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 AN EXPERIMENTAL STUDY OF DYNAMIC STALL ON ADVANCED AIRFOIL SECT--ETC(U)
 JUL 82 W J MCCROSKEY, K W MCALISTER, L W CARR
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An Experimental Study of Dynamic Stall on Advanced Airfoil Sections Volume 1. Summary of the Experiment

W. J. McCroskey, K. W. McAlister, L. W. Carr, and
S. L. Pucci

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An Experimental Study of Dynamic Stall on Advanced Airfoil Sections

Volume 1. Summary of the Experiment

W. J. McCroskey

K. W. McAlister

L. W. Carr

S. L. Pucci, Aeromechanics Laboratory
AVRADCOR Research and Technology Laboratories
Ames Research Center, Moffett Field, California



National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, California 94035

United States Army
Aviation Research and
Development Command
St. Louis, Missouri 63166



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SYMBOLS

A	static lift coefficient at $\alpha = 0$ (see table 10)
B	static $C_{L\alpha} \sqrt{1 - M_\infty^2}$ (see table 10)
C_C	chord force coefficient
C_D	form drag coefficient derived from surface pressure measurements
C_{DW}	total drag coefficient derived from wake survey (see table 7)
C_L	lift coefficient
$C_{L\alpha}$	lift-curve slope at low α , per deg
C_M	quarter-chord pitching moment coefficient
C_{M_0}	static pitching-moment coefficient at zero angle of attack
C_N	normal force coefficient
C_p	pressure coefficient
c	airfoil chord, m
k	reduced frequency, $\omega c/2U_\infty$
L/D	ratio of lift to drag
M_∞	free-stream Mach number (also M in table 11 and fig. 14)
$M_{\max}$	maximum local Mach number on the airfoil
q_∞	free-stream dynamic pressure, N/m^2 (also Q, psi, in table 11)
Re	Reynolds number based on chord and free-stream conditions
r_0	leading-edge radius, m
t	time, sec
U_∞	free-stream velocity, m/sec
$X_{a.c.}$	chordwise location of the aerodynamic center of pressure at zero lift
x	chordwise coordinate, m (see fig. 6)
y	normal coordinate, m (see fig. 6)
α	angle of attack, deg
$\alpha_{C_{\min}}$	angle of attack for maximum negative chordwise force, deg

$\alpha_{L_{\max}}$ angle of attack for maximum lift, deg
 $\alpha_{M_{\max}}$ angle of attack for maximum local Mach number, deg
 α_0 mean angle, deg (also $A0$ in computer printouts); also angle for zero lift in table 8 and figs. 9-11
 α_{ss} static-stall angle, corresponding to $C_{L_{\max}}$, deg
 α_1 amplitude, deg (also $A1$ in table 11 and fig 14)
 α_2 magnitude of second harmonic of α , deg
 β $\sqrt{1 - M_\infty^2}$
 ζ aerodynamic pitch damping coefficient, $-\frac{1}{4\alpha_1^2} \oint C_M d\alpha$
 ϕ_2 phase of second harmonic component of α , deg
 ω circular frequency, rad/sec

AN EXPERIMENTAL STUDY OF DYNAMIC STALL ON ADVANCED AIRFOIL SECTIONS

VOLUME 1. SUMMARY OF THE EXPERIMENT

W. J. McCroskey, K. W. McAlister, L. W. Carr, and S. L. Pucci

U.S. Army Aeromechanics Laboratory (AVRADCOM), Ames Research Center

SUMMARY

The static and dynamic characteristics of seven helicopter sections and a fixed-wing supercritical airfoil were investigated over a wide range of nominally two-dimensional flow conditions, at Mach numbers up to 0.30 and Reynolds numbers up to 4×10^6 . Details of the experiment, estimates of measurement accuracy, and test conditions are described in this volume (the first of three volumes). Representative results are also presented and comparisons are made with data from other sources. The complete results for pressure distributions, forces, pitching moments, and boundary-layer separation and reattachment characteristics are available in graphical form in volumes 2 and 3.

The results of the experiment show important differences between airfoils, which would otherwise tend to be masked by differences in wind tunnels, particularly in steady cases. All of the airfoils tested provide significant advantages over the conventional NACA 0012 profile. In general, however, the parameters of the unsteady motion appear to be more important than airfoil shape in determining the dynamic-stall airloads.

1. INTRODUCTION

Retreating-blade stall limits the high-speed performance of most modern helicopters. In the past decade, numerous new airfoils have been designed in attempts to improve the stall characteristics of rotors without compromising the advancing-blade performance. Only a few of these have been tested under unsteady conditions, and some have not been tested at all. Furthermore, there is almost no overlap between the existing data sets with regard to the important parameters of oscillatory motion.

The motivation of the present experimental investigation was the obvious need for a standard data base for a series of modern rotor-blade sections. The primary objective was to measure the unsteady airloads, over an extensive matrix of test conditions, on the eight profiles shown in figure 1. Other investigations were also overlapped as much as possible. The NACA 0012 served primarily as a standard reference section; the six modern helicopter sections were chosen as representative of contemporary designs from several different companies and research organizations. A modern fixed-wing supercritical profile was also included to extend the range of leading-edge geometries and to provide a basis for comparison with oscillating-airfoil results obtained in other wind tunnels.

Secondary objectives were to investigate the type of stall and boundary-layer separation characteristics for each profile, to provide guidelines for estimating the dynamic-stall characteristics of new airfoils in the future, to supplement the conventional lift and pitching-moment measurements with unsteady drag data and

stall-flutter boundaries, and to determine the effects of leading-edge roughness that is comparable to the erosion of blades in service or in incipient icing conditions.

Dynamic stall depends on a large number of parameters. Consequently, a very large number of unsteady test points (more than 600) plus 44 sets of static data were required to fulfill the objectives of this investigation. As a result, the complete report consists of three volumes. The present volume summarizes the experiment and some of the principal results, including comparisons with data from other sources. It also contains a comprehensive index of the individual unsteady data points. Volume 2 (Pressure and Force Data) contains the pressure, force, and moment data in graphical form. These data are also available upon request on digital computer tapes, one tape for each airfoil, as explained in volume 2. In addition, there is a single tape containing only the 10 test cases that were discussed in reference 1 for the NACA 0012, Vertol VR-7, and NLR-7301 airfoils. Boundary-layer transition, flow reversal, and reattachment results appear in volume 3 (Hot-Wire and Hot-Film Measurements).

This report is primarily intended to assist the users of the data; therefore, the results are not discussed at length. The principal results have been published in references 1 and 2.

2. DESCRIPTION OF THE EXPERIMENT

Test Apparatus

The experiment was performed in the 2- by 3-m atmospheric-pressure, solid-wall Wind Tunnel at the U.S. Army Aeromechanics Laboratory. The tests were conducted in essentially the same manner as those in a previous experiment (refs. 3,4), except that the free-stream Mach number was extended to 0.3, the model chord c was reduced to 0.61 m (except for the Hughes HH-02 airfoil, $c = 0.69$ m), the frequency of oscillation was extended to 11 Hz, and the data processing was refined considerably. The models spanned the 2.13-m vertical dimension of the wind tunnel, as indicated in figure 2, and were oscillated sinusoidally in pitch about the quarter chord. A gap of approximately 2 mm existed between the ends of the model and the wind-tunnel walls.

The drive mechanism used (fig. 3) was the same one described in references 3 and 4, with some notable improvements. In some cases, the connecting push rod was fitted with a remotely controlled jackscrew mechanism that allowed the mean angle, α_0 , to be varied continuously while the tunnel was operating. Discrete amplitudes of oscillation of 2°, 5°, 6°, 8°, 10°, or 14° could be set between runs. The motion of the airfoils was given by $\alpha \approx \alpha_0 + \alpha_1 \sin \omega t$, with maximum higher harmonic distortion approximately 2% of α_1 . Table 1 gives the harmonic content of the mechanism for various values of α_0 and α_1 . The frequency of oscillation could be varied between approximately 0.02 and 12 Hz.

The models of the eight airfoils (fig. 1) consisted of interchangeable shells constructed of wood and fiberglass. These shells surrounded a stainless steel spar that contained the instrumentation and wiring, as indicated schematically in figures 2 and 4. The shells contained special fittings for the pressure transducers and hot-wire or hot-film sensors (fig. 5) that facilitated model changes without disconnecting the instrumentation.

Each set of shells was precision-machined, while mounted on the spar, to a design accuracy of ± 0.1 mm. However, measurements after the test revealed that the rms standard deviation of the coordinates from the design values was about 0.4 mm, or 0.06% of chord, and that the maximum error was about 0.8 mm. The nominal design coordinates of the airfoils are given in tables 2-5, referred to the standard coordinate system sketched in figure 6. The coordinates were taken originally from references 5-9 and from Amer (K. Amer, private communication, 1977).

A limited amount of static and dynamic data were obtained on each airfoil at $M_\infty = 0.185$ and 0.29 with a boundary-layer trip, consisting of a 3-mm-wide band of 0.10-mm-diam glass spheres glued to the leading edge. The purpose of the trip was to eliminate the laminar separation bubble that would normally form near the leading edge as the stall angle was approached. It also approximately simulated surface abrasion on helicopter blades operating under severe field conditions, as well as roughness caused by incipient icing conditions.

Instrumentation

The primary data were obtained from 26 Kulite differential pressure transducers, types YCQH-250-1 and YCQL-093-15. Those of the latter type were used in the leading- and trailing-edge regions, because of their smaller size. The locations of the transducers for each airfoil are given in table 6. The back side of each transducer was referenced to the total pressure of the wind tunnel; total pressure was measured about 1.5 m upstream of the model. The measuring side of the transducers mated with the fittings shown in figure 5, which had 0.79-mm-diam orifices. The transducers thus installed had flat amplitude versus frequency responses of 250 Hz or better and typical cavity resonance frequencies of about 850 Hz.

Special on-line analog computers that calculated and displayed the instantaneous normal force, pitching moment, pitch damping, and pressure distributions proved to be extremely valuable in assessing the dynamic-stall behavior, as well as the performance of the instrumentation, while the tests were in progress. These devices also enabled the unsteady parameters to be adjusted until some desired result was obtained, such as the maximum lift condition in the absence of moment stall or neutral aerodynamic damping in pitch.

Boundary-layer transition, flow reversal, separation, and reattachment were studied with a variety of surface hot films and hot-wire sensors (single-, double-, and triple-element probes), using the techniques described in references 4, 10, and 11. Six sensors were used on the upper surface of each airfoil, at the locations given in table 6. In addition, a hot-wire probe protruding just outside the boundary layer was mounted near the leading edge of the NLR-1 profile to aid in diagnosing the local supersonic zone that was frequently inferred at high incidence.

The leading-edge region was also examined with a shadowgraph flow visualization system (fig. 7). The high-intensity strobe light was fired at selected phase angles during the oscillation, and the pattern that developed on the Scotchlite high-gain reflective sheeting on the floor of the tunnel was photographed by the pulse camera above the test section. A representative photograph is shown in figure 8.

Finally, a traversing pitot-static probe was used to survey the wake behind each airfoil under steady-flow conditions. The steady drag of the airfoils at $M_\infty = 0.30$ was derived from these measurements; these drag coefficients are listed in table 7.

Data Analysis and Measurement Accuracy

For quantitative purposes, the pressure transducer and hot-wire signals were amplified and recorded on a 32-channel analog tape recorder with 2500-Hz flat frequency response. In addition, the average free-stream dynamic pressure, the instantaneous angle of attack of the model, and 1/cycle and 200/cycle timing indicators were recorded simultaneously. Calibrations of the pressure transducers were recorded at the beginning and end of each analog tape. The unsteady data tapes were digitized and ensemble-averaged off line. At least 50 cycles of data were normally sampled 200 times per cycle; however, for the NACA 0012 airfoil at very low frequencies, that is, $k < 0.002$, only about 10 cycles were recorded. Reference and calibration signals and the steady pressure data were acquired with the same system and were digitally sampled 100 times over a 5-sec interval. The averaged pressure data were then processed and integrated numerically by trapezoidal rule to determine the unsteady lift, moment, and pressure drag.

End-to-end checks of the data acquisition and processing system indicated that the pressure signals were reproduced to within an rms error of approximately 70 N/m^2 (0.01 psi), and that the transducer calibrations were reliable to better than $\pm 150 \text{ N/m}^2$ (0.02 psi) or $\pm 3\%$ of the reading, whichever was greater, over the range of tunnel speeds and temperatures. The model temperature, measured inside the shells, was closely monitored and not allowed to vary more than 3°C between records of no-flow pressure readings. Transducer zero drift was normally controlled to within the greater value of either $\pm 150 \text{ N/m}^2$ (0.02 psi) or $\pm 5\%$ of free-stream dynamic pressure. However, some exceptions are noted later in this section.

The hot-wire and hot-film signals were recorded as consecutive, separate data frames, and individual cycles of the analog records were examined to determine the boundary-layer characteristics, as discussed in references 4, 10, and 11. For these data, the results from three to eight cycles were averaged to obtain the relative times within the cycle, ωt , at which the various boundary-layer events occurred.

The instantaneous angle of attack was measured with a potentiometer attached to the tubular portion of the model spar (fig. 3). The angle-of-attack signal was calibrated for each data point based on the value of α_1 , which was set by the oscillation linkage, and physical measurements of $\alpha_{\max}$ and $\alpha_{\min}$ that were obtained from the trailing-edge position relative to the centerline of the tunnel with the wind off. The maximum absolute error in α was estimated to be $\pm 0.2^\circ$, with a relative uncertainty of $\pm 0.05^\circ$ over the cycle. The maximum torsional deflection of the model at the centerline was calculated to be $\pm 0.3^\circ$. Table 1 gives the amplitude and phase of the second harmonic component of α for various nominal values of α_1 . The frequency of the oscillation was maintained and measured to an estimated accuracy of $\pm 0.03 \text{ Hz}$.

The tunnel dynamic pressure was measured with a conventional pitot-static probe mounted approximately 1.5 m upstream of the model and connected to a pressure transducer and amplifier system with a net accuracy of approximately $\pm 14 \text{ N/m}^2$ (0.002 psi) under steady conditions. The measured values ranged from 90 N/m^2 (0.013 psi) at $M_\infty = 0.04$ to 6200 N/m^2 (0.90 psi) at $M_\infty = 0.3$. The output of this transducer was recorded by hand and on the 32-channel analog tape recorder. An average of these two values, which rarely differed by more than 2%, was used to compute q_∞ , except in a few cases in the early stages of the test program in which the tape-recorded value was obviously in error and was therefore ignored. The 25-mm-thick ground plane shown in figure 2 caused a 1% reduction in tunnel cross-sectional area between the pitot-static tube and the model; this was ignored except as noted in connection with the steady lift results presented in section 4 under the heading Static Data.

A detailed examination of the digitized data revealed that the 200/cycle sampling of the analog signals was not always synchronized perfectly with the 200/cycle timing indicators. That is, the effective time base of the digitized data was in error, the cumulative effect of which was either to leave a small gap in the data at the end of the cycle or to overlap the 200th sample of a given cycle with the first sample of the next cycle. Consequently, a corrected time base for the digital data arrays was obtained by least-squares curve-fitting a first- and second-harmonic sine wave to the angle-of-attack signal, α . All of the pressure data were then linearly interpolated onto the new time base at 200 even intervals per cycle and stored in new arrays, with the first data point in each array corresponding to $\omega t = 0$. The end result is that the final data appear at the desired times, but suffer an effective "smearing" that would be, at worst, equivalent to sampling at a rate of 100 points per cycle instead of 200 per cycle.

Experimental uncertainty of the airloads- For the purposes of comparing the static and dynamic-stall characteristics of the eight airfoil sections, the absolute accuracy of the measurements and the consequences of wind-tunnel blockage, circulation interference, and sidewall boundary-layer interference are less important than the random experimental errors outlined above. However, an attempt was made to assess all of these, as described below.

The total measurement uncertainty in the pressure, force, and moment coefficients depends on the operating conditions. For example, the probable error in C_p based on the instrumentation characteristics quoted above varies from less than ± 0.07 at $M_\infty = 0.3$ and $\alpha = 0$ to about ± 0.4 near the leading edge at $M_\infty = 0.11$ and α approaching the stall angle. For most of the static data at $M_\infty = 0.3$, the measurement uncertainty is estimated at ± 0.03 for $C_{L_{max}}$, ± 0.005 for C_M , and ± 0.0005 for C_D derived from the wake measurements. However, the uncertainty in the SC-1095 lift and moment data is thought to be at least twice as large, because of some unresolved difficulties with the pressure measurements. These values increase with decreasing Mach number, rising by a factor of about 5 in the extreme case $M_\infty = 0.035$, where the pressure signals were very small.

Some representative examples of static C_L and C_M versus α are given in figures 9-11, and the primary characteristics of each airfoil at $M_\infty = 0.30$ are presented in table 8. The symbols in the figures indicate the individual uncorrected data points, as presented in volume 2 of this report; the shaded bands denote the estimated bounds of the airfoil characteristics. The bounds of the airfoil characteristic include static wind-tunnel-wall corrections according to Allen and Vincenti (ref. 12) and a 1% correction due to the reduction in test-section area at the model caused by the steel plate on the floor of the tunnel (fig. 2). (This wall correction method is only valid below stall, where the corrections are about 1% for α and 1.5% for C_L .) These boundaries were derived based on the measurement uncertainties described above, on data that were obtained with the on-line analog computers, and on the dynamic data obtained at $k \leq 0.01$. It should be noted that the scatter in the data and the uncertainty bounds increase considerably for conditions above the stall angle. The last line in table 8 indicates the experimental uncertainties for the various quantities listed. The static data are discussed further in section 4.

A novel feature of the present experiment was the determination of unsteady pressure drag, $C_D = C_C \cos \alpha + C_N \sin \alpha$, where C_C and C_N are the chordwise and normal force coefficients derived from the upper and lower surface-pressure distributions. The two terms in this expression for C_D are approximately equal and opposite at high angles of attack below stall, so that the probable percentage errors of

C_D are much greater than for C_C , C_N , C_L , or C_M . Figure 12 shows a typical static lift-drag polar based on pressure measurements and on the more accurate wake survey of the total drag (table 7). The measured pressure drag, which neglects the contribution due to skin friction, is less than the total drag at low lift coefficients, but it incorrectly exceeds the wake measurements by as much as 0.02 near the stall angle, that is, by as much as 100%. (It may be noted that Woodward (ref. 13) reported similar, unexplained discrepancies between measured pressure drag and C_D based on wake surveys.) However, the percentage errors are much less in the stall regime, where the magnitude of C_C decreases considerably and the maximum drag coefficient becomes of the order of $C_L \tan \alpha$ (i.e., of the order of unity) for the deep-dynamic-stall cases studied.

The measurement uncertainty of the unsteady data is probably comparable to that of the static data, but fewer independent checks were available to assess the random experimental errors and the wind-tunnel interference, especially in the post-stall regime. Fromme and Golberg (ref. 14) have indicated that unsteady wall corrections can be greater than the corresponding static corrections, but it is not clear to what extent their potential flow analysis can be applied to the present measurements. Likewise, it is not possible to estimate reliably the post-stall tunnel sidewall effects nor how these vary from one airfoil to another, but tuft flow visualization and experience suggested that these problems became less important as the frequency of oscillation is increased. It is the authors' judgment that for $M_\infty \geq 0.2$, the unsteady data in the deep-dynamic-stall regime should be in error by no more than ± 0.2 for C_L , ± 0.05 for C_M , and ± 0.10 for C_D , except as noted in the next section. The results are thought to be about twice this accurate below stall and in light stall, whereas the accuracy was seriously degraded for $M_\infty < 0.1$ because of the small values of the pressure signals.

Special cases of questionable accuracy- Despite efforts to monitor the performance of the pressure instrumentation during the test and to control and minimize the measurement uncertainties, various problems sometimes arose that only became evident during the post-test reduction and analysis of the data. In most cases, it was possible to correct these problems on an individual basis, using redundant information or by interpolating in time or space between neighboring values, without significantly compromising the accuracy of the results. In other instances, the measurements appeared to be qualitatively correct, but the experimental uncertainty was likely to have been outside the normal bounds discussed in the previous section. These cases are identified below by data-point or "frame" number.

