	0.67367	0.01715	0.27485
.0	100	0.99295	0.15650	0.64777	0.01115	0.25418
.0	101	0.99788	0.15650	0.61649	0.01819	0.24026
.0	102	1.00000	0.15650	0.61649	0.01819	0.24026
.1	1	1.00000	0.17200	0.62318	0.00323	0.23282
.1	2	0.99803	0.17200	0.61602	0.01267	0.23570
.1	3	0.99348	0.17200	0.64382	-0.00155	0.24210
.1	4	0.98747	0.17200	0.65210	0.00890	0.25518
.1	5	0.97954	0.17200	0.66434	0.00574	0.26052
.1	6	0.96908	0.17200	0.67045	0.00714	0.26543
.1	7	0.95529	0.17200	0.67508	0.00696	0.26823
.1	8	0.93856	0.17200	0.67724	0.00678	0.26946
.1	9	0.92102	0.17200	0.67749	0.00685	0.26967
.1	10	0.90391	0.17200	0.67657	0.00680	0.26905
.1	11	0.88722	0.17200	0.67495	0.00689	0.26809
.1	12	0.87093	0.17200	0.67266	0.00666	0.26647
.1	13	0.85502	0.17200	0.67003	0.00684	0.26494
.1	14	0.83949	0.17200	0.66714	0.00661	0.26294
.1	15	0.82431	0.17200	0.66408	0.00670	0.26107
.1	16	0.80946	0.17200	0.66106	0.00668	0.25915
.1	17	0.79494	0.17200	0.65782	0.00651	0.25699
.1	18	0.78072	0.17200	0.65457	0.00664	0.25504
.1	19	0.76679	0.17200	0.65136	0.00648	0.25290
.1	20	0.75314	0.17200	0.64819	0.00656	0.25097
.1	21	0.73974	0.17200	0.64510	0.00647	0.24897
.1	22	0.72658	0.17200	0.64203	0.00646	0.24704
.1	23	0.71364	0.17200	0.63907	0.00647	0.24520
.1	24	0.70091	0.17200	0.63615	0.00636	0.24330
.1	25	0.68837	0.17200	0.63336	0.00641	0.24159
.1	26	0.67601	0.17200	0.63076	0.00641	0.23997
.1	27	0.66380	0.17200	0.62822	0.00628	0.23830
.1	28	0.65173	0.17200	0.62583	0.00636	0.23688

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-18
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.1	29	0.63979	0.17200	0.62360	0.00625	0.23541
.1	30	0.62795	0.17200	0.62153	0.00626	0.23413
.1	31	0.61620	0.17200	0.61967	0.00621	0.23295
.1	32	0.60453	0.17200	0.61805	0.00618	0.23193
.1	33	0.59291	0.17200	0.61670	0.00614	0.23106
.1	34	0.58133	0.17200	0.61570	0.00612	0.23043
.1	35	0.56978	0.17200	0.61511	0.00605	0.23001
.1	36	0.55823	0.17200	0.61506	0.00608	0.23000
.1	37	0.54667	0.17200	0.61571	0.00596	0.23031
.1	38	0.53550	0.17200	0.61724	0.00597	0.23126
.1	39	0.52548	0.17200	0.61970	0.00617	0.23294
.1	40	0.51684	0.17200	0.62301	0.00625	0.23505
.1	41	0.50939	0.17200	0.62721	0.00627	0.23766
.1	42	0.50296	0.17200	0.63229	0.00652	0.24101
.1	43	0.49742	0.17200	0.63832	0.00645	0.24471
.1	44	0.49264	0.17200	0.64532	0.00680	0.24936
.1	45	0.48852	0.17200	0.65363	0.00622	0.25413
.1	46	0.48496	0.17200	0.66241	0.00763	0.26072
.1	47	0.48190	0.17200	0.67375	0.00529	0.26615
.1	48	0.47926	0.17200	0.68757	0.00568	0.27523
.1	49	0.47697	0.17200	0.69734	0.00799	0.28313
.1	50	0.47501	0.17200	0.72063	-0.00535	0.28859
.1	51	0.47331	0.17200	0.76723	-0.02030	0.30888
.1	52	0.47253	0.17200	0.76723	-0.02030	0.30888
.1	53	0.47501	0.17200	0.91487	0.04193	0.44264
.1	54	0.47698	0.17200	0.91463	0.05701	0.45127
.1	55	0.47926	0.17200	0.91054	0.05210	0.44594
.1	56	0.48190	0.17200	0.90824	0.05997	0.44916
.1	57	0.48496	0.17200	0.90843	0.05920	0.44882
.1	58	0.48852	0.17200	0.90970	0.06151	0.45094
.1	59	0.49264	0.17200	0.91295	0.06125	0.45273
.1	60	0.49742	0.17200	0.91827	0.06110	0.45583
.1	61	0.50296	0.17200	0.92589	0.06015	0.45984
.1	62	0.50938	0.17200	0.93579	0.05926	0.46524
.1	63	0.51684	0.17200	0.94856	0.05857	0.47245
.1	64	0.52548	0.17200	0.96488	0.05782	0.48169
.1	65	0.53550	0.17200	0.98557	0.05732	0.49359
.1	66	0.54667	0.17200	1.01084	0.05672	0.50796
.1	67	0.55823	0.17200	1.03824	0.05500	0.52282
.1	68	0.56978	0.17200	1.06581	0.05451	0.53819
.1	69	0.58133	0.17200	1.09261	0.05351	0.55263
.1	70	0.59291	0.17200	1.11730	0.05300	0.56593
.1	71	0.60453	0.17200	1.13910	0.05208	0.57727
.1	72	0.61620	0.17200	1.15703	0.05105	0.58635
.1	73	0.62795	0.17200	1.17058	0.04968	0.59289
.1	74	0.63979	0.17200	1.17953	0.04814	0.59690
.1	75	0.65173	0.17200	1.18369	0.04616	0.59823
.1	76	0.66380	0.17200	1.18358	0.04446	0.59746
.1	77	0.67601	0.17200	1.17938	0.04215	0.59429
.1	78	0.68837	0.17200	1.17167	0.04020	0.58940
.1	79	0.70091	0.17200	1.16127	0.03816	0.58300
.1	80	0.71364	0.17200	1.14837	0.03598	0.57512
.1	81	0.72658	0.17200	1.13348	0.03404	0.56615
.1	82	0.73974	0.17200	1.11701	0.03203	0.55615
.1	83	0.75314	0.17200	1.09925	0.03005	0.54530
.1	84	0.76679	0.17200	1.08050	0.02819	0.53377
.1	85	0.78072	0.17200	1.06089	0.02634	0.52158
.1	86	0.79494	0.17200	1.04042	0.02474	0.50882
.1	87	0.80946	0.17200	1.01921	0.02312	0.49544
.1	88	0.82430	0.17200	0.99748	0.02154	0.48157
.1	89	0.83949	0.17200	0.97525	0.01995	0.46722
.1	90	0.85502	0.17200	0.95244	0.01847	0.45238
.1	91	0.87093	0.17200	0.92907	0.01689	0.43697

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-19
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.1	92	0.88722	0.17200	0.90500	0.01550	0.42106
.1	93	0.90391	0.17200	0.87998	0.01392	0.40428
.1	94	0.92102	0.17200	0.85316	0.01297	0.38659
.1	95	0.93855	0.17200	0.82334	0.01236	0.36709
.1	96	0.95528	0.17200	0.79133	0.01165	0.34603
.1	97	0.96908	0.17200	0.75980	0.01067	0.32508
.1	98	0.97954	0.17200	0.73110	0.00891	0.30540
.1	99	0.98747	0.17200	0.70110	0.01174	0.28823
.1	100	0.99348	0.17200	0.67431	0.00459	0.26599
.1	101	0.99803	0.17200	0.64398	0.01246	0.25280
.1	102	1.00000	0.17200	0.64398	0.01246	0.25280
.2	1	1.00000	0.18900	0.65586	0.00525	0.25481
.2	2	0.99821	0.18900	0.64492	0.01579	0.25590
.2	3	0.99406	0.18900	0.66553	-0.00024	0.25684
.2	4	0.98858	0.18900	0.66816	0.01048	0.26645
.2	5	0.98136	0.18900	0.67660	0.00662	0.26893
.2	6	0.97182	0.18900	0.67926	0.00800	0.27165
.2	7	0.95924	0.18900	0.68123	0.00764	0.27262
.2	8	0.94400	0.18900	0.68153	0.00737	0.27262
.2	9	0.92801	0.18900	0.68063	0.00735	0.27203
.2	10	0.91242	0.18900	0.67901	0.00722	0.27091
.2	11	0.89721	0.18900	0.67695	0.00727	0.26964
.2	12	0.88236	0.18900	0.67438	0.00702	0.26783
.2	13	0.86786	0.18900	0.67157	0.00720	0.26618
.2	14	0.85370	0.18900	0.66858	0.00698	0.26413
.2	15	0.83986	0.18900	0.66545	0.00708	0.26223
.2	16	0.82633	0.18900	0.66239	0.00710	0.26030
.2	17	0.81309	0.18900	0.65912	0.00696	0.25815
.2	18	0.80013	0.18900	0.65587	0.00713	0.25622
.2	19	0.78744	0.18900	0.65265	0.00701	0.25411
.2	20	0.77499	0.18900	0.64950	0.00713	0.25222
.2	21	0.76278	0.18900	0.64642	0.00709	0.25027
.2	22	0.75079	0.18900	0.64339	0.00712	0.24839
.2	23	0.73900	0.18900	0.64048	0.00719	0.24662
.2	24	0.72739	0.18900	0.63763	0.00713	0.24480
.2	25	0.71596	0.18900	0.63492	0.00722	0.24319
.2	26	0.70469	0.18900	0.63241	0.00727	0.24166
.2	27	0.69357	0.18900	0.63000	0.00721	0.24011
.2	28	0.68257	0.18900	0.62775	0.00733	0.23881
.2	29	0.67168	0.18900	0.62568	0.00727	0.23749
.2	30	0.66089	0.18900	0.62381	0.00733	0.23637
.2	31	0.65018	0.18900	0.62217	0.00732	0.23534
.2	32	0.63954	0.18900	0.62079	0.00732	0.23450
.2	33	0.62895	0.18900	0.61973	0.00730	0.23382
.2	34	0.61840	0.18900	0.61903	0.00728	0.23338
.2	35	0.60787	0.18900	0.61879	0.00722	0.23318
.2	36	0.59734	0.18900	0.61912	0.00722	0.23339
.2	37	0.58680	0.18900	0.62019	0.00709	0.23394
.2	38	0.57663	0.18900	0.62214	0.00704	0.23512
.2	39	0.56749	0.18900	0.62501	0.00722	0.23703
.2	40	0.55962	0.18900	0.62869	0.00726	0.23934
.2	41	0.55282	0.18900	0.63324	0.00721	0.24213
.2	42	0.54697	0.18900	0.63865	0.00740	0.24564
.2	43	0.54191	0.18900	0.64496	0.00730	0.24950
.2	44	0.53756	0.18900	0.65220	0.00760	0.25426
.2	45	0.53380	0.18900	0.66072	0.00697	0.25916
.2	46	0.53056	0.18900	0.66965	0.00829	0.26577
.2	47	0.52777	0.18900	0.68097	0.00597	0.27124
.2	48	0.52536	0.18900	0.69469	0.00635	0.28025
.2	49	0.52328	0.18900	0.70449	0.00820	0.28785
.2	50	0.52149	0.18900	0.72647	-0.00402	0.29333
.2	51	0.51994	0.18900	0.77041	-0.01840	0.31228
.2	52	0.51922	0.18900	0.77041	-0.01840	0.31228

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-20
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.2	53	0.52149	0.18900	0.91796	0.03633	0.44129
.2	54	0.52328	0.18900	0.91669	0.05227	0.44976
.2	55	0.52536	0.18900	0.91140	0.04778	0.44394
.2	56	0.52777	0.18900	0.90864	0.05574	0.44691
.2	57	0.53056	0.18900	0.90846	0.05466	0.44617
.2	58	0.53380	0.18900	0.90904	0.05700	0.44790
.2	59	0.53756	0.18900	0.91116	0.05682	0.44907
.2	60	0.54191	0.18900	0.91498	0.05677	0.45134
.2	61	0.54697	0.18900	0.92067	0.05579	0.45420
.2	62	0.55282	0.18900	0.92814	0.05478	0.45811
.2	63	0.55961	0.18900	0.93779	0.05386	0.46337
.2	64	0.56749	0.18900	0.95015	0.05285	0.47020
.2	65	0.57663	0.18900	0.96597	0.05206	0.47918
.2	66	0.58680	0.18900	0.98574	0.05129	0.49044
.2	67	0.59734	0.18900	1.00783	0.04955	0.50247
.2	68	0.60787	0.18900	1.03084	0.04887	0.51547
.2	69	0.61840	0.18900	1.05438	0.04784	0.52844
.2	70	0.62895	0.18900	1.07780	0.04748	0.54151
.2	71	0.63954	0.18900	1.10050	0.04702	0.55395
.2	72	0.65018	0.18900	1.12171	0.04660	0.56540
.2	73	0.66089	0.18900	1.14081	0.04600	0.57547
.2	74	0.67168	0.18900	1.15714	0.04525	0.58388
.2	75	0.68257	0.18900	1.16999	0.04405	0.59016
.2	76	0.69357	0.18900	1.17929	0.04303	0.59462
.2	77	0.70469	0.18900	1.18460	0.04134	0.59668
.2	78	0.71596	0.18900	1.18596	0.03997	0.59681
.2	79	0.72739	0.18900	1.18395	0.03846	0.59512
.2	80	0.73900	0.18900	1.17865	0.03667	0.59158
.2	81	0.75079	0.18900	1.17044	0.03506	0.58655
.2	82	0.76278	0.18900	1.15972	0.03334	0.58008
.2	83	0.77499	0.18900	1.14673	0.03166	0.57232
.2	84	0.78744	0.18900	1.13183	0.03014	0.56349
.2	85	0.80013	0.18900	1.11516	0.02866	0.55358
.2	86	0.81309	0.18900	1.09693	0.02753	0.54281
.2	87	0.82633	0.18900	1.07730	0.02635	0.53105
.2	88	0.83986	0.18900	1.05646	0.02525	0.51847
.2	89	0.85370	0.18900	1.03445	0.02415	0.50501
.2	90	0.86786	0.18900	1.01126	0.02311	0.49068
.2	91	0.88236	0.18900	0.98697	0.02196	0.47544
.2	92	0.89720	0.18900	0.96149	0.02083	0.45927
.2	93	0.91242	0.18900	0.93454	0.01953	0.44188
.2	94	0.92801	0.18900	0.90511	0.01887	0.42311
.2	95	0.94399	0.18900	0.87217	0.01839	0.40203
.2	96	0.95924	0.18900	0.83681	0.01750	0.37899
.2	97	0.97182	0.18900	0.80219	0.01634	0.35610
.2	98	0.98136	0.18900	0.77072	0.01442	0.33464
.2	99	0.98858	0.18900	0.73793	0.01824	0.31629
.2	100	0.99406	0.18900	0.70983	0.00892	0.29178
.2	101	0.99821	0.18900	0.68041	0.01818	0.27984
.2	102	1.00000	0.18900	0.68041	0.01818	0.27984
.3	1	1.00000	0.20490	0.69648	0.00093	0.27747
.3	2	0.99837	0.20490	0.67993	0.01703	0.27869
.3	3	0.99460	0.20490	0.69221	-0.00238	0.27234
.3	4	0.98962	0.20490	0.68701	0.01014	0.27812
.3	5	0.98305	0.20490	0.69099	0.00519	0.27706
.3	6	0.97438	0.20490	0.68916	0.00727	0.27740
.3	7	0.96295	0.20490	0.68794	0.00703	0.27645
.3	8	0.94908	0.20490	0.68600	0.00705	0.27522
.3	9	0.93455	0.20490	0.68376	0.00715	0.27387
.3	10	0.92038	0.20490	0.68134	0.00705	0.27226
.3	11	0.90654	0.20490	0.67879	0.00710	0.27068
.3	12	0.89304	0.20490	0.67591	0.00685	0.26867

DORNIER JAMESON	AR 211		W.Schmidt A.Jameson	15-9-21
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.3	13	0.87986	0.20490	0.67292	0.00701	0.26690
.3	14	0.86699	0.20490	0.66984	0.00677	0.26476
.3	15	0.85441	0.20490	0.66667	0.00685	0.26282
.3	16	0.84211	0.20490	0.66359	0.00683	0.26086
.3	17	0.83007	0.20490	0.66033	0.00667	0.25869
.3	18	0.81829	0.20490	0.65710	0.00681	0.25675
.3	19	0.80675	0.20490	0.65390	0.00667	0.25464
.3	20	0.79543	0.20490	0.65077	0.00678	0.25275
.3	21	0.78433	0.20490	0.64772	0.00672	0.25080
.3	22	0.77343	0.20490	0.64471	0.00674	0.24893
.3	23	0.76271	0.20490	0.64183	0.00680	0.24717
.3	24	0.75216	0.20490	0.63902	0.00674	0.24537
.3	25	0.74177	0.20490	0.63635	0.00684	0.24378
.3	26	0.73152	0.20490	0.63389	0.00689	0.24229
.3	27	0.72141	0.20490	0.63154	0.00684	0.24079
.3	28	0.71141	0.20490	0.62937	0.00697	0.23954
.3	29	0.70151	0.20490	0.62740	0.00694	0.23829
.3	30	0.69170	0.20490	0.62564	0.00701	0.23726
.3	31	0.68196	0.20490	0.62414	0.00703	0.23634
.3	32	0.67229	0.20490	0.62293	0.00707	0.23562
.3	33	0.66266	0.20490	0.62205	0.00709	0.23510
.3	34	0.65307	0.20490	0.62159	0.00711	0.23483
.3	35	0.64349	0.20490	0.62162	0.00710	0.23484
.3	36	0.63392	0.20490	0.62228	0.00713	0.23527
.3	37	0.62435	0.20490	0.62373	0.00706	0.23611
.3	38	0.61509	0.20490	0.62614	0.00703	0.23758
.3	39	0.60679	0.20490	0.62948	0.00721	0.23979
.3	40	0.59963	0.20490	0.63361	0.00722	0.24237
.3	41	0.59345	0.20490	0.63860	0.00712	0.24540
.3	42	0.58813	0.20490	0.64442	0.00725	0.24913
.3	43	0.58353	0.20490	0.65110	0.00706	0.25317
.3	44	0.57957	0.20490	0.65867	0.00725	0.25808
.3	45	0.57616	0.20490	0.66749	0.00652	0.26310
.3	46	0.57321	0.20490	0.67665	0.00767	0.26975
.3	47	0.57067	0.20490	0.68802	0.00530	0.27523
.3	48	0.56848	0.20490	0.70168	0.00557	0.28417
.3	49	0.56659	0.20490	0.71161	0.00684	0.29143
.3	50	0.56496	0.20490	0.73256	-0.00471	0.29681
.3	51	0.56356	0.20490	0.77325	-0.01799	0.31443
.3	52	0.56290	0.20490	0.77325	-0.01799	0.31443
.3	53	0.56496	0.20490	0.91918	0.03059	0.43871
.3	54	0.56659	0.20490	0.91765	0.04687	0.44721
.3	55	0.56848	0.20490	0.91175	0.04215	0.44086
.3	56	0.57067	0.20490	0.90897	0.04998	0.44374
.3	57	0.57321	0.20490	0.90880	0.04842	0.44273
.3	58	0.57616	0.20490	0.90907	0.05069	0.44422
.3	59	0.57957	0.20490	0.91045	0.05053	0.44497
.3	60	0.58353	0.20490	0.91320	0.05060	0.44668
.3	61	0.58813	0.20490	0.91746	0.04971	0.44874
.3	62	0.59345	0.20490	0.92303	0.04880	0.45159
.3	63	0.59963	0.20490	0.93017	0.04800	0.45545
.3	64	0.60679	0.20490	0.93925	0.04714	0.46044
.3	65	0.61509	0.20490	0.95089	0.04646	0.46707
.3	66	0.62435	0.20490	0.96560	0.04591	0.47558
.3	67	0.63392	0.20490	0.98231	0.04460	0.48481
.3	68	0.64349	0.20490	1.00007	0.04423	0.49512
.3	69	0.65307	0.20490	1.01869	0.04342	0.50562
.3	70	0.66266	0.20490	1.03783	0.04298	0.51651
.3	71	0.67229	0.20490	1.05743	0.04243	0.52751

DORNIER JAMESON	AR 211		W.Schmidt A.Jameson	15-9-22
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.3	72	0.68196	0.20490	1.07694	0.04212	0.53844
.3	73	0.69170	0.20490	1.09590	0.04195	0.54901
.3	74	0.70151	0.20490	1.11380	0.04196	0.55894
.3	75	0.71141	0.20490	1.12990	0.04176	0.56767
.3	76	0.72141	0.20490	1.14406	0.04174	0.57534
.3	77	0.73152	0.20490	1.15568	0.04099	0.58124
.3	78	0.74177	0.20490	1.16445	0.04034	0.58563
.3	79	0.75216	0.20490	1.17057	0.03931	0.58844
.3	80	0.76271	0.20490	1.17353	0.03794	0.58942
.3	81	0.77343	0.20490	1.17330	0.03671	0.58877
.3	82	0.78433	0.20490	1.16999	0.03531	0.58641
.3	83	0.79543	0.20490	1.16368	0.03386	0.58243
.3	84	0.80675	0.20490	1.15470	0.03252	0.57701
.3	85	0.81829	0.20490	1.14312	0.03110	0.57011
.3	86	0.83007	0.20490	1.12920	0.02997	0.56196
.3	87	0.84211	0.20490	1.11305	0.02872	0.55242
.3	88	0.85441	0.20490	1.09486	0.02761	0.54167
.3	89	0.86699	0.20490	1.07471	0.02657	0.52967
.3	90	0.87986	0.20490	1.05264	0.02559	0.51641
.3	91	0.89304	0.20490	1.02876	0.02458	0.50187
.3	92	0.90654	0.20490	1.00306	0.02353	0.48599
.3	93	0.92037	0.20490	0.97526	0.02242	0.46856
.3	94	0.93455	0.20490	0.94433	0.02208	0.44940
.3	95	0.94908	0.20490	0.90931	0.02184	0.42748
.3	96	0.96294	0.20490	0.87171	0.02093	0.40329
.3	97	0.97438	0.20490	0.83532	0.01976	0.37947
.3	98	0.98305	0.20490	0.80263	0.01773	0.35729
.3	99	0.98962	0.20490	0.76862	0.02312	0.33918
.3	100	0.99460	0.20490	0.74223	0.01057	0.31371
.3	101	0.99837	0.20490	0.71881	0.01992	0.30532
.3	102	1.00000	0.20490	0.71881	0.01992	0.30532
.4	1	1.00000	0.21840	0.73978	-0.00454	0.30163
.4	2	0.99851	0.21840	0.71710	0.01971	0.30409
.4	3	0.99506	0.21840	0.72172	-0.00374	0.29044
.4	4	0.99050	0.21840	0.70815	0.01092	0.29214
.4	5	0.98449	0.21840	0.70783	0.00390	0.28691
.4	6	0.97656	0.21840	0.70074	0.00667	0.28435
.4	7	0.96609	0.21840	0.69595	0.00588	0.28072
.4	8	0.95341	0.21840	0.69124	0.00588	0.27771
.4	9	0.94010	0.21840	0.68730	0.00583	0.27516
.4	10	0.92713	0.21840	0.68384	0.00555	0.27275
.4	11	0.91447	0.21840	0.68063	0.00545	0.27064
.4	12	0.90212	0.21840	0.67738	0.00505	0.26828
.4	13	0.89006	0.21840	0.67421	0.00505	0.26627
.4	14	0.87828	0.21840	0.67106	0.00468	0.26399
.4	15	0.86676	0.21840	0.66791	0.00462	0.26195
.4	16	0.85551	0.21840	0.66490	0.00448	0.25994
.4	17	0.84449	0.21840	0.66175	0.00422	0.25776
.4	18	0.83371	0.21840	0.65864	0.00425	0.25581
.4	19	0.82315	0.21840	0.65558	0.00402	0.25371
.4	20	0.81279	0.21840	0.65257	0.00403	0.25182
.4	21	0.80263	0.21840	0.64965	0.00389	0.24988
.4	22	0.79265	0.21840	0.64677	0.00383	0.24803
.4	23	0.78284	0.21840	0.64402	0.00381	0.24628
.4	24	0.77319	0.21840	0.64134	0.00369	0.24451
.4	25	0.76368	0.21840	0.63880	0.00370	0.24293
.4	26	0.75430	0.21840	0.63647	0.00368	0.24145
.4	27	0.74505	0.21840	0.63424	0.00358	0.23998
.4	28	0.73589	0.21840	0.63221	0.00365	0.23876
.4	29	0.72684	0.21840	0.63038	0.00357	0.23756
.4	30	0.71786	0.21840	0.62878	0.00359	0.23658
.4	31	0.70895	0.21840	0.62744	0.00357	0.23574
.4	32	0.70010	0.21840	0.62642	0.00357	0.23510

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-23
	DILLNER WING: MACH = 0.70, ALPHA = 15			

4	33	0.69129	0.21840	0.62575	0.00356	0.23468
4	34	0.68251	0.21840	0.62552	0.00356	0.23454
4	35	0.67374	0.21840	0.62583	0.00354	0.23471
4	36	0.66499	0.21840	0.62681	0.00356	0.23534
4	37	0.65622	0.21840	0.62865	0.00349	0.23643
4	38	0.64775	0.21840	0.63149	0.00348	0.23819
4	39	0.64015	0.21840	0.63530	0.00370	0.24074
4	40	0.63360	0.21840	0.63990	0.00376	0.24365
4	41	0.62795	0.21840	0.64535	0.00368	0.24701
4	42	0.62308	0.21840	0.65161	0.00385	0.25108
4	43	0.61887	0.21840	0.65869	0.00368	0.25542
4	44	0.61525	0.21840	0.66661	0.00391	0.26060
4	45	0.61212	0.21840	0.67576	0.00317	0.26586
4	46	0.60943	0.21840	0.68517	0.00428	0.27268
4	47	0.60710	0.21840	0.69660	0.00196	0.27830
4	48	0.60510	0.21840	0.71018	0.00224	0.28723
4	49	0.60337	0.21840	0.72031	0.00293	0.29425
4	50	0.60188	0.21840	0.74057	-0.00830	0.29953
4	51	0.60059	0.21840	0.77602	-0.01855	0.31590
4	52	0.59999	0.21840	0.77602	-0.01855	0.31590
4	53	0.60188	0.21840	0.91357	0.03153	0.43579
4	54	0.60337	0.21840	0.91222	0.04763	0.44435
4	55	0.60510	0.21840	0.90641	0.04202	0.43751
4	56	0.60710	0.21840	0.90418	0.04935	0.44046
4	57	0.60943	0.21840	0.90466	0.04666	0.43917
4	58	0.61212	0.21840	0.90531	0.04830	0.44054
4	59	0.61525	0.21840	0.90664	0.04757	0.44091
4	60	0.61887	0.21840	0.90897	0.04736	0.44221
4	61	0.62308	0.21840	0.91246	0.04619	0.44365
4	62	0.62795	0.21840	0.91675	0.04521	0.44570
4	63	0.63360	0.21840	0.92190	0.04456	0.44845
4	64	0.64015	0.21840	0.92812	0.04415	0.45200
4	65	0.64776	0.21840	0.93585	0.04412	0.45668
4	66	0.65622	0.21840	0.94554	0.04445	0.46272
4	67	0.66499	0.21840	0.95659	0.04420	0.46923
4	68	0.67375	0.21840	0.96861	0.04460	0.47665
4	69	0.68251	0.21840	0.98155	0.04453	0.48433
4	70	0.69129	0.21840	0.99521	0.04465	0.49248
4	71	0.70010	0.21840	1.00949	0.04454	0.50082
4	72	0.70895	0.21840	1.02407	0.04451	0.50932
4	73	0.71786	0.21840	1.03878	0.04449	0.51783
4	74	0.72684	0.21840	1.05349	0.04455	0.52630
4	75	0.73589	0.21840	1.06782	0.04439	0.53439
4	76	0.74505	0.21840	1.08159	0.04457	0.54224
4	77	0.75431	0.21840	1.09431	0.04426	0.54921
4	78	0.76368	0.21840	1.10559	0.04418	0.55544
4	79	0.77319	0.21840	1.11541	0.04388	0.56071
4	80	0.78284	0.21840	1.12327	0.04313	0.56467
4	81	0.79265	0.21840	1.12894	0.04220	0.56734
4	82	0.80263	0.21840	1.13229	0.04082	0.56854
4	83	0.81279	0.21840	1.13303	0.03916	0.56820
4	84	0.82315	0.21840	1.13111	0.03744	0.56638
4	85	0.83371	0.21840	1.12637	0.03550	0.56291
4	86	0.84449	0.21840	1.11879	0.03383	0.55796
4	87	0.85550	0.21840	1.10829	0.03210	0.55132
4	88	0.86676	0.21840	1.09511	0.03050	0.54317
4	89	0.87828	0.21840	1.07945	0.02883	0.53348
4	90	0.89006	0.21840	1.06135	0.02707	0.52220
4	91	0.90212	0.21840	1.04086	0.02526	0.50934
4	92	0.91447	0.21840	1.01790	0.02335	0.49478
4	93	0.92713	0.21840	0.99211	0.02149	0.47830
4	94	0.94010	0.21840	0.96248	0.02062	0.45976
4	95	0.95340	0.21840	0.92829	0.01992	0.43822

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-24
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.4	96	0.96609	0.21840	0.89165	0.01810	0.41418
.4	97	0.97656	0.21840	0.85691	0.01624	0.39102
.4	98	0.98449	0.21840	0.82678	0.01309	0.36977
.4	99	0.99050	0.21840	0.79468	0.02100	0.35436
.4	100	0.99506	0.21840	0.77424	0.00472	0.33037
.4	101	0.99851	0.21840	0.76456	0.01069	0.32816
.4	102	1.00000	0.21840	0.76456	0.01069	0.32816
.5	1	1.00000	0.23500	0.78251	-0.00143	0.33163
.5	2	0.99868	0.23500	0.75161	0.02641	0.33063
.5	3	0.99562	0.23500	0.74922	-0.00141	0.30995
.5	4	0.99158	0.23500	0.72882	0.01540	0.30850
.5	5	0.98626	0.23500	0.72513	0.00633	0.29975
.5	6	0.97923	0.23500	0.71342	0.00978	0.29468
.5	7	0.96996	0.23500	0.70532	0.00833	0.28847
.5	8	0.95872	0.23500	0.69774	0.00819	0.28353
.5	9	0.94693	0.23500	0.69187	0.00789	0.27958
.5	10	0.93544	0.23500	0.68713	0.00734	0.27616
.5	11	0.92423	0.23500	0.68306	0.00703	0.27335
.5	12	0.91328	0.23500	0.67928	0.00643	0.27050
.5	13	0.90259	0.23500	0.67582	0.00623	0.26816
.5	14	0.89215	0.23500	0.67255	0.00567	0.26567
.5	15	0.88195	0.23500	0.66940	0.00542	0.26349
.5	16	0.87198	0.23500	0.66648	0.00510	0.26140
.5	17	0.86222	0.23500	0.66349	0.00467	0.25919
.5	18	0.85267	0.23500	0.66057	0.00452	0.25724
.5	19	0.84331	0.23500	0.65772	0.00415	0.25516
.5	20	0.83414	0.23500	0.65494	0.00401	0.25330
.5	21	0.82513	0.23500	0.65225	0.00374	0.25140
.5	22	0.81629	0.23500	0.64961	0.00356	0.24960
.5	23	0.80760	0.23500	0.64711	0.00341	0.24792
.5	24	0.79905	0.23500	0.64468	0.00319	0.24622
.5	25	0.79062	0.23500	0.64239	0.00309	0.24471
.5	26	0.78232	0.23500	0.64029	0.00298	0.24331
.5	27	0.77411	0.23500	0.63832	0.00279	0.24193
.5	28	0.76601	0.23500	0.63654	0.00277	0.24080
.5	29	0.75798	0.23500	0.63497	0.00262	0.23970
.5	30	0.75003	0.23500	0.63362	0.00257	0.23883
.5	31	0.74213	0.23500	0.63256	0.00249	0.23810
.5	32	0.73429	0.23500	0.63180	0.00243	0.23758
.5	33	0.72648	0.23500	0.63143	0.00237	0.23730
.5	34	0.71871	0.23500	0.63151	0.00231	0.23731
.5	35	0.71094	0.23500	0.63214	0.00224	0.23765
.5	36	0.70318	0.23500	0.63348	0.00220	0.23845
.5	37	0.69542	0.23500	0.63569	0.00211	0.23977
.5	38	0.68791	0.23500	0.63895	0.00206	0.24177
.5	39	0.68118	0.23500	0.64315	0.00227	0.24457
.5	40	0.67537	0.23500	0.64810	0.00233	0.24772
.5	41	0.67037	0.23500	0.65388	0.00225	0.25132
.5	42	0.66605	0.23500	0.66045	0.00246	0.25562
.5	43	0.66233	0.23500	0.66780	0.00230	0.26017
.5	44	0.65911	0.23500	0.67594	0.00256	0.26553
.5	45	0.65635	0.23500	0.68526	0.00186	0.27097
.5	46	0.65396	0.23500	0.69479	0.00294	0.27785
.5	47	0.65190	0.23500	0.70612	0.00075	0.28355
.5	48	0.65012	0.23500	0.71936	0.00113	0.29236
.5	49	0.64859	0.23500	0.72959	0.00137	0.29914
.5	50	0.64727	0.23500	0.74926	-0.00998	0.30407
.5	51	0.64613	0.23500	0.77729	-0.01468	0.31933
.5	52	0.64560	0.23500	0.77729	-0.01468	0.31933
.5	53	0.64727	0.23500	0.89543	0.04721	0.43386
.5	54	0.64859	0.23500	0.89409	0.06264	0.44222
.5	55	0.65012	0.23500	0.88863	0.05591	0.43491
.5	56	0.65190	0.23500	0.88704	0.06239	0.43782

