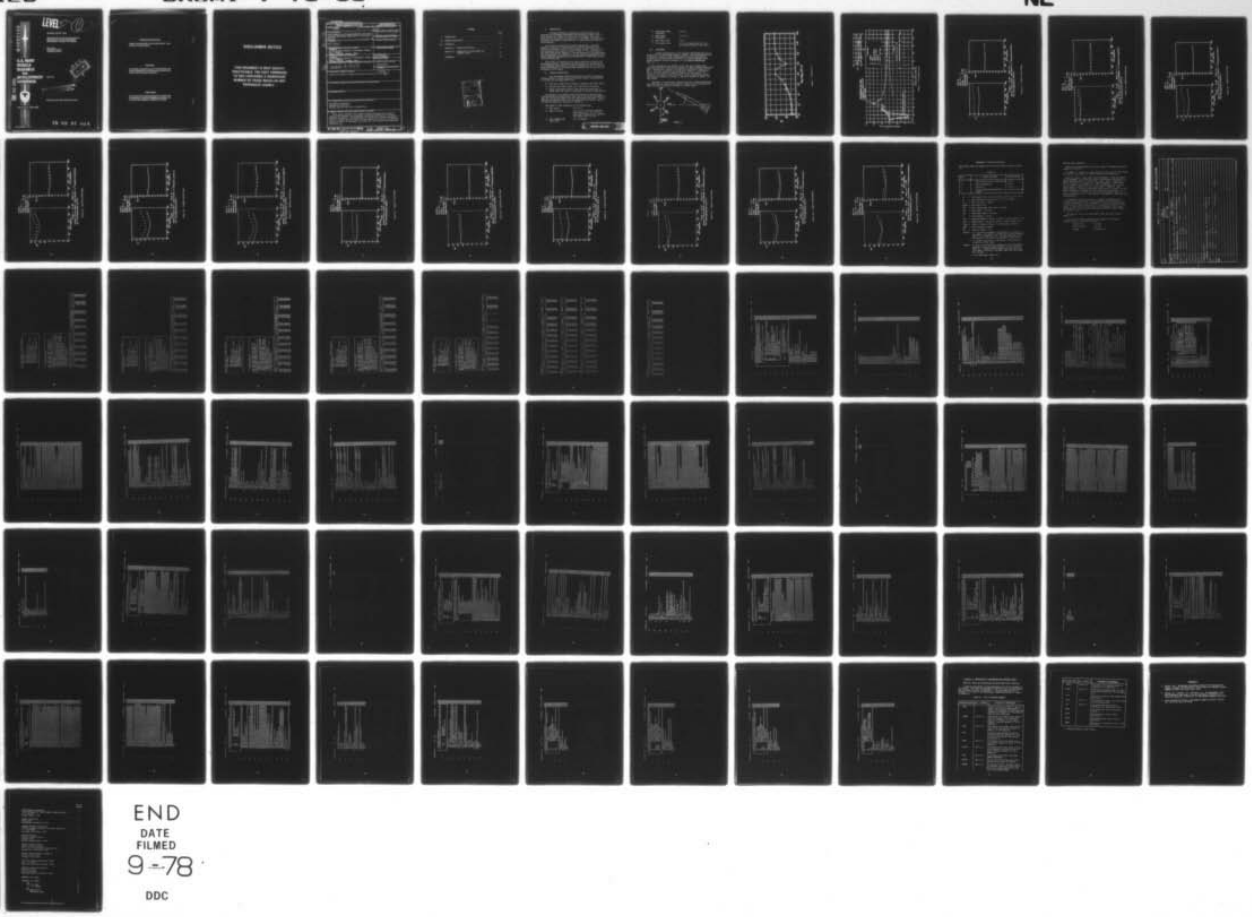
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JUN 78 G C WINN

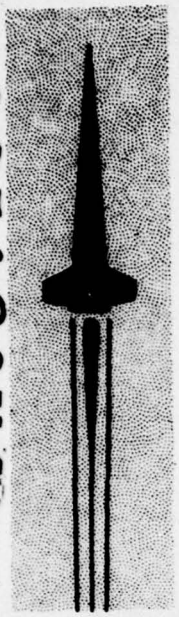
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LEVEL II

TECHNICAL REPORT T-78-63

# USER'S MANUAL FOR THE MARTIN–MARIETTA HIGH ANGLE OF ATTACK AERODYNAMIC METHODOLOGY FOR BODY-TAIL MISSILES

Gary C. Winn
Aeroballistics Directorate
Technology Laboratory

DDC
AUG 8 1978
F

## U.S. ARMY MISSILE RESEARCH AND DEVELOPMENT COMMAND

JUNE 1978

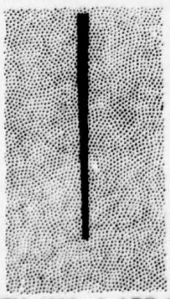
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This report documents the computer program developed by the Army to evaluate and implement an aerodynamic methodology developed by the Martin Marietta Corporation. The methodology was developed to predict aerodynamic forces on slender missile bodies with low aspect ratio tails at low and high angles of attack, at arbitrary roll angles for both transonic and supersonic velocities.

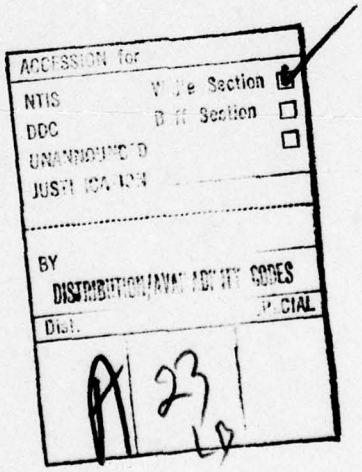
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## I. INTRODUCTION

The Martin Marietta Corporation, Orlando Division, has developed an aerodynamic methodology and published a report (Ref. 1) under Contract No. DAAH01-74-C-0621 with the US Army. The report describes the development and application of semiempirical methods for predicting aerodynamic characteristics of slender body and body-tail configurations.

In an effort to evaluate the Martin Methodology, a computer program was developed to incorporate the various theoretical and empirical procedures called for in the Martin report. The results of this evaluation are covered in detail in Ref. 2. As a follow-up to the Martin Methodology analysis, a few modifications of the methodology were accomplished in an attempt to correct certain disagreements found between measured experimental data and associated predictions derived from the methodology.

This report is intended to be a user's guide for the use of the methodology program. The methods and procedures used in developing the aerodynamic methodology are covered extensively in Ref. 1 and only those modifications to the methodology implemented by the Army will be discussed in this report.

## II. PROGRAM CAPABILITIES

The Aerodynamic Methodology Program can predict aerodynamic characteristics of slender body and body-tail missile configurations, to include the following predictions:

1) Body alone normal force, center of pressure, and axial force.
2) Isolated tail panel normal force and center of pressure.
3) Mutual interference effects that enable the prediction of normal force and center of pressure of body-tail combinations.

The program in its present form was developed to predict these characteristics for missiles with four fins in cruciform configuration, with the fin trailing edges flush with the missile body base. The fin numbering convention, as well as the conventions for angle of attack ($\alpha$) and roll angle ($\phi$), are shown in Figure 1.

The range of input parameters for the program are:

| | | |
|---|---|---|
| 1) | Mach number | 0.8 to 3.0 |
| 2) | Angle of attack | 0 to 180 for isolated components (roll angle = 0). 0 to 45 for body-tail combinations at arbitrary roll angles from 0 to 180 . |
| 3) | Tail leading edge sweep angle | 0 to 70 degrees |



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| | | |
|---|---|---|
| 4) | After-body length (calibers) | 6 to 18 |
| 5) | Nose length (calibers) | 1.5 to 3.5 |
| 6) | Tail taper ratio | 0 to 1 |
| 7) | Tail aspect ratio | .5 to 2.0 (aspect ratio of two tail panels joined at root chord) |

## III. DISCUSSION

Certain modifications of the original methodology were incorporated into the methodology computer program. These modifications were an attempt to correct certain disagreements between experimentally obtained data and associated predictions from the methodology which became apparent during an evaluation of the **original methodology** (Ref. 2).

The modifications are limited to the body alone normal force prediction methods and involve the addition of newly obtained unpublished data. Specifically, equation 16, page 36 as depicted in Figure 20 of Ref. 1, has been eliminated and replaced by values of $\eta$ (correlation factor for end effects) as shown in Figure 2 of this report. In addition, the crossflow drag coefficient versus crossflow Mach number curve shown in Figure 22a of Ref. 1, has been replaced by Figure 3 of this report.

Comparisons of predictions generated from the original methodology and those with the above modifications, compared with the experimental data, are shown in Figures 4 through 10 of this report.

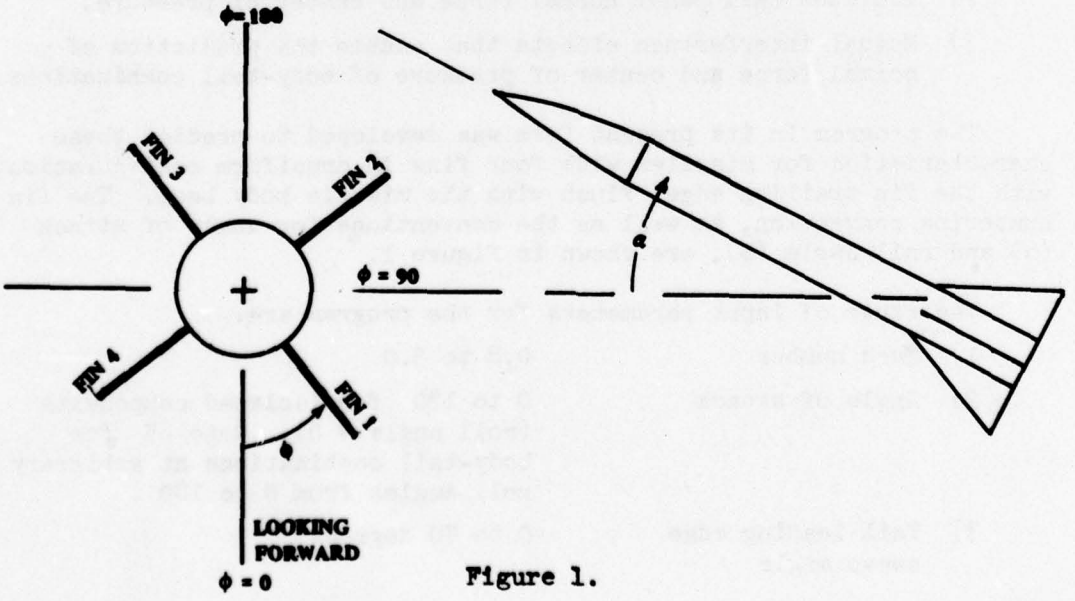



Figure 1.

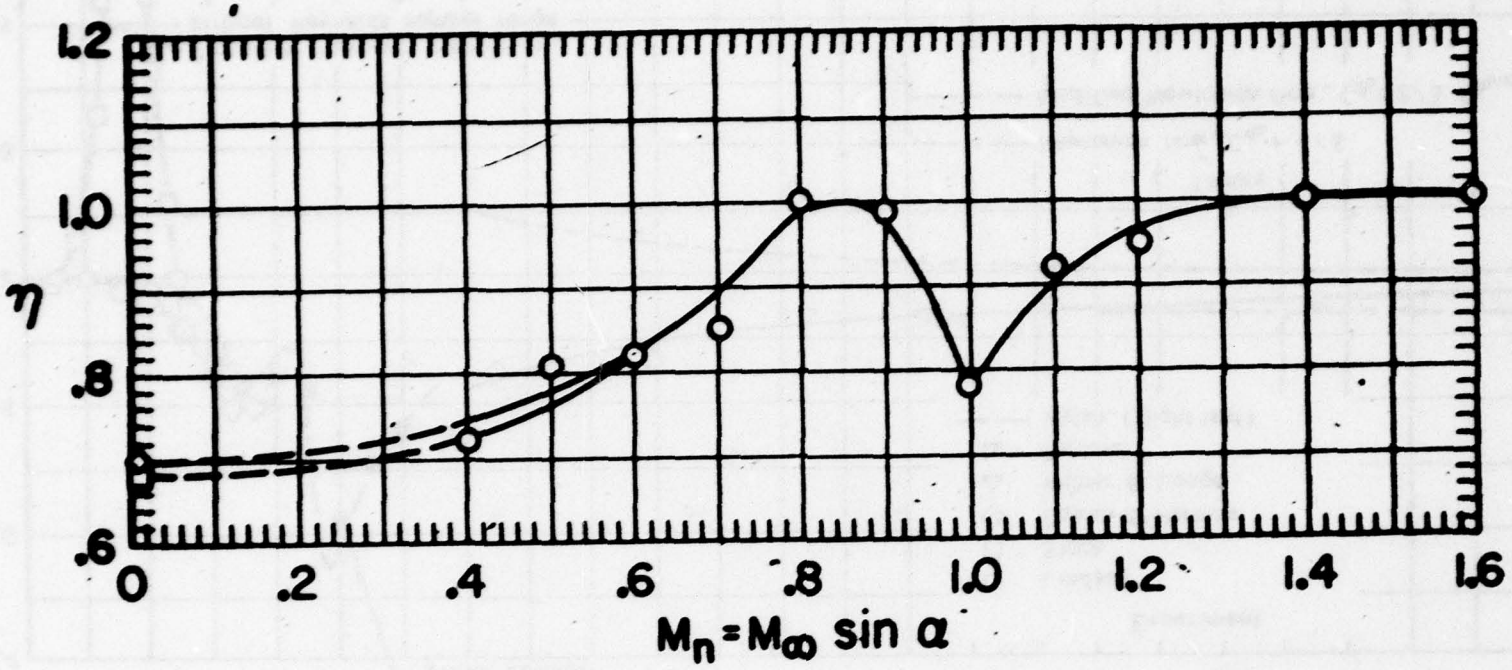



Figure 2. Values of η.

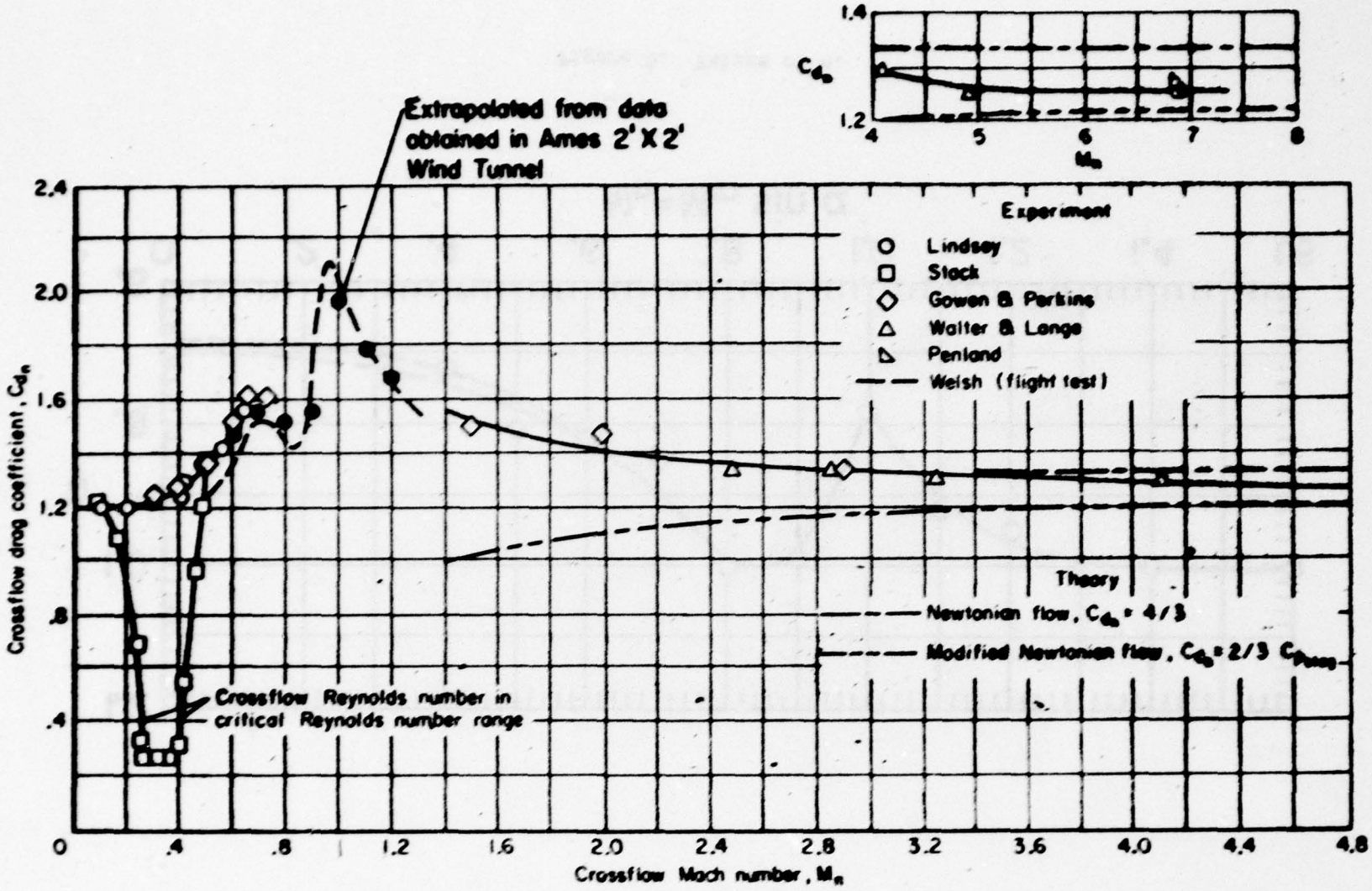



Figure 3. Unpublished data.

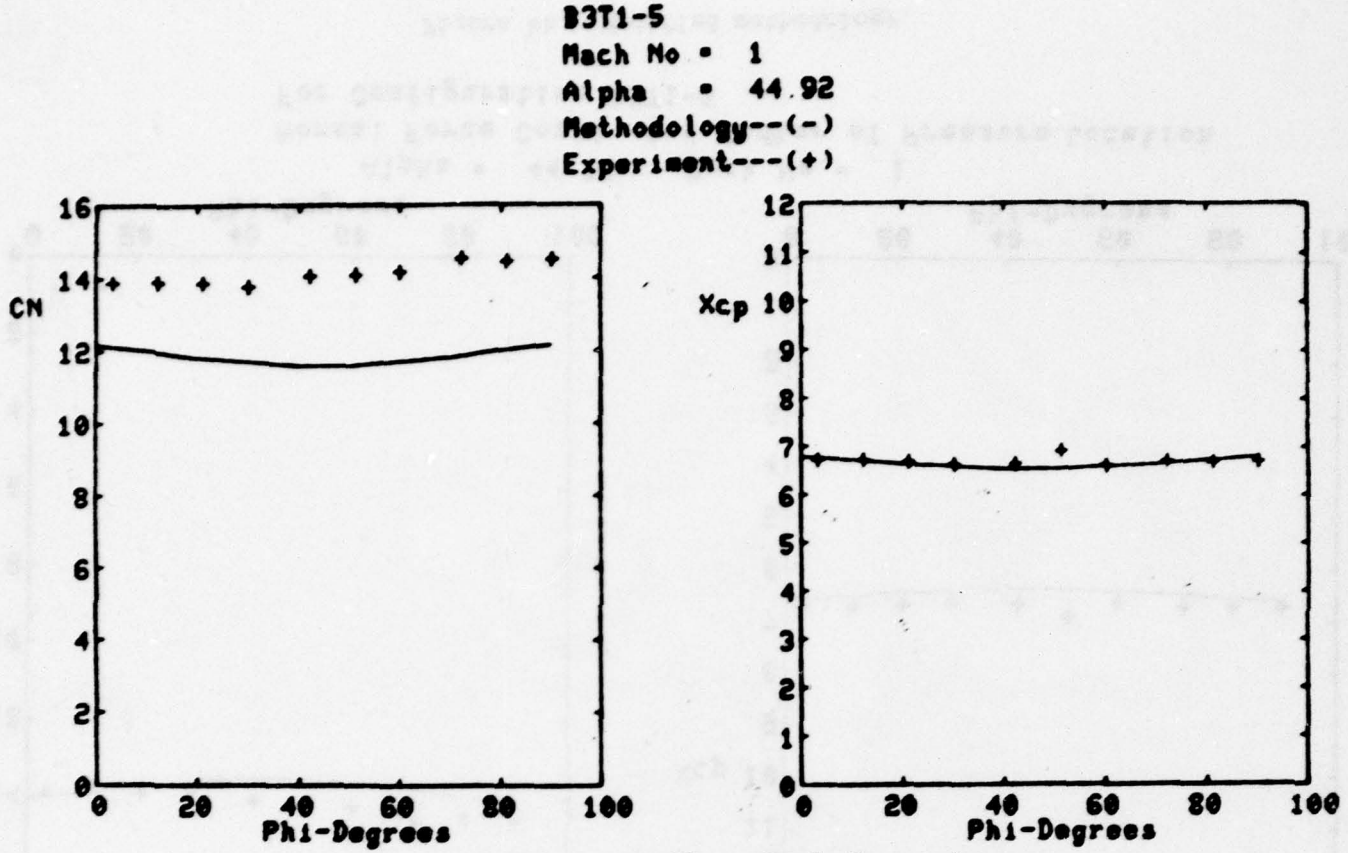



Figure 4a. Original methodology.

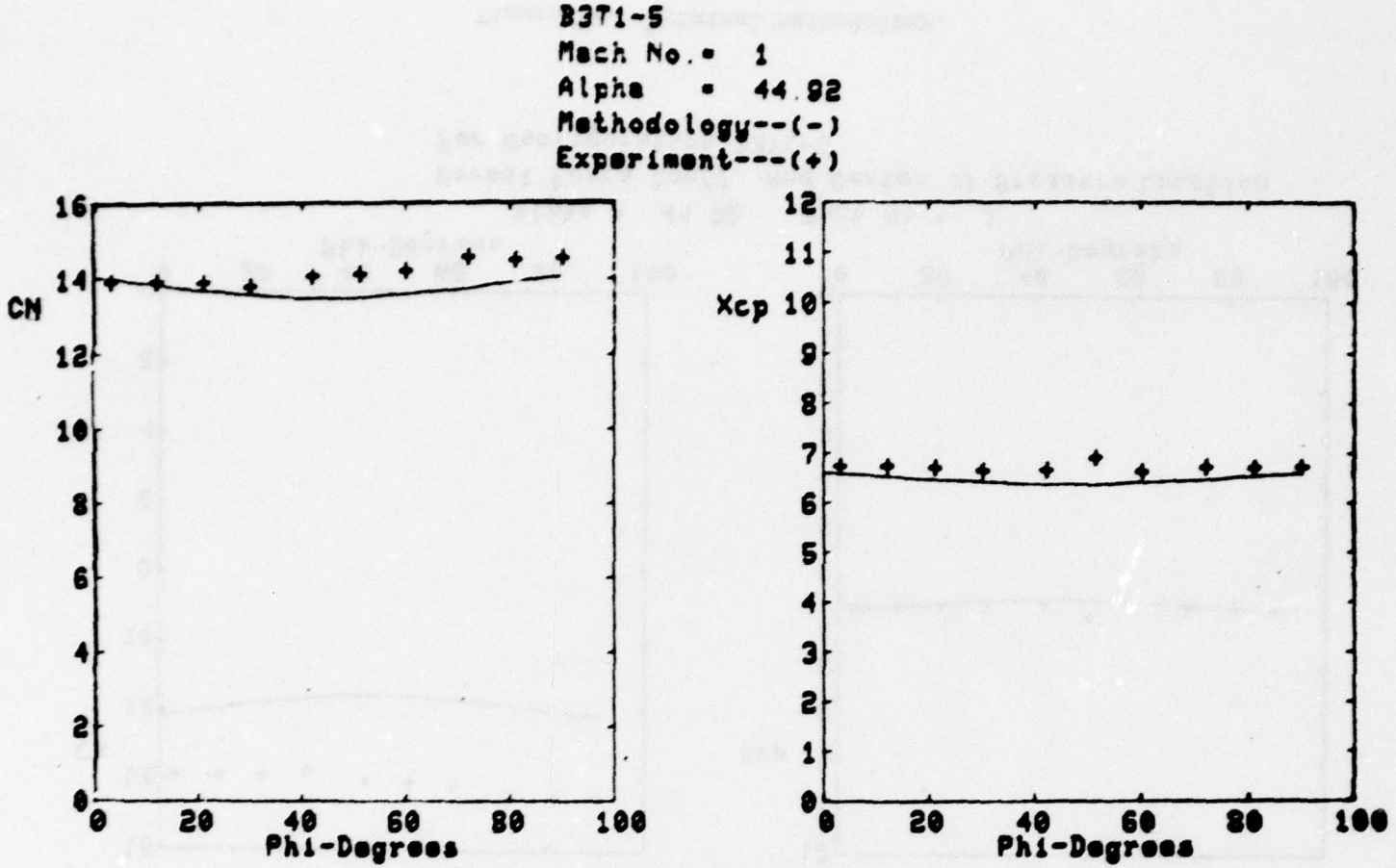
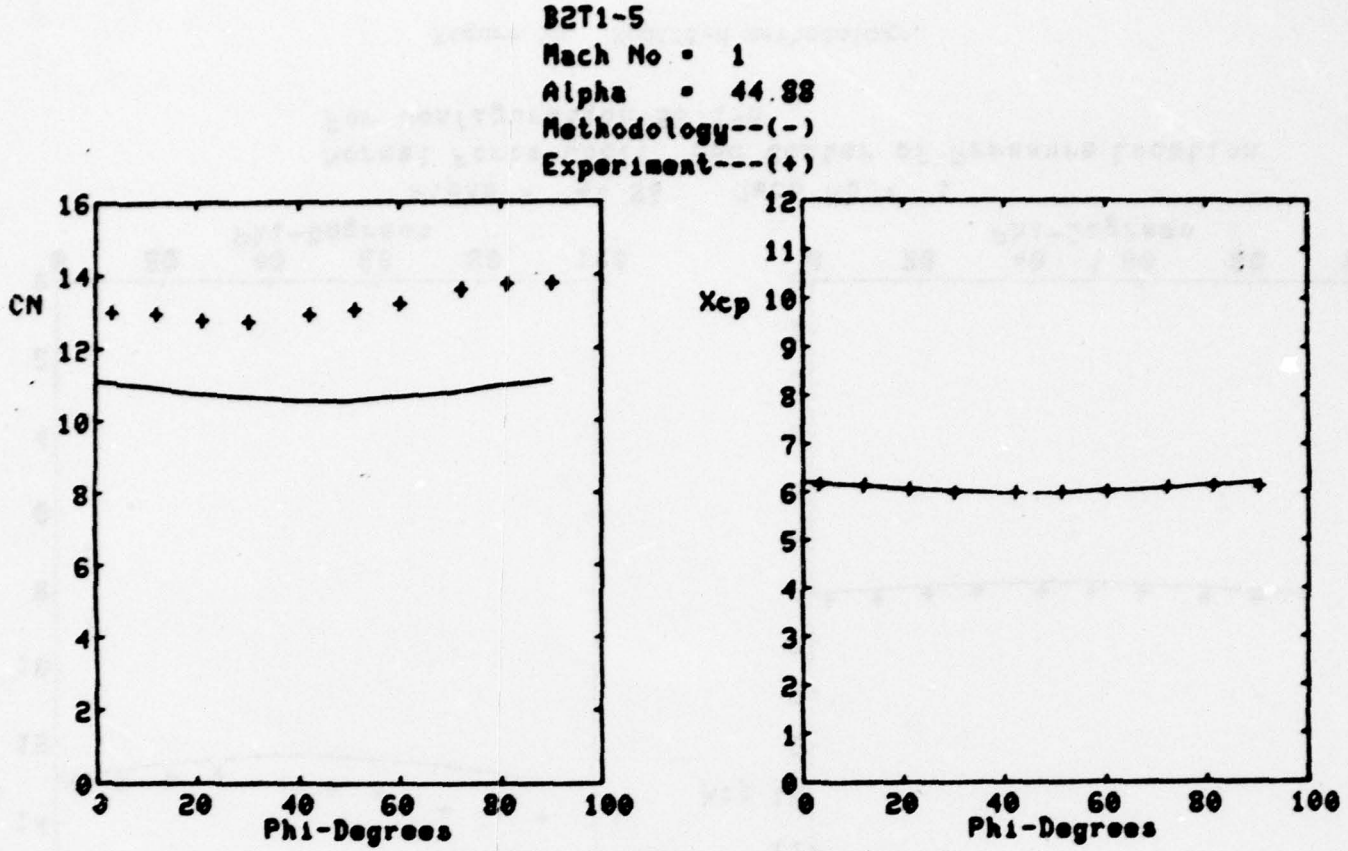
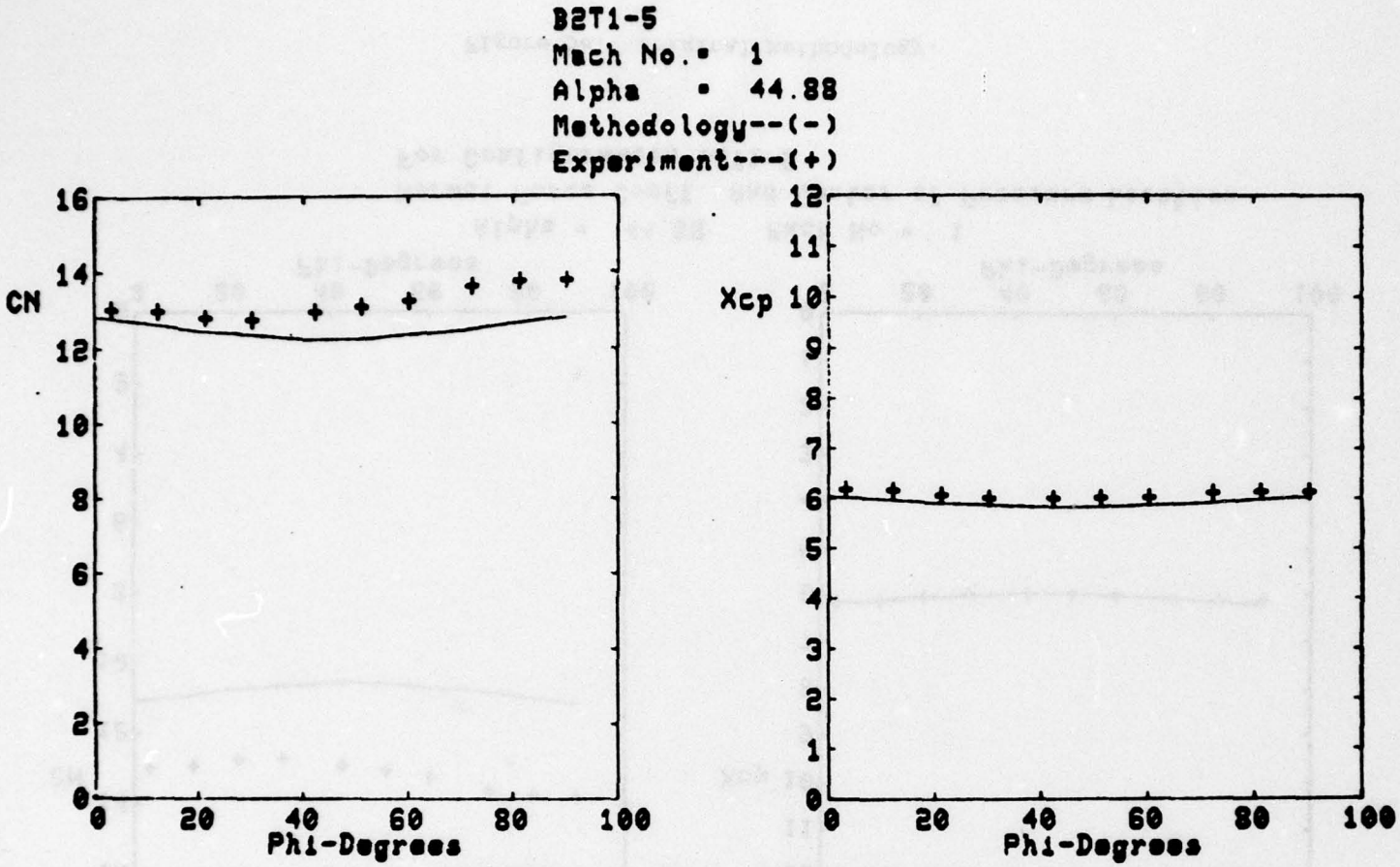



Figure 4b. Modified methodology.




Alpha • 44.88 Mach No. • 1
Normal Force Coeff. And Center of Pressure Location
For Configuration B2T1-5

Figure 5a. Original methodology.




Alpha = 44.88 Mach No.= 1
Normal Force Coeff. And Center of Pressure Location
For Configuration B2T1-5

Figure 5b. Modified methodology.