Frame 10202 for the NACA 0012 airfoil had an unusually large number of random irregularities, a total of 44 in the 5,200 pressure data samples. These were eliminated by linearly interpolating between data at preceding and succeeding time increments. Because some of these irregularities occurred during rapid fluctuations of the flow, the time-histories of part of the pressure data for this particular frame may have been degraded. However, the effect on the integrated force and moment coefficients was probably small.

Table 9 lists the frames for which the "zero" drift of one or more of the transducers appeared to have exceeded by a significant amount the nominal values quoted in the previous section. Also included are the low Mach-number cases for which the no-flow pressure readings taken before and after recording data varied by more than 50% of free-stream dynamic pressure, even though this drift amounted to less than the nominal measurement uncertainty of 150 N/m^2 (0.02 psi). It should be mentioned that in all cases the differences between these pretest and post-test zeros were linearly interpolated with respect to elapsed time to obtain effective zeros for the individual

data frames. In principle, this should have reduced the effects of the transducer drift; however, the actual improvement in the measurement accuracy because of this technique remains unknown.

For the Hughes HH-02 airfoil, the responses of pressure transducers No. 1 (leading edge) and No. 25 ($x/c = 0.0081$, lower surface) were rather sluggish, possibly because the orifices were partially clogged. Therefore, the unsteady data from these two transducers are suspect. In calculating the force and moment data for this airfoil, transducer No. 25 was ignored and the pressure integrals

$$C_N = -\oint C_p dx/c \quad \text{etc.}$$

were replaced by

$$C_N = -2 \oint C_p \xi d\xi \quad \text{etc.}$$

where $\xi = \sqrt{x/c}$, thereby eliminating the influence of transducer No. 1, since $C_{p1} \sqrt{x_1} = 0$. Another problem with the HH-02 force and moment data is that the trailing-edge transducers were at $x/c = 0.925$ instead of 0.98, so that the error in extrapolating to $x/c = 1.0$ is greater for this airfoil. The net effect of these modifications is difficult to assess, but it probably increased the experimental uncertainties for the lift, pressure drag, and pitching moment data by no more than 50%.

The NLR-7301 airfoil had a large amount of concave curvature on the lower surface downstream of $x/c = 0.5$, which produced larger pressure gradients there than existed on the other airfoils. Therefore, the relatively sparse distribution of pressure transducers in that region may have led to larger errors in determining the forces and moments than the nominal values quoted in the preceding section.

The reduced data for the Sikorsky SC-1095 airfoil under static conditions and at low frequencies consistently exhibited values of maximum lift coefficient and lift-curve slope that appeared to be about 5% too large, based on comparisons with the other airfoils and with the results obtained from the special on-line analog computer described above under Instrumentation. In particular, the comparison with the present NACA 0012 data (fig. 13) contrasts significantly with the steady results of Noonam and Bingham (ref. 15) and Jepson (ref. 16), who found C_{L_α} to be approximately the same for both airfoils. A detailed examination of the present data and the transducer calibrations revealed somewhat erratic performance in a few cases, but no systematic behavior emerged that could explain the apparent problem. Therefore, the conclusion is that the SC-1095 results should be viewed with caution, even though they appear to be qualitatively correct.

Test Conditions

The primary reference conditions for the initial comparisons of the various airfoils were static and deep-dynamic stall at $M_\infty = 0.3$, with the nominal unsteady motion given by $\alpha = 10^\circ + 10^\circ \sin \omega t$ and $k = \omega c / 2U_\infty = 0.10$. Limited but systematic variations in Mach number and the unsteady parameters were explored for all airfoils as indicated below and in section 3, where the specific test points are indexed and cross-referenced.

Static data- Pressure measurements were recorded at discrete values of α between -5° and 20° for $M_\infty = 0.11, 0.185, 0.25,$ and 0.30 for all airfoils except the NACA 0012. In the latter case, static data were recorded only at $M_\infty = 0.30$; quasi-steady data were obtained for a continuous range of $\alpha = \alpha_0 + 10^\circ \sin \omega t$ for $k \approx 0.001$ for nine values of M_∞ between 0.035 and 0.30 . A number of the static conditions were repeated with a boundary-layer trip at the leading edge. Wake surveys for static drag were obtained at $M_\infty = 0.3$ for α between -5° and the static stall angle.

Unsteady data- The parameters that were varied under dynamic-stall conditions were Mach number, reduced frequency, mean angle, and amplitude of the oscillation. The effect of Mach number was studied between $M_\infty = 0.035$ and 0.30 , primarily in the deep-stall regime for $\alpha = 15^\circ + 10^\circ \sin \omega t$ and $k = 0.10$. In these cases, the Reynolds number also varied, proportional to Mach number, according to the relation $Re \approx 14 \times 10^6 M_\infty$.

The principal ranges of reduced frequency, mean angle, and amplitude were $0.01 \leq k \leq 0.20$, $\alpha_0 = 10^\circ$ and 15° , and $\alpha_1 = 2^\circ, 5^\circ,$ and 10° , respectively; the effects of these parameters were studied primarily at $M_\infty = 0.30$. Additional variations in k and α_0 were effected to achieve specific dynamic effects, such as no stall, stall onset, stall suppression because of unsteady effects, and neutral aerodynamic damping in pitch.

Finally, additional test points were selected that duplicated some of the conditions of references 3 and 17-19 as closely as possible. A complete list of the unsteady test conditions and descriptions of the parametric variations are given in the following section.

3. GUIDE TO THE DATA

A very large data base was generated in this investigation. As mentioned in the Introduction, summary graphs of the pressure, force, and moment coefficients and selected results from the boundary-layer studies are contained in separate volumes. The airloads data are also stored on digital computer tapes, one for each airfoil, as explained in volume 2. This section describes briefly the data presentations to be found in the subsequent volumes and indicates by test point, or "frame number," the various types of data that are available.

Figure 14 illustrates the format of volume 2 for the unsteady pressure, force, and moment coefficient data, that is, C_L , C_M , and C_D versus α and ωt , and the upper-surface pressure distributions throughout the cycle. Additional information is listed at the top of the graphs. Following the airfoil name is the identification number for each test point. As explained in volume 2, these frame numbers comprise data at a single angle of attack for the steady data, and data at 200 evenly spaced time intervals throughout the cycle for the unsteady cases. The quantities $A0$ and $A1$ are the mean value and the first-harmonic amplitude, respectively, of the instantaneous angle of attack, α ; $M_{\max}$ is the estimated maximum value of the local Mach number at any time in the cycle, calculated from the classical gas-dynamic equations for steady isentropic flow and the measured pressure coefficient, $-C_{p_{\min}}$ (cf. ref. 2); $\alpha_{L_{\max}}$, $\alpha_{C_{\min}}$, and $\alpha_{M_{\max}}$ are the angles of attack corresponding to maximum lift, minimum chord force (cf. ref. 3), and $M_{\max}$, respectively; and ζ is

the aerodynamic damping in pitch. The asterisk on the ordinate of the pressure-coefficient graph represents sonic conditions.

The dotted line in the C_L vs α curve in figure 14 is an approximation to the quasi-static lift behavior for this flow condition, according to the relation

$$C_L = A + \frac{B\alpha}{\sqrt{1 - M_\infty^2}}$$

where α is in degrees and A and B were obtained from the relevant steady and very low-frequency data, that is, for $k \leq 0.01$. The values of A and B are given in table 10. Finally, it should be mentioned that in contrast to the data in table 8 and the static results presented in section 4 under the heading Static Data, wind-tunnel wall corrections have not been applied to A and B, to the data in volume 2, nor to the numerical data tapes.

Figure 15 shows two representative examples of the boundary-layer "flow reversal" information contained in volume 3. The abscissa in the figures show the position on the airfoil where the surface instrumentation first indicated a breakdown of the attached boundary-layer flow at the beginning of dynamic stall, as explained and discussed in volume 3 and in references 4, 10, and 11. This event either signifies or is closely associated with the separation that accompanies the beginning stages of dynamic stall. The ordinate indicates the nondimensional time in the cycle, ωt , at which this event occurred.

Tables 11-24 provide a comprehensive summary and index of the entire experimental program. Table 11 lists the frame numbers of all the pressure data, in the sequence in which they appear on the data tapes. The airfoil and pertinent test conditions are also listed, and the conditions for which boundary-layer data were recorded are indicated in the last column. The letter "Y" in the "TRIP" column indicates the use of the boundary-layer trip; "N" denotes the standard smooth condition. The notations "ST" and "US" denote steady and unsteady data, respectively, and the frequency of oscillation in Hertz is given in the column labeled "FREQ."

Table 12 is an index of the steady-data sets, arranged by airfoil and Mach number. The use of a boundary-layer trip is indicated by the letter "T." The notation "Quasi-steady" indicates the data that were acquired on the NACA 0012 airfoil as unsteady data, but at very low frequency, $k \leq 0.002$.

A cross-reference index that groups the unsteady data by types for each of the eight airfoils is given in tables 13-24. There are some duplicate entries in these tables, in order to facilitate the identification of data sets with variations in the individual parameters of the unsteady motion. There are also blank entries, since not all conditions were recorded for all airfoils. The principal types of unsteady conditions are outlined below.

Variations in Mach number- Table 13 lists the test points concerned with the effect of Mach number on deep dynamic stall, for $\alpha = 15^\circ + 10^\circ \sin \omega t$ and $k = 0.10$. Although the NLR-7301 airfoil was only tested at three values of M_∞ with $\alpha_0 = 15^\circ$, it was also tested with $\alpha_0 = 10^\circ$ at $M_\infty = 0.11, 0.18, 0.22$, and 0.30 ; these frames are given in table 24. Stall-suppression conditions, tables 19 and 20, and the effects of leading-edge trips, table 23, were studied at $M_\infty = 0.18$ and 0.30 for various values of α_0 and k . As stated in section 2 under Test Conditions, the variation of Reynolds number with Mach number was $Re = 14 \times 10^6 M_\infty$.

Reduced frequency sweeps- The test points concerned with the effect of frequency on dynamic stall are given in tables 14-17. These data cover the range $0.01 \leq k \leq 0.20$ at $M_\infty = 0.3$, with mean angles of 10° and 15° and amplitudes of 5° and 10° . In addition, the NACA 0012 airfoil was tested over an extensive range of other values of α_0 (table 24).

Stall onset- This condition, defined in references 1 and 2 as obtaining the maximum possible lift without moment stall occurring at any time throughout the cycle of oscillation, was studied at $M_\infty = 0.30$, $k = 0.10$, $\alpha_1 = 10^\circ$, and variable mean angle, as indicated in table 18.

Stall suppression caused by unsteady effects- With α_1 fixed at 10° , α_0 was varied so that $\alpha_{\max}$ was slightly greater than the static-stall angle. Data were then recorded (tables 19 and 20) at various reduced frequencies to study whether stall would diminish or increase with increasing k .

Pitch damping boundaries- Stall conditions relevant to small-amplitude flutter boundaries are listed in table 21, at $\alpha_1 = 2^\circ$ and $M_\infty = 0.30$. Mean angle and reduced frequency were varied to obtain approximate boundaries of neutral aerodynamic damping in pitch and to obtain the maximum negative value of pitch damping, $-\zeta_{\min}$. However, no data of this type were recorded for the NACA 0012 airfoil.

No separation- A limited number of test points were recorded at $M_\infty = 0.30$ and $\alpha = 5^\circ + 5^\circ \sin \omega t$, as indicated in table 22. Some additional conditions for the NLR-1 and NLR-7301 profiles without separation are given in table 24.

Boundary-layer trip- Data with the leading-edge trip were obtained statically for α between 0° and 20° and dynamically for $\alpha = 15^\circ + 10^\circ \sin \omega t$ at two values of Mach number, 0.18 and 0.30. The values of k for the dynamic data are given in table 23; the static data with trip are so indicated in table 12. An exception was the NLR-7301 section at $M_\infty = 0.30$, for which $\alpha = 10^\circ + 5^\circ \sin \omega t$ (table 24). In addition, the NLR-1 section with trip was studied with $\alpha_0 = 2.5^\circ$ (table 24).

Miscellaneous- These test points are included in table 24. In addition to the cases mentioned above, the unsteady test conditions of references 3 and 17 for the NACA 0012, of reference 18 for the Sikorsky SC-1095, and of reference 19 for the NLR-1 airfoil were reproduced insofar as possible. Also, for the Vertol VR-7 airfoil, k was varied from 0.01 to 0.25 at $M_\infty = 0.18$ with $\alpha_0 = 10^\circ$ and 15° and $\alpha_1 = 10^\circ$. Finally, dynamic stall on the NLR-1 profile at negative incidence was studied at $M_\infty = 0.30$ for $\alpha = -2^\circ + 10^\circ \sin \omega t$ and $0.01 \leq k \leq 0.10$.

Selected test cases- Finally, table 25 lists the unsteady data that were proposed in reference 1 as specific test cases for evaluating unsteady viscous flow theories and computational methods. These data were obtained on the NACA 0012, Vertol VR-7, and NLR-7301 airfoils. They include conditions of no-stall, stall-onset, light-stall, and deep-dynamic-stall, all at $M_\infty = 0.3$.

4. RESULTS AND DISCUSSION

Static Data

The measurements performed under steady or quasi-static flow conditions provide a frame of reference for the dynamic-stall results and a basis for comparison with

data from other wind tunnels. Some of the highlights of the static data are presented below, with particular reference to the force and moment coefficients at $M_\infty = 0.3$. With the exception of the drag data listed in table 7, wind-tunnel-wall corrections have been applied to all of the static results presented in this section, using the formulae of reference 12.

As noted earlier, table 8 gives a summary of the primary static characteristics of each airfoil at $M_\infty = 0.30$, and figures 16-23 show the basic variations of lift, pitching moment, and drag coefficients for the eight sections. The dashed lines in the "a" parts of figures 17-23 represent curve-fits of the lift data in the linear $C_L - \alpha$ regime. The drag data derived from the wake surveys are listed in table 7. In the following discussions, some comparisons are made for each airfoil between the present measurements and data obtained elsewhere.

NACA 0012 airfoil- This profile has been tested by many investigators, with a wide range of results. Figure 24 shows the variation in $C_{L_{max}}$ with Mach number, including results reported or summarized in references 3, 5, 15-17, and 20-24 over a wide range of Reynolds numbers. The present values of $C_{L_{max}}$ increase with increasing Mach number for $M_\infty < 0.22$, probably because of the effects of increasing Reynolds number, whereas compressibility effects are thought to be responsible for the decrease in $C_{L_{max}}$ for $M_\infty > 0.22$. The boundary-layer trip was found to be relatively unimportant for this airfoil at the Mach and Reynolds numbers of the test.

The present $C_{L_{max}}$ data tend to lie near the upper range of the values from other sources. The same is true for the lift-curve slopes in the linear regime, C_{L_α} , which is not shown.

Ames A-01 airfoil- Figure 25 compares the data from the present test with measurements made in a transonic wind tunnel at somewhat lower Reynolds numbers (ref. 6) for the A-01 airfoil. Although the lift-curve slopes for $C_L < 1.0$ were not significantly different in the two tests, the airfoil stalled at lower angles of attack in the transonic tunnel. Consequently, lower values of maximum lift coefficient were measured and reported in reference 6 at $M_\infty = 0.2$ and 0.3 , which was near the lower operating limit of that facility.

Wortmann FX-098 airfoil- Maximum-lift data from several investigations (refs. 8, 24-26) are compared with the present data in figure 26 for the FX-098 airfoil. All of the data agree reasonably well over the Mach-number range of the present test. However, there are marked differences at higher Mach numbers.

Sikorsky SC-1095 airfoil- Steady results for this section are shown in figure 27, where the comparison is generally unfavorable. The suspicious nature of the present lift data was mentioned earlier in section 2 under Data Analysis and Measurement Accuracy; here the open circles indicate the present data analyzed in the normal way and the solid symbols represent what are thought to be the true values. The latter, somewhat lower, values are based primarily on the on-line measurements. It should be mentioned that the data of Noonan and Bingham (ref. 15) were obtained on a modified profile with a reflex training edge that reduced C_{M_0} to approximately zero, compared with the present value of -0.027 at $M_\infty = 0.3$ (cf. table 8). Also, the data of Jepson (ref. 16) in figure 27 came from a slotted-wall tunnel with 12.5% porosity, which was thought to yield somewhat lower values of C_L than comparable tests in solid-wall tunnels. Furthermore, the Reynolds numbers in references 15 and 16 were

lower than those of the present tests. Nevertheless, the discrepancies in figure 27 seem to be too large to be attributed to these factors or to measurement uncertainties. It will be shown later that dynamic data on the SC-1095 section are generally in better agreement.

Hughes HH-02 airfoil- Figure 28 shows the measured maximum lift coefficients for the present HH-02 airfoil, in comparison with data from a section that is almost identical except for a slightly smaller leading-edge radius (ref. 27). Although the Mach number range does not overlap, the two sets of results seem consistent.

Vertol VR-7 airfoil- Results from four sources are plotted in figure 29 for the VR-7 profile. The present data are somewhat higher than those of Coulomb (ref. 28), primarily because the stall occurred at slightly higher angles of attack, but the lift-curve slopes (not shown) and the effect of a boundary-layer trip were approximately the same. The value of $C_{L_{max}}$ at $M_\infty = 0.3$ is slightly lower than that of Dadone (ref. 5), whose measurements at higher Mach numbers exceed considerably those of Bingham et al. (ref. 29).

NLR-1 airfoil- Figure 30 shows the good agreement of the present measurements with those of Dadone (ref. 19) for the NLR-1 airfoil. It should be mentioned, however, that the details of the pitching-moment behavior in the vicinity of $C_{L_{max}}$ (not shown) were somewhat different. As in the previous example, the data of Noonan and Bingham (ref. 24) for $C_{L_{max}}$ at $M_\infty \geq 0.35$ tend to be lower than the data of Dadone (ref. 19). This airfoil appears to be more sensitive to Mach number than any of the other modern helicopter sections.

NLR-7301 airfoil- As shown in figure 31, the maximum static lift for the NLR-7301 airfoil exceeded that of the other sections by a considerable margin; however, C_{M_0} was -0.083 (cf. table 8). The values of $C_{L_{max}}$ shown are also greater than those obtained at NLR under virtually identical conditions (ref. 30). This was obtained at a significantly larger stall angle, more than 1° larger at $M_\infty = 0.18$, than in the NLR experiments, apparently because of different boundary-layer separation characteristics and sidewall interferences.

Dynamic Data

Although the static data described above comprised an essential part of the investigation, the primary objective was to obtain a common data base of unsteady characteristics for helicopter applications. In this section some representative examples are presented and comparisons made with other investigations. More complete discussions of the basic phenomena and of the results obtained are given in references 1 and 2.

The unsteady stall-onset and dynamic-stall counterparts of the static $C_{L_{max}}$ results discussed above are shown in figures 32 and 33, reproduced from reference 2 with some minor corrections. The dashed lines in figure 33 indicate the estimated deep-stall $C_{L_{max}}$ for the NLR-7301 airfoil; data were not obtained for this condition for $M_\infty > 0.25$. These results have not been corrected for wind-tunnel-wall interference.

Figures 32 and 33 illustrate an important general result of the investigation: the parameters of the unsteady motion tend to be more important than the airfoil geometry. For example, the differences in the values of $C_{L_{max}}$ for the Wortmann, Sikorsky, and Hughes airfoils can hardly be discerned within the experimental uncertainty, but the unsteady stall-onset and deep-stall results are much higher than the static values shown in figures 26-28 and 33. It is also interesting to note that at least for $M \leq 0.25$, the deep-stall $C_{L_{max}}$ values for the NLR-1 and NLR-7301 airfoils are almost identical. In contrast, the static and unsteady stall-onset results for these two very different profiles are considerably different and represent the lower and upper bounds, respectively, of all the airfoils tested.

In view of the aforementioned scatter in the static results from different wind tunnels, it is logical to inquire how different sets of dynamic data might compare. Because of the large number of parameters that affect dynamic stall and the tendency for past investigators to select different combinations of these parameters, the possibilities for direct comparison of unsteady results are much more limited. However, some examples are given below.