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-25
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.5	57	0.65396	0.23500	0.88837	0.05822	0.43613
.5	58	0.65635	0.23500	0.88981	0.05849	0.43717
.5	59	0.65911	0.23500	0.89156	0.05645	0.43700
5	60	0.66233	0.23500	0.89399	0.05512	0.43769
.5	61	0.66605	0.23500	0.89728	0.05276	0.43829
5	62	0.67037	0.23500	0.90100	0.05066	0.43930
.5	63	0.67537	0.23500	0.90492	0.04893	0.44067
.5	64	0.68118	0.23500	0.90907	0.04769	0.44247
5	65	0.68791	0.23500	0.91370	0.04695	0.44485
5	66	0.69542	0.23500	0.91916	0.04664	0.44800
5	67	0.70318	0.23500	0.92534	0.04597	0.45136
5	68	0.71094	0.23500	0.93216	0.04581	0.45540
5	69	0.71871	0.23500	0.93963	0.04533	0.45965
.5	70	0.72648	0.23500	0.94767	0.04507	0.46435
.5	71	0.73429	0.23500	0.95625	0.04470	0.46930
.5	72	0.74213	0.23500	0.96526	0.04434	0.47451
.5	73	0.75003	0.23500	0.97469	0.04388	0.47989
.5	74	0.75798	0.23500	0.98453	0.04336	0.48547
5	75	0.76601	0.23500	0.99462	0.04257	0.49103
.5	76	0.77411	0.23500	1.00492	0.04198	0.49679
.5	77	0.78232	0.23500	1.01517	0.04104	0.50233
5	78	0.79062	0.23500	1.02501	0.04049	0.50780
5	79	0.79905	0.23500	1.03414	0.04012	0.51293
5	80	0.80760	0.23500	1.04233	0.03973	0.51748
.5	81	0.81629	0.23500	1.04934	0.03955	0.52144
5	82	0.82513	0.23500	1.05494	0.03936	0.52456
.5	83	0.83414	0.23500	1.05876	0.03924	0.52670
.5	84	0.84331	0.23500	1.06070	0.03923	0.52781
.5	85	0.85267	0.23500	1.06061	0.03897	0.52762
5	86	0.86222	0.23500	1.05846	0.03865	0.52623
.5	87	0.87198	0.23500	1.05428	0.03783	0.52343
.5	88	0.88195	0.23500	1.04790	0.03683	0.51925
.5	89	0.89215	0.23500	1.03917	0.03554	0.51354
.5	90	0.90259	0.23500	1.02799	0.03396	0.50620
.5	91	0.91328	0.23500	1.01431	0.03215	0.49720
.5	92	0.92422	0.23500	0.99793	0.03010	0.48638
.5	93	0.93544	0.23500	0.97835	0.02821	0.47359
.5	94	0.94693	0.23500	0.95461	0.02734	0.45866
.5	95	0.95872	0.23500	0.92638	0.02684	0.44100
.5	96	0.96996	0.23500	0.89619	0.02467	0.42094
.5	97	0.97923	0.23500	0.86827	0.02230	0.40195
.5	98	0.98626	0.23500	0.84463	0.01867	0.38471
5	99	0.99158	0.23500	0.81766	0.02908	0.37422
.5	100	0.99562	0.23500	0.80536	0.01003	0.35401
.5	101	0.99868	0.23500	0.81137	0.01107	0.35856
5	102	1.00000	0.23500	0.81137	0.01107	0.35856
.6	1	1.00000	0.25500	0.80756	-0.00077	0.34840
.6	2	0.99888	0.25500	0.77169	0.02639	0.34334
.6	3	0.99630	0.25500	0.76800	-0.00391	0.32049
.6	4	0.99289	0.25500	0.74543	0.01451	0.31849
6	5	0.98839	0.25500	0.74096	0.00409	0.30839
.6	6	0.98245	0.25500	0.72697	0.00819	0.30225
.6	7	0.97461	0.25500	0.71705	0.00628	0.29452
6	8	0.96512	0.25500	0.70733	0.00627	0.28828
.6	9	0.95516	0.25500	0.69972	0.00602	0.28323
6	10	0.94545	0.25500	0.69355	0.00552	0.27893
.6	11	0.93597	0.25500	0.68833	0.00531	0.27544
6	12	0.92672	0.25500	0.68365	0.00480	0.27209
6	13	0.91769	0.25500	0.67950	0.00470	0.26937
6	14	0.90887	0.25500	0.67574	0.00425	0.26665
6	15	0.90026	0.25500	0.67225	0.00410	0.26433
6	16	0.89183	0.25500	0.66912	0.00388	0.26217
6	17	0.88358	0.25500	0.66603	0.00355	0.25997

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-26
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.6	18	0.87551	0.25500	0.66311	0.00350	0.25808
.6	19	0.86760	0.25500	0.66032	0.00321	0.25610
.6	20	0.85985	0.25500	0.65766	0.00315	0.25437
.6	21	0.85224	0.25500	0.65513	0.00297	0.25264
.6	22	0.84477	0.25500	0.65269	0.00286	0.25102
.6	23	0.83743	0.25500	0.65040	0.00279	0.24952
.6	24	0.83020	0.25500	0.64821	0.00264	0.24803
.6	25	0.82308	0.25500	0.64617	0.00261	0.24672
.6	26	0.81607	0.25500	0.64434	0.00255	0.24553
.6	27	0.80913	0.25500	0.64264	0.00243	0.24437
.6	28	0.80228	0.25500	0.64114	0.00245	0.24344
.6	29	0.79550	0.25500	0.63986	0.00235	0.24257
.6	30	0.78878	0.25500	0.63882	0.00234	0.24191
.6	31	0.78211	0.25500	0.63806	0.00230	0.24140
.6	32	0.77548	0.25500	0.63763	0.00226	0.24110
.6	33	0.76889	0.25500	0.63758	0.00222	0.24104
.6	34	0.76232	0.25500	0.63799	0.00219	0.24127
.6	35	0.75576	0.25500	0.63896	0.00214	0.24184
.6	36	0.74920	0.25500	0.64063	0.00211	0.24287
.6	37	0.74264	0.25500	0.64318	0.00206	0.24442
.6	38	0.73630	0.25500	0.64674	0.00202	0.24664
.6	39	0.73061	0.25500	0.65119	0.00228	0.24964
.6	40	0.72570	0.25500	0.65631	0.00238	0.25294
.6	41	0.72147	0.25500	0.66219	0.00236	0.25664
.6	42	0.71782	0.25500	0.66878	0.00262	0.26102
.6	43	0.71468	0.25500	0.67606	0.00254	0.26559
.6	44	0.71196	0.25500	0.68401	0.00287	0.27090
.6	45	0.70962	0.25500	0.69304	0.00229	0.27626
.6	46	0.70761	0.25500	0.70216	0.00342	0.28292
.6	47	0.70587	0.25500	0.71284	0.00140	0.28835
.6	48	0.70437	0.25500	0.72495	0.00223	0.29675
.6	49	0.70307	0.25500	0.73461	0.00178	0.30268
.6	50	0.70195	0.25500	0.75249	-0.00826	0.30736
.6	51	0.70099	0.25500	0.77185	-0.00772	0.32044
.6	52	0.70054	0.25500	0.77185	-0.00772	0.32044
.6	53	0.70195	0.25500	0.86352	0.06687	0.42635
.6	54	0.70307	0.25500	0.86140	0.08215	0.43448
.6	55	0.70437	0.25500	0.85598	0.07520	0.42696
.6	56	0.70587	0.25500	0.85440	0.08150	0.42992
.6	57	0.70761	0.25500	0.85591	0.07681	0.42791
.6	58	0.70962	0.25500	0.85775	0.07632	0.42871
.6	59	0.71196	0.25500	0.85968	0.07357	0.42817
.6	60	0.71468	0.25500	0.86206	0.07163	0.42840
.6	61	0.71782	0.25500	0.86516	0.06860	0.42840
.6	62	0.72147	0.25500	0.86852	0.06571	0.42866
.6	63	0.72570	0.25500	0.87176	0.06310	0.42902
.6	64	0.73061	0.25500	0.87472	0.06100	0.42953
.6	65	0.73630	0.25500	0.87752	0.05933	0.43022
.6	66	0.74264	0.25500	0.88043	0.05803	0.43120
.6	67	0.74920	0.25500	0.88348	0.05658	0.43218
.6	68	0.75576	0.25500	0.88676	0.05556	0.43355
.6	69	0.76232	0.25500	0.89030	0.05431	0.43496
.6	70	0.76889	0.25500	0.89408	0.05321	0.43660
.6	71	0.77548	0.25500	0.89812	0.05202	0.43835
.6	72	0.78211	0.25500	0.90243	0.05078	0.44024
.6	73	0.78878	0.25500	0.90702	0.04940	0.44222
.6	74	0.79550	0.25500	0.91193	0.04790	0.44433
.6	75	0.80228	0.25500	0.91713	0.04604	0.44641
.6	76	0.80913	0.25500	0.92269	0.04407	0.44866
.6	77	0.81607	0.25500	0.92862	0.04152	0.45080
.6	78	0.82308	0.25500	0.93490	0.03859	0.45295
.6	79	0.83020	0.25500	0.94162	0.03529	0.45518
.6	80	0.83743	0.25500	0.94800	0.03228	0.45738

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-27
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.6	81	0.84477	0.25500	0.95348	0.03021	0.45957
.6	82	0.85224	0.25500	0.95782	0.02908	0.46159
.6	83	0.85985	0.25500	0.96080	0.02891	0.46331
.6	84	0.86760	0.25500	0.96242	0.02958	0.46467
.6	85	0.87551	0.25500	0.96275	0.03057	0.46541
6	86	0.88358	0.25500	0.96189	0.03177	0.46555
.6	87	0.89183	0.25500	0.95989	0.03263	0.46481
.6	88	0.90025	0.25500	0.95660	0.03333	0.46320
.6	89	0.90887	0.25500	0.95189	0.03373	0.46056
6	90	0.91769	0.25500	0.94568	0.03379	0.45681
.6	91	0.92672	0.25500	0.93787	0.03357	0.45191
6	92	0.93597	0.25500	0.92820	0.03317	0.44576
6	93	0.94545	0.25500	0.91611	0.03304	0.43824
6	94	0.95516	0.25500	0.90104	0.03354	0.42921
6	95	0.96512	0.25500	0.88353	0.03395	0.41858
6	96	0.97461	0.25500	0.86539	0.03218	0.40620
.6	97	0.98245	0.25500	0.84922	0.03013	0.39478
.6	98	0.98839	0.25500	0.83517	0.02739	0.38421
.6	99	0.99289	0.25500	0.81513	0.04037	0.37972
.6	100	0.99630	0.25500	0.81060	0.02149	0.36483
.6	101	0.99888	0.25500	0.82873	0.01748	0.37382
.6	102	1.00000	0.25500	0.82873	0.01748	0.37382
.7	1	1.00000	0.27500	0.79634	-0.01685	0.33050
.7	2	0.99909	0.27500	0.76631	0.00531	0.32563
.7	3	0.99698	0.27500	0.77296	-0.02242	0.31126
.7	4	0.99419	0.27500	0.75723	-0.00344	0.31378
.7	5	0.99052	0.27500	0.75675	-0.01309	0.30686
.7	6	0.98567	0.27500	0.74512	-0.00809	0.30266
.7	7	0.97927	0.27500	0.73643	-0.00949	0.29600
.7	8	0.97152	0.27500	0.72628	-0.00836	0.29015
.7	9	0.96339	0.27500	0.71752	-0.00755	0.28502
.7	10	0.95546	0.27500	0.70976	-0.00697	0.28038
.7	11	0.94772	0.27500	0.70278	-0.00606	0.27650
7	12	0.94017	0.27500	0.69635	-0.00546	0.27277
.7	13	0.93280	0.27500	0.69054	-0.00445	0.26976
.7	14	0.92559	0.27500	0.68524	-0.00380	0.26682
.7	15	0.91856	0.27500	0.68036	-0.00287	0.26436
.7	16	0.91168	0.27500	0.67601	-0.00207	0.26217
.7	17	0.90494	0.27500	0.67189	-0.00143	0.26000
.7	18	0.89835	0.27500	0.66812	-0.00064	0.25819
7	19	0.89190	0.27500	0.66469	-0.00018	0.25635
7	20	0.88557	0.27500	0.66156	0.00037	0.25476
.7	21	0.87936	0.27500	0.65870	0.00068	0.25318
.7	22	0.87326	0.27500	0.65603	0.00098	0.25171
.7	23	0.86726	0.27500	0.65359	0.00123	0.25036
.7	24	0.86136	0.27500	0.65133	0.00134	0.24902
7	25	0.85555	0.27500	0.64928	0.00151	0.24785
7	26	0.84981	0.27500	0.64747	0.00161	0.24679
.7	27	0.84416	0.27500	0.64586	0.00162	0.24578
.7	28	0.83856	0.27500	0.64448	0.00173	0.24499
7	29	0.83302	0.27500	0.64336	0.00170	0.24427
.7	30	0.82754	0.27500	0.64252	0.00173	0.24376
7	31	0.82209	0.27500	0.64199	0.00170	0.24341
7	32	0.81668	0.27500	0.64182	0.00167	0.24328
7	33	0.81129	0.27500	0.64203	0.00164	0.24339
.7	34	0.80593	0.27500	0.64271	0.00160	0.24378
7	35	0.80057	0.27500	0.64393	0.00158	0.24453
.7	36	0.79522	0.27500	0.64581	0.00156	0.24570
7	37	0.78986	0.27500	0.64855	0.00154	0.24741
7	38	0.78468	0.27500	0.65222	0.00150	0.24969
7	39	0.78004	0.27500	0.65666	0.00176	0.25270
7	40	0.77603	0.27500	0.66160	0.00188	0.25592
7	41	0.77258	0.27500	0.66716	0.00186	0.25943

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-28
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.7	42	0.76960	0.27500	0.67325	0.00213	0.26350
.7	43	0.76703	0.27500	0.67983	0.00205	0.26763
.7	44	0.76481	0.27500	0.68685	0.00238	0.27236
.7	45	0.76290	0.27500	0.69466	0.00182	0.27696
.7	46	0.76126	0.27500	0.70226	0.00297	0.28266
.7	47	0.75983	0.27500	0.71102	0.00092	0.28683
.7	48	0.75861	0.27500	0.72030	0.00240	0.29386
.7	49	0.75755	0.27500	0.72779	0.00022	0.29717
.7	50	0.75664	0.27500	0.73936	-0.00505	0.30100
.7	51	0.75585	0.27500	0.74950	-0.00521	0.30751
.7	52	0.75549	0.27500	0.74950	-0.00521	0.30751
.7	53	0.75664	0.27500	0.81785	0.05377	0.39025
.7	54	0.75755	0.27500	0.81370	0.06891	0.39749
.7	55	0.75861	0.27500	0.80765	0.06450	0.39095
.7	56	0.75983	0.27500	0.80497	0.07136	0.39379
.7	57	0.76126	0.27500	0.80536	0.06802	0.39185
.7	58	0.76290	0.27500	0.80636	0.06806	0.39249
.7	59	0.76481	0.27500	0.80735	0.06605	0.39178
.7	60	0.76703	0.27500	0.80860	0.06485	0.39176
.7	61	0.76960	0.27500	0.81040	0.06264	0.39141
.7	62	0.77258	0.27500	0.81237	0.06048	0.39122
.7	63	0.77603	0.27500	0.81410	0.05848	0.39099
.7	64	0.78004	0.27500	0.81542	0.05686	0.39074
.7	65	0.78468	0.27500	0.81644	0.05543	0.39045
.7	66	0.78986	0.27500	0.81744	0.05412	0.39022
.7	67	0.79522	0.27500	0.81844	0.05256	0.38983
.7	68	0.80057	0.27500	0.81952	0.05131	0.38970
.7	69	0.80593	0.27500	0.82074	0.04981	0.38948
.7	70	0.81129	0.27500	0.82209	0.04836	0.38939
.7	71	0.81668	0.27500	0.82361	0.04676	0.38931
.7	72	0.82209	0.27500	0.82531	0.04507	0.38927
.7	73	0.82754	0.27500	0.82720	0.04320	0.38926
.7	74	0.83302	0.27500	0.82931	0.04122	0.38931
.7	75	0.83856	0.27500	0.83156	0.03901	0.38931
.7	76	0.84416	0.27500	0.83388	0.03691	0.38943
.7	77	0.84981	0.27500	0.83606	0.03477	0.38944
.7	78	0.85555	0.27500	0.83779	0.03314	0.38949
.7	79	0.86136	0.27500	0.83872	0.03223	0.38950
.7	80	0.86726	0.27500	0.83845	0.03231	0.38938
.7	81	0.87326	0.27500	0.83688	0.03354	0.38917
.7	82	0.87935	0.27500	0.83440	0.03546	0.38883
.7	83	0.88557	0.27500	0.83159	0.03746	0.39834
.7	84	0.89190	0.27500	0.82885	0.03923	0.38775
.7	85	0.89835	0.27500	0.82630	0.04050	0.38697
.7	86	0.90494	0.27500	0.82389	0.04148	0.38609
.7	87	0.91167	0.27500	0.82148	0.04210	0.38499
.7	88	0.91856	0.27500	0.81895	0.04257	0.38372
.7	89	0.92559	0.27500	0.81631	0.04282	0.38223
.7	90	0.93280	0.27500	0.81356	0.04278	0.38049
.7	91	0.94017	0.27500	0.81064	0.04247	0.37848
.7	92	0.94772	0.27500	0.80733	0.04204	0.37613
.7	93	0.95546	0.27500	0.80318	0.04176	0.37336
.7	94	0.96339	0.27500	0.79782	0.04174	0.37000
.7	95	0.97152	0.27500	0.79148	0.04203	0.36623
.7	96	0.97927	0.27500	0.78547	0.04062	0.36154
.7	97	0.98567	0.27500	0.78110	0.03837	0.35731
.7	98	0.99052	0.27500	0.77758	0.03478	0.35270
.7	99	0.99419	0.27500	0.76616	0.04467	0.35222
.7	100	0.99698	0.27500	0.76555	0.03096	0.34254
.7	101	0.99909	0.27500	0.78557	0.02510	0.35128
.7	102	1.00000	0.27500	0.78557	0.02510	0.35128
.8	1	1.00000	0.29650	0.65781	0.05967	0.29674
.8	2	0.99931	0.29650	0.63783	0.07144	0.29384

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-29
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.8	3	0.99771	0.29650	0.65261	0.05462	0.28985
.8	4	0.99560	0.29650	0.64700	0.06790	0.29652
.8	5	0.99281	0.29650	0.65064	0.06212	0.29431
.8	6	0.98913	0.29650	0.64560	0.06463	0.29323
.8	7	0.98428	0.29650	0.64146	0.06287	0.28945
.8	8	0.97840	0.29650	0.63569	0.06196	0.28537
.8	9	0.97223	0.29650	0.63038	0.06034	0.28100
.8	10	0.96622	0.29650	0.62563	0.05807	0.27647
.8	11	0.96035	0.29650	0.62166	0.05565	0.27227
.8	12	0.95462	0.29650	0.61864	0.05252	0.26808
.8	13	0.94903	0.29650	0.61683	0.04926	0.26450
.8	14	0.94357	0.29650	0.61635	0.04522	0.26108
.8	15	0.93823	0.29650	0.61715	0.04088	0.25821
.8	16	0.93301	0.29650	0.61928	0.03598	0.25569
.8	17	0.92791	0.29650	0.62241	0.03050	0.25335
.8	18	0.92291	0.29650	0.62640	0.02490	0.25146
.8	19	0.91801	0.29650	0.63077	0.01919	0.24975
.8	20	0.91321	0.29650	0.63475	0.01445	0.24859
.8	21	0.90850	0.29650	0.63800	0.01070	0.24775
.8	22	0.90387	0.29650	0.64062	0.00786	0.24722
.8	23	0.89933	0.29650	0.64278	0.00569	0.24692
.8	24	0.89485	0.29650	0.64451	0.00396	0.24671
.8	25	0.89044	0.29650	0.64588	0.00277	0.24666
.8	26	0.88609	0.29650	0.64698	0.00191	0.24670
.8	27	0.88180	0.29650	0.64789	0.00125	0.24678
.8	28	0.87756	0.29650	0.64871	0.00087	0.24701
.8	29	0.87336	0.29650	0.64950	0.00055	0.24727
.8	30	0.86920	0.29650	0.65032	0.00041	0.24768
.8	31	0.86507	0.29650	0.65120	0.00036	0.24820
.8	32	0.86096	0.29650	0.65220	0.00045	0.24889
.8	33	0.85688	0.29650	0.65345	0.00057	0.24978
.8	34	0.85281	0.29650	0.65511	0.00063	0.25087
.8	35	0.84875	0.29650	0.65727	0.00069	0.25228
.8	36	0.84468	0.29650	0.66000	0.00070	0.25402
.8	37	0.84062	0.29650	0.66346	0.00078	0.25628
.8	38	0.83670	0.29650	0.66768	0.00081	0.25898
.8	39	0.83317	0.29650	0.67247	0.00115	0.26228
.8	40	0.83013	0.29650	0.67754	0.00134	0.26565
.8	41	0.82751	0.29650	0.68308	0.00139	0.26923
.8	42	0.82525	0.29650	0.68901	0.00177	0.27330
.8	43	0.82331	0.29650	0.69530	0.00180	0.27735
.8	44	0.82163	0.29650	0.70194	0.00225	0.28194
.8	45	0.82018	0.29650	0.70933	0.00179	0.28636
.8	46	0.81893	0.29650	0.71639	0.00308	0.29182
.8	47	0.81785	0.29650	0.72459	0.00106	0.29568
.8	48	0.81692	0.29650	0.73323	0.00255	0.30232
.8	49	0.81612	0.29650	0.73992	0.00046	0.30519
.8	50	0.81543	0.29650	0.75080	-0.00564	0.30806
.8	51	0.81483	0.29650	0.76065	-0.00625	0.31409
.8	52	0.81455	0.29650	0.76065	-0.00625	0.31409
.8	53	0.81543	0.29650	0.81613	0.05751	0.39160
.8	54	0.81612	0.29650	0.81129	0.07194	0.39800
.8	55	0.81692	0.29650	0.80723	0.06551	0.39136
.8	56	0.81785	0.29650	0.80581	0.06980	0.39329
.8	57	0.81893	0.29650	0.80652	0.06533	0.39081
.8	58	0.82018	0.29650	0.80701	0.06461	0.39063
.8	59	0.82163	0.29650	0.80718	0.06218	0.38916
.8	60	0.82331	0.29650	0.80733	0.06065	0.38825
.8	61	0.82525	0.29650	0.80771	0.05832	0.38697
.8	62	0.82751	0.29650	0.80792	0.05619	0.38571
.8	63	0.83013	0.29650	0.80761	0.05431	0.38429
.8	64	0.83317	0.29650	0.80666	0.05280	0.38272
.8	65	0.83670	0.29650	0.80518	0.05141	0.38091

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-30
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.8	66	0.84062	0.29650	0.80345	0.05017	0.37903
.8	67	0.84469	0.29650	0.80156	0.04888	0.37701
.8	68	0.84875	0.29650	0.79973	0.04794	0.37526
.8	69	0.85281	0.29650	0.79809	0.04671	0.37344
.8	70	0.85688	0.29650	0.79671	0.04542	0.37173
.8	71	0.86096	0.29650	0.79563	0.04386	0.37003
.8	72	0.86507	0.29650	0.79482	0.04210	0.36836
.8	73	0.86920	0.29650	0.79417	0.04020	0.36671
.8	74	0.87336	0.29650	0.79349	0.03841	0.36510
.8	75	0.87756	0.29650	0.79238	0.03695	0.36343
.8	76	0.88180	0.29650	0.79042	0.03641	0.36185
.8	77	0.88609	0.29650	0.78714	0.03692	0.36013
.8	78	0.89044	0.29650	0.78219	0.03892	0.35836
.8	79	0.89485	0.29650	0.77575	0.04199	0.35639
.8	80	0.89933	0.29650	0.76881	0.04511	0.35418
.8	81	0.90387	0.29650	0.76311	0.04629	0.35143
.8	82	0.90850	0.29650	0.76044	0.04443	0.34851
.8	83	0.91321	0.29650	0.75870	0.04208	0.34582
.8	84	0.91801	0.29650	0.75648	0.04034	0.34324
.8	85	0.92291	0.29650	0.75337	0.03957	0.34078
.8	86	0.92791	0.29650	0.74934	0.03969	0.33834
.8	87	0.93301	0.29650	0.74514	0.03984	0.33582
.8	88	0.93823	0.29650	0.74120	0.03974	0.33331
.8	89	0.94357	0.29650	0.73761	0.03933	0.33078
.8	90	0.94903	0.29650	0.73430	0.03869	0.32827
.8	91	0.95462	0.29650	0.73118	0.03786	0.32575
.8	92	0.96035	0.29650	0.72806	0.03707	0.32324
.8	93	0.96622	0.29650	0.72461	0.03651	0.32070
.8	94	0.97223	0.29650	0.72062	0.03638	0.31811
.8	95	0.97840	0.29650	0.71633	0.03698	0.31587
.8	96	0.98428	0.29650	0.71301	0.03668	0.31359
.8	97	0.98913	0.29650	0.71176	0.03548	0.31196
.8	98	0.99281	0.29650	0.71177	0.03295	0.31016
.8	99	0.99560	0.29650	0.70541	0.03930	0.31075
.8	100	0.99771	0.29650	0.70254	0.03291	0.30438
.8	101	0.99931	0.29650	0.71007	0.03363	0.30958
.8	102	1.00000	0.29650	0.71007	0.03363	0.30958
.9	1	1.00000	0.31300	0.61613	0.07624	0.28497
.9	2	0.99948	0.31300	0.60477	0.08243	0.28332
.9	3	0.99827	0.31300	0.62018	0.07094	0.28320
.9	4	0.99667	0.31300	0.62237	0.07831	0.29014
.9	5	0.99457	0.31300	0.62948	0.07335	0.29044
.9	6	0.99179	0.31300	0.63008	0.07337	0.29080
.9	7	0.98812	0.31300	0.63070	0.07000	0.28858
.9	8	0.98368	0.31300	0.62985	0.06662	0.28550
.9	9	0.97902	0.31300	0.62897	0.06248	0.28182
.9	10	0.97448	0.31300	0.62798	0.05783	0.27767
.9	11	0.97004	0.31300	0.62724	0.05291	0.27346
.9	12	0.96571	0.31300	0.62685	0.04729	0.26892
.9	13	0.96149	0.31300	0.62707	0.04158	0.26466
.9	14	0.95736	0.31300	0.62796	0.03522	0.26032
.9	15	0.95333	0.31300	0.62950	0.02881	0.25634
.9	16	0.94939	0.31300	0.63176	0.02216	0.25263
.9	17	0.94553	0.31300	0.63436	0.01545	0.24911
.9	18	0.94175	0.31300	0.63706	0.00922	0.24604
.9	19	0.93805	0.31300	0.63952	0.00343	0.24317
.9	20	0.93442	0.31300	0.64146	-0.00135	0.24077
.9	21	0.93087	0.31300	0.64286	-0.00534	0.23862
.9	22	0.92737	0.31300	0.64384	-0.00853	0.23683
.9	23	0.92393	0.31300	0.64456	-0.01103	0.23540
.9	24	0.92055	0.31300	0.64503	-0.01300	0.23421
.9	25	0.91722	0.31300	0.64535	-0.01440	0.23335
.9	26	0.91394	0.31300	0.64559	-0.01543	0.23273

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-31
	DILLNER WING: MACH = 0.70, ALPHA = 15			

9	27	0.91069	0.31300	0.64579	-0.01617	0.23230
9	28	0.90749	0.31300	0.64603	-0.01658	0.23214
9	29	0.90432	0.31300	0.64634	-0.01684	0.23214
9	30	0.90117	0.31300	0.64676	-0.01685	0.23240
9	31	0.89805	0.31300	0.64732	-0.01669	0.23289
9	32	0.89495	0.31300	0.64811	-0.01638	0.23363
9	33	0.89186	0.31300	0.64922	-0.01598	0.23463
9	34	0.88879	0.31300	0.65073	-0.01556	0.23592
9	35	0.88572	0.31300	0.65275	-0.01506	0.23760
9	36	0.88265	0.31300	0.65536	-0.01455	0.23966
9	37	0.87958	0.31300	0.65870	-0.01388	0.24230
9	38	0.87661	0.31300	0.66283	-0.01325	0.24543
9	39	0.87395	0.31300	0.66756	-0.01234	0.24915
9	40	0.87166	0.31300	0.67253	-0.01168	0.25285
9	41	0.86968	0.31300	0.67791	-0.01114	0.25672
9	42	0.86797	0.31300	0.68359	-0.01036	0.26096
9	43	0.86650	0.31300	0.68955	-0.00993	0.26513
9	44	0.86523	0.31300	0.69574	-0.00910	0.26975
9	45	0.86413	0.31300	0.70253	-0.00921	0.27407
9	46	0.86319	0.31300	0.70897	-0.00772	0.27933
9	47	0.86237	0.31300	0.71629	-0.00937	0.28291
9	48	0.86167	0.31300	0.72364	-0.00760	0.28897
9	49	0.86107	0.31300	0.72981	-0.01029	0.29111
9	50	0.86054	0.31300	0.73889	-0.01642	0.29279
9	51	0.86009	0.31300	0.73662	-0.01062	0.29533
9	52	0.85988	0.31300	0.73662	-0.01062	0.29533
9	53	0.86054	0.31300	0.76291	0.04706	0.35183
9	54	0.86107	0.31300	0.75840	0.05964	0.35763
9	55	0.86167	0.31300	0.75723	0.05251	0.35203
9	56	0.86237	0.31300	0.75701	0.05475	0.35344
9	57	0.86319	0.31300	0.75786	0.05076	0.35123
9	58	0.86413	0.31300	0.75813	0.04989	0.35080
9	59	0.86523	0.31300	0.75845	0.04724	0.34919
9	60	0.86650	0.31300	0.75877	0.04525	0.34802
9	61	0.86797	0.31300	0.75911	0.04259	0.34642
9	62	0.86968	0.31300	0.75908	0.04022	0.34478
9	63	0.87166	0.31300	0.75852	0.03802	0.34294
9	64	0.87395	0.31300	0.75742	0.03608	0.34092
9	65	0.87661	0.31300	0.75586	0.03414	0.33861
9	66	0.87958	0.31300	0.75404	0.03243	0.33629
9	67	0.88265	0.31300	0.75214	0.03067	0.33389
9	68	0.88572	0.31300	0.75031	0.02932	0.33181
9	69	0.88879	0.31300	0.74864	0.02784	0.32973
9	70	0.89186	0.31300	0.74713	0.02649	0.32785
9	71	0.89495	0.31300	0.74573	0.02515	0.32603
9	72	0.89805	0.31300	0.74434	0.02397	0.32434
9	73	0.90117	0.31300	0.74275	0.02308	0.32272
9	74	0.90432	0.31300	0.74070	0.02281	0.32123
9	75	0.90749	0.31300	0.73783	0.02335	0.31979
9	76	0.91069	0.31300	0.73384	0.02513	0.31850
9	77	0.91394	0.31300	0.72852	0.02808	0.31722
9	78	0.91722	0.31300	0.72198	0.03223	0.31603
9	79	0.92055	0.31300	0.71486	0.03685	0.31487
9	80	0.92393	0.31300	0.70836	0.04084	0.31368
9	81	0.92737	0.31300	0.70384	0.04301	0.31244
9	82	0.93086	0.31300	0.70172	0.04296	0.31110
9	83	0.93442	0.31300	0.70052	0.04215	0.30978
9	84	0.93805	0.31300	0.69890	0.04176	0.30850
9	85	0.94175	0.31300	0.69646	0.04207	0.30722
9	86	0.94553	0.31300	0.69360	0.04290	0.30606
9	87	0.94939	0.31300	0.69074	0.04388	0.30502
9	88	0.95333	0.31300	0.68817	0.04473	0.30405
9	89	0.95736	0.31300	0.68600	0.04532	0.30316

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-32
	DILLNER WING: MACH = 0.70, ALPHA = 15			