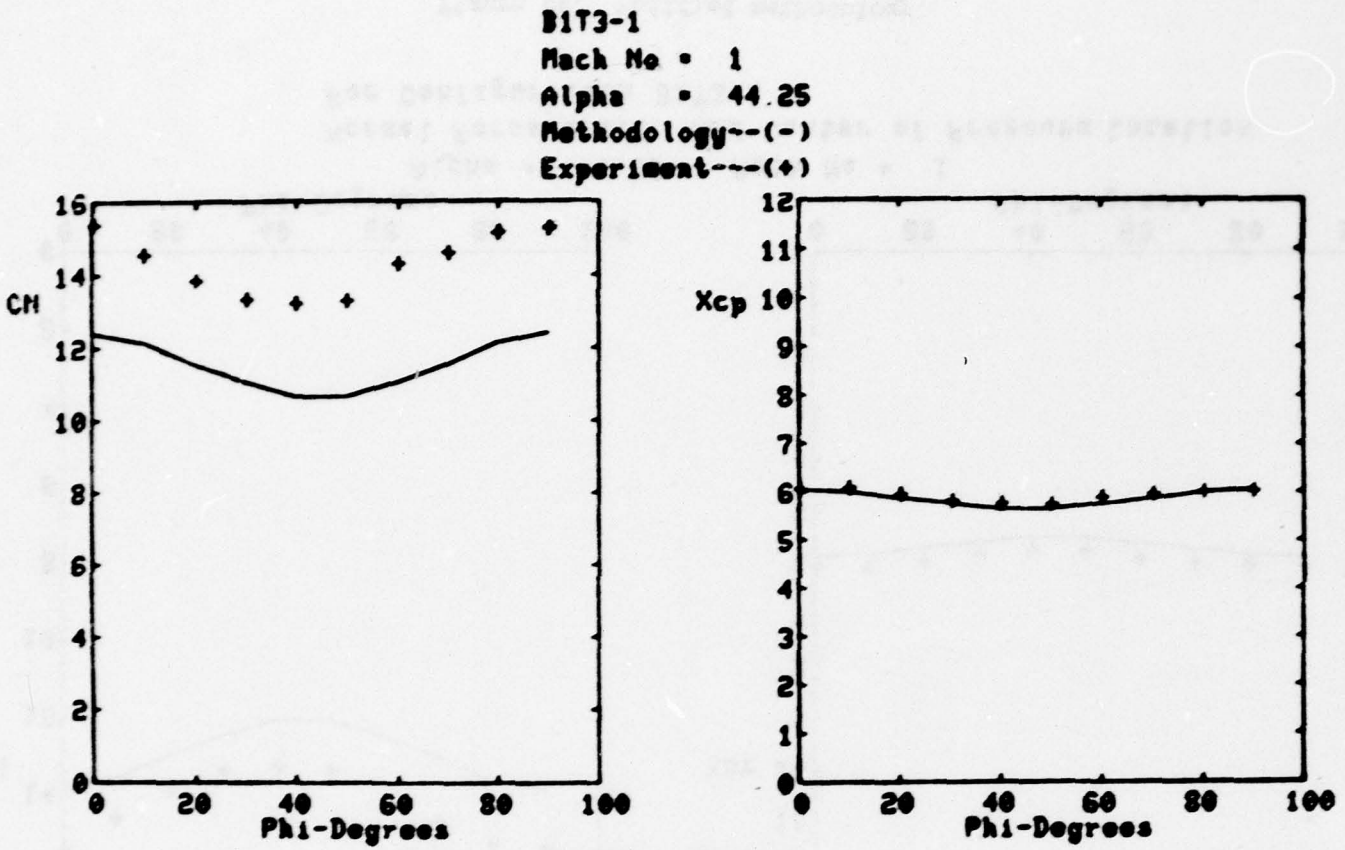



Figure 6a. Original methodology.

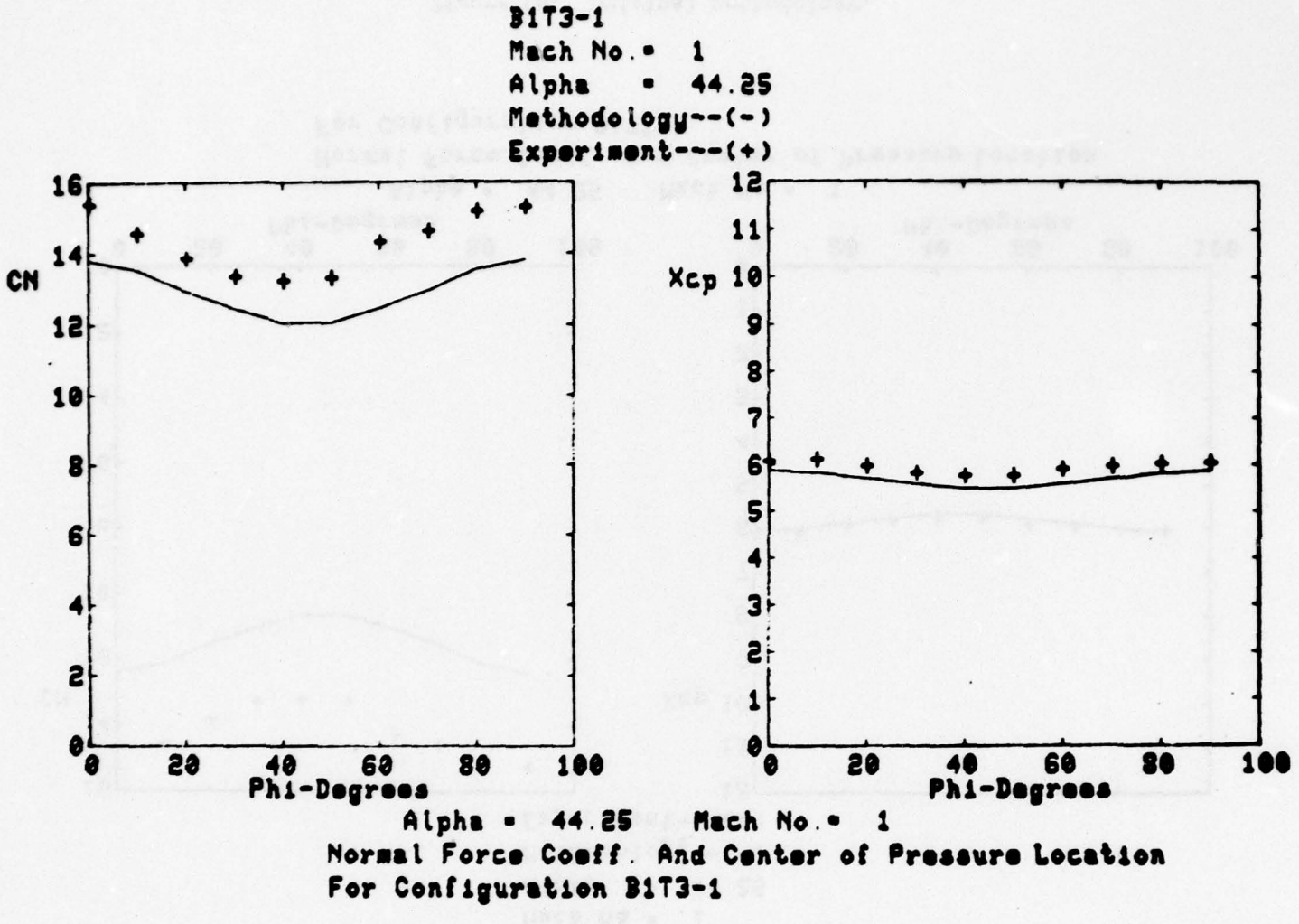



Figure 6b. Modified methodology.

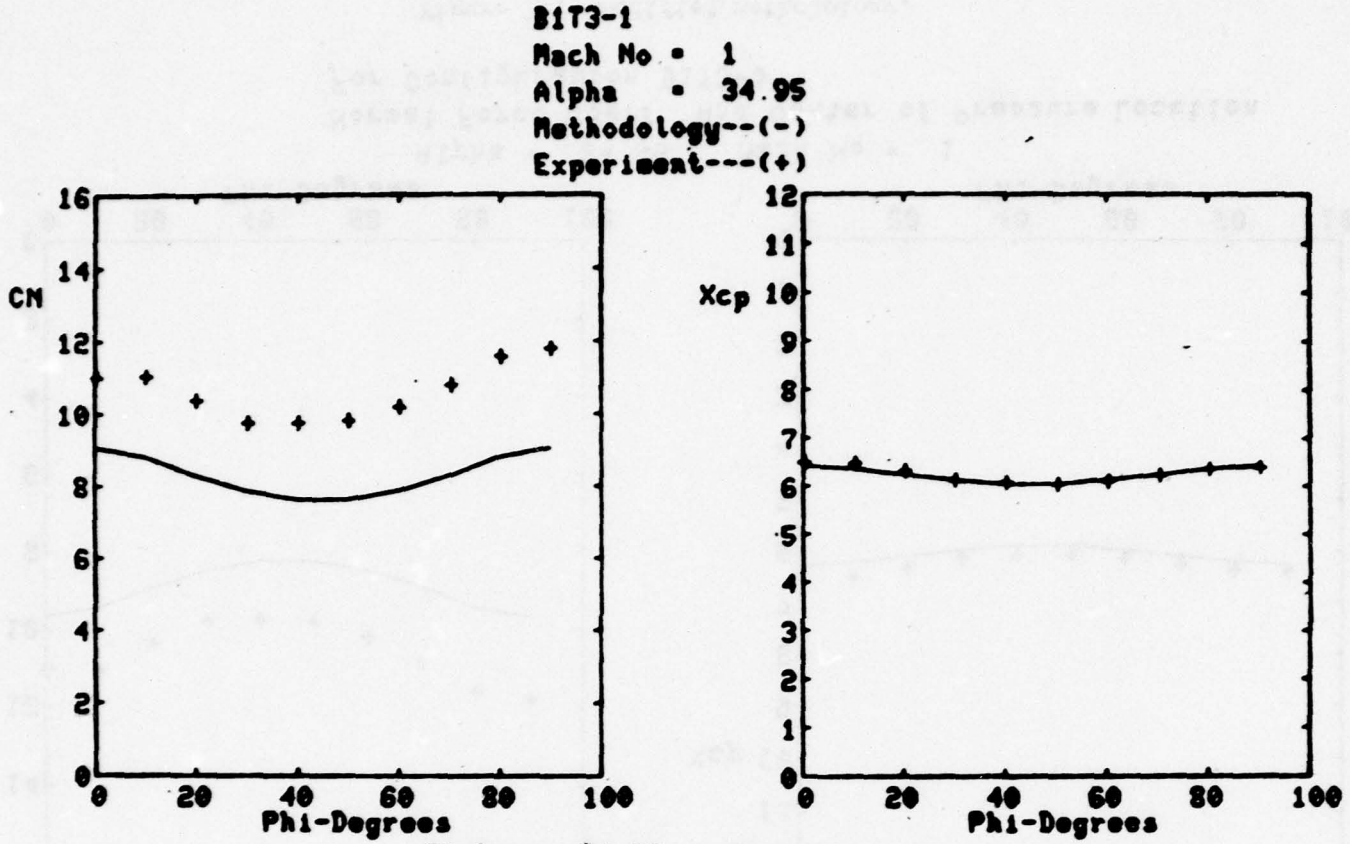
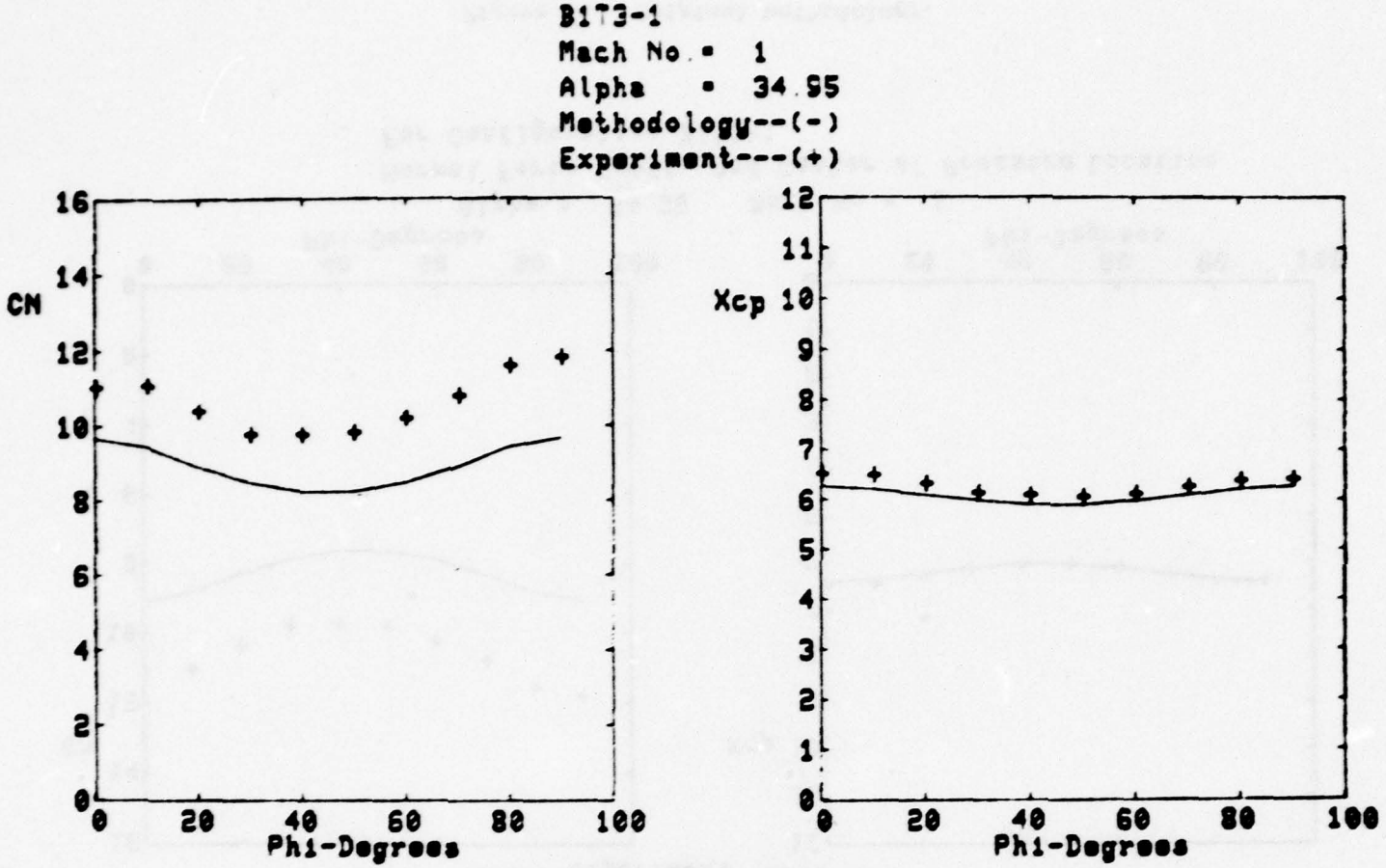
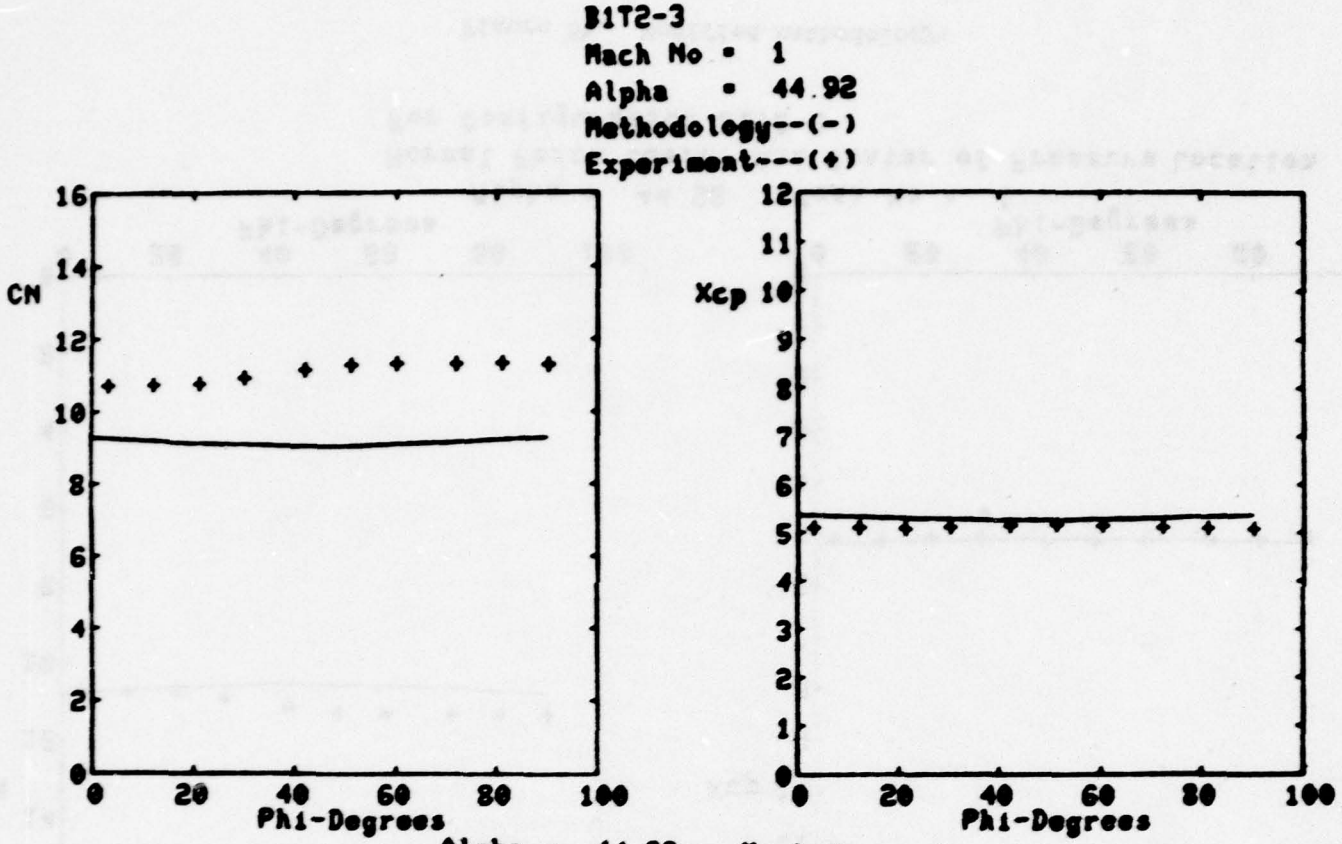



Figure 7a. Original methodology.




Alpha = 34.95 Mach No. = 1
Normal Force Coeff. And Center of Pressure Location
For Configuration B1T3-1

Figure 7b. Modified methodology.




Alpha = 44.92 Mach No. = 1
Normal Force Coeff. And Center of Pressure Location
For Configuration B1T2-3

Figure 8a. Original methodology.

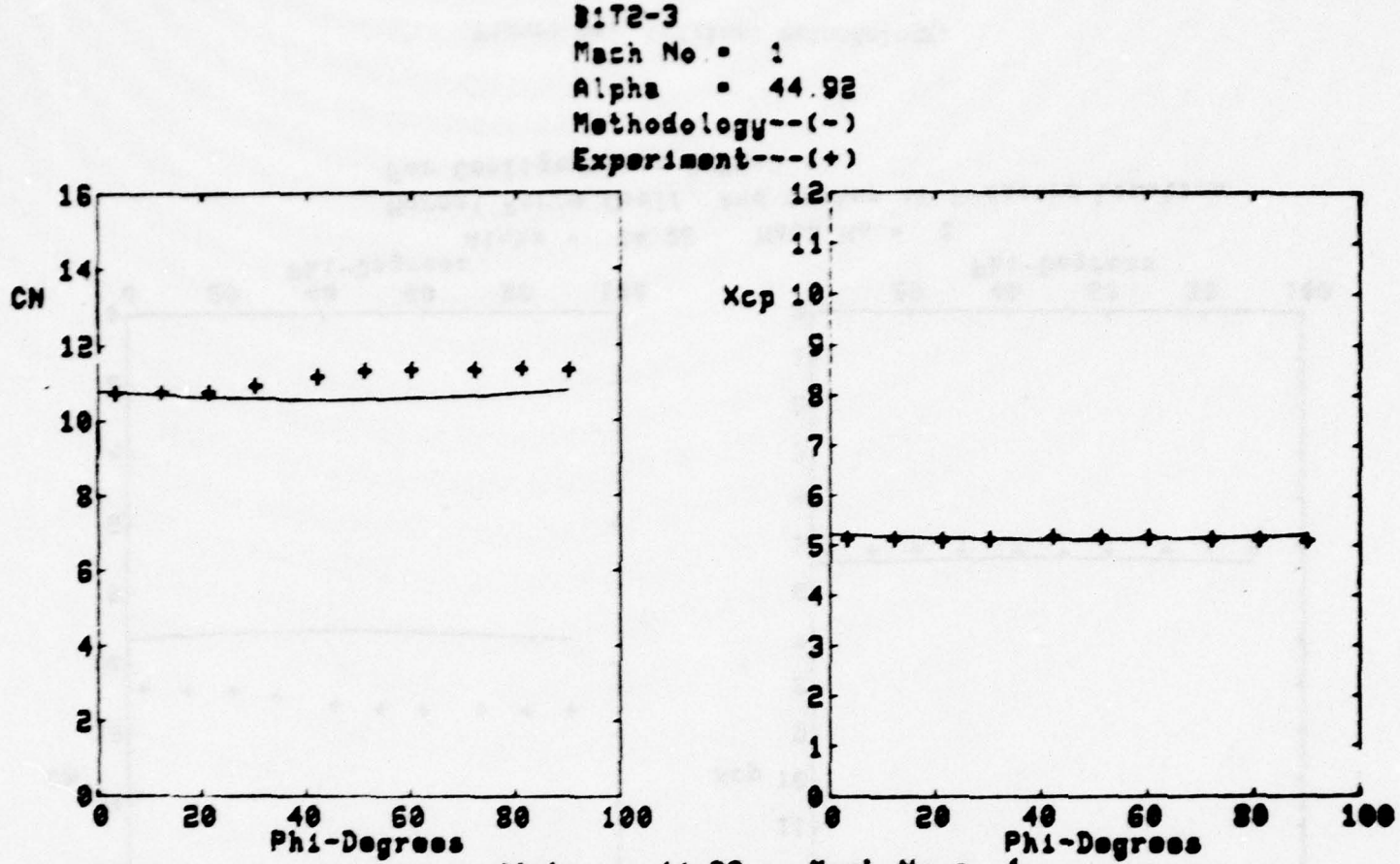



Figure 8b. Modified methodology.

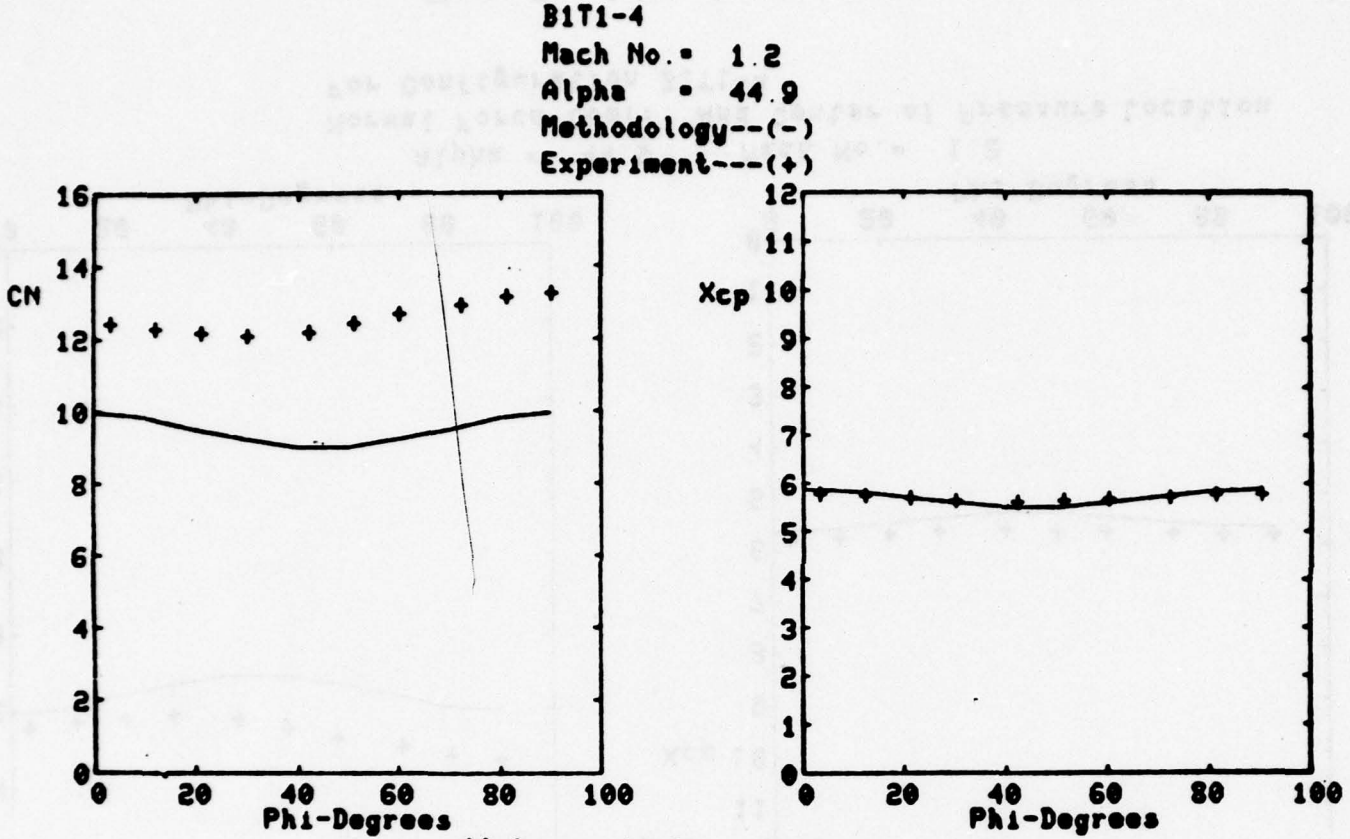
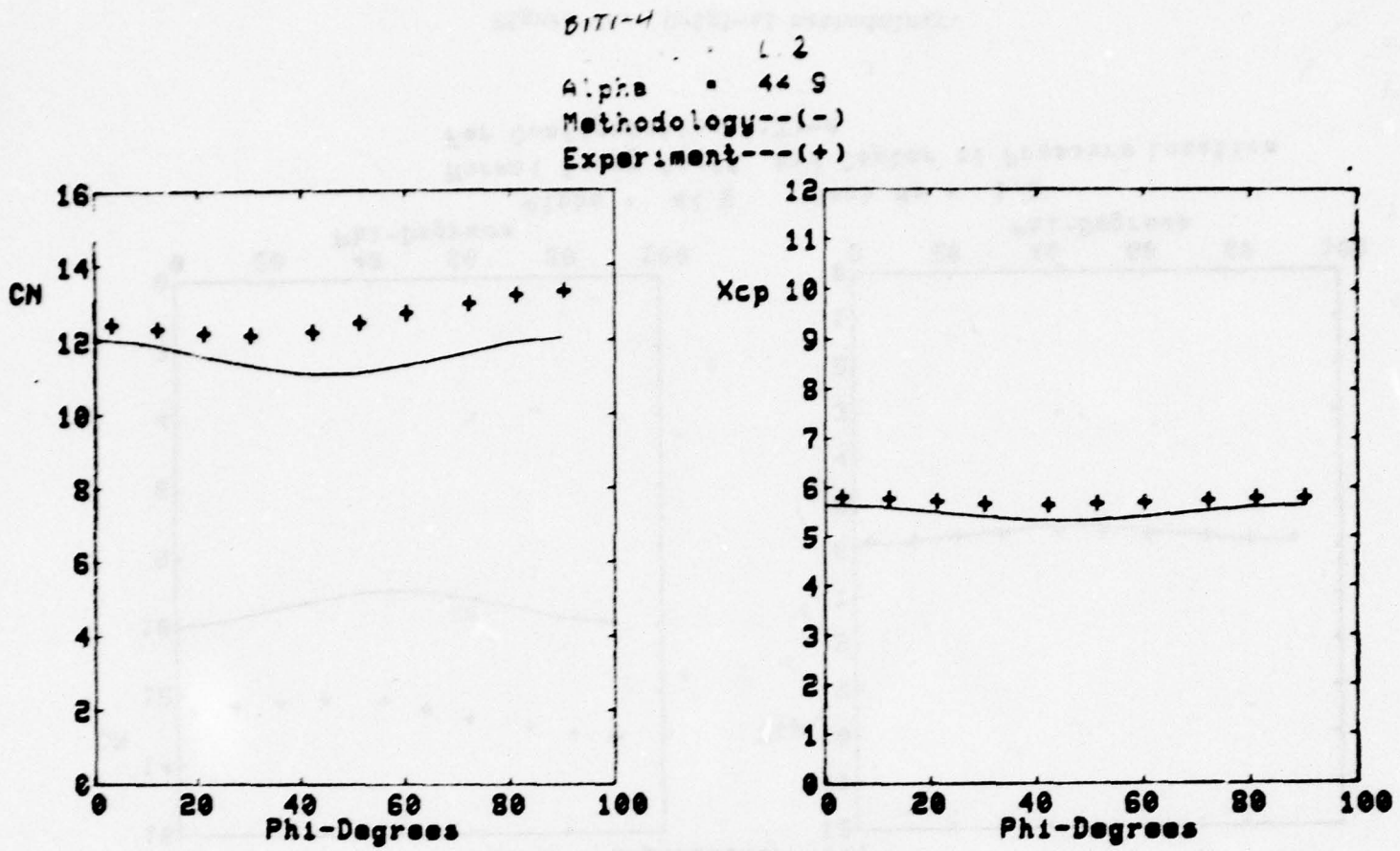
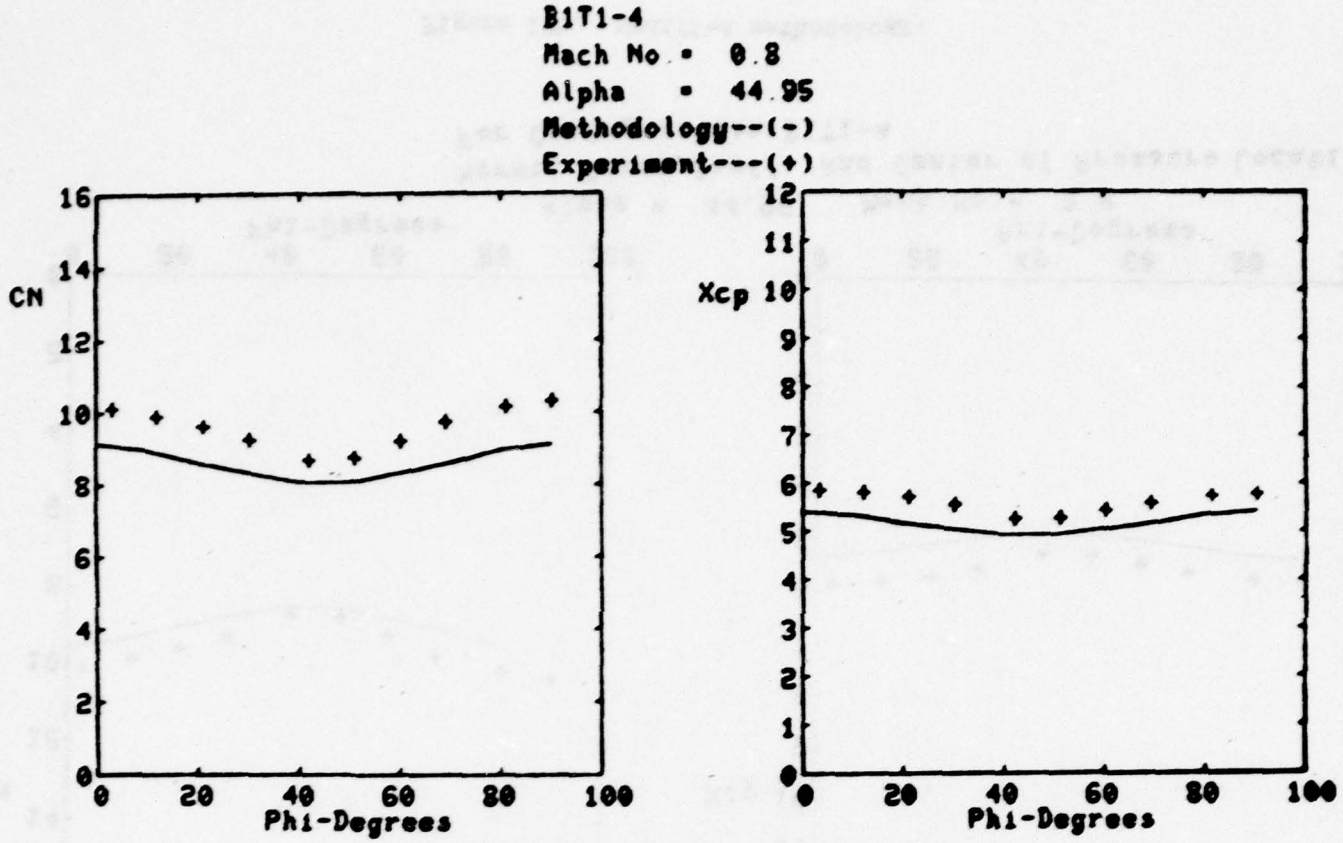



Figure 9a. Original methodology.




Alpha • 44.9 Mach No.• 1.2
Normal Force Coeff. And Center of Pressure Location
For Configuration B1T1-4

Figure 9b. Original methodology.




Alpha = 44.95 Mach No. = 0.8
Normal Force Coeff. And Center of Pressure Location
For Configuration B1T1-4

Figure 10a. Original methodology.