NACA 0012 airfoil- The first comparison for this profile is shown in figures 34 and 35, where data from reference 3 were obtained in the same wind tunnel as the present results, but with a model whose chord was twice as large. Figure 34 shows that the large values of $C_{L_{max}}$ reported in reference 3 were not realized in the present experiment. Figure 35 shows C_L versus α , where the two results are seen to differ by approximately 10% during the portion of the cycle when α is increasing but before dynamic stall begins. This is approximately the same as the difference in the lift-curve slopes for the corresponding static data, and it is consistent with the differences that would be predicted for static wind-tunnel-wall corrections (ref. 12) for the two chord-to-height ratios. However, it can be inferred from the differences in the peaks of the lift curves in figure 35 that the organized vortex-shedding phenomenon was more pronounced on the larger model after stall began. Also, reattachment of the boundary layer on the downstroke occurred earlier. These do not seem to be solely Reynolds-number effects; rather, it is suspected that in the earlier tests there was excessive interference between the boundary layers on the upper and lower walls of the tunnel and the unsteady viscous flow on the ends of the vertically mounted airfoil.

St. Hilaire and Carta (ref. 17) have reported on dynamic-stall tests of the NACA 0012 airfoil at UTRC under conditions similar to those in the present experiment. Figure 36 compares some of the data from the two investigations. The format and choice of unsteady parameters is based on an extension of the observation in reference 2, that for sinusoidal pitching oscillations the values of α_{max} and the product $\alpha_1 k^2$ seem to be particularly important in determining the detailed time-history of the unsteady airloads during dynamic stall. In order to compare as many test points as possible, data were selected that satisfied the criterion $0.0014 < \alpha_1 k^2 < 0.0022$, where α_1 is in radians. The variations in $C_{L_{max}}$ and $C_{M_{min}}$ in figure 36 are seen to correlate reasonably well on this basis, and the results from the two sources are in fairly good agreement. Some of the $C_{L_{max}}$ data from the UTRC wind tunnel are slightly higher than the present measurements.

SC-1095 airfoil- Gangwani (ref. 18) has reported data that were obtained on the SC-1095 section in the same facility that was used by St. Hilaire and Carta (ref. 17) to obtain the NACA 0012 data described in the preceding paragraph. The results are

compared with the present data in figure 37, following the same format as above. Fewer data points are available, but the degree of correlation is approximately comparable to that of the NACA 0012 results in figure 36. In contrast with that figure, however, the present values of $C_{L_{max}}$ tend to be slightly higher than the UTRC data (ref. 18). In any case, the discrepancies generally appear to be within the measurement uncertainty, and the agreement is better than for the static results (fig. 27).

NLR-1 airfoil- This profile was tested by Dadone (ref. 19) over a wide range of Mach numbers, mean angles, and amplitudes. Based on the considerations outlined above regarding α_{max} and $\alpha_1 k^2$, his results are compared with the present data in figure 38 as functions of $\alpha_1 k^2$ at a constant value $\alpha_{max} = 20^\circ$, where α_1 is also in degrees. The lift data are in better agreement than in the previous examples, but more scatter appears in the pitching-moment results than before.

No unsteady results from other sources are presently available from other sources for comparison with the data obtained on the Wortmann FX-098, Ames A-01, Hughes HH-02, Vertol VR-7, and NLR 7301 airfoils.

Comments on Wind-Tunnel Effects

It is well known that testing the same airfoil in different wind tunnels often gives different results, especially for the static-stall characteristics. This is borne out in figures 24-31. In fact, if the results from these eight figures were overlaid, the real differences between the individual airfoils would be almost completely obscured by the differences attributable to the test facilities.

Although more limited in scope, the comparisons of dynamic-stall data shown in figures 36-38 are more encouraging than the static results. Since all of these data came from tests with either high aspect-ratio models or sidewall boundary-layer control, this suggests that the present dynamic data may be relatively free of wind-tunnel-wall contamination and other three-dimensional effects. A detailed examination of the complete time-histories of the unsteady airloads and further studies on models of various aspect ratios would be required to confirm this speculation.

A special feature of the present experiment is that a large number of airfoils were studied over a wide range of unsteady flow conditions in the same facility. This provides the basis for meaningful comparisons, even though wind-tunnel interference effects were not completely negligible. However, as stated in reference 1, it is recommended that the wind-tunnel walls be included or considered in any quantitative uses of the data.

5. SUMMARY AND CONCLUSIONS

A large amount of steady and unsteady data has been obtained on eight airfoil sections over a wide range of test conditions, at Mach numbers up to 0.30. The details of the experimental arrangements, estimates of the measurement accuracy, and the test conditions are described in this volume. Some comparisons are also made with data from other sources. Volume 2 (Pressure and Force Data) presents the results in graphical form and describes the digital computer tapes that contain the extensive numerical data. Volume 3 (Hot-Wire and Hot-Film Measurements) describes the boundary-layer studies performed with surface-mounted hot wires and hot films.

The results of the experiment show important differences between airfoils, differences that would otherwise tend to be masked by differences in wind tunnels, particularly in steady cases. All of the airfoils tested offer significant advantages over the standard NACA 0012 profile. In general, however, the parameters of the unsteady motion appear to be more important than airfoil shape in determining the dynamic-stall airloads.

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TABLE 1.- HARMONIC COEFFICIENTS
OF THE OSCILLATION MECHANISM

$$\alpha = \alpha_0 + \alpha_1 \sin \omega t + \alpha_2 \sin(\omega t + \phi_2)$$

α_0	Nominal α_1	α_1	α_2	ϕ_2
5	5	5.00	0.05	(a)
10	5	4.90	.05	(a)
0	10	10.20	.20	(a)
5	10	10.05	.20	(a)
10	10	9.90	.20	260°
15	10	9.90	.20	(a)
15	14	14.10	.38	200°

^aNot measured.

TABLE 2. - AIRFOIL COORDINATES: NACA 0012 AND AMES A-01 AIRFOILS

x/c	NACA 0012, y/c		AMES A-01, y/c	
	upper	lower	upper	lower
0.0000	0.00000	0.00000	0.00000	0.00000
0.0005	0.00395	-0.00395	0.00377	-0.00338
0.0010	0.00556	-0.00556	0.00541	-0.00472
0.0020	0.00781	-0.00781	0.00766	-0.00651
0.0035	0.01027	-0.01027	0.01013	-0.00844
0.0050	0.01221	-0.01221	0.01214	-0.00994
0.0065	0.01386	-0.01386	0.01388	-0.01120
0.0080	0.01531	-0.01531	0.01543	-0.01227
0.0100	0.01704	-0.01704	0.01732	-0.01350
0.0125	0.01894	-0.01894	0.01945	-0.01481
0.0160	0.02127	-0.02127	0.02214	-0.01634
0.0200	0.02360	-0.02360	0.02490	-0.01777
0.0250	0.02615	-0.02615	0.02801	-0.01922
0.0350	0.03043	-0.03043	0.03335	-0.02137
0.0500	0.03555	-0.03555	0.03991	-0.02365
0.0650	0.03966	-0.03966	0.04523	-0.02549
0.0800	0.04307	-0.04307	0.04961	-0.02710
0.1000	0.04683	-0.04683	0.05421	-0.02902
0.1250	0.05055	-0.05055	0.05829	-0.03104
0.1500	0.05345	-0.05345	0.06098	-0.03277
0.2000	0.05737	-0.05737	0.06344	-0.03551
0.2500	0.05941	-0.05941	0.06431	-0.03727
0.3000	0.06002	-0.06002	0.06446	-0.03828
0.3500	0.05949	-0.05949	0.06409	-0.03866
0.4000	0.05803	-0.05803	0.06316	-0.03848
0.4500	0.05581	-0.05581	0.06154	-0.03782
0.5000	0.05294	-0.05294	0.05924	-0.03665
0.5500	0.04952	-0.04952	0.05623	-0.03501
0.6000	0.04563	-0.04563	0.05249	-0.03297
0.6500	0.04132	-0.04132	0.04792	-0.03056
0.7000	0.03664	-0.03664	0.04246	-0.02785
0.7500	0.03160	-0.03160	0.03600	-0.02486
0.8000	0.02623	-0.02623	0.02860	-0.02153
0.8500	0.02053	-0.02053	0.02064	-0.01786
0.9000	0.01448	-0.01448	0.01260	-0.01374
0.9250	0.01132	-0.01132	0.00899	-0.01144
0.9500	0.00807	-0.00807	0.00598	-0.00888
0.9750	0.00472	-0.00472	0.00392	-0.00603
0.9900	0.00265	-0.00265	0.00322	-0.00421
1.0000	0.00126	-0.00126	0.00299	-0.00300
	$r_o/c = 0.0158$		$r_o/c = 0.012$	

TABLE 3. - AIRFOIL COORDINATES: WORTMANN FX-098 AND SIKORSKY SC-1095 AIRFOILS

x/c	WORTMANN FX-098, y/c		SIKORSKY SC-1095, y/c	
	upper	lower	upper	lower
0.0000	0.00000	0.00000	0.00000	0.00000
0.0005	0.00293	-0.00249	0.00307	-0.00257
0.0010	0.00426	-0.00343	0.00443	-0.00368
0.0020	0.00619	-0.00471	0.00640	-0.00535
0.0035	0.00837	-0.00609	0.00865	-0.00724
0.0050	0.01017	-0.00717	0.01054	-0.00880
0.0065	0.01175	-0.00807	0.01221	-0.01016
0.0080	0.01319	-0.00886	0.01374	-0.01138
0.0100	0.01494	-0.00978	0.01560	-0.01285
0.0125	0.01692	-0.01079	0.01771	-0.01450
0.0160	0.01944	-0.01202	0.02041	-0.01657
0.0200	0.02204	-0.01321	0.02320	-0.01865
0.0250	0.02501	-0.01451	0.02635	-0.02092
0.0350	0.03021	-0.01664	0.03140	-0.02454
0.0500	0.03681	-0.01913	0.03677	-0.02842
0.0650	0.04234	-0.02111	0.04070	-0.03108
0.0800	0.04705	-0.02277	0.04374	-0.03295
0.1000	0.05222	-0.02464	0.04680	-0.03464
0.1250	0.05714	-0.02658	0.04963	-0.03619
0.1500	0.06073	-0.02819	0.05174	-0.03739
0.2000	0.06491	-0.03059	0.05447	-0.03884
0.2500	0.06650	-0.03198	0.05548	-0.03933
0.3000	0.06630	-0.03251	0.05524	-0.03918
0.3500	0.06515	-0.03242	0.05437	-0.03858
0.4000	0.06336	-0.03184	0.05299	-0.03760
0.4500	0.06097	-0.03096	0.05105	-0.03622
0.5000	0.05798	-0.02982	0.04854	-0.03446
0.5500	0.05445	-0.02843	0.04555	-0.03234
0.6000	0.05040	-0.02678	0.04212	-0.02985
0.6500	0.04586	-0.02487	0.03819	-0.02702
0.7000	0.04085	-0.02273	0.03375	-0.02384
0.7500	0.03543	-0.02034	0.02887	-0.02034
0.8000	0.02962	-0.01768	0.02362	-0.01658
0.8500	0.02337	-0.01473	0.01808	-0.01265
0.9000	0.01642	-0.01134	0.01235	-0.00865
0.9250	0.01253	-0.00932	0.00943	-0.00664
0.9500	0.00856	-0.00702	0.00642	-0.00454
0.9750	0.00476	-0.00423	0.00328	-0.00233
0.9900	0.00255	-0.00237	0.00132	-0.00093
1.0000	0.00110	-0.00110	0.00000	0.00000
	$r_o/c = 0.007$		$r_o/c = 0.008$	

TABLE 4. - AIRFOIL COORDINATES: HUGHES HH-02 (-5° TAB) AND VERTOL VR-7 (-3° TAB) AIRFOILS

x/c	HUGHES HH-02, y/c		VERTOL VR-7, y/c	
	upper	lower	upper	lower
0.0000	0.00000	0.00000	0.00000	0.00000
0.0005	0.00283	-0.00284	0.00337	-0.00330
0.0010	0.00405	-0.00388	0.00483	-0.00460
0.0020	0.00594	-0.00532	0.00696	-0.00633
0.0035	0.00819	-0.00683	0.00943	-0.00800
0.0050	0.01009	-0.00800	0.01149	-0.00919
0.0065	0.01176	-0.00895	0.01330	-0.01010
0.0080	0.01327	-0.00978	0.01494	-0.01086
0.0100	0.01510	-0.01072	0.01695	-0.01172
0.0125	0.01717	-0.01172	0.01923	-0.01263
0.0160	0.01975	-0.01290	0.02213	-0.01367
0.0200	0.02237	-0.01404	0.02512	-0.01467
0.0250	0.02531	-0.01524	0.02846	-0.01575
0.0350	0.03029	-0.01714	0.03423	-0.01751
0.0500	0.03640	-0.01943	0.04144	-0.01966
0.0650	0.04137	-0.02127	0.04759	-0.02154
0.0800	0.04553	-0.02276	0.05299	-0.02320
0.1000	0.05012	-0.02432	0.05922	-0.02516
0.1250	0.05468	-0.02575	0.06565	-0.02709
0.1500	0.05828	-0.02675	0.07091	-0.02855
0.2000	0.06328	-0.02793	0.07887	-0.03055
0.2500	0.06608	-0.02843	0.08378	-0.03186
0.3000	0.06738	-0.02834	0.08592	-0.03273
0.3500	0.06750	-0.02755	0.08574	-0.03308
0.4000	0.06640	-0.02600	0.08365	-0.03271
0.4500	0.06391	-0.02377	0.07984	-0.03148
0.5000	0.06008	-0.02104	0.07451	-0.02952
0.5500	0.05504	-0.01797	0.06781	-0.02712
0.6000	0.04891	-0.01482	0.05996	-0.02464
0.6500	0.04174	-0.01176	0.05171	-0.02207
0.7000	0.03344	-0.00952	0.04322	-0.01929
0.7500	0.02403	-0.00851	0.03442	-0.01639
0.8000	0.01436	-0.00889	0.02527	-0.01346
0.8500	0.00481	-0.00984	0.01575	-0.01050
0.9000	-0.00431	-0.01041	0.00558	-0.00744
0.9250	-0.00394	-0.00777	0.00117	-0.00609
0.9500	-0.00203	-0.00583	-0.00016	-0.00512
0.9750	-0.00006	-0.00387	0.00115	-0.00380
0.9900	0.00112	-0.00269	0.00194	-0.00300
1.0000	0.00190	-0.00190	0.00247	-0.00247
	$r_o/c = 0.008$		$r_o/c = 0.011$	

TABLE 5. - AIRFOIL COORDINATES: NLR-1 AND NLR-7301 AIRFOILS

x/c	NLR-1, y/c		NLR-7301, y/c	
	upper	lower	upper	lower
0.0000	0.00000	0.00000	0.00000	0.00000
0.0005	0.00359	-0.00288	0.00730	-0.00748
0.0010	0.00499	-0.00388	0.01051	-0.01020
0.0020	0.00687	-0.00518	0.01518	-0.01373
0.0035	0.00890	-0.00643	0.02030	-0.01735
0.0050	0.01053	-0.00730	0.02424	-0.02016
0.0065	0.01194	-0.00799	0.02756	-0.02252
0.0080	0.01321	-0.00858	0.03043	-0.02455
0.0100	0.01475	-0.00929	0.03375	-0.02688
0.0125	0.01648	-0.01006	0.03729	-0.02935
0.0160	0.01868	-0.01101	0.04140	-0.03225
0.0200	0.02097	-0.01196	0.04514	-0.03502
0.0250	0.02358	-0.01301	0.04873	-0.03794
0.0350	0.02799	-0.01477	0.05372	-0.04264
0.0500	0.03328	-0.01688	0.05920	-0.04806
0.0650	0.03750	-0.01859	0.06321	-0.05229
0.0800	0.04093	-0.02007	0.06636	-0.05576
0.1000	0.04435	-0.02179	0.06985	-0.05962
0.1250	0.04701	-0.02363	0.07347	-0.06358
0.1500	0.04905	-0.02522	0.07648	-0.06689
0.2000	0.05200	-0.02775	0.08115	-0.07194
0.2500	0.05386	-0.02958	0.08441	-0.07527
0.3000	0.05489	-0.03082	0.08649	-0.07713
0.3500	0.05528	-0.03154	0.08755	-0.07763
0.4000	0.05511	-0.03185	0.08764	-0.07672
0.4500	0.05443	-0.03176	0.08678	-0.07412
0.5000	0.05327	-0.03126	0.08495	-0.06934
0.5500	0.05164	-0.03025	0.08206	-0.06237
0.6000	0.04948	-0.02882	0.07789	-0.05386
0.6500	0.04677	-0.02707	0.07212	-0.04397
0.7000	0.04348	-0.02503	0.06458	-0.03316
0.7500	0.03892	-0.02276	0.05551	-0.02227
0.8000	0.03172	-0.02028	0.04523	-0.01221
0.8500	0.02368	-0.01756	0.03415	-0.00409
0.9000	0.01562	-0.01427	0.02269	0.00108
0.9250	0.01179	-0.01199	0.01696	0.00228
0.9500	0.00811	-0.00903	0.01129	0.00246
0.9750	0.00454	-0.00511	0.00577	0.00153
0.9900	0.00244	-0.00253	0.00258	0.00042
1.0000	0.00103	-0.00103	0.00055	-0.00055
	$r_o/c = 0.007$		$r_o/c = 0.055$	

TABLE 6.- TRANSDUCER LOCATIONS ON THE AIRFOILS

Transducer Number ^a	Nominal ^b x/c		Actual pressure transducer location							
	Pressure	Hot wire	0012	A-01	FX-098	SC-1095	VR-7	NLR-1	NLR-7301	HH-02
1 LE	0.		0.	0.	0.0002U	0.	0.	0.	0.0015U	0.
2 U	.005 (.004)		.0060	.0054	.0038	.0040	.0044	.0054	.0101	.0050
3	.010 (.010)		.0103	.010	.0067	.0110	.0083	.0108	.0165	.0087
4	.025 (.030)	0.025 (.025)	.0242	.024	.0196	.0275	.0225	.028	.0335	.0326
5	.050 (.06)		.052	.050	.051	.053	.050	.051	.0512	.0581
6	.100 (.12)	.10 (.12)	.102	.100	.101	.1025	.100	.101	.102	.1167
7	.175 (.18)		.176	.175	.177	.178	.175	.177	.177	.183
8	.25 (.25)		.252	.250	.252	.252	.250	.250	.252	.250
9	.325 (.32)		.326	.325	.326	.325	.325	.325	.326	.317
10	.40 (.38)	.40 (.38)	.40	.40	.40	.40	.40	.40	.40	.383
11	.50 (.48)		.50	.50	.50	.50	.50	.50	.50	.472
12	.60 (.56)	.60 (.56)	.60	.60	.60	.60	.60	.60	.60	.561
13	.70 (.65)		.70	.70	.70	.70	.70	.70	.70	.650
14	.80 (.74)	.80 (.74)	.80	.80	.80	.80	.80	.80	.80	.739
15 U	.90 (.84)		.899	.90	.90	.90	.90	.90	.90	.840
16 U	.98 (.93)		.98	.98	.98	.98	.98	.98	.98	.925
17 L	.98 (.93)		.979	.98	.98	.98	.98	.98	.98	.925
18	.90 (.84)		.90	.90	.90	.90	.90	.90	.90	.840
19	.70 (.65)		.70	.70	.70	.70	.70	.70	.70	.650
20	.50 (.48)		.50	.50	.50	.50	.50	.50	.50	.472
21	.30 (.29)		.30	.30	.30	.30	.30	.30	.30	.294
22	.15 (.16)		.153	.150	.153	.150	.150	.150	.155	.161
23	.05 (.072)		.0504	.050	.051	.052	.050	.051	.0517	.0730
24	.025 (.030)		.023	.026	.027	.028	.0246	.0220	.0194	.0293
25	.010 (.010)		.0093	.0130	.0125	.009	.0094	.0108	.0051	.0081
26 L	.005 (.004)		.0049	.0073	.0061	.005	.0040	.0062	.0021	.0044

^aLE = leading edge; U = upper surface; L = lower surface.^bLocations for HH-02, for which c = 68.6 cm, are shown in parentheses; for all other airfoils shown, c = 61.0 cm.