.9	90	0.96149	0.31300	0.68422	0.04570	0.30235
.9	91	0.96571	0.31300	0.68279	0.04586	0.30160
.9	92	0.97004	0.31300	0.68159	0.04603	0.30099
.9	93	0.97447	0.31300	0.68043	0.04629	0.30047
.9	94	0.97902	0.31300	0.67922	0.04673	0.30005
9	95	0.98368	0.31300	0.67772	0.04797	0.30005
.9	96	0.98812	0.31300	0.67593	0.04903	0.29974
.9	97	0.99179	0.31300	0.67411	0.04967	0.29911
.9	98	0.99457	0.31300	0.67246	0.04822	0.29704
.9	99	0.99667	0.31300	0.66543	0.05335	0.29659
.9	100	0.99827	0.31300	0.66020	0.04659	0.28840
L9	101	0.99948	0.31300	0.65427	0.05626	0.29208
.9	102	1.00000	0.31300	0.65427	0.05626	0.29208
20	1	1.00000	0.32350	0.61551	0.05024	0.26448
20	2	0.99959	0.32350	0.61322	0.06385	0.27368
20	3	0.99862	0.32350	0.62874	0.05889	0.27893
20	4	0.99736	0.32350	0.63466	0.06490	0.28700
20	5	0.99568	0.32350	0.64235	0.06157	0.28900
20	6	0.99348	0.32350	0.64509	0.06072	0.28997
20	7	0.99057	0.32350	0.64757	0.05686	0.28853
20	8	0.98704	0.32350	0.64896	0.05237	0.28597
20	9	0.98334	0.32350	0.65011	0.04701	0.28263
20	10	0.97973	0.32350	0.65072	0.04132	0.27872
20	11	0.97621	0.32350	0.65126	0.03550	0.27466
20	12	0.97277	0.32350	0.65172	0.02910	0.27013
20	13	0.96942	0.32350	0.65222	0.02284	0.26574
20	14	0.96614	0.32350	0.65277	0.01619	0.26108
20	15	0.96294	0.32350	0.65331	0.00977	0.25660
20	16	0.95981	0.32350	0.65392	0.00343	0.25222
20	17	0.95674	0.32350	0.65431	-0.00275	0.24783
20	18	0.95374	0.32350	0.65450	-0.00829	0.24380
20	19	0.95080	0.32350	0.65442	-0.01350	0.23984
20	20	0.94792	0.32350	0.65406	-0.01799	0.23624
20	21	0.94510	0.32350	0.65349	-0.02202	0.23284
20	22	0.94232	0.32350	0.65274	-0.02554	0.22972
20	23	0.93959	0.32350	0.65191	-0.02860	0.22688
20	24	0.93691	0.32350	0.65104	-0.03132	0.22427
20	25	0.93426	0.32350	0.65019	-0.03365	0.22197
20	26	0.93165	0.32350	0.64944	-0.03572	0.21991
20	27	0.92908	0.32350	0.64880	-0.03760	0.21807
20	28	0.92653	0.32350	0.64830	-0.03921	0.21653
20	29	0.92401	0.32350	0.64795	-0.04069	0.21519
20	30	0.92152	0.32350	0.64779	-0.04196	0.21412
20	31	0.91904	0.32350	0.64782	-0.04310	0.21329
20	32	0.91658	0.32350	0.64808	-0.04412	0.21269
20	33	0.91412	0.32350	0.64864	-0.04503	0.21237
20	34	0.91168	0.32350	0.64954	-0.04588	0.21232
20	35	0.90924	0.32350	0.65086	-0.04661	0.21265
20	36	0.90681	0.32350	0.65266	-0.04727	0.21334
20	37	0.90437	0.32350	0.65499	-0.04772	0.21455
20	38	0.90201	0.32350	0.65783	-0.04812	0.21614
20	39	0.89990	0.32350	0.66105	-0.04814	0.21826
20	40	0.89808	0.32350	0.66443	-0.04830	0.22039
20	41	0.89651	0.32350	0.66815	-0.04851	0.22271
20	42	0.89515	0.32350	0.67211	-0.04847	0.22540
20	43	0.89398	0.32350	0.67634	-0.04876	0.22801
20	44	0.89297	0.32350	0.68078	-0.04862	0.23109
20	45	0.89210	0.32350	0.68578	-0.04938	0.23389
20	46	0.89135	0.32350	0.69054	-0.04857	0.23767
20	47	0.89071	0.32350	0.69623	-0.05085	0.23987
20	48	0.89015	0.32350	0.70173	-0.04884	0.24503
20	49	0.88967	0.32350	0.70798	-0.05360	0.24584
20	50	0.88925	0.32350	0.71556	-0.05452	0.25034

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-33
	DILLNER WING: MACH = 0.70, ALPHA = 15			

'0	51	0.88890	0.32350	0.71612	-0.06337	0.24444
'0	52	0.88873	0.32350	0.71612	-0.06337	0.24444
'0	53	0.88925	0.32350	0.70633	0.09809	0.35347
'0	54	0.88967	0.32350	0.70353	0.10955	0.36007
'0	55	0.89015	0.32350	0.70439	0.09848	0.35262
'0	56	0.89071	0.32350	0.70441	0.09975	0.35354
'0	57	0.89135	0.32350	0.70491	0.09495	0.35038
'0	58	0.89210	0.32350	0.70479	0.09345	0.34924
'0	59	0.89297	0.32350	0.70476	0.09018	0.34687
'0	60	0.89398	0.32350	0.70455	0.08774	0.34500
'0	61	0.89515	0.32350	0.70424	0.08477	0.34268
'0	62	0.89651	0.32350	0.70355	0.08210	0.34035
'0	63	0.89808	0.32350	0.70250	0.07947	0.33784
'0	64	0.89990	0.32350	0.70110	0.07703	0.33526
'0	65	0.90202	0.32350	0.69955	0.07439	0.33243
'0	66	0.90437	0.32350	0.69810	0.07179	0.32969
'0	67	0.90681	0.32350	0.69685	0.06898	0.32691
'0	68	0.90925	0.32350	0.69578	0.06632	0.32434
'0	69	0.91168	0.32350	0.69484	0.06350	0.32174
'0	70	0.91412	0.32350	0.69395	0.06083	0.31927
'0	71	0.91658	0.32350	0.69304	0.05824	0.31684
'0	72	0.91904	0.32350	0.69200	0.05591	0.31452
'0	73	0.92152	0.32350	0.69066	0.05394	0.31228
'0	74	0.92401	0.32350	0.68884	0.05255	0.31017
'0	75	0.92653	0.32350	0.68635	0.05184	0.30813
'0	76	0.92908	0.32350	0.68301	0.05200	0.30622
'0	77	0.93165	0.32350	0.67878	0.05297	0.30437
'0	78	0.93426	0.32350	0.67381	0.05465	0.30260
'0	79	0.93691	0.32350	0.66853	0.05659	0.30086
'0	80	0.93959	0.32350	0.66364	0.05821	0.29914
'0	81	0.94232	0.32350	0.65981	0.05898	0.29742
'0	82	0.94510	0.32350	0.65718	0.05882	0.29573
'0	83	0.94792	0.32350	0.65519	0.05825	0.29411
'0	84	0.95080	0.32350	0.65316	0.05782	0.29258
'0	85	0.95374	0.32350	0.65071	0.05786	0.29115
'0	86	0.95674	0.32350	0.64788	0.05825	0.28976
'0	87	0.95981	0.32350	0.64483	0.05894	0.28847
'0	88	0.96294	0.32350	0.64172	0.05975	0.28724
'0	89	0.96614	0.32350	0.63868	0.06061	0.28610
'0	90	0.96942	0.32350	0.63574	0.06162	0.28514
'0	91	0.97277	0.32350	0.63294	0.06263	0.28425
'0	92	0.97621	0.32350	0.63025	0.06391	0.28366
'0	93	0.97973	0.32350	0.62761	0.06535	0.28322
'0	94	0.98334	0.32350	0.62511	0.06697	0.28300
'0	95	0.98704	0.32350	0.62246	0.06930	0.28326
'0	96	0.99057	0.32350	0.61966	0.07191	0.28366
'0	97	0.99348	0.32350	0.61676	0.07430	0.28383
'0	98	0.99568	0.32350	0.61412	0.07401	0.28209
'0	99	0.99736	0.32350	0.60678	0.07757	0.28066
'0	100	0.99862	0.32350	0.60253	0.06834	0.27102
'0	101	0.99959	0.32350	0.58874	0.07739	0.27031
'0	102	1.00000	0.32350	0.58874	0.07739	0.27031
'1	1	1.00000	0.33450	0.61551	0.05024	0.26448
'1	2	0.99970	0.33450	0.61322	0.06385	0.27368
'1	3	0.99900	0.33450	0.62874	0.05889	0.27893
'1	4	0.99807	0.33450	0.63466	0.06490	0.28700
'1	5	0.99686	0.33450	0.64235	0.06157	0.28900
'1	6	0.99525	0.33450	0.64509	0.06072	0.28997
'1	7	0.99313	0.33450	0.64757	0.05686	0.28853
'1	8	0.99056	0.33450	0.64896	0.05237	0.28597
'1	9	0.98786	0.33450	0.65011	0.04701	0.28263
'1	10	0.98524	0.33450	0.65072	0.04132	0.27872
'1	11	0.98267	0.33450	0.65126	0.03550	0.27466

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-34
	DILLNER WING: MACH = 0.70, ALPHA = 15			

1	12	0.98017	0.33450	0.65172	0.02910	0.27013
1	13	0.97772	0.33450	0.65222	0.02284	0.26574
1	14	0.97534	0.33450	0.65277	0.01619	0.26108
1	15	0.97300	0.33450	0.65331	0.00977	0.25660
1	16	0.97072	0.33450	0.65392	0.00343	0.25222
1	17	0.96849	0.33450	0.65431	-0.00275	0.24783
1	18	0.96631	0.33450	0.65450	-0.00829	0.24380
1	19	0.96417	0.33450	0.65442	-0.01350	0.23984
1	20	0.96207	0.33450	0.65406	-0.01799	0.23624
1	21	0.96001	0.33450	0.65349	-0.02202	0.23284
1	22	0.95799	0.33450	0.65274	-0.02554	0.22972
1	23	0.95600	0.33450	0.65191	-0.02860	0.22688
1	24	0.95404	0.33450	0.65104	-0.03132	0.22427
1	25	0.95212	0.33450	0.65019	-0.03365	0.22197
1	26	0.95022	0.33450	0.64944	-0.03572	0.21991
1	27	0.94834	0.33450	0.64880	-0.03760	0.21807
1	28	0.94649	0.33450	0.64830	-0.03921	0.21653
1	29	0.94465	0.33450	0.64795	-0.04069	0.21519
1	30	0.94283	0.33450	0.64779	-0.04196	0.21412
1	31	0.94103	0.33450	0.64782	-0.04310	0.21329
1	32	0.93923	0.33450	0.64808	-0.04412	0.21269
1	33	0.93745	0.33450	0.64864	-0.04503	0.21237
1	34	0.93567	0.33450	0.64954	-0.04588	0.21232
1	35	0.93389	0.33450	0.65086	-0.04661	0.21265
1	36	0.93212	0.33450	0.65266	-0.04727	0.21334
1	37	0.93034	0.33450	0.65499	-0.04772	0.21455
1	38	0.92863	0.33450	0.65783	-0.04812	0.21614
1	39	0.92709	0.33450	0.66105	-0.04814	0.21826
1	40	0.92576	0.33450	0.66443	-0.04830	0.22039
1	41	0.92461	0.33450	0.66815	-0.04851	0.22271
1	42	0.92363	0.33450	0.67211	-0.04847	0.22540
1	43	0.92278	0.33450	0.67634	-0.04876	0.22801
1	44	0.92204	0.33450	0.68078	-0.04862	0.23109
1	45	0.92141	0.33450	0.68578	-0.04938	0.23389
1	46	0.92086	0.33450	0.69054	-0.04857	0.23767
1	47	0.92039	0.33450	0.69623	-0.05085	0.23987
1	48	0.91998	0.33450	0.70173	-0.04884	0.24503
1	49	0.91963	0.33450	0.70798	-0.05360	0.24584
1	50	0.91933	0.33450	0.71556	-0.05452	0.25034
1	51	0.91907	0.33450	0.71612	-0.06337	0.24444
1	52	0.91895	0.33450	0.71612	-0.06337	0.24444
1	53	0.91933	0.33450	0.70633	0.09809	0.35347
1	54	0.91963	0.33450	0.70353	0.10955	0.36007
1	55	0.91998	0.33450	0.70439	0.09848	0.35262
1	56	0.92039	0.33450	0.70441	0.09975	0.35354
1	57	0.92086	0.33450	0.70491	0.09495	0.35038
1	58	0.92141	0.33450	0.70479	0.09345	0.34924
1	59	0.92204	0.33450	0.70476	0.09018	0.34687
1	60	0.92278	0.33450	0.70455	0.08774	0.34500
1	61	0.92363	0.33450	0.70424	0.08477	0.34268
1	62	0.92461	0.33450	0.70355	0.08210	0.34035
1	63	0.92576	0.33450	0.70250	0.07947	0.33784
1	64	0.92709	0.33450	0.70110	0.07703	0.33526
1	65	0.92863	0.33450	0.69955	0.07439	0.33243
1	66	0.93034	0.33450	0.69810	0.07179	0.32969
1	67	0.93212	0.33450	0.69685	0.06898	0.32691
1	68	0.93389	0.33450	0.69578	0.06632	0.32434
1	69	0.93567	0.33450	0.69484	0.06350	0.32174
1	70	0.93745	0.33450	0.69395	0.06083	0.31927
1	71	0.93923	0.33450	0.69304	0.05824	0.31684
1	72	0.94103	0.33450	0.69200	0.05591	0.31452
1	73	0.94283	0.33450	0.69066	0.05394	0.31228
1	74	0.94465	0.33450	0.68884	0.05255	0.31017

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-35
	DILLNER WING: MACH = 0.70, ALPHA = 15			

'1	75	0.94649	0.33450	0.68635	0.05184	0.30813
'1	76	0.94834	0.33450	0.68301	0.05200	0.30622
'1	77	0.95022	0.33450	0.67878	0.05297	0.30437
'1	78	0.95212	0.33450	0.67381	0.05465	0.30260
'1	79	0.95404	0.33450	0.66853	0.05659	0.30086
'1	80	0.95600	0.33450	0.66364	0.05821	0.29914
'1	81	0.95799	0.33450	0.65981	0.05898	0.29742
'1	82	0.96001	0.33450	0.65718	0.05882	0.29573
'1	83	0.96207	0.33450	0.65519	0.05825	0.29411
'1	84	0.96417	0.33450	0.65316	0.05782	0.29258
'1	85	0.96631	0.33450	0.65071	0.05786	0.29115
'1	86	0.96849	0.33450	0.64788	0.05825	0.28976
'1	87	0.97072	0.33450	0.64483	0.05894	0.28847
'1	88	0.97300	0.33450	0.64172	0.05975	0.28724
'1	89	0.97534	0.33450	0.63868	0.06061	0.28610
'1	90	0.97772	0.33450	0.63574	0.06162	0.28514
'1	91	0.98017	0.33450	0.63294	0.06263	0.28425
'1	92	0.98267	0.33450	0.63025	0.06391	0.28366
'1	93	0.98523	0.33450	0.62761	0.06535	0.28322
'1	94	0.98786	0.33450	0.62511	0.06697	0.28300
'1	95	0.99056	0.33450	0.62246	0.06930	0.28326
'1	96	0.99313	0.33450	0.61966	0.07191	0.28366
'1	97	0.99525	0.33450	0.61676	0.07430	0.28383
'1	98	0.99686	0.33450	0.61412	0.07401	0.28209
'1	99	0.99807	0.33450	0.60678	0.07757	0.28066
'1	100	0.99900	0.33450	0.60253	0.06834	0.27102
'1	101	0.99970	0.33450	0.58874	0.07739	0.27031
'1	102	1.00000	0.33450	0.58874	0.07739	0.27031
'2	1	1.00000	0.34000	0.61551	0.05024	0.26448
'2	2	0.99975	0.34000	0.61322	0.06385	0.27368
'2	3	0.99918	0.34000	0.62874	0.05883	0.27893
'2	4	0.99843	0.34000	0.63466	0.06490	0.28700
'2	5	0.99744	0.34000	0.64235	0.06157	0.28900
'2	6	0.99614	0.34000	0.64509	0.06072	0.28997
'2	7	0.99441	0.34000	0.64757	0.05686	0.28853
'2	8	0.99232	0.34000	0.64896	0.05237	0.28597
'2	9	0.99013	0.34000	0.65011	0.04701	0.28263
'2	10	0.98799	0.34000	0.65072	0.04132	0.27872
'2	11	0.98590	0.34000	0.65126	0.03550	0.27466
'2	12	0.98386	0.34000	0.65172	0.02910	0.27013
'2	13	0.98188	0.34000	0.65222	0.02284	0.26574
'2	14	0.97993	0.34000	0.65277	0.01619	0.26108
'2	15	0.97804	0.34000	0.65331	0.00977	0.25660
'2	16	0.97618	0.34000	0.65392	0.00343	0.25222
'2	17	0.97436	0.34000	0.65431	-0.00275	0.24783
'2	18	0.97259	0.34000	0.65450	-0.00829	0.24380
'2	19	0.97085	0.34000	0.65442	-0.01350	0.23984
'2	20	0.96914	0.34000	0.65406	-0.01799	0.23624
'2	21	0.96746	0.34000	0.65349	-0.02202	0.23284
'2	22	0.96582	0.34000	0.65274	-0.02554	0.22972
'2	23	0.96420	0.34000	0.65191	-0.02860	0.22688
'2	24	0.96261	0.34000	0.65104	-0.03132	0.22427
'2	25	0.96104	0.34000	0.65019	-0.03365	0.22197
'2	26	0.95950	0.34000	0.64944	-0.03572	0.21991
'2	27	0.95797	0.34000	0.64880	-0.03760	0.21807
'2	28	0.95646	0.34000	0.64830	-0.03921	0.21653
'2	29	0.95497	0.34000	0.64795	-0.04069	0.21519
'2	30	0.95349	0.34000	0.64779	-0.04196	0.21412
'2	31	0.95202	0.34000	0.64782	-0.04310	0.21329
'2	32	0.95056	0.34000	0.64808	-0.04412	0.21269
'2	33	0.94911	0.34000	0.64864	-0.04503	0.21237
'2	34	0.94766	0.34000	0.64954	-0.04588	0.21232
'2	35	0.94622	0.34000	0.65086	-0.04661	0.21265

DORNIER/JAMESON	AR 211		W.Schmidt A Jameson	15-9-36
	DILLNER WING: MACH = 0.70, ALPHA = 15			

2	36	0.94477	0.34000	0.65266	-0.04727	0.21334
2	37	0.94333	0.34000	0.65499	-0.04772	0.21455
2	38	0.94193	0.34000	0.65783	-0.04812	0.21614
2	39	0.94068	0.34000	0.66105	-0.04814	0.21826
2	40	0.93960	0.34000	0.66443	-0.04830	0.22039
2	41	0.93867	0.34000	0.66815	-0.04851	0.22271
2	42	0.93786	0.34000	0.67211	-0.04847	0.22540
2	43	0.93717	0.34000	0.67634	-0.04876	0.22801
2	44	0.93657	0.34000	0.68078	-0.04862	0.23109
2	45	0.93606	0.34000	0.68578	-0.04938	0.23389
2	46	0.93561	0.34000	0.69054	-0.04857	0.23767
2	47	0.93523	0.34000	0.69623	-0.05085	0.23987
2	48	0.93490	0.34000	0.70173	-0.04884	0.24503
2	49	0.93462	0.34000	0.70798	-0.05360	0.24584
2	50	0.93437	0.34000	0.71556	-0.05452	0.25034
2	51	0.93416	0.34000	0.71612	-0.06337	0.24444
2	52	0.93406	0.34000	0.71612	-0.06337	0.24444
2	53	0.93437	0.34000	0.70633	0.09809	0.35347
2	54	0.93462	0.34000	0.70353	0.10955	0.36007
2	55	0.93490	0.34000	0.70439	0.09848	0.35262
2	56	0.93523	0.34000	0.70441	0.09975	0.35354
2	57	0.93561	0.34000	0.70[illegible]1	0.09495	0.35038
2	58	0.93606	0.34000	0.7[illegible]479	0.09345	0.34924
2	59	0.93657	0.34000	0.70476	0.09018	0.34687
2	60	0.93717	0.34000	0.70455	0.08774	0.34500
2	61	0.93786	0.34000	0.70424	0.08477	0.34268
2	62	0.93867	0.34000	0.70355	0.08210	0.34035
2	63	0.93960	0.34000	0.70250	0.07947	0.33784
2	64	0.94068	0.34000	0.70110	0.07703	0.33526
2	65	0.94193	0.34000	0.69955	0.07439	0.33243
2	66	0.94333	0.34000	0.69810	0.07179	0.32969
2	67	0.94477	0.34000	0.69685	0.06898	0.32691
2	68	0.94622	0.34000	0.69578	0.06632	0.32434
2	69	0.94766	0.34000	0.69484	0.06350	0.32174
2	70	0.94911	0.34000	0.69395	0.06083	0.31927
2	71	0.95056	0.34000	0.69304	0.05824	0.31684
2	72	0.95202	0.34000	0.69200	0.05591	0.31452
2	73	0.95349	0.34000	0.69066	0.05394	0.31228
2	74	0.95497	0.34000	0.68884	0.05255	0.31017
2	75	0.95646	0.34000	0.68635	0.05184	0.30813
2	76	0.95797	0.34000	0.68301	0.05200	0.30622
2	77	0.95950	0.34000	0.67878	0.05297	0.30437
2	78	0.96104	0.34000	0.67381	0.05465	0.30260
2	79	0.96261	0.34000	0.66853	0.05659	0.30086
2	80	0.96420	0.34000	0.66364	0.05821	0.29914
2	81	0.96582	0.34000	0.65981	0.05898	0.29742
2	82	0.96746	0.34000	0.65718	0.05882	0.29573
2	83	0.96914	0.34000	0.65519	0.05825	0.29411
2	84	0.97085	0.34000	0.65316	0.05782	0.29258
2	85	0.97259	0.34000	0.65071	0.05786	0.29115
2	86	0.97436	0.34000	0.64788	0.05825	0.28976
2	87	0.97618	0.34000	0.64483	0.05894	0.28847
2	88	0.97804	0.34000	0.64172	0.05975	0.28724
2	89	0.97993	0.34000	0.63868	0.06061	0.28610
2	90	0.98188	0.34000	0.63574	0.06162	0.28514
2	91	0.98386	0.34000	0.63294	0.06263	0.28425
2	92	0.98590	0.34000	0.63025	0.06391	0.28366
2	93	0.98799	0.34000	0.62761	0.06535	0.28322
2	94	0.99013	0.34000	0.62511	0.06697	0.28300
2	95	0.99232	0.34000	0.62246	0.06930	0.28326
2	96	0.99441	0.34000	0.61966	0.07191	0.28366
2	97	0.99614	0.34000	0.61676	0.07430	0.28383
2	98	0.99744	0.34000	0.61412	0.07401	0.28209

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-37
	DILLNER WING: MACH = 0.70, ALPHA = 15			

2	99	0.99843	0.34000	0.60678	0.07757	0.28066
2	100	0.99918	0.34000	0.60253	0.06834	0.27102
2	101	0.99975	0.34000	0.58874	0.07739	0.27031
2	102	1.00000	0.34000	0.58874	0.07739	0.27031
3	1	1.00000	0.36399	0.68271	-0.00943	0.26107
3	2	1.00000	0.36399	0.68092	-0.01121	0.25860
3	3	1.00000	0.36399	0.67958	-0.01155	0.25749
3	4	1.00000	0.36399	0.67871	-0.01280	0.25602
3	5	1.00000	0.36399	0.67746	-0.01338	0.25478
3	6	1.00000	0.36399	0.67613	-0.01420	0.25331
3	7	1.00000	0.36399	0.67446	-0.01462	0.25193
3	8	1.00000	0.36399	0.67300	-0.01485	0.25081
3	9	1.00000	0.36399	0.67180	-0.01491	0.24999
3	10	1.00000	0.36399	0.67080	-0.01474	0.24947
3	11	1.00000	0.36399	0.67001	-0.01445	0.24917
3	12	1.00000	0.36399	0.66935	-0.01403	0.24905
3	13	1.00000	0.36399	0.66878	-0.01351	0.24907
3	14	1.00000	0.36399	0.66827	-0.01291	0.24919
3	15	1.00000	0.36399	0.66781	-0.01225	0.24938
3	16	1.00000	0.36399	0.66740	-0.01156	0.24963
3	17	1.00000	0.36399	0.66704	-0.01086	0.24992
3	18	1.00000	0.36399	0.66672	-0.01016	0.25023
3	19	1.00000	0.36399	0.66644	-0.00947	0.25056
3	20	1.00000	0.36399	0.66618	-0.00879	0.25090
3	21	1.00000	0.36399	0.66593	-0.00812	0.25123
3	22	1.00000	0.36399	0.66568	-0.00748	0.25155
3	23	1.00000	0.36399	0.66545	-0.00689	0.25184
3	24	1.00000	0.36399	0.66525	-0.00635	0.25212
3	25	1.00000	0.36399	0.66509	-0.00588	0.25236
3	26	1.00000	0.36399	0.66499	-0.00549	0.25259
3	27	1.00000	0.36399	0.66495	-0.00516	0.25281
3	28	1.00000	0.36399	0.66497	-0.00489	0.25302
3	29	1.00000	0.36399	0.66504	-0.00468	0.25322
3	30	1.00000	0.36399	0.66517	-0.00452	0.25342
3	31	1.00000	0.36399	0.66535	-0.00440	0.25363
3	32	1.00000	0.36399	0.66559	-0.00431	0.25385
3	33	1.00000	0.36399	0.66588	-0.00425	0.25408
3	34	1.00000	0.36399	0.66619	-0.00418	0.25433
3	35	1.00000	0.36399	0.66651	-0.00407	0.25461
3	36	1.00000	0.36399	0.66676	-0.00389	0.25491
3	37	1.00000	0.36399	0.66682	-0.00352	0.25522
3	38	1.00000	0.36399	0.66675	-0.00300	0.25556
3	39	1.00000	0.36399	0.66669	-0.00251	0.25588
3	40	1.00000	0.36399	0.66670	-0.00210	0.25620
3	41	1.00000	0.36399	0.66691	-0.00187	0.25650
3	42	1.00000	0.36399	0.66740	-0.00191	0.25679
3	43	1.00000	0.36399	0.66816	-0.00220	0.25705
3	44	1.00000	0.36399	0.66910	-0.00271	0.25728
3	45	1.00000	0.36399	0.67013	-0.00333	0.25747
3	46	1.00000	0.36399	0.67116	-0.00406	0.25760
3	47	1.00000	0.36399	0.67190	-0.00460	0.25767
3	48	1.00000	0.36399	0.67224	-0.00488	0.25768
3	49	1.00000	0.36399	0.67206	-0.00479	0.25763
3	50	1.00000	0.36399	0.67294	-0.00869	0.25532
3	51	1.00000	0.36399	0.67294	-0.00869	0.25532
3	52	1.00000	0.36399	0.67501	-0.01049	0.25532
3	53	1.00000	0.36399	0.67391	-0.00640	0.25763
3	54	1.00000	0.36399	0.67166	-0.00437	0.25768
3	55	1.00000	0.36399	0.67051	-0.00339	0.25767
3	56	1.00000	0.36399	0.67038	-0.00338	0.25760
3	57	1.00000	0.36399	0.67060	-0.00374	0.25747
3	58	1.00000	0.36399	0.67087	-0.00424	0.25728
3	59	1.00000	0.36399	0.67096	-0.00462	0.25705

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	15-9-38
	DILLNER WING: MACH = 0.70, ALPHA = 15			

23	60	1.00000	0.36399	0.67078	-0.00483	0.25679
23	61	1.00000	0.36399	0.67034	-0.00483	0.25650
23	62	1.00000	0.36399	0.66969	-0.00467	0.25620
23	63	1.00000	0.36399	0.66889	-0.00441	0.25588
23	64	1.00000	0.36399	0.66802	-0.00409	0.25556
23	65	1.00000	0.36399	0.66716	-0.00381	0.25522
23	66	1.00000	0.36399	0.66641	-0.00359	0.25491
23	67	1.00000	0.36399	0.66581	-0.00347	0.25461
23	68	1.00000	0.36399	0.66537	-0.00348	0.25433
23	69	1.00000	0.36399	0.66510	-0.00359	0.25408
23	70	1.00000	0.36399	0.66496	-0.00377	0.25385
23	71	1.00000	0.36399	0.66490	-0.00401	0.25363
23	72	1.00000	0.36399	0.66487	-0.00426	0.25342
23	73	1.00000	0.36399	0.66485	-0.00452	0.25322
23	74	1.00000	0.36399	0.66480	-0.00475	0.25302
23	75	1.00000	0.36399	0.66471	-0.00495	0.25281
23	76	1.00000	0.36399	0.66457	-0.00512	0.25259
23	77	1.00000	0.36399	0.66438	-0.00527	0.25236
23	78	1.00000	0.36399	0.66415	-0.00540	0.25212
23	79	1.00000	0.36399	0.66387	-0.00553	0.25184
23	80	1.00000	0.36399	0.66355	-0.00565	0.25155
23	81	1.00000	0.36399	0.66322	-0.00579	0.25123
23	82	1.00000	0.36399	0.66291	-0.00597	0.25090
23	83	1.00000	0.36399	0.66264	-0.00620	0.25056
23	84	1.00000	0.36399	0.66244	-0.00646	0.25023
23	85	1.00000	0.36399	0.66227	-0.00675	0.24992
23	86	1.00000	0.36399	0.66212	-0.00700	0.24963
23	87	1.00000	0.36399	0.66193	-0.00717	0.24938
23	88	1.00000	0.36399	0.66168	-0.00721	0.24919
23	89	1.00000	0.36399	0.66135	-0.00708	0.24907
23	90	1.00000	0.36399	0.66093	-0.00675	0.24905
23	91	1.00000	0.36399	0.66044	-0.00618	0.24917
23	92	1.00000	0.36399	0.65988	-0.00529	0.24947
23	93	1.00000	0.36399	0.65927	-0.00408	0.24999
23	94	1.00000	0.36399	0.65863	-0.00244	0.25081
23	95	1.00000	0.36399	0.65789	-0.00031	0.25193
23	96	1.00000	0.36399	0.65699	0.00229	0.25331
23	97	1.00000	0.36399	0.65601	0.00509	0.25478
23	98	1.00000	0.36399	0.65532	0.00731	0.25602
23	99	1.00000	0.36399	0.65477	0.00975	0.25749
23	100	1.00000	0.36399	0.65494	0.01108	0.25860
23	101	1.00000	0.36399	0.65511	0.01329	0.26036
23	102	1.00000	0.36399	0.65511	0.01329	0.26036