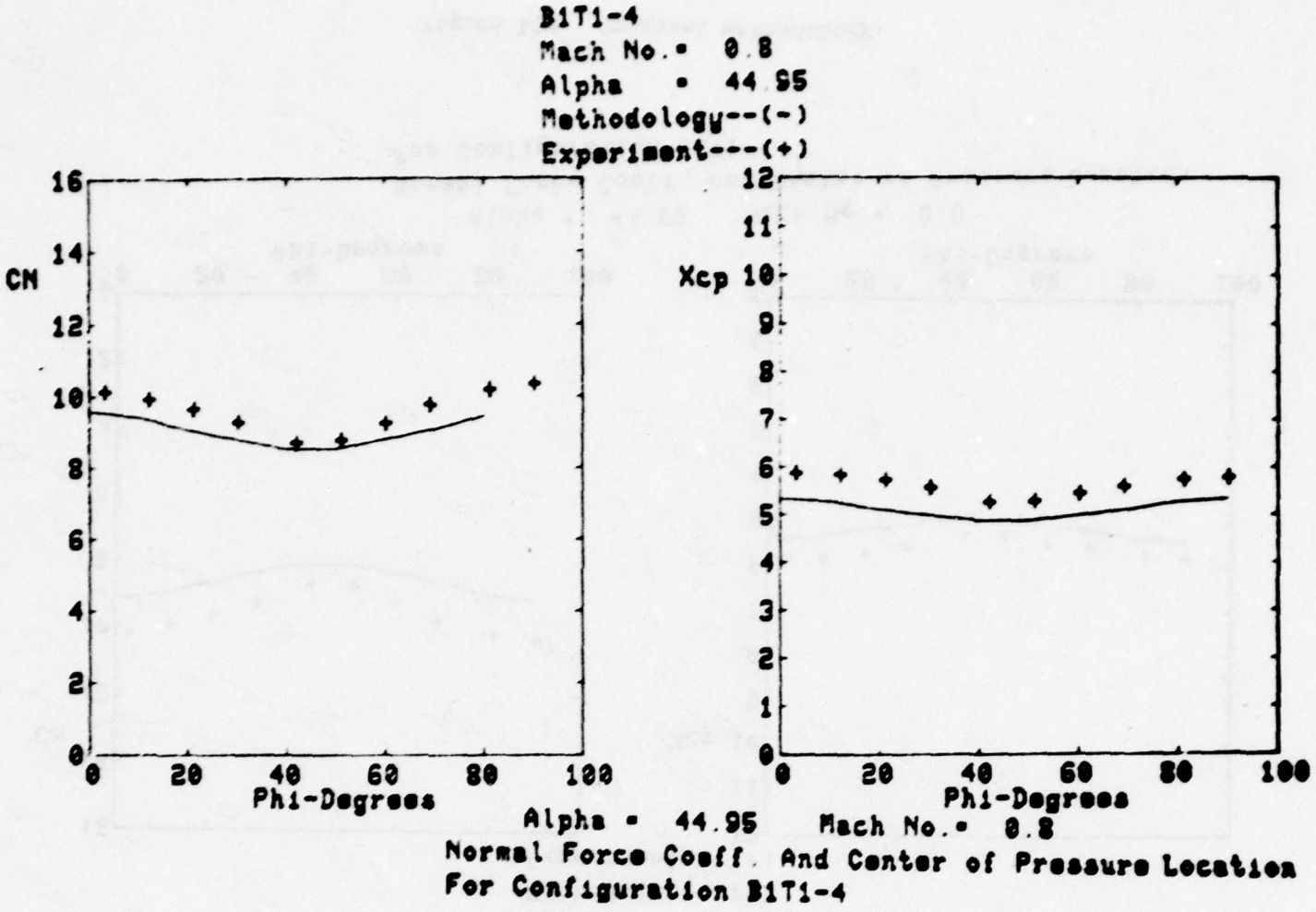



Figure 10b. Modified methodology.

## Appendix A. PROGRAM UTILIZATION

The proper format and sequence for the input cards are shown in Table A-1.

TABLE A-1.

| CARD | SYMBOL REFERENCE | FORMAT(FORTRAN) |
|---|---|---|
| 1 | Title card for each configuration | 12A6 |
| 2 | AR,S,CR,LAMDA,ALE | 5F10.3 |
| 3 | LND,LAD,D | 3F10.3 |
| 4 | ALF1,ALF2,DELAF,MACH,RN,OPTPHI, OPTMAC | 4F10.3,F13.2,2I2 |

AR = Tail aspect ratio (two tail panels joined at root chord)

S = Tail Semispan including body, (b + D)/2, inches

CR = Tail root chord - Inches

LAMDA = Tail taper ratio

ALE = Tail leading edge sweep angle - Degrees

LND = Nose length - Calibers

LAD = After-body length - Calibers

D = Body diameter - Inches

ALF1 = Beginning angle of attack for angle of attack sweep - Deg.

ALF2 = Ending angle of attack for angle of attack sweep - Deg.

DELAF = Angle of attack increment for alpha sweep - Degrees

MACH = Free stream Mach number

RN = Reynolds number - /Ft.

OPTPHI = 1 to calculate aerodynamic coefficients as a function of roll angle. Roll angle is automatically varied between 0° and 90° in increments of 10°. No additional data cards are required. See Sample Configuration 2 Input Data.

= 0 to delete calculation of aerodynamic coefficients as a function of roll angle

OPTMAC = 1 allows for multiple Mach numbers for the configuration and angle of attack range determined by the four cards Table A-1. Additional Mach numbers are added after the four cards of Table A-1, one Mach number per card using F10.3 Format

= 0 for single Mach number only

MULTIPLE CASE CAPABILITY:

Additional configurations can be input simply by repeating the card sequence of Table A-1.

If OPTMAC = 1, however, a blank card must follow the last Mach number card before the program will accept additional configurations.

Table A-2 shows a sample input card arrangement. Using this input card arrangement the program will predict aerodynamic coefficients for sample configuration No. 1 for Mach No. equal .8 and for angles of attack from 0.0 to 45. degrees in 5 degree increments. Since OPTPHI is 0 for sample configuration No. 1, the coefficients will be given versus angle of attack only (roll angle equals 0 degrees). Now, OPTMAC equals 1, therefore additional predictions will be made for the same configuration and angle of attack range for Mach numbers: .9, 1.0, 1.1, 1.2, and 1.3. A blank card follows the Mach number cards for sample configuration No. 1, which signals the program to read additional configurations.

The program then reads the cards for sample configuration No. 2, and computes the predictions of the aerodynamic coefficients and centers of pressure for this configuration. Now, since OPTPHI equals 1 in this case, these predictions will be given as a function of roll angle, for the angle of attack range 0 to 40 degrees. Also, since OPTMAC equals 0 for this case, the predictions will be made for Mach No. equal 2.0 only.

The resulting output for these sample input cards are found in Table A-3.

As a guide for time and storage requirements, the following figures for the CDC 6600 are provided:

| | | |
|---|---|---|
| Compile Time | - | 14 seconds |
| Execution Time | - | 2 seconds |
| Storage | - | Less than 100K. |

AMSMI-W FORM 22, 1 SEP 71 REPLACES
AMSMI-K FORM 745 WHICH MAY BE USED

FORTRAN - 7090 CODING FORM

TITLE: TABLE A-2.

CODER:

Identification 73 80

DATE

PAGE OF

C FOR COMMENT

| STATEMENT NUMBER 1 5 | Cont. 6 | FORTRAN STATEMENT 7 72 |
|---|---|---|
| | | SAMPLE CONFIGURATION 1 OPTPHI=0 OPTMAC=1 |
| 10 | | 3.75 7.5 0.0 7.5.964 |
| 3 | | 7.0 3.75 |
| 0.0 | | 45.0 5.0 .8 70000000. 0010 |
| .9 | | |
| 1.0 | | |
| 1.1 | | |
| 1.2 | | |
| 1.3 | | |
| (BLANK CARD) | | |
| | | SAMPLE CONFIGURATION 2 OPTPHI=1 OPTMAC=0 |
| 1.0 | | 3.75 5.0 .5 53.13 |
| 3. | | 8.25 3.75 |
| 0.0 | | 40. 10. 20.0 650000000. 0100 |
| EOF | | |



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# TABLE A-3.

SAMPLE CONFIGURATION 1 OPTPHI=0. OPTMAC=1

INPUT PARAMETERS

MACH = .80
TAIL ASPECT RATIO = 1.00
TAIL TAPER RATIO = 0.00
TAIL L.E. SWEEP ANGLE = 75.96 DEGREES
TAIL ROOT CHORD= 7.500
NOSE LENGTH = 3.000 CAL.
AFTER BODY LENGTH = 7.000 CAL.
BODY DIAMETER = 3.75
TAIL SEMI-SPAN(INCLUDING BODY) = 3.75
REYNOLDS NUMBER = 7000000.00

OUTPUT DEFINITIONS

CNB = BODY ALONE NORMAL FORCE COEFFICIENT
XCPB= BODY ALONE CENTER OF PRESSURE
CNT = TAIL ALONE NORMAL FORCE COEFFICIENT
XCPT= TAIL ALONE CENTER OF PRESSURE
CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE COEFFICIENT
XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED AFT FROM ROOT CHORD LEADING EDGE)
YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING BODY) MEASURED OUTWARD FROM BODY
XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL CONFIGURATION (CAL. FROM NOSE)
CNT(B+T)= NORMAL FORCE COEFFICIENT OF BODY PLUS TAIL CONFIGURATION
CA = AXIAL FORCE COEFFICIENT

| ALPHA | ISOLATED COMPONENTS | | | | BODY TAIL CONFIGURATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CNB | XCPB | CNT | XCPT | CNT(B) | XCPT(B) | YCPT(B) | CN(B+T) | XCP(B+T) | CA |
| 0.00 | 0.000 | 2.545 | 0.000 | .651 | 0.000 | .651 | .335 | 0.000 | | .286 |
| 5.00 | .245 | 2.741 | .140 | .651 | .202 | .647 | .335 | .706 | 6.932 | .278 |
| 10.00 | .612 | 3.181 | .307 | .643 | .431 | .632 | .335 | 1.541 | 6.784 | .256 |
| 15.00 | .961 | 3.649 | .494 | .632 | .660 | .618 | .335 | 2.335 | 6.883 | .219 |
| 20.00 | .888 | 3.927 | .695 | .620 | .863 | .613 | .316 | 2.651 | 7.394 | .169 |
| 25.00 | 1.151 | 3.927 | .906 | .616 | 1.020 | .617 | .301 | 3.219 | 7.281 | .141 |
| 30.00 | 1.652 | 3.927 | 1.234 | .611 | 1.236 | .623 | .282 | 4.081 | 7.042 | .093 |
| 35.00 | 3.695 | 3.927 | 1.220 | .617 | 1.219 | .630 | .282 | 6.168 | 6.026 | .019 |
| 40.00 | 5.701 | 3.927 | .967 | .622 | .975 | .637 | .282 | 7.908 | 5.386 | -.081 |
| 45.00 | 7.039 | 3.927 | 1.213 | .628 | 1.239 | .644 | .282 | 9.610 | 5.331 | -.202 |

SAMPLE CONFIGURATION 1 OPTPHI=0, OPTMAC=1

INPUT PARAMETERS

MACH = .90
TAIL ASPECT RATIO = 1.00
TAIL TAPER RATIO = 0.00
TAIL L.E. SWEEP ANGLE = 75.96 DEGREES
TAIL ROOT CHORD= 7.500
NOSE LENGTH = 3.000 CAL.
AFTER BODY LENGTH = 7.000 CAL.
BODY DIAMETER = 3.75
TAIL SEMI-SPAN(INCLUDING BODY) = 3.75
REYNOLDS NUMBER = 7000000.00

OUTPUT DEFINITIONS

CNB = BODY ALONE NORMAL FORCE COEFFICIENT
XCPB= BODY ALONE CENTER OF PRESSURE
CNT = TAIL ALONE NORMAL FORCE COEFFICIENT
XCPT= TAIL ALONE CENTER OF PRESSURE
CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE COEFFICIENT
XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED AFT FROM ROOT CHORD LEADING EDGE)
YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING BODY) MEASURED OUTWARD FROM BODY CONFIGURATION (CAL. FROM NOSE)
CNT(B+T)= NORMAL FORCE COEFFICIENT OF BODY PLUS TAIL CONFIGURATION
CA = AXIAL FORCE COEFFICIENT

| ALPHA | ISOLATED COMPONENTS | | | | BODY TAIL CONFIGURATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CNB | XCPB | CNT | XCPT | CNT(B) | XCPT(B) | YCPT(B) | CN(B+T) | XCP(B+T) | CA |
| 0.00 | 0.000 | 2.729 | 0.000 | .651 | 0.000 | .651 | .335 | 0.000 | | .305 |
| 5.00 | .246 | 2.880 | .143 | .651 | .207 | .648 | .335 | .708 | 6.987 | .298 |
| 10.00 | .604 | 3.223 | .311 | .644 | .436 | .633 | .335 | 1.534 | 6.820 | .275 |
| 15.00 | .894 | 3.596 | .497 | .632 | .664 | .619 | .335 | 2.266 | 6.956 | .238 |
| 20.00 | .893 | 3.835 | .696 | .621 | .864 | .613 | .316 | 2.650 | 7.353 | .188 |
| 25.00 | 1.195 | 3.835 | .903 | .616 | 1.017 | .617 | .301 | 3.254 | 7.197 | .166 |
| 30.00 | 2.782 | 3.835 | 1.239 | .612 | 1.241 | .624 | .282 | 5.213 | 6.319 | .126 |
| 35.00 | 4.615 | 3.835 | 1.192 | .618 | 1.192 | .631 | .282 | 7.050 | 5.675 | .065 |
| 40.00 | 6.240 | 3.835 | .993 | .623 | 1.004 | .638 | .282 | 8.482 | 5.242 | -.018 |
| 45.00 | 8.114 | 3.835 | 1.218 | .629 | 1.253 | .644 | .282 | 10.701 | 5.126 | -.120 |

MPLE CONFIGURATION 1 OPTPHI=0, OPTMAC=1

INPUT PARAMETERS

MACH = 1.00
TAIL ASPECT RATIO = 1.00
TAIL TAPER RATIO = 0.00
TAIL L.E. SWEEP ANGLE = 75.96 DEGREES
TAIL ROOT CHORD = 7.500
NOSE LENGTH = 3.000 CAL.
AFTER BODY LENGTH = 7.000 CAL.
BODY DIAMETER = 1.75
TAIL SEMI-SPAN(INCLUDING BODY) = 3.75
REYNOLDS NUMBER = 7000000.00

OUTPUT DEFINITIONS

CNB = BODY ALONE NORMAL FORCE COEFFICIENT
XCPB= BODY ALONE CENTER OF PRESSURE
CNT = TAIL ALONE NORMAL FORCE COEFFICIENT
XCPT= TAIL ALONE CENTER OF PRESSURE
CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE COEFFICIENT
XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED AFT FROM ROOT CHORD LEADING EDGE)
YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING BODY) MEASURED OUTWARD FROM BODY
XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL CONFIGURATION (CAL. FROM NOSE)
CNT(B+T)= NORMAL FORCE COEFFICIENT OF BODY PLUS TAIL CONFIGURATION
CA = AXIAL FORCE COEFFICIENT

| ALPHA | ISOLATED COMPONENTS | | | | BODY TAIL CONFIGURATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CNB | XCPB | CNT | XCPT | CNT(B) | XCPT(B) | YCPT(B) | CN(B+T) | XCP(B+T) | CA |
| .00 | 0.000 | 2.963 | 0.000 | .652 | 0.000 | .652 | .335 | 0.000 | | .400 |
| .00 | .246 | 3.056 | .149 | .652 | .214 | .649 | .335 | .724 | 7.097 | .392 |
| .00 | .550 | 3.260 | .319 | .645 | .447 | .635 | .335 | 1.544 | 6.907 | .370 |
| .00 | .648 | 3.496 | .505 | .635 | .675 | .622 | .335 | 2.046 | 7.360 | .333 |
| 0.00 | .897 | 3.679 | .703 | .624 | .873 | .617 | .316 | 2.677 | 7.314 | .283 |
| 2.00 | 1.737 | 3.804 | .907 | .620 | 1.021 | .621 | .301 | 3.812 | 6.716 | .265 |
| 4.00 | 3.858 | 3.934 | 1.265 | .618 | 1.271 | .627 | .282 | 6.336 | 5.980 | .234 |
| 3.00 | 4.930 | 4.062 | 1.147 | .621 | 1.144 | .633 | .282 | 7.310 | 5.722 | .186 |
| 4.00 | 7.082 | 4.190 | 1.068 | .626 | 1.085 | .640 | .282 | 9.431 | 5.429 | .120 |
| .00 | 8.995 | 4.317 | 1.258 | .632 | 1.309 | .646 | .282 | 11.654 | 5.427 | .038 |

AMPLE CONFIGURATION, I  OPTPHI=0. OPTMAC=1

INPUT PARAMETERS

MACH = 1.10
TAIL ASPECT RATIO = 1.00
TAIL TAPER RATIO = 0.00
TAIL L.E. SWEEP ANGLE = 75.96 DEGREES
TAIL ROOT CHORD= 7.500
NOSE LENGTH = 3.000 CAL.
AFTER BODY LENGTH = 7.000 CAL.
BODY DIAMETER = 3.75
TAIL SEMI-SPAN(INCLUDING BODY) = 3.75
REYNOLDS NUMBER = 7000000.00

OUTPUT DEFINITIONS

CNB = BODY ALONE NORMAL FORCE COEFFICIENT
XCPB= BODY ALONE CENTER OF PRESSURE
CNT = TAIL ALONE NORMAL FORCE COEFFICIENT
XCPT= TAIL ALONE CENTER OF PRESSURE
CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE COEFFICIENT
XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED AFT FROM ROOT CHORD LEADING EDGE)
YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING BODY) MEASURED OUTWARD FROM BODY
XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL CONFIGURATION (CAL. FROM NOSE)
CNT(B+T)= NORMAL FORCE COEFFICIENT OF BODY PLUS TAIL CONFIGURATION
CA = AXIAL FORCE COEFFICIENT

| ALPHA | ISOLATED COMPONENTS | | | | BODY TAIL CONFIGURATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CNB | XCPB | CNT | XCPT | CNT(B) | XCPT(B) | YCPT(B) | CN(B+T) | XCP(B+T) | CA |
| 1.00 | 0.000 | 2.625 | 0.000 | .654 | 0.000 | .654 | .335 | 0.000 | I | .510 |
| 3.00 | .246 | 2.788 | .146 | .654 | .211 | .651 | .335 | .722 | 7.037 | .503 |
| 3.00 | .569 | 3.157 | .713 | .647 | .438 | .638 | .335 | 1.517 | 6.941 | .480 |
| 3.00 | .647 | 3.555 | .496 | .638 | .540 | .626 | .335 | 2.027 | 7.411 | .443 |
| 3.00 | .920 | 3.606 | .687 | .628 | .653 | .622 | .315 | 2.679 | 7.344 | .393 |
| 5.00 | 2.351 | 3.529 | .885 | .624 | .497 | .625 | .301 | 4.399 | 6.378 | .380 |
| 0.00 | 3.746 | 4.043 | 1.184 | .621 | 1.186 | .630 | .282 | 6.121 | 6.045 | .358 |
| 5.00 | 5.427 | 4.162 | 1.247 | .620 | 1.261 | .636 | .282 | 7.968 | 5.764 | .323 |
| 3.00 | 7.743 | 4.281 | 1.372 | .618 | 1.333 | .642 | .282 | 10.408 | 5.542 | .273 |
| 5.00 | 9.352 | 4.355 | 1.368 | .615 | 1.397 | .648 | .282 | 12.124 | 5.500 | .211 |

AMPLE CONFIGURATION 1 OPTPHI=0. OPTMAC=1

INPUT PARAMETERS

MACH = 1.20
TAIL ASPECT RATIO = 1.00
TAIL TAPER RATIO = 0.00
TAIL L.E. SWEEP ANGLE = 75.96 DEGREES
TAIL ROOT CHORD= 7.500
NOSE LENGTH = 3.000 CAL.
AFTER BODY LENGTH = 7.000 CAL.
BODY DIAMETER = 3.75
TAIL SEMI-SPAN(INCLUDING BODY) = 3.75
REYNOLDS NUMBER = 7000000.00

OUTPUT DEFINITIONS

CNB = BODY ALONE NORMAL FORCE COEFFICIENT
XCPB= BODY ALONE CENTER OF PRESSURE
CNT = TAIL ALONE NORMAL FORCE COEFFICIENT
XCPT= TAIL ALONE CENTER OF PRESSURE
CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE COEFFICIENT
XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED AFT FROM ROOT CHORD LEADING EDGE)
YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING BODY) MEASURED OUTWARD FROM BODY CONFIGURATION (CAL. FROM NOSE)
CNT(B+T)= NORMAL FORCE COEFFICIENT OF BODY PLUS TAIL CONFIGURATION
CA = AXIAL FORCE COEFFICIENT

| ALPHA | ISOLATED COMPONENTS | | | | BODY TAIL CONFIGURATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CNB | XCPB | CNT | XCPT | CNT(B) | XCPT(B) | YCPT(B) | CN(B+T) | XCP(B+T) | CA |
| 0.00 | 0.000 | 2.431 | 0.000 | .655 | 0.000 | .655 | .335 | 0.000 | | .526 |
| 5.00 | .245 | 2.665 | .144 | .655 | .207 | .652 | .335 | .721 | 7.008 | .518 |
| 10.00 | .549 | 3.191 | .307 | .649 | .431 | .641 | .335 | 1.491 | 7.013 | .495 |
| 15.00 | .645 | 3.741 | .486 | .640 | .649 | .630 | .335 | 2.020 | 7.474 | .459 |
| 20.00 | 1.159 | 4.051 | .674 | .632 | .837 | .626 | .316 | 2.903 | 7.155 | .409 |
| 25.00 | 2.751 | 4.152 | .869 | .628 | .978 | .629 | .301 | 4.780 | 6.302 | .400 |
| 30.00 | 4.082 | 4.253 | 1.145 | .625 | 1.147 | .634 | .282 | 6.407 | 6.056 | .387 |
| 35.00 | 5.911 | 4.355 | 1.255 | .629 | 1.252 | .639 | .282 | 8.432 | 5.810 | .364 |
| 40.00 | 8.002 | 4.456 | 1.340 | .633 | 1.345 | .644 | .282 | 10.682 | 5.652 | .332 |
| 45.00 | 9.299 | 4.557 | 1.404 | .638 | 1.420 | .649 | .282 | 12.100 | 5.638 | .289 |

SAMPLE CONFIGURATION 1 OPTPHI=0. OPTMAC=1

INPUT PARAMETERS

MACH = 1.30
TAIL ASPECT RATIO = 1.00
TAIL TAPER RATIO = 0.00
TAIL L.E. SWEEP ANGLE = 75.96 DEGREES
TAIL ROOT CHORD= 7.500
NOSE LENGTH = 3.000 CAL.
AFTER BODY LENGTH = 7.000 CAL.
BODY DIAMETER = 3.75
TAIL SEMI-SPAN(INCLUDING BODY) = 3.75
REYNOLDS NUMBER = 7000000.00

OUTPUT DEFINITIONS

CNB = BODY ALONE NORMAL FORCE COEFFICIENT
XCPB= BODY ALONE CENTER OF PRESSURE
CNT = TAIL ALONE NORMAL FORCE COEFFICIENT
XCPT= TAIL ALONE CENTER OF PRESSURE
CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE COEFFICIENT
XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED AFT FROM ROOT CHORD LEADING EDGE)
YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING BODY) MEASURED OUTWARD FROM BODY
XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL CONFIGURATION (CAL. FROM NOSE)
CNT(B+T)= NORMAL FORCE COEFFICIENT OF BODY PLUS TAIL CONFIGURATION
CA = AXIAL FORCE COEFFICIENT

| ALPHA | ISOLATED COMPONENTS | | | | BODY TAIL CONFIGURATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CNB | XCPB | CNT | XCPT | CNT(B) | XCPT(B) | YCPT(B) | CN(B+T) | XCP(B+T) | CA |
| 0.00 | 0.000 | 2.242 | 0.000 | .656 | 0.000 | .656 | .328 | 0.000 | | .530 |
| 5.00 | .245 | 2.540 | .142 | .656 | .200 | .653 | .328 | .713 | 5.963 | .522 |
| 10.00 | .529 | 3.204 | .304 | .650 | .411 | .642 | .328 | 1.450 | 7.052 | .499 |
| 15.00 | .647 | 3.889 | .482 | .642 | .619 | .632 | .328 | 1.989 | 7.503 | .463 |
| 20.00 | 1.491 | 4.252 | .670 | .633 | .805 | .628 | .315 | 3.199 | 6.913 | .413 |
| 25.00 | 2.825 | 4.339 | .865 | .630 | .954 | .631 | .302 | 4.828 | 6.369 | .409 |
| 30.00 | 4.417 | 4.426 | 1.115 | .627 | 1.116 | .636 | .287 | 6.707 | 6.067 | .405 |
| 35.00 | 6.108 | 4.512 | 1.241 | .631 | 1.237 | .641 | .287 | 8.613 | 5.886 | .395 |
| 40.00 | 7.536 | 4.599 | 1.339 | .635 | 1.341 | .646 | .287 | 10.213 | 5.814 | .379 |
| 45.00 | 10.281 | 4.686 | 1.414 | .639 | 1.424 | .650 | .287 | 13.087 | 5.661 | .356 |

SAMPLE CONFIGURATION 2, OPTPHI=1, OPTMAC=0

INPUT PARAMETERS

MACH = 2.00
TAIL ASPECT RATIO = 1.00
TAIL TAPER RATIO = .50
TAIL L.E. SWEEP ANGLE = 53.13 DEGREES
TAIL ROOT CHORD= 5.000
NOSE LENGTH = 3.000 CAL.
AFTER BODY LENGTH = 8.250 CAL.
BODY DIAMETER = 3.75
TAIL SEMI-SPAN(INCLUDING BODY) = 3.75
REYNOLDS NUMBER = 6500000.00

OUTPUT DEFINITIONS

CNB = BODY ALONE NORMAL FORCE COEFFICIENT
XCPB= BODY ALONE CENTER OF PRESSURE
CNT = TAIL ALONE NORMAL FORCE COEFFICIENT
XCPT= TAIL ALONE CENTER OF PRESSURE
CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE COEFFICIENT
XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED AFT FROM ROOT CHORD LEADING EDGE)
YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING BODY) MEASURED OUTWARD FROM BODY
XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL CONFIGURATION (CAL. FROM NOSE)
CNT(B+T)= NORMAL FORCE COEFFICIENT OF BODY PLUS TAIL CONFIGURATION
CA = AXIAL FORCE COEFFICIENT

ALPHA= 0.00

| PHI | CNT(B) | | XCPT(B) | | | | YCPT(B) | | XCP(B+T) | | CN(B+T) | CA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FIN 2 | FIN 4 | FIN 2 | | FIN 4 | | FIN 2 | FIN 4 | UPPER | LOWER | | |
| | | | UPPER | LOWER | UPPER | LOWER | | | | | | |
| 0. | 0.000 | 0.000 | .536 | .536 | .536 | .536 | .407 | .407 | | | 0.000 | .343 |
| 10. | 0.000 | 0.000 | .536 | .536 | .536 | .536 | .408 | .407 | | | 0.000 | .343 |
| 20. | 0.000 | 0.000 | .536 | .536 | .536 | .536 | .413 | .407 | | | 0.000 | .343 |
| 30. | 0.000 | 0.000 | .536 | .536 | .536 | .536 | .429 | .407 | | | 0.000 | .343 |
| 40. | 0.000 | 0.000 | .536 | .536 | .536 | .536 | .458 | .407 | | | 0.000 | .343 |
| 50. | 0.000 | 0.000 | .536 | .536 | .536 | .536 | .507 | .407 | | | 0.000 | .343 |
| 60. | 0.000 | 0.000 | .536 | .536 | .536 | .536 | .579 | .407 | | | 0.000 | .343 |
| 70. | 0.000 | 0.000 | .536 | .536 | .536 | .536 | .681 | .407 | | | 0.000 | .343 |
| 80. | 0.000 | 0.000 | .639 | .417 | .536 | .536 | .816 | .407 | | | 0.000 | .343 |
| 90. | 0.000 | 0.000 | .974 | .098 | .536 | .536 | .989 | .407 | | | 0.000 | .343 |

LPHA= 10.00

| PHI | CNT(B) FIN 2 | CNT(B) FIN 4 | XCPT(B) FIN 2 UPPER | XCPT(B) FIN 2 LOWER | XCPT(B) FIN 4 UPPER | XCPT(B) FIN 4 LOWER | YCPT(B) FIN 2 | YCPT(B) FIN 4 | XCP(B+T) UPPER | XCP(B+T) LOWER | CN(B+T) | CA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0. | .361 | .361 | .562 | .562 | .562 | .562 | .407 | .407 | 7.196 | 7.196 | .961 | .343 |
| 10. | .316 | .380 | .558 | .558 | .562 | .562 | .409 | .407 | 7.154 | 7.154 | .950 | .343 |
| 20. | .258 | .397 | .557 | .558 | .561 | .561 | .426 | .407 | 7.062 | 7.065 | .927 | .343 |
| 30. | .192 | .390 | .553 | .558 | .559 | .559 | .470 | .407 | 6.985 | 6.981 | .907 | .343 |
| 40. | .124 | .371 | .553 | .553 | .556 | .556 | .557 | .407 | 6.966 | 6.962 | .902 | .343 |
| 50. | .063 | .326 | .619 | .507 | .552 | .552 | .699 | .407 | 6.966 | 6.962 | .902 | .343 |
| 60. | .013 | .254 | .870 | .173 | .545 | .545 | .912 | .407 | 6.985 | 6.981 | .907 | .343 |
| 70. | -.019 | .173 | .742 | .299 | .537 | .537 | 1.000 | .407 | 7.062 | 7.065 | .927 | .343 |
| 80. | -.025 | .088 | .549 | .522 | .536 | .536 | 1.000 | .407 | 7.154 | 7.154 | .950 | .343 |
| 90. | .000 | 0.000 | .536 | .536 | .536 | .536 | 1.000 | .407 | 7.196 | 7.196 | .961 | .343 |

LPHA= 20.00

| PHI | CNT(B) FIN 2 | CNT(B) FIN 4 | XCPT(B) FIN 2 UPPER | XCPT(B) FIN 2 LOWER | XCPT(B) FIN 4 UPPER | XCPT(B) FIN 4 LOWER | YCPT(B) FIN 2 | YCPT(B) FIN 4 | XCP(B+T) UPPER | XCP(B+T) LOWER | CN(B+T) | CA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0. | .682 | .682 | .583 | .583 | .583 | .583 | .407 | .407 | 6.309 | 6.309 | 4.115 | .343 |
| 10. | .660 | .766 | .572 | .572 | .582 | .582 | .411 | .407 | 6.280 | 6.280 | 4.088 | .343 |
| 20. | .619 | .788 | .572 | .572 | .581 | .581 | .442 | .407 | 6.208 | 6.208 | 4.023 | .343 |
| 30. | .272 | .776 | .572 | .572 | .578 | .578 | .527 | .407 | 6.146 | 6.149 | 3.970 | .343 |
| 40. | .132 | .756 | .667 | .471 | .575 | .575 | .690 | .407 | 6.143 | 6.138 | 3.964 | .343 |
| 50. | .012 | .684 | .955 | .088 | .571 | .571 | .960 | .407 | 6.143 | 6.138 | 3.964 | .343 |
| 60. | -.074 | .572 | .681 | .349 | .563 | .563 | 1.000 | .407 | 6.146 | 6.149 | 3.970 | .343 |
| 70. | -.114 | .364 | .555 | .555 | .554 | .554 | 1.000 | .407 | 6.208 | 6.208 | 4.023 | .343 |
| 80. | -.093 | .185 | .536 | .536 | .578 | .578 | 1.000 | .407 | 6.280 | 6.280 | 4.088 | .343 |
| 90. | -.000 | 0.000 | .536 | .536 | .536 | .536 | 1.000 | .407 | 6.309 | 6.309 | 4.115 | .343 |

LPHA= 30.00

| PHI | CNT(B) FIN 2 | CNT(B) FIN 4 | XCPT(B) FIN 2 UPPER | XCPT(B) FIN 2 LOWER | XCPT(B) FIN 4 UPPER | XCPT(B) FIN 4 LOWER | YCPT(B) FIN 2 | YCPT(B) FIN 4 | XCP(B+T) UPPER | XCP(B+T) LOWER | CN(B+T) | CA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0. | .997 | .997 | .587 | .587 | .587 | .587 | .407 | .407 | 6.065 | 6.065 | 8.098 | .343 |
| 10. | .902 | 1.109 | .584 | .584 | .587 | .587 | .410 | .407 | 6.064 | 6.064 | 8.097 | .343 |
| 20. | .621 | 1.140 | .584 | .584 | .587 | .587 | .433 | .407 | 6.025 | 6.026 | 8.030 | .343 |
| 30. | .430 | 1.128 | .584 | .584 | .586 | .586 | .496 | .407 | 5.990 | 5.991 | 7.970 | .343 |
| 40. | .246 | 1.091 | .603 | .573 | .585 | .585 | .617 | .407 | 5.992 | 5.988 | 7.970 | .343 |
| 50. | .085 | .986 | .776 | .397 | .587 | .583 | .817 | .407 | 5.992 | 5.988 | 7.970 | .343 |
| 60. | -.037 | .767 | .951 | .170 | .576 | .576 | 1.000 | .407 | 5.990 | 5.991 | 7.970 | .343 |
| 70. | -.102 | .524 | .686 | .470 | .565 | .565 | 1.000 | .407 | 6.025 | 6.026 | 8.030 | .343 |
| 80. | -.096 | .266 | .576 | .576 | .548 | .548 | 1.000 | .407 | 6.064 | 6.064 | 8.097 | .343 |
| 90. | .000 | 0.000 | .536 | .536 | .536 | .536 | 1.000 | .407 | 6.065 | 6.065 | 8.098 | .343 |