TABLE 7. - STATIC DRAG COEFFICIENTS AT $M = 0.30$ BASED ON WAKE SURVEYS

α , deg	N-0012	AMES-01	W-098	SC-1095	HH-02	VR-7	NLR-1	NLR-7301
-5.0	0.00843	0.00851	0.00886	0.00739	0.00846	0.00899	0.02602	0.00952
-2.0	0.00729	0.00832	0.00771	0.00713	0.00719	0.00759	0.00743	0.00780
0.0	0.00711	0.00794	0.00683	0.00708	0.00679	0.00723	0.00710	0.00968
2.0	0.00718	0.00662	0.00664	0.00670	0.00655	0.00707	0.00745	0.00891
5.0	0.00865	0.00767	0.00755	0.00807	0.00816	0.00800	0.00831	0.01011
8.0	0.01031	0.00965	0.01142	0.01013	0.01112	0.01059	0.01086	0.01305
10.0	0.01190	0.01248	0.01405	0.01127	0.01382	0.01353	0.01322	0.01569
12.0	0.01711	0.01600	0.01773	0.01586	0.01849	0.02156	0.02006	0.02022
13.0	--	--	--	0.02015	0.02236	--	--	--
14.0	0.02901	--	0.08922	--	--	--	--	--
-4.0	--	--	--	--	--	--	0.00773	0.00843
-1.75	--	--	--	--	--	--	--	0.00874
-1.0	--	--	--	--	--	--	--	0.00962
1.0	--	0.00738	--	--	--	--	--	0.00973
1.5	--	--	--	--	--	--	--	0.00910
2.5	--	--	--	--	--	--	--	0.00896
3.0	--	0.00702	--	--	--	--	--	--
4.0	--	0.00712	--	--	--	--	--	--
6.0	--	0.00791	--	--	--	--	--	--
9.9	--	0.01218	--	--	--	--	--	--

TABLE 8.- SUMMARY OF THE MEASURED STATIC AIRFOIL CHARACTERISTICS AT $M_\infty = 0.30$, INCLUDING WIND TUNNEL WALL CORRECTIONS

Airfoil	C_{L_α}	α_o	C_{M_o}	$C_{D_{min}}$	$X_{a.c.}$	$C_{L_{max}}$	α_{ss}	$(L/D)_{max}$
NACA 0012	0.109	-0.1°	-0.007	0.0072	0.24	1.33	13.7°	90
Ames-01	.111	-.6	-.005	.0070	.25	1.45	13.6	100
FX-098	.109	-1.3	-.026	.0066	.24	1.43	13.1	94
SC-1095	(.110) ^a	-.9	-.027	.0073	.245	(1.46) ^a	13.5	(98) ^a
HH-02	.114	-.6	-.002	.0066	.255	1.42	13.2	92
VR-7	.117	-1.6	-.016	.0071	.26	1.51	12.6	107
NLR-1	.102	-1.0	-.025	.0071	.22	1.29	12.4	87
NLR-7301	.117	-1.9	-.083	.0078	.25	(1.83) ^a	(17.2) ^a	89
Nominal uncertainty	±.003	.2	.005	.0005	.005	.03	.3	5

^aUncertainty larger than nominal value in table.

TABLE 9.- LIST OF TEST POINTS WITH UNUSUAL ZERO DRIFT OF PRESSURE TRANSDUCERS

Airfoil	Frame	M _∞	Type ^a	Problem transducers	Airfoil	Frame	M _∞	Type ^a	Problem transducers
NACA 0012	8019	0.035	U	All	Wortmann FX-098	18414	.11	S	20,22
	8021	↓	↓	↓		19401	.25	↓	2,3,4
	8023	↓	↓	↓		19402	.25	↓	↓
	8102	↓	↓	↓		19405	.25	↓	↓
	8104	↓	↓	↓		19406	.25	↓	↓
	8106	↓	↓	↓		20103	.25	↓	2,3
	8114	.07	↓	23		20104	.25	↓	↓
	8116	.07	↓	23		20122	.30	↓	↓
	8118	.07	↓	23		20123	.30	↓	↓
	8210	.11	↓	4		20203	.30	↓	↓
	12118	.26	Q.S.	3		20204	.30	↓	↓
	13107	.11	↓	1,4,20	Sikorsky SC-1095	33022	.07	U	1,17,18,25
	13115	.07	↓	Many		33106	.11	U	Many
	13120	.07	↓	1,3,4,18, 24,26		33110	.11	U	Many
	13205	.035	↓	Many		34409	.29	U	2,3
	13217	.035	↓	Many		35021	.30	S	11
	14104	.18	U	3,8		35023	.30	↓	11
	14106	.18	U	3,8		35100	.30	↓	11
	14108	.18	U	3,8		35102	.30	↓	11
	26306	.30	S	2,3		35103	.30	↓	11
	26307	.30	↓	2,3		36209	.11	↓	1,20,22
Ames A-01	28019	.11	↓	1,20		36210	.11	↓	1,20,22
	28021	↓	↓	1,20		35211	.11	↓	1,20,22
	28023	↓	↓	1,20		35212	.11	↓	1,20,22
	28101	↓	↓	1,20		35213	.11	↓	1,20,22
	28106	↓	↓	All	Hughes HH-02	42309	.22	U	6
	28107	↓	↓	↓		42313	.25	↓	6
	28109	↓	↓	↓		43308	.30	↓	13
	28110	↓	↓	↓		43309	.30	↓	13
	28115	↓	↓	↓	Vertol VR-7	47213	.18	↓	1,4,24
	28116	↓	↓	↓		47217	.22	↓	1,4,24
	28117	↓	↓	↓		47301	.25	↓	3,24
	28119	↓	↓	↓		47305	.28	↓	3,24
	28120	↓	↓	↓		62020	.07	↓	1,16,18
	29317	.035	U	5,12,14,23	NLR-1	63018	.30	↓	2
Wortmann FX-098	16019	.035	U	Many		63019	.30	↓	2
	16200	.18	U	4,11		63020	.30	↓	2
	17220	.30	U	2		63021	.30	↓	2
	18102	.18	S	2,3,4		65207	.20	↓	2,3,4
	18106	.18	↓	2,3,4		65209	.30	↓	2,3,4
	18108	.18	↓	2,3,4		NLR-7301	.11	S	Many
	18410	.11	↓	20,22		NLR-7301	.11	S	Many
	18411	.11	↓	20,22					
	18413	.11	↓	20,22					

^aS = steady; U = unsteady; Q = quasi-steady, k ≤ 0.002.

TABLE 10.- COEFFICIENTS OF LINEAR CURVE-FIT OF STATIC LIFT DATA
WITHOUT WIND-TUNNEL CORRECTIONS

$$C_L = A + \frac{B\alpha}{\sqrt{1 - M_\infty^2}}$$

Airfoil	A = C _L (0)	B = βC _{Lα}
NACA 0012	0	0.110
Ames 01	.15	.108
Wortmann FX-098	.07	.111
Sikorsky SC-1095	.11	.110
Hughes HH-02	.07	.116
Vertol VR-7	.19	.117
NLR-1	.11	.102
NLR-7301	.24	.116

TABLE 11.- LIST OF DATA FRAMES

(a) NACA 0012 airfoil.

A										B									
FRAME	TRIP	TYPE	A0	A1	Q	H	RE	K	FREQ	FRAME	TRIP	TYPE	A0	A1	Q	H	RE	K	FREQ
4019	N	ST	-5.0	0.0	875	301	3957803	0.0000	0.00	4020	N	US	9.0	5.0	878	301	3909814	1.496	8.10
4100	N	ST	-2.0	0.0	877	301	3932537	0.0000	0.00	4101	N	US	9.0	5.0	878	301	3901884	0.249	1.35
4102	N	ST	2.0	0.0	877	301	3933848	0.0000	0.00	4103	N	US	8.0	5.0	878	301	3920784	0.350	1.35
4109	N	ST	4.0	0.0	877	302	3931136	0.0000	0.00	4110	N	US	8.0	5.0	878	301	3933187	0.997	5.40
4111	N	ST	4.0	0.0	885	299	3931136	0.0000	0.00	4112	N	US	8.0	5.0	877	301	3934727	0.992	10.80
4113	N	ST	8.0	0.0	877	302	3938235	0.0000	0.00	4114	N	US	10.0	5.0	877	301	3879891	0.252	1.37
4119	N	ST	10.0	0.0	877	301	3900532	0.0000	0.00	4120	N	US	10.0	5.0	877	301	3877295	0.094	5.40
4123	N	ST	12.0	0.0	877	302	3876047	0.0000	0.00	4200	N	US	11.0	5.0	877	301	3891815	1.987	10.80
4201	N	ST	13.0	0.0	877	302	3937058	0.0000	0.00	4202	N	US	11.0	5.0	878	301	3875085	0.249	1.35
4203	N	ST	13.5	0.0	874	301	3867132	0.0000	0.00	4204	N	US	11.0	5.0	877	301	3865664	0.933	2.70
4209	N	ST	14.0	0.0	877	302	3861326	0.0000	0.00	4210	N	US	11.0	5.0	877	301	3860258	1.488	8.10
4211	N	ST	14.5	0.0	868	305	3822671	0.0000	0.00	4212	N	US	11.0	5.0	878	301	3852461	1.983	10.80
4213	N	ST	15.0	0.0	877	302	3843407	0.0000	0.00	4214	N	US	12.0	5.0	878	301	3876632	0.249	1.35
4215	N	ST	15.0	0.0	784	284	3628769	0.0000	0.00	4216	N	US	12.0	5.0	877	302	3853339	0.091	5.40
4217	N	ST	16.0	0.0	688	266	3390340	0.0000	0.00	4218	N	US	12.0	5.0	877	302	3845471	1.981	10.80
4219	N	ST	17.8	0.0	717	271	3462550	0.0000	0.00	4220	N	US	8.8	5.0	877	302	3844684	1.488	8.10
4301	N	ST	20.0	0.0	700	266	3445278	0.0000	0.00	4302	N	US	8.8	5.0	877	302	3859691	0.092	5.40
4401	N	ST	13.0	0.0	877	302	3795037	0.0000	0.00	4403	N	US	10.0	5.0	877	302	3856685	0.096	2.70
4403	N	ST	11.0	0.0	877	302	3783629	0.0000	0.00	4404	N	US	10.0	5.0	877	300	3957627	0.745	8.10
4405	N	ST	8.0	0.0	877	302	3780176	0.0000	0.00	4406	N	US	12.0	5.0	877	300	3966326	1.510	8.10
4407	N	ST	5.0	0.0	877	302	3781319	0.0000	0.00	4408	N	US	10.0	5.0	877	300	3966326	1.510	8.10
4410	N	ST	2.0	0.0	877	302	3781623	0.0000	0.00	4411	N	US	10.0	5.0	877	303	3845471	1.981	10.80
4412	N	ST	-2.0	0.0	877	302	3778643	0.0000	0.00	4413	N	US	10.0	5.0	877	303	3844684	1.488	8.10
11018	N	ST	-5.0	0.0	875	302	3949932	0.0000	0.00	8021	N	US	10.0	10.0	0.13	0.35	486001	1515	97
11019	N	ST	-2.0	0.0	875	301	3949932	0.0000	0.00	8022	N	US	10.0	10.0	0.13	0.35	485755	2529	1.62
11020	N	ST	2.0	0.0	875	302	3978739	0.0000	0.00	8023	N	US	15.0	10.0	0.13	0.36	485630	1032	66
11101	N	ST	2.0	0.0	875	302	3978739	0.0000	0.00	8106	N	US	15.0	10.0	0.13	0.36	484039	1529	98
11102	N	ST	2.0	0.0	875	301	3958541	0.0000	0.00	8114	N	US	15.0	14.0	0.13	0.36	483453	1039	67
11105	N	ST	4.0	0.0	875	301	3958541	0.0000	0.00	8116	N	US	15.0	10.0	0.54	0.72	980395	0.992	1.30
11110	N	ST	10.0	0.0	875	301	3936424	0.0000	0.00	8118	N	US	15.0	10.0	0.54	0.72	979893	1.487	1.95
11111	N	ST	12.3	0.0	875	301	3921945	0.0000	0.00	8123	N	US	15.0	10.0	0.54	0.72	978493	2.477	3.25
11112	N	ST	13.4	0.0	875	301	3921945	0.0000	0.00	8203	N	US	10.0	10.0	0.54	0.72	980066	0.991	1.30
11113	N	ST	13.8	0.0	875	301	3921945	0.0000	0.00	8210	N	US	10.0	10.0	1.22	1.09	978307	2.476	3.25
11118	N	ST	14.0	0.0	875	301	3930467	0.0000	0.00	8214	N	US	10.0	10.0	1.22	1.09	1491495	2.497	4.90
11121	N	ST	14.6	0.0	867	302	3929975	0.0000	0.00	8222	N	US	15.0	10.0	0.339	184	1450389	0.996	1.96
11123	N	ST	15.0	0.0	867	304	3925323	0.0000	0.00	8306	N	US	15.0	10.0	0.339	184	2432854	0.993	3.30
11200	N	ST	15.5	0.0	811	289	3745403	0.0000	0.00	9022	N	US	15.0	14.0	0.339	184	2423357	1.487	4.95
11201	N	ST	16.0	0.0	811	290	3733698	0.0000	0.00	9022	N	US	15.0	10.0	0.339	184	2404523	0.988	3.30
11204	N	ST	17.0	0.0	841	295	3793167	0.0000	0.00	9101	N	US	15.0	6.0	0.339	184	2358259	2.352	7.92
11205	N	ST	17.9	0.0	803	288	3725491	0.0000	0.00	9106	N	US	10.0	5.0	0.339	184	2358520	2.842	9.57
11208	N	ST	24.9	0.0	610	280	3616412	0.0000	0.00	9110	N	US	10.0	10.0	0.339	184	2353336	2.453	8.25
11209	N	ST	30.0	0.0	561	249	3252565	0.0000	0.00	9118	N	US	8.0	10.0	0.339	184	2476299	0.100	1.33
11211	N	ST	25.0	0.0	619	251	3254780	0.0000	0.00	9202	N	US	8.0	10.0	0.339	184	2475104	0.500	1.65
11213	N	ST	20.0	0.0	725	273	3515071	0.0000	0.00	9203	N	US	15.0	10.0	0.479	220	2449160	1.990	6.60
11214	N	ST	18.0	0.0	764	280	3628495	0.0000	0.00	9208	N	US	15.0	10.0	0.610	249	2847551	0.985	3.93
11215	N	ST	16.0	0.0	875	302	3566108	0.0000	0.00	9210	N	US	15.0	10.0	0.762	280	3187113	0.984	4.46
11216	N	ST	14.0	0.0	869	302	3861556	0.0000	0.00	9213	N	US	15.0	10.0	0.842	295	3520275	0.975	4.98
11221	N	ST	11.0	0.0	875	301	3864733	0.0000	0.00	9214	N	US	15.0	10.0	0.842	295	3672459	0.098	1.53
11222	N	ST	11.0	0.0	875	302	3864733	0.0000	0.00	9217	N	US	15.0	10.0	0.842	295	3596380	0.243	1.31
11223	N	ST	8.0	0.0	875	302	3876254	0.0000	0.00	9218	N	US	15.0	10.0	0.842	295	3566725	0.089	2.62
11304	N	ST	5.0	0.0	875	302	3876254	0.0000	0.00	9219	N	US	15.0	10.0	0.842	295	3549571	0.983	5.24
11305	N	ST	5.0	0.0	875	302	3864492	0.0000	0.00	9222	N	US	15.0	10.0	0.842	295	3450727	1.509	7.86
11308	N	ST	2.0	0.0	875	302	3864492	0.0000	0.00	9223	N	US	10.0	10.0	0.842	295	3672528	0.098	1.54
11309	N	ST	2.0	0.0	875	302	3873682	0.0000	0.00	9302	N	US	10.0	10.0	0.842	295	3652176	0.241	1.34
7019	N	US	9.0	5.0	878	301	3870953	0.0000	0.00	9302	N	US	10.0	10.0	0.842	295	3652005	0.963	5.36
7021	N	US	9.0	5.0	886	297	3894008	0.0538	2.70	10022	N	US	12.0	10.0	0.877	301	3670847	1.447	8.04
7023	N	US	9.0	5.0	886	299	3962010	1.004	5.40	10101	N	US	20.0	10.0	0.877	301	3769502	0.976	5.36
						299	3944777	2.005	10.80	10104	N	US	12.0	8.0	0.877	303	3711352	0.485	2.68
										7020									
										7022									
										7100									

TABLE 11.- Continued.

(a) Concluded.

A FRAME	TRIP	TYPE	A0	A1	Q	M	RE	K	FREQ	B FRAME
10105	N	US	12.0	8.0	.878	.302	3694271.	.0568	5.36	12023
10108	N	US	12.0	8.0	.847	.294	3635589.	.1253	6.81	12105
10113	N	US	15.0	5.0	.876	.402	3896845.	.0098	1.53	12112
10114	N	US	15.0	5.0	.841	.285	3501337.	.0252	1.34	12121
10118	N	US	15.0	5.0	.823	.291	3748526.	.1020	5.36	12121
10120	N	US	15.0	5.0	.842	.294	3785165.	.1511	6.04	12121
10123	N	US	15.0	5.0	.832	.293	3758528.	.2024	10.72	12121
10202	N	US	10.0	5.0	.877	.301	3658103.	.0098	5.36	12121
10203	N	US	10.0	5.0	.870	.301	3647481.	.0246	1.34	12121
10204	N	US	10.0	5.0	.870	.300	3826614.	.0493	2.68	12121
10207	N	US	10.0	5.0	.877	.302	3844529.	.0740	4.02	12121
10208	N	US	10.0	5.0	.870	.300	3859785.	.0990	5.36	12121
10211	N	US	10.0	5.0	.870	.300	3863353.	.1486	8.04	12121
10212	N	US	10.0	5.0	.870	.300	3850737.	.1979	10.72	12121
10218	N	US	5.0	5.0	.880	.300	3933484.	.0098	5.36	12121
10221	N	US	5.0	5.0	.878	.301	3925387.	.0993	5.36	12121
10222	N	US	5.0	5.0	.878	.301	3912114.	.1983	10.72	12121
10303	N	US	5.0	5.0	.877	.301	3910580.	.0991	5.36	12121
10305	N	US	5.0	5.0	.877	.301	3911328.	.0991	5.36	12121
10309	N	US	3.8	10.0	.877	.301	3896261.	.0989	5.36	12121
12020	N	US	20.0	10.0	.718	.270	3490909.	.0010	0.5	12023
12102	N	US	5.0	10.0	.882	.302	3820000.	.0009	0.5	12105
12109	N	US	5.0	10.0	.756	.279	3455765.	.0010	0.5	12112
12118	N	US	20.0	10.0	.676	.262	3246704.	.0010	0.5	12121
12203	N	US	20.0	10.0	.531	.231	2887477.	.0011	0.5	12121
12208	N	US	7.0	10.0	.587	.244	3269975.	.0010	0.5	12121
12300	N	US	20.0	10.0	.421	.204	2706734.	.0011	0.4	12301
12305	N	US	20.0	10.0	.292	.169	2252844.	.0011	0.3	12306
13021	N	US	7.0	10.0	.350	.186	2469266.	.0010	0.3	13104
13107	N	US	7.0	10.0	.120	.108	1502757.	.0017	0.3	13108
13115	N	US	20.0	10.0	.113	.105	1421201.	.0017	0.3	13116
13120	N	US	20.0	10.0	.048	.068	916563.	.0027	0.3	13116
13205	N	US	5.0	10.0	.053	.072	962303.	.0025	0.3	13202
13217	N	US	5.0	10.0	.014	.036	488772.	.0025	0.2	13213
13222	N	US	20.0	10.0	.013	.036	485631.	.0026	0.2	13213
13303	N	US	20.0	10.0	.749	.276	3456957.	.0010	0.5	13104
13308	N	US	7.0	10.0	.603	.247	3298109.	.0010	0.5	13108
13310	N	US	7.0	10.0	.461	.215	2894310.	.0010	0.4	13316
13313	N	US	7.0	10.0	.466	.216	2884723.	.0010	0.4	13316
13321	Y	US	7.0	10.0	.332	.181	2404990.	.0010	0.3	13405
14019	Y	US	15.0	10.0	.839	.294	3740954.	.0009	1.65	14020
14021	Y	US	15.0	10.0	.339	.183	2453890.	.0499	3.30	14022
14023	Y	US	15.0	10.0	.336	.182	2434182.	.1001	4.95	14100
14104	Y	US	15.0	10.0	.335	.182	2426579.	.1504	1.65	14105
14106	Y	US	15.0	10.0	.338	.183	2448651.	.0499	1.65	14107
14108	Y	US	15.0	10.0	.340	.184	2449389.	.0994	3.30	14109
14117	Y	US	15.0	10.0	.339	.183	2443079.	.1493	4.95	14109
14119	Y	US	15.0	10.0	.837	.293	3843264.	.0257	1.35	14118
14200	Y	US	15.0	10.0	.836	.293	3818432.	.0509	2.68	14120
14202	Y	US	15.0	10.0	.843	.294	3822179.	.0253	1.34	14201
14208	Y	US	15.0	10.0	.839	.293	3792702.	.0506	2.68	14209
14210	Y	US	15.0	10.0	.828	.291	3764396.	.1019	5.36	14209
14218	N	US	15.0	10.0	.832	.292	3760353.	.1014	5.36	14211
14219	N	US	15.0	10.0	.820	.292	3762798.	.0254	1.34	14211
14220	N	US	15.0	10.0	.824	.291	3735990.	.0509	2.68	14221
15218	N	US	15.0	10.0	.805	.287	3683317.	.1031	5.36	7201
10117	N	US	15.0	10.0	.818	.290	3678973.	.0994	5.24	7223
7202	N	US	15.0	5.0	.843	.295	3802563.	.0504	2.68	7201
7222	N	US	12.0	5.0	.877	.302	3861194.	.0496	2.70	7223
		US	10.0	5.0	.876	.298	3975490.	.0509	2.70	

TABLE 11.- Continued.