WING CONTOUR **

AGARD FDP – WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 17

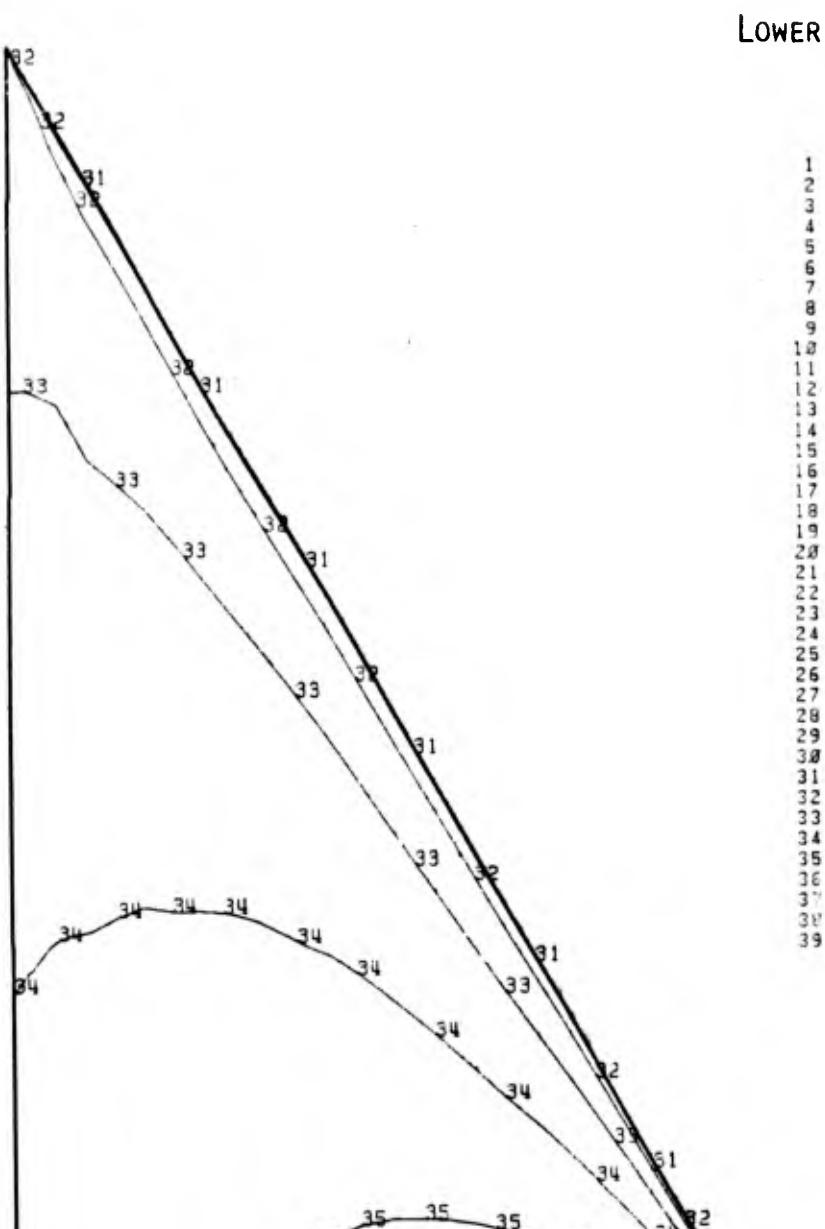
AGARD B: MACH = 1.50, ALPHA = 0

Contributor No 9

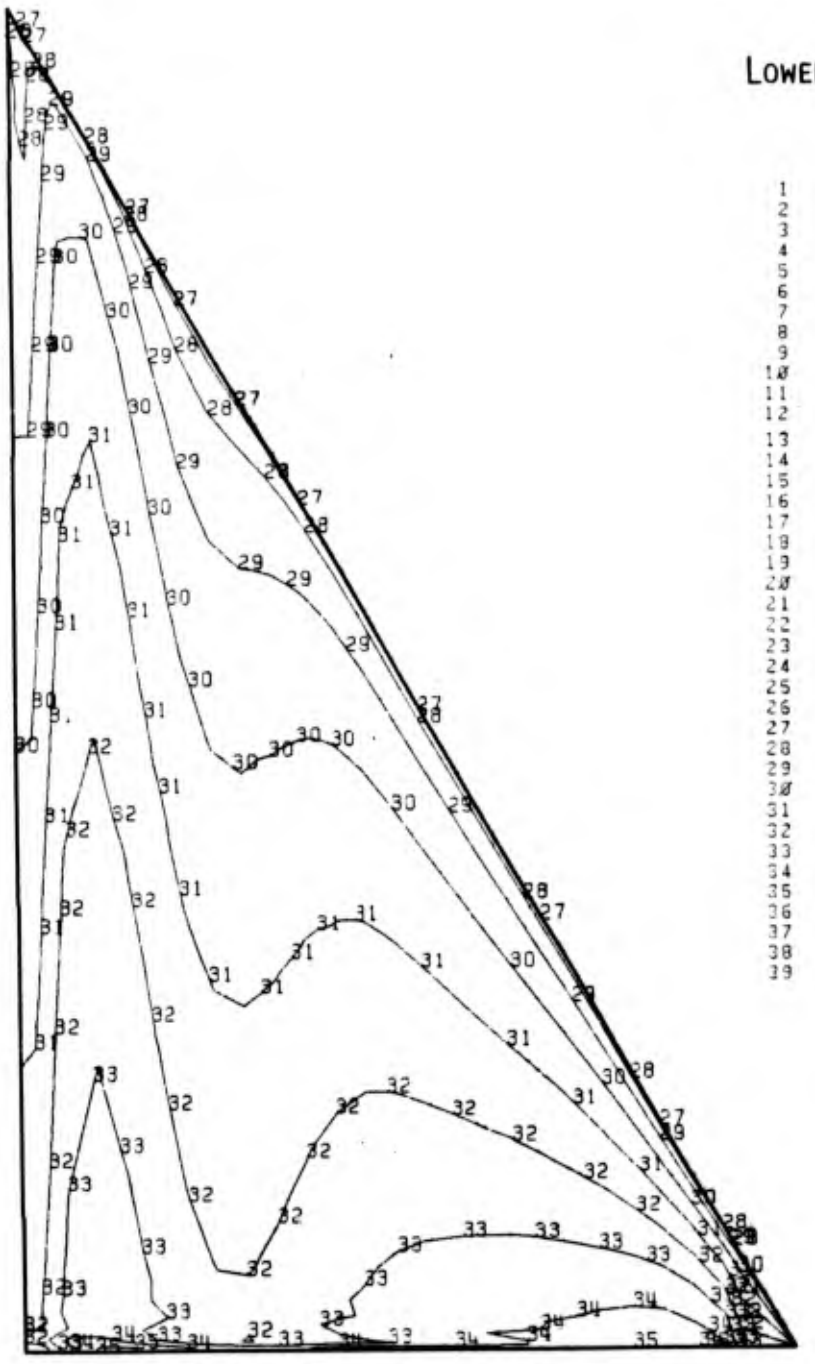
W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-1
	AGARD B: MACH = 1.50, ALPHA = 0			



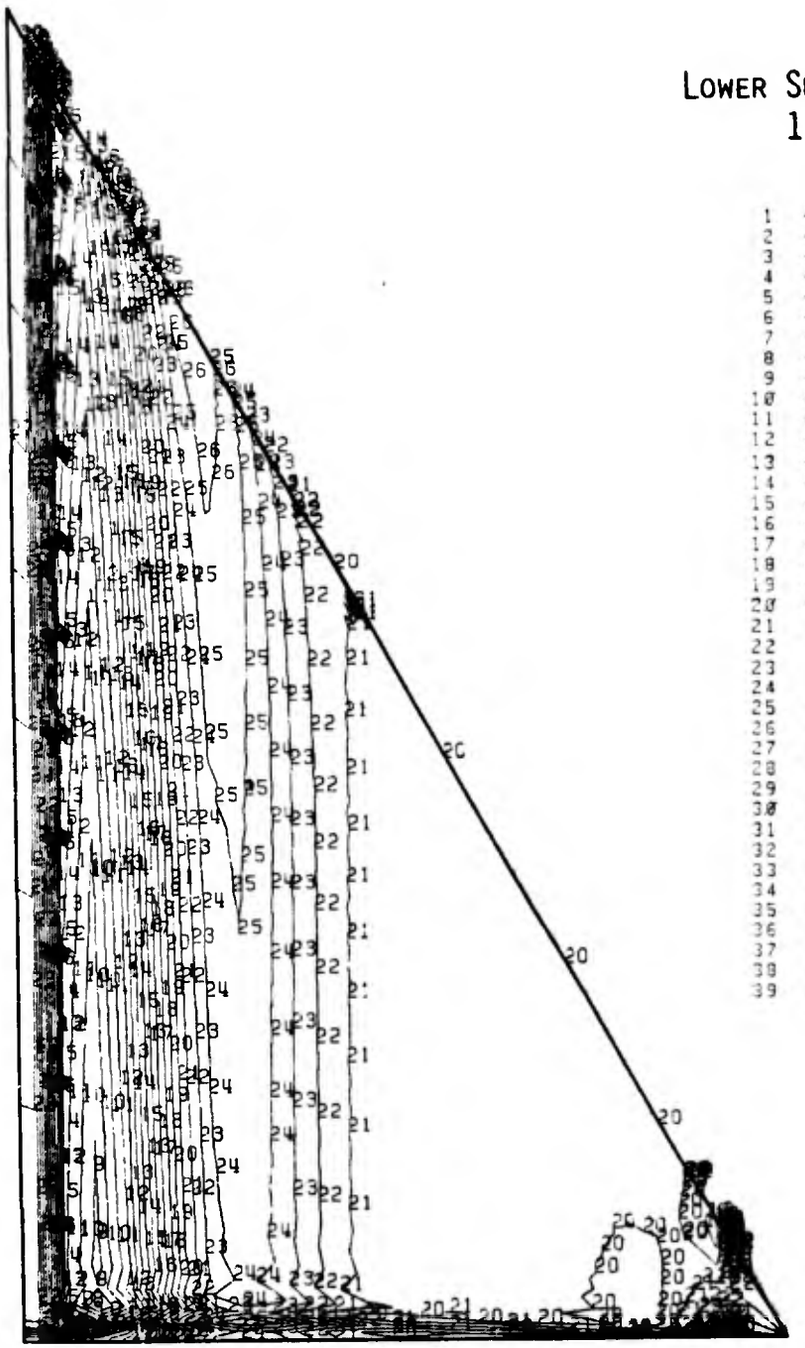
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-2
	AGARD B: MACH = 1.50, ALPHA = 0			



LOWER SURFACE
MACH

1	0.05000
2	0.10000
3	0.15000
4	0.20000
5	0.25000
6	0.30000
7	0.35000
8	0.40000
9	0.45000
10	0.50000
11	0.55000
12	0.60000
13	0.65000
14	0.70000
15	0.75000
16	0.80000
17	0.85000
18	0.90000
19	0.95000
20	1.00000
21	1.05000
22	1.10000
23	1.15000
24	1.20000
25	1.25000
26	1.30000
27	1.35000
28	1.40000
29	1.45000
30	1.50000
31	1.55000
32	1.60000
33	1.65000
34	1.70000
35	1.75000
36	1.80000
37	1.85000
38	1.90000
39	1.95000

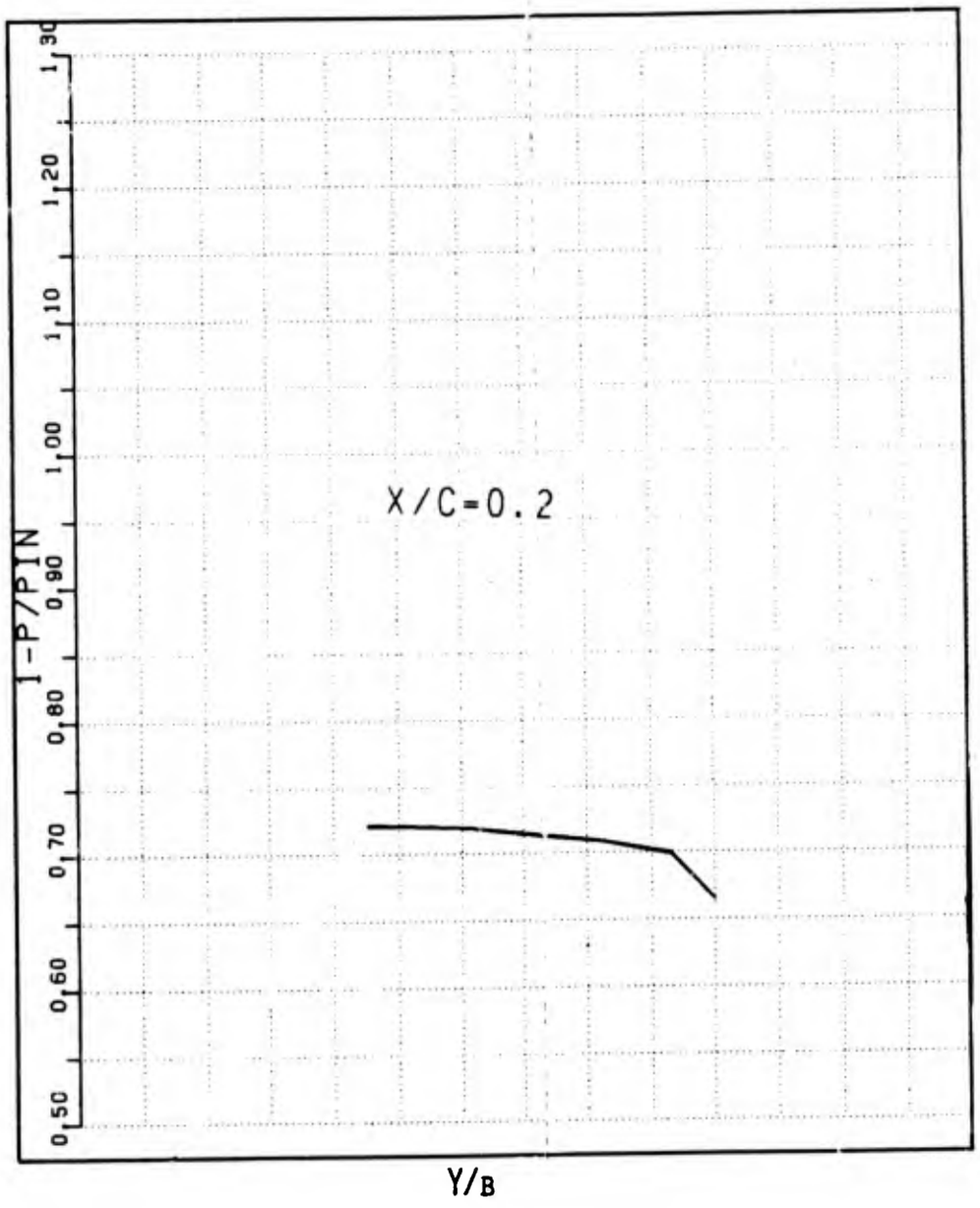
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-3
	AGARD B: MACH = 1.50, ALPHA = 0			



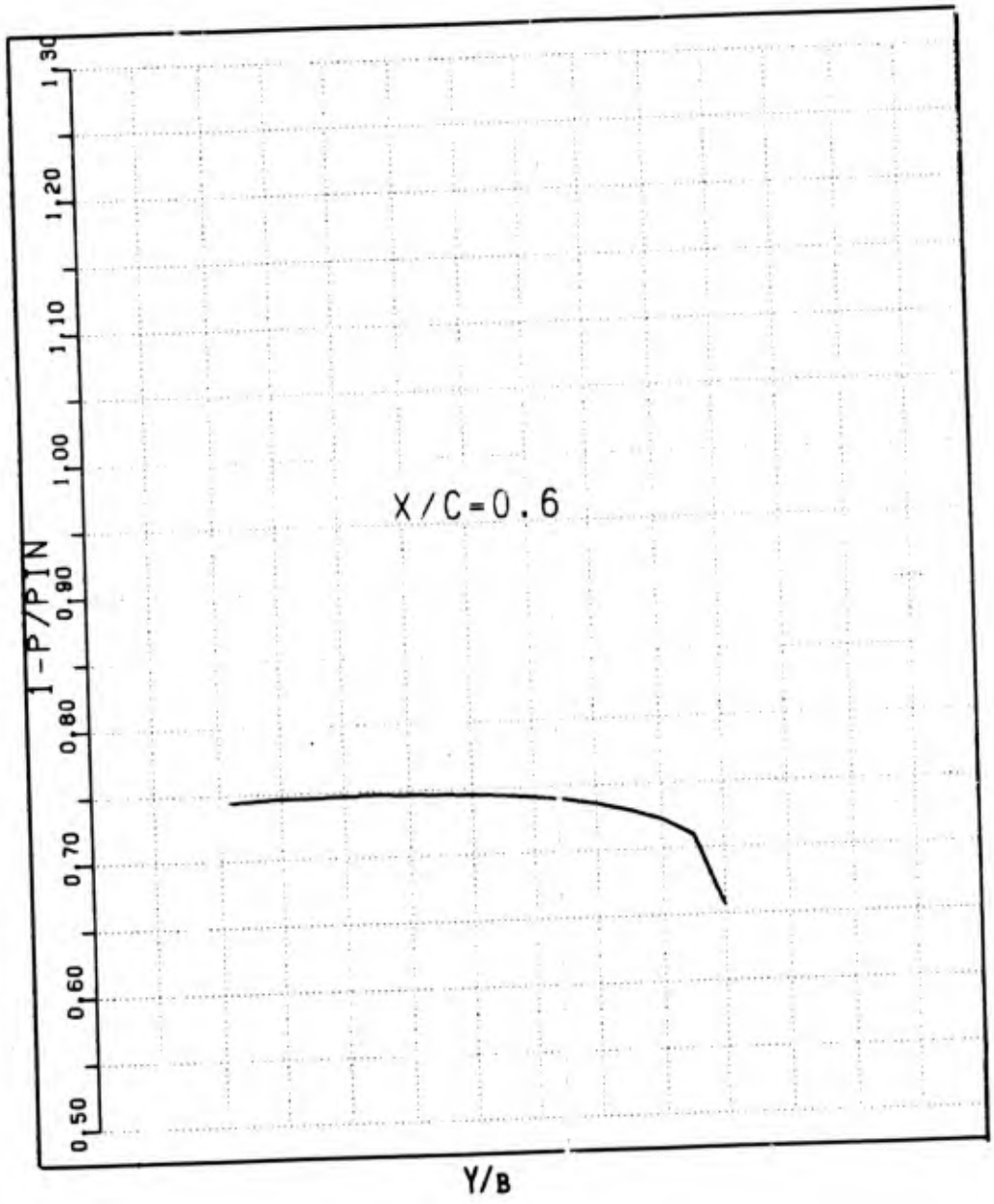
LOWER SURFACE
$1 - PI/PI_{INF}$

1	-0.19000
2	-0.18000
3	-0.17000
4	-0.16000
5	-0.15000
6	-0.14000
7	-0.13000
8	-0.12000
9	-0.11000
10	-0.10000
11	-0.09000
12	-0.08000
13	-0.07000
14	-0.06000
15	-0.05000
16	-0.04000
17	-0.03000
18	-0.02000
19	-0.01000
20	-0.00000
21	0.01000
22	0.02000
23	0.03000
24	0.04000
25	0.05000
26	0.06000
27	0.07000
28	0.08000
29	0.09000
30	0.10000
31	0.11000
32	0.12000
33	0.13000
34	0.14000
35	0.15000
36	0.16000
37	0.17000
38	0.18000
39	0.19000

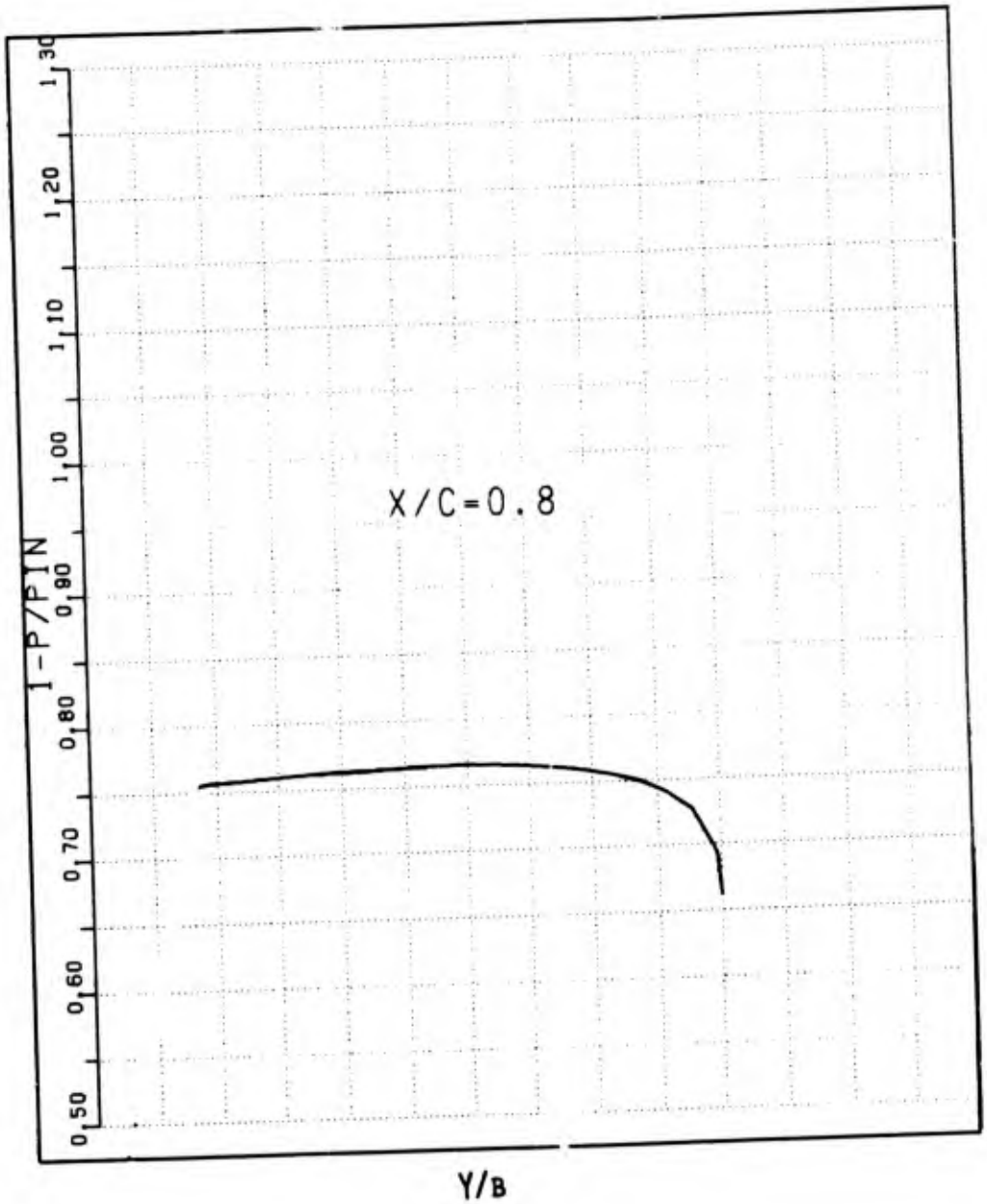
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-4
	AGARD B: MACH = 1.50, ALPHA = 0			



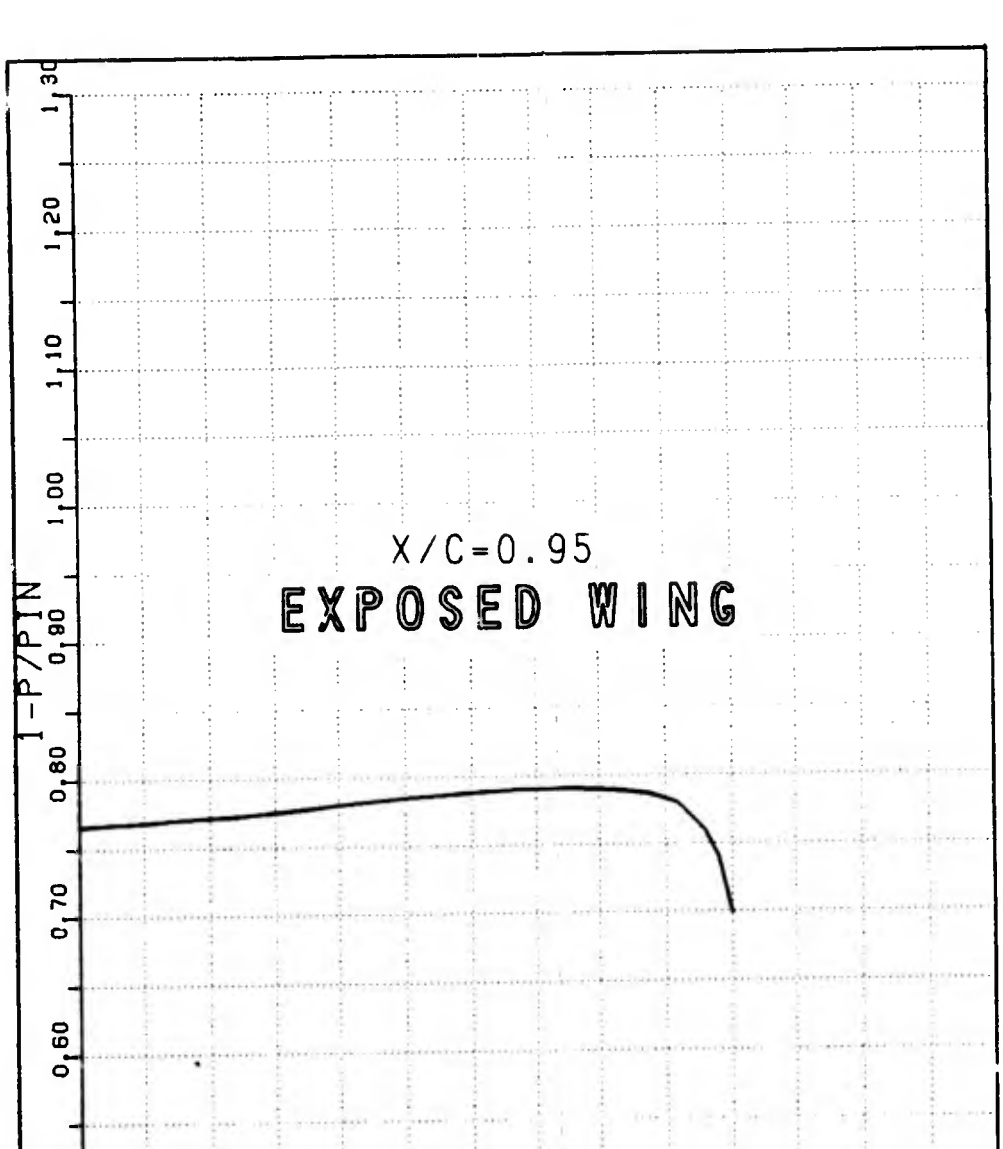
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-5
	AGARD B: MACH = 1.50, ALPHA = 0			



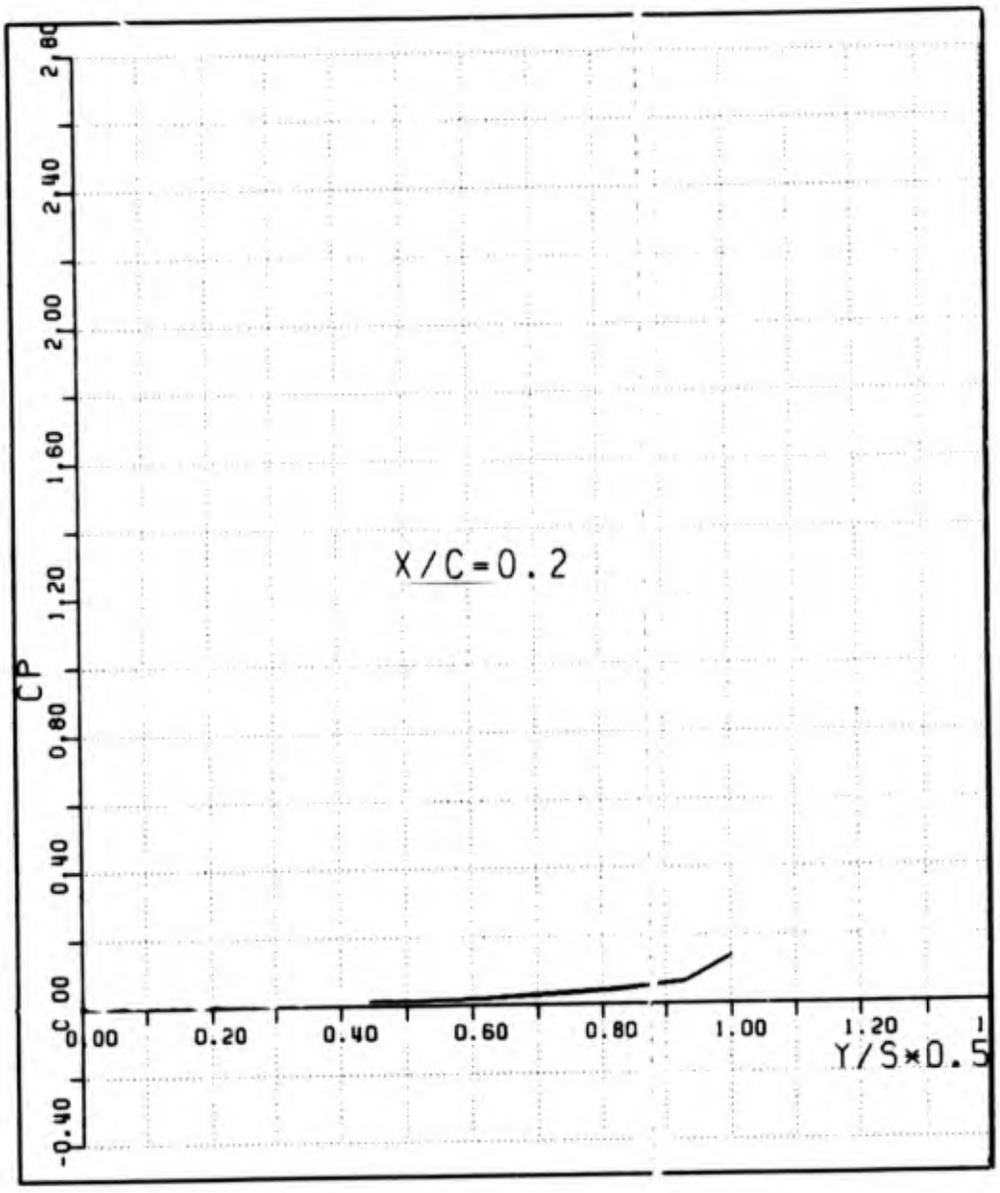
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-6
	AGARD B: MACH = 1.50, ALPHA = 0			



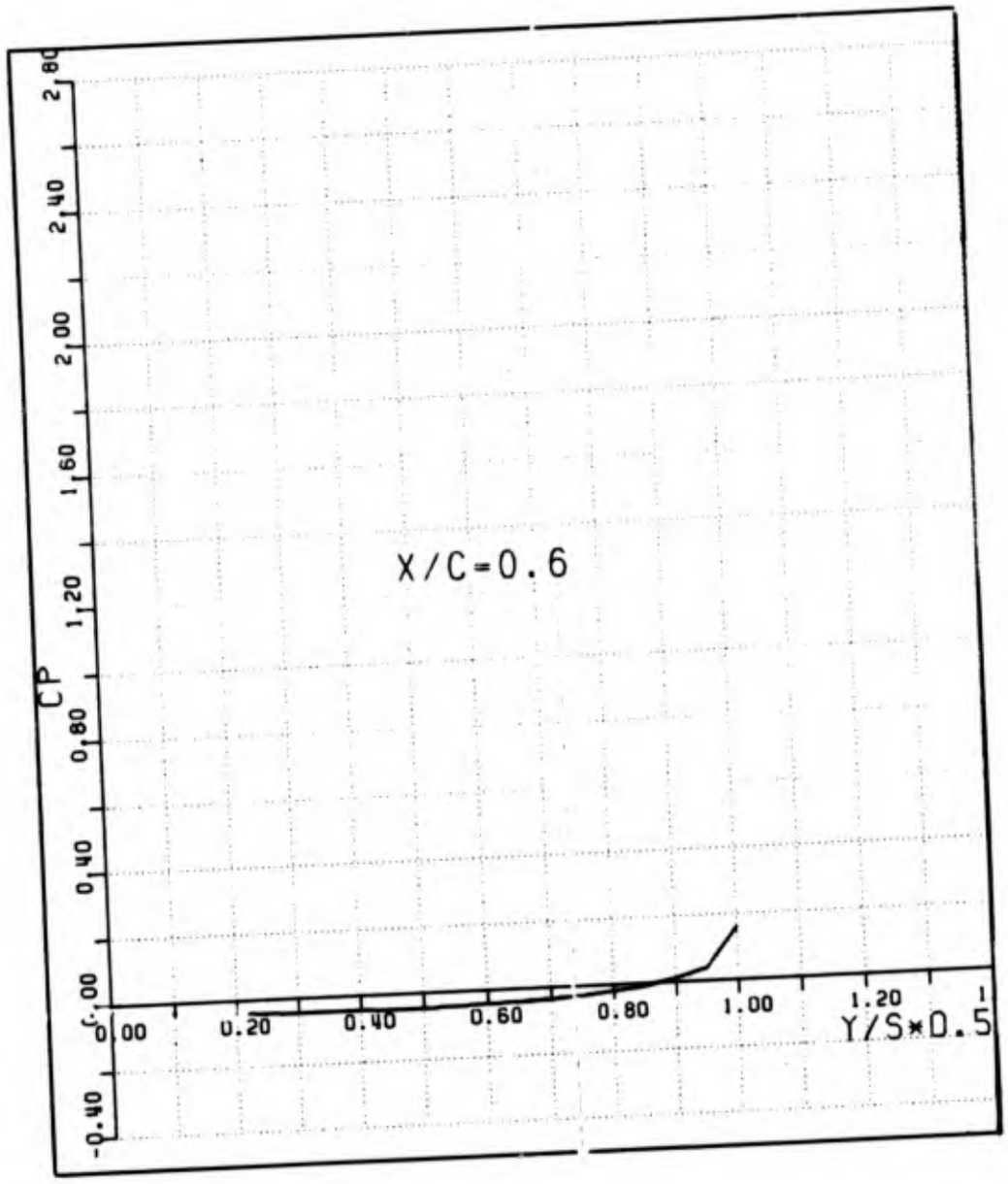
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-7
	AGARD B: MACH = 1.50, ALPHA = 0			