LPHA= 40.00

| PHI | CNT(B) FIN 2 | CNT(B) FIN 4 | XCPT(B) FIN 2 UPPER | XCPT(B) FIN 2 LOWER | XCPT(B) FIN 4 UPPER | XCPT(B) FIN 4 LOWER | YCPT(B) FIN 2 | YCPT(B) FIN 4 | XCP(B+T) UPPER | XCP(B+T) LOWER | CN(B+T) | CA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0. | 1.245 | 1.245 | .592 | .592 | .592 | .592 | .407 | .407 | 6.074 | 6.074 | 12.217 | .343 |
| 10. | 1.052 | 1.427 | .587 | .587 | .592 | .592 | .409 | .407 | 6.074 | 6.074 | 12.218 | .343 |
| 20. | .837 | 1.474 | .587 | .587 | .591 | .591 | .424 | .407 | 6.050 | 6.050 | 12.156 | .343 |
| 30. | .614 | 1.448 | .587 | .587 | .590 | .590 | .463 | .407 | 6.032 | 6.031 | 12.108 | .343 |
| 40. | .404 | 1.411 | .587 | .587 | .588 | .588 | .539 | .407 | 6.040 | 6.039 | 12.129 | .343 |
| 50. | .215 | 1.281 | .615 | .574 | .587 | .587 | .668 | .407 | 6.040 | 6.039 | 12.129 | .343 |
| 60. | .065 | .998 | .797 | .407 | .585 | .585 | .854 | .407 | 6.032 | 6.031 | 12.108 | .343 |
| 70. | -.051 | .681 | .831 | .199 | .576 | .576 | 1.000 | .407 | 6.050 | 6.050 | 12.156 | .343 |
| 80. | -.098 | .346 | .877 | .400 | .557 | .557 | 1.000 | .407 | 6.074 | 6.074 | 12.218 | .343 |
| 90. | -.000 | 0.000 | .916 | .536 | .536 | .536 | 1.000 | .407 | 6.074 | 6.074 | 12.217 | .343 |

```
      PROGRAM MAIN(TAPE5,TAPE6)                                          000100
C*****************************************************************     *000110
C     THIS PROGRAM USES AN AERODYNAMIC METHODOLOGY DEVELOPED BY THE    *000120
C     MARTIN MARIETTA CORP. TO PREDICT AERODYNAMIC COEFFICIENTS OF     *000130
C     MISSILES WITH LOW ASPECT RATIO TAILS AT LOW AND HIGH ANGLES OF   *000140
C     ATTACK AND ARBITRARY ROLL ANGLES.                                *000150
C                                                                      *000160
C     THE INPUT PARAMETERS AND THIER LIMITS FOR THIS METHOD ARE.       *000170
C                                                                      *000180
C        MACH   = MACH NUMBER          .8 TO 3.0                       *000190
C        ALPHA  = ANGLE OF ATTACK (DEG)   0. TO 180 (0 TO 45 FOR ROLL) *000200
C        ALE     = TAIL LEADING EDGE SWEEP ANGLE (DEG)   0 TO 70 DEG   *000210
C        LAD    = AFTER BODY LENGTH IN CAL.   6 TO 18                   *000220
C        LND    = NOSE LENGTH IN CAL.   1.5 TO 3.5                      *000230
C        LAMDA =  TAIL TAPER RATIO  0 TO 1                              *000240
C        AR     = TAIL ASPECT RATIO (TWO PANELS)   .5 TO 3.5            *000250
C        ALF1   = BEGINNING ALPHA FOR DESIRED ALPHA SWEEP (DEG)         *000260
C        ALF2   = END POINT FOR ALPHA SWEEP (DEG)                       *000270
C        DELAF  = ALPHA INCREMENT FOR ALPHA SWEEP (DEG)                 *000280
C        RN     = REYNOLDS NUMBER/FT.                                   *000290
C        S      = TAIL SEMI SPAN INCLUDING BODY,(B+D)/2, INCHES         *000300
C        CR     = TAIL ROOT CHORD  INCHES                               *000310
C        D      = BODY DIAMETER  INCHES                                 *000320
C        OPTPHI= 0  GIVES NO PREDICTIONS VS. ROLL ANGLE                 *000330
C                                                                       *000340
C              = 1  GIVES AERODYNAMIC COEFFICIENTS AND CENTER OF        *000350
C                   PRESSURE AS A FUNCTION OF ROLL ANGLE               *000360
C        OPTMAC= 1  ALLOWS FOR MULTIPLE MACH NO. CALCULATIONS FOR       *000370
C                   A GIVEN CONFIGURATIN                               *000380
C                                                                      *000390
C              = 0  CALCULATIONS FOR SINGLE MACH NO. ONLY              *000400
C*****************************************************************     *000410
      INTEGER OPTPHI,OPTMAC                                            000420
      DIMENSION ANAME(12)                                              000430
      REAL MACH,LAMDA,LND,LAD,IBT                                      000440
      GO TO 11                                                         000450
    1 IF(OPTMAC.EQ. 1) GO TO 2                                         000460
   11 READ(5,208) (ANAME(I),I=1,12)                                    000470
      IF(EOF(5)) 400,25                                                000480
   25 READ(5,200) AR,S,CR,LAMDA,ALE                                    000490
      READ(5,201) LND,LAD,D                                            000500
   15 READ(5,202) ALF1,ALF2,DELAF,MACH,RN,OPTPHI,OPTMAC                000510
      GO TO 3                                                          000520
    2 READ(5,203) MACH                                                 000530
      IF(EOF(5))400,26                                                 000540
   26 IF(MACH.EQ. 0.) GO TO 11                                         000550
    3 WRITE(6,140)                                                     000560
      WRITE(6,208) (ANAME(I),I=1,12)                                   000570
      WRITE(6,117)                                                     000580
      WRITE(6,109)                                                     000590
      WRITE(6,110)                                                     000600
      WRITE(6,111) MACH                                                000610
      WRITE(6,112) AR                                                  000620
      WRITE(6,113) LAMDA                                               000630
      WRITE(6,114) ALE                                                 000640
      WRITE(6,115) CR                                                  000650
      WRITE(6,116) LND                                                 000660
```

```
                WRITE(6,117) LAD                                                  000670
                WRITE(6,150) D                                                    000680
                WRITE(6,151) S                                                    000690
60              WRITE(6,118) RN                                                   000700
                WRITE(6,110)                                                      000710
                WRITE(6,119)                                                      000720
                WRITE(6,141)                                                      000730
65              WRITE(6,141)                                                      000740
                WRITE(6,119)                                                      000750
                WRITE(6,120)                                                      000760
                WRITE(6,110)                                                      000770
                WRITE(6,121)                                                      000780
70              WRITE(6,122)                                                      000790
                WRITE(6,123)                                                      000800
                WRITE(6,124)                                                      000810
                WRITE(6,125)                                                      000820
                WRITE(6,126)                                                      000830
75              WRITE(6,127)                                                      000840
                WRITE(6,128)                                                      000850
                WRITE(6,161)                                                      000860
                WRITE(6,129)                                                      000870
                WRITE(6,130)                                                      000880
80              WRITE(6,131)                                                      000890
                WRITE(6,162)                                                      000900
                WRITE(6,132)                                                      000910
                WRITE(6,133)                                                      000920
                WRITE(6,134)                                                      000930
85              WRITE(6,135)                                                      000940
                WRITE(6,110)                                                      000950
                WRITE(6,119)                                                      000960
              5 PI = 3.14159265359                                                000970
                RAD = PI/180.                                                     000980
90              ST = .5*CR*(1.+LAMDA)*(S-D/2.)                                    000990
                SBASE = 3.14159*(D/2.)**2                                         001000
                ARATIO = ST/SBASE                                                 001010
                R=LND**2 +.25                                                     001020
                AWETS = ((2.*PI*R)*((R-.5)*ASIN(-LND/R)+LND))*D**2+LAD*D*2.*      001030
95             1PI*(D/2.)                                                         001040
                AWOR=AWETS/SBASE                                                  001050
                KOUNT = 0                                                         001060
                KIT = 2                                                           001070
                ALPHA = ALFI                                                      001080
100             IF(OPTPHI .EQ. 1) GO TO 5                                         001090
              4 WRITE(6,142)                                                      001100
                WRITE(6,106)                                                      001110
                WRITE(6,107)                                                      001120
                WRITE(6,142)                                                      001130
105           5 CALL AXIAL(LAD,LND,MACH,AWOR,ALPHA,RN,CA)                         001140
                CALL XCPRTT(ALPHA,LAMDA,MACH,AR,D,S,XCPBT)                        001150
                XCPI = (LND*LAD-CR/D)* XCPBT*CR/D                                 001160
                CALL CNBOD(LAD,LND,MACH,ALPHA,D,CNB,RN)                           001170
                CALL XCPBOD(LAD,LND,D,MACH,ALPHA,XCPB)                            001180
110             IF(OPTPHI .EQ. 3) GO TO 10                                        001190
                CALL CNTT(ALPHA,LAMDA,MACH,AR,CNT)                                001200
                CALL XCPTT(ALPHA,LAMDA,MACH,AR,XCPT)                              001210
                IF(ALPHA .GT.45.) GO TO 300                                       001220
                PHI = 90.                                                         001230
```

```
      CALL CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI,CR,ALE,CNTB,                  001240
      CALL IBTT(LAMDA,MACH,AR,ALPHA,PHI,S,D,IBT)                            001250
      CALL XCPTBB(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI,XCPTB1,XCPTB2)             001260
      CALL YCPTS(LAMDA,PHI,ALPHA,MACH,S,D,CR,YCPT)                          001270
      CNBT = CNB + 2.*CNTB*ARATIO + IBT                                     001280
      XXCPTI = LAD*LND-CR/D + XCPTB1*CR/D                                   001290
      GO TO 16                                                              001300
  300 WRITE(6,204) ALPHA,CNB,XCPB,CNT,XCPT,CA                               001310
      GO TO 30                                                              001320
   16 XCPBT = (CNB*XCPB + 2.*CNTB*ARATIO*XXCPT1      + IBT*XCPI)/CNBT        001330
      WRITE(6,108) ALPHA,CNB,XCPB,CNT,XCPT,CNTB,XCPTB1,YCPT,CNBT,XCPBT,     001340
     1CA                                                                    001350
   30 ALPHA = ALPHA + DELAF                                                 001360
      IF(ALPHA .GT. ALF2) GO TO 1                                           001370
      KOUNT = KOUNT + 1                                                     001380
      IF(KOUNT .EQ. 50 .AND. OPTPHI .EQ. 0) GO TO 4                         001390
      GO TO 5                                                               001400
   10 IF(KIT .EQ. 0) WRITE(6,140)                                           001410
      WRITE(6,141)                                                          001420
      WRITE(6,101) ALPHA                                                    001430
      WRITE(6,105)                                                          001440
      WRITE(6,102)                                                          001450
      WRITE(6,103)                                                          001460
      WRITE(6,104)                                                          001470
      WRITE(6,105)                                                          001480
      KIT = KIT + 1                                                         001490
      IF(KIT.EQ. 3) KIT = 0                                                 001500
      PHI = 0.                                                              001510
      DO 20 I=1,10                                                          001520
      PHI1 = 180. - PHI                                                     001530
      PHI2 = PHI + 90.                                                      001540
      PHI3 = PHI                                                            001550
      PHI4 = 90.- PHI                                                       001560
      CALL CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI1,CR,ALE,CNTB1)                001570
      CALL CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI2,CR,ALE,CNTB2)                001580
      CALL CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI3,CR,ALE,CNTB3)                001590
      CALL CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI4,CR,ALE,CNTB4)                001600
      CALL XCPTBB(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI1,XCPTU1,XCPTL1)            001610
      CALL XCPTBB(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI2,XCPTU2,XCPTL2)            001620
      CALL XCPTBB(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI3,XCPTU3,XCPTL3)            001630
      CALL XCPTBB(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI4,XCPTU4,XCPTL4)            001640
      CALL YCPTS(LAMDA,PHI1,ALPHA,MACH,S,D,CR,YCPT1)                        001650
      CALL YCPTS(LAMDA,PHI2,ALPHA,MACH,S,D,CR,YCPT2)                        001660
      CALL YCPTS(LAMDA,PHI3,ALPHA,MACH,S,D,CR,YCPT3)                        001670
      CALL YCPTS(LAMDA,PHI4,ALPHA,MACH,S,D,CR,YCPT4)                        001680
      CALL IBTT(LAMDA,MACH,AR,ALPHA,PHI,S,D,IBT)                            001690
      IF(ALPHA.GT. 90.) GO TO 35                                            001700
      XCTL1=LAD*LND-CR/D + XCPTL1*CR/D                                      001710
      XCTL2=LAD*LND-CR/D + XCPTL2*CR/D                                      001720
      XCTL3=LAD*LND-CR/D + XCPTL3*CR/D                                      001730
      XCTL4=LAD*LND-CR/D + XCPTL4*CR/D                                      001740
      XCTU1=LAD*LND-CR/D + XCPTU1*CR/D                                      001750
      XCTU2=LAD*LND-CR/D + XCPTU2*CR/D                                      001760
      XCTU3=LAD*LND-CR/D + XCPTU3*CR/D                                      001770
      XCTU4=LAD*LND-CR/D + XCPTU4*CR/D                                      001780
      GO TO 36                                                              001790
   35 XCTL1=LAD*LND-XCPTL1*CR/D                                             001800
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      XCTL2=LAD*LND-XCPTL2*CR/D                                          001810
      XCTL3=LAD*LND-XCPTL3*CR/D                                          001820
      XCTL4=LAD*LND-XCPTL4*CR/D                                          001830
      XCTU1=LAD*LND-XCPTU1*CR/D                                          001840
      XCTU2=LAD*LND-XCPTU2*CR/D                                          001850
      XCTU3=LAD*LND-XCPTU3*CR/D                                          001860
      XCTU4=LAD*LND-XCPTU4*CR/D                                          001870
   36 P = PHI*RAD                                                        001880
      CNBT = CNB + (CNTB1*SIN(P) + CNTB2*COS(P) + CNTB3*SIN(P) + CNTB4* 001890
     1COS(P))*ARATIO + IBT                                              001900
      XCPBTU = (CNB*XCPB + (CNTB1*XCTU1 *SIN(P) + CNTB2*XCTU2 *COS(P)   001910
     1+CNTB3*XCTU3 *SIN(P) + CNTB4*XCTU4 *COS(P))*ARATIO     +IBT*XCPI) 001920
     2/CNBT                                                             001930
      XCPBTL = (CNB*XCPB + (CNTB1*XCTL1 *SIN(P) + CNTB2*XCTL2 *COS(P)   001940
     1+CNTB3*XCTL3 *SIN(P) + CNTB4*XCTL4 *COS(P))*ARATIO     +IBT*XCPI) 001950
     2/CNBT                                                             001960
      WRITE(66,100) PHI,CNTB2,CNTB4,XCPTU2,XCPTL2,XCPTU4,XCPTL4,YCPT2,  001970
     1YCPT4,XCPBTU,XCPBTL,CNBT,CA                                       001980
      PHI = PHI + 10.                                                   001990
   20 CONTINUE                                                          002000
      PHI = 0.                                                          002010
      GO TO 30                                                          002020
  102 FORMAT (1H ,*I  PHI  I     CNT(B)    I            XCPT(B)         002030
     1   I   XCPT(B)    I     XCP(B*T)      I    CN(B*T)     I  CA   I*002040
     1)                                                                 002050
  103 FORMAT(1H ,*I       I FIN 2 I FIN 4 I     FIN 2     I     FIN 4   002060
     1  I FIN 2 I FIN 4 I  UPPER  I  LOWER  I               I       I*)002070
  104 FORMAT(1H ,*I       I       I       I       I UPPER I LOWER I UPPER I LOWE002080
     1R I       I       I       I       I                   I       I*)002090
  105 FORMAT(1H ,*----------------------------------------------------------002100
     1----------------------------------------------------------------*)002110
  100 FORMAT(1H ,2X,F6.0,    BB.3,F9.3,1X,F9.3,5X,F8.3,5X,F8.3)          002120
  101 FORMAT(1H ,*ALPHA=*,F6.2)                                         002130
  108 FORMAT(1H , F6.2,3X,F7.3,2X,F7.3,2X,F7.3,2X,F7.3,2X,F7.3,2X,F8.3,2002140
     1X,F7.3,3X,F9.3,3X,F10.3,3X,F7.3)                                  002150
  106 FORMAT(1H ,*I ALPHA I       ISOLATED COMPONENTS        I          002160
     1       BODY TAIL CONFIGURATION                        I*)         002170
  107 FORMAT(1H ,*I       I   CNB  I  XCPB  I   CNT  I  XCPT  I CNT(B) I002180
     1 XCPT(B) I YCPT(B) I  CN(B*T)  I  XCP(B*T)  I   CA   I*)          002190
  142 FORMAT(1H ,*----------------------------------------------------------002200
     1-----------------------------------------------------*)           002210
  109 FORMAT(1H ,*I        INPUT PARAMETERS                          I*)002220
  110 FORMAT(1H ,*I                                                  I*)002230
  111 FORMAT(1H ,*I         MACH = *,F5.2,*                          002240
     1I*)                                                               002250
  112 FORMAT(1H ,*I         TAIL ASPECT RATIO = *,F5.2,*             002260
     1I*)                                                               002270
  113 FORMAT(1H ,*I         TAIL TAPER RATIO = *,F5.2,*              002280
     1I*)                                                               002290
  114 FORMAT(1H ,*I         TAIL L.E. SWEEP ANGLE = *,F5.2,* DEGREES 002300
     1I*)                                                               002310
  115 FORMAT(1H ,*I         TAIL ROOT CHORD= *,F6.3,*                I002320
     1*)                                                                002330
  116 FORMAT(1H ,*I         NOSE LENGTH =*,F6.3,* CAL.               I 002340
     1*)                                                                002350
  117 FORMAT(1H ,*I         AFTER BODY LENGTH =*,F6.3,* CAL.         I002360
     1*)                                                                002370
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      150 FORMAT(1H +,I          BODY DIAMETER = +,F5.2,+                          002380
     1I+)                                                                         002390
  230 151 FORMAT(1H +,I          TAIL SEMI-SPAN(INCLUDING BODY) =+,F5.2,+          002400
     1I+)                                                                         002410
      118 FORMAT(1H +,I          REYNOLDS NUMBER =+,F13.2,+           I+)          002420
      119 FORMAT(1H +,I----------------------------------------------------------+)002430
  235 120 FORMAT(1H +,I              OUTPUT DEFINITIONS                           I+)002440
      121 FORMAT(1H +,I   CNB = BODY ALONE NORMAL FORCE COEFFICIENT               I+)002450
      122 FORMAT(1H +,I   XCPB= BODY ALONE CENTER OF PRESSURE                     I+)002460
      123 FORMAT(1H +,I   CNT = TAIL ALONE NORMAL FORCE COEFFICIENT               I+)002470
      124 FORMAT(1H +,I   XCPT= TAIL ALONE CENTER OF PRESSURE                     I+)002480
  240 125 FORMAT(1H +,I   CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE          I+)002490
      126 FORMAT(1H +,I      COEFFICIENT                                          I+)002500
      127 FORMAT(1H +,I   XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE          I+)002510
      128 FORMAT(1H +,I     CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED          I+)002520
      161 FORMAT(1H +,I     AFT FROM ROOT CHORD LEADING EDGE)                     I+)002530
  245 129 FORMAT(1H +,I   YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE          I+)002540
      130 FORMAT(1H +,I     CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING          I+)002550
      162 FORMAT(1H +,I       BODY) MEASURED OUTWARD FROM BODY                    I+)002560
      131 FORMAT(1H +,I   XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL          I+)002570
      132 FORMAT(1H +,I     CONFIGURATION (CAL. FROM NOSE)                        I+)002580
  250 133 FORMAT(1H +,I   CNT(B+T)= NORMAL FORCE COEFFICIENT  OF BODY            I+)002590
      134 FORMAT(1H +,I     PLUS TAIL CONFIGURATION                               I+)002600
      135 FORMAT(1H +,I   CA = AXIAL FORCE COEFFICIENT                            I+)002610
      140 FORMAT(1H1)                                                            002620
      141 FORMAT(1H0)                                                            002630
  255 200 FORMAT(5F10.3)                                                         002640
      201 FORMAT(3F10.3)                                                         002650
      202 FORMAT(4F10.3,F13.2,12,I2)                                             002660
      203 FORMAT(F10.2)                                                          002670
      205 FORMAT(11F6.3)                                                         002680
  260 206 FORMAT(4F10.3)                                                         002690
      207 FORMAT(15,F6.3)                                                        002700
      208 FORMAT(12A6)                                                           002710
      204 FORMAT(1H ,F6.2,3X,F7.3,2X,F7.3,2X,F7.3,2X,F7.3,2X,F7.3,2X,+ ----- +,2X,+002720
     1+ ---- +,2X,+ ---- +,3X,+ ----- +,3X,+ ----- +,3X,F7.2)                     002730
  265 400 STOP                                                                   002740
          END                                                                    002750
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      SUBROUTINE CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI,CR,ALE,CNTP)          002760
C*****************************************************************************002770
C                                                                             *002780
C     THIS SUBROUTINE CALCULATES TAIL NORMAL FORCE COEFFICIENT IN             *002790
C     PRESENCE OF CYLINDRICAL BODY AS A FUNCTION OF ROLL ANGLE                *002800
C                                                                             *002810
C        MACH      = MACH NUMBER                                            *002820
C        AR        = ASPECT RATIO                                           *002830
C        LAMDA     = TAIL TAPER RATIO                                       *002840
C        D         = BODY DIAMETER                                          *002850
C        S         = TAIL SEMI-SPAN (INCLUDING BODY)                        *002860
C        ALPHA     = ANGLE OF ATTACK (DEGREES)                              *002870
C        PHI       = ROLL ANGLE (DEGREES)                                   *002880
C        CR        = ROOT CHORD LENGTH                                      *002890
C        ALE       = LEADING EDGE ANGLE (DEGREES)                           *002900
C        CNTP = TAIL NORMAL FORCE COEFF.  IN PRESENTS OF CYLIN. BODY        *002910
C                                                                             *002920
C*****************************************************************************002930
      REAL LAMDA,MACH,MACHTP,KTP,KTBT,KTBDS                                 002940
      DIMENSION RTBPCT(3,3),RTHPAR(3),RTBPLC(3),                            002950
     *          RPRMT(19,10,3),RPRMM(19),RPRMA(10),RPRMLM(3),               002960
     *          RTHTT(19,10,2),RTRTM(19),RTRTA(10),RTRTAR(2),               002970
     *          KTBT(11),KTBDS(11),                                         002980
     *          RTBP2T(12,3),RTBP2M(12),RTBP2L(3),                          002990
     *          CHIPT(6),PHIPAT(6),                                         003000
     *          RBT(9,9,3),BEALFT(9),BEALET(9),BEMACT(3),                   003010
     *          RTHPGT(14,3),RTBPGA(14),RTBPGM(3),                          003020
     *          RTBPAT(3,7),                                                003030
     *          RBT(5,8,4),BBALFT(5),BEALET(8),BBMACT(4)                    003040
      DATA (RPRMM(I),I=1,19)/1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,2.0,2.1,       003050
     12.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,3.0/                                  003060
      DATA (RPRMA(I),I=1,10)/0.,5.,10.,15.,20.,25.,30.,35.,40.,45./         003070
      DATA ((RPRMT(I,J,1),I=1,19),J=1,10)/0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,003080
     10.,7.,0.,0.,0.,0.,0.,0.,0.,0.,0.,-0.41,-.11,-.257,-.498,-.612,-.629, 003090
     2-.633,-.637,-.641,-.645,-.649,-.649,-.649,-.653,-.653,-.653,-.657,003100
     3-.661,0.,-.052,-.169,-.307,-.836,-.954,-.974,-.979,-.979,-.979,      003110
     4-.981,-.987,-.987,-.983,-.983,-.983,-.983,-.983,-.987,0.,-.057,      003120
     5-.208,-.653,-1.,-1.049,-1.086,-1.09,-1.082,-1.073,-1.061,-1.045,     003130
     6-1.029,-1.012,-.988,-.963,-.939,-.914,-.89,0.,-.057,-.204,-.657,     003140
     7-1.008,-1.077,-1.09,-1.086,-1.086,-1.073,-1.057,-1.037,-1.016,       003150
     8-.988,-.958,-.927,-.894,-.861,-.824,0.,-.053,-.171,-.51,-.98,-1.,    003160
     9-1.,-1.,-1.,-.996,-.984,-.967,-.947,-.927,-.906,-.882,-.853,-.829,003170
     *-.808,0.,-.053,-.163,-.441,-.751,-.845,-.861,-.861,-.861,-.861,      003180
     1-.837,-.856,-.849,-.841,-.837,-.833,-.824,-.816,-.808,0.,-.057,      003190
     2-.167,-.41,-.71,-.804,-.812,-.812,-.812,-.812,-.812,-.816,-.82,      003200
     3-.824,-.824,-.833,-.837,-.849,-.857,0.,-.045,-.147,-.371,-.669,      003210
     4-.767,-.78,-.784,-.784,-.788,-.792,-.796,-.804,-.816,-.829,-.849,    003220
     5-.878,-.906,-.935,0.,-.045,-.127,-.343,-.629,-.735,-.751,-.751,      003230
     6-.751,-.755,-.767,-.78,-.796,-.816,-.841,-.878,-.922,-.971,-1.037/003240
      DATA ((RPRMT(I,J,2),I=1,19),J=1,10)/0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,003250
     10.,0.,0.,0.,0.,0.,0.,0.,0.,0.,-.037,-.139,-.302,-.4,-.445,-.461,     003260
     2-.469,-.478,-.482,-.49,-.494,-.498,-.502,-.506,-.506,-.510,-.510,    003270
     3-.514,0.,-.037,-.167,-.42,-.559,-.624,-.641,-.641,-.641,-.641,       003280
     4-.645,-.649,-.657,-.673,-.69,-.714,-.739,-.776,-.82,0.,-.041,        003290
     5-.196,-.731,-.739,-.42,-.833,-.837,-.837,-.833,-.824,-.816,-.804,    003300
     6-.792,-.76,-.763,-.747,-.739,-.722,0.,-.045,-.204,-.571,-.816,       003310
     7-.91,-.971,-.971,-.971,-.922,-.91,-.89,-.869,-.845,-.816,-.784,      003320
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      6-.751,-.722,-.69,8,,-.645,-.204,-.571,-.816,-.91,-.931,-.931,     003330
      9-.931,-.922,-.911,-.89,-.869,-.845,-.816,-.784,-.751,-.722,-.69,  003340
     60 *0,,-.641,-.184,-.527,-.714,-.792,-.812,-.812,-.812,-.812,-.808,  003350
      1-.808,-.804,-.8,-.796,-.788,-.784,-.776,-.771,8,,-.641,-.196,     003360
      2-.635,-.747,-.849,-.861,-.861,-.857,-.857,-.857,-.853,-.853,-.849,003370
      3-.849,-.849,-.849,-.849,-.851,8,,-.841,-.176,-.49,-.714,-.792,    003380
      4-.808,-.812,-.812,-.812,-.808,-.808,-.804,-.8,-.816,-.841,-.865,  003390
     65 5-.878,-.918,8,,-.841,-.167,-.457,-.645,-.727,-.747,-.743,-.743,  003400
      6-.747,-.755,-.767,-.788,-.808,-.837,-.869,-.914,-.967,-1.037/     003410
       DATA ((RPRMTI(J,I),I=1,19),J=1,10)/8,8,8,8,8,8,8,8,8,8,8,8,8,8,8,003420
     10,,8,8,8,8,8,8,8,8,8,8,,-.032,-.127,-.286,-.38,-.437,-.457,       003430
      2-.465,-.463,-.459,-.455,-.447,-.443,-.433,-.416,-.4,-.384,-.363,  003440
     70 3-.347,8,,,-.029,-.127,-.282,-.38,-.424,-.441,-.441,-.441,-.441,  003450
      4-.445,-.449,-.457,-.469,-.486,-.502,-.522,-.555,-.596,8,,-.837,   003460
      5-.851,-.847,-.869,-.527,-.539,-.539,-.539,-.539,-.543,-.543,-.543,003470
      6-.551,-.555,-.559,-.567,-.576,-.584,8,,-.837,-.151,-.437,-.616,   003480
      7-.694,-.71,-.71,-.71,-.702,-.698,-.686,-.682,-.673,-.661,-.649,   003490
     75 8-.637,-.629,-.616,8,,-.037,-.156,-.494,-.747,-.833,-.853,-.857,   003500
      9-.853,-.849,-.837,-.829,-.808,-.788,-.767,-.747,-.727,-.702,-.678,003510
      *8,,-.037,-.151,-.498,-.747,-.837,-.853,-.857,-.857,-.849,-.845,   003520
      1-.837,-.829,-.816,-.804,-.792,-.776,-.763,-.751,8,,-.037,-.155,   003530
      2-.473,-.698,-.78,-.796,-.796,-.8,-.8,-.8,-.804,-.808,-.812,-.812, 003540
     80 3-.82,-.824,-.829,-.837,8,,-.037,-.159,-.469,-.669,-.751,-.763,   003550
      4-.768,-.767,-.767,-.771,-.776,-.788,-.8,-.816,-.837,-.857,-.894,  003560
      5-.927,8,,-.033,-.151,-.449,-.641,-.722,-.739,-.739,-.743,-.743,   003570
      6-.751,-.763,-.78,-.804,-.833,-.865,-.902,-.959,-1.02/             003580
       DATA (RPRMLM(I),I=1,33)/3,,,5,1,/                                 003590
     85 DATA(RTRTAR(I),I=1,23)/.5,2,/                                     003600
       DATA (RTRTAC(I),I=1,19)/1,,5,,10,,15,,20,,25,,30,,35,,40,,45,/    003610
       DATA (RTRTMP(I),I=1,19)/1,,2,1,3,1,4,1,5,1,6,1,7,1,8,1,9,2,,2,1,2,2,003620
     12,3,2,4,2,5,2,6,2,7,2,8,2,9,3,/                                    003630
       DATA ((RTRTTT(I,,J),I=1,19),J=1,10)/1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,003640
     90 1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,003650
      2,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,003660
      3,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,003670
      4,,1,,,,999,,,976,,,966,,,961,,,959,,,959,,,959,,,961,             003680
      5,,964,,,966,,,971,,,976,,,981,,,985,,,994,,,999,,,999,,1,,,,996,,,976,,,941,    003690
     95 6,,932,,,889,,,884,,,884,,,884,,,889,,,897,,,904,,,917,,,931,,,946,,,966,,,981, 003700
      7,,991,,,999,,1,,,,996,,,976,,,941,,,902,,,889,,,884,,,884,,,884,,,889,,,897,    003710
      8,,904,,,917,,,931,,,946,,,966,,,981,,,991,,,999,,1,,,,989,,,951,,,892,,,849,    003720
      9,,824,,,814,,,812,,,817,,,827,,,839,,,857,,,882,,,907,,,931,,,956,,,974,,,989,  003730
     *1,,1,,,,994,,,924,,,842,,,762,,,727,,,712,,,71,,,715,,,727,,,745,,,767,,,792,   003740
     100 1,,824,,,849,,,877,,,897,,,909,,,914,,1,,,,994,,,926,,,824,,,687,,,617,,,6,,,598,003750
      2,,607,,,625,,,655,,,69,,,722,,,757,,,782,,,802,,,822,,,834,,,844/ 003760
       DATA ((RPTRTT(I,,J),I=1,19),J=1,10)/1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,003770
     10,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,,1,003780
     20,,1,,1,,1,,1,,1,,1,,,,999,,,969,,,924,,,894,,,879,,,872,,,869,,,872,,,877,003790
     105 1,,887,,,899,,,912,,,929,,,951,,,969,,,981,,,989,,,996,1,,,,979,,,929,,,822,  003800
      4,,752,,,715,,,7,,,697,,,705,,,722,,,74,,,767,,,797,,,839,,,884,,,919,,,949,   003810
      5,,976,,,996,1,,,,981,,,939,,,857,,,787,,,745,,,73,,,727,,,735,,,75,,,769,,,797,003820
      6,,827,,,867,,,904,,,936,,,961,,,979,1,,,,999,,,981,,,939,,,857,,,787,,,745,   003830
      7,,73,,,727,,,735,,,75,,,769,,,797,,,827,,,867,,,904,,,936,,,961,,,979,1,,1,,  003840
     110 8,,994,,,959,,,912,,,872,,,852,,,842,,,844,,,849,,,859,,,872,,,889,,,909,   003850
      9,,934,,,959,,,974,,,986,1,,1,,,,994,,,984,,,971,,,956,,,949,,,946,,,944,,,946,003860
      *,,949,,,954,,,959,,,964,,,971,,,979,,,986,,,994,1,,1,,1,,1,,1,,1,,1,816,    003870
      11,,959,1,,,888,1,,,106,1,,,111,1,,,111,1,,,106,1,,,098,1,,,088,1,,,076,1,,,056,1,,,041,003880
      21,,024,1,,,009,1,,,001,,,999,,,996,1,,,1,,,013,1,,,041,1,,,138,1,,,223,1,,,268,  003890
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      31.2R6,1.285,1.278,1.258,1.233,1.203,1.183,1.118,1.071,1.044,1.024,003900
     41.004,.009/                                                          003910
      DATA (PHIPAT(I),I=1,6)/20.,25.,30.,35.,40.,45./                      003920
      DATA (PHIFT(I),I=1,6)/45.,41.,37.75,35.5,33.,31.5/                   003930
      DATA(RTPPBA(I),I=1,14)/20.,22.,24.,26.,28.,30.,32.,34.,36.,38.,40.003940
     *,42.,44.,45./                                                       003950
      DATA (RTBPAM(I),I=1,5)/.8,1.,1.2/                                    003960
      DATA (RPMACT(I),I=1,4)/1.75,2.,2.5,3./                               003970
      DATA (RPMACT(I),I=1,3)/.8,1.,1.2/                                    003980
      DATA ((RTPPCT(I,J),I=1,3),J=1,3)/1.74,1.74,1.58,1.6,1.56,1.37,1.56003990
     *,1.55,1.36/                                                          004000
      DATA (RTPPA(I),I=1,3)/.5,1.0,2.0/                                    004010
      DATA (RTBPLC(I),I=1,3)/0.,.5,1.0/                                    004020
      DATA ((RTPPAT(I,J),I=1,3),J=1,3)/1.796,1.7,1.619,1.7,1.599,1.498,1004030
     *,.55R,1.452,1.32F/                                                   004040
      DATA ((RTPPCT(I,J),I=1,14),J=1,3)/1.549,1.697,1.841,1.954,2.036,2.004050
     *11,2.17,2.241,2.297,2.349,2.4,2.446,2.487,2.503,1.523,1.59,1.677004060
     *,1.754,1.826,1.892,1.954,2.021,2.082,2.138,2.2,2.256,2.313,2.338,1004070
     *,.50,1.579,1.651,1.718,1.764,1.81,1.846,1.882,1.913,1.944,1.969,1.004080
     *79,2.035,2.01F/                                                      004090
      DATA (((PPT(I,J,K),I=1,5),J=1,8),K=1,4)/-.015,.039,.113,.098,.029,004100
     *-.011,.103,.147,.132,.025,-.029,.098,.162,.142,.054,-.025,.088,.15004110
     *7,.167,.123,-.01,.078,.172,.162,.113,.015,.093,.137,.167,.152,.015004120
     *,.123,.176,.167,.157,.054,.186,.216,.216,.211,-.025,.015,.074,.132004130
     *,.102,-.025,.044,.107,.147,.123,.015,.064,.113,.162,.147,.039,.074004140
     *,.142,.166,.098,.054,.098,.142,.191,.172,.049,.103,.157,.211,.172,004150
     *.054,.147,.167,.176,.186,.108,.191,.206,.201,.245,-.034,-.005,.03004160
     *,.127,.181,.001,.064,.125,.186,.225,.025,.068,.142,.206,.23,.034,.004170
     *078,.142,.196,.245,.029,.088,.142,.196,.245,.044,.093,.137,.191,.2004180
     *7,.224,.188,.127,.157,.195,.005,.162,.176,.181,.211,-.034,.010,.08004190
     *3,.137,.186,-.034,.059,.122,.162,.196,.010,.078,.167,.196,.216,.02004200
     *,.115,.181,.206,.221,.015,.132,.186,.225,.255,.034,.152,.167,.230,004210
     *.26,.059,.127,.132,.191,.245,.044,.172,.191,.196,.211/               004220
      DATA (RBALFT(I),I=1,5)/0.,10.,20.,30.,45./                           004230
      DATA (RBALFT(I),I=1,8)/0.,10.,20.,30.,40.,50.,60.,70./               004240
      DATA (((BETA[I,J,K),I=1,9),J=1,9),K=1,2)/.005,.074,.028,-.041,-.046004250
     *,-.038,-.027,-.005,.005,.010,.030,.023,-.036,-.053,-.048,-.041,-.0004260
     *36,-.033,-.004,.01,-.005,-.043,-.074,-.066,-.056,-.051,-.051,-.008,-004270
     *.003,-.023,-.079,-.091,-.074,-.063,-.056,-.053,.005,.005,-.041,-.1004280
     *02,-.117,-.048,-.063,-.048,-.033,.005,.018,-.038,-.119,-.15,-.112,004290
     *-.063,-.02,.003,.008,.015,-.079,-.137,-.145,-.124,-.071,-.015,.02,004300
     *.005,.105,.112,.046,-.058,-.048,-.02,.018,.033,.008,.162,.195,.096004310
     *,.02,-.015,.018,.038,.043,.008,-.005,-.023,-.051,-.066,-.071,-.066004320
     *,-.056,-.042,-.008,.0,.0,-.018,-.053,-.109,-.112,-.107,-.091,-.074,.0004330
     *1,-.01,-.013,-.081,-.15,-.14,-.129,-.117,-.107,.008,.03,.013,-.094,004340
     *-.105,-.183,-.152,-.124,-.104,0.0,.018,.008,-.071,-.173,-.185,-.15004350
     *5,-.135,-.117,.013,.036,.025,-.033,-.175,-.178,-.142 ,-.117,-.094,.004360
     *005,.056,.048,-.023,-.137,-.17,-.142,-.086,-.063,.025,.124,.14,.1004370
     *09,.071,.051,.047,.041,.043,.003,.162,.195,.168,.114,.094,.086,.08004380
     *1,.0P1/                                                              004390
      DATA ((BET(I,J,3),I=1,9),J=1,9)/.003,.089,.076,.013,-.03,-.041,-.0004400
     *36,-.018,-.008,.013,.048,.051,-.008,-.074,-.076,-.056,-.041,-.028,004410
     *,.005,.033,.033,-.038,-.074,-.091,-.086,-.058,-.041,.010,.038,.03,-004420
     *.036,-.051,-.114,-.102,-.071,-.048,.003,.058,.036,.005,-.051,-.091004430
     *,-.094,-.071,-.056,.005,.091,.084,.056,-.008,-.053,-.053,-.051,-.0004440
     *41,.005,.124,.15,.14,.099,.048,0.0,-.03,-.038,.013,.137,.17,.168,.004450
     *046,.02,.03,.036,.038,0.0,-.19,-.213,-.203,-.117,-.094,-.094,-.084,-.069/ 004460
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      DATA(BEALET(I),I=1,9)/0.,10.,15.,20.,25.,30.,35.,40.,45./          004470
      DATA(BEALET(I),I=1,9)/0.,10.,20.,30.,40.,50.,60.,70.,80./          004480
      DATA (KTBT(I),I=1,11)/1.,1.075,1.155,1.25,1.35,1.455,1.55,1.66,    004490
     *1.77,1.88,1.995/                                                   004500
175   DATA (KTBCS(I),I=1,11)/0.,.1,.2,.3,.4,.5,.6,.7,.8,.9,1./           004510
      DATA ((RTBP2T(I,J),I=1,12),J=1,3)/1.205,1.221,1.253,1.288,1.343,    004520
     *1.253,1.205,1.181,1.122,1.051,1.031,1.027,1.707,1.731,1.754,1.798,  004530
     *1.857,1.75,1.703,1.675,1.64,1.66,1.707,1.743,2.205,2.225,2.256,     004540
     *2.252,2.355,2.244,2.197,2.173,2.138,2.157,2.201,2.244/              004550
180   DATA (RTBP2M(I),I=1,12)/.6,.7,.8,.9,1.,1.1,1.2,1.3,1.5,2.,2.5,3./  004560
      DATA (RTBP2L(I),I=1,3)/0.,.5,1./                                    004570
      IFLAG = 0                                                           004580
      JFLAG=0                                                             004590
      KFLAG=0                                                             004600
185   LFLAG = 0                                                           004610
      DS=0/(2.**8)                                                        004620
      RAD = .01745329?5                                                   004630
      PI = 3.14159265                                                     004640
      IF(.8 .LE. MACH .AND.1.2 .GE. MACH) GO TO 200                       004650
190   IF(1.75 .LE. MACH .AND.3.0 .GE. MACH) GO TO 220                     004660
      IF(1.2 .LT. MACH .AND.1.75 .GT. MACH) GO TO 250                     004670
      GO TO 26                                                            004680
      GO TO 26                                                            004690
   25 CONTINUE                                                            004700
      IF(PHI.GT. 90.) GO TO 600                                           004710
195   IF(.8 .LE. MACH .AND. 1.2 .GE. MACH) GO TO 30                       004720
      IF(1.75 .LE. MACH .AND.3.0 .GE. MACH) GO TO 40                      004730
      IF(1.2 .LT. MACH .AND.1.75 .GT. MACH) GO TO 50                      004740
   26 WRITE(6,500)                                                        004750
500   FORMAT(*ERROR   MACH OUTSIDE ALLOWABLE LIMITS*)                     004760
200   STOP                                                                004770
   30 IF(ALPHA .GT. 20.) GO TO 60                                         004780
      CALL LOOK2(RTBP,RTBPCT,3,AR,RTBPAR,3,LAMDA,RTBPLD,3,IX,IY,1)        004790
      IF(PHI.LT. 45.) GO TO 70                                            004800
      RT845 = RTBP*SIN(.7853981)                                          004810
205   A = RT845-RTBO                                                      004820
      CALL LOOK1(H ,BET,9,9,ALPHA,BEALET,9,ALE,BEALET,9,MACH,BEMACT,3,    004830
     *IX,IY,IZ,1)                                                         004840
      PHIP = 45.                                                          004850
      PHIPRM = 90.-PHI                                                    004860
210   PPRIM = 90.- PHIP                                                   004870
      A3=(160000.*PHIPRM-16000.*PHIPRM**2+400.*PHIPRM**3)/(400.*(400.*    004880
     *PPRIM-40.*(PPRIM**2)+PPRIM**3))                                     004890
      A4= (40.*(PPRIM**3)*PHIPRM-1200.*PHIPRM*(PPRIM**2)-(PPRIM**3)*(     004900
215   *PHIPRM**2)+1200.*PPRIM*(PHIPRM**2)+(PPRIM**2)*(PHIPRM**3)-40.*     004910
     *PPRIM*(PHIPRM**3))/(400.*(400.*PPRIM-40.*(PPRIM**2)+PPRIM**3))      004920
      RTB = RTBO + A*A3 + B *A4                                           004930
      GO TO 80                                                            004940
   70 RTB = RTBP*SIN(PHI*.0174532)                                        004950
220   IF(JFLAG .EQ. 1) GO TO 90                                           004960
   80 IF(KFLAG .EQ. 1) GO TO 100                                          004970
  110 CONTINUE                                                            004980
      CALL CNTT(ALPHA,LAMDA,MACH,AR,CNT)                                  004990
      CNTP = RTB*CNT                                                      005000
225   RETURN                                                              005010
   90 CALL LOOK2(RTBP,RTBPGT,14,ALPHA,RTBPGA,14,MACH,RTBPGM,3,IX,IY,1)    005020
      CALL LOOK1(PHIP,PHIPT,ALPHA,PHIPAT,6,IX,1)                          005030
      IF(PHI .LT. PHIP) GO TO 140
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                      PHIPRM = 90.-PHI                                                  005040
230                   PPRIM = 90.- PHIP                                                 005050
                      A3=(160000.*PHIPRM-16000.*PHIPRM**2+400.*PHIPRM**3)/(400.*(400.*  005060
                     *PPRIM-40.*(PPRIM**2)+PPRIM**3))                                   005070
                      A4= (40.*(PPRIM**3)*PHIPRM-1200.*PHIPRM*(PPRIM**2)-(PPRIM**3)*(   005080
                     *PHIPRM**2)+1200.*PPRIM*(PHIPRM**2)+(PPRIM**2)*(PHIPRM**3)-40.*   005090
235                  *PPRIM*(PHIPRM**3))/(400.*(400.*PPRIM-40.*(PPRIM**2)+PPRIM**3))   005100
                      RTBPHP = RTBP*SIN(PHIP*.0174532)                                  005110
                      A = RTBPHP-RTBO                                                   005120
                      CALL LOOK3(B ,BET,9,9,ALPHA,BEALFT,9,ALE,BEALET,9,MACH,BEMACT,3,  005130
                     *IX,IY,IZ,1)                                                       005140
240                   RTB = RTBO + A*A3 + B *A4                                         005150
                      GO TO 80                                                          005160
                  140 RTB = RTBP*SIN(PHI*.0174532)                                      005170
                      GO TO 80                                                          005180
                   90 JFLAG = 0                                                         005190
245                   RTB1 = RTB                                                        005200
                      MACH = 1.75                                                       005210
                      KFLAG = 1                                                         005220
                      GO TO 40                                                          005230
                   50 JFLAG = 1                                                         005240
250                   MACHTP = MACH                                                     005250
                      MACH = 1.2                                                        005260
                      GO TO 30                                                          005270
                  100 KFLAG = 0                                                         005280
                      MACH = MACHTP                                                     005290
255                   RTB2 = RTB                                                        005300
                      RTB = RTB1 +((MACH-1.2)/.55)*(RTB2-RTB1)                          005310
                      GO TO 110                                                         005320
                   40 CALL LOOK2(RTBP,RTBPAT,3,AR,RTBPAR,3,LAMDA,RTBPLD,3,IX,IY,1)      005330
                      IF(PHI .LT. 45.) GO TO 120                                        005340
260                   RTB45 = RTBP*SIN(45.*.0174532)                                    005350
                      A = RTB45-RTBO                                                    005360
                      CALL LOOK3(B ,BET,5,8,ALPHA,BBALFT,5,ALE,BBALET,8,MACH,BBMACT,4,I 005370
                     *X,IY,IZ,1)                                                        005380
                      PHIP = 45.                                                        005390
265                   PHIPRM = 90.-PHI                                                  005400
                      PPRIM = 90.- PHIP                                                 005410
                      A3=(160000.*PHIPRM-16000.*PHIPRM**2+400.*PHIPRM**3)/(400.*(400.*  005420
                     *PPRIM-40.*(PPRIM**2)+PPRIM**3))                                   005430
                      A4= (40.*(PPRIM**3)*PHIPRM-1200.*PHIPRM*(PPRIM**2)-(PPRIM**3)*(   005440
270                  *PHIPRM**2)+1200.*PPRIM*(PHIPRM**2)+(PPRIM**2)*(PHIPRM**3)-40.*   005450
                     *PPRIM*(PHIPRM**3))/(400.*(400.*PPRIM-40.*(PPRIM**2)+PPRIM**3))    005460
                      RTB = RTBO + A*A3 + B *A4                                         005470
                      GO TO 80                                                          005480
                  120 RTB = RTBP*SIN(PHI*.0174532)                                      005490
275                   GO TO 80                                                          005500
                  200 IF(ALPHA .GT. 30.) GO TO 210                                      005510
                      ALF = ALPHA + 10.                                                 005520
                      A0=-2.07752E-07*ALF**4 + 1.72193E-05*ALF**3 + 6.24467E-04*ALF**2  005530
                     * -.016458069*ALF +  .087604485                                    005540
280                   A1 = 4.69769E-07*ALF**4 - 4.22259E-05*ALF**3 + 2.32986E-04*ALF**2 005550
                     * +3.6936E-03*ALF + .981598545                                     005560
                      CALL LOOK1(KTP,KTPT,DS,KTBDS,11,IX,1)                             005570
                      RTBO = A0 + A1*KTP                                                005580
                      IF(IFLAG .EQ. 1) GO TO 290                                        005590
285                   IF(LFLAG .EQ. 1) GO TO 300                                        005600
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                      GO TO 25                                                          005610
                  210 ALF = ALPHA + 10.                                                 005620
                      A0 = 4.57998E-12*ALF**6 - 2.30809E-09*ALF**5 + 3.96812E-07*ALF**4 005630
                     * -2.15272E-05*ALF**3 - 8.10606E-04*ALF**2 + .092902183*ALF        005640
                     * -.838353052                                                      005650
      290             A1 = 1.67133E-11*ALF**6 - 9.5912E-09*ALF**5 + 2.09288E-06*ALF**4 005660
                     * -2.19478E-04*ALF**3 + .011664495*ALF**2 - .303221946*ALF        005670
                     * + 3.06745046                                                     005680
                  225 CALL LOOK1(KTH,KTRT,DS,KTRDS,11,IX,1)                             005690
                      A2= -2.16611E-11*ALF**6 + 1.21153E-08*ALF**5 - 2.53877E-06*ALF**4 005700
      295             * +2.46417E-04*ALF**3 - .01114855*ALF**2 + .217380211*ALF         005710
                     * -1.282772555                                                     005720
                      CALL LOOK2(RTBP2,RTBP2T,12,MACH,RTBP2M,12,LAMDA,RTBP2L,3,IX,IY,1) 005730
                      RTBP2 = RTBP2-LAMDA                                               005740
                      RTBO = A0 + A1*KTH + A2*RTBP2                                     005750
      300             IF(LFLAG.EQ. 1) GO TO 300                                         005760
                      IF(IFLAG.EQ.1) GO TO 290                                          005770
                      GO TO 25                                                          005780
                  220 ALF = ALPHA + 10.                                                 005790
                      A0 = 4.57998E-12*ALF**6 - 2.30809E-09*ALF**5 + 3.96812E-07*ALF**4 005800
      305             * -2.15272E-05*ALF**3 - 8.10606E-04*ALF**2 + .092902183*ALF       005810
                     * -.838353052                                                      005820
                      A1 = 1.67133E-11*ALF**6 - 9.5912E-09*ALF**5 + 2.09288E-06*ALF**4 005830
                     * -2.19478E-04*ALF**3 + .011664495*ALF**2 - .303221946*ALF        005840
      310             * + 3.06745046                                                    005850
                      GO TO 225                                                         005860
                  250 IFLAG = 1                                                         005870
                      MACHTP = MACH                                                     005880
                      MACH = 1.2                                                        005890
      315             GO TO 200                                                         005900
                  290 IFLAG = 0                                                         005910
                      RTB01 = RTBO                                                      005920
                      MACH = 1.75                                                       005930
                      LFLAG = 1                                                         005940
      320             GO TO 220                                                         005950
                  300 LFLAG = 0                                                         005960
                      MACH = MACHTP                                                     005970
                      RTB02 = RTBO                                                      005980
                      RTBO = RTB01+((MACH-1.2)/.55)*(RTB02-RTB01)                       005990
      325             GO TO 25                                                          006000
                  600 DCR = D/CR                                                        006010
                      CALL PHCC(ALPHA,MACH,DCR,PHC1)                                    006020
                      PHC = PHC1*RAD                                                    006030
                      PHI =(PHI-90.)*RAD                                                006040
      330             A = (1.-(1./(PHC**2)+(1./PHC-PHC/(PI/2.)**2)/(PI/2.-PHC))*PHI**2 006050
                     * +((1./(PHC**2)-1./(PI/2.)**2)/(PI/2.-PHC))*PHI**3)               006060
                      B = (PHI-(1./PHC+(1.-PHC/(PI/2.))/(PI/2.-PHC))*PHI**2+((1./PHC    006070
                     * -1./(PI/2.))/(PI/2.-PHC))*PHI**3)                                006080
                      PHI = PHI/RAD+90.                                                 006090
      335             IF(MACH.LT.1.2) GO TO 610                                         006100
                      CALL LOOK3(RPRM,RPRMT,19,10,MACH,RPRMM,19,ALPHA,RPRMA,10,LAMDA,   006110
                     *RPRMLM,3,IX,IY,IZ,1)                                              006120
                      IF(AR.EQ.1.) GO TO 620                                            006130
                      CALL LOOK2(RTRT,RTRTT,19,10,MACH,RTRTM,19,ALPHA,RTRTA,10,AR,      006140
      340             *RTRTAR,2,IX,IY,IZ,1)                                             006150
                      RPRM = RPRM*RTRT                                                  006160
                      GO TO 620                                                         006170
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                610 RPRM = 0.                                          006180
                620 RTE = RTIO*A + RPRM*B                              006190
345                 GO TO 110                                          006200
                    END                                                006210
```