(b) Ames A-01 airfoil.

A FRAME	TRIP	TYPE	AO	A1	Q	H	RE	K	FREQ	B FRAME
26020	N	ST 5.0	0.0	0.0	342	184	2418525.	0.0000	0.00	27401
26022	N	ST 2.0	0.0	0.0	342	184	2422139.	0.0000	0.00	27401
26023	N	ST 0.0	0.0	0.0	342	184	2422443.	0.0000	0.00	27401
26101	N	ST 2.0	0.0	0.0	343	185	2426831.	0.0000	0.00	27404
26107	N	ST 4.0	0.0	0.0	341	184	2422433.	0.0000	0.00	27404
26108	N	ST 8.0	0.0	0.0	339	184	2422586.	0.0000	0.00	27404
26109	N	ST 10.0	0.0	0.0	342	184	2423309.	0.0000	0.00	27404
26114	N	ST 12.0	0.0	0.0	121	109	1536531.	0.0000	0.00	27415
26122	N	ST 13.0	0.0	0.0	123	110	1550354.	0.0000	0.00	27415
26200	N	ST 13.5	0.0	0.0	121	108	1533751.	0.0000	0.00	27415
26205	N	ST 14.0	0.0	0.0	122	109	1536087.	0.0000	0.00	27415
26207	N	ST 15.0	0.0	0.0	122	109	1532038.	0.0000	0.00	27415
26209	N	ST 16.0	0.0	0.0	122	110	1527387.	0.0000	0.00	27415
26215	N	ST 18.0	0.0	0.0	121	109	1522167.	0.0000	0.00	27417
26216	N	ST 20.0	0.0	0.0	122	110	1525614.	0.0000	0.00	27417
26218	N	ST 25.0	0.0	0.0	121	109	1491021.	0.0000	0.00	28020
26219	N	ST 25.0	0.0	0.0	121	109	1485106.	0.0000	0.00	28020
26300	N	ST 14.0	0.0	0.0	132	114	1541856.	0.0000	0.00	28100
26301	N	ST 14.0	0.0	0.0	132	112	1526677.	0.0000	0.00	28102
26302	N	ST 11.0	0.0	0.0	124	110	149052.	0.0000	0.00	28108
26305	N	ST 11.0	0.0	0.0	124	110	1492163.	0.0000	0.00	28108
26306	N	ST 5.0	0.0	0.0	122	109	1474403.	0.0000	0.00	28108
26307	N	ST 5.0	0.0	0.0	122	109	1487571.	0.0000	0.00	28108
26313	N	ST 5.0	0.0	0.0	122	109	1476171.	0.0000	0.00	28108
26318	N	ST 2.0	0.0	0.0	121	109	1474187.	0.0000	0.00	28108
26320	N	ST 2.0	0.0	0.0	121	109	1465336.	0.0000	0.00	28108
26321	N	ST 2.0	0.0	0.0	121	109	1476032.	0.0000	0.00	28108
26414	N	ST 8.0	0.0	0.0	121	108	1459583.	0.0000	0.00	28208
26415	N	ST 8.0	0.0	0.0	341	184	2421332.	0.0000	0.00	28208
26417	N	ST 10.0	0.0	0.0	338	183	2424855.	0.0000	0.00	28212
26419	N	ST 13.0	0.0	0.0	342	184	2439422.	0.0000	0.00	28212
26421	N	ST 13.0	0.0	0.0	343	185	2439519.	0.0000	0.00	28216
27020	N	ST 15.0	0.0	0.0	342	184	2432247.	0.0000	0.00	28219
27022	N	ST 16.0	0.0	0.0	341	185	2427824.	0.0000	0.00	28223
27100	N	ST 20.0	0.0	0.0	342	184	2426509.	0.0000	0.00	28301
27101	N	ST 20.0	0.0	0.0	343	185	2423535.	0.0000	0.00	28301
27103	N	ST 25.0	0.0	0.0	343	185	2426376.	0.0000	0.00	28303
27107	N	ST 20.0	0.0	0.0	878	301	3926655.	0.0000	0.00	28313
27108	N	ST 20.0	0.0	0.0	886	303	3959734.	0.0000	0.00	28315
27109	N	ST 10.0	0.0	0.0	884	302	3939559.	0.0000	0.00	28320
27110	N	ST 13.0	0.0	0.0	878	301	3913926.	0.0000	0.00	28322
27111	N	ST 11.0	0.0	0.0	860	298	3863673.	0.0000	0.00	28400
27116	N	ST 5.0	0.0	0.0	827	292	3779496.	0.0000	0.00	28432
27117	N	ST 5.0	0.0	0.0	859	298	3837643.	0.0000	0.00	28432
27123	N	ST 5.0	0.0	0.0	857	298	3842021.	0.0000	0.00	28432
27201	N	ST 2.0	0.0	0.0	882	302	3836732.	0.0000	0.00	28439
27202	N	ST 2.0	0.0	0.0	850	296	3729813.	0.0000	0.00	28439
27204	N	ST 2.0	0.0	0.0	814	290	3732983.	0.0000	0.00	28439
27205	N	ST 4.0	0.0	0.0	813	289	3714780.	0.0000	0.00	28439
27211	N	ST 8.0	0.0	0.0	779	283	3625374.	0.0000	0.00	28439
27212	N	ST 10.0	0.0	0.0	765	280	3598067.	0.0000	0.00	28439
27214	N	ST 12.0	0.0	0.0	609	248	3211200.	0.0000	0.00	28439
27216	N	ST 13.0	0.0	0.0	480	220	2846350.	0.0000	0.00	28439
27218	N	ST 14.0	0.0	0.0	340	184	2361118.	0.0000	0.00	28439
27220	N	ST 14.9	0.0	0.0	341	184	236387.	0.0000	0.00	28439
27301	N	ST 16.0	0.0	0.0	343	184	2364970.	0.0000	0.00	28439
27303	N	ST 18.0	0.0	0.0	341	184	2364970.	0.0000	0.00	28439
27304	N	ST 20.0	0.0	0.0	054	073	994952.	0.0000	0.00	28439
27306	N	ST 25.0	0.0	0.0	881	302	3844899.	0.0000	0.00	28439

TABLE 11.- Continued.

(b) Concluded.

FRAME	TRIP	TYPE	A0	A1	Q	H	RE	K	FREQ	FRAME
25102	N	US	10.0	10.0	881	302	3831527	.0489	2.68	25103
25104	N	US	10.0	10.0	880	302	3816708	.0978	5.36	25108
25109	N	US	10.0	10.0	879	302	3810775	.1468	8.04	25110
25117	N	US	10.0	5.0	884	303	3829075	.0242	1.34	
25118	N	US	10.0	5.0	879	302	3803407	.0489	2.68	
25119	N	US	10.0	5.0	883	303	3805390	.0975	5.36	
25121	N	US	10.0	5.0	881	302	3813088	.1465	8.04	
25122	N	US	10.0	5.0	884	303	3819823	.1462	8.04	
25123	N	US	10.0	5.0	885	303	3816827	.1947	10.72	
29023	Y	US	15.0	10.0	820	291	3637799	.0248	1.31	29100
29101	Y	US	15.0	10.0	805	298	3634654	.0500	2.62	29102
29106	Y	US	15.0	10.0	806	298	3646183	.1001	5.24	29107
29115	Y	US	15.0	10.0	340	194	2418131	.0494	1.65	29116
29117	Y	US	15.0	10.0	341	184	2418248	.0987	3.30	29118
29119	Y	US	15.0	10.0	341	184	2417060	.1481	4.95	29121
29205	N	US	5.0	10.0	876	301	3947215	.0098	5.3	29206
29207	N	US	5.0	10.0	877	301	3918856	.0496	2.68	29210
29211	N	US	5.0	10.0	877	301	3902857	.0991	5.36	29212
29213	N	US	5.0	10.0	879	301	3896095	.1483	8.04	29214
29215	N	US	5.0	10.0	879	301	3891313	.1481	8.04	
29223	N	US	13.5	2.0	876	301	3611877	.1965	10.72	29300
29304	N	US	14.5	2.0	870	300	3777473	.1967	10.72	29306
29309	N	US	16.5	2.0	852	296	3722411	.1986	10.72	29310
29317	N	US	15.0	10.0	013	035	473349	.1021	65	29318
30019	N	US	15.0	10.0	865	298	3856941	.0097	52	30021
30020	N	US	15.0	10.0	864	298	3828146	.0096	52	30021
30105	N	US	10.0	10.0	880	301	3844592	.0097	53	30106
30110	N	US	10.0	10.0	877	301	3817844	.0097	53	30111
30119	N	US	10.0	5.0	874	300	3819252	.0097	53	30120
30201	N	US	11.0	5.0	877	301	3814196	.0099	54	30202
30206	N	US	14.0	2.0	876	301	3818960	.0097	53	30208
30215	N	US	7.5	10.0	338	183	2415733	.0099	33	30216
31102	N	US	10.0	10.0	878	302	3680208	.0247	1.34	31103
31104	N	US	10.0	10.0	878	302	3659857	.0492	2.68	31105
31110	N	US	10.0	10.0	880	302	3841535	.1471	8.04	31111
31112	N	US	10.0	10.0	880	302	3832051	.1469	8.04	31111
31119	N	US	5.0	10.0	884	303	3856266	.0245	1.34	31120
31121	N	US	5.0	10.0	880	302	3826984	.0489	2.68	31122
31123	N	US	5.0	10.0	884	303	3823741	.0975	5.36	31200
31201	N	US	5.0	10.0	883	303	3816623	.1463	8.04	31202
31209	N	US	15.0	10.0	341	184	2421436	.0987	3.30	31210
31215	N	US	7.5	10.0	341	184	2425489	.0494	1.65	31216
31217	N	US	7.5	10.0	341	185	2423083	.1972	6.60	31218
31310	N	US	14.5	2.0	852	297	3765532	.1990	10.72	31304
25204	N	US	14.5	2.0	854	298	3731989	.1485	8.04	31312
25205	N	US	15.0	5.0	877	301	3973275	.0249	1.34	
25208	N	US	15.0	5.0	878	301	3952662	.0497	2.68	
25209	N	US	15.0	5.0	857	298	3687213	.1506	8.04	
25210	N	US	15.0	5.0	852	297	3865306	.2013	10.72	
25214	N	US	11.0	5.0	880	302	3726436	.0495	2.68	25215
25216	N	US	11.0	5.0	883	302	3909711	.0986	5.36	25217
25301	N	US	5.0	5.0	884	302	3903998	.0984	5.36	25302
25303	N	US	5.0	5.0	885	303	3878688	.1962	10.72	25304
25311	N	US	5.0	10.1	881	302	3852707	.0982	5.36	25312
25319	N	US	5.5	10.0	881	302	3833693	.0980	5.36	25320

TABLE 11.- Continued.

(c) Wortmann FX-098 airfoil.

A										B									
FRAME	TRIP	TYPE	A0	A1	Q	M	RE	K	FREQ	FRAME	TRIP	TYPE	A0	A1	Q	M	RE	K	FREQ
17208	Y	ST	5.0	0.0	0.877	301	3975279.	0.0000	0.00	17209	N	ST	13.0	0.0	0.340	185	2353097.	0.0000	0.00
17212	Y	ST	5.0	0.0	0.880	301	3928557.	0.0000	0.00	17213	N	ST	11.0	0.0	0.341	185	2354186.	0.0000	0.00
17220	Y	ST	10.0	0.0	0.879	302	3911481.	0.0000	0.00	17221	N	ST	5.0	0.0	0.340	185	2357348.	0.0000	0.00
17303	Y	ST	12.0	0.0	0.847	296	3802285.	0.0000	0.00	17304	N	ST	0.0	0.0	0.340	185	2354786.	0.0000	0.00
17305	Y	ST	13.0	0.0	0.870	300	3835772.	0.0000	0.00	17306	N	ST	-5.0	0.0	0.614	250	3151118.	0.0000	0.00
17310	Y	ST	14.0	0.0	0.866	299	3820036.	0.0000	0.00	17311	N	ST	-2.0	0.0	0.611	250	3138172.	0.0000	0.00
17312	Y	ST	15.0	0.0	0.866	299	3805980.	0.0000	0.00	17313	N	ST	0.0	0.0	0.612	250	3137611.	0.0000	0.00
17314	Y	ST	16.0	0.0	0.828	292	3710084.	0.0000	0.00	17315	N	ST	2.0	0.0	0.616	251	3300956.	0.0000	0.00
18019	Y	ST	0.0	0.0	0.341	184	2398709.	0.0000	0.00	18020	N	ST	4.0	0.0	0.616	251	3297074.	0.0000	0.00
18102	Y	ST	5.0	0.0	0.343	185	2400750.	0.0000	0.00	18103	N	ST	8.0	0.0	0.617	251	3278867.	0.0000	0.00
18106	Y	ST	10.0	0.0	0.339	184	2378846.	0.0000	0.00	18107	N	ST	10.0	0.0	0.614	250	3275608.	0.0000	0.00
18108	Y	ST	12.0	0.0	0.343	185	2389927.	0.0000	0.00	18109	N	ST	12.0	0.0	0.618	251	3278455.	0.0000	0.00
18115	Y	ST	13.0	0.0	0.346	185	2394744.	0.0000	0.00	18116	N	ST	13.0	0.0	0.618	251	3268218.	0.0000	0.00
18117	Y	ST	14.0	0.0	0.345	185	2388872.	0.0000	0.00	18118	N	ST	13.5	0.0	0.620	251	3264994.	0.0000	0.00
18119	Y	ST	15.0	0.0	0.341	184	2374587.	0.0000	0.00	18120	N	ST	14.0	0.0	0.613	250	3233310.	0.0000	0.00
18121	Y	ST	16.0	0.0	0.340	184	2368089.	0.0000	0.00	18122	N	ST	15.0	0.0	0.613	250	3233310.	0.0000	0.00
18123	Y	ST	19.9	0.0	0.342	184	2370588.	0.0000	0.00	18200	N	ST	18.0	0.0	0.602	248	3194789.	0.0000	0.00
18206	Y	ST	0.0	0.0	0.341	134	2379635.	0.0000	0.00	18207	N	ST	18.0	0.0	0.602	248	3194789.	0.0000	0.00
18215	N	ST	-5.0	0.0	0.122	110	1500031.	0.0000	0.00	20019	N	ST	25.0	0.0	0.610	249	3162267.	0.0000	0.00
18217	N	ST	0.0	0.0	0.123	110	1502458.	0.0000	0.00	20020	N	ST	20.0	0.0	0.612	250	3158666.	0.0000	0.00
18218	N	ST	0.0	0.0	0.121	109	1487692.	0.0000	0.00	20021	N	ST	16.0	0.0	0.614	250	3163174.	0.0000	0.00
18220	N	ST	2.0	0.0	0.122	110	1487692.	0.0000	0.00	20022	N	ST	14.0	0.0	0.614	250	3163970.	0.0000	0.00
18221	N	ST	4.0	0.0	0.121	109	1486754.	0.0000	0.00	20103	N	ST	13.0	0.0	0.610	249	3155282.	0.0000	0.00
18304	N	ST	8.0	0.0	0.121	109	1480425.	0.0000	0.00	20104	N	ST	11.0	0.0	0.609	249	3150506.	0.0000	0.00
18305	N	ST	10.0	0.0	0.122	110	1483466.	0.0000	0.00	20109	N	ST	5.0	0.0	0.615	250	3157103.	0.0000	0.00
18307	N	ST	12.0	0.0	0.122	109	1476483.	0.0000	0.00	20112	N	ST	5.0	0.0	0.615	250	3152218.	0.0000	0.00
18312	N	ST	13.0	0.0	0.121	109	1466753.	0.0000	0.00	20118	N	ST	-5.0	0.0	0.893	304	3774892.	0.0000	0.00
18319	N	ST	13.5	0.0	0.123	109	1469738.	0.0000	0.00	20122	N	ST	0.0	0.0	0.883	303	3776701.	0.0000	0.00
18321	N	ST	14.0	0.0	0.124	110	1474082.	0.0000	0.00	20123	N	ST	0.0	0.0	0.877	302	3758789.	0.0000	0.00
18323	N	ST	15.0	0.0	0.122	110	1463922.	0.0000	0.00	20203	N	ST	2.0	0.0	0.879	303	3748627.	0.0000	0.00
18401	N	ST	16.0	0.0	0.122	109	1461183.	0.0000	0.00	20204	N	ST	2.0	0.0	0.878	302	3741653.	0.0000	0.00
18410	N	ST	18.0	0.0	0.124	111	1459953.	0.0000	0.00	20210	N	ST	8.0	0.0	0.876	303	3768915.	0.0000	0.00
18411	N	ST	20.0	0.0	0.123	110	1447617.	0.0000	0.00	20211	N	ST	10.0	0.0	0.880	299	3764181.	0.0000	0.00
18413	N	ST	25.0	0.0	0.123	109	1445110.	0.0000	0.00	20213	N	ST	12.0	0.0	0.860	299	3709078.	0.0000	0.00
18414	N	ST	20.0	0.0	0.122	110	1439675.	0.0000	0.00	20222	N	ST	13.0	0.0	0.821	291	3820534.	0.0000	0.00
18421	N	ST	16.0	0.0	0.123	109	1445948.	0.0000	0.00	20300	N	ST	13.5	0.0	0.841	295	3849559.	0.0000	0.00
18422	N	ST	14.0	0.0	0.122	110	1438216.	0.0000	0.00	20302	N	ST	14.0	0.0	0.875	301	3916076.	0.0000	0.00
18423	N	ST	13.0	0.0	0.122	109	1439933.	0.0000	0.00	20307	N	ST	15.0	0.0	0.866	299	3903574.	0.0000	0.00
18500	N	ST	11.0	0.0	0.122	110	1437504.	0.0000	0.00	20309	N	ST	16.0	0.0	0.877	302	3913381.	0.0000	0.00
18501	N	ST	5.0	0.0	0.122	109	1436482.	0.0000	0.00	20311	N	ST	18.0	0.0	0.895	294	3811625.	0.0000	0.00
18502	N	ST	0.0	0.0	0.122	110	1439616.	0.0000	0.00	20312	N	ST	20.0	0.0	0.737	275	3577136.	0.0000	0.00
19020	N	ST	-5.0	0.0	0.342	185	2454849.	0.0000	0.00	20318	N	ST	25.0	0.0	0.668	261	3411407.	0.0000	0.00
19022	N	ST	0.0	0.0	0.342	184	2447610.	0.0000	0.00	20319	N	ST	16.0	0.0	0.881	302	3832367.	0.0000	0.00
19023	N	ST	2.0	0.0	0.340	185	2441467.	0.0000	0.00	20320	N	ST	14.0	0.0	0.862	302	3832367.	0.0000	0.00
19101	N	ST	4.0	0.0	0.341	185	2443653.	0.0000	0.00	20321	N	ST	13.0	0.0	0.857	300	3850866.	0.0000	0.00
19110	N	ST	8.0	0.0	0.341	185	2398777.	0.0000	0.00	20322	N	ST	11.0	0.0	0.879	302	3875469.	0.0000	0.00
19116	N	ST	10.0	0.0	0.340	185	2327613.	0.0000	0.00	16019	N	UN	15.0	10.0	0.013	036	488137.	1.007	66
19117	N	ST	12.0	0.0	0.343	185	2379520.	0.0000	0.00	16105	N	UN	15.0	10.0	0.056	074	986067.	0.972	1.30
19119	N	ST	13.0	0.0	0.343	185	2379520.	0.0000	0.00	16115	N	UN	15.0	10.0	0.123	110	1463255.	0.932	1.96
19121	N	ST	13.5	0.0	0.343	185	2370521.	0.0000	0.00	16200	N	UN	15.0	10.0	0.343	185	2429922.	0.933	3.30
19123	N	ST	14.0	0.0	0.340	185	2361633.	0.0000	0.00	16201	N	UN	15.0	10.0	0.340	184	2502119.	0.950	1.65
19206	N	ST	15.0	0.0	0.342	185	2364851.	0.0000	0.00	16213	N	UN	6.5	10.0	0.340	184	2434598.	0.999	6.62
19208	N	ST	16.0	0.0	0.342	185	2361273.	0.0000	0.00	16215	N	UN	6.5	10.0	0.340	184	2434598.	0.999	6.62
19214	N	ST	18.0	0.0	0.341	185	2365586.	0.0000	0.00	16308	N	UN	15.0	10.0	0.612	249	3223332.	0.988	4.46
19216	N	ST	20.0	0.0	0.340	185	2368408.	0.0000	0.00	16309	N	UN	15.0	10.0	0.612	249	3223332.	0.988	4.46
19217	N	ST	25.0	0.0	0.341	184	2351317.	0.0000	0.00	17103	Y	UN	15.0	10.0	0.341	184	2457108.	0.947	1.65
19221	N	ST	16.0	0.0	0.341	185	2359002.	0.0000	0.00	17109	Y	UN	15.0	10.0	0.341	184	2452721.	0.992	3.30
19222	N	ST	14.0	0.0	0.343	186	2364589.	0.0000	0.00	17117	Y	UN	15.0	10.0	0.830	293	372247.	1.486	4.95
										17119	Y	UN	15.0	10.0	0.823	291	3724643.	0.947	2.62
										17123	Y	UN	15.0	10.0	0.823	291	3724643.	0.947	2.62

TABLE 11.- Continued.