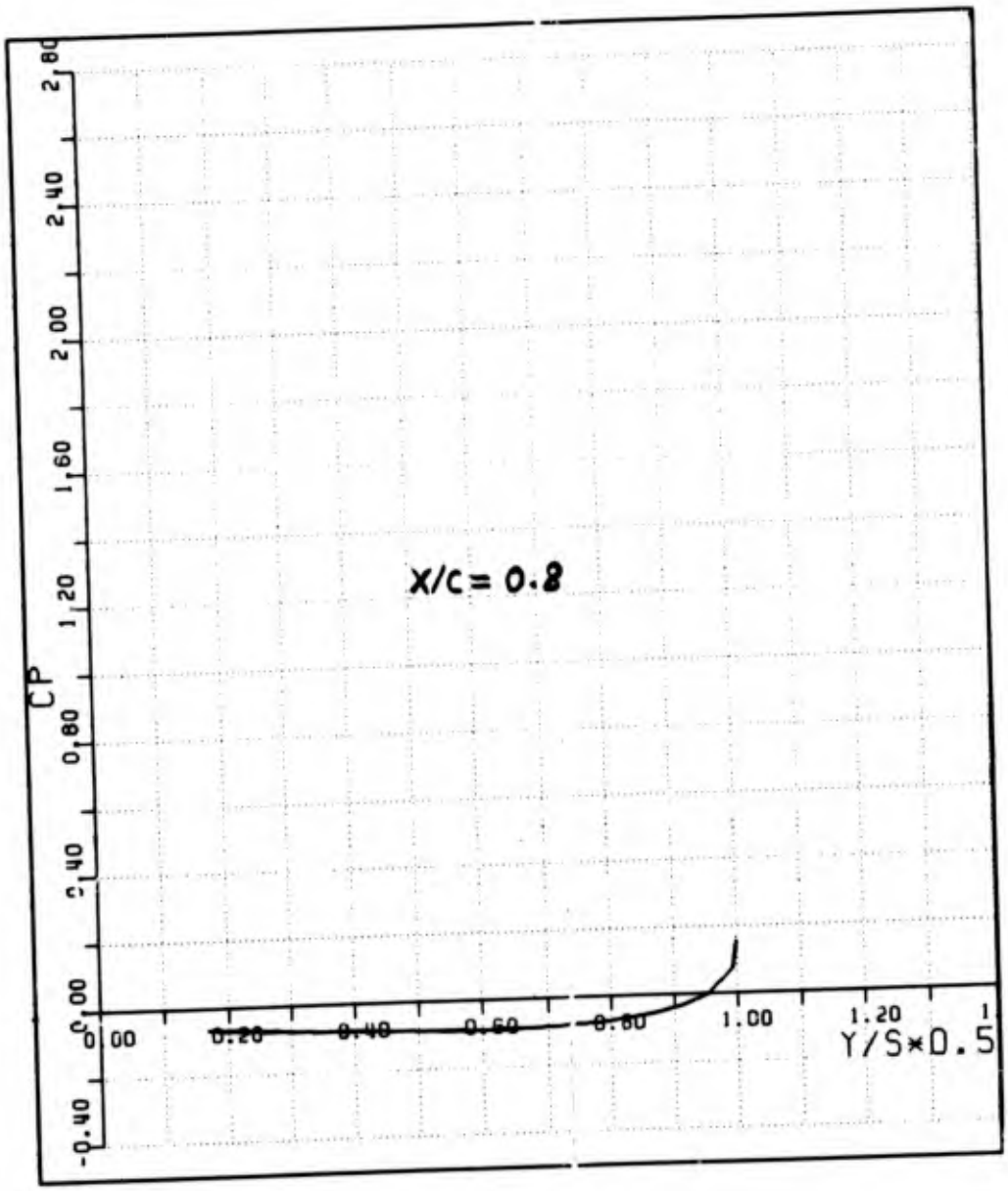
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-8
	AGARD B: MACH = 1.50, ALPHA = 0			



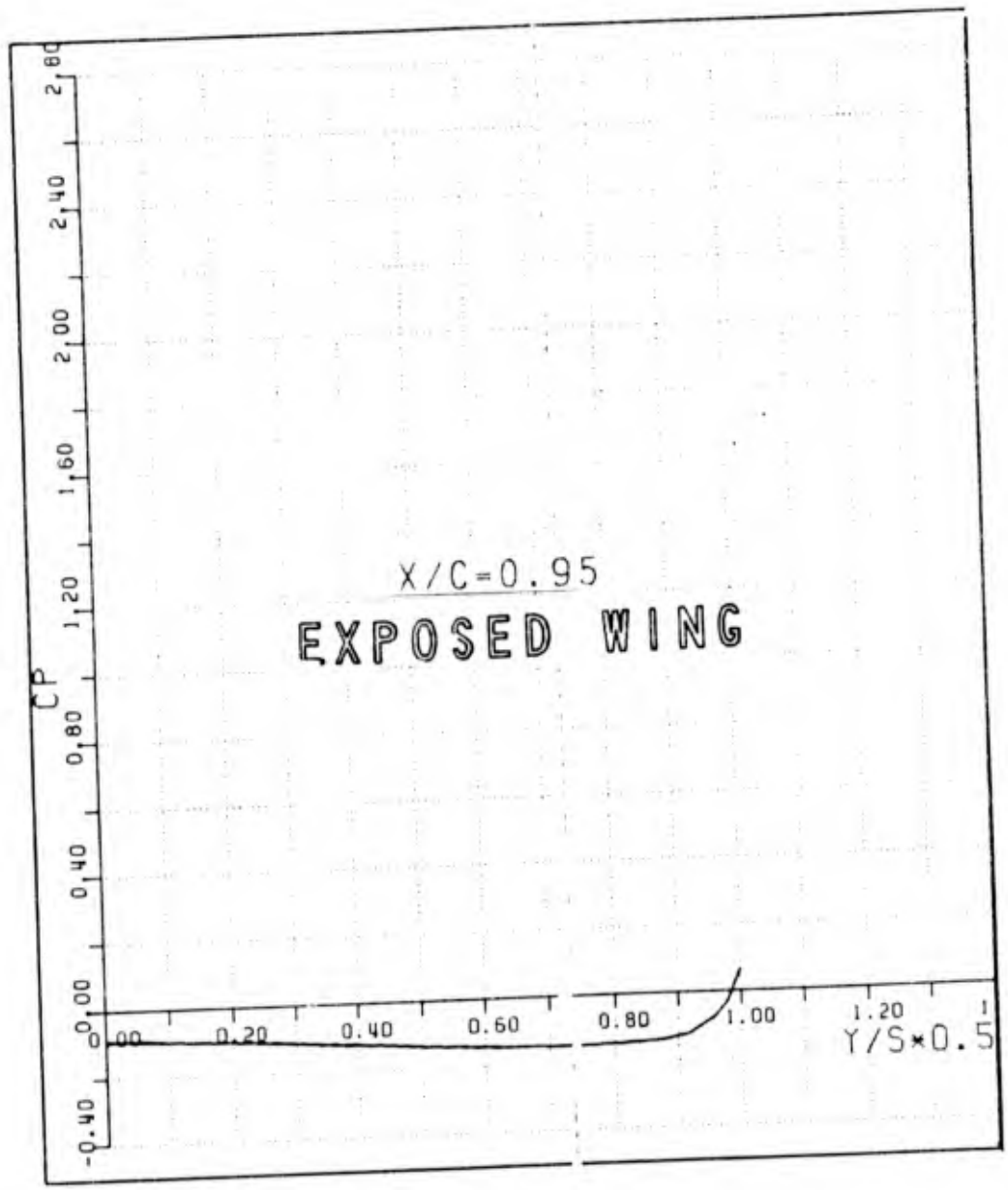
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-9
	AGARD B: MACH = 1.50, ALPHA = 0			



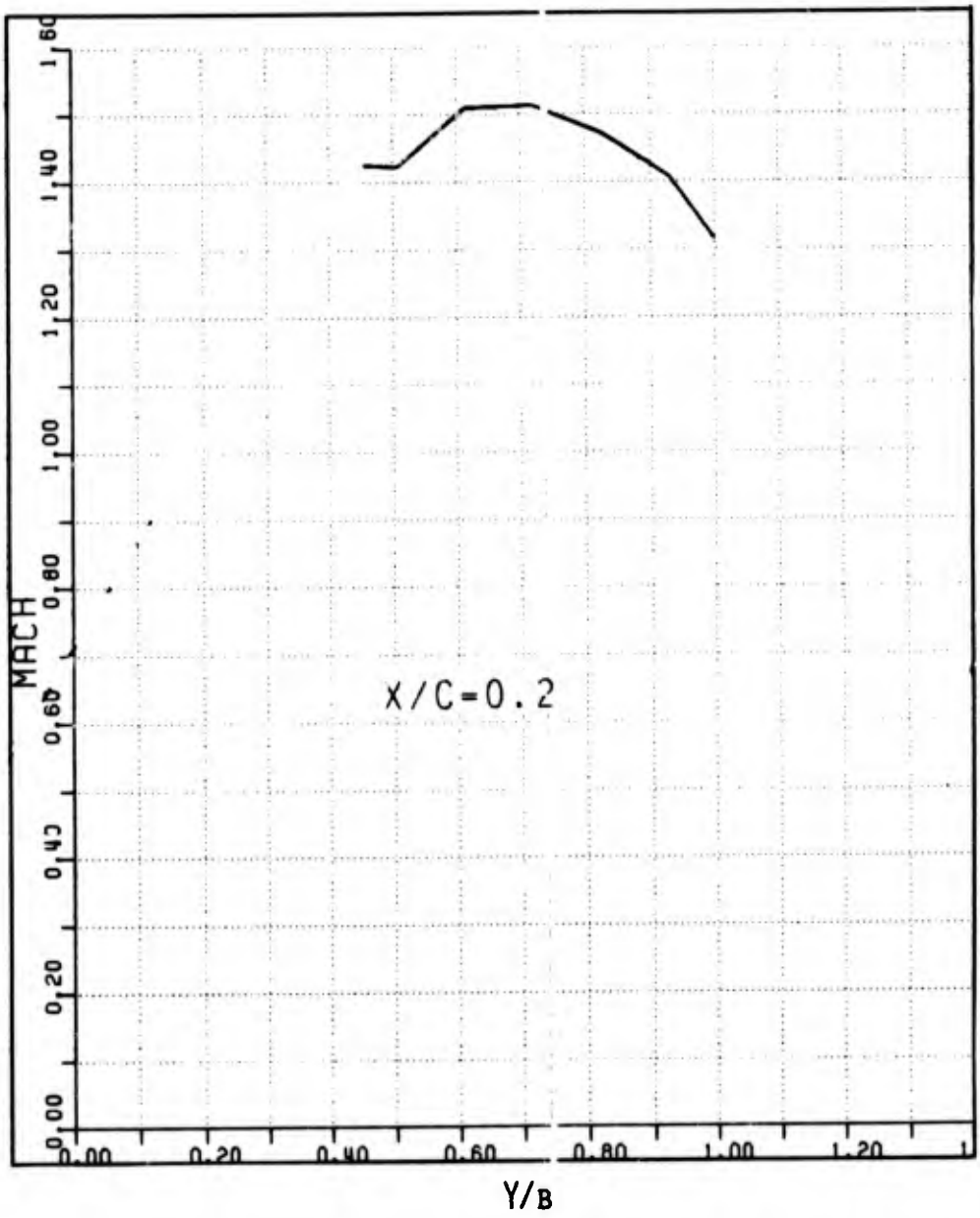
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-10
	AGARD B: MACH = 1.50, ALPHA = 0			



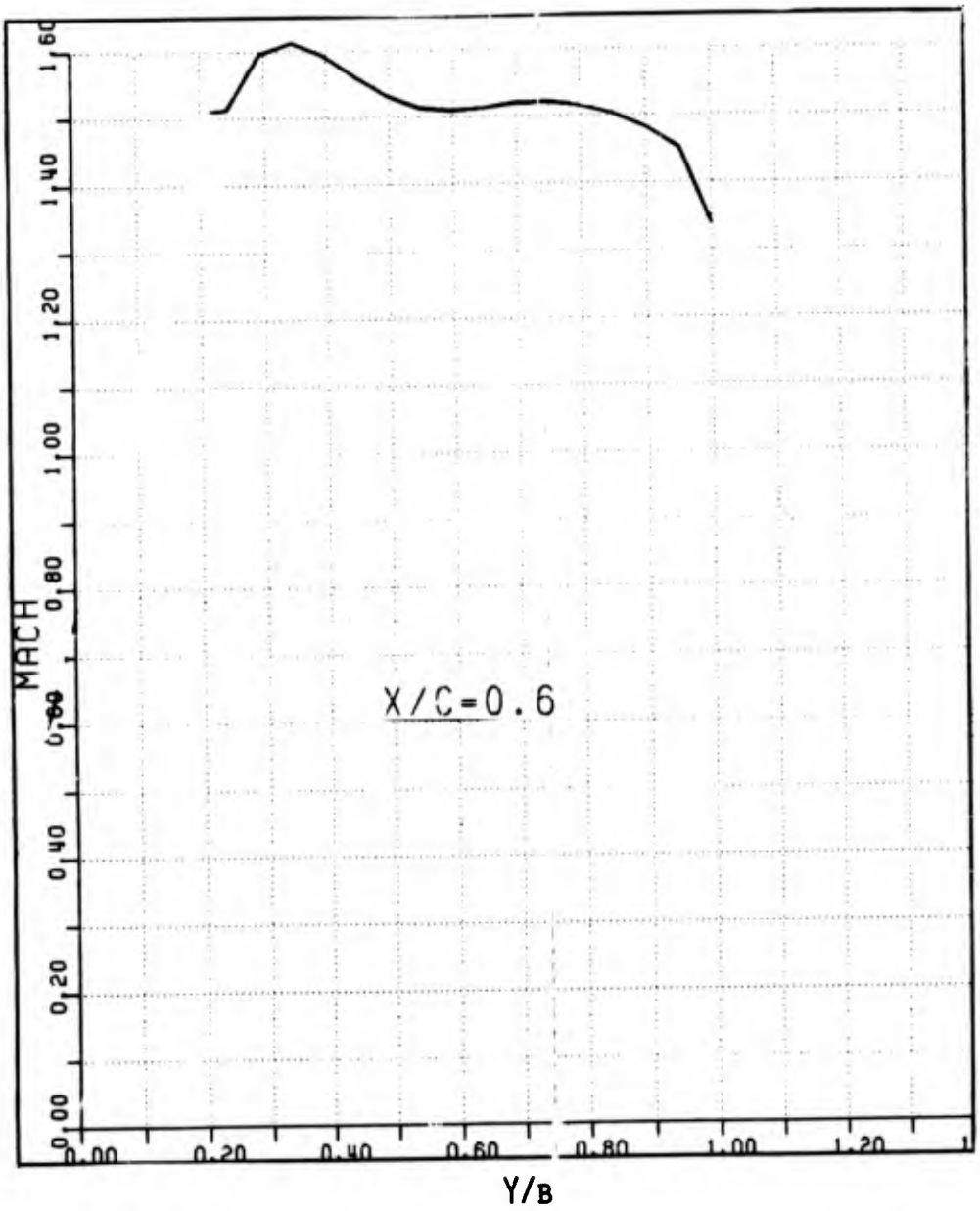
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-11
	AGARD B: MACH = 1.50, ALPHA = 0			



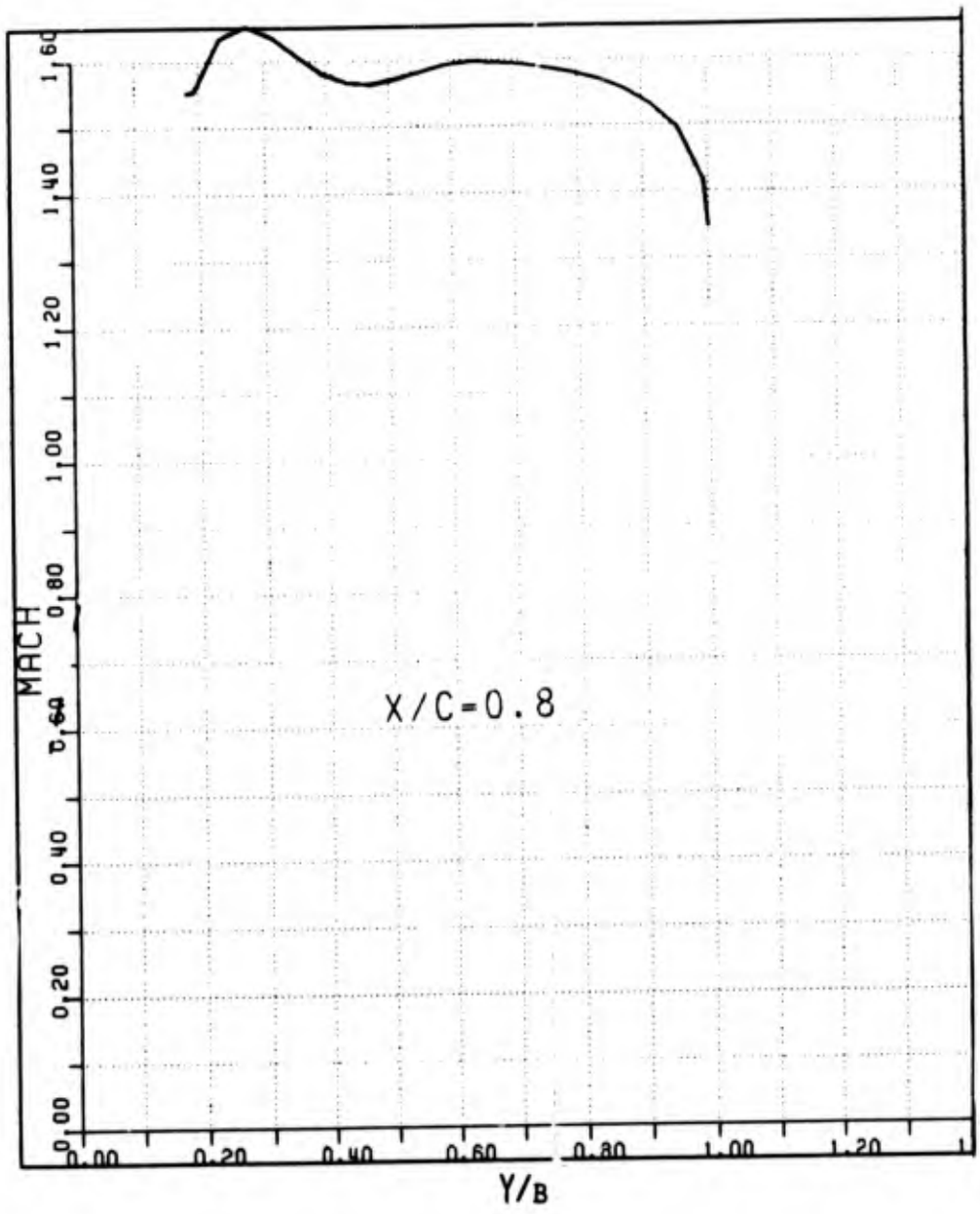
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-12
	AGARD B: MACH = 1.50, ALPHA = 0			



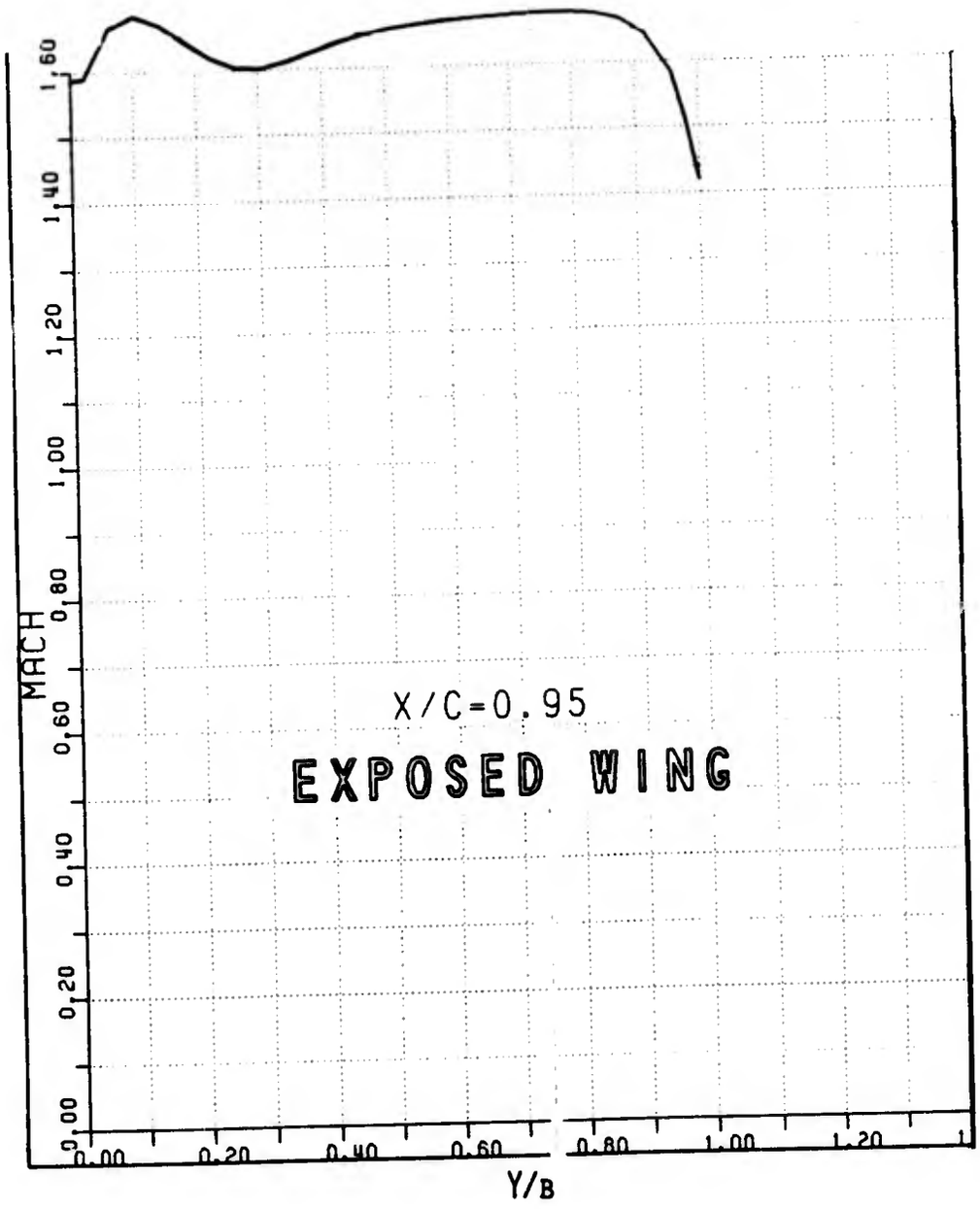
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-13
	AGARD B: MACH = 1.50, ALPHA = 0			



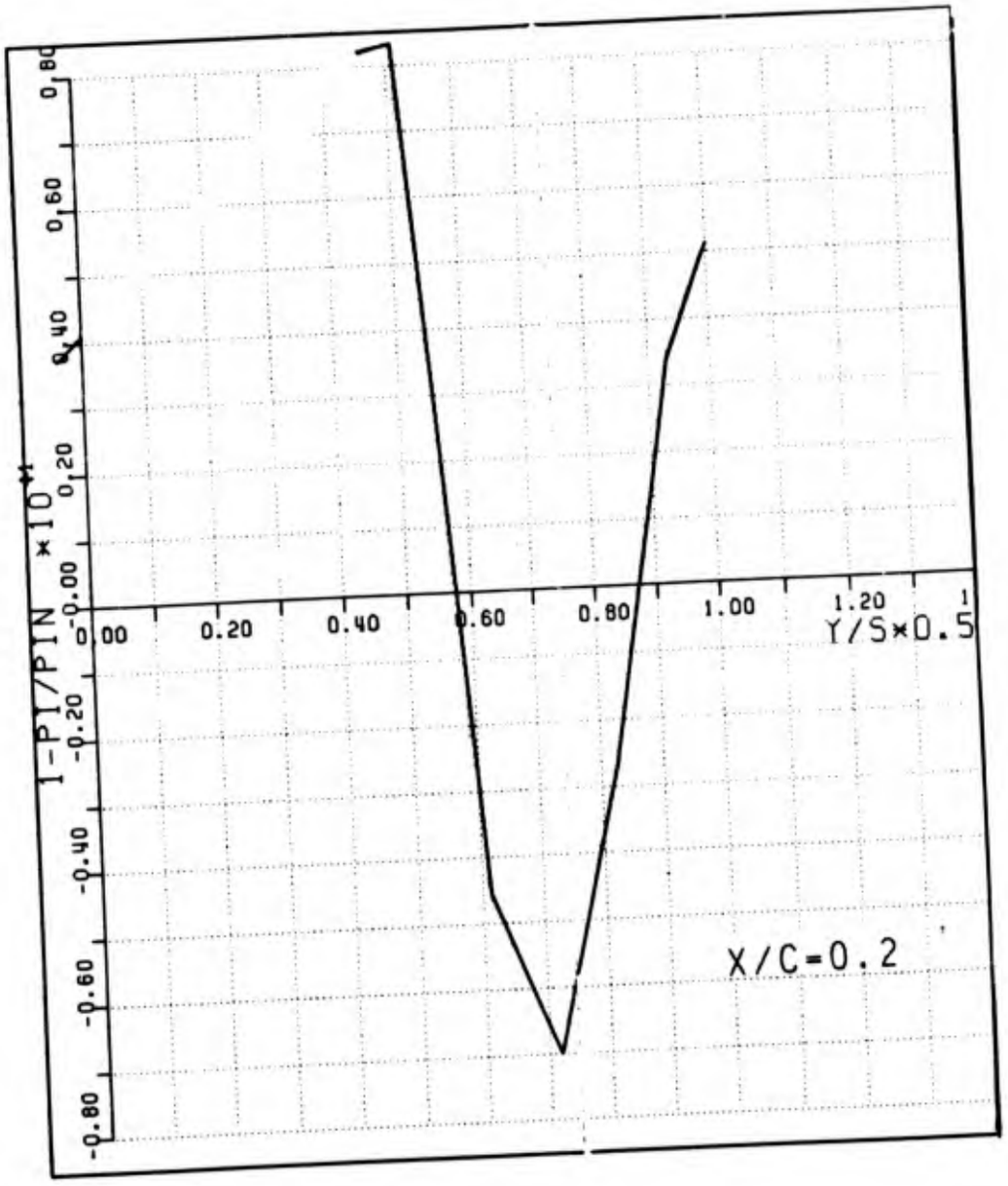
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-14
	AGARD B: MACH = 1.50, ALPHA = 0			



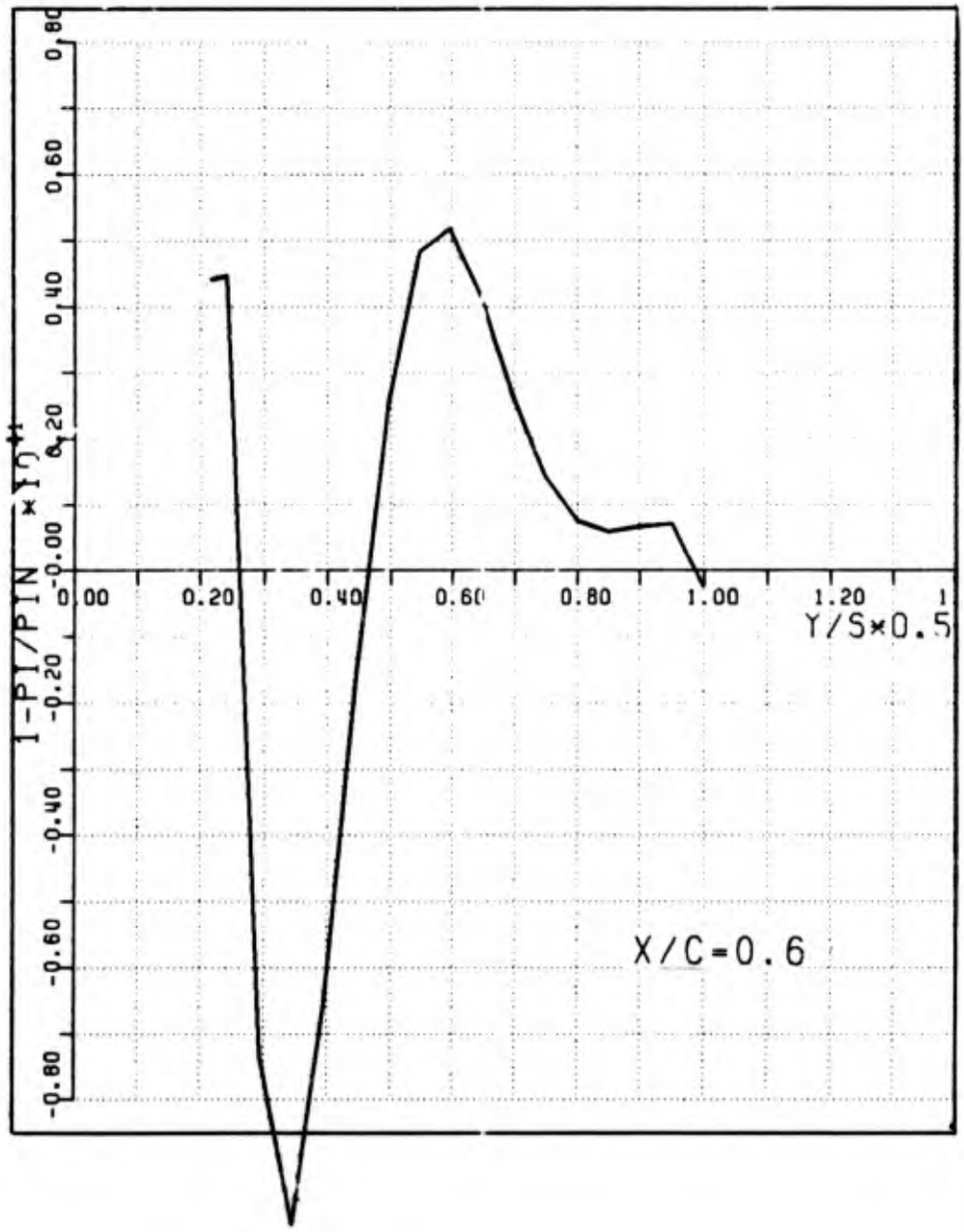
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-15
	AGARD B: MACH = 1.50, ALPHA = 0			



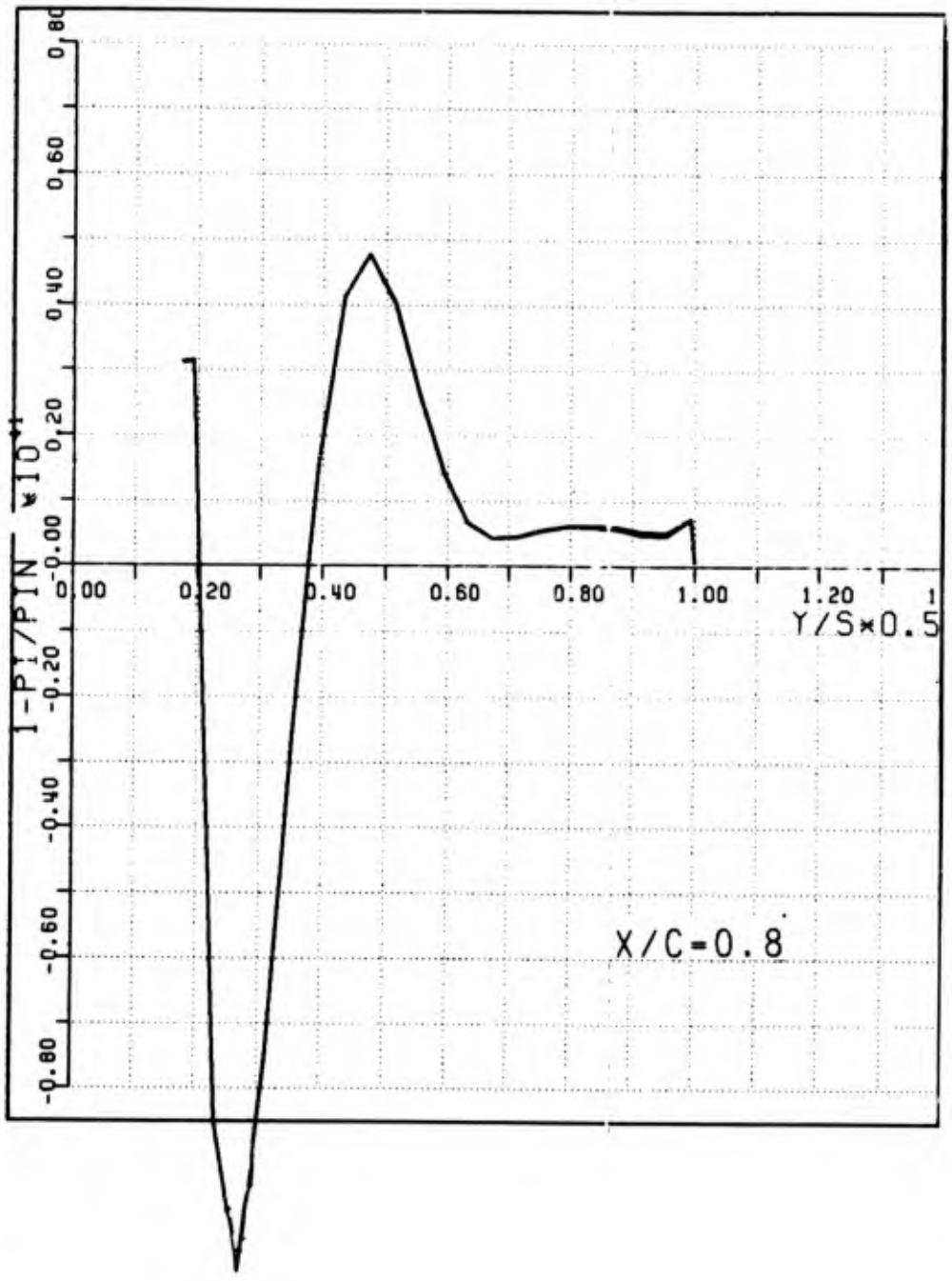
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-16
	AGARD B: MACH = 1.50, ALPHA = 0			