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      SUBROUTINE CNTT(ALPHA,LAMDA,MACH,AR,CNT)                          006220
C*****************************************************************    006230
C                                                                      *006240
C     THIS SUBROUTINE CALCULATES TAIL NORMAL FORCE COEFFICIENT  OF     *006250
C     AN ISOLATED TAIL                                                 *006260
C                                                                      *006270
C        ALPHA     = ANGLE OF ATTACK (DEGREES)                       *006280
C        LAMDA     = TAIL TAPER RATIO                                *006290
C        MACH      = MACH NUMBER                                     *006300
C        AR        = ASPECT RATIO                                    *006310
C        CNT       = TAIL NORMAL FORCE COEFFICIENT  (ISOLATED TAIL)  *006320
C                                                                      *006330
C*****************************************************************    006340
      REAL LAMDA,MACH                                                  006350
      DIMENSION FPI2T(25,3,3),FPIMAC(25),FPIAR(3),FPILAM(3),           006360
     *          APRIMT(5,3),APRLAM(5),APRAR(3),                        006370
     1          DCNTAT(11),SCALM(9),CNCMAT(23),                        006380
     *          DCDCT(6,3,7),ADIFT(6),DCDLAM(3),DCDMAC(3),             006390
     *          DCNMT(7,3),CNMLAM(7),CNMAR(3),                         006400
     *          F30T(19,3,3),F30MT(19),F30ART(3),F30LMT(3),            006410
     *          FP30T(19,3,3),FP3MT(19),FP3ART(3),                     006420
     *          CNCT(23),DCNTT(11),SCALET(5)                           006430
      DATA (((DCDCT(I,J,K),I=1,6),J=1,3),K=1,3)/.0,..15,..34,..42,..45,..48,0006440
     *,..3,..61,..59,..5,..49,0,..,6,1,..,72,..62,..49,0,..,21,..39,..46,..64,..63,0.006450
     *,..25,..48,..59,..63,..7,0,..,46,..85,..95,..99,1,..0,..,15,..35,..47,..53,..65,0006460
     *,..,24,..48,..5,..67,..79,0,..,52,..79,..9,..94,1./                006470
      DATA(ADIFT(I),I=1,6)/.0,..2,..5,..7,..8,1./                      006480
      DATA(DCDLAM(I),I=1,3)/.0,..5,1./                                 006490
      DATA(DCDMAC(I),I=1,3)/.8,..9,1./                                 006500
      DATA ((DCNMT(I,J),I=1,7),J=1,3)/0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.006510
     *0,..225,..265,..29,..25,..14,0.0,0.0,0.0,..11,..32,..465,..465,..42/ 006520
      DATA (CNMLAM(I),I=1,7)/0,..,1,..2,..3,..5,..75,1.0/              006530
      DATA (CNMAR(I),I=1,3)/.5,1.0,2.0/                                006540
      DATA ((APRIMT(I,J),I=1,5),J=1,3)/30.,.30.,.30.,.30.,.30.,.30.,.21.,.19.,2006550
     *0,..21,..23,..13,..11,..11,..11./                                006560
      DATA (APRLAM(I),I=1,5)/0,..,25,..5,..75,1.0/                     006570
      DATA (APRAR(I),I=1,3)/.5,1.0,2.0/                                006580
      DATA (DCNTT(I),I=1,11)/0.0,.035,.059,.077,.091,.1,-.026,-.084,-.11006590
     *8,-.14,-.153/                                                    006600
      DATA(DCNTAT(I),I=1,11)/30.,.31.,.32.,.33.,.34.,.35.,.36.,.37.,.38.,.39.,.40.006610
     */                                                                006620
      DATA(SCALET(I),I=1,9)/1.,.98,.932,.868,.788,.7,.584,.452,.296/   006630
      DATA(SCALM(I),I=1,9)/.8,.825,.85,.875,.9,.925,.95,.975,1./       006640
      DATA (((FPI2T(I,J,K),I=1,25),J=1,3),K=1,2)/2.348,2.348,2.348,2.348006650
     *,2.323,2.273,2.197,2.172,2.121,2.071,2.045,2.02,1.995,1.995,1.944,006660
     *1.919,1.869,1.818,1.793,1.768,1.717,1.667,1.641,1.616,1.591,2.727,006670
     *2.727,2.727,2.677,2.626,2.551,2.5,2.5,2.525,2.5,2.399,2.273,2.121,006680
     *2.045,1.97,1.894,1.843,1.818,1.742,1.742,1.692,1.667,1.641,1.591,1006690
     *,.591,3.46,3.46,3.434,3.384,3.283,3.131,2.854,2.955,3.005,3.005,2.8006700
     *79,2.576,2.298,2.071,1.97,1.894,1.869,1.818,1.742,1.717,1.692,1.64006710
     *1,1.616,1.591,1.566,2.98,2.98,3.056,3.207,3.182,3.005,2.929,2.879,006720
     *2.828,2.803,2.727,2.626,2.5,2.348,2.222,2.121,2.045,1.97,1.894,1.8006730
     *18,1.793,1.768,1.768,1.717,1.742,3.46,3.434,3.46,3.864,4.015,3.914006740
     *,3.712,3.409,3.182,3.005,2.879,2.702,2.525,2.374,2,247,2.146,2.02,006750
     *1.894,1.818,1.768,1.742,1.717,1.692,1.667,1.667,2.955,2.955,2.98,3006760
     *,.106,5.051,4.116,3.611,3.283,3.03,2.854,2.727,2.576,2.475,2.348,2.006770
     *247,2.146,2.071,1.995,1.944,1.869,1.843,1.818,1.793,1.793,1.793/  006780
```

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      DATA ((FPI2T(I,J,3),I=1,25),J=1,3)/3.005,2.98,2.98,2.98,3.207,3.05006790
     *6,2.955,2.854,2.753,2.652,2.525,2.424,2.323,2.222,2.121,2.071,1.99006800
     *5,1.919,1.843,1.818,1.793,1.742,1.717,1.692,1.667,2.727,2.753,2.80006810
     *3,2.98,3.561,3.535,3.308,3.056,2.904,2.753,2.601,2.5,2.374,2.298,2006820
     *,222,2.121,2.071,1.995,1.944,1.919,1.694,1.869,1.818,1.818,1.818,1006830
     *,894,1.87,2.323,3.081,3.662,3.333,3.03,2.753,2.601,2.424,2.323,2.2006840
     *47,2.172,2.096,2.045,2.02,1.944,1.919,1.869,1.843,1.818,1.793,1.76006850
     *8,1.742,1.742/                                                    006860
      DATA (FPIMAC(I),I=1,25)/.6,.7,.8,.9,1.,1.1,1.2,1.3,1.4,1.5,1.6,1.7006870
     *,1.8,1.9,2.0,2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,3.0/            006880
      DATA (FPIARC(I),I=1,3)/.5,1.0,2.0/                               006890
      DATA (FPILAM(I),I=1,3)/0.0,.5,1.0/                               006900
      DATA (((FP30T(I,J,K),I=1,19),J=1,3),K=1,3)/0.,.0,.0,.579,.981,1.20006910
     *8,1.409,1.535,1.610,1.736,1.761,1.811,1.686,1.61,1.56,1.535,1.56,1006920
     *,56,1.585,0.,.0,.0,.579,.981,1.208,1.409,1.535,1.610,1.736,1.761,1006930
     *,811,1.686,1.610,1.56,1.535,1.56,1.56,1.585,.0,.0,.0,.403,.755,1.0006940
     *57,1.308,1.535,1.736,1.862,1.91,1.836,1.711,1.61,1.585,1.535,1.56006950
     *,1.585,1.61,1.233,.604,.101,.553,.931,1.258,1.409,1.585,1.736,1.86006960
     *2,1.937,2.013,2.063,2.088,2.063,2.013,1.962,1.887,1.811,1.233,.604006970
     *,.075,.704,1.157,1.434,1.585,1.711,1.836,1.937,1.987,2.038,2.038,2006980
     *,.063,2.038,1.987,1.962,1.887,1.786,1.233,.629,.075,.403,.805,1.283006990
     *,1.736,2.189,2.138,2.088,2.013,1.937,1.862,1.786,1.761,1.761,1.761007000
     *,1.761,1.786,2.541,1.233,0.,1.434,2.013,2.314,2.39,2.365,2.289,2.1007010
     *89,2.113,1.962,1.862,1.811,1.736,1.736,1.711,1.711,1.736,.654,.352007020
     *,.0,1.409,1.962,1.711,1.61,1.585,1.585,1.66,1.761,1.987,1.862,1.81007030
     *1,1.736,1.711,1.686,1.711,1.736,1.082,.579,0.0,1.384,2.013,2.365,2007040
     *,.465,2.465,2.365,2.239,2.138,2.013,1.887,1.811,1.761,1.736,1.711,1007050
     *,.736,1.736/                                                     007060
      DATA (FP3MT(I),I=1,19)/.8,.9,1.,1.05,1.1,1.15,1.2,1.25,1.3,1.35,1.007070
     *4,1.5,1.6,1.7,1.8,1.9,2.,2.1,2.2/                                007080
      DATA(FP3ART(I),I=1,3)/.5,1.,2./                                  007090
      DATA(((F30T(I,J,K),I=1,19),J=1,3),K=1,3)/.969,.971,.971,.971,.969,007100
     *,964,.961,.954,.948,.933,.918,.898,.873,.855,.837,.817,.805,.789,.007110
     *777,1.234,1.234,1.239,1.252,1.269,1.214,1.186,1.666,1.145,1.115,1.007120
     *1,1.067,1.019,.971,.928,.901,.88,.87,.868,1.198,1.193,1.198,1.231,007130
     *1.274,1.353,1.443,1.401,1.373,1.342,1.317,1.282,1.236,1.198,1.153,007140
     *1.118,1.09,1.072,1.06,1.098,1.123,1.123,1.116,1.095,1.073,1.047,1.007150
     *025,1.002,.972,.959,.952,.921,.896,.871,.851,.83,.818,.81,.936,.95007160
     *9,1.015,1.108,1.242,1.267,1.265,1.249,1.224,1.174,1.128,1.093,1.05007170
     *8,1.027,1.002,.977,.959,.941,.929,.994,.936,.954,1.065,1.202,1.356007180
     *,1.527,1.52,1.52,1.53,1.406,1.313,1.239,1.176,1.118,1.07,1.047,1.0007190
     *37,1.035,1.146,1.126,1.108,1.093,1.08,1.07,1.065,1.058,1.058,1.06,007200
     *1.027,.984,.949,.916,.891,.866,.848,.835,.823,.835,.858,.898,1.053007210
     *,1.184,1.227,1.224,1.207,1.191,1.171,1.159,1.123,1.063,1.015,.974,007220
     *,.946,.926,.911,.904,.86P,.891,.931,1.055,1.199,1.353,1.520,1.558,1007230
     *,.54,1.424,1.24,1.27,1.214,1.169,1.133,1.106,1.083,1.065,1.05/   007240
      DATA (F30MT(I),I=1,19)/.8,.85,.9,.95,1.,1.05,1.1,1.15,1.2,1.3,1.4,007250
     *1.5,1.6,1.7,1.8,1.9,2.0,2.1,2.2/                                 007260
      DATA (F30ART(I),I=1,3)/.5,1.,2./                                 007270
      DATA (F30LMT(I),I=1,3)/.0,.5,1./                                 007280
      DATA(CNCT(I),I=1,23)/1.1,1.102,1.196,1.423,1.476,1.509,1.535,1.555007290
     *,1.572,1.588,1.6,1.61,1.623,1.631,1.643,1.651,1.661,1.669,1.676,1.007300
     *684,1.691,1.696,1.701/                                           007310
      DATA(CNCMAT(I),I=1,23)/.8,.9,1.,1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.007320
     *9,2.0,2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,3.0/                   007330
      RAD = .01745329                                                  007340
      J = 0                                                            007350
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                                                                                                                    007360
                      M = 1                                                                                         007370
  110                 ASW = ATAN((2.*(1.-LAMDA))/(AR*(1.+LAMDA)))*57.295779                                         007380
                      CALL PRINT(MACH,AR,LAMDA,ASW,FPRIMO,XCPCB)                                                    007390
                      IF(ALPHA .GT. 70.) GO TO 200                                                                  007400
                    5 IF(ALPHA .GE. 30.) GO TO 10                                                                   007410
  120                 7? CALL LOOK1(FPI2,FPI2T,25,3,MACH,FPIMAC,25,AR,FPIAR,3,LAMDA,FPILAM                         007420
                     *,3,IX,IY,IZ,1)                                                                                007430
                      IF(MACH .GT. 1.) GO TO 20                                                                     007440
                   55 CONTINUE                                                                                      007450
                      CALL LOOK2(FPRIM,FPRIMT,9,LAMDA,FPRLAM,5,AR,APRAR,3,IX,IY,1)                                 007460
  130                 IF(ALPHA .LT. APRIM .OR. APRIM .EQ. 30.) GO TO 20                                             007470
                      ADIF = (ALPHA-APRIM)/(30.-APRIM)                                                              007480
                      CALL LOOK3(DCDLC,DCDCT,6,3,ADIF,ADIFT,6,LAMDA,DCDLAM,3,MACH,DCDMAC                            007490
                     *,3,IX,IY,IZ,1)                                                                                007500
                      CALL LOOK2(CDNM,CDNMT,7,LAMDA,CNMLAM,7,AR,CNMAR,3,IX,IY,1)                                    007510
  150                 DCN = DCDC*CDNM                                                                               007520
                      GO TO 50                                                                                      007530
                   20 DCN= 0.                                                                                       007540
                   50 CONTINUE                                                                                      007550
                      CNT= FPRIMO*ALPHA*RAD*(16.*FPI2/3.14156**2 - 5.*FPRIMO/3.14156)*                              007560
  160                 * (ALPHA*RAD)**2 + (12.*FPRIMO/3.14156**2 - 32.*FPI2/3.14156**3)*                             007570
                      * (ALPHA*RAD)**3 + (16.*FPI2/3.14156**4 - 4.*FPRIMO/3.14156**3)*                              007580
                      * (ALPHA*RAD)**4                                                                              007590
                      CNT = CNT + DCN                                                                               007600
                   60 IF(J.EQ.1) GO TO 60                                                                           007610
  170                 IF(J.EQ.1) GO TO 210                                                                          007620
                      RETURN                                                                                        007630
                   10 IF(MACH .GE. 2.5) GO TO 70                                                                    007640
                  110 IF(ALPHA .EQ. 0. .AND. AR .EQ. 1. .AND. MACH .LE. 1.) GO TO 80                                007650
                  111 CALL LOOK3(FP30,F30T,19,3,MACH,F30MT,19,AR,F30ART,3,LAMDA,F30LMT,                             007660
  180                 *3,IX,IY,IZ,1)                                                                                007670
                      CALL LOOK1(FP80,FP80T,19,5,MACH,FP8MT,19,AR,FP8ART,3,LAMDA,F80LMT,                            007680
                     *,IX,IY,IZ,1)                                                                                  007690
                      CALL LOOK1(CNC,CNCT,MACH,CNCMAT,23,IX,1)                                                      007700
                      CNT = -1.3711*FP30 + CNC  + (3.7501*FP30-4.29731*(CNC-F30))*                                  007710
  190                 *(ALPHA*RAD)*(-3.74215*FP80+5.47487*(CNC-F80))*(ALPHA*RAD)**2                                 007720
                     **(.4313921*FP30-1.741426*(CNC-F30))*(ALPHA*RAD)**3                                            007730
                      GO TO 90                                                                                      007740
                   80 IF(90. .LT. ALPHA .AND.40. .GE. ALPHA) GO TO 100                                              007750
                      GO TO 111                                                                                     007760
  200               100 K=1                                                                                         007770
                      ATEMP = ALPHA                                                                                 007780
                      ALPHA = 70.                                                                                   007790
                      GO TO 30                                                                                      007800
                   40 K=0                                                                                           007810
  210                 ALPHA = ATEMP                                                                                 007820
                      CALL LOOK1(CONT,CONTT,9,ALPHA,DCNTAT,11,IX,1)                                                 007830
                      CALL LOOK1(SCALE,SCALET,MACH,SCALM,9,IX,1)                                                    007840
                      DCNT = DCNT*SCALE                                                                             007850
                      CNT = CNT + DCNT                                                                              007860
                      GO TO 60                                                                                      007870
  220               200 ATEMP2= ALPHA                                                                               007880
                      J=1                                                                                           007890
                      ALPHA = 180.-ALPHA                                                                            007900
                      GO TO 5                                                                                       007910
  230               210 ALPHA = ATEMP2                                                                              007920
                      J=0
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```
      GO TO 90                                                    007930
      END                                                         007940
```