(c) Concluded.

A	FRAME	TRIP	TYPE	AO	A1	Q	M	RE	K	FREQ	B	FRAME
17200	N	UN	15.0	10.0	8.14	.823	290	3702477.	.0999	5.24	17201	21102
21100	N	UN	15.0	10.0	.823	.823	291	3718613.	.0099	.52	21201	21102
21107	N	UN	10.0	10.0	.857	.857	299	3792469.	.0098	.53	21201	21201
21200	N	UN	10.0	5.0	.875	.875	301	3922117.	.0098	.53	21209	21209
21208	N	UN	3.3	10.0	.882	.882	302	3833549.	.0098	.53	21220	21220
21219	N	UN	6.5	10.0	.839	.839	184	2455159.	.0098	.53	21220	21220
22023	N	UN	15.0	10.0	.827	.827	293	3727583.	.0247	1.31	22100	22100
22103	N	UN	15.0	10.0	.837	.837	294	3749080.	.0492	2.62	22104	22104
22201	N	UN	15.0	10.0	.785	.785	285	3552419.	.1008	5.24	22202	22202
22206	N	UN	15.0	10.0	.754	.754	274	3477029.	.1342	7.86	22207	22207
22208	N	UN	15.0	10.0	.763	.763	281	3483672.	.0969	4.98	22209	22209
22216	N	UN	10.0	10.0	.875	.875	302	3732111.	.0243	1.34		
22217	N	UN	10.0	10.0	.875	.875	302	3720266.	.0485	2.68		
22218	N	UN	10.0	10.0	.862	.862	300	3694571.	.0977	5.36		
22219	N	UN	10.0	10.0	.835	.835	294	3618609.	.1490	8.04		
22307	N	UN	10.0	5.0	.875	.875	301	3654387.	.0246	1.34	22223	22223
22308	N	UN	10.0	5.0	.880	.880	303	3857324.	.0491	2.68	22300	22300
22309	N	UN	10.0	5.0	.881	.881	303	3853491.	.0980	5.36	22301	22301
22311	N	UN	10.0	5.0	.877	.877	322	3849798.	.1475	8.04	22302	22302
22312	N	UN	10.0	5.0	.882	.882	303	3849072.	.1957	10.72	22303	22303
23021	N	UN	15.0	5.0	.858	.858	298	3792196.	.0248	1.34		
23022	N	UN	15.0	5.0	.851	.851	297	3750472.	.0497	2.68		
23023	N	UN	15.0	5.0	.840	.840	295	3716891.	.1000	5.36		
23100	N	UN	15.0	5.0	.822	.822	292	3670934.	.1515	8.04		
23107	N	UN	5.0	5.0	.867	.867	300	3802836.	.0986	5.36	23108	23108
23109	N	UN	5.0	5.0	.867	.867	300	3769174.	.1970	10.72	23110	23110
23117	N	UN	5.0	10.0	.869	.869	300	3803440.	.0985	5.36	23118	23118
23201	N	UN	3.8	10.0	.866	.866	299	3948210.	.1003	5.36	23202	23202
23206	N	UN	3.3	10.0	.866	.866	299	3924045.	.0500	2.68	23207	23207
23208	N	UN	3.3	10.0	.871	.871	300	3914485.	.0996	5.36	23210	23210
23211	N	UN	3.3	10.0	.870	.870	300	3895319.	.1492	8.04	23212	23212
23219	N	UN	12.0	2.0	.864	.864	299	3865609.	.1994	10.72	23220	23220
23305	N	UN	14.0	2.0	.858	.858	298	3831711.	.1995	10.72	23306	23306
23310	N	UN	16.0	2.0	.839	.839	294	3768762.	.2014	10.72	23311	23311
23112	N	UN	15.0	5.0	.873	.873	301	3940131.	.0099	.53		
23101	N	UN	15.0	5.0	.800	.800	287	3617353.	.2049	10.72		

TABLE 11.- Continued.

(d) Sikorsky SC-1095 airfoil.

A										B									
FRAME	TRIP	TYPE	A0	A1	Q	M	RE	K	FREQ	FRAME	TRIP	TYPE	A0	A1	Q	M	RE	K	FREQ
34022	Y	ST	0.0	0.0	0.0	0.878	3985083.	0.0000	0.00	34023	N	ST	16.0	0.0	0.340	184	2432059.	0.0000	0.00
34100	Y	ST	5.0	0.0	0.0	0.880	3976998.	0.0000	0.00	34101	N	ST	20.0	0.0	0.341	185	2424852.	0.0000	0.00
34102	Y	ST	10.0	0.0	0.0	0.884	3969476.	0.0000	0.00	34108	N	ST	5.0	0.0	0.123	111	1457009.	0.0000	0.00
34109	Y	ST	12.0	0.0	0.0	0.879	3961576.	0.0000	0.00	34110	N	ST	0.0	0.0	0.124	111	1461763.	0.0000	0.00
34111	Y	ST	13.0	0.0	0.0	0.883	3946692.	0.0000	0.00	34204	N	ST	5.0	0.0	0.123	110	1455304.	0.0000	0.00
34113	Y	ST	14.0	0.0	0.0	0.856	3986234.	0.0000	0.00	34209	N	ST	10.0	0.0	0.122	110	1429342.	0.0000	0.00
34115	Y	ST	15.0	0.0	0.0	0.806	3973539.	0.0000	0.00	34210	N	ST	12.0	0.0	0.121	109	1420840.	0.0000	0.00
34116	Y	ST	16.0	0.0	0.0	0.850	3902976.	0.0000	0.00	34211	N	ST	13.5	0.0	0.122	110	1420840.	0.0000	0.00
34200	Y	ST	0.0	0.0	0.0	0.841	3902976.	0.0000	0.00	34212	N	ST	14.0	0.0	0.124	110	1430614.	0.0000	0.00
34202	Y	ST	5.0	0.0	0.0	0.842	2465733.	0.0000	0.00	34213	N	ST	15.0	0.0	0.122	110	1421260.	0.0000	0.00
34204	Y	ST	10.0	0.0	0.0	0.842	2455124.	0.0000	0.00	34216	N	ST	15.5	0.0	0.123	110	1425215.	0.0000	0.00
34208	Y	ST	13.0	0.0	0.0	0.842	2449358.	0.0000	0.00	34217	N	ST	16.0	0.0	0.121	109	1413387.	0.0000	0.00
34210	Y	ST	14.0	0.0	0.0	0.842	2447959.	0.0000	0.00	34218	N	ST	20.0	0.0	0.120	109	1408711.	0.0000	0.00
34212	Y	ST	16.0	0.0	0.0	0.841	2441097.	0.0000	0.00	34219	N	UN	15.0	0.0	0.054	073	975044.	0.0000	0.00
34214	Y	ST	0.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33022	N	UN	15.0	0.0	0.124	110	1462074.	0.0000	0.00
34215	Y	ST	5.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33106	N	UN	15.0	0.0	0.339	183	2400379.	0.0000	0.00
34216	Y	ST	10.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33110	N	UN	6.2	0.0	0.334	182	2390916.	0.0000	0.00
34217	Y	ST	15.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33118	N	UN	6.2	0.0	0.334	182	2409037.	0.0000	0.00
34218	Y	ST	20.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33121	N	UN	15.0	0.0	0.479	219	2837984.	0.0000	0.00
34219	Y	ST	0.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33205	N	UN	15.0	0.0	0.612	249	3185055.	0.0000	0.00
34220	Y	ST	5.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33207	N	UN	15.0	0.0	0.762	279	3744973.	0.0000	0.00
34221	Y	ST	10.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33215	N	UN	15.0	0.0	0.855	297	3920520.	0.0000	0.00
34222	Y	ST	15.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33217	N	UN	15.0	0.0	0.855	297	3920520.	0.0000	0.00
34223	Y	ST	20.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33222	N	UN	15.0	0.0	0.855	297	3920520.	0.0000	0.00
34224	Y	ST	0.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33300	N	UN	15.0	0.0	0.832	292	3875513.	0.0000	0.00
34225	Y	ST	5.0	0.0	0.0	0.841	2444858.	0.0000	0.00	33306	N	UN	15.0	0.0	0.828	292	3875513.	0.0000	0.00
34226	Y	ST	10.0	0.0	0.0	0.841	2444858.	0.0000	0.00	34306	Y	UN	15.0	0.0	0.876	302	3915346.	0.0000	0.00
34227	Y	ST	15.0	0.0	0.0	0.841	2444858.	0.0000	0.00	34308	Y	UN	15.0	0.0	0.880	302	3915346.	0.0000	0.00
34228	Y	ST	20.0	0.0	0.0	0.841	2444858.	0.0000	0.00	34318	Y	UN	15.0	0.0	0.879	302	3915346.	0.0000	0.00
34229	Y	ST	0.0	0.0	0.0	0.841	2444858.	0.0000	0.00	34321	Y	UN	15.0	0.0	0.879	302	3915346.	0.0000	0.00
34230	Y	ST	5.0	0.0	0.0	0.841	2444858.	0.0000	0.00	34323	Y	UN	15.0	0.0	0.879	302	3915346.	0.0000	0.00
34231	Y	ST	10.0	0.0	0.0	0.841	2444858.	0.0000	0.00	34409	N	UN	15.0	0.0	0.881	302	3915346.	0.0000	0.00
34232	Y	ST	15.0	0.0	0.0	0.841	2444858.	0.0000	0.00	34418	N	UN	4.1	0.0	0.881	302	3915346.	0.0000	0.00
34233	Y	ST	20.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37023	N	UN	10.0	0.0	0.866	300	3936295.	0.0000	0.00
34234	Y	ST	0.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37101	N	UN	10.0	0.0	0.876	301	3928667.	0.0000	0.00
34235	Y	ST	5.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37107	N	UN	10.0	0.0	0.880	302	3915346.	0.0000	0.00
34236	Y	ST	10.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37109	N	UN	10.0	0.0	0.879	302	3915346.	0.0000	0.00
34237	Y	ST	15.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37119	N	UN	4.1	0.0	0.879	302	3915346.	0.0000	0.00
34238	Y	ST	20.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37121	N	UN	4.1	0.0	0.886	302	3915346.	0.0000	0.00
34239	Y	ST	0.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37123	N	UN	4.1	0.0	0.886	302	3915346.	0.0000	0.00
34240	Y	ST	5.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37207	N	UN	10.0	0.0	0.879	302	3915346.	0.0000	0.00
34241	Y	ST	10.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37208	N	UN	10.0	0.0	0.871	301	3750400.	0.0000	0.00
34242	Y	ST	15.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37210	N	UN	10.0	0.0	0.879	302	3915346.	0.0000	0.00
34243	Y	ST	20.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37213	N	UN	10.0	0.0	0.885	303	3780389.	0.0000	0.00
34244	Y	ST	0.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37215	N	UN	10.0	0.0	0.883	303	3780389.	0.0000	0.00
34245	Y	ST	5.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37219	N	UN	11.0	0.0	0.871	301	3752512.	0.0000	0.00
34246	Y	ST	10.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37221	N	UN	11.0	0.0	0.878	302	3752461.	0.0000	0.00
34247	Y	ST	15.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37222	N	UN	12.0	0.0	0.878	301	4001117.	0.0000	0.00
34248	Y	ST	20.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37304	N	UN	12.0	0.0	0.878	301	3984111.	0.0000	0.00
34249	Y	ST	0.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37306	N	UN	12.0	0.0	0.878	301	3984111.	0.0000	0.00
34250	Y	ST	5.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37308	N	UN	12.0	0.0	0.878	301	3984111.	0.0000	0.00
34251	Y	ST	10.0	0.0	0.0	0.841	2444858.	0.0000	0.00	37313	N	UN	12.0	0.0	0.878	301	3984111.	0.0000	0.00
34252	Y	ST	15.0	0.0	0.0	0.841	2444858.	0.0000	0.00	38021	N	UN	15.0	0.0	0.865	299	3936597.	0.0000	0.00
34253	Y	ST	20.0	0.0	0.0	0.841	2444858.	0.0000	0.00	38022	N	UN	15.0	0.0	0.865	299	3936597.	0.0000	0.00
34254	Y	ST	0.0	0.0	0.0	0.841	2444858.	0.0000	0.00	38102	N	UN	15.0	0.0	0.840	294	3784896.	0.0000	0.00
34255	Y	ST	5.0	0.0	0.0	0.841	2444858.	0.0000	0.00	38103	N	UN	15.0	0.0	0.830	293	3747172.	0.0000	0.00
34256	Y	ST	10.0	0.0	0.0	0.841	2444858.	0.0000	0.00	38104	N	UN	15.0	0.0	0.808	289	3688250.	0.0000	0.00
34257	Y	ST	15.0	0.0	0.0	0.841	2444858.	0.0000	0.00	38109	N	UN	14.0	0.0	0.870	300	3853545.	0.0000	0.00
34258	Y	ST	20.0	0.0	0.0	0.841	2444858.	0.0000	0.00	38201	N	UN	12.3	2.0	0.876	301	3876423.	0.0000	0.00
34259	Y	ST	0.0	0.0	0.0	0.841	2444858.	0.0000	0.00	38216	N	UN	6.2	0.0	0.339	183	2468863.	0.0000	0.00
34260	Y	ST	5.0	0.0	0.0	0.841	2444858.	0.0000	0.00	38300	N	UN	15.0	0.0	0.862	298	3951336.	0.0000	0.00
34261	Y	ST	10.0	0.0	0.0	0.841	2444858.	0.0000	0.00	38306	N	UN	10.0	0.0	0.864	299	3931609.	0.0000	0.00
34262	Y	ST	15.0	0.0	0.0	0.841	2444858.	0.0000	0.00	39021	N	UN	4.1	0.0	0.875	300	3811898.	0.0000	0.00
34263	Y	ST	20.0	0.0	0.0	0.841	2444858.	0.0000	0.00	39104	N	UN	15.0	0.0	0.856	297	3926571.	0.0000	0.00

TABLE 11.- Continued.

(d) Concluded.

A								B			
FRAME	TRIP	TYPE	AD	A1	Q	M	RE	K	FREQ	FRAME	
39110	N	UN	11.0	5.0	.869	.299	3896487.	.0099	.53		
39115	N	UN	14.0	2.0	.865	.298	3838822.	.0100	.54		
38110	N	UN	16.0	2.0	.832	.293	3754517.	.2023	10.72	38111	
39107	N	UN	10.0	5.0	.876	.300	3939495.	.0098	.53		

TABLE 11.- Continued.

(e) Hughes HH-02 airfoil.

A	FRAME	B	FRAME	A1	Q	M	RE	K	FREQ	B	FRAME
40018	N	110	1508746.	0.00	0.00	0.0000	0.00	0.0000	0.00	41215	N
40019	N	109	1502749.	0.00	0.00	0.0000	0.00	0.0000	0.00	41221	Y
40020	N	121	1511661.	0.00	0.00	0.0000	0.00	0.0000	0.00	41223	Y
40101	N	123	1511504.	0.00	0.00	0.0000	0.00	0.0000	0.00	41301	Y
40102	N	123	1490668.	0.00	0.00	0.0000	0.00	0.0000	0.00	41303	Y
40103	N	123	1514773.	0.00	0.00	0.0000	0.00	0.0000	0.00	41305	Y
40104	N	125	1502336.	0.00	0.00	0.0000	0.00	0.0000	0.00	41307	Y
40105	N	123	1499223.	0.00	0.00	0.0000	0.00	0.0000	0.00	41312	Y
40106	N	122	1494155.	0.00	0.00	0.0000	0.00	0.0000	0.00	41314	Y
40107	N	121	1487366.	0.00	0.00	0.0000	0.00	0.0000	0.00	41401	Y
40108	N	122	1497097.	0.00	0.00	0.0000	0.00	0.0000	0.00	41403	Y
40114	N	122	2477234.	0.00	0.00	0.0000	0.00	0.0000	0.00	41405	Y
40115	N	341	185 2465667.	0.00	0.00	0.0000	0.00	0.0000	0.00	41407	Y
40117	N	341	185 2469822.	0.00	0.00	0.0000	0.00	0.0000	0.00	41409	Y
40201	N	341	2478173.	0.00	0.00	0.0000	0.00	0.0000	0.00	41411	Y
40203	N	343	2483039.	0.00	0.00	0.0000	0.00	0.0000	0.00	41413	Y
40205	N	343	2474050.	0.00	0.00	0.0000	0.00	0.0000	0.00	41415	Y
40207	N	344	2483787.	0.00	0.00	0.0000	0.00	0.0000	0.00	41417	Y
40213	N	340	2474314.	0.00	0.00	0.0000	0.00	0.0000	0.00	41419	Y
40215	N	340	2473795.	0.00	0.00	0.0000	0.00	0.0000	0.00	42021	Y
40222	N	340	2473125.	0.00	0.00	0.0000	0.00	0.0000	0.00	42109	Y
40223	N	879	302 4129994.	0.00	0.00	0.0000	0.00	0.0000	0.00	42110	Y
40301	N	874	301 4103323.	0.00	0.00	0.0000	0.00	0.0000	0.00	42113	Y
40303	N	875	300 4035502.	0.00	0.00	0.0000	0.00	0.0000	0.00	42116	Y
40308	N	878	301 4059676.	0.00	0.00	0.0000	0.00	0.0000	0.00	42121	N
40310	N	878	301 4041789.	0.00	0.00	0.0000	0.00	0.0000	0.00	42206	N
40312	N	883	302 4039947.	0.00	0.00	0.0000	0.00	0.0000	0.00	42208	N
40314	N	884	303 4032069.	0.00	0.00	0.0000	0.00	0.0000	0.00	42210	N
40319	N	806	288 3854130.	0.00	0.00	0.0000	0.00	0.0000	0.00	42212	N
40321	N	715	270 3619314.	0.00	0.00	0.0000	0.00	0.0000	0.00	42217	N
40322	N	881	301 4009498.	0.00	0.00	0.0000	0.00	0.0000	0.00	42218	N
40323	N	869	299 3960164.	0.00	0.00	0.0000	0.00	0.0000	0.00	42219	N
40400	N	871	300 3981021.	0.00	0.00	0.0000	0.00	0.0000	0.00	42302	N
40406	N	877	301 4024289.	0.00	0.00	0.0000	0.00	0.0000	0.00	42309	N
40407	N	878	301 4023056.	0.00	0.00	0.0000	0.00	0.0000	0.00	42313	N
41019	N	874	300 4148783.	0.00	0.00	0.0000	0.00	0.0000	0.00	43019	N
41021	N	874	300 4123880.	0.00	0.00	0.0000	0.00	0.0000	0.00	43106	N
41022	N	875	300 4107145.	0.00	0.00	0.0000	0.00	0.0000	0.00	43108	N
41102	N	875	301 4097393.	0.00	0.00	0.0000	0.00	0.0000	0.00	43114	N
41103	N	877	301 4069950.	0.00	0.00	0.0000	0.00	0.0000	0.00	43117	N
41110	N	610	248 3409824.	0.00	0.00	0.0000	0.00	0.0000	0.00	43202	N
41111	N	610	248 3971741.	0.00	0.00	0.0000	0.00	0.0000	0.00	43204	N
41112	N	611	248 3993868.	0.00	0.00	0.0000	0.00	0.0000	0.00	43212	N
41113	N	611	248 3991537.	0.00	0.00	0.0000	0.00	0.0000	0.00	43206	N
41114	N	609	248 3981054.	0.00	0.00	0.0000	0.00	0.0000	0.00	43209	N
41119	N	610	248 3361027.	0.00	0.00	0.0000	0.00	0.0000	0.00	43215	N
41120	N	609	248 3342575.	0.00	0.00	0.0000	0.00	0.0000	0.00	43219	N
41121	N	609	248 3337152.	0.00	0.00	0.0000	0.00	0.0000	0.00	43219	N
41122	N	612	249 3337882.	0.00	0.00	0.0000	0.00	0.0000	0.00	43304	N
41123	N	614	249 3341019.	0.00	0.00	0.0000	0.00	0.0000	0.00	43304	N
41200	N	611	249 3327247.	0.00	0.00	0.0000	0.00	0.0000	0.00	43305	N
41201	N	610	248 3321682.	0.00	0.00	0.0000	0.00	0.0000	0.00	43309	N
41202	N	608	248 3315976.	0.00	0.00	0.0000	0.00	0.0000	0.00	43316	N
41205	N	608	248 3317238.	0.00	0.00	0.0000	0.00	0.0000	0.00	43316	N
41206	N	608	248 3305068.	0.00	0.00	0.0000	0.00	0.0000	0.00	44019	N
41207	N	614	249 3321536.	0.00	0.00	0.0000	0.00	0.0000	0.00	44021	N
41208	N	609	248 3310470.	0.00	0.00	0.0000	0.00	0.0000	0.00	44033	N
41209	N	613	249 3319411.	0.00	0.00	0.0000	0.00	0.0000	0.00	44034	N
41214	N	613	249 3342072.	0.00	0.00	0.0000	0.00	0.0000	0.00	44106	N

TABLE 11.- Continued.