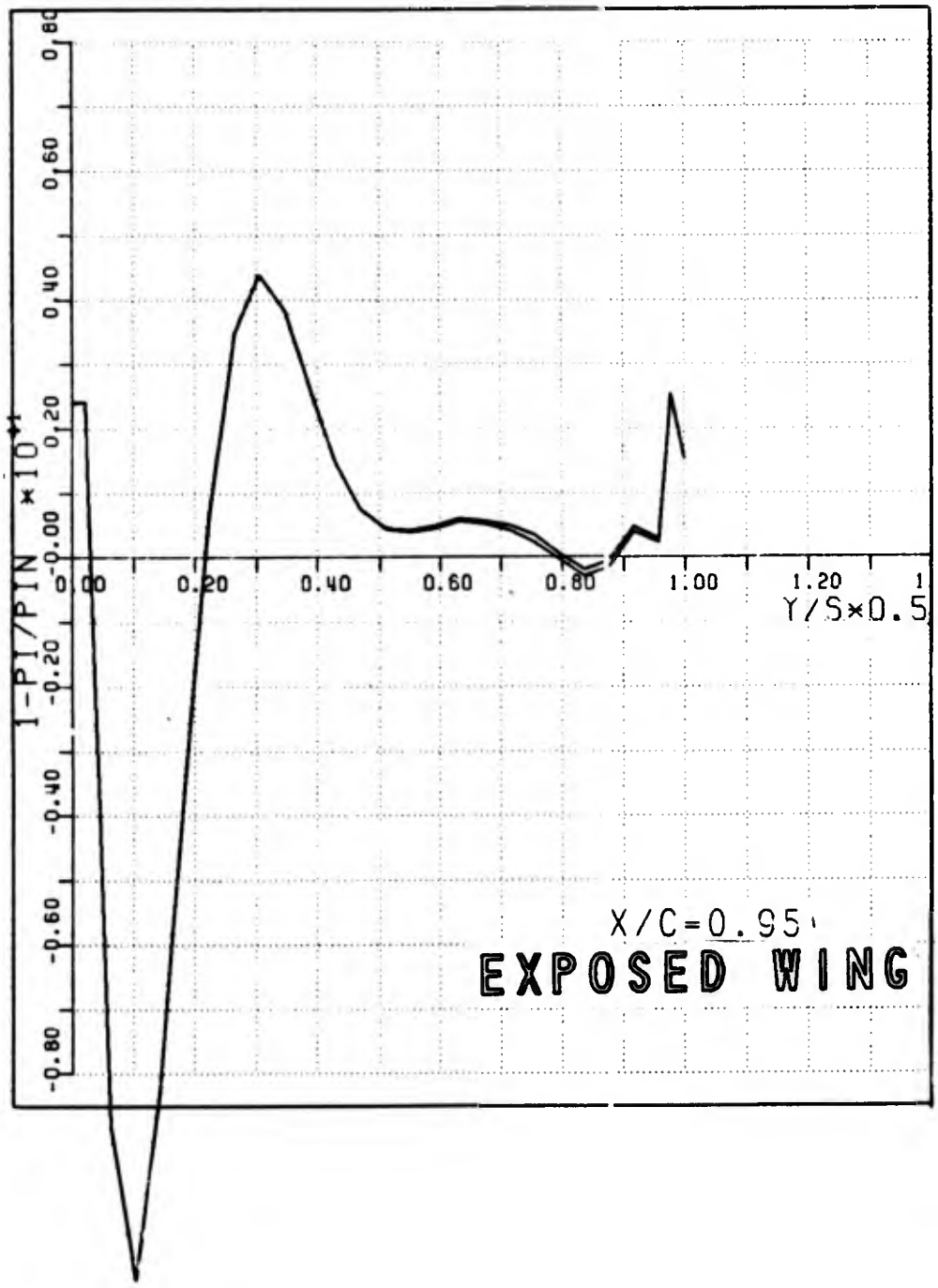
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-17
	AGARD B: MACH = 1.50, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-18
	AGARD B: MACH = 1.50, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-19
	AGARD B: MACH = 1.50, ALPHA = 0			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	17-9-20
	AGARD B: MACH = 1.50, ALPHA = 0			

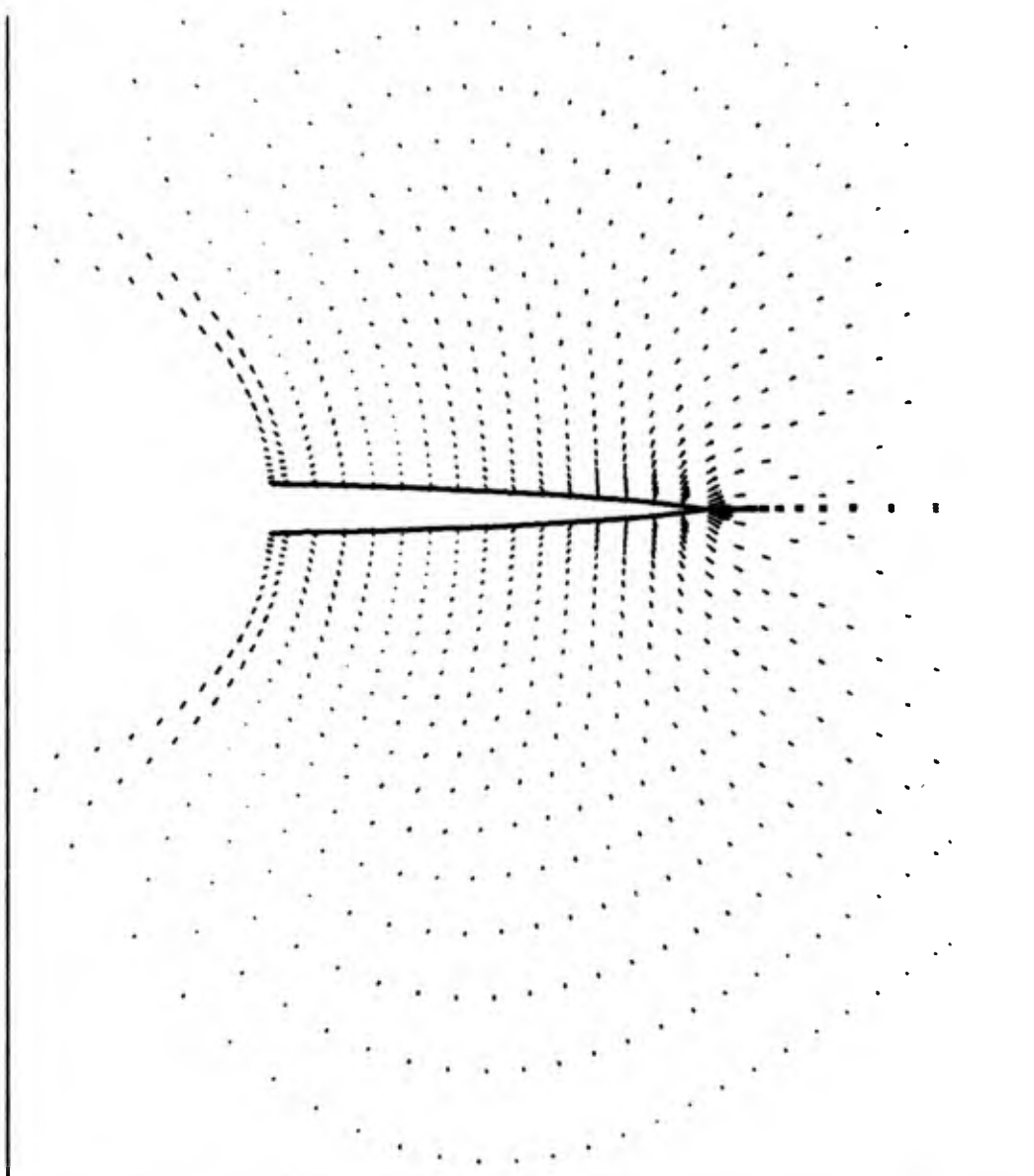


ABB. : AGARD FDP-WG07 EUD03D AGARD WING/BODY VELOCITIES
X/C = 0.6

AGARD FDP — WG 07

TEST CASES FOR STEADY INVISCID TRANSONIC OR SUPERSONIC FLOW

TEST CASE 18

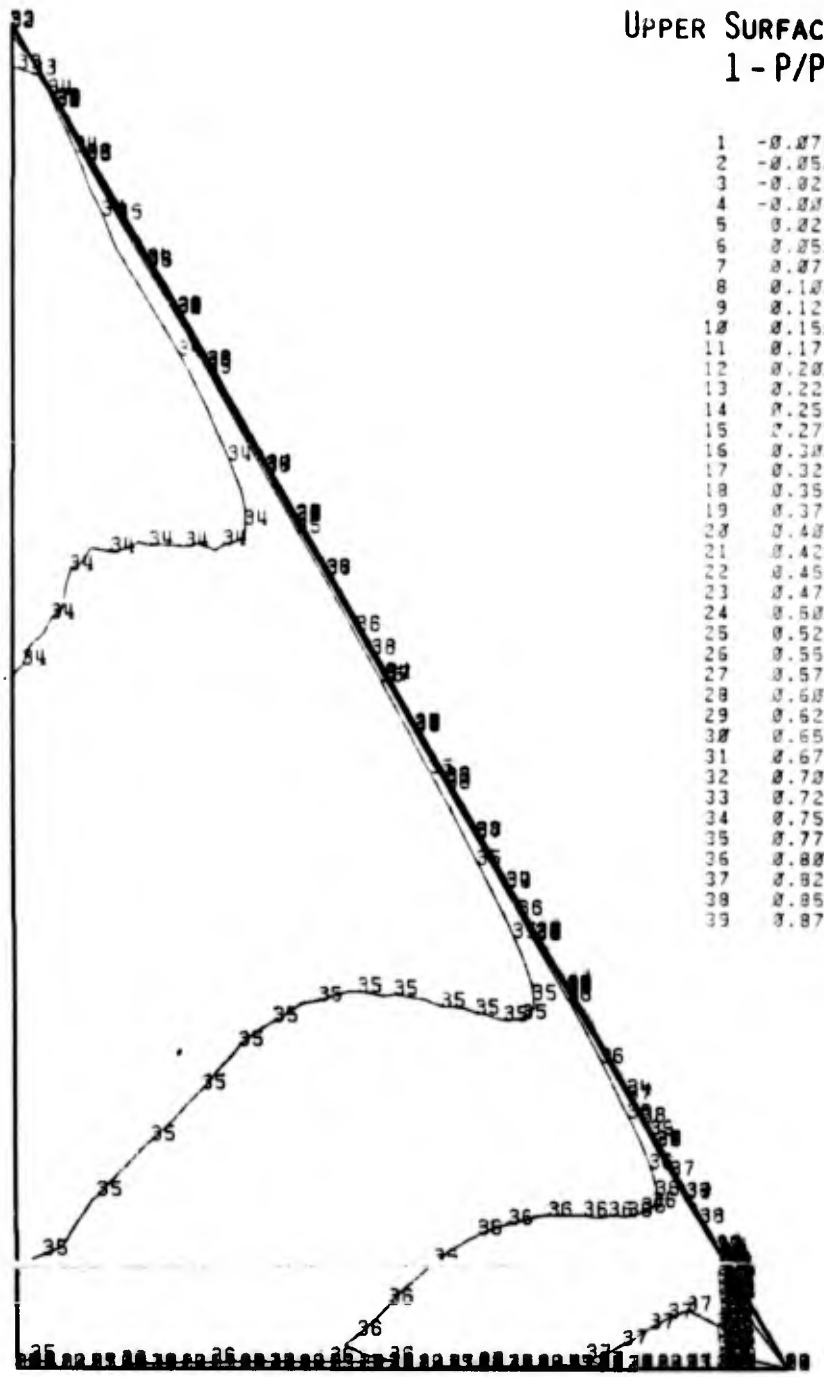
AGARD B: MACH = 1.50, ALPHA = 2

Contributor No 9

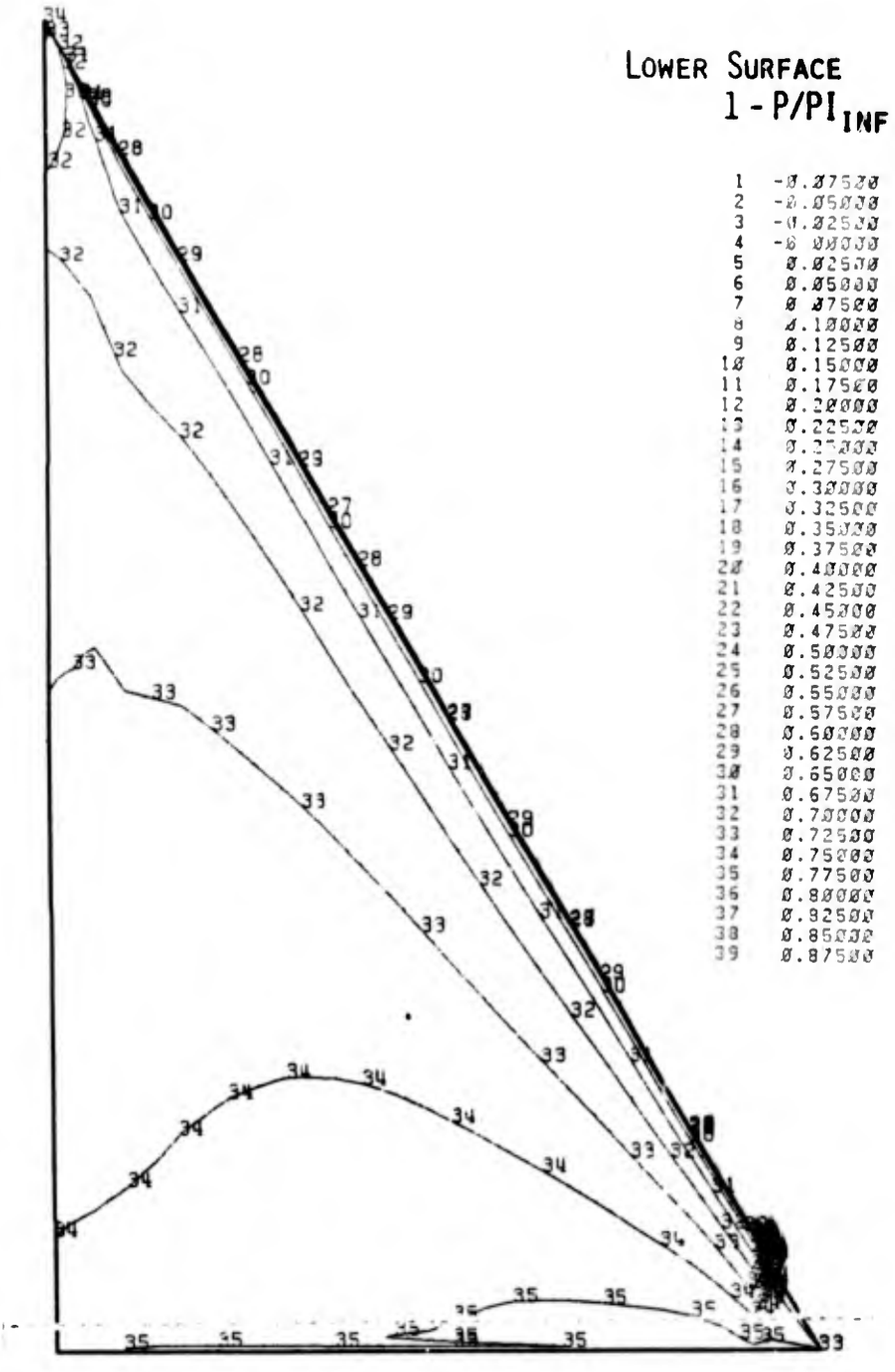
W.Schmidt and A.Jameson

(Dornier, F.R.G.) and (Princeton Univ., U.S.A.)

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-1
	AGARD B: MACH = 1.50, ALPHA = 2			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-2
	AGARD B: MACH = 1.50, ALPHA = 2			

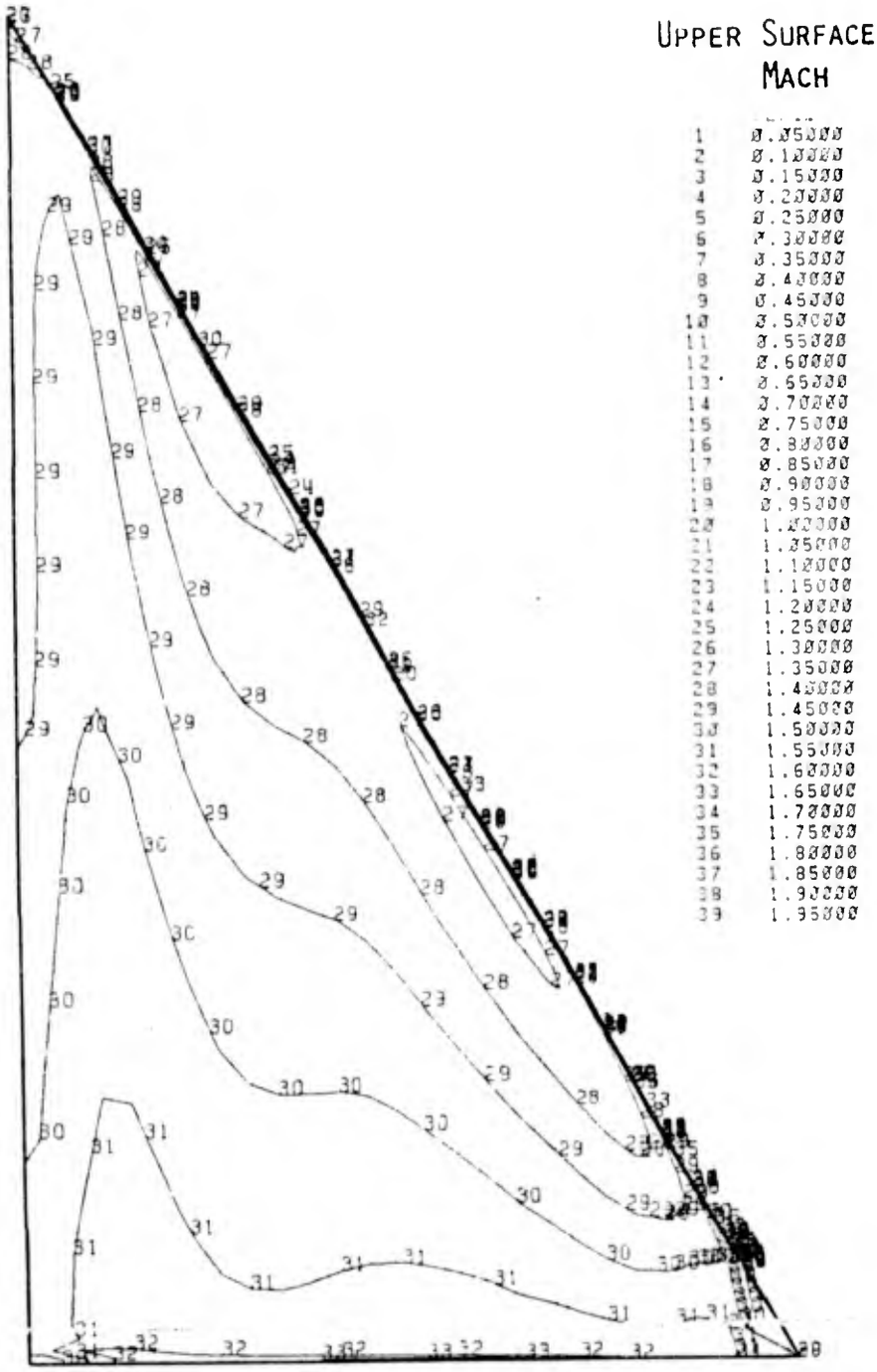


		14-9-7	14-9-8	14-9-9	14-9-10	14-9-11	14-9-12	14-9-13	14-9-14	14-9-15	14-9-16	14-9-17	14-9-18
14-9-19	14-9-20	14-9-21	14-9-22	14-9-23	14-9-24	14-9-25	14-9-26	14-9-27	14-9-28	14-9-29	14-9-30	14-9-31	14-9-32
14-9-33	14-9-34	14-9-35	14-9-36	14-9-37	14-9-38	TEST CASE 15 CONTRIBUTOR 9	15-9-1	15-9-2	15-9-3	15-9-4	15-9-5	15-9-6	15-9-7
15-9-8	15-9-9	15-9-10	15-9-11	15-9-12	15-9-13	15-9-14	15-9-15	15-9-16	15-9-17	15-9-18	15-9-19	15-9-20	15-9-21
15-9-22	15-9-23	15-9-24	15-9-25	15-9-26	15-9-27	15-9-28	15-9-29	15-9-30	15-9-31	15-9-32	15-9-33	15-9-34	15-9-35
15-9-36	15-9-37	15-9-38	TEST CASE 17 CONTRIBUTOR 9	17-9-1	17-9-2	17-9-3	17-9-4	17-9-5	17-9-6	17-9-7	17-9-8	17-9-9	17-9-10
17-9-11	17-9-12	17-9-13	17-9-14	17-9-15	17-9-16	17-9-17	17-9-18	17-9-19	17-9-20	TEST CASE 18 CONTRIBUTOR 9	18-9-1	18-9-2	CONTINUED

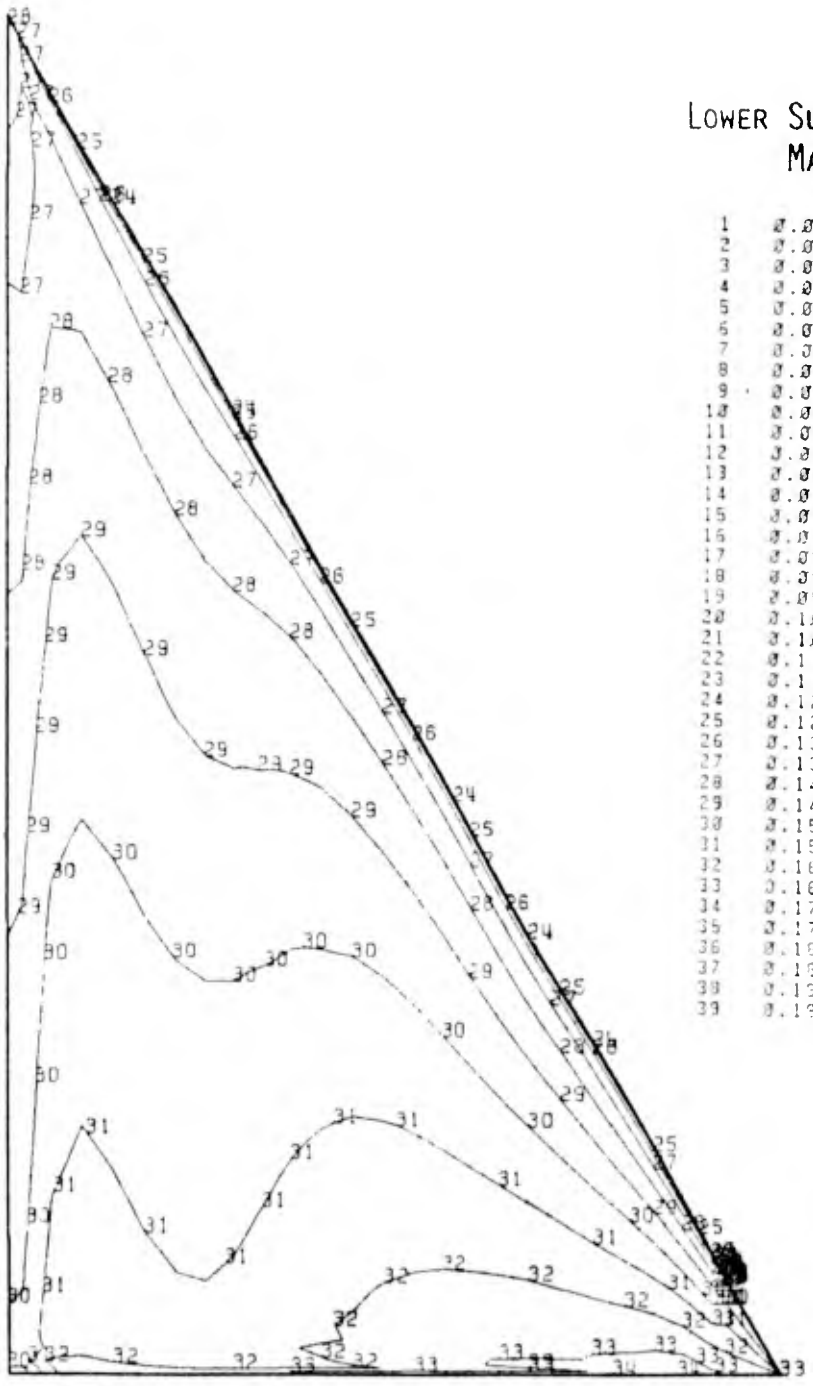
FICHE Nº 14

| | | |

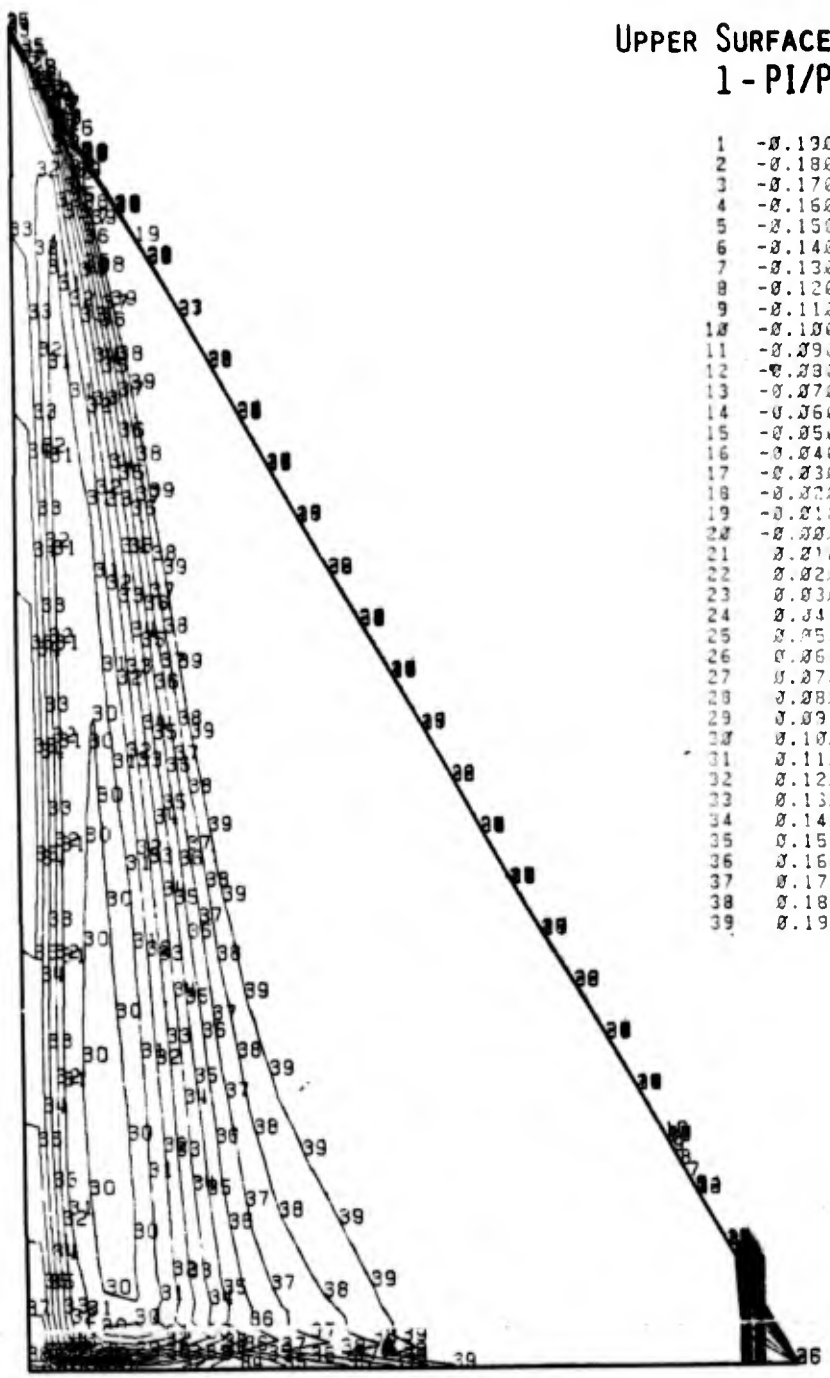
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-3
	AGARD B: MACH = 1.50, ALPHA = 2			



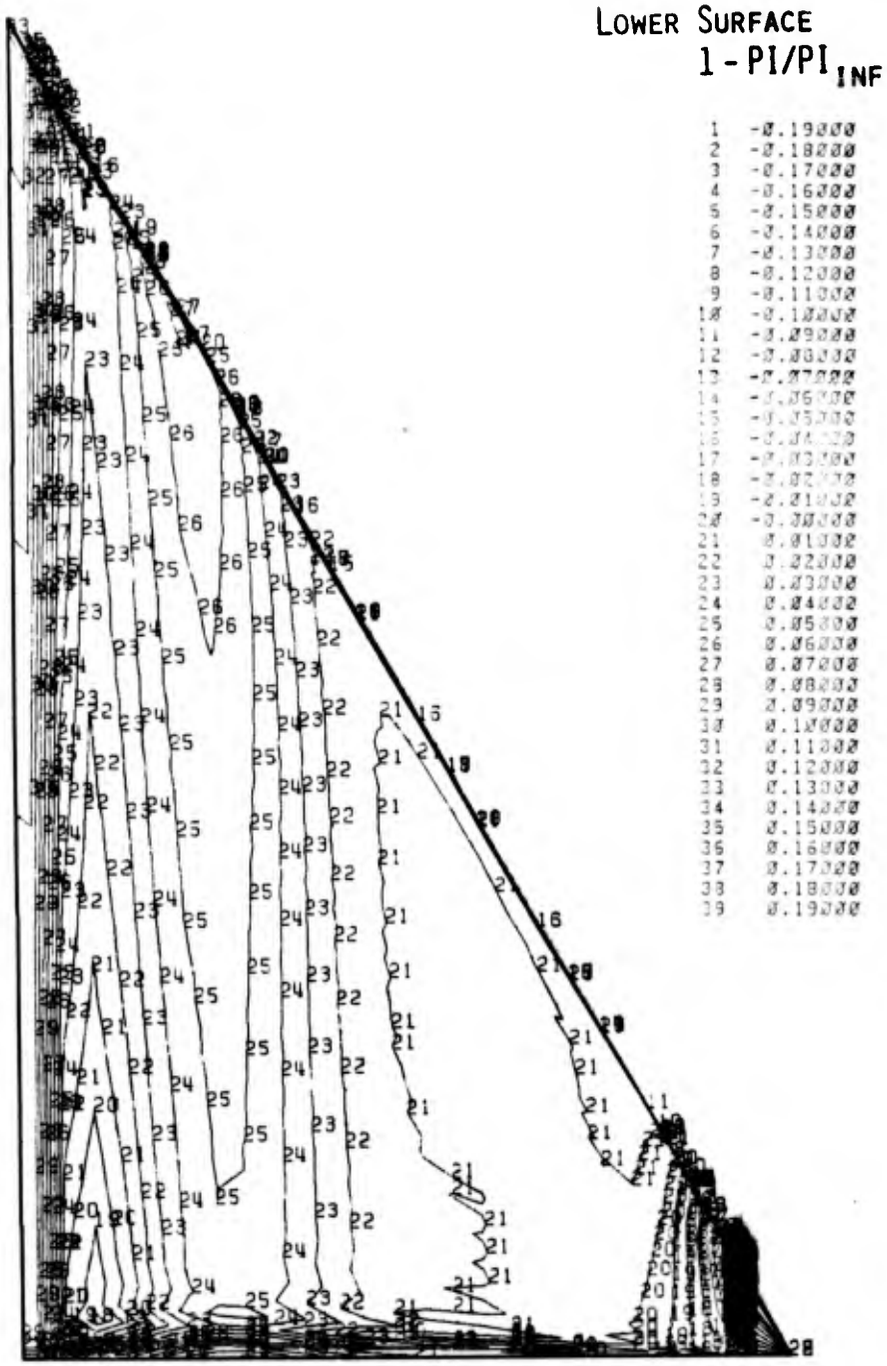
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-4
	AGARD B: MACH = 1.50, ALPHA = 2			