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      SUBROUTINE BRIT (XM,AR,TR,SWEEP,CLA,XCPCB)                        007950
C     TAKEN FROM THE BRITISH DATA SHEETS  S.01.03.06                    007960
C                                         S.01.03.05                    007970
C                                         S.01.03.04                    007980
C                                         S.01.03.03                    007990
C                                         S.08.01.02                    008000
C     XM    = FREE STREAM MACH NO.                                      008010
C     AR    = ASPECT RATIO (TWO WINGS JOINED WITHOUT BODY)              008020
C     TR    = TAPER RATIO                                               008030
C     SWEEP = WING MID-CHORD SWEEPBACK ANGLE (DEG)                      008040
C     CLA   = LIFT COEFF. SLOPE, BASED ON EXPOSED WING AREA  1/RAD.     008050
C     XCPCB = CENTER OF PRESSURE (PERCENT MEAN GEOMETERIC CHORD),       008060
C             MEASURED FROM LEADING EDGE MEAN GEOMETERIC CHORD.         008070
      DIMENSION XT1(15),YT1(7),ZT1(4),XT2(8),YT2(5),ZT2(4),YT4(7)       008080
      DIMENSION BAR1(15,7,4), BAR2(8,5,4),BAR3(15,7,4),BAR4(8,7,4)      008090
      DATA XT1/0.,.5,1.,1.5,2.,2.5,3.,3.5,4.,4.5,5.,5.5,6.,6.5,7./      008100
      DATA YT1/0.,1.,2.,3.,4.,5.,6./                                    008110
      DATA ZT1/0.,.25,.5,1./                                            008120
      DATA XT2/0.,1.,2.,3.,4.,5.,6.,7./                                 008130
      DATA YT2/0.,1.,2.,3.,4./                                          008140
      DATA YT4/0.,1.,2.,3.,4.,5.,6./                                    008150
      DATA ZT2/0.,.25,.5,1./                                            008160
      DATA(BAR1(I), I=1,210 )                                           008170
     A                  /1.56,1.52,1.41,1.30,1.20,1.11,1.03,.95,.89,.83,  008180
     1.78,.74,.70,.66,.63,1.56,1.52,1.40,1.27,1.17,1.08,1.00,.93,.87,   008190
     2.82,.77,.73,.69,.65,.62,1.56,1.47,1.30,1.17,1.08,1.01,.95,.89,.84,008200
     3.79,.75,.71,.67,.64,.61,1.26,1.21,1.13,1.05,.99,.93,.88,.83,.79,  008210
     4.75,.71,.68,.65,.62,.59,1.05,1.01,.98,.94,.89,.85,.81,.77,.73,.7, 008220
     5.67,.64,.61,.59,.57,.90,.88,.86,.83,.80,.77,.74,.71,.68,.66,.63,  008230
     6.61,.59,.57,.55,.79,.78,.77,.75,.73,.70,.68,.65,.63,.61,.59,.57,  008240
     7.55,.53,.52,1.57,1.53,1.45,1.34,1.25,1.16,1.07,1.,.93,.875,.82,.78008250
     8,.735,.695,.66,1.57,1.53,1.42,1.31,1.20,1.11,1.03,.97,.91,.86,.81,008260
     9.765,.72,.685,.65,1.57,1.45,1.31,1.205,1.12,1.05,.98,.925,.87,.82,008270
     1.78,.74,.70,.665,.63,1.26,1.19,1.12,1.06,1.00,.95,.90,.85,.81,.77,008280
     2.74,.70,.67,.64,.61,1.05,1.00,.96,.92,.885,.86,.83,.79,.76,.725,  008290
     3.69,.665,.64,.61,.59,.90,.855,.82,.80,.78,.76,.74,.72,.70,.67,.64,008300
     4.62,.60,.57,.55,.79,.75,.73,.71,.70,.68,.67,.65,.64,.62,.60,.58,  008310
     5.56,.55,.53/                                                      008320
      DATA(BAR1(I),I=211,420    )                                       008330
     A                  /1.58,1.53,1.45,1.35,1.25,1.16,1.07,1.00,.93,.88,  008340
     1.82,.78,.73,.69,.66,1.58,1.52,1.42,1.31,1.21,1.12,1.04,.98,.915,  008350
     2.86,.805,.76,.72,.68,.64,1.58,1.44,1.32,1.20,1.12,1.05,.98,.92,   008360
     3.87,.82,.78,.74,.70,.76,.63,1.26,1.20,1.13,1.06,1.01,.96,.90,.85, 008370
     4.81,.77,.74,.70,.66,.63,.60,1.05,1.01,                            008380
     5                  ,.97,.93,.89,.85,.82,.78,.75,.72,.68,.66,.63,008390
     6.60,.58,.90,.87,.84,.81,.79,.76,.73,.71,.68,.66,.64,.62,.59,.57,  008400
     7.55,.79,.76,.74,.71,.69,.87,.65,.64,.62,.60,.59,.57,.55,.54,.52,  008410
     81.57,1.52,1.45,1.34,1.22,1.12,1.04,.97,.90,.84,.77,.74,.70,.67,   008420
     9.64,1.57,1.51,1.42,1.30,1.18,1.08,1.00,.94,.88,.82,.78,.73,.69,   008430
     1.65,.63,1.57,1.48,1.36,1.22,1.10,1.02,.95,.88,.82,.78,.73,.69,.66,008440
     2.63,.61,1.27,1.17,1.10,1.12,.96,.91,.86,.81,.77,.73,.69,.65,.63,  008450
     3.60,.58,1.06,.99,.94,.89,.84,.81,.78,.74,.71,.68,.65,.62,.60,.58, 008460
     4.56,.91,.85,.80,.77,.74,.72,.70,.68,.65,.62,.60,.58,.56,.55,.54,  008470
     5.79,.74,.70,.67,.65,.63,.61,.59,.58,.56,.54,.53,.52,.50/          008480
      DATA(BAR2(I),I=1,160    )                                         008490
     A                  /.26,.270,.273,.275,.274,.273,.270,.268,.380,     008500
     1.397,.327,.314,.303,.295,.290,.285,.500,.470,.378,.352,.335,.325,  008510
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     2.318,.313,.305,.445,.405,.380,.365,.353,.345,.340,.505,.460,.440, 008520
     3.410,.395,.383,.375,.370,.195,.195,.220,.240,.247,.250,.250,.250, 008530
     4.262,.265,.267,.267,.267,.267,.267,.267,.380,.332,.305,.290,.283, 008540
     5.282,.282,.282,.395,.355,.330,.315,.405,.298,.295,.293,.405,.385, 008550
     6.365,.345,.325,.315,.307,.303,.070,.185,.225,.237,.243,.245,.247, 008560
     7.248,.177,.217,.235,.243,.245,.245,.245,.244,.285,.247,.243,.247, 008570
     8.250,.250,.248,.247,.305,.267,.257,.255,.255,.255,.255,.255,.317, 008580
     9.287,.275,.270,.270,.270,.270,.270,.0,.175,.225,.237,.243,.245,   008590
     1.245,.245,.085,.120,.165,.205,.220,.225,.227,.230,.165,.167,.170, 008600
     1.192,.197,.205,.210,.213,.193,.190,.189,.190,.193,.197,           008610
     2          .200,.203,.200,.197,.189,.190,.193,.195,.196,.198/      008620
      DATA(BAR1(I), I=1,210   )                                         008630
     A                  /1.58,1.70,1.76,1.75,1.70,1.43,1.22,1.06,.94,.85, 008640
     1.77,.71,.65,.60,.56,1.56,1.735,1.76,1.62,1.48,1.35,1.24,1.09,.96, 008650
     2.85,.78,.715,.66,.61,.565,1.56,1.535,1.47,1.395,1.31,1.22,1.14,   008660
     3.07,1.005,.96,.905,.73,.67,.62,.58,1.26,1.30,1.275,1.235,1.17,    008670
     4.11,1.05,1.00,.945,.90,.86,.775,.70,.645,.60,1.046,1.07,1.085,    008680
     5.065,1.06,1.023,.986,.95,.90,.88,.822,.79,.76,.682,.635,.985,     008690
     6.915,.93,.94,.94,.93,.91,.888,.855,.822,.788,.76,.73,.707,.682,   008700
     7.79,.795,.80,.80,.80,.802,.805,.81,.81,.78,.755,.73,.71,.68,.661, 008710
     8.57,1.56,1.85,1.82,1.64,1.41,1.21,1.06,.94,.845,.77,.71,.65,.60,  008720
     9.558,1.57,1.56,1.63,1.72,1.585,1.41,1.215,1.065,.955,.86,.78,.716,008730
     1.66,.61,.562,1.57,1.13,1.46,1.46,1.40,1.305,1.22,1.11,.985,.89,   008740
     2.804,.73,.67,.62,.572,1.26,1.18,1.10,1.03,1.275,1.20,1.125,1.065, 008750
     31.01,.94,.85,.772,.71,.65,.60,1.05,1.05,1.05,1.05,1.05,1.05,1.04,008760
     41.01,.962,.92,.87,.815,.74,.68,.63,.90,.908,.915,.923,.93,.942,   008770
     5.95,.935,.91,.879,.84,.815,.78,.73,.67,.79,.786,.78,.78,.779,.78, 008780
     6.785,.80,.82,.83,.82,.785,.755,.73,.704/                          008790
      DATA(BAR2(I), I=211,420   )                                       008800
     A                  /1.58,1.88,1.92,1.80,1.59,1.36,1.17,1.03,.92,.84, 008810
     1.75,.69,.635,.59,.55,1.58,1.80,1.90,1.76,1.55,1.355,1.18,1.045,   008820
     2.935,.847,.77,.705,.645,1.80,1.56,1.58,1.46,1.35,1.445,1.43,1.32, 008830
     31.20,1.08,.97,.87,.79,.72,.66,1.51,1.57,1.26,1.25,1.235,1.22,1.26, 008840
     41.21,1.145,1.08,.955,.91,.83,.756,.693,.64,.59,1.05,1.05,1.055,   008850
     51.055,1.055,1.07,1.05,1.015,.97,.925,.88,.80,.74,.68,.63,.90,.90, 008860
     6.902,.907,.905,.907,.91,.91,.90,.88,.85,.83,.77,.71,.67,.79,.792, 008870
     7.80,.80,.804,.81,.813,.816,.82,.822,.817,.798,.774,.74,.69,1.57,  008880
     81.74,2.0,1.8,1.52,1.29,1.12,.985,.88,.795,.72,.665,.62,.575,.535, 008890
     91.57,1.60,2.0,1.72,1.48,1.29,1.13,1.0,.90,.81,.74,.68,.63,.583,   008900
     1.545,1.57,1.55,1.52,1.48,1.44,1.29,1.16,1.03,.93,.835,.76,.70,    008910
     2.645,.60,.56,1.27,1.30,1.30,1.28,1.24,1.19,1.145,1.05,.96,.87,.80,008920
     3.735,.68,.625,.58,1.06,1.055,1.05,1.04,1.02,.995,.98,.97,.97,.90, 008930
     4.83,.765,.70,.655,.61,.905,.90,.885,.875,.865,.86,.858,.855,.853, 008940
     5.85,.84,.795,.735,.69,.65,.795,.783,.78,.77,.762,.76,.757,.75,.75,008950
     6.758,.76,.77,.74,.72,.71/                                         008960
      DATA(BAR4(I), I=1,224   )                                         008970
     A                  /.250,.350,.450,.465,.475,.483,.486,.490,.380,  008980
     1.472,.472,.472,.480,.487,.490,.495,.5,.5,.5,.5,.5,.5,.501,.501,    008990
     2.505,.54,.54,.54,.54,.54,.525,520,.505,.542,.580,.580,.580,.580,   009000
     3.580,.558,.560,.548,.585,.625,.625,.625,.625,.625,.565,.555,.595,  009010
     4.633,.673,.673,.673,.673,.145,.295,.450,.475,.485,.490,.495,.495,  009020
     5.267,.350,.437,.473,.483,.487,.492,.493,.380,.445,.445,.445,.488,  009030
     6.502,.502,.502,.395,.440,.481,.481,.481,.532,.530,.523,.405,.433,  009040
     7.470,.525,.525,.525,.570,.560,.413,.407,.503,.550,.520,.520,.520,  009050
     8.615,.425,.450,.477,.510,.560,.625,.625,.625,.070,.210,.450,.477,  009060
     9.485,.490,.493,.493,.177,.270,.365,.457,.475,.482,.485,.485,.285,  009070
     1.360,.385,.415,.480,.485,.485,.485,.305,.355,.400,.435,.465,.511,  009080
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      2.510,.505,.517,.523,.526,.460,.487,.501,.593,.537,.330,.320,.310, 009090
      3.425,.505,.521,.550,.585,.337,.315,.300,.423,.500,.560,.580,.605, 009100
      40.00,.330,.445,.465,.475,.483,.485,.485,.085,.310,.400,.440,.455, 009110
      5.465,.470,.470,.165,.290,.380,.425,.448,.458,.467,.475,.193,.300, 009120
      6.390,.433,.457,.470,.477,.477,.200,.330,.423,.465,.485,.493,.496, 009130
      7.495,.200,.330,.423,.465,.485,.493,.496,.495,.200,.330,.423,.465, 009140
      8.485,.493,.496,.495/                                              009150
        X=AR*SQRT(ABS(1.-XM**2))                                         009160
       Y=AR*TAN(SWEEP/57.29578)                                          009170
       Z=TR                                                              009180
       IF(X.GT.7.) WRITE (6,900) X                                       009190
       IF(Z.GT.1.) WRITE (6,902) Z                                       009200
       IF(XM.GT.1.0) GO TO 1                                             009210
       CALL LOOK3(CLAR,BAR1,15,7,X,XT1,15,Y,YT1,7,Z,ZT1,4,IX,IY,IZ,1)    009220
       IF(Y.GT.4.) WRITE (6,901) Y                                       009230
       CALL LOOK3(XCPCB,BAR2,8,5,X,XT2,8,Y,YT2,5,Z,ZT2,4,IX,IY,IZ,1)     009240
       CLA=CLAR*AR                                                       009250
       RETURN                                                            009260
     1 CALL LOOK3(CLAR,BAR3,15,7,X,XT1,15,Y,YT1,7,Z,ZT1,4,IX,IY,IZ,1)    009270
       IF(Y.GT.6.) WRITE (6,901) Y                                       009280
       CALL LOOK3(XCPCB,BAR4,8,5,X,XT2,8,Y,YT2,5,Z,ZT2,4,IX,IY,IZ,1)     009290
       CLA=CLAR*AR                                                       009300
       RETURN                                                            009310
   900 FORMAT (1X,,EXTRAPOLATION REQUIRED, ,10HAR*BETA = F10.4)          009320
   901 FORMAT (1X,,EXTRAPOLATION REQUIRED, ,11HAR*TANSW = F10.4)         009330
   902 FORMAT (1X,,EXTRAPOLATION REQUIRED, TAPER RATIO = ,F10.4)         009340
       END                                                               009350
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      SUBROUTINE CNBODY(LNC,MACH,ALPHA,D,CNB,PN)                        119361
C*****************************************************************    119371
C                                                                       *119381
C     THIS SUBROUTINE CALCULATES BODY ALONE NORMAL FORCE COEFF.         *119391
C                                                                       *119401
C        LAC =    AFTER BODY LENGTH IN CAL.                           *119411
C        LNC =    NOSE LENGTH IN CAL.                                 *119421
C        MACH =   MACH NUMBER                                         *119431
C        ALPHA =  ANGLE OF ATTACH                                     *119441
C        CNB =    BODY ALONE NORMAL FORCE COEFF. ( RETURNED VALUE)    *119451
C                                                                       *119461
C*****************************************************************    119471
      REAL LAC,LNC,MUC,MU,MACH,MACHT,LC,MAC                             119481
      DIMENSION CNBAT(9,4,3),CNBAM(9),CNBALA(4),CNBALN(3),              119491
     *          CNATT(3,4,4),CNAM(13),CNALA(4),CNALC(4),               119501
     *          TMUC(21),TMUL(21),                                     119511
     *          CDCT(23),CDCM(23),                                     119521
     *          CDCT2(12),CDCM2(12),TMU(14),TMUM(14)                   119531
      DATA (CNALC(I),I=1,4)/2.5,3.,3.5,4./                              119541
      DATA (CNALA(I),I=1,4)/4.,6.,8.,10./                               119551
      DATA (CNAM(I),I=1,13)/1.5,1.75,2.0,2.1,2.2,2.3,2.4,2.5,2.6,2.7,  119561
     *2.8,2.9,3./                                                       119571
      DATA (CNBALN(I),I=1,3)/1.5,2.5,3.5/                               119581
      DATA (CNBALA(I),I=1,4)/5.,10.,15.,18./                            119591
      DATA (CNBAM(I),I=1,9)/.8,.85,.9,.95,1.,1.05,1.1,1.15,1.2/         119601
      DATA (TMUC(I),I=1,21)/2.,4.,6.,8.,10.,12.,14.,16.,18.,21.,22.,    119611
     *24.,26.,28.,31.,32.,34.,36.,38.,40./                              119621
      DATA (TMUM(I),I=1,21)/.567,.612,.642,.662,.682,.706,.721,.736,    119631
     *.746,.756,.761,.771,.775,.785,.791,.796,.806,.811,.816,.821/      119641
      DATA(CDCM(I),I=1,23)/.1,.198,.305,.55,.6,.674,.698,.835,.875,.9,  119651
     * .94,.964,1.102,1.2,1.397,1.598,1.8,1.997,2.198,2.4,2.597,2.8,3./ 119661
      DATA(CDCT(I),I=1,23)/1.206,1.211,1.234,1.279,1.378,1.498,1.512,   119671
     * 1.418,1.433,1.46,1.874,2.87,1.796,1.692,1.557,1.478,1.428,1.393,  119681
     1 1.768,1.357,1.338,1.333,1.133/                                   119691
      DATA (((CNBAT(I,J,K),I=1,9),J=1,4),K=1,3)/4.735,4.735,4.759,      119701
     *4.819,4.916,5.112,5.148,5.112,4.904,6.478,6.587,6.566,6.663,      119711
     *6.759,6.843,6.928,6.952,6.892,8.887,8.855,8.976,9.096,9.215,      119721
     *9.289,9.331,9.253,9.169,10.277,10.337,10.418,10.518,10.682,       119731
     *10.699,11.735,11.699,11.591,4.739,4.783,4.843,4.888,4.892,4.916,  119741
     *4.928,4.914,4.892,6.482,6.516,6.578,6.699,6.831,6.916,6.916,      119751
     *6.819,6.735,8.735,8.783,8.881,9.,9.145,9.229,9.241,9.145,9.836,   119761
     *10.133,10.181,10.277,10.298,10.518,10.651,10.831,10.90,10.94,     119771
     *4.639,4.627,4.699,4.795,4.817,4.771,4.852,4.892,4.771,6.682,      119781
     *6.542,6.542,6.662,6.817,6.711,6.627,6.55,6.578,8.651,8.675,8.771, 119791
     *8.928,9.148,9.121,9.196,9.136,9.036,9.988,11.,11.124,11.12,10.373,119801
     *11.554,11.663,11.711,11.614/                                      119811
      DATA (((CNATT(I,J,K),I=1,13),J=1,4),K=1,4)/2.559,2.686,2.648,2.693,119821
     *2.75,2.813,2.878,2.954,2.811,3.152,3.196,3.133,3.176,2.685,2.718, 119831
     *2.726,2.761,2.819,2.862,2.927,3.017,3.062,3.106,3.147,3.184,3.214,119841
     *2.821,2.831,2.813,2.827,2.872,2.917,2.981,3.062,3.113,3.159,3.198,119851
     *3.227,3.249,2.952,2.944,2.893,2.899,2.935,2.972,3.031,3.113,3.166,119861
     *3.206,3.245,3.269,3.282,2.516,2.557,2.683,2.644,2.697,2.764,2.827,119871
     *2.895,2.941,2.981,3.013,3.149,3.178,2.642,2.673,2.683,2.715,2.756,119881
     *2.819,2.881,2.908,2.995,3.133,3.168,3.192,3.115,2.772,2.787,2.768,119891
     *2.781,2.819,2.872,2.935,3.185,3.149,3.086,3.117,3.135,3.155,2.911,119901
     *2.899,2.846,2.842,2.878,2.923,2.984,3.056,3.186,3.141,3.164,3.181,119911
     *3.188,2.451,2.518,2.551,2.585,2.626,2.673,2.734,2.797,2.858,2.911,119921
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                10,948,2,990,1,030,2,091,2,426,2,630,2,685,2,685,2,734,2,789,2,852,  009930
                22,905,2,959,2,987,3,037,3,076,2,711,2,730,2,711,2,718,2,746,2,791,009940
60              32,842,2,907,2,960,3,007,3,045,3,060,3,113,2,842,2,836,2,791,2,781,009950
                42,801,2,846,2,885,2,928,2,975,3,015,3,058,3,100,3,127,3,149,2,384,2,424,009960
                52,871,2,900,2,939,2,993,2,944,2,781,2,754,2,803,2,856,2,905,2,958,009970
                62,914,2,956,2,991,2,973,2,601,2,650,2,695,2,756,2,805,2,852,2,901,009980
                72,944,2,994,2,940,2,450,2,634,2,644,2,695,2,701,2,748,2,803,2,850,009990
70              82,895,2,944,2,984,3,031,2,774,2,782,2,718,2,717,2,758,2,760,2,805,010000
                92,844,2,911,2,952,2,994,3,051,3,066/                                010010
                 DATA(CDCT2(I),I=1,10)/1,214,1,056,,647,,737,,270,,275,,275,,32,     010020
                1 ,858,,972,1,02,1,377/                                              010030
                 DATA(CDC90(I),I=1,10)/,1,,164,,247,,264,,26,,316,,361,,395,,412,    010040
80              1 ,457,,496,,5/                                                      010050
                 DATA(TMU(I),I=1,14)/,682,,688,,705,,73,,765,,821,,89,,965,,98,      010060
                1 ,992,,9,,965,,995,1,/                                              010070
                 DATA(TMUM(I),I=1,14)/0,,,2,,3,,4,,5,,6,,7,,8,,9,1,,1,1,1,2,1,3,    010080
                1 1,4/                                                               010090
90               RAD=,0174532925199                                                  010100
                 PI=3,1415926535898                                                  010110
                 IFLAG=0                                                             010120
                 JFLAG=0                                                             010130
                 KFLAG=0                                                             010140
100              LD=ELAD*LAD                                                         010150
                 AMU=,6*2                                                            010160
                 RNC=RN*SIN(ALPHA*RAD)                                               010170
                 MAC=MACH*SIN(ALPHA*RAD)                                             010180
                 IF(MACH,GT,1,2) GO TO 20                                            010190
110              IF(ALPHA,LT, 40,) GO TO 50                                          010200
              10 CALL LOOK3(CNBA,CNBAT,9,,,MACH,CNBAM,9,LAD,CNBALA,4,LND,CNBALN,3,   010210
                *IX,IY,IZ,1)                                                         010220
                 CNA=CNBA-,6*LAD                                                     010230
              100 IF(IFLAG,EQ,1)GO TO 20                                             010240
120              IF(JFLAG,EQ,1) GO TO 40                                             010250
                 GO TO 55                                                            010260
               50 KFLAG=1                                                            010270
               55 RD=(FLAT )**2+,25)                                                 010280
                  SAP = 0,,2*(-2,*LNE*(RD-,5)+LND*SQRT(RD,,2-LND,,2))+RD,,2+ASIN(LND 010290
130              */RD,))                                                             010300
                 SP = 0,,2*LAD + SAP                                                 010310
                 SREF=PI*(D/2,)**2                                                   010320
                 IF(RNC,GT,,5000000,,AND,RNC,LT,,5001000,,AND,MAC,GT,,1,AND,MAC,LT,,5)010330
                1 GO TO 200                                                          010340
140              CALL LOOK1(CDC,CDCT,MAC ,CDCM,20,IX,1)                              010350
              105 CALL LOOK1(MU,TMUD,LD,TMULD,20,IX,1)                               010360
                 IF(MAC,GT,1,4) GO TO 70                                             010370
                 CALL LOOK1(MU,TMU,MAC ,TMUM,14,IX,1)                                010380
                 IF(MAC ,GT,,9) GO TO 80                                             010390
150              MU=((MUD-BMU)/BMU)*((,4-MAC)/,4)+MU                                 010400
                 GO TO 80                                                            010410
              200 CALL LOOK1(CDC,CDCT2,MAC ,CDCM2,12,IX,1)                           010420
                 GO TO 105                                                           010430
               70 MU=1,0                                                             010440
               80 IF(KFLAG,EQ,1)GO TO 75                                             010450
160              CNPIC=CDC*MU*SP/SREF                                                010460
                 A=ALPHA*RAD                                                         010470
                 CNP=(16-(4,*A**2))/PI + (13,*A**3)/PI**2 - (12,*A**4)/PI**3         010480
                * +(4,*A**5)/PI**4)*CNA+ ((16,*A**2)/PI**2-(32,*A**3)/PI**3          010490
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115                 * + (16.*A**4)/PI**4)*CNPI2                                    010500
                    RETURN                                                         010510
                 20 IF(MACH.LT.1.0) GO TO 90                                       010520
                110 CALL LOOK3(CNA,CNAT,13,4,MACH,CNAM,13,LAD,CNALA,4,LND,CNALD,4,  010530
                   *IX,IY,IZ,1)                                                    010540
120                 GO TO 100                                                      010550
                 30 CNA1=CNA                                                       010560
                    IFLAG=0                                                        010570
                    MACH=1.5                                                       010580
                    JFLAG=1                                                        010590
125                 GO TO 110                                                      010600
                 40 CNA2=CNA                                                       010610
                    MACH = MACHT                                                   010620
                    JFLAG=0                                                        010630
                    CNA=CNA2-(CNA2-CNA1)*(1.5-MACH)/.3                             010640
130                 GO TO 50                                                       010650
                 90 IFLAG = 1                                                      010660
                    MACHT=MACH                                                     010670
                    MACH = 1.2                                                     010680
                    GO TO 10                                                       010690
135              75 A=ALPHA*RAD                                                    010700
                    CNB=SIN(2.*A)*COS(A/2.)+CDC*MU*(SP/SREF)*(SIN(A))**2           010710
                    RETURN                                                         010720
                    END                                                            010730
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      SUBROUTINE XCPBOD(LAD,LND,D,MACH,ALPHA,XCPB)
C*****************************************************************************010740
C                                                                              010750
C     THIS SUBROUTINE CALCULATES BODY ALONE CENTER OF PRESSURE                 010760
C         LAD =     AFTER BODY LENGTH IN CAL.                                  *010770
C         LND =     NOSE LENGTH IN CAL.                                        *010780
C         D =       BODY DIAMETER IN INCHES                                    *010790
C         MACH =    FREE STREAM MACH NUMBER                                    *010800
C         ALPHA =   ANGLE OF ATTACH IN DEGREES                                 *010810
C         XCPB =    BODY CENTER OF PRESSURE FROM NOSE IN CAL.                  *010820
C                                                                              *010830
C*****************************************************************************010840
      REAL MACH,LAD,LND,LN,LD,MACHT,LA                                         *010850
      DIMENSION XOT1(9,4,3),XOT1M(9),XOT1LA(4),XOT1LN(3),                      010860
     *          XOT2(7,4,3),XOT2M(7),XOT2LA(4),XOT2LN(3),                      010870
     *          DELXT(23),DELXM(23)                                            010880
      DATA (((XOT1(I,J,K),I=1,9),J=1,4),K=1,3)/4.012,4.012,4.012,4.036,        010890
     13.988,3.868,3.916,3.820,3.604,6.246,6.294,6.462,6.655,6.799,6.631,       010900
     26.679,6.703,6.511,10.066,10.162,10.330,10.715,10.979,10.955,             010910
     310.787,10.330,9.730,12.228,12.276,12.492,12.853,13.237,13.381,           010920
     413.045,12.565,12.180,4.492,4.589,4.733,4.805,4.709,4.348,4.372,          010930
     54.420,4.324,7.063,7.135,7.231,7.423,7.568,7.544,7.303,6.967,6.607,       010940
     610.282,10.426,10.787,11.171,11.459,11.387,10.955,10.354,9.994,          010950
     712.517,12.781,13.189,13.550,13.862,13.838,13.862,14.126,13.982,          010960
     84.877,4.887,5.021,5.333,5.405,5.141,4.997,4.877,4.805,7.592,7.592,       010970
     97.736,7.976,8.240,8.024,8.,7.976,7.856,11.147,11.267,11.532,             010980
     *12.084,12.517,12.348,12.252,12.132,12.060,13.285,13.309,13.429,          010990
     113.814,14.799,15.375,15.568,15.736,15.351/                               011000
      DATA (XOT1M(I),I=1,9)/.8,.85,.9,.95,1.,1.05,1.1,1.15,1.2/                011010
      DATA (XOT1LA(I),I=1,4)/6.,10.,15.,18./                                   011020
      DATA (XOT1LN(I),I=1,3)/1.5,2.5,3.5/                                      011030
      DATA (((XOT2(I,J,K),I=1,7),J=1,4),K=1,3)/2.852,2.802,2.815,2.877,        011040
     12.975,3.42,3.852,3.914,3.815,3.815,3.877,3.988,4.432,4.864,4.951,        011050
     24.79,4.757,4.7,4.901,5.37,5.827,5.988,5.802,5.753,5.790,5.914,           011060
     76.346,6.765,3.296,3.21,3.21,3.272,3.383,3.79,4.198,4.37,4.235,           011070
     44.21,4.259,4.37,4.802,5.198,5.42,5.247,5.198,5.235,5.321,5.741,          011080
     56.16,6.432,6.198,6.136,6.16,6.259,6.679,7.074,3.556,3.444,3.432,         011090
     63.494,3.605,4.025,4.457,4.605,4.457,4.420,4.481,4.580,5.025,5.444,       011100
     75.691,5.481,5.407,5.444,5.556,6.,6.420,6.716,6.469,6.383,6.407,          011110
     86.494,6.938,7.370/                                                       011120
      DATA (XOT2M(I),I=1,7)/1.5,1.75,2.,2.25,2.5,3.5,4.5/                      011130
      DATA (XOT2LA(I),I=1,4)/4.,6.,8.,10./                                     011140
      DATA (XOT2LN(I),I=1,3)/2.5,3.5,4./                                       011150
      DATA (DELXT(I),I=1,23)/.169,.157,.138,.124,.11,.091,.071,.118,           011160
     1.162,.201,.236,.254,.261,.269,.274,.278,.283,.287,.286,.289,.288,        011170
     2.287,.285/                                                               011180
      DATA (DELXM(I),I=1,23)/.6,.695,.801,.855,.902,.952,1.,1.1,1.2,1.3,       011190
     11.4,1.465,1.5,1.6,1.7,1.8,2.,2.2,2.4,2.596,2.798,2.9,3./                 011200
      JFLAG = 0                                                                011210
      IFLAG = 0                                                                011220
      LD = LND+LAD                                                             011230
      IF(MACH.GT. 1.2) GO TO 10                                                011240
  100 CALL LOOK3(XO,XOT1,9,4,MACH,XOT1M,9,LAD,XOT1LA,4,LND,XOT1LN,3,           011250
     *IX,IY,IZ,1)                                                              011260
   30 XO = XO-.4*LAD                                                           011270
      IF(IFLAG.EQ.1) GO TO 100                                                 011280
      IF(JFLAG.EQ.1) GO TO 110                                                 011290
                                                                               011300
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                  140 CALL LOOK1(DELX,DFLXT,MACH,DELAM,23,IX,1)                          011310
                      DFLX = DELX*LD                                                     011320
                  60  X20 = XC+DFLX                                                     011330
                      A = ALPHA                                                          011340
                      A0 = 1.+(7.*A**3/28000.-21.*A**2/2800.)                            011350
                      A1 = 23.*A**2/2800.-8.*A**3/28000.                                 011360
                      A2 = A**3/28000. - 2.*A**2/2800.                                   011370
                  65  LN = LND*D                                                        011380
                      LA = LAD*D                                                         011390
                      R = 1/4.*LND**2+D                                                  011400
                      SPN = LN*SQRT(-LN**2+R**2)+R**2*ASIN(LN/R)-2.*(R-D/2.)*LN          011410
                      XBARN = 2.*(-R**3/3.+ (R**2-LN**2)/3.*SQRT(R**2-LN**2)+(LN**2/2.) 011420
                     **SQRT(R**2-LN**2)*((LN*R**2/2.)*ASIN(LN/R))-(R-D/2.)*LN**2         011430
                  70  SPA = LA*D                                                        011440
                      XBARA = (LN+LA/2.)*LA*D                                            011450
                      XBAR = (XBARN+XBARA)/(SPN+SPA)                                     011460
                      XPI2 = XBAR/D                                                      011470
                  75  IF(ALPHA .GT. 20.) GO TO 20                                       011480
                      XCPE = A0*XC + A1*X20+A2*XPI2                                      011490
                   70 CONTINUE                                                           011500
                      RETURN                                                             011510
                   10 IF(MACH.LT. 1.5) GO TO 90                                          011520
                  80  120 CALL LOOK3(XD,XDT2,7,4,MACH,XDT2M,7,LAD,XDT2LA,4,LND,XDT2LN,3, 011530
                     *IX,IY,IZ,1)                                                        011540
                      GO TO 30                                                           011550
                   20 IF(MACH.GE. 1.) GO TO 40                                           011560
                      APRIM = 90.                                                        011570
                  85  GO TO 50                                                          011580
                   40 APRIM = 20.                                                       011590
                   50 AM = (X20-XPI2)/(APRIM-90.)                                       011600
                      IF(ALPHA.LT. APRIM) GO TO 60                                       011610
                      IF(ALPHA.LE. 160.) GO TO 80                                        011620
                  90  X160 = 70.*AM + XPI2                                             011630
                      B0 = (-51840000. + 900000.*ALPHA-5200.*ALPHA**2+10.*ALPHA**3)/     011640
                     *4000.                                                              011650
                      B1 =(4B64000.-B6400.*ALPHA+510.*ALPHA**2-ALPHA**3)/4000.           011660
                      B2 = (-4B60000.+B6400.*ALPHA-510.*ALPHA**2+ALPHA**3)/4000.         011670
                  95  XCPB = B0*AM + B1*(LAD+LND) + B2*X160                             011680
                      GO TO 70                                                           011690
                   60 XCPB = X20                                                        011700
                      GO TO 70                                                           011710
                   80 XCPB = AM*(ALPHA-APRIM)+X20                                       011720
                 100  GO TO 70                                                          011730
                   90 IFLAG = 1                                                         011740
                      MACHT = MACH                                                       011750
                      MACH = 1.2                                                         011760
                      GO TO 120                                                          011770
                 105  100 X01 = XC                                                      011780
                      IFLAG = 0                                                          011790
                      JFLAG = 1                                                          011800
                      MACH = 1.5                                                         011810
                      GO TO 130                                                          011820
                 110  110 X02 = XC                                                      011830
                      JFLAG = 0                                                          011840
                      MACH = MACHT                                                       011850
                      XC = X02-(X02-X01)*(1.5-MACH)/.3                                   011860
                      GO TO 140                                                          011870
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115          END                                                    011880
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      SUBROUTINE IBTT(LAMDA,MACH,AR,ALPHA,PHI,S,D,IBT)                  011890
C*****************************************************************    011900
C                                                                      011910
C     THIS SUBROUTINE CALCULATES BODY NORMAL CARRYOVER FORCE COEFF.    011920
C                                                                      011930
C        LAMDA     = TAIL TAPER RATIO                                  011940
C        MACH      = MACH NUMBER                                       011950
C        AR        = TAIL ASPECT RATIO                                 011960
C        ALPHA     = ANGLE OF ATTACK                                   011970
C        PHI       = BODY ROLL ANGLE                                   011980
C        S         = TAIL SEMI SPAN(INCLUDING BODY                     011990
C        D         = BODY DIAMETER                                     012000
C        IBT       = BODY CARRY OVER FORCE COEFF.  (RETURNED VALUE)    012010
C                                                                      012020
C*****************************************************************    012030
      REAL LAMDA,MACH,IABAS,IABAST,IB,IBT,ICBAS,ICBAST,I1BAS,I2BAS,    012040
     *I3BAS,MACHT,I1,I2,I3,IBT1,IBT2,IABDB,IBTAR,ICBADB,IBTO,IBBT,IA,IC 012050
     *,IBTM                                                            012060
      DIMENSION TDIBT(6,3,3),DIBTAF(6),DIBTLM(3),DIBTAR(3),            012070
     *          IBBT(5,3),IBTM(5),IBTAR(3),                            012080
     *          FCART(6),FCATT(6),                                     012090
     *          ICBAST(2),ICBADB(2),                                   012100
     *          FAMMT(5,3),FAMAC(5),FAMAR(3),                          012110
     *          FAART(11),FFAR(11),                                    012120
     *          IABAST(2),IABDB(2),                                    012130
     *          TF3AR(10),TFAR(10),                                    012140
     *          TF2DB(13),TFDB2(13),                                   012150
     *          TF2M(2),TF2MACH(2),                                    012160
     *          TI2BAS(11),TI2BLM(11),                                 012170
     *          TF1DB(13),TFDB1(13),                                   012180
     *          TI1BAS(2),TI1BLM(2)                                    012190
      DATA (((TDIBT(I,J,K),I=1,6),J=1,3),K=1,3)/0.,0.018,.106,.405,.884,012200
     11.639,0.,.02,.119,.332,.649,1.117,.0,.023,.109,.299,.557,.768,.0, 012210
     2.015,.068,.21,.408,.646,.0,.018,.081,.167,.296,.446,.0,.02,.071,  012220
     3.149,.256,.304,.0,.013,.043,.139,.218,.271,0.,.013,.051,.109,.155,012230
     4.205,.0,.015,.043,.099,.137,.122/                                 012240
      DATA (DIBTAF(I),I=1,6)/0.,.5,.10,.15,.20,.25./                    012250
      DATA (DIBTLM(I),I=1,3)/0.,.5,1./                                  012260
      DATA (DIBTAR(I),I=1,3)/.5,1.,2./                                  012270
      DATA ((IBBT(I,J),I=1,5),J=1,3)/1.484,-.113,-.239,.73,1.006,.252,  012280
     1-.491,-.805,-.252,.403,.491,-.226,-.491,-.39,.415/                012290
      DATA (IBTM(I),I=1,5)/.6,.8,.9,1.,1.3/                             012300
      DATA (IBTAR(I),I=1,3)/.5,1.,2./                                   012310
      DATA (FCART(I),I=1,6)/2.496,1.941,1.462,1.109,1.,1./              012320
      DATA (FCATT(I),I=1,6)/.5,.599,.688,.803,.93,2./                   012330
      DATA (ICBAST(I),I=1,2)/.5,.3/                                     012340
      DATA (ICBADB(I),I=1,2)/.3,.5/                                     012350
      DATA ((FAMMT(I,J),I=1,5),J=1,3)/1.78,1.668,1.494,1.332,1.,2.,2.,  012360
     12.,2.,2.,3.,3.,3.,3.,3./                                          012370
      DATA (FAMAC(I),I=1,5)/.6,.8,.9,1.,1.3/                            012380
      DATA (FAMAR(I),I=1,3)/.5,1.,2./                                   012390
      DATA (FAART(I),I=1,11)/2.597,2.118,1.714,1.311,1.134,1.,1.,1.,1., 012400
     11.,1./                                                            012410
      DATA (FFAR(I),I=1,11)/.487,.564,.628,.731,.808,.91,1.,1.103,1.295,012420
     11.5,2./                                                           012430
      DATA (IABAST(I),I=1,2)/1.5,1./                                    012440
      DATA (IABDB(I),I=1,2)/.3,.5/                                      012450
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      DATA (TF1AR(I),I=1,10)/.013,.176,.366,.504,.643,.756,.832,.906,
     1.971,1./                                                          012460
      DATA (TF4R(I),I=1,10)/.5,.655,.856,1.,1.186,1.364,1.5,1.669,1.835,012470
     12./                                                               012480
      DATA (TF2DR(I),I=1,13)/1.,.823,.658,.544,.43,.342,.278,.19,.139,  012490
     1.114,.076,.078,.5/                                                012500
      DATA (TFDR2(I),I=1,13)/.3,.317,.333,.35,.368,.385,.4,.424,.439,.45012510
     1,.468,.485,.5/                                                    012520
      DATA (TF2M(I),I=1,2)/.6,1.375/                                    012530
      DATA (TF2MACH(I),I=1,2)/2.,3./                                    012540
      DATA (TI2RAS(I),I=1,11)/-.715,-.992,-1.28,-1.494,-1.644,-1.757,   012550
     1-1.845,-1.913,-1.956,-2.,-2./                                     012560
      DATA (TI2RLM(I),I=1,11)/0.,.025,.082,.139,.196,.247,.31,.386,.475,012570
     1.5,1./                                                            012580
      DATA (TF1DR(I),I=1,13)/1.,.89,.788,.699,.636,.585,.508,.458,.419, 012590
     1.394,.369,.356,.343/                                              012600
      DATA (TFDR1(I),I=1,13)/.3,.316,.333,.349,.367,.38,.4,.418,.435,   012610
     1.449,.466,.486,.5/                                                012620
      DATA (TI1RAS(I),I=1,2)/1.,.5/                                     012630
      DATA (TI1RLM(I),I=1,2)/0.,1./                                     012640
      IFLAG = 0                                                         012650
      JFLAG = 0                                                         012660
      PI = 3.14159265                                                   012670
      RAD = PI/180.                                                     012680
      B = 2.*S                                                          012690
      DR = D/B                                                          012700
      IF(MACH.GT. 1.3) GO TO 10                                         012710
      IF(MACH .LT. .6) GO TO 20                                         012720
   30 CALL LOOK1(IARAS,IARAST,DR,IARDR,2,IX,1)                          012730
      CALL LOOK1(FAAR,FAART,AR,FFAR,11,IX,1)                            012740
      CALL LOOK2(FAMM,FAMMT,5,MACH,FAMAC,5,AR,FAMAR,3,IX,IY,1)          012750
      FAM = FAMM - AP                                                   012760
      IA = IARAS*FAAR*FAM                                               012770
      CALL LOOK2(IB,IBRT,5,MACH,IBTM,5,AR,IBTAR,3,IX,IY,1)              012780
      CALL LOOK1(ICRAS,ICRAST,DR,ICRADR,2,IX,1)                         012790
      CALL LOOK1(FCAR,FCART,AR,FCATT,6,IX,1)                            012800
      IC = ICRAS*FCAR                                                   012810
      A = ALPHA*RAD                                                     012820
      IF(ALPHA .GT. 130.) GO TO 40                                      012830
      IRTO=(.172*IB+2.962*IA)*A-(.394*IB+1.93*IA)*A**2+(.353*IA+.226*IB)012840
     **A**3                                                             012850
      GO TO 50                                                          012860
   40 IRTO = 15.992*IB-39.869*IC+(30.271*IC-13.286*IB)*A+(2.244*IB-5.596012870
     **IC)*A**2                                                         012880
   50 IF(PHI .GT. 90.) GO TO 55                                         012890
      P = PHI*RAD                                                       012900
      GO TO 56                                                          012910
   55 P = (PHI-90.)*RAD                                                 012920
   56 IF(ALPHA .GT. 25.) GO TO 60                                       012930
      CALL LOOK3(DIRT,TDIRT,6,3,ALPHA,DIRTAF,6,LAMDA,DIRTLM,3,AR,DIRTAR,012940
     *3,IX,IY,IZ,1)                                                     012950
      GO TO 70                                                          012960
   60 CALL LOOK3(DIRT,TDIRT,6,3,25.,DIRTAF,6,LAMDA,DIRTLM,3,AR,DIRTAR,  012970
     *3,IX,IY,IZ,1)                                                     012980
   70 IRT = IRTO+DIRT*(-16.*P**2/(PI/2.)**2+32.*P**3/(PI/2.)**3-16.*P**4012990
     */(PI/2.)**4)                                                      013000
      IF(IFLAG .EQ. 1) GO TO 80                                         013010
                                                                        013020
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                      RETURN                                                    013030
                   80 IFLAG = 0                                                 013040
                      JFLAG = 1                                                 013050
                      IBT1=IBT                                                  013060
                      MACH = 2.0                                                013070
                      GO TO 90                                                  013080
                  100 JFLAG = 0                                                 013090
                      IBT2 = IBT                                                013100
                      MACH = MACHT                                              013110
                      IBT = IBT2-(2.0-MACH)*(IBT2-IBT1)/.7                      013120
                      RETURN                                                    013130
                   10 IF(MACH .GE. 2.) GO TO 90                                 013140
                      IFLAG = 1                                                 013150
                      MACHT = MACH                                              013160
                      MACH = 1.3                                                013170
                      GO TO 30                                                  013180
                   90 CALL LOOK1(I1BAS,TI1BAS,LAMDA,TI1BLM,2,IX,1)              013190
                      CALL LOOK1(F1DB,TF1DB,DB,TFDB1,13,IX,1)                   013200
                      I1 = I1BAS*F1DB                                           013210
                      CALL LOOK1(I2BAS,TI2BAS,LAMDA,TI2BLM,11,IX,1)             013220
                      CALL LOOK1(F2M,TF2M,MACH,TF2MACH,2,IX,1)                  013230
                      CALL LOOK1(F2DB,TF2DB,DB,TFDB2,13,IX,1)                   013240
                      I2 = I2BAS*F2M*F2DB                                       013250
                      CALL LOOK1(F3AR,TF3AR,AR,TFAR,10,IX,1)                    013260
                      I3 = .5*F3AR                                              013270
                      IF (ALPHA .GT. 90.) GO TO 105                             013280
                      IBTO = I1*SIN(ALPHA*RAD)                                  013290
                      GO TO 110                                                 013300
                  105 IF ( ALPHA .GT. 115.) GO TO 120                           013310
                      IBTO = I1-(I1-I2)*SQRT((ALPHA-90.)/25.)                   013320
                      GO TO 110                                                 013330
                  120 IBTO = -19.325*I3+11.926*I2+(15.816*I3-8.382*I2)*(ALPHA*RAD)  013340
                     **(1.46*I2-3.076*I3)*(ALPHA*RAD)**2                        013350
                  110 IBT = IBTO                                                013360
                      IF (JFLAG .EQ. 1) GO TO 100                               013370
                      RETURN                                                    013380
                   20 WRITE(6,500)                                              013390
                  500 FORMAT(1H ,*MACH NUMBER OUTSIDE ALLOWABLE LIMITS*)        013400
                      RETURN                                                    013410
                      END                                                       013420
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      SUBROUTINE XCPBTT(ALPHA,LAMDA,MACH,AR,D,S,XCPBT)                  013430
C*****************************************************************    013440
C                                                                      013450
C     THIS SUBROUTINE CALCULATES TAIL-TO-BODY CARRY OVER NORMAL FORCE  013460
C     CENTER OF PRESSURE.                                              013470
C                                                                      013480
C        ALPHA      = ANGLE OF ATTACH (DEGS.)                         013490
C        LAMDA      = TAIL TAPER RATIO                                013500
C        MACH.      = MACH NUMBER                                     013510
C        AR         = ASPECT RATIO                                    013520
C        D          = BODY DIAMETER                                   013530
C        S          = TAIL SEMI-SPAN(INCLUDING BODY)                  013540
C        XCPT       = TAIL TO BODY CARRY-OVER NORMAL FORCE CENTER OF    013550
C                     PRESSURE/TAIL ROOT CHORD, MEASURED FROM,         013560
C                      ROOT CHORD LEADING EDGE - AFT (ALPHA 0 TO 90 DEG) 013570
C                      ROOT CHORD TRAILING EDGE - FWD (ALPHA 90 TO 180 DEG)013580
C                                                                      013590
C*****************************************************************    013600
      REAL LAMDA,MACH                                                  013610
      DIMENSION TCP4(8,4,3),TBAR(8),TDB(4),TLAM(3),                    013620
     *          TCP3(8,4,3),TCP2(8,4,3),TCP1(8,4,3)                    013630
      DATA (((TCP4(I,J,K),I=1,8),J=1,4),K=1,3)/0.,.184,.369,.426,.5,.5, 013640
     1.5,.5,0.,.241,.44,.582,.723,.78,.851,.879,0.,.369,.681,.95,1.135, 013650
     21.291,1.433,1.546,0.,.638,1.106,1.475,1.801,2.113,2.355,2.582,0., 013660
     3.261,.456,.489,.5,.5,.5,.5,0.,.394,.672,.806,.894,.978,1.056,    013670
     41.128,0.,.572,.95,1.2,1.4,1.6,1.79,1.97,0.,.956,1.478,1.883,2.256,013680
     52.578,2.867,3.106,0.,.333,.494,.5,.5,.5,.5,.5,0.,.539,.772,.883, 013690
     6.994,1.089,1.189,1.278,0.,.789,1.122,1.4,1.661,1.911,2.144,2.361, 013700
     70.,1.161,1.783,2.322,2.78,3.26,3.65,4.03/                       013710
      DATA (TBAR(I),I=1,8)/0.,1.,2.,3.,4.,5.,6.,7./                    013720
      DATA (TDB(I),I=1,4)/0.,2.,4.,6/                                  013730
      DATA (TLAM(I),I=1,3)/0.,.5,1./                                   013740
      DATA (((TCP3(I,J,K),I=1,8),J=1,4),K=1,3)/.5,.5,.5,.5,.5,.5,.5,.5, 013750
     1.5,.561,.597,.63,.646,.659,.666,.666,.5,.616,.659,.666,.666,.666, 013760
     2.666,.666,.5,.666,.666,.666,.666,.666,.666,.666,.3,.426,.482,.498,013770
     3.5,.5,.5,.5,.298,.577,.63,.649,.666,.666,.666,.666,.3,.643,.662,  013780
     4.666,.666,.666,.666,.666,.3,.666,.666,.666,.666,.666,.666,.666,   013790
     50.,.354,.449,.492,.5,.5,.5,.5,0.,.6,.639,.666,.666,.666,.666,    013800
     6.666,0.,.656,.666,.666,.666,.666,.666,.666,0.,.666,.666,.666,.666,013810
     7.666,.666,.666/                                                  013820
      DATA (((TCP2(I,J,K),I=1,8),J=1,4),K=1,3)/0.,.164,.218,.24,.25,.25,013830
     1.25,.25,0.,.129,.17,.189,.195,.195,.195,.195,0.,.11,.15,.168,.174,013840
     2.174,.174,.174,0.,.1,.136,.156,.163,.163,.163,.163,0.,.16,.223,   013850
     3.244,.25,.25,.25,.25,.0,.14,.194,.215,.221,.221,.221,.221,0.,.128,013860
     4.183,.204,.21,.21,.21,.21,0.,.118,.175,.196,.203,.203,.203,.203,  013870
     50.,.159,.213,.233,.244,.25,.25,.25,0.,.159,.213,.233,.244,.25,.25,013880
     6.25,0.,.159,.213,.233,.244,.25,.25,.25,0.,.159,.213,.233,.244,    013890
     7.25,.25,.25/                                                     013900
      DATA (((TCP1(I,J,K),I=1,8),J=1,4),K=1,3)/.5,.436,.367,.316,.284,  013910
     1.265,.253,.249,.5,.469,.436,.412,.402,.402,.402,.402,.5,.492,.48, 013920
     2.473,.469,.469,.469,.469,.5,.509,.511,.511,.511,.511,.511,.511,   013930
     3.25,.25,.25,.25,.25,.25,.25,.25,.25,.25,.294,.316,.327,.327,.327,.327,013940
     4.327,.25,.305,.335,.353,.358,.361,.361,.361,.25,.316,.353,.371,   013950
     5.378,.378,.378,.378,.378,0.,.162,.219,.233,.246,.251,.251,.251,0.,.162,013960
     6.219,.233,.246,.251,.251,.251,.251,0.,.162,.219,.233,.246,.251,.251,  013970
     7.251,0.,.162,.219,.233,.246,.251,.251,.251/                      013980
      PI = 3.141592653                                                 013990
```