(e) Concluded.

A		B									
FRAME	TRIP	TYPE	AO	A1	Q	M	RE	K	FREQ	FRAME	
44112	N	US	10.0	5.0	.880	.303	4003278.	.1989	10.72	44113	
44118	N	US	10.0	5.0	.880	.302	4037690.	.0999	5.36		
44119	N	US	10.0	5.0	.876	.302	4019097.	.0250	1.34		
44120	N	US	10.0	5.0	.878	.302	4007236.	.1997	10.72		
44202	N	US	14.0	2.0	.875	.301	4004232.	.1001	5.36	44203	
44204	N	US	14.0	2.0	.872	.301	3987136.	.2002	10.72	44205	
44209	N	US	17.5	2.0	.773	.282	3756572.	.2132	10.72		
44212	N	US	15.5	2.0	.854	.297	3961107.	.0102	.54		
44214	N	US	15.5	2.0	.851	.297	3917470.	.0253	1.34		
44215	N	US	15.5	2.0	.849	.296	3904494.	.0506	2.68		
44216	N	US	15.5	2.0	.829	.293	3854681.	.1024	5.36		
44217	N	US	15.5	2.0	.820	.291	3826794.	.1545	8.04		
44218	N	US	15.5	2.0	.824	.292	3832243.	.2054	10.72		
44221	N	US	12.5	2.0	.871	.301	3956905.	.0101	.54		
44222	N	US	12.5	2.0	.877	.302	3945321.	.0248	1.34		
44223	N	US	12.5	2.0	.871	.301	3926050.	.0493	2.68		
44300	N	US	12.5	2.0	.874	.301	3924775.	.0994	5.36		
44303	N	US	12.5	2.0	.877	.302	3952217.	.1490	8.04		
44304	N	US	12.5	2.0	.878	.302	3945918.	.1984	10.72		
44308	N	US	15.0	5.0	.813	.290	3809287.	.1549	8.04		

TABLE 11.- Continued.

(f) Vertol VR-7 airfoil.

A FRAME	TRIP	TYPE	AO	A1	Q	M	RE	K	FREQ	B FRAME
46018	N	ST	-5.0	0.0	121	108	1551001.	0.0000	0.00	
46019	N	ST	0.0	0.0	121	108	1546271.	0.0000	0.00	
46020	N	ST	5.0	0.0	123	109	1557517.	0.0000	0.00	
46101	N	ST	10.0	0.0	118	107	1512690.	0.0000	0.00	
46102	N	ST	12.5	0.0	122	109	1540066.	0.0000	0.00	46622
46103	N	ST	12.0	0.0	123	109	1547844.	0.0000	0.00	46700
46104	N	ST	13.0	0.0	123	109	1543789.	0.0000	0.00	46702
46105	N	ST	13.5	0.0	123	109	1542255.	0.0000	0.00	46704
46106	N	ST	14.0	0.0	122	109	1532252.	0.0000	0.00	46706
46107	N	ST	15.0	0.0	122	109	1537932.	0.0000	0.00	46708
46108	N	ST	17.0	0.0	123	109	1541148.	0.0000	0.00	46715
46109	N	ST	20.0	0.0	122	109	1534206.	0.0000	0.00	46717
46110	N	ST	25.0	0.0	120	108	1532301.	0.0000	0.00	46719
46116	N	ST	-5.0	0.0	341	184	2550698.	0.0000	0.00	46903
46117	N	ST	0.0	0.0	342	183	2552564.	0.0000	0.00	46905
46119	N	ST	5.0	0.0	341	183	2546264.	0.0000	0.00	46907
46203	N	ST	10.0	0.0	343	184	2562110.	0.0000	0.00	46909
46205	N	ST	12.0	0.0	341	183	2551368.	0.0000	0.00	46911
46207	N	ST	12.5	0.0	342	183	2553262.	0.0000	0.00	46916
46209	N	ST	13.0	0.0	342	184	2553793.	0.0000	0.00	46918
46211	N	ST	13.5	0.0	341	183	2550511.	0.0000	0.00	46920
46217	N	ST	14.0	0.0	342	183	2637541.	0.0000	0.00	46922
46219	N	ST	15.0	0.0	341	183	2630320.	0.0000	0.00	46930
46221	N	ST	17.0	0.0	340	183	2624424.	0.0000	0.00	46932
46223	N	ST	20.0	0.0	340	183	2622591.	0.0000	0.00	46934
46301	N	ST	25.0	0.0	340	183	2614669.	0.0000	0.00	46936
46307	N	ST	-5.0	0.0	612	248	3462182.	0.0000	0.00	46938
46308	N	ST	-2.0	0.0	612	248	3476509.	0.0000	0.00	46940
46309	N	ST	2.0	0.0	612	248	3469801.	0.0000	0.00	46942
46310	N	ST	2.0	0.0	611	248	3461144.	0.0000	0.00	46944
46317	N	ST	8.0	0.0	614	248	3462655.	0.0000	0.00	46946
46318	N	ST	10.0	0.0	611	249	3457898.	0.0000	0.00	46948
46319	N	ST	12.0	0.0	611	248	3435015.	0.0000	0.00	46950
46320	N	ST	12.5	0.0	615	248	3433344.	0.0000	0.00	46952
46321	N	ST	13.0	0.0	615	249	3429825.	0.0000	0.00	46954
46322	N	ST	13.5	0.0	612	243	3419429.	0.0000	0.00	46956
46323	N	ST	14.0	0.0	610	248	3409796.	0.0000	0.00	46958
46400	N	ST	15.0	0.0	613	249	3417715.	0.0000	0.00	46960
46403	N	ST	17.0	0.0	616	249	3413348.	0.0000	0.00	46962
46404	N	ST	20.0	0.0	616	249	3427697.	0.0000	0.00	46964
46405	N	ST	25.0	0.0	615	249	3412222.	0.0000	0.00	46966
46406	N	ST	13.0	0.0	614	248	3396768.	0.0000	0.00	46968
46407	N	ST	12.0	0.0	610	248	3398737.	0.0000	0.00	46970
46412	N	ST	0.0	0.0	614	248	3391942.	0.0000	0.00	46972
46418	N	ST	-5.0	0.0	877	300	3946125.	0.0000	0.00	46974
46420	N	ST	-2.0	0.0	878	301	3926471.	0.0000	0.00	46976
46423	N	ST	2.0	0.0	875	300	3966854.	0.0000	0.00	46978
46500	N	ST	5.0	0.0	877	300	3965878.	0.0000	0.00	46980
46509	N	ST	8.0	0.0	878	300	4161706.	0.0000	0.00	46982
46511	N	ST	10.0	0.0	876	299	4126333.	0.0000	0.00	46984
46513	N	ST	12.0	0.0	874	299	4119351.	0.0000	0.00	46986
46515	N	ST	12.5	0.0	874	299	4096803.	0.0000	0.00	46988
46517	N	ST	13.0	0.0	867	298	4070743.	0.0000	0.00	46990
46519	N	ST	13.5	0.0	879	300	4037558.	0.0000	0.00	46992
46520	N	ST	14.0	0.0	878	300	4077474.	0.0000	0.00	46994
46600	N	ST	15.0	0.0	873	299	4089463.	0.0000	0.00	46996
46602	N	ST	17.0	0.0	878	300	4078318.	0.0000	0.00	46998
46604	N	ST	20.0	0.0	831	291	3955720.	0.0000	0.00	47000
46608	N	ST	25.0	0.0	690	265	3626593.	0.0000	0.00	47002

TABLE 11.- Continued.

(f) Concluded.

A	FRAME	TRIP	TYPE	AO	A1	Q	M	RE	K	FREQ	B
54216	N	UN	15.0	10.0	10.0	.340	184	2547606.	.1514	4.95	54217
48019	N	UN	4.1	10.0	.874	.299	4215503.	.0103	.54	48020	
48023	N	UN	4.1	10.0	.880	.300	4189985.	.0255	1.34	48100	
48101	N	UN	4.1	10.0	.877	.299	4160141.	.0509	2.68	48102	
48103	N	UN	4.1	10.0	.879	.300	4154411.	.1016	5.36	48104	
48116	N	UN	13.0	2.0	.878	.299	4054662.	.0253	1.34	48117	
48118	N	UN	13.0	2.0	.878	.299	4057323.	.0504	2.68	48119	
48122	N	UN	13.0	2.0	.876	.299	4057706.	.1010	5.36	48123	
48209	N	UN	16.0	2.0	.870	.298	4059728.	.2028	10.72	48211	
48215	N	UN	14.0	2.0	.877	.300	4057579.	.0504	2.68		
48216	N	UN	14.0	2.0	.879	.300	4047826.	.1005	5.36		
48217	N	UN	14.0	2.0	.879	.300	4035080.	.2009	10.72	48218	
48300	N	UN	12.5	2.0	.878	.300	4033369.	.0101	.54		
48301	N	UN	12.5	2.0	.878	.300	4011900.	.0251	1.34		
48302	N	UN	12.5	2.0	.831	.301	4009053.	.0500	2.68		
48303	N	UN	12.5	2.0	.874	.299	3686169.	.1004	5.36		
48304	N	UN	12.5	2.0	.873	.299	3980450.	.1505	8.04		
48308	N	UN	12.5	2.0	.875	.300	3998448.	.2007	10.72	48309	
49110	N	UN	15.0	10.0	.339	.184	2634248.	.0257	.83	49111	
49117	N	UN	15.0	10.0	.342	.185	2619396.	.0507	1.65	49118	
49120	N	UN	15.0	10.0	.340	.185	2599912.	.1014	3.30	49121	
49203	N	UN	15.0	10.0	.341	.185	2592737.	.1518	4.95	49204	
49206	N	UN	15.0	10.0	.341	.185	2564616.	.2020	6.60	49207	
49216	N	UN	4.7	10.0	.340	.184	2550439.	.0254	.83	49217	
49300	N	UN	4.7	10.0	.339	.184	2535655.	.1009	3.30	49301	
49307	N	UN	4.7	10.0	.342	.185	2546693.	.2005	6.60	49308	
49310	N	UN	4.7	10.0	.343	.185	2543519.	.2503	8.25	49311	
49323	N	UN	15.0	10.0	.338	.184	2543127.	.0101	.33	49100	
50116	N	UN	4.7	10.0	.339	.183	2531156.	.0101	.33	50117	
57018	N	UN	15.0	10.0	.340	.184	2555187.	.1516	4.95	57019	
58018	N	UN	15.0	10.0	.338	.183	2437793.	.1495	4.95	58019	
58102	N	UN	15.0	10.0	.014	.037	496703.	.0983	.65	58103	
58111	N	UN	15.0	10.0	.121	.109	1528745.	.1010	1.96	58112	
58120	N	UN	15.0	10.0	.340	.184	2536174.	.1511	4.95		
58121	N	UN	15.0	10.0	.340	.184	2532230.	.1007	3.30		
47022	Y	UN	15.0	10.0	.841	.296	3990015.	.0501	2.62	47023	
48200	N	UN	13.0	2.0	.884	.301	4062447.	.2006	10.72	48201	

TABLE 11.- Continued.

(g) NLR-1 airfoil.

FRAME	TRIP	TYPE	AO	A1	Q	M	RE	K	FREQ	B
61018	N	ST	-5.0	0.0	0.339	.184	2345411.	0.0000	0.00	63009
61019	N	ST	10.0	0.0	0.342	.184	2349991.	0.0000	0.00	63002
61020	N	ST	5.0	0.0	0.341	.185	2346533.	0.0000	0.00	63004
61101	N	ST	10.0	0.0	0.341	.185	2344362.	0.0000	0.00	63006
61102	N	ST	12.0	0.0	0.349	.187	2370314.	0.0000	0.00	63008
61103	N	ST	14.0	0.0	0.344	.186	2345780.	0.0000	0.00	63010
61104	N	ST	15.0	0.0	0.344	.186	2355621.	0.0000	0.00	63012
61105	N	ST	16.5	0.0	0.875	.301	3814433.	0.0000	0.00	65102
61106	N	ST	16.5	0.0	0.875	.301	3814433.	0.0000	0.00	65104
61107	N	ST	18.0	0.0	0.875	.301	3790531.	0.0000	0.00	65108
61108	N	ST	20.0	0.0	0.874	.301	3790531.	0.0000	0.00	65110
61114	N	ST	-5.0	0.0	0.874	.301	3790531.	0.0000	0.00	65114
61115	N	ST	0.0	0.0	0.875	.301	3766507.	0.0000	0.00	65114
61117	N	ST	5.0	0.0	0.875	.302	3783080.	0.0000	0.00	65102
61201	N	ST	10.0	0.0	0.875	.302	3783080.	0.0000	0.00	65104
61203	N	ST	12.0	0.0	0.842	.295	3697279.	0.0000	0.00	65108
61205	N	ST	14.0	0.0	0.858	.298	3722261.	0.0000	0.00	65110
61208	N	ST	15.4	0.0	0.839	.294	3665290.	0.0000	0.00	65111
61212	N	ST	16.5	0.0	0.800	.288	3674574.	0.0000	0.00	65114
61213	N	ST	18.0	0.0	0.879	.302	3745010.	0.0000	0.00	65114
61215	N	ST	20.0	0.0	0.879	.302	3745010.	0.0000	0.00	65114
61221	N	ST	-5.0	0.0	0.121	.184	2407546.	0.0000	0.00	62021
61222	N	ST	-2.0	0.0	0.121	.184	2407546.	0.0000	0.00	62021
61223	N	ST	2.0	0.0	0.121	.184	2407546.	0.0000	0.00	62021
61225	N	ST	5.0	0.0	0.396	.200	2657024.	0.0000	0.00	62021
61300	N	ST	2.0	0.0	0.396	.200	2657024.	0.0000	0.00	62021
61301	N	ST	5.0	0.0	0.396	.200	2657024.	0.0000	0.00	62021
61306	N	ST	8.0	0.0	0.396	.200	2657024.	0.0000	0.00	62021
61307	N	ST	10.0	0.0	0.480	.220	2777505.	0.0000	0.00	62209
61308	N	ST	12.0	0.0	0.612	.250	33113246.	0.0000	0.00	62219
61309	N	ST	12.5	0.0	0.612	.250	33113246.	0.0000	0.00	62219
61311	N	ST	13.0	0.0	0.838	.295	3859287.	0.0000	0.00	62303
61312	N	ST	14.0	0.0	0.834	.294	3816841.	0.0000	0.00	62305
61315	N	ST	15.0	0.0	0.835	.294	3816841.	0.0000	0.00	62308
61316	N	ST	16.0	0.0	0.796	.287	3692269.	0.0000	0.00	62310
61317	N	ST	16.0	0.0	0.796	.287	3692269.	0.0000	0.00	62310
61318	N	ST	20.0	0.0	0.872	.301	3725580.	0.0000	0.00	62318
61319	N	ST	25.0	0.0	0.874	.302	3704354.	0.0000	0.00	62321
61318	N	ST	14.0	0.0	0.873	.301	3685360.	0.0000	0.00	62323
61319	N	ST	12.5	0.0	0.878	.302	3685360.	0.0000	0.00	62323
61400	N	ST	5.0	0.0	0.881	.303	3701055.	0.0000	0.00	62401
61401	N	ST	5.0	0.0	0.866	.300	3656985.	0.0000	0.00	62404
61407	N	ST	-5.0	0.0	0.855	.297	3912793.	0.0000	0.00	62406
61409	N	ST	-2.0	0.0	0.862	.299	3895789.	0.0000	0.00	62406
61410	N	ST	0.0	0.0	0.862	.299	3895789.	0.0000	0.00	62406
61411	N	ST	2.0	0.0	0.862	.299	3895789.	0.0000	0.00	62406
61412	N	ST	2.0	0.0	0.850	.297	3856177.	0.0000	0.00	62406
61413	N	ST	5.0	0.0	0.848	.296	3831403.	0.0000	0.00	62406
61421	N	ST	8.0	0.0	0.839	.295	3650552.	0.0000	0.00	62406
61422	N	ST	10.0	0.0	0.812	.299	3730364.	0.0000	0.00	62406
61500	N	ST	12.0	0.0	0.891	.303	3797137.	0.0000	0.00	63109
61502	N	ST	12.5	0.0	0.873	.301	3755339.	0.0000	0.00	63113
61508	N	ST	12.5	0.0	0.876	.302	3748040.	0.0000	0.00	63115
61510	N	ST	13.0	0.0	0.868	.300	3740346.	0.0000	0.00	63123
61512	N	ST	14.0	0.0	0.789	.286	3674699.	0.0000	0.00	63209
61513	N	ST	16.0	0.0	0.790	.286	3652598.	0.0000	0.00	63214
61519	N	ST	20.0	0.0	0.780	.284	3610518.	0.0000	0.00	63216
61521	N	ST	20.0	0.0	0.833	.294	3728864.	0.0000	0.00	63221
61522	N	ST	14.5	0.0	0.866	.300	3769898.	0.0000	0.00	63305
61523	N	ST	12.5	0.0	0.874	.302	3790896.	0.0000	0.00	63303
61605	N	ST	5.0	0.0	0.877	.302	3763317.	0.0000	0.00	63315
61606	N	ST	0.0	0.0	0.877	.302	3761348.	0.0000	0.00	63315
64221	Y	ST	0.0	0.0	0.874	.303	3756218.	0.0000	0.00	63319

TABLE 11.- Continued.

(g) Concluded.