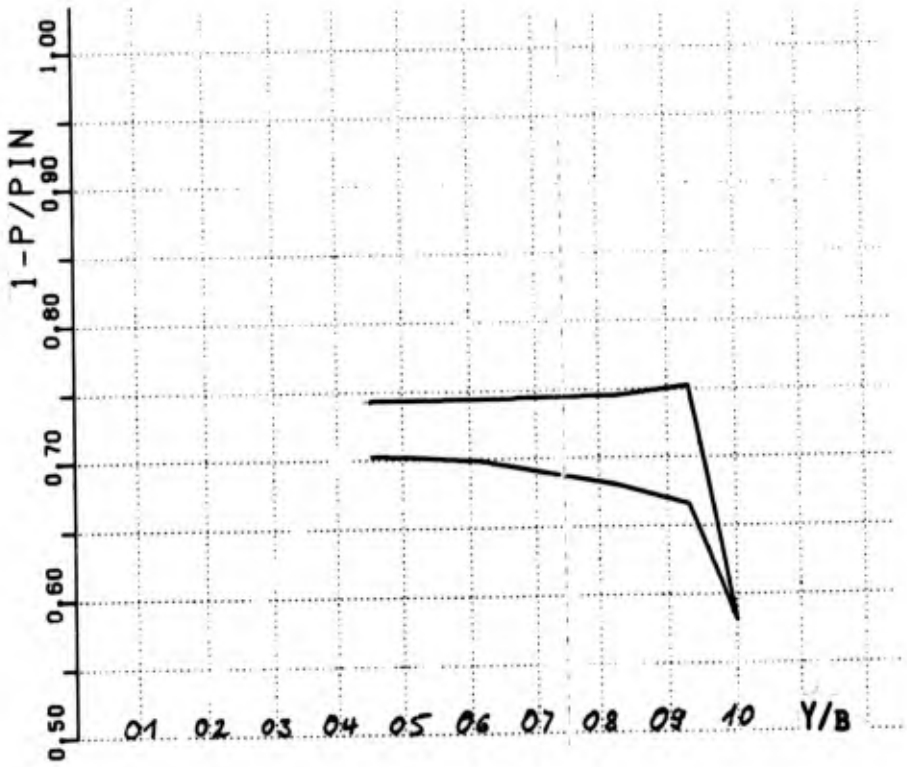
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-5
	AGARD B: MACH = 1.50, ALPHA = 2			



DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-6
	AGARD B: MACH = 1.50, ALPHA = 2			

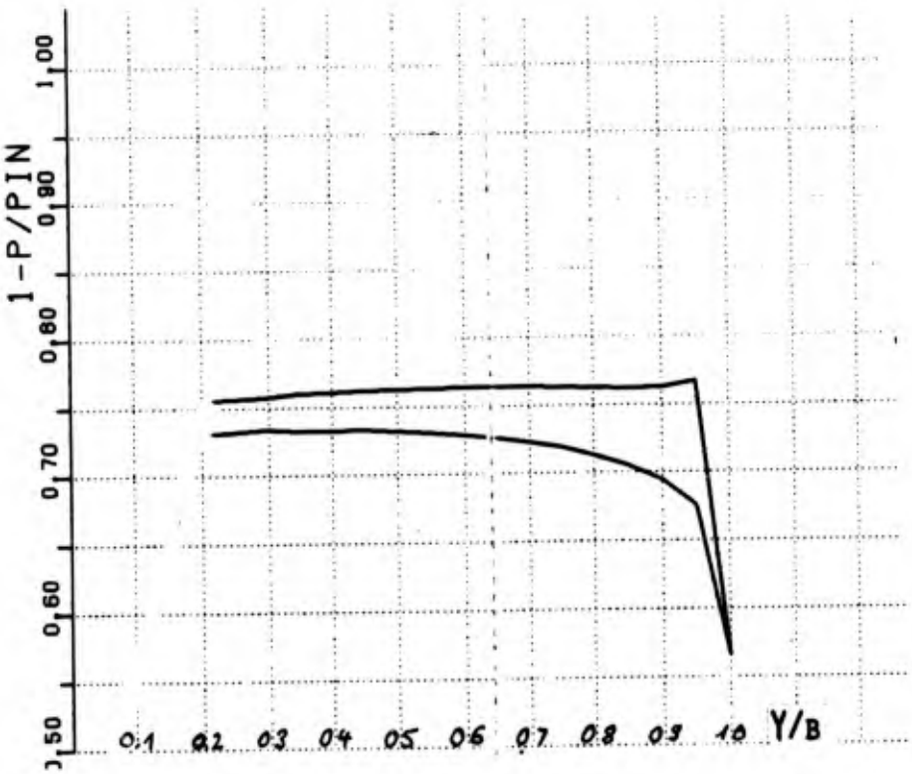


DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-7
	AGARD B: MACH = 1.50, ALPHA = 2			



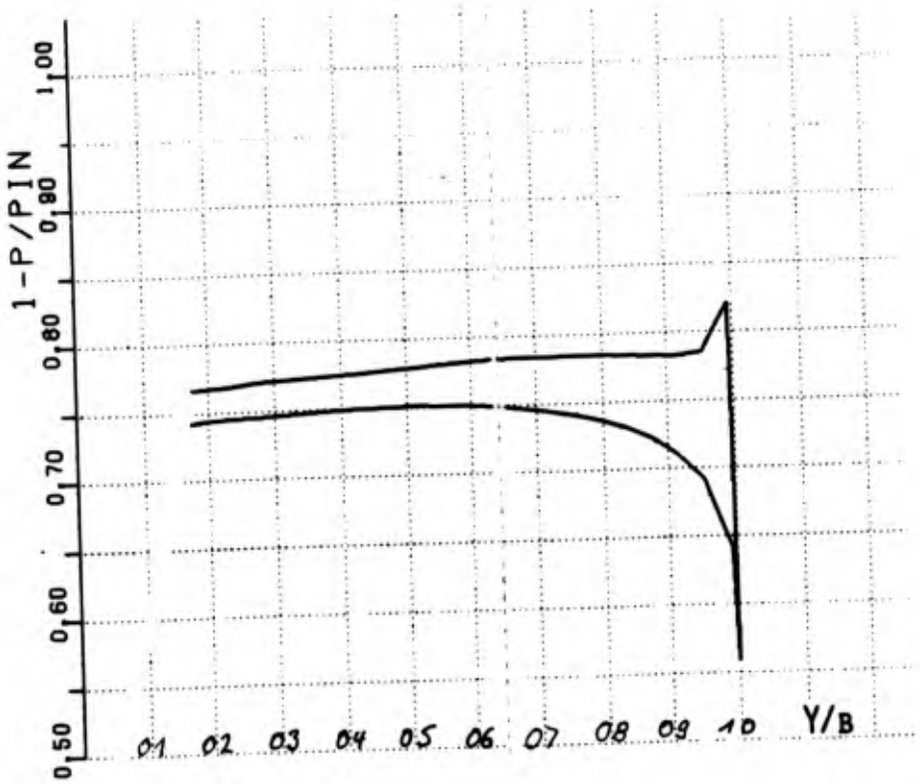
X/C=0.2

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-8
	AGARD B: MACH = 1.50, ALPHA = 2			



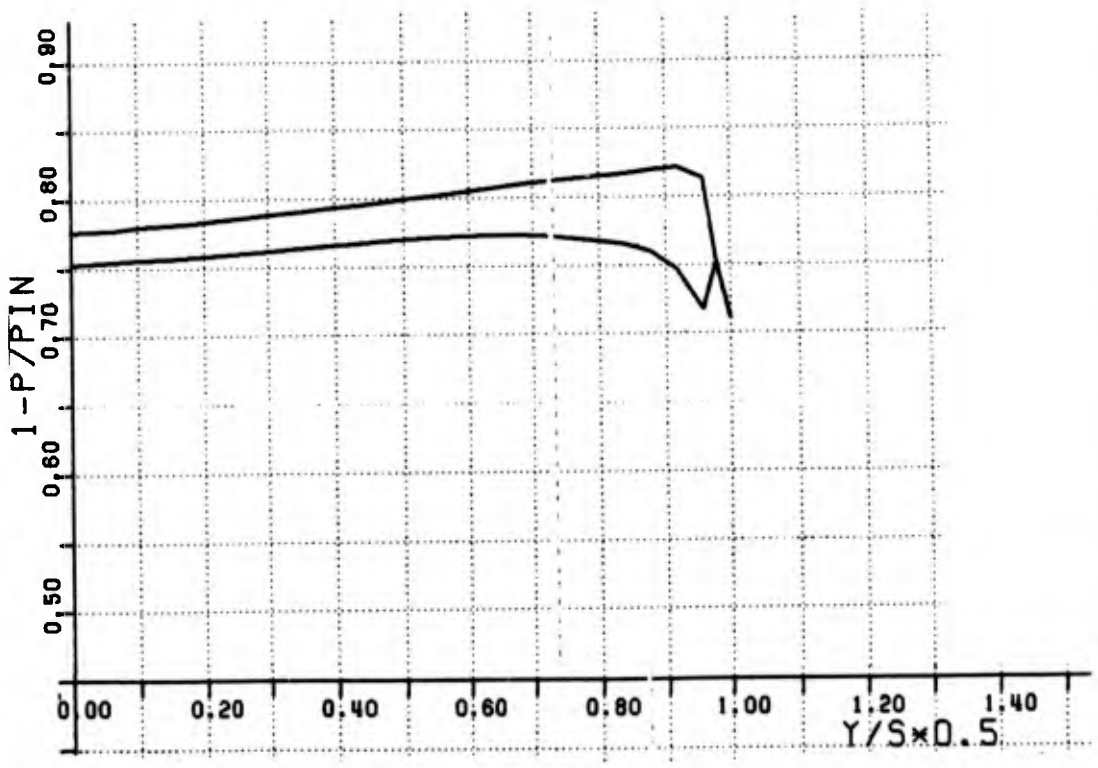
X/C=0.6

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-9
	AGARD B: MACH = 1.50, ALPHA = 2			



X/C=0.8

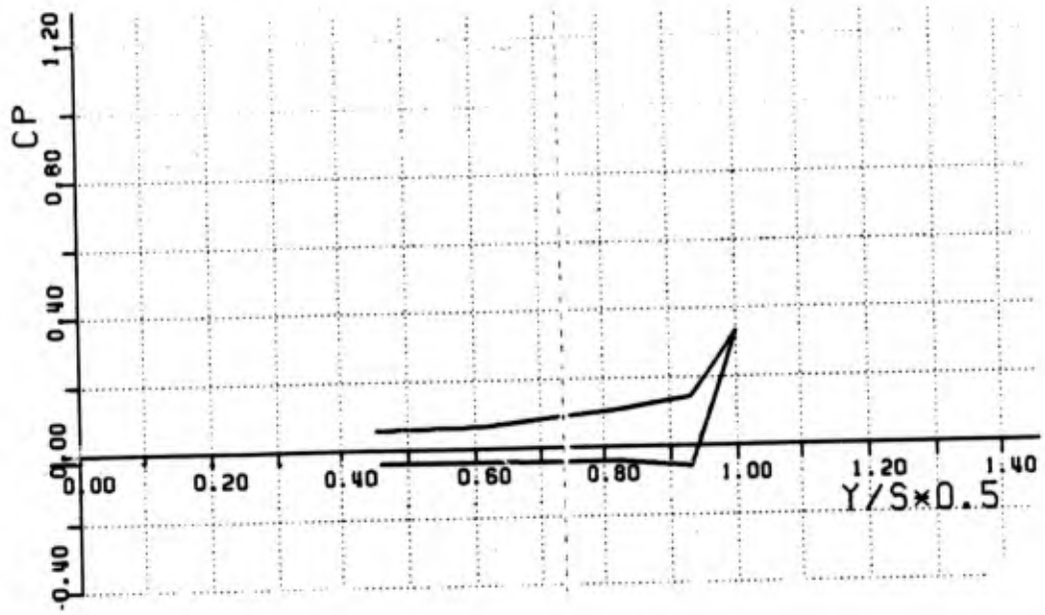
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-10
	AGARD B: MACH = 1.50, ALPHA = 2			



EXPOSED WING

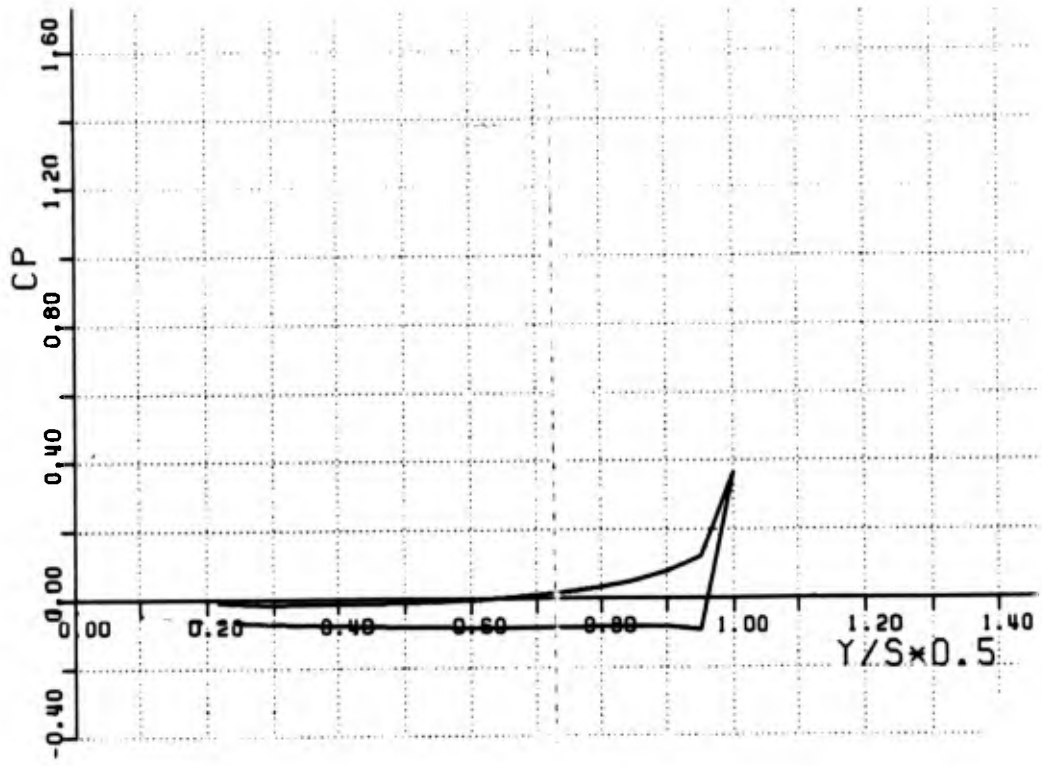
X/C=0.95

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-11
	AGARD B: MACH = 1.50, ALPHA = 2			



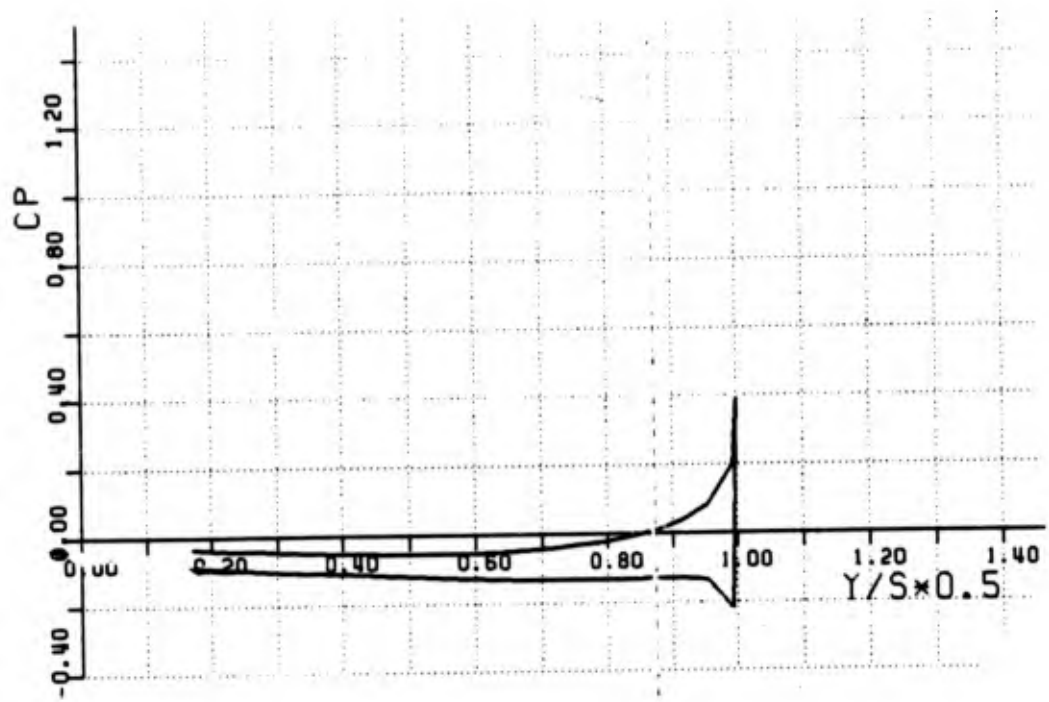
X/C=0.2

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-12
	AGARD B: MACH = 1.50, ALPHA = 2			



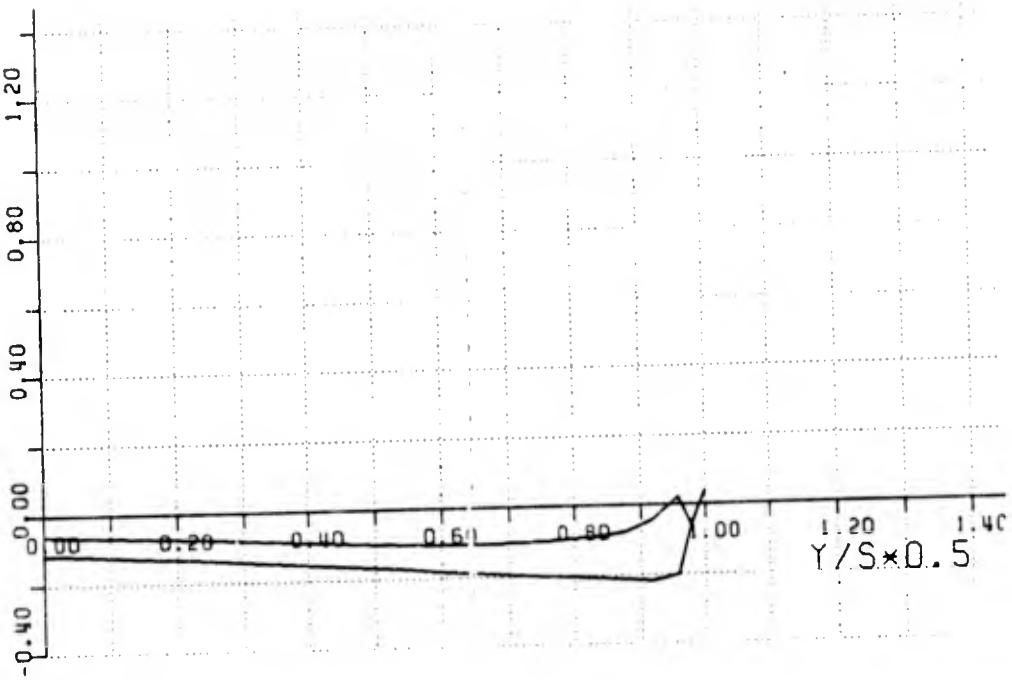
X/C=0.6

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-13
	AGARD B: MACH = 1.50, ALPHA = 2			



X/C=0.8

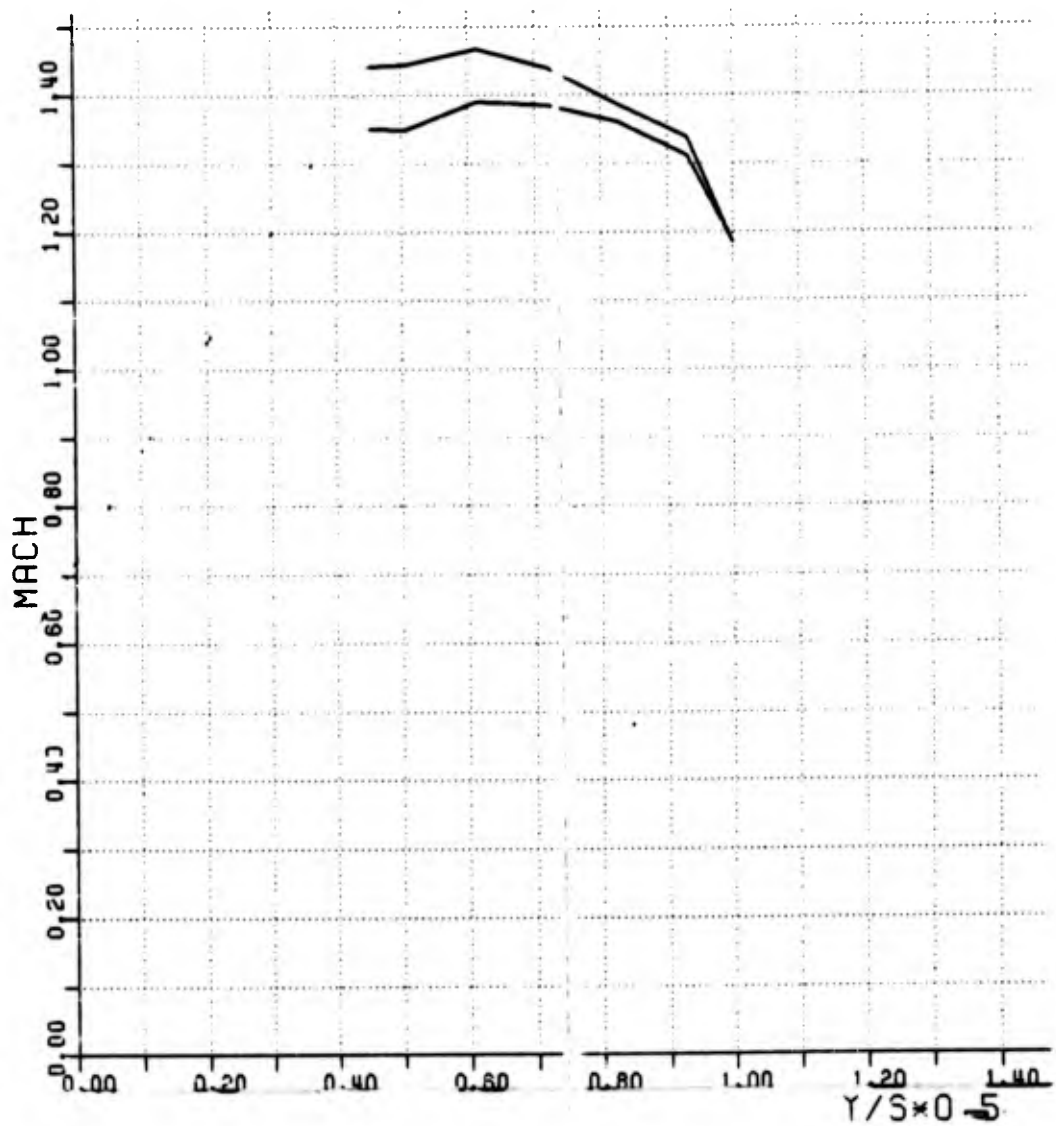
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-14
	AGARD B: MACH = 1.50, ALPHA = 2			



EXPOSED WING

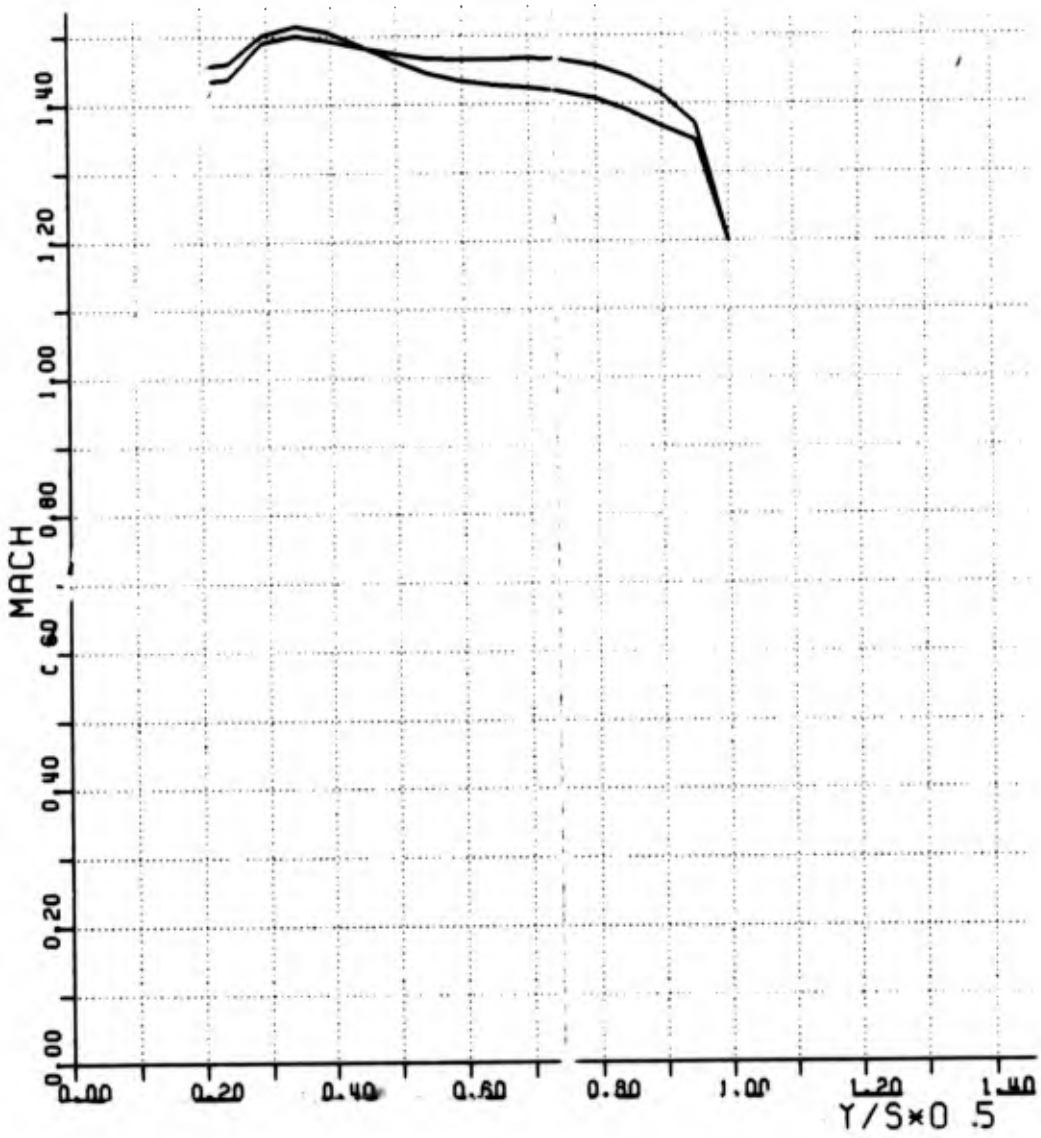
X/C=0.95

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-15
	AGARD B: MACH = 1.50, ALPHA = 2			



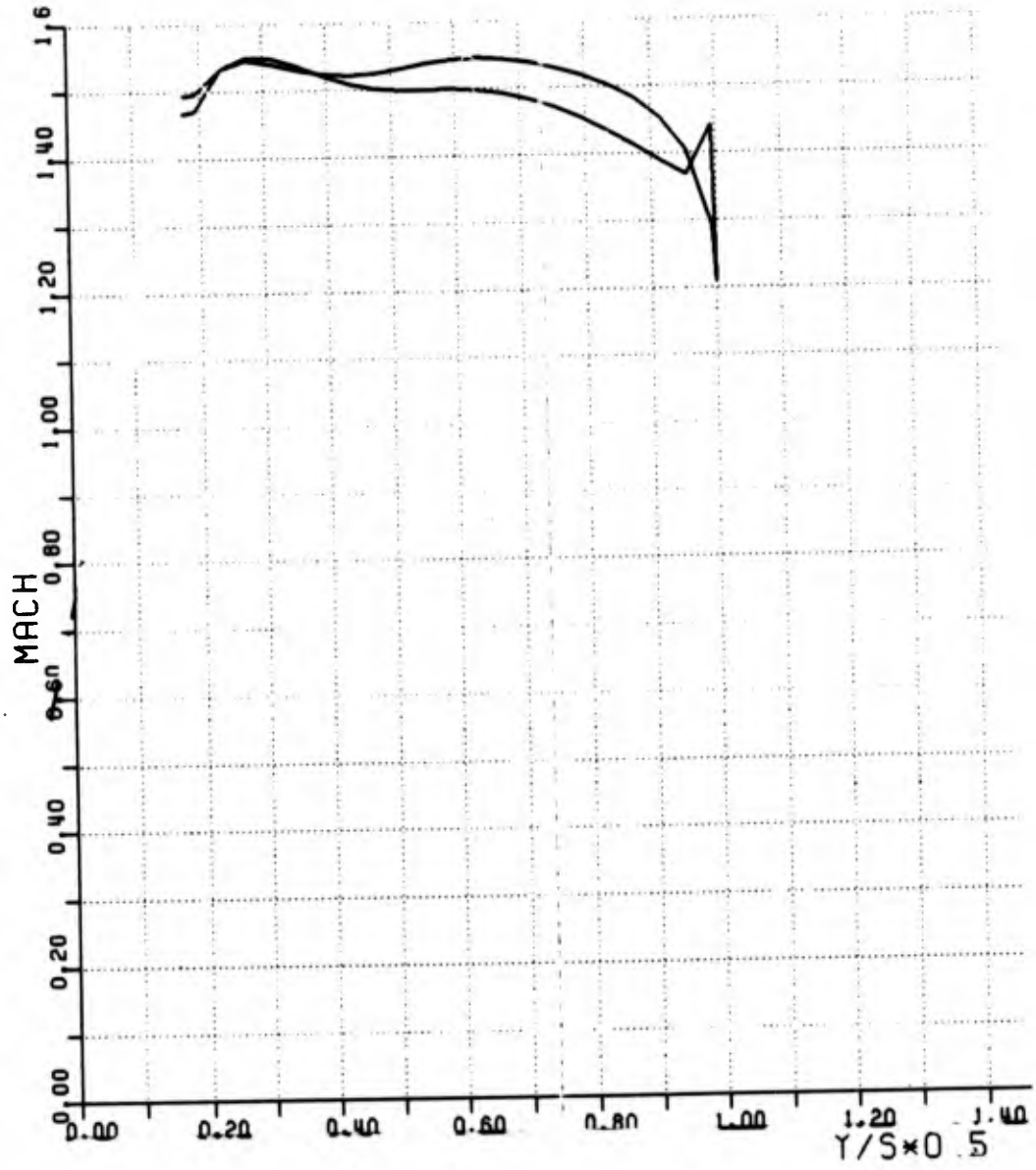
X/C=0.20

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-16
	AGARD B: MACH = 1.50, ALPHA = 2			



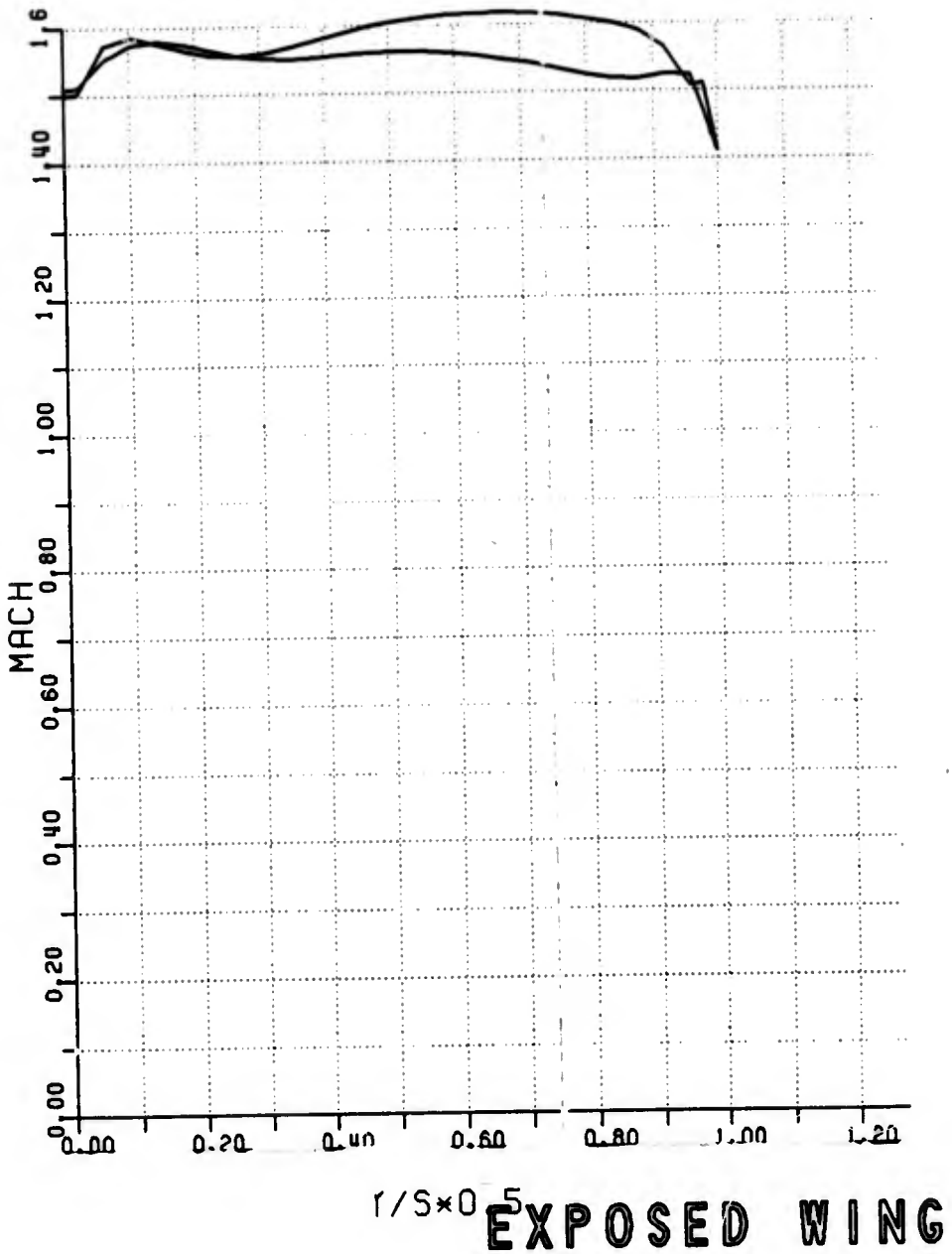
X/C=0.60

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-17
	AGARD B: MACH = 1.50, ALPHA = 2			