```
      RAD = PI/180.                                                          014000
      DR = 0/(2.*S)                                                          014010
   60 IF(ALPHA.GT.90.) GO TO 10                                              014020
      IF(MACH.GT. 1.) GO TO 20                                               014030
      BETA = SQRT(1.-MACH**2)                                                014040
      BAR = BETA*AR                                                          014050
      CALL LOOK3(XCPB0,TCP1,8,4,BAR,TBAR,8,DR,TDR,4,LAMDA,TLAM,3,IX,IY,      014060
   65 *IZ,1)                                                                 014070
   40 A = ALPHA*RAD                                                          014080
      DIF = (2.*A**3)/(PI/2.)**3-(3.*A**2)/(PI/2.)**2                        014090
      XCPBT = XCPB0+DIF*(XCPB0-.5)                                           014100
      RETURN                                                                 014110
   70 10 IF(MACH.GT. 1.) GO TO 30                                            014120
      BETA = SQRT(1.-MACH**2)                                                014130
      BAR = BETA*AR                                                          014140
      CALL LOOK3(XCPB0,TCP2,8,4,BAR,TBAR,8,DB,TDB,4,LAMDA,TLAM,3,IX,IY,      014150
     *IZ,1)                                                                  014160
   75 50 A = (180.-ALPHA)*RAD                                                014170
      DIF = (2.*A**3)/(PI/2.)**3-(3.*A**2)/(PI/2.)**2                        014180
      XCPBT = XCPB0 + DIF*(XCPB0-.5)                                         014190
      RETURN                                                                 014200
   20 BETA = SQRT(MACH**2-1.)                                                014210
   80 BAR = BETA*AR                                                          014220
      CALL LOOK3(XCPB0,TCP3,8,4,BAR,TBAR,8,DB,TDB,4,LAMDA,TLAM,3,IX,IY,      014230
     *IZ,1)                                                                  014240
      GO TO 40                                                               014250
   30 BETA = SQRT(MACH**2-1.)                                                014260
   85 BAR = BETA*AR                                                          014270
      CALL LOOK3(XCPB0,TCP4,8,4,BAR,TBAR,8,DB,TDB,4,LAMDA,TLAM,3,IX,IY,      014280
     *IZ,1)                                                                  014290
      GO TO 50                                                               014300
      END                                                                    014310
```

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      SUBROUTINE XCPTBR(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI,XCPTBU,XCPTBL)   014320
C*****************************************************************************014330
C     THIS SUBROUTINE CALCULATES THE TAIL CHORDWISE CENTER OF PRESSURE/*014340
C     TAIL ROOT CHORD MEASURED AFT FROM ROOT CHORD LEADING EDGE        *014350
C                                                                      *014360
C        ALPHA   =     ANGLE OF ATTACK  (DEG)                          *014370
C        AR      =     ASPECT RATIO                                    *014380
C        CR      =     ROOT CHORD ( TAIL ) ,                           *014390
C        D       =     BODY DIAMETER                                   *014400
C        LAMDA   =     TAPER RATIO                                     *014410
C        MACH    =     MACH NUMBER                                     *014420
C        PHI     =     ROLL ANGLE (DEGREES)                            *014430
C        S       =     SEMI-SPAN (TAIL PLUS BODY RADIUS)               *014440
C        XCPTBU  =     CHORDWISE CENTER OF PRESSURE  (UPPER BOUND)     *014450
C        XCPTBL  =     CHORDWISE CENTER OF PRESSURE  (LOWER BOUND)     *014460
C                                                                      *014470
C*****************************************************************************014480
      DIMENSION TDPHI1(10),DPLMT(10)                                   014490
      REAL LAMDA,MACH                                                  014500
      DATA(TDPHI1(I),I=1,10)/40.,35.842,32.475,29.703,27.327,24.356,21.9014510
     $8,20.198,20.,20./                                                014520
      DATA(DPLMT(I),I=1,10)/0.0,0.027,0.067,0.104,0.144,0.211,0.302,0.40014530
     $6,0.50,1.0/                                                      014540
      DCR = D/CR                                                       014550
      ALP = ALPHA                                                      014560
      B=2.*S                                                           014570
      IF (PHI.LE.90.) GO TO 10                                         014580
      IF (PHI.GT.90.) GO TO 20                                         014590
   10 CONTINUE                                                         014600
      ALP = (1.0 + D/S)*(TAN(ALP/57.29578)*SIN(PHI/57.29578))          014610
      ALPRES = ATAN(ALP)*57.29578                                      014620
      CALL  XCPTT(ALPRES,LAMDA,MACH,AR,XCPTB)                          014630
      XCPTBU = XCPTB                                                   014640
      XCPTBL = XCPTBU                                                  014650
      GO TO 30                                                         014660
   20 CONTINUE                                                         014670
      CALL PHCC(ALPHA,MACH,DCR,PHC1)                                   014680
      PHIC = PHC1 + 90.0                                               014690
      CALL LOOK1(DPHI1,TDPHI1,LAMDA,DPLMT,10,IX,1)                     014700
      PHI1 = PHIC-DPHI1                                                014710
      PHI2 = PHIC+DPHI1                                                014720
      CALL XCPTT(ALPHA,LAMDA,MACH,AR,XCPTB)                            014730
      XCPTBU = XCPTB                                                   014740
      XCPTBL = XCPTBU                                                  014750
      IF(PHI.LT.PHI1) GO TO 30                                         014760
      ALE = (1.0 + D/S)*TAN(ALP/57.29578)                              014770
      ALPEFF = ATAN(ALE)*57.29578                                      014780
      CALL XCPTT(ALPEFF,LAMDA,MACH,AR,XCPTB1)                          014790
      IF(PHI.GT.PHIC) GO TO 25                                         014800
      XCPTBU = XCPTB1 + ((PHI-PHI1)/(PHIC-PHI1))**2*(1.0-XCPTB1)       014810
      XCPTBL = XCPTB1 * (1.0-((PHI-PHI1)/(PHIC-PHI1))**2)              014820
      GO TO 30                                                         014830
   25 CONTINUE                                                         014840
      CALL XCPTT(0.,LAMDA,MACH,AR,XCPTBA)                              014850
      IF(PHI.GT.PHI2) GO TO 40                                         014860
      XCPTBU = XCPTBA*(((PHI2-PHI)/(PHI2-PHIC))**2)*(1.0-XCPTBA)       014870
      XCPTBL = XCPTBA*(1.0-((PHI2-PHI)/(PHI2-PHIC))**2)                014880
```

```
                GO TO 30                                                014890
             40 CONTINUE                                                014900
60              XCPTBU = XCPTBA                                         014910
                XCPTBL = XCPTBU                                         014920
             30 CONTINUE                                                014930
                RETURN                                                  014940
                END                                                     014950
```

```
      SUBROUTINE YCPTS (LAMDA,PHI,ALPHA,MACH,S,D,CR,YCPT)                    014960
C*********************************************************************     014970
C     THIS SUBROUTINE CALCULATES THE TAIL SPANWISE CENTER OF PRESSURE  *     014980
C                                                                      *     014990
C        ALPHA   =     ANGLE OF ATTACK  (DEG)                          *     015000
C        AR      =     ASPECT RATIO                                    *     015010
C        CR      =     ROOT CHORD ( TAIL )                             *     015020
C        D       =     BODY DIAMETER                                   *     015030
C        LAMDA   =     TAPER RATIO                                     *     015040
C        MACH    =     MACH NUMBER                                     *     015050
C        PHI     =     ROLL ANGLE (DEGREES)                            *     015060
C        S       =     SEMI-SPAN (TAIL PLUS BODY RADIUS)               *     015070
C        YCPT    =     SPANWISE CENTER OF PRESSURE                     *     015080
C                                                                      *     015090
C*********************************************************************     015100
      REAL LAMDA,MACH,KY                                                     015110
      DIMENSION TLAMDA(3),TRADR(11),  TYCPT(11,3),TMACH(6),TALPHA(10)        015120
      DIMENSION TKY(10,6)                                                    015130
      DATA (TLAMDA(I),I=1,3)/0.,.5,1./                                       015140
      DATA (TRADR(I),I=1,11)/0.05,0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,0.0,   015150
     *65/                                                                    015160
      DATA((TYCPT(I,J),I=1,11),J=1,3)/0.311,0.303,0.296,0.298,.302,.307,     015170
     1.31,.318,.325,.330,.331,.425,.414,.402,.401,.402,.407,.416,.424,       015180
     2.430,.436,.441,.445,.471,.459,.455,.459,.463,.469,.477,.487,.493,      015190
     3.499/                                                                  015200
      DATA(TMACH(I),I=1,6)/0.8,1.2,1.4,1.6,1.75,3.0/                         015210
      DATA(TALPHA(I),I=1,10)/0.0,5.0,10.0,15.0,20.0,25.0,30.0,35.0,40.0,     015220
     *45.0/                                                                  015230
      DATA((TKY(I,J),I=1,10),J=1,6)/1.09,1.09,1.09,1.09,1.03,0.98,0.92,      0015240
     *.92,0.92,0.92,1.05,1.09,1.09,1.09,1.03,0.98,0.92,0.92,0.92,0.92,1     015250
     *.05,1.05,1.05,1.05,1.021,0.99,0.95,0.95,0.95,0.95,1.025,1.025,1.02    015260
     *5,1.025,1.01,0.99,0.978,0.978,0.978,0.978,1.0,1.0,1.0,1.0,1.0,1.0,1.0,015270
     *1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0/          015280
      DCR = D/CR                                                             015290
      CALL PHCC(ALPHA,MACH,DCR,PHC1)                                         015300
      PHIC = PHC1 + 90.0                                                     015310
      RADR = D/(2.*S)                                                        015320
      IF(PHI.GT.PHIC) GO TO 10                                               015330
      CALL LOOK2(KY,TKY,10,ALPHA,TALPHA,10,MACH,TMACH,6,IX,IY,1)             015340
      CALL LOOK2(YCP,TYCPT,11,RADR,TRADR,11,LAMDA,TLAMDA,3,IX,IY,1)          015350
      YCPT = KY*YCP                                                          015360
      IF(PHI.LE.90.0) GO TO 15                                               015370
      YCPTT = YCPT                                                           015380
      YCPT = YCPTT+((PHI-90.0)/(PHIC-90.0))**3 * (1.0-YCPTT)                 015390
      GO TO 15                                                               015400
   10 CONTINUE                                                               015410
      YCPT = 1.0                                                             015420
   15 CONTINUE                                                               015430
      RETURN                                                                 015440
      END                                                                    015450
```

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      SUBROUTINE XCPTT(ALPHA,LAMDA,MACH,AR,XCPT)                        015460
C*****************************************************************    *015470
C                                                                       *015480
C       THIS SUBROUTINE CALCULATES THE CHORDWISE CENTER OF PRESSURE     *015490
C       /TAIL ROOT CHORD FOR AN ISOLATED TAIL PANEL, MEASURED AFT       *015500
C       FROM THE TAIL ROOT CHORD LEADING EDGE                           *015510
C                                                                       *015520
C          ALPHA=    ANGLE OF ATTACK (DEGREES)                        *015530
C          LAMDA=    TAIL TAPER RATIO                                 *015540
C          MACH=     FREE STREAM MACH NUMBER                          *015550
C          AR=       TAIL ASPECT RATIO (TWO TAIL PANELS)              *015560
C          XCPT=     TAIL CHORDWISE CENTER OF PRESSURE (RETURNED      *015570
C                    VALUE)                                           *015580
C                                                                       *015590
C*****************************************************************    *015600
      REAL LAMDA,MACH                                                   015610
      COMMON XCP90,XCPA,DELXCP,FMACH,DDXCP,XCP160,XP160,XCPD,SI,B,C     015620
      DIMENSION XCP90T(21),XCP9LM(21),                                  015630
     *          XCPAT(20,3,3),XCPALF(20),XCPALM(3),XCPAAR(3),          015640
     *          XCPDT(14,3,3),XCPDMC(14),XCPDLM(3),XCPDAR(3),          015650
     *          FMACHT(14,4),FMACHM(14),FMACHA(4),                     015660
     *          DDXCPT(21),DDXM(21)                                    015670
      DATA (XCP9LM(I),I=1,21)/0.,.051,.1,.152,.201,.252,.301,.35,.402, 015680
     1.451,.502,.551,.6,.652,.701,.752,.801,.852,.902,.951,1./          015690
      DATA (XCP90T(I),I=1,21)/.667,.665,.662,.659,.655,.649,.641,.635,  015700
     1.627,.619,.61,.601,.592,.582,.57,.561,.549,.537,.526,.513,.5/     015710
      DATA (((XCPAT(I,J,K),I=1,20),J=1,3),K=1,3)/.662,.662,.659,.650,   015720
     1.647,.647,.647,.647,.647,.654,.662,.676,.699,.725,.752,.789,.816, 015730
     2.858,.924,1.005,.422,.422,.468,.515,.527,.534,.542,.551,.566,.588,015740
     3.613,.645,.667,.674,.676,.686,.718,.765,.836,.919,.118,.118,.199, 015750
     4.306,.365,.397,.419,.439,.461,.480,.498,.517,.534,.547,.551,.561, 015760
     5.596,.657,.757,.848,.652,.652,.645,.623,.615,.625,.637,.650,.657, 015770
     6.654,.662,.723,.74,.745,.745,.752,.784,.843,.926,1.064,.402,.402, 015780
     7.449,.502,.537,.544,.556,.578,.583,.593,.608,.630,.645,.645,.65,  015790
     8.662,.676,.745,.846,.978,.228,.228,.284,.368,.404,.429,.441,.446, 015800
     9.446,.446,.495,.505,.517,.532,.547,.551,.559,.618,.694,.811,.635, 015810
     *.635,.630,.627,.603,.603,.637,.652,.657,.662,.667,.661,.699,.711, 015820
     1.723,.738,.755,.792,.863,.902,.471,.471,.498,.534,.547,.549,.556, 015830
     2.571,.578,.593,.613,.623,.630,.637,.642,.647,.662,.696,.757,.873, 015840
     3.216,.216,.301,.373,.407,.426,.446,.456,.471,.483,.495,.507,.517, 015850
     4.527,.539,.547,.561,.598,.694,.775/                               015860
      DATA (XCPALF(I),I=1,20)/0.,5.,10.,20.,30.,40.,50.,60.,70.,80.,90.,015870
     1100.,110.,120.,130.,140.,150.,160.,170.,180./                     015880
      DATA (XCPALM(I),I=1,3)/0.,.5,1./                                  015890
      DATA (XCPAAR(I),I=1,3)/.5,1.,2./                                  015900
      DATA (((XCPDT(I,J,K),I=1,14),J=1,3),K=1,3)/1.01,1.012,1.01,1.006, 015910
     1.972,.954,.942,.934,.909,.882,.863,.852,.846,.844,.9,.908,        015920
     2.918,.918,.895,.873,.856,.836,.807,.771,.745,.732,.726,.723,      015930
     3.884,.876,.858,.846,.809,.775,.744,.724,.708,.679,.654,.634,      015940
     4.620,.609,.988,1.018,1.062,1.065,1.01,.942,.898,.863,.852,.845,   015950
     5.841,.835,.835,.777,.926,.94,.996,.989,.887,.829,.785,.75,.723,   015960
     6.706,.695,.686,.680,.674,.808,.824,.823,.814,.771,.705,.649,.614, 015970
     7.59,.584,.584,.583,.583,.583,.935,.934,.916,.903,.874,.849,.825,  015980
     8.803,.783,.766,.749,.739,.739,.751,.861,.874,.882,.874,.777,.726, 015990
     9.696,.681,.669,.663,.664,.666,.676,.684,.755,.776,.786,.78,.668,  016000
     *.634,.618,.606,.596,.589,.585,.599,.62,.665/                      016010
      DATA (XCPDMC(I),I=1,14)/.6,.8,.97,1.,1.2,1.4,1.6,1.8,2.,2.2,2.4,  016020
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     12.6,2.8,3./                                                        016030
      DATA (XCPDLM(I),I=1,3)/0.,.5,1./                                   016040
60    DATA (XCPDAR(I),I=1,3)/.5,1.,2./                                   016050
      DATA ((FMACHT(I,J),I=1,14),J=1,4)/.028,.030,.028,-.019,-.2,-.284,  016060
     1-.345,-.503,-.589,-.628,-.645,-.65,-.643,-.628,.072,.07,.067,      016070
     2-.019,-.196,-.272,-.382,-.557,-.645,-.687,-.687,-.665,-.64,-.616,  016080
     3.114,.116,.116,-.026,-.196,-.269,-.372,-.503,-.594,-.621,-.616,    016090
65   4-.589,-.549,-.483,.151,.156,.163,-.026,-.2,-.274,-.314,-.314,      016100
     5-.309,-.306,-.301,-.294,-.284,-.277/                               016110
      DATA (FMACHM(I),I=1,14)/.6,.8,.88,1.,1.2,1.4,1.6,1.8,2.,2.2,2.4,   016120
     12.6,2.8,3./                                                        016130
      DATA (FMACHA(I),I=1,4)/.5,1.,1.5,2./                               016140
70    DATA (DDXCPT(I),I=1,21)/.0,-.007,-.013,-.02,-.026,-.032,-.038,     016150
     1-.044,-.049,-.055,-.06,-.065,-.069,-.074,-.078,-.082,-.086,-.089,  016160
     2-.093,-.096,-.1/                                                   016170
      DATA (DDXM(I),I=1,21)/1.,1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,2.,   016180
     12.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,3./                            016190
75    PI = 3.14159265                                                    016200
      RAD = PI/180.                                                      016210
      CALL LOOK1(XCP90,XCP90T,LAMDA,XCP9LM,21,IX,1)                      016220
      IF(ALPHA.GT. 90.) GO TO 10                                         016230
      CALL LOOK3(XCPA,XCPAT,20,3,ALPHA,XCPALF,20,LAMDA,XCPALM,3,AR,      016240
80   *XCPAAR,3,IX,IY,IZ,1)                                               016250
      DELXCP = XCP90-XCPA                                                016260
      CALL LOOK2(FMACH,FMACHT,14,MACH,FMACHM,14,AR,FMACHA,4,IX,IY,1)     016270
      XCPT = XCP90 - DELXCP*(1.+FMACH)                                   016280
      RETURN                                                             016290
85  10 CALL LOOK3(XCP160,XCPAT,20,3,160.,XCPALF,20,LAMDA,XCPALM,3,AR,     016300
     *XCPAAR,3,IX,IY,IZ,1)                                               016310
      CALL LOOK3(XCPD,XCPDT,14,3,MACH ,XCPDMC,14,LAMDA,XCPDLM,3,AR,      016320
     *XCPDAR,3,IX,IY,IZ,1)                                               016330
      IF(MACH.GT. 1.) GO TO 20                                           016340
90    DDXCP = 0.                                                         016350
      GO TO 30                                                           016360
   20 CALL LOOK1(DDXCP,DDXCPT,MACH,DDXM,21,IX,1)                         016370
   30 XP160 = XCP160 + DDXCP                                             016380
      IF(ALPHA .GT. 90. .AND. ALPHA .LT. 160.) GO TO 40                  016390
95    DXCP = XCPD - XP160                                                016400
      SI = (XP160-XCP90)/(PI*(70./180.))                                 016410
      A = ALPHA*RAD                                                      016420
      B = 112.75928 - 81.4741*A + 14.58789*A**2                          016430
      C = -32.57471 + 22.32992*A - 3.81911*A**2                          016440
100   XCPT = XCPD + B*DXCP + C*SI                                        016450
      RETURN                                                             016460
   40 CALL LOOK3(XCP90,XCPAT,20,3,90.  ,XCPALF,20,LAMDA,XCPALM,3,AR,     016470
     * XCPAAR,3,IX,IY,IZ,1)                                             016480
      XCPT = XCP90 + (XP160-XCP90)*(ALPHA-90.)/70.                       016490
105   RETURN                                                             016500
      END                                                                016510
```

```
      SUBROUTINE PHCC(ALPHA,MACH,DCR,PHC1)                                  016520
C*****************************************************************************016530
C     THIS SUBROUTINE CALCULATES PHC1, A VALUE REQUIRED BY SEVERAL            *016540
C     OTHER MARTIN METHODOLOGY SUBROUTINES                                    *016550
C                                                                             *016560
C        ALPHA     = ANGLE OF ATTACH                                        *016570
C        MACH      = MACH NUMBER                                            *016580
C        DCR       = RATIO OF BODY DIAMETER TO TAIL ROOT CHORD              *016590
C                                                                             *016600
C*****************************************************************************016610
      REAL MACH                                                             016620
      DIMENSION PC1M2(19,12,3),PC1M2A(19),PC1M2M(12),PC1M2D(3)              016630
      DATA ((PC1M2(I,J,1),I=1,19),J=1,6)/57.26,56.75,55.73,54.23,52.06,     016640
     1A8.86,45.24,42.46,40.95,39.31,37.57,36.07,34.31,32.79,31.20,29.95,016650
     2B8.89,27.95,26.86,90.1,89.28,87.28,83.79,80.08,74.14,67.11,63.27,    016660
     360.74,58.58,56.74,54.97,53.49,52.06,50.89,49.3,47.98,46.48,45.03,    016670
     4129.48,128.31,125.43,120.97,115.06,102.29,92.15,84.17,78.28,73.80,016680
     569.90,67.41,65.90,65.01,65.01,65.01,66.20,67.72,71.82,176.22,        016690
     6176.22,170.72,159.49,145.67,131.25,117.72,107.03,97.75,91.33,86.1,016700
     783.04,81.18,80.08,80.08,81.54,86.1,93.,105.11,230.25,                016710
     8230.25,218.06,194.7,176.22,158.77,145.01,133.65,125.43,119.33,       016720
     9116.86,116.62,118.79,120.97,126.,131.85,139.22,144.36,149.01,        016730
     *291.45,284.02,266.19,237.67,211.25,190.33,176.22,166.139,160.95,     016740
     1158.77,158.05,160.95,166.13,174.63,186.07,196.47,202.8,202.8,196./016750
      DATA ((PC1M2(I,J,1),I=1,19),J=7,12)/360.65,349.38,324.94,286.21,      016760
     1252.10,229.21,214.14,206.51,204.65,206.51,210.29,217.07,226.11,      016770
     2237.67,247.57,255.55,262.59,257.88,239.84,432.34,415.05,386.02,      016780
     3335.42,295.44,272.29,259.05,255.55,256.71,261.41,269.83,279.80,      016790
     4290.13,303.58,314.79,323.47,330.89,320.55,296.78,515.93,499.82,      016800
     5456.50,391.31,346.23,329.39,322.01,320.55,320.55,326.42,333.9,       016810
     6343.11,357.39,368.91,386.32,396.66,405.75,407.6,400.27,610.14,       016820
     7588.41,532.57,452.38,402.09,387.77,382.54,386.02,389.53,394.87,      016830
     8403.92,415.05,428.44,442.25,456.5,469.09,482.02,490.84,499.82,       016840
     9711.80,699.57,615.7,523.,462.75,446.27,442.25,444.26,454.44,469.1,016850
     *488.62,504.37,520.63,532.57,547.25,557.26,562.34,567.46,570.04,      016860
     1815.48,775.82,702.19,610.14,537.42,506.66,495.31,497.556,520.63,     016870
     2547.25,577.84,598.18,621.5,635.55,644.25,650.11,647.17,641.33,       016880
     3626.96/                                                              016890
      DATA ((PC1M2(I,J,2),I=1,19),J=1,6)/57.74,57.26,55.98,54.47,52.06,     016900
     149.08,48.23,42.65,41.31,41.13,41.69,42.65,43.43,42.84,41.5,40.02,    016910
     238.77,37.73,36.72,90.1,89.69,87.68,84.56,80.44,74.82,67.41,63.55,    016920
     361.29,59.91,59.1,59.1,59.77,59.91,60.19,61.04,60.19,59.11,56.04,     016930
     4130.06,128.88,126.,121.51,115.08,102.75,92.58,84.94,78.64,73.8,      016940
     570.21,68.02,66.2,65.46,65.55,66.2,67.9,76.88,85.71,176.22,177.02,    016950
     6170.72,160.88,149.67,131.25,117.72,117.52,98.20,91.74,86.89,83.41,016960
     781.54,80.44,80.44,81.41,86.49,94.7,105.11,231.29,232.34,219.05,      016970
     8197.36,176.22,160.22,145.01,134.47,126.57,120.42,117.19,117.19,      016980
     9118.79,121.01,126.57,133.05,139.85,145.01,149.69,294.1,286.21,       016990
     *267.4,247.67,210.29,191.2,174.22,166.14,160.95,159.49,158.77,        017000
     1160.95,166.13,173.84,183.23,198.26,203.73,204.65,198.26/             017010
      DATA ((PC1M2(I,J,2),I=1,19),J=7,12)/362.26,352.56,326.42,286.21,      017020
     1252.24,230.25,214.14,206.51,204.65,206.51,209.34,217.07,226.11,      017030
     2237.67,248.69,256.71,263.79,259.05,239.84,432.34,416.94,387.77,      017040
     3335.42,298.13,274.77,260.22,256.71,256.71,260.22,267.4,278.53,       017050
     4292.77,304.94,314.79,324.94,332.39,322.47,298.13,515.93,502.09,      017060
     5456.5,393.08,347.8,330.89,322.01,322.55,320.55,324.96,333.9,         017070
     6346.23,359.02,373.96,387.77,398.46,405.75,407.6,400.27,607.38,       017080
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      7593.77,532.57,452.38,403.92,387.77,382.54,386.02,389.53,396.66,    017090
      8407.6,418.83,434.3,446.27,458.58,466.97,479.84,488.62,499.82,      017100
60    9705.38,686.45,618.49,518.28,464.86,448.3,442.25,444.26,452.38,     017110
     *469.09,493.07,508.97,523.,534.99,544.77,552.23,559.79,564.89,       017120
      1570.04,815.48,775.82,702.19,610.14,537.42,508.97,495.31,499.82,    017130
      2520.63,549.74,585.75,610.14,629.81,638.43,644.25,650.11,650.11,    017140
      3638.,626.96/                                                       017150
65    DATA ((PC1M2(I,J,3),I=1,19),J=1,6)/58.04,57.26,56.23,54.47,52.3,    017160
      149.08,45.23,42.65,41.5,41.5,41.88,42.65,43.23,44.02,44.42,44.83,   017170
      245.03,45.23,45.65,90.92,90.1,88.08,84.56,80.44,74.46,67.41,63.84,  017180
      361.25,59.37,59.1,59.64,59.91,60.46,61.01,61.85,62.69,63.,64.13,130017190
      4.06,128.89,126.,121.51,115.08,102.29,92.58,84.56,79.,74.14,70.53,  017200
70    568.02,66.20,65.3,65.7,66.5,70.21,77.23,85.71,177.02,177.02,171.49,017210
      6160.95,147.,131.25,118.25,108.01,98.2,92.16,86.89,83.41,81.54,     017220
      7P0.44,80.74,82.29,86.49,94.27,105.11,231.29,232.34,220.04,198.26,  017230
      8177.02,160.95,146.33,135.48,126.,119.87,117.19,117.19,118.79,      017240
      9122.07,126.57,133.05,139.65,145.01,149.69,294.1,287.51,269.83,     017250
75    *238.75,211.25,192.07,177.02,166.89,161.68,159.49,159.49,160.95,    017260
      1166.13,174.63,185.23,197.36,203.73,204.65,199.16/                  017270
      DATA ((PC1M2(I,J,3),I=1,19),J=7,12)/363.93,350.97,326.42,287.51,    017280
      1253.24,232.34,215.11,207.45,205.58,207.45,211.25,217.07,227.14,    017290
      2236.6,247.57,255.55,264.98,260.22,239.84,434.3,418.83,389.53,      017300
80    3336.94,298.13,274.77,262.59,256.71,257.88,262.59,271.06,279.8,     017310
      4291.45,303.58,314.79,324.94,332.39,323.47,296.78,518.28,504.37,    017320
      5460.66,393.08,350.97,332.39,323.47,322.01,322.01,326.42,333.9,     017330
      6344.66,357.39,372.27,386.02,396.66,403.92,407.6,400.27,612.91,     017340
      7596.47,534.99,458.58,405.75,389.53,384.27,387.77,391.3,398.46,     017350
85    8405.75,416.94,432.34,446.27,456.5,466.97,479.84,490.84,499.82,     017360
      9715.04,692.71,621.3,525.37,466.97,448.3,442.25,444.26,456.5,469.1,017370
      *488.62,504.37,520.63,532.57,544.77,552.23,559.79,564.89,572.63,    017380
      1819.19,782.89,708.58,612.91,539.86,506.66,495.31,499.82,520.63,    017390
      2549.74,583.1,604.63,624.13,635.55,644.25,647.17,647.17,641.33,     017400
90    3626.96/                                                            017410
      DATA (PC1M2A(I),I=1,19)/0.,2.5,5.,7.5,10.,12.5,15.,17.5,20.,22.,25017420
      1.,27.5,30.,32.5,35.,37.5,40.,42.5,45./                             017430
      DATA (PC1M2M(I),I=1,12)/.8,1.,1.2,1.4,1.6,1.8,2.0,2.2,2.4,2.6,2.8,017440
      13.0/                                                               017450
95    DATA (PC1M2D(I),I=1,3)/.5,.75,1./                                   017460
      IF(DCR.GE.1.) DCR=1.                                                017470
      IF(DCR.LE. .5) DCR=.5                                               017480
      CALL LOOK3(PHC1M2,PC1M2,19,12,ALPHA,PC1M2A,19,MACH,PC1M2M,12,DCR,   017490
     *PC1M2D,3,IX,IY,IZ,1)                                                017500
100   PHC1 = PHC1M2/MACH**2                                               017510
      RETURN                                                              017520
      END                                                                 017530
```

```
      SUBROUTINE AXIAL(LAD,LND,MACH,AWOR,ALPHA,RN,CA)                    018570
C*****************************************************************************018580
C     THIS PROGRAM CALCULATES THE AXIAL FORCE COEFFICIENT ON THE BODY      *018590
C                                                                          *018600
C       LAD     =     LENGTH OF AFTER-BODY DIVIDED BY BODY DIAMETER       *018610
C       LND     =     LENGTH OF NOSE DIVIDED BY BODY DIAMETER            *018620
C       MACH    =     MACH NUMBER                                        *018630
C       ALPHA   =     ANGLE OF ATTACK                                    *018640
C       RN      =     REYNOLDS NUMBER                                    *018650
C       CA      =     AXIAL FORCE COEFFICIENT                            *018660
C                                                                          *018670
C*****************************************************************************018680
      DIMENSION TLAD(4),TLND(3),TMACH(12),TRN(14),TCAOCA(14),TCDB(12),     018690
     $TCA1B(8,4,3),TMACH1(8)                                               018700
      REAL LAD,LND,MACH                                                    018710
      DATA(TLAD(I),I=1,4)/6.0,10.0,15.0,18.0/                              018720
      DATA(TLND(I),I=1,3)/1.5,2.5,3.5/                                     018730
      DATA(TMACH(I),I=1,12)/0.6,0.7,0.8,0.9,1.0,1.1,1.2,1.3,1.5,2.0,2.5,018740
     $3.0/                                                                 018750
      DATA(TMACH1(I),I=1,8)/.6,.7,.8,.9,1.,1.1,1.2,1.3/                    018760
      DATA(TRN(I),I=1,14)/1.05E06,1.15E06,1.3E06,1.55E06,1.85E06,2.55E0 018770
     $6,3.6E06,4.7E06,6.25E06,8.3E06,10.25E06,12.05E06,14.35E06,16.3E06/018780
      DATA(TCAOCA(I),I=1,14)/4.45,4.05,3.625,3.038,2.65,2.313,2.013,1.76018790
     $3,1.525,1.325,1.2,1.113,1.05,1.025/                                  018800
      DATA(TCDB(I),I=1,12)/0.135,0.139,0.145,0.160,0.184,0.222,0.217,0.2018810
     $08,0.194,0.158,0.125,0.099/                                          018820
      DATA(((TCA1B(I,J,K),I=1,8),J=1,4),K=1,3)/0.316,0.316,0.318,0.350, 018830
     $0.453,0.547,0.593,0.608,0.51,                                        018840
     $0.51,0.515,0.542,0.630,0.739,0.795,0.812,0.817,0.817,0.825,0.844, 018850
     $0.935,1.036,1.095,1.120,0.967,0.972,0.972,0.997,1.088,1.184,1.240,018860
     $1.265,0.322,0.324,0.324,0.327,0.396,0.456,0.463,0.463,0.518,0.518,018870
     $0.520,0.528,0.590,0.652,0.664,0.667,0.751,0.751,0.766,0.798,0.865,018880
     $0.900,0.905,0.910,0.907,0.912,0.932,0.959,1.004,1.039,1.054,1.059,018890
     $0.329,0.329,0.332,0.334,0.364,0.403,0.426,0.448,0.525,0.528,0.528,018900
     $.530,.560,.600,.609,.612,.788,0.793,0.793,0.793,0.883,0.870,0.887,018910
     $0.885,0.925,0.927,0.927,0.932,0.982,1.019,1.011,1.016/              018920
      CALL LOOK1(CDB,TCDB,MACH,TMACH,12,IX,1)                              018930
      ALPHAP = (9.0/7.0)*SIN((ALPHA-90.0)/57.2957)*57.2957                 018940
      IF(MACH.GT.1.3) GO TO 70                                             018950
      CALL LOOK1(CAOCA,TCAOCA,RN,TRN,14,IX,1)                              018960
      CALL LOOK3(CA1B,TCA1B,8,4,MACH,TMACH1,8,LAD,TLAD,4,LND,TLND,3,IX,  018970
     $IY,IZ,1)                                                             018980
      CA1 = (CA1B-(0.04*LAD))*CAOCA                                        018990
      CA0 = CA1 + CDB                                                      019000
      IF (ALPHA.LT.20.0) GO TO 10                                          019010
      IF(ALPHA.GT.90.) GO TO 20                                            019020
      CABAR = -1.3 + 1.42857*(MACH-0.6)                                    019030
      FFMA = -0.844489*(ALPHA/57.2957) + 1.92007*(ALPHA/57.2957)**2 -    019040
     $ 1.445868*(ALPHA/57.2957)**3 + 0.360182*(ALPHA/57.2957)**4 +       019050
     $ CABAR*(0.147331*(ALPHA/57.2957) - 1.84236*(ALPHA/57.2957)**2 +    019060
     $4.913366*(ALPHA/57.2957)**3 - 2.419275*(ALPHA/57.2957)**4)         019070
      GO TO 30                                                             019080
   10 FFMA = -SIN(ALPHA/57.2957)**2                                        019090
   30 CA = CA0 +FFMA                                                       019100
      GO TO 40                                                             019110
   20 CAPI = -(2.9217-9.1867*(MACH)+14.0023*(MACH)**2-8.7943*(MACH)**3+ 019120
     $2.4985*(MACH)**4-0.2658*(MACH)**5)                                   019130
```

```
      IF(ALPHA.GE. 160.) GO TO 15                                          019140
      CA = CA0-(CA0-CAPI)*SIN(ALPHAP/57.2957)                              019150
60    GO TO 40                                                             019160
   15 CONTINUE                                                             019170
      CA = CAPI                                                            019180
      GO TO 40                                                             019190
   70 IF(ALPHA.GT.90.) GO TO 50                                            019200
65    CAW =(-0.0008 + 0.1501*(MACH/LND) + 0.3641*(MACH/LND)**2 + 0.0928*019210
     $(MACH/LND)**3 - 0.0409*(MACH/LND)**4 + 0.004*(MACH/LND)**5)/(0.7+ 019220
     $MACH**2)                                                           019230
      CALL CSF(RN,MACH,CF)                                                 019240
      CASF = (4.0/5.0)*CF*AWOR                                             019250
70    CA0 = CAW + CASF +CDB                                                019260
      CA = CA0                                                             019270
      GO TO 40                                                             019280
   50 IF(ALPHA.GE. 160.) GO TO 60                                          019290
      CAPI = -(2.9217-9.1867*(MACH)+14.0023*(MACH)**2-8.7943*(MACH)**3+ 019300
     $2.4985*(MACH)**4-0.2658*(MACH)**5)                                 019310
75    CA = CA0-(CA0-CAPI)*SIN(ALPHAP/57.2957)                              019320
      GO TO 40                                                             019330
   60 CAPI = -(2.9217-9.1867*(MACH)+14.0023*(MACH)**2-8.7943*(MACH)**3+ 019340
     $2.4985*(MACH)**4-0.2658*(MACH)**5)                                 019350
80    CA = CAPI                                                            019360
   40 CONTINUE                                                             019370
      RETURN                                                               019380
      END                                                                  019390
```

```
      SUBROUTINE CSF(RN,MACH,CF)                                                019480
C*****************************************************************************019410
C     THIS PROGRAM CALCULATES THE SKIN FRICTION COEFFICIENT ON THE BODY *019420
C                                                                       *019430
C        RN      =     REYNOLDS NUMBER                                  *019440
C        MACH    =     MACH NUMBER                                      *019450
C        CF      =     SKIN FRICTION COEFFICIENT                        *019460
C                                                                       *019470
C*****************************************************************************019480
      REAL MACH,LAM                                                             019490
      G = 1.4                                                                   019500
      LAM = 1.0/SQRT((2.0/((G-1.0)*MACH**2))+1.0)                               019510
      CF1 = 0.074*(1.0/RN**.2)*1.0/(1.0+(0.9*((G-1.0)/2.0)*MACH**2)**.44 019520
      FCF1  = (ASIN(LAM)/LAM)*1.0/SQRT(1.0+((G-1.0)/2.0)*MACH**2)*(.242/019530
     $SQRT(CF1))-ALOG10(CF1*RN)*1.26*(ALOG10(1.+((G-1.)/2.)*MACH**2))   019540
      CF2 = CF1 + 0.00001                                                       019550
      FCF2  = (ASIN(LAM)/LAM)*1.0/SQRT(1.0+((G-1.0)/2.0)*MACH**2)*(.242/019560
     $SQRT(CF2))-ALOG10(CF2*RN)*1.26*(ALOG10(1.+((G-1.)/2.)*MACH**2))   019570
      N = 1                                                                     019580
   10 DCFODF = ((CF2-CF1)/(FCF2-FCF1))                                          019590
      CF3 = CF2 - DCFODF*FCF2                                                   019600
      IF(FCF2.LT.0.0) GO TO 15                                                  019610
      CF3 = CF1 - DCFODF*FCF1                                                   019620
   15 N = N + 1                                                                 019630
      FCF3  = (ASIN(LAM)/LAM)*1.0/SQRT(1.0+((G-1.0)/2.0)*MACH**2)*(.242/019640
     $SQRT(CF3))-ALOG10(CF3*RN)*1.26*(ALOG10(1.+((G-1.)/2.)*MACH**2))   019650
      IF(ABS(FCF3).LE.0.000001) GO TO 20                                        019660
      CF1 = CF2                                                                 019670
      FCF1 = FCF2                                                               019680
      CF2 = CF3                                                                 019690
      FCF2 = FCF3                                                               019700
      IF(N.GT.50.0) GO TO 30                                                    019710
      GO TO 10                                                                  019720
   20 CF = CF3                                                                  019730
      GO TO 50                                                                  019740
   30 WRITE(6,35)                                                               019750
   35 FORMAT(1H0,* THE ITERATION HAS  GONE THROUGH 50 CYCLES*)                  019760
   50 CONTINUE                                                                  019770
      RETURN                                                                    019780
      END                                                                       019790
```

```
      SUBROUTINE LOOK1(F,FT,X,XT,NX,IX,MULT)                                017540
C*****************************************************************************017550
C   ONE-DIMENSIONAL TABLE LOOKUP ROUTINE  (* = RETURNED VALUES)              017560
C    *F              = FT(X)                                                 017570
C     FT             FUNCTION TABLE  FT(NR)                                  017580
C     NR             NO. OF ROWS IN FT-TABLE                                 017590
C     NC             NO. OF COLUMNS IN FT-TABLE                              017600
C     X              WORKING VALUE OF INDEPENDENT VARIABLE                   017610
C     XT             INDEPENDENT VARIABLE TABLE                              017620
C     NX             DIMENSION OF XT TABLE                                   017630
C    *IX             X  INDEX ON PRIVIOUS LOOKUP  (UPDATED ON EACH CALL)     017640
C     MULT           =0,  USE PREVIOUS X                                     017650
C                    *1,  LOOKUP NEW X                                       017660
C*****************************************************************************017670
      DIMENSION FT(1),XT(1)                                                 017680
      IF(MULT-1)2,1,2                                                       017690
    1 CALL INDEX(X,XT,NX,IX,KEEP,RX)                                        017700
    2 F=FT(IX)                                                              017710
      IF(KEEP-1)3,4,3                                                       017720
    3 F=(FT(IX+1)-F)*RX+F                                                   017730
    4 RETURN                                                                017740
      END                                                                   017750
```

```
      SUBROUTINE LOOK3(F,FT,NR,NC,X,XT,NX,Y,YT,NY,Z,ZT,NZ,IX,IY,IZ,MULT)017760
C*****************************************************************************017770
C   THREE-DIMENSIONAL TABLE LOOKUP ROUTINE  (* = RETURNED VALUES)          017780
C     F             =FT(X,Y,Z)  (RETURNED VALUE)                          017790
C     FT            FUNCTION TABLE FT(NR,NC,NP)                           017800
C     NR            NO. OF ROWS IN FT-TABLE                               017810
C     NC            NO. OF COLUMNS IN FT-TABLE                            017820
C     X,Y,Z         WORKING VALUES OF INDEPENDENT VARIABLES               017830
C     XT,YT,ZT      INDEPENDENT VARIABLE TABLES                           017840
C     NX,NY,NZ      DIMENSION OF XT,YT,ZT TABLES                          017850
C    *IX,IY,IZ      X,Y,Z INDEXES ON PREVIOUS LOOKUP (UPDATED ON EACH CAL)017860
C     MULT          =0, USE PREVIOUS X,Y,Z                                017870
C                   =1, LOOK UP NEW X,Y,Z                                 017880
C*****************************************************************************017890
      DIMENSION FT(1),XT(1),YT(1),ZT(1)                                    017900
      IF(MULT-1)2,1,2                                                      017910
    1 CALL INDEX(Z,ZT,NZ,IZ,KEEP,RZ)                                      017920
      I = 1+(IZ-1)*NR*NC                                                   017930
      II = I+NP*NC                                                         017940
    2 CALL LOOK2(F,FT(I),NR,X,XT,NX,Y,YT,NY,IX,IY,MULT)                    017950
      IF(KEEP-1)3,4,3                                                      017960
    3 CALL LOOK2(F2,FT(II),NR,X,XT,NX,Y,YT,NY,IX,IY,1)                     017970
      F=(F2-F)*RZ+F                                                        017980
    4 RETURN                                                               017990
      END                                                                  018000
```

```
      SUBROUTINE LOOK2(F,FT,NR,X,XT,NX,Y,YT,NY,IX,IY,MULT)                018320
C*****************************************************************************016330
C     TWO-DIMENSIONAL TABLE LOOKUP ROUTINE  (* = RETURNED VALUES)          018340
C     F             =FT(X,Y)                                               018350
C     FT            FUNCTION TABLE FT(NR,NC)                               018360
C     NR            NO. OF ROWS IN FT-TABLE                                018370
C     NC            NO. OF COLUMNS IN FT-TABLE                             018380
C     X,Y           WORKING VALUES OD INDEPENDENT VARIABLES                018390
C     XT,YT,        INDEPENDENT VARIABLE TABLES                            018400
C     NX,NY         DIMENSION OF XT,YT,TABLES                              018410
C    *IX,IY         X,Y  INDEXES ON PREVIOUS LOOKUP (UPDATED ON EACH CALL  018420
C     MULT          =0,  USE PREVIOUS X,Y                                  018430
C                   =1,  LOOKUP NEW X,Y                                    018440
C*****************************************************************************018450
      DIMENSION FT(1),XT(1),YT(1)                                          018460
      IF(MULT-1)2,1,2                                                      018470
    1 CALL INDEX(Y,YT,NY,IY,KEEP,RY)                                       018480
      I = 1+(IY-1)*NR                                                      018490
      II = I+NR                                                            018500
    2 CALL LOOK1(F,FT(I),X,XT,NX,IX,MULT)                                  018510
      IF(KEEP-1)3,4,3                                                      018520
    3 CALL LOOK1(F2,FT(II),X,XT,NX,IX,1)                                   018530
      F=(F2-F)*RY+F                                                        018540
    4 RETURN                                                               018550
      END                                                                  018560
```

```
      SUBROUTINE INDEX(X,XT,NX,IX,KEEP,RATIO)                          018010
C*****************************************************************    018020
C  TABLE INDEX LOOKUP ROUTINE  (* = RETURNED VALUES)                   018030
C     X              WORKING VALUE OF INDEPENDENT VARIABLE             018040
C     XT             INDEPENDENT VARIABLE TABLE  XT(NX)                018050
C     NX             DIMENSION OF X-TABLE                              018060
C     IX             INDEX OF PREVIOUS LOOKUP (UPDATED EACH CALL)      018070
C    *KEEP           =0   X.NE.ANY XT. INTERPLOATION WAS REQUIRED.     018080
C                    =1   X.EQ.XT(IX). INTERPOLATION NOT REQUIRED.     018090
C    *RATIO          INTERPOLATION RATIO                               018100
C*****************************************************************    018110
      DIMENSION XT(1)                                                  018120
      RATIO = 0.                                                       018130
      KEEP = 0                                                         018140
      IF(NX-IX)1,1,2                                                   018150
    1 IX = NX-1                                                        018160
    2 IF(IX-1)3,3,4                                                    018170
    3 IX = 1                                                           018180
    4 IF(NX-1)10,10,5                                                  018190
    5 IF(XT(IX)-X)6,10,7                                               018200
    6 IF(XT(IX+1)-X)8,9,11                                             018210
    7 IX = IX-1                                                        018220
      IF(IX-1)9,5,5                                                    018230
    8 IX = IX+1                                                        018240
      IF(IX-NX)5,10,10                                                 018250
    9 IX = IX+1                                                        018260
   10 KEEP = 1                                                         018270
      RETURN                                                           018280
   11 RATIO = (X-XT(IX))/(XT(IX+1)-XT(IX))                             018290
      RETURN                                                           018300
      END                                                              018310
```

## Appendix B. DESCRIPTION OF SUBROUTINES AND PROGRAM LISTING

Table B-1 lists the subroutines and gives their basic function.

A detailed description of each subroutine will not be included in this report. The logic and procedures required of each included method are discussed in detail in Reference 1. The applicable section of Reference 1 for each of the Methodology Program Subroutines is listed in Table B-1.

TABLE B-1. LIST OF PROGRAM ELEMENTS

| SUBPROGRAM NAME | REF. 1 SECTION | FUNCTION OF SUBPROGRAM |
|---|---|---|
| MAIN | | Controls input and output to the program. Uses various subroutines to calculate aerodynamic coefficients and centers of pressure for total missile and isolated components. |
| CNTPHI | SEC.5.2.1 | Calculates tail normal force coefficient in presence of a cylindrical body as a function of roll angle. (Angle of attack limited to 0 to 45 degrees). |
| CNTT | SEC.5.1.4 | Calculates tail normal force coefficient of an isolated tail (angle of attack 0 to 180 degrees). |
| BRIT | | Contains data required by several other Methodology subroutines. Data is taken from British Data Sheets. (Reference 3). |
| CNBOD | SEC.5.1.1 | Calculates body alone normal force coefficient (angle of attack 0 to 180 degrees). |
| XCPBOD | SEC.5.1.2 | Calculates body alone center of pressure measured in calibers from the nose. (Angle of attack 0 to 180 degrees). |
| IBTT | SEC.5.2.4 | Calculates body normal carry over force coefficent. |
| XCPBTT | SEC.5.2.5 | Calculates tail-to-body carry over normal force center of pressure. |
| XCPTBB | SEC.5.2.2 | Calculates the tail chordwise center of pressure (upper and lower bound)/ tail root chord, measured aft from root chord leading edge. |

| SUBPROGRAM NAME | REF. 1 SECTION | FUNCTION OF SUBPROGRAM |
|---|---|---|
| YCPTS | SEC.5.2.3 | Calculates tail spanwise center of pressure for isolated tail. |
| XCPTT | SEC.5.1.5 | Calculates chordwise center of pressure for isolated tail for roll angle = 0. |
| PHCC | | Required by several other Methodology Subroutines. |
| AXIAL | SEC.5.1.3 | Calculates the axial force coefficient for the missile body. |
| CSF | SEC.5.1.3 | Calculates the skin friction coefficient for the missile body. |
| LOOK1 | | One-dimensional table look-up subroutine. |
| LOOK2 | | Two-dimensional table look-up subroutine. |
| LOOK3 | | Three-dimensional table look-up subroutine. |
| INDEX | | Required for subroutines LOOK1, LOOK2, and LOOK3. |

A complete program listing follows.

## REFERENCES


1. Aiello, G.F., "Aerodynamic Methodology (Bodies With Arbitrary Roll Angles, Transonic and Supersonic)", Final report on USAMICOM Contract DAAH01-74-C-0621, OR 14,145, April 1976.

2. Spring, D.J., Derrick, J.N., and Winn, G.C., "An Assessment of the Martin-Marietta High Angle of Attack Aerodynamic Methodology for Body-Tail Missiles", TR RD-76-33, US Army Missile Command, June 1976.

3. Royal Aeronautical Society, Data Sheets, Wings 5.01.03.03, 5.01.03.04, 5.01.03.05, and 5.01.03.06.

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