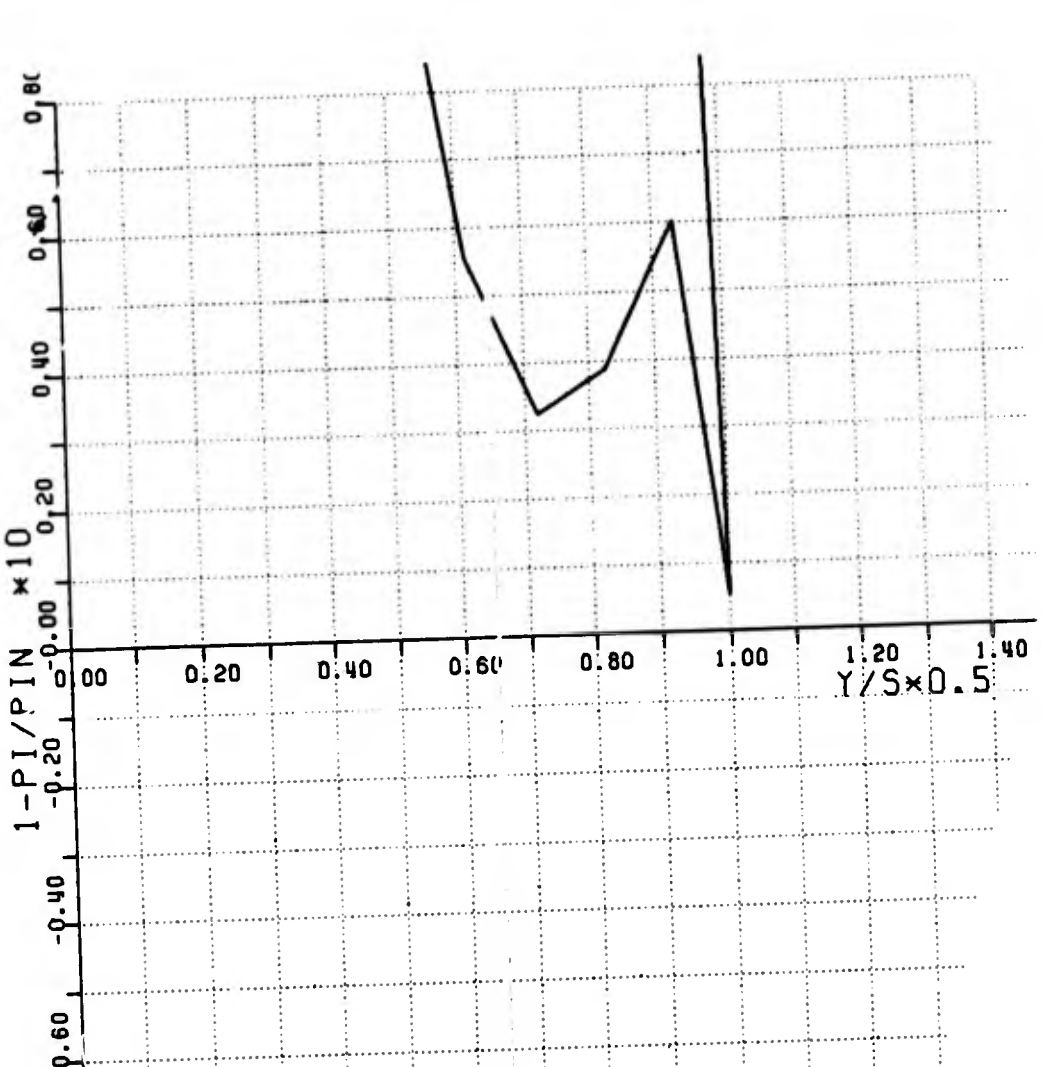
X/C=0.80

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-18
	AGARD B: MACH = 1.50, ALPHA = 2			



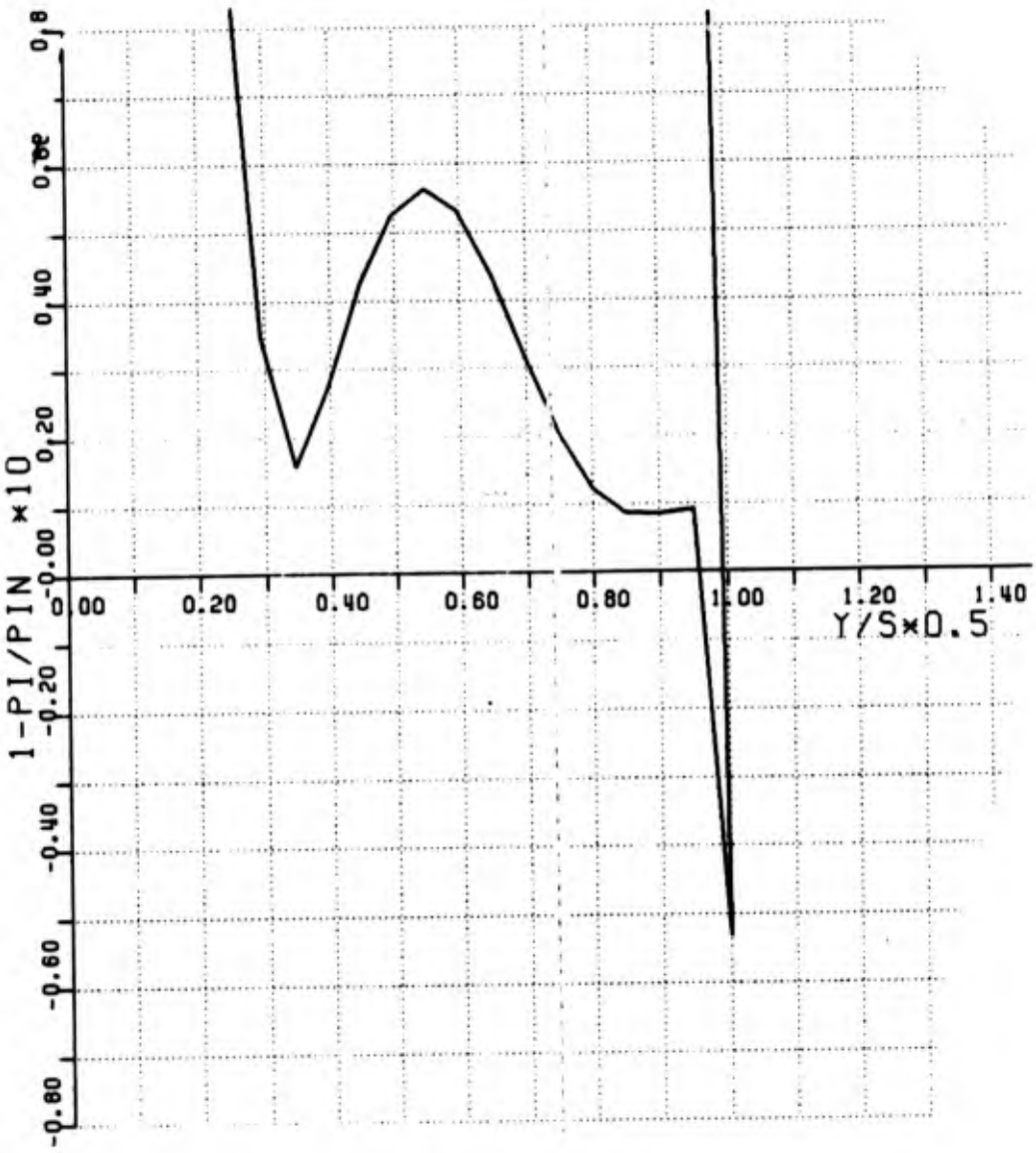
X/C=0.95

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-19
	AGARD B: MACH = 1.50, ALPHA = 2			



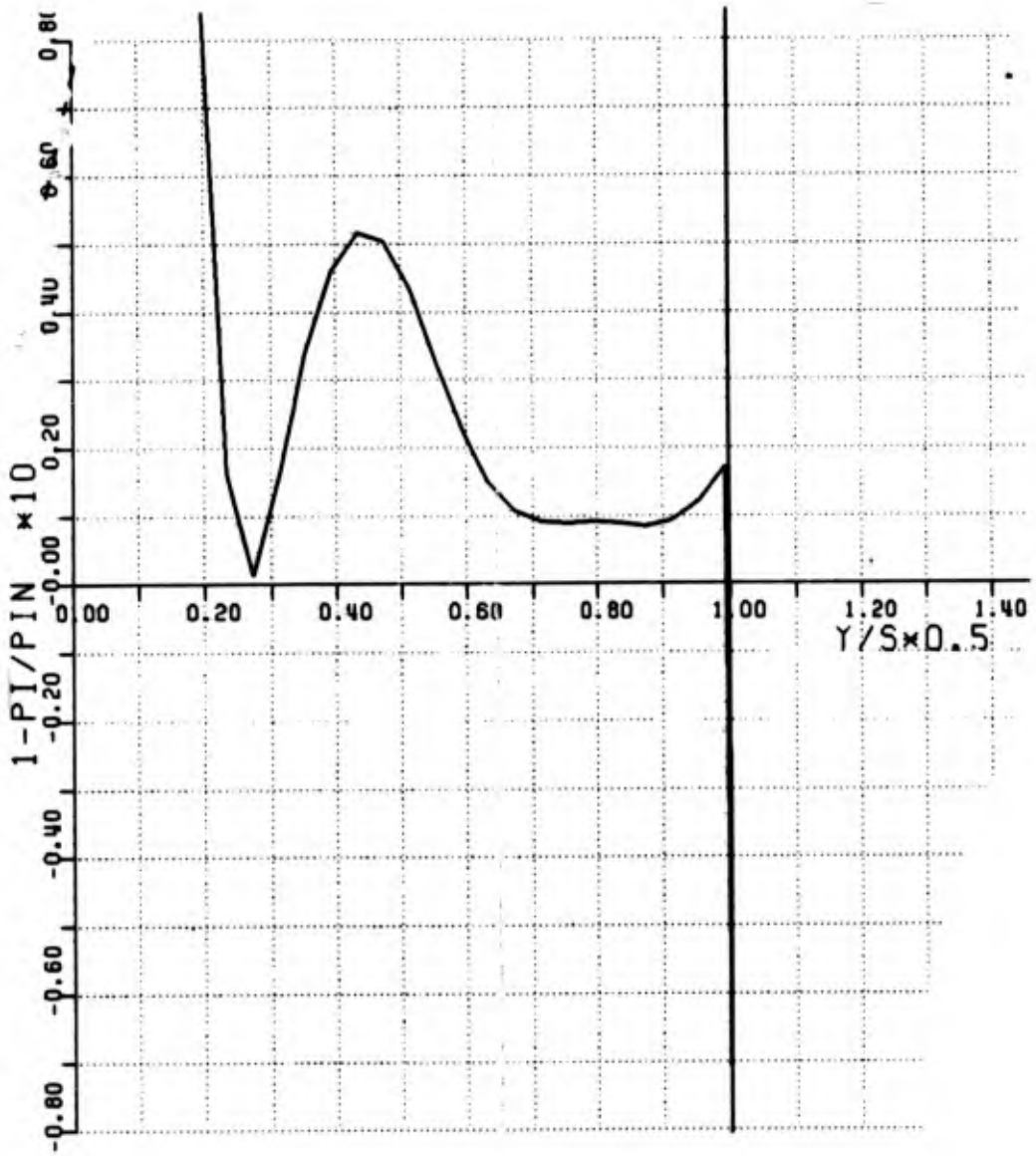
X/C=0.2

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-20
	AGARD B: MACH = 1.50, ALPHA = 2			



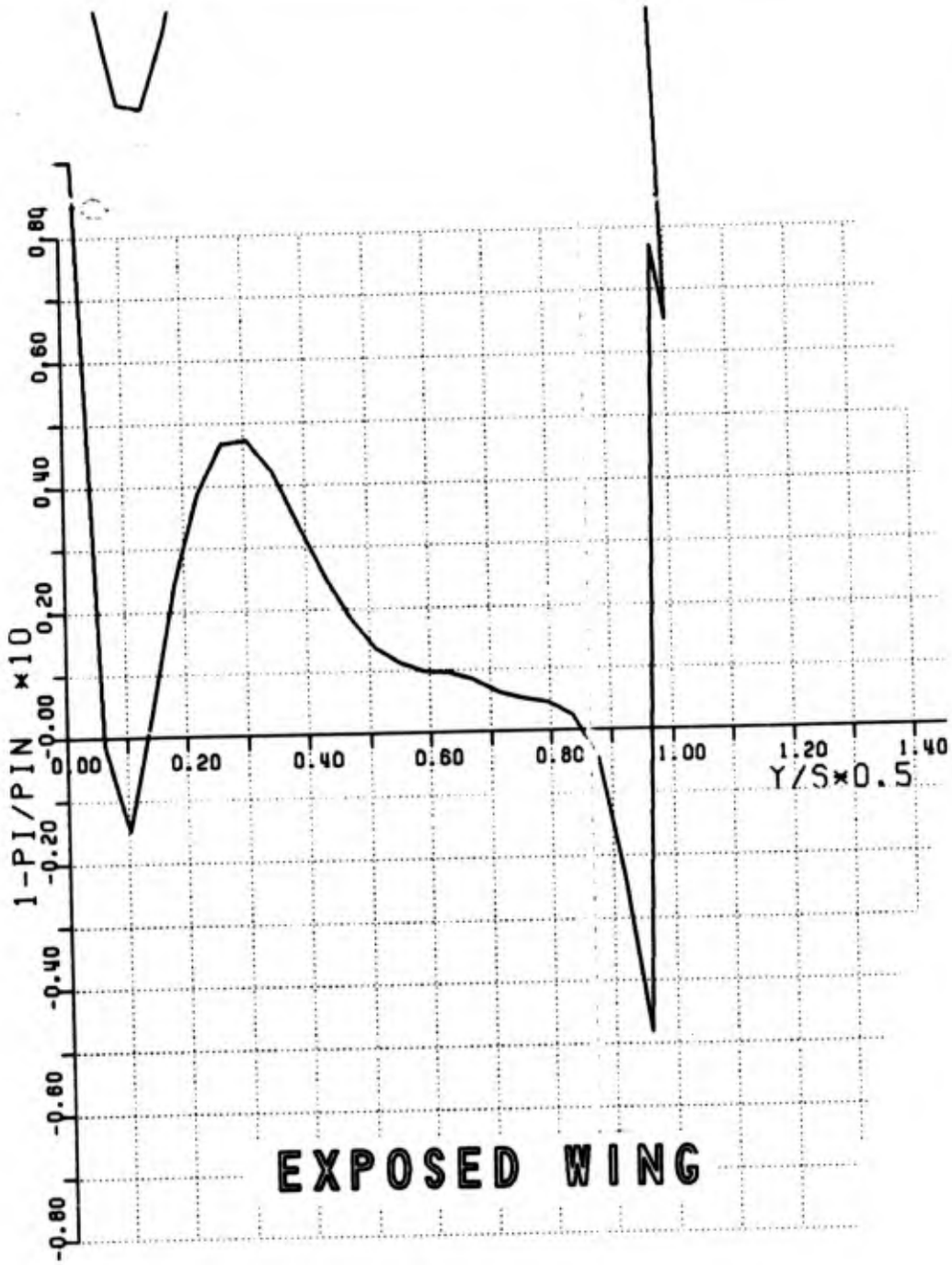
X/C=0.6

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-21
	AGARD B: MACH = 1.50, ALPHA = 2			



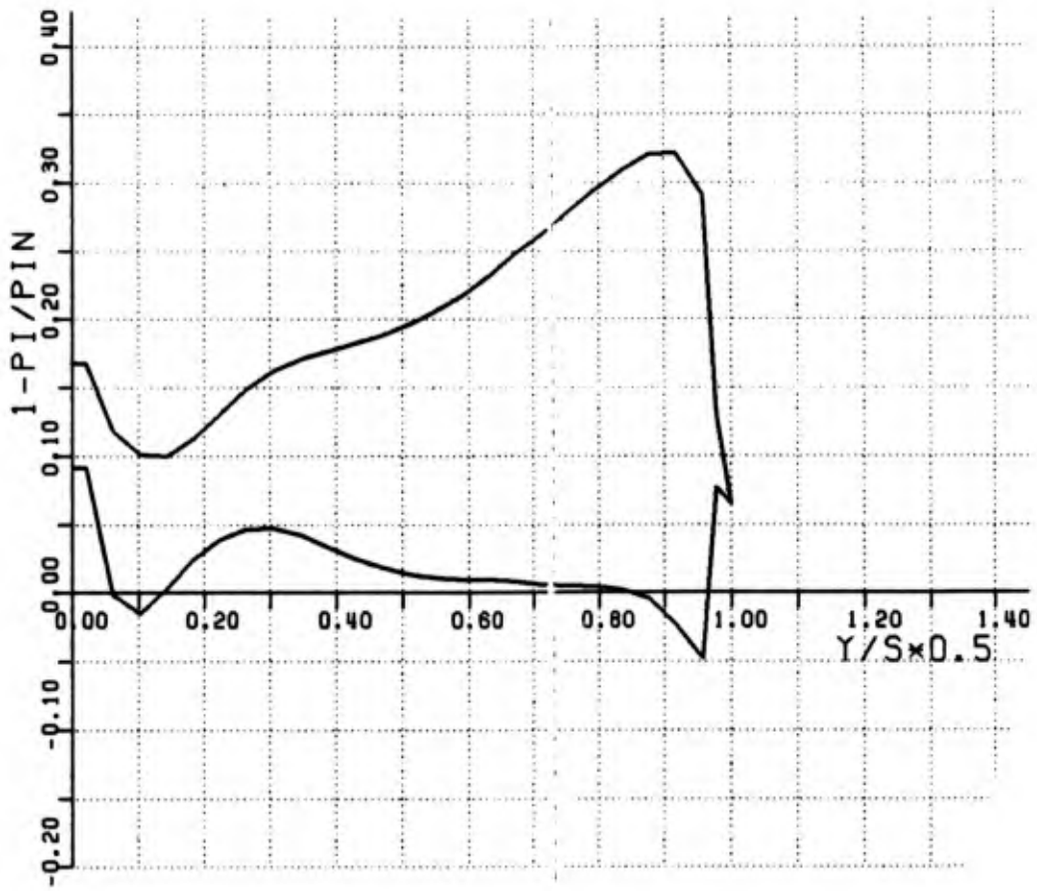
X/C=0.8

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-22
	AGARD B: MACH = 1.50, ALPHA = 2			



X/C-0.95

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-23
	AGARD B: MACH = 1.50, ALPHA = 2			

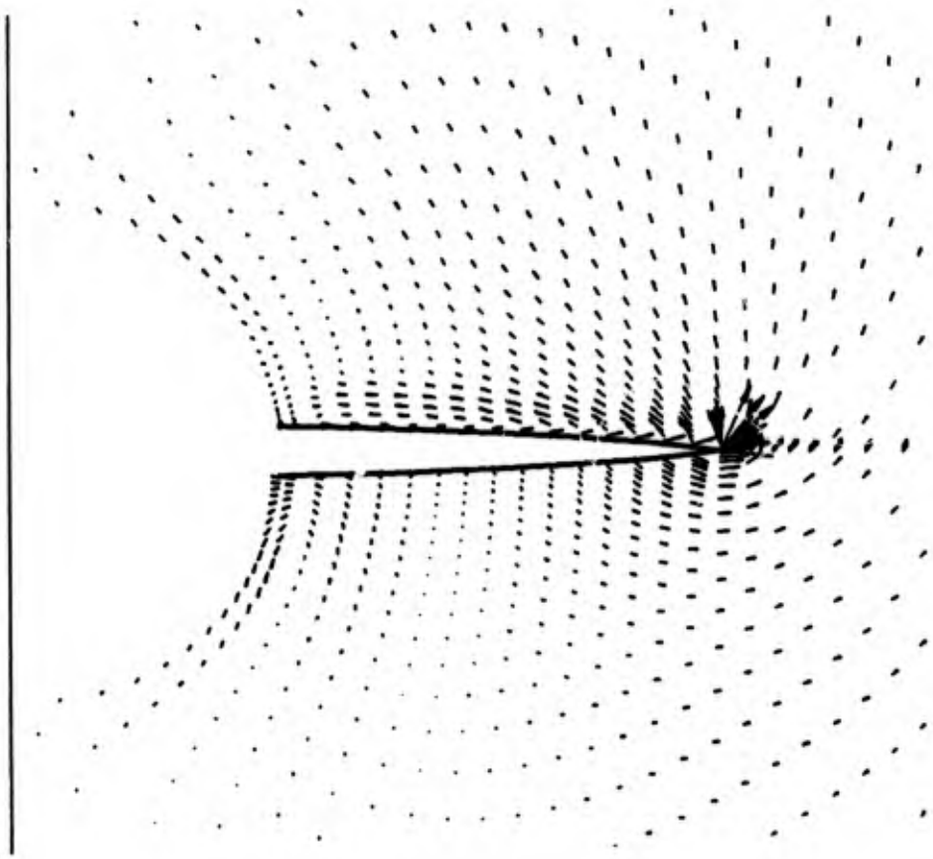


EXPOSED WING

X/C=0.95

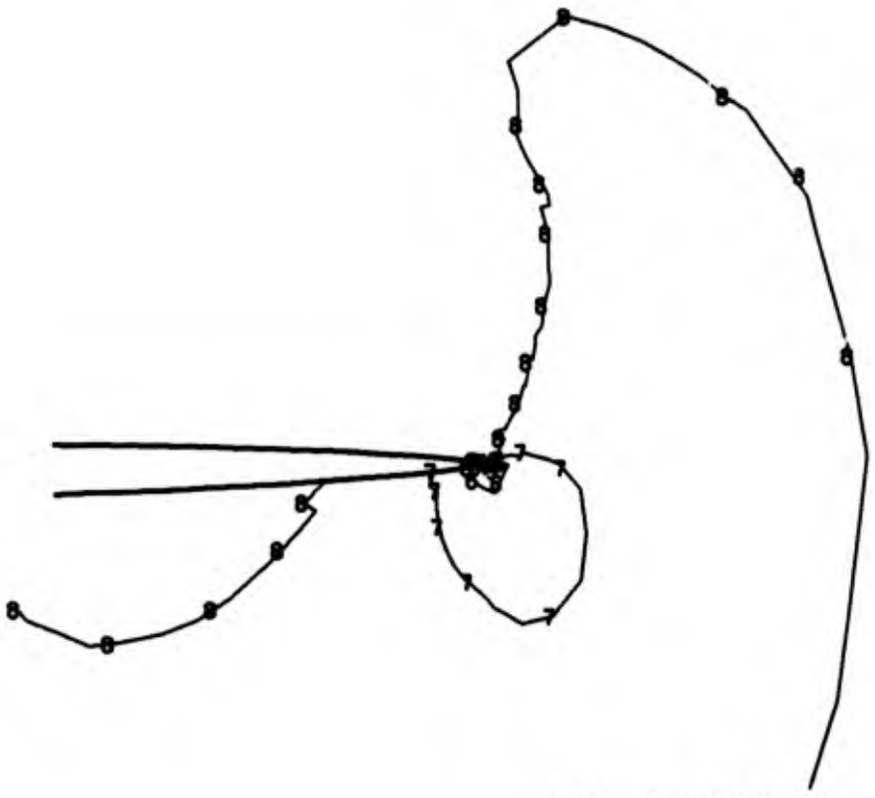
REDUCED SCALE

DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-24
	AGARD B: MACH = 1.50, ALPHA = 2			



AGARD FDP-WG07 EUD03D AGARD WING/BODY VELOCITIES
MACH = 1.5, ALPHA = 2.0, X/C = 0.6

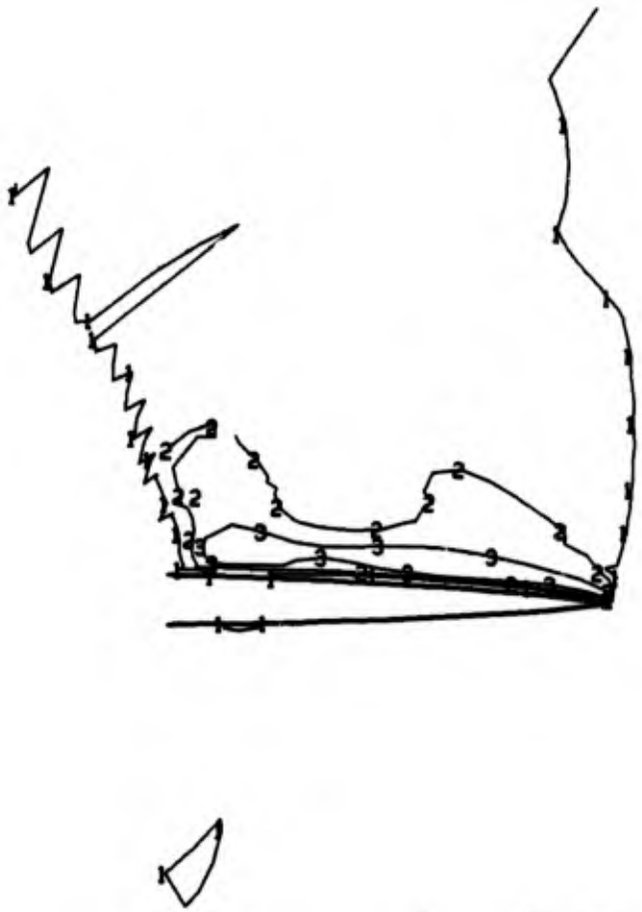
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-25
	AGARD B: MACH = 1.50, ALPHA = 2			



8	7.2500E-01
7	7.0000E-01
6	6.7500E-01
5	6.5000E-01
4	6.2500E-01
3	6.0000E-01
2	5.7500E-01

AGARD FDP-WG07 EUD03D AGARDB WING/BODY ISO 1-P/PINF LINES
MACH = 1.5, ALPHA = 2.0, X/C = 0.6

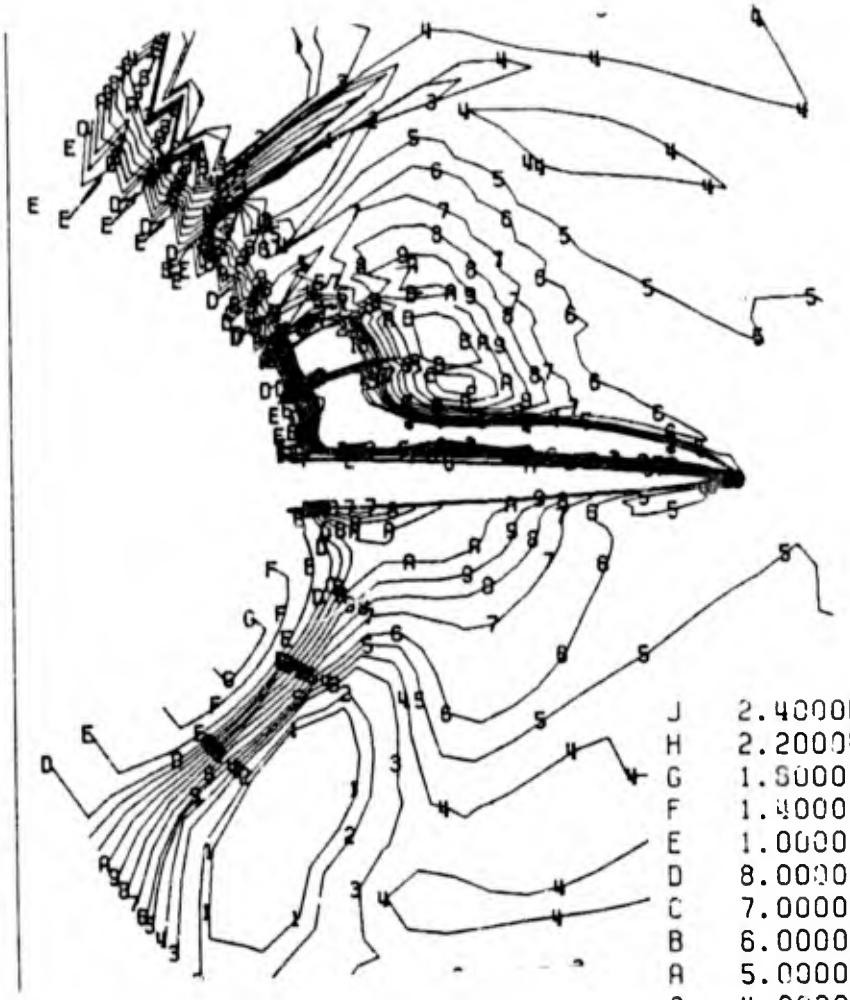
DORNIER/JAMESON	AR 211		W.Schmidt A.Jameson	18-9-26
	AGARD B: MACH = 1.50, ALPHA = 2			



3 1.6000E+00
2 1.5500E+00
1 1.5000E+00

AGARD FDP-WG07 EUD03D AGARD WING/BODY ISO MACH LINES
MACH = 1.5, ALPHA = 2.0, X/C = 0.6

DORNIER JAMESON	AR 211		W.Schmidt A.Jameson	18-9-27
	AGARD B: MACH = 1.50, ALPHA = 2			



J	2.4000E-01
H	2.2000E-01
G	1.8000E-01
F	1.6000E-01
E	1.0000E-01
D	8.0000E-02
C	7.0000E-02
B	6.0000E-02
A	5.0000E-02
9	4.0000E-02
8	3.0000E-02
7	2.0000E-02
6	1.0000E-02
5	5.0000E-03
4	0.0000E+00
3	-5.0000E-03
2	-1.5000E-02
1	-2.0000E-02

AGARD FDP-WG07 EUD03D AGARDB WING/BODY ISO 1-PI/PINF LINES
MACH = 1.5, ALPHA = 2.0, X/C = 0.6

SUPPLEMENTAR

INFORMATION

REPRODUCED AT GOVERNMENT EXPENSE

F.F.A.	AR 211		A.Rizzi	03-8-5
	NACA 0012: MACH = 0.95, ALPHA = 0			

1		1.003723	0.000000	0.570567	-0.357891	1.160447	0.010530
2		1.011506	0.000000	0.563298	-0.347325	1.147377	0.010420
3		1.020008	0.000000	0.556989	-0.329474	1.137125	0.009089
4		1.029354	0.000000	0.558352	-0.333329	1.137277	0.011948
5		1.039740	0.000000	0.561172	-0.341310	1.139846	0.015060
6		1.051447	0.000000	0.563323	-0.347395	1.142035	0.017164
7		1.064851	0.000000	0.563796	-0.348732	1.142109	0.018136
8		1.080446	0.000000	0.562833	-0.346008	1.140597	0.017353
9		1.098357	0.000000	0.561039	-0.340934	1.138022	0.017034
10		1.120866	0.000000	0.558413	-0.333503	1.134086	0.016060
11		1.147440	0.000000	0.555789	-0.326078	1.130506	0.014674
12		1.179757	0.000000	0.553966	-0.320920	1.128075	0.013656
13		1.219246	0.000000	0.552918	-0.317957	1.126384	0.013441
14		1.267629	0.000000	0.551879	-0.315017	1.124073	0.014016
15		1.326968	0.000000	0.549776	-0.309065	1.120173	0.014219
16		1.399727	0.000000	0.547309	-0.302087	1.116148	0.013808
17		1.488833	0.000000	0.545377	-0.296620	1.113192	0.013251
18		1.597764	0.000000	0.543782	-0.292107	1.110585	0.013005
19		1.730633	0.000000	0.541009	-0.284261	1.105943	0.012732
20		1.892299	0.000000	0.534275	-0.265208	1.094161	0.012775
21		2.088495	0.000000	0.520066	-0.225006	1.069236	0.013302
22		2.325974	0.000000	0.496519	-0.158384	1.029162	0.013641
23		2.612079	0.000000	0.459266	-0.081276	0.964152	0.013665
24		2.957951	0.000000	0.448282	-0.021903	0.931145	0.012564
25		3.372759	0.000000	0.435558	0.014095	0.931346	0.011936
26		3.869976	0.000000	0.428417	0.034300	0.920481	0.011392
27		4.464706	0.000000	0.424892	0.044275	0.914873	0.011409
28		5.174656	0.000000	0.423960	0.046910	0.914045	0.010707
29		6.020579	0.000000	0.425556	0.042396	0.916382	0.010914
30		7.026787	-0.000001	0.428951	0.032789	0.922900	0.009677
31		8.221754	-0.000001	0.433915	0.018745	0.930113	0.010414
32		9.638821	-0.000001	0.438523	0.005708	0.939159	0.008529

DOWNSTREAM