A		B							
FRAME	TRIP TYPE	A0	A1	Q	N	RE	K	FREQ	FRAME
63320	N US	2.5	10.0	.878	.303	3739575.	.0969	5.36	63321
63323	N US	2.7	10.0	.880	.303	3746774.	.0969	5.36	63400
64019	Y US	15.0	10.0	.844	.296	3865490.	.0247	1.31	64020
64021	Y US	15.0	10.0	.840	.295	3813567.	.0493	2.62	64022
64023	Y US	15.0	10.0	.821	.292	3752005.	.0997	5.24	64100
64107	Y US	15.0	10.0	.340	.185	2448919.	.0496	1.65	64108
64109	Y US	15.0	10.0	.340	.184	2439010.	.0991	3.30	64110
64111	Y US	15.0	10.0	.341	.185	2439626.	.1481	4.95	64112
64119	Y US	2.5	10.0	.876	.302	3823417.	.0099	5.4	64120
64121	Y US	2.5	10.0	.875	.302	3785031.	.0244	1.34	64122
64202	Y US	2.5	10.0	.879	.303	3794515.	.0437	2.68	64203
64204	Y US	2.5	10.0	.878	.302	3774318.	.0974	5.36	64205
64212	Y US	-2.0	10.0	.877	.302	3717936.	.0098	5.4	
64213	Y US	-2.0	10.0	.878	.303	3695424.	.0241	1.34	
64214	Y US	-2.0	10.0	.878	.302	3685179.	.0482	2.68	
64215	Y US	-2.0	10.0	.880	.303	3683703.	.0963	5.36	
65121	N US	-2.0	10.0	.869	.300	3717371.	.0098	5.4	
65122	N US	-2.0	10.0	.873	.301	3700235.	.0243	1.34	
65123	N US	-2.0	10.0	.874	.301	3694893.	.0485	2.68	
65200	N US	-2.0	10.0	.877	.302	3694943.	.0958	5.36	
65207	N US	15.0	10.0	.395	.199	264668.	.0997	3.57	
65209	N US	15.0	10.0	.828	.292	3779170.	.1019	5.36	
65223	N US	7.0	5.0	.121	.109	1475396.	.0249	4.9	
65300	N US	7.0	5.0	.121	.109	1472656.	.1996	3.92	
65311	N US	7.0	5.0	.879	.301	3862901.	.1969	10.72	
65309	N US	7.0	5.0	.876	.301	3889117.	.0100	5.4	
63222	N US	15.0	2.0	.818	.291	3675798.	.2028	10.72	63223

(h) NLR-7301.

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TABLE 11.- Concluded.

(h) Concluded.

A										B										
FRAME	TRIP	TYPE	AO	A1	Q	H	RE	K	FREQ	FRAME	TRIP	TYPE	AO	A1	Q	H	RE	K	FREQ	
69100	N	US	10.0	10.0	.873	.300	3918788.	.0249	1.34	69101	N	US	10.0	10.0	.876	.300	3900063.	.0496	2.68	
69102	N	US	10.0	10.0	.876	.300	3900063.	.0496	2.68	69103	N	US	10.0	10.0	.877	.301	3904003.	.0991	5.36	
69105	N	US	10.0	10.0	.877	.301	3904003.	.0991	5.36	69106	N	US	10.0	10.0	.876	.300	3884160.	.1484	8.04	
69107	N	US	10.0	10.0	.876	.300	3884160.	.1484	8.04	69108	N	US	16.8	2.0	.727	.273	3492462.	.0270	1.34	
69119	N	US	16.8	2.0	.727	.273	3492462.	.0270	1.34	69120	N	US	16.8	2.0	.710	.270	3430737.	.0546	2.68	
69121	N	US	16.8	2.0	.710	.270	3430737.	.0546	2.68	69122	N	US	16.8	2.0	.700	.268	3396634.	.1100	5.36	
69123	N	US	16.8	2.0	.692	.267	3396634.	.1100	5.36	69200	N	US	16.8	2.0	.692	.267	3346793.	.2208	10.72	
69201	N	US	16.8	2.0	.692	.267	3346793.	.2208	10.72	69202	N	US	17.2	2.0	.734	.275	3160151.	.0268	1.34	
69206	N	US	17.2	2.0	.734	.275	3160151.	.0268	1.34	69207	N	US	17.2	2.0	.745	.277	3469110.	.0530	2.68	
69208	N	US	17.2	2.0	.745	.277	3469110.	.0530	2.68	69209	N	US	17.2	2.0	.709	.270	3370869.	.1086	5.36	
69211	N	US	17.2	2.0	.709	.270	3370869.	.1086	5.36	69212	N	US	17.2	2.0	.719	.272	3387722.	.1616	8.04	
69213	N	US	17.2	2.0	.719	.272	3387722.	.1616	8.04	69214	N	US	17.2	2.0	.755	.279	3459727.	.2098	10.72	
69215	N	US	17.2	2.0	.755	.279	3459727.	.2098	10.72	69216	N	US	17.5	2.0	.726	.273	3404711.	.0536	2.68	
69221	N	US	17.5	2.0	.726	.273	3404711.	.0536	2.68	69222	N	US	17.5	2.0	.684	.265	3286912.	.2205	10.72	
69223	N	US	17.5	2.0	.684	.265	3286912.	.2205	10.72	69300	N	US	18.5	2.0	.688	.266	3265767.	.0549	2.68	
69304	N	US	18.5	2.0	.688	.266	3265767.	.0549	2.68	69305	N	US	18.5	2.0	.671	.262	3218013.	.0554	2.68	
69310	N	US	18.5	2.0	.671	.262	3218013.	.0554	2.68	69311	N	US	9.4	10.0	.341	.185	2344307.	.0245	1.34	
70019	N	US	9.4	10.0	.341	.185	2344307.	.0245	1.34	70020	N	US	9.4	10.0	.340	.185	2328519.	.0973	3.30	
70021	N	US	9.4	10.0	.340	.185	2328519.	.0973	3.30	70022	N	US	9.4	10.0	.340	.185	2336677.	.1948	6.60	
70023	N	US	9.4	10.0	.340	.185	2336677.	.1948	6.60	70100	N	US	5.7	10.0	.875	.301	3916444.	.0104	.56	
70107	N	US	5.7	10.0	.875	.301	3916444.	.0104	.56	70108	N	US	5.7	10.0	.876	.301	3876178.	.0247	1.34	
70109	N	US	5.7	10.0	.876	.301	3876178.	.0247	1.34	70110	N	US	5.7	10.0	.872	.300	3851569.	.0495	2.68	
70113	N	US	5.7	10.0	.872	.300	3851569.	.0495	2.68	70114	N	US	5.7	10.0	.875	.301	3854554.	.0936	5.36	
70115	N	US	5.7	10.0	.875	.301	3854554.	.0936	5.36	70116	N	US	5.7	10.0	.874	.301	3843662.	.1479	8.04	
70117	N	US	5.7	10.0	.874	.301	3843662.	.1479	8.04	70118	N	US	5.7	10.0						

TABLE 12.- LIST OF STATIC DATA

Airfoil ^a	M _∞	First frame	Last frame	No. of frames	α_{min}	α_{max}	Figure	Airfoil ^a	M _∞	First frame	Last frame	No. of frames	α_{min}	α_{max}	Figure
N-0012	0.30	04019	04412	24	-5.0	20.0		FX-098T	0.30	17208	17314	8	0.0	20.0	
	.30	11018	11309	33	-5.0	30.0	9,12,16	FX-098T	.18	18019	18206	10	0.0	20.0	
	.30	12102	(quasi-steady)		-5.0	15.0	16	SC-1095	.30	35021	35214	17	-5.0	16.0	19
	.28	12109			-4.0	16.0		SC-1095	.25	35220	35401	20	-5.0	25.0	
	.28	13222			10.1	29.9		SC-1095	.18	36019	36120	10	-5.0	20.0	
	.27	12020			10.1	29.9		SC-1095	.11	36202	36218	11	-5.0	20.0	
	.26	12118			10.1	29.9		SC-1095T	.30	34022	34115	8	0.0	16.0	
	.25	12208			-3.0	17.0		SC-1095T	.18	34200	34214	7	0.0	16.0	
	.25	13303			-3.0	17.0		HH-02	.30	40222	41103	20	-5.0	20.0	20
	.23	12203			10.1	29.9		HH-02	.25	41110	41215	20	-5.0	20.0	
	.22	13308			-3.0	17.0		HH-02	.18	40114	40215	10	-5.0	20.0	
	.22	13310			-3.0	17.0		HH-02	.11	40018	40108	11	-5.0	20.0	
	.20	12300			10.1	29.9		HH-02T	.30	41221	41314	8	0.0	16.0	
	.18	12310			-3.0	17.0		HH-02T	.18	41401	41419	10	0.0	16.0	
	.17	12305			10.1	29.9		VR-7	.30	46418	46615	18	-5.0	25.0	11,21
	.11	13021			-3.0	17.0		VR-7	.25	46307	46412	19	-5.0	25.0	
	.11	13107			10.1	29.9		VR-7	.18	46116	46301	13	-5.0	25.0	
	.07	13120			-3.0	17.0		VR-7	.11	46018	46110	13	-5.0	25.0	
	.07	13115			10.1	29.9		VR-7T	.30	46802	46823	10	0.0	20.0	
	.04	13205			-5.0	15.0		VR-7T	.18	46621	46718	10	0.0	20.0	
	.04	13217			10.1	29.9		NLR-1	.30	61407	61606	19	-5.0	25.0	22
N-0012T	.29	13321			-3.0	17.0		NLR-1	.25	61221	61401	19	-5.0	25.0	
N-0012T	.18	13313			-3.0	17.0		NLR-1	.18	61114	61215	10	-5.0	20.0	
Ames-01	.30	26020	26307	23	-5.0	25.0	17	NLR-1	.11	61018	61108	11	-5.0	20.0	
Ames-01	.25	26313	27117	22	-5.0	25.0		NLR-1T	.30	65019	65115	13	-11.0	16.0	
Ames-01	.18	27123	27318	22	-5.0	25.0		NLR-1T	.18	64221	64311	8	0.0	16.0	
Ames-01	.11	27400	28120	21	-5.0	25.0		NLR-7301	.30	66019	66209	17	-5.0	20.0	23
Ames-01T	.30	28312	28410	9	0.0	16.0		NLR-7301	.25	66214	66314	17	-5.0	25.0	
Ames-01T	.19	28207	28304	10	0.0	20.0		NLR-7301	.18	66320	66511	18	-5.0	25.0	
FX-098	.30	20118	20322	21	-5.0	25.0	18	NLR-7301	.11	66516	66617	17	-5.0	25.0	
FX-098	.25	19314	20112	22	-5.0	25.0		NLR-7301T	.30	66810	66822	6	0.0	13.0	
FX-098	.18	19020	19308	23	-5.0	25.0		NLR-7301T	.18	66623	66802	13	0.0	25.0	
FX-098	.11	18215	18502	23	-5.0	25.0	10								

^aT = trip.

TABLE 13.- MACH NUMBER SWEEP AT $\alpha = 15^\circ + 10^\circ \sin \omega t$, $k = 0.10$

M_∞^α	NACA 0012	A-01	FX-098	SC-1095	HH-02	VR-7	NLR-1	NLR-7301
0.035	8102		16019			58102		
.07	8114	24323	16105	33022	42121	47123	62020	
.11	8214	24314	16114	33106	42321	$\begin{cases} 47206 \\ 58111 \end{cases}$	62104	67120
.18	8220	$\begin{cases} 24217 \\ 31209 \end{cases}$	16200	33110	42302	$\begin{cases} 47213 \\ 58121 \end{cases}$	62112	67220
.18T	$\begin{cases} 14021 \\ 14106 \end{cases}$	29117	17103	34321	42110	47112	64109	67021
.20							$\begin{cases} 62114 \\ 65207 \end{cases}$	
.22	9202	24209	16300	33205	42309	47217	62208	
.25	9203	24201	16308	33207	42313	47301	62210	67305
.28	9208	24117	22208	33215	42218	47305	62218	
.29	$\begin{cases} 9217 \\ 14220 \end{cases}$	24105	22201	33300	42210	45023	$\begin{cases} 62307 \\ 65209 \end{cases}$	
.29T	$\begin{cases} 14208 \\ 14210 \end{cases}$	29106	17200	34308	42100	47100	64023	

 $\alpha_T = \text{trip.}$ TABLE 14.- FREQUENCY SWEEP AT $M_\infty = 0.29$, $\alpha = 15^\circ + 10^\circ \sin \omega t$

k^α	NACA 0012	A-01	FX-098	SC-1095	HH-02	VR-7	NLR-1	NLR-7301
0.01	9210	$\begin{cases} 30019 \\ 30020 \end{cases}$	21100	38300				
.025	$\begin{cases} 9213 \\ 14218 \end{cases}$	24022	22023	33217	42206	45019	62302	
.025T	$\begin{cases} 14117 \\ 14200 \end{cases}$	29023	17117		42019	47020	64019	
.05	$\begin{cases} 9214 \\ 14219 \end{cases}$	24100	22103	33222	42208	45021	62304	
.05T	$\begin{cases} 14119 \\ 14202 \end{cases}$	29101	17119	34306	42021	47022	64021	
.10	$\begin{cases} 9217 \\ 14220 \end{cases}$	24105	22201	33300	42210	45023	$\begin{cases} 62307 \\ 65209 \end{cases}$	
.10T	$\begin{cases} 14208 \\ 14210 \end{cases}$	29106	17200	34308	42100	47100	64023	
.15	9218	24109	22206	34409	$\begin{cases} 42212 \\ 42217 \end{cases}$	45101	62309	

 $\alpha_T = \text{trip.}$

TABLE 15.- FREQUENCY SWEEP AT $M_\infty = 0.30$, $\alpha = 10^\circ + 10^\circ \sin \omega t$

k	NACA 0012	A-01	FX-098	SC-1095	HH-02	VR-7	NLR-1	NLR-7301
0.01	9221	30105	21107	38306	43019	45109	62317	69019
.025	9222	{25022 31102	22216	37023	43106	45111	62320	69100
.05	9223	{25102 31104	22217	37101	43108	45113	62322	69102
.10	9302	25104	22218	37107	43112	45117	62400	69105
.12							62403	
.15	9307	{25109 31110 31112	22219	37109	{43114 43117	45119	62405	69107

TABLE 16.- FREQUENCY SWEEP AT $M_\infty = 0.30$, $\alpha = 15^\circ + 5^\circ \sin \omega t$

k	NACA 0012	A-01	FX-098	SC-1095	HH-02	VR-7	NLR-1	NLR-7301
0.01	10113	30110	21112	39104		45203	63018	68019
.025	10114	25204	23021	38021	43303	45205	63019	68100
.05	10117	25205	23022	38022	43304	45207	63020	68102
.10	10118	25208	23023	38102	43305	45209	63021	68104
.12							63100	
.15	10120	25209	23100	38103	43308	45211	63101	68109
.20	10123	25210	23101	38104	43309	45213	63102	68111

TABLE 17.- FREQUENCY SWEEP AT $M_\infty = 0.30$, $\alpha = 10^\circ + 5^\circ \sin \omega t$

k	NACA 0012	A-01	FX-098	SC-1095	HH-02	VR-7	NLR-1	NLR-7301	NLR-7301T
0.01	10202	30119	21200	39107	44019			68119	
.025	{7112 10203	25117	22307	37207	{44021 44119	45221	63108	68121	67108
.05	{7222 10204	25118	22308	37208	44023	45223		68123	67110
.075	10207								
.10	{7113 10208	25119	22309	37210	{44104 44118	45300	63112	68201	67112
.15	{7300 10211	{25121 25122	22311	37213	44106	45302			
.20	{7114 10212	25123	22312	37215	{44112 44120	45303	63114	68203	

TABLE 18.- STALL ONSET AT $M_\infty = 0.30$, $\alpha = \alpha_0 + 10^\circ \sin \omega t$, $k = 0.10$

NACA 0012, $\alpha_0 = 3.8^\circ$	A-01, $\alpha_0 = 5.5^\circ$	FX-098, $\alpha_0 = 3.8^\circ$	SC-1095, $\alpha_0 = 4.4^\circ$	HH-02, $\alpha_0 = 4.0^\circ$	VR-7, $\alpha_0 = 4.6^\circ$	NLR-1, $\alpha_0 = 2.7^\circ$	NLR-7301, $\alpha_0 = 5.7^\circ$
10305	25319	23201	34418	43219	63323	70115	

TABLE 19.- STALL SUPPRESSION AT $M_\infty = 0.30$, $\alpha = \alpha_0 + 10^\circ \sin \omega t$

k	NACA 0012 $\alpha_0 = 5.0^\circ$	A-01, $\alpha_0 = 5.0^\circ$	FX-098, $\alpha_0 = 3.3^\circ$	SC-1095, $\alpha_0 = 4.1^\circ$	HH-02, $\alpha_0 = 3.8^\circ$	VR-7, $\alpha_0 = 4.1^\circ$	NLR-1, $\alpha_0 = 2.5^\circ$	NLR-7301, $\alpha_0 = 5.7^\circ$
0.01	29205	21208	39021	43215	48019	63312	70107	
.025	31119			43202	48023	63314	70109	
.05	{29207 31121 25311}	23206	37119	43204	48101	63318	70113	
.10	{29211 31123 29213}	23208	37121	43206	48103	63320	70115	
.15	{29215 31201}	23211	37123	43209			70117	

^aSee table 24.TABLE 20.- STALL SUPPRESSION AT $M_\infty = 0.18$, $\alpha = \alpha_0 + 10^\circ \sin \omega t$

k	NACA 0012, $\alpha_0 = 8.0^\circ$	A-01, $\alpha_0 = 7.5^\circ$	FX-098, $\alpha_0 = 6.5^\circ$	SC-1095, $\alpha_0 = 6.2^\circ$	HH-02	VR-7, $\alpha_0 = 4.7^\circ$	NLR-1	NLR-7301, $\alpha_0 = 9.4^\circ$
0.01	9110	30215	21219			50116		
.025						49216		70019
.05	9112	{24302 31215}	16213	33118				
.10						49300		70021
.20	9118	{24306 31217}	16215	33121		49307		70023
.25						49310		

TABLE 21.- PITCH DAMPING STUDIES AT $M_\infty = 0.30$, $\alpha = \alpha_0 + 2^\circ \sin \omega t$

NACA 0012	A-01	FX-098	SC-1095	HH-02	VR-7	NLR-1	NLR-7301a
$k \approx 0.01$							
$\alpha_0 = 14.0^\circ$ 30206 $\alpha_0 = 14.0^\circ$ $\alpha_0 = 12.5^\circ$ $\alpha_0 = 12.5^\circ$ 39115 44221 48300 $\alpha_0 = 15.5^\circ$ 44212							
$k \approx 0.025$							
$\alpha_0 = 12.5^\circ$ $\alpha_0 = 12.5^\circ$ 44222 48301 $\alpha_0 = 15.5^\circ$ $\alpha_0 = 13.0^\circ$ 44214 48116 $\alpha_0 = 16.8^\circ$ 69119 $\alpha_0 = 17.2^\circ$ 69206							
$k \approx 0.05$							
$\alpha_0 = 12.5^\circ$ $\alpha_0 = 12.5^\circ$ $\alpha_0 = 11.1^\circ$ $\alpha_0 = 16.5^\circ$ 44223 48302 63302 69310 $\alpha_0 = 15.5^\circ$ $\alpha_0 = 13.0^\circ$ $\alpha_0 = 15.0^\circ$ $\alpha_0 = 16.8^\circ$ 44215 48118 63220 69121 $\alpha_0 = 14.0^\circ$ $\alpha_0 = 17.0^\circ$ $\alpha_0 = 17.2^\circ$ 48215 63213 69208 $\alpha_0 = 17.5^\circ$ 69221 $\alpha_0 = 18.5^\circ$ 69304							
$k \approx 0.10$							
$\alpha_0 = 12.5^\circ$ $\alpha_0 = 12.5^\circ$ 44300 48303 $\alpha_0 = 14.0^\circ$ $\alpha_0 = 13.0^\circ$ 44202 48122 $\alpha_0 = 15.5^\circ$ $\alpha_0 = 14.0^\circ$ 44216 48216 $\alpha_0 = 16.8^\circ$ 69123 $\alpha_0 = 17.2^\circ$ 69211							

Table 21.- Concluded.

NACA 0012	A-01	FX-098	SC-1095	HH-02	VR-7	NLR-1	NLR-7301 ^a
k = 0.15							
$\alpha_o = 14.5^\circ$ 31310		$\alpha_o = 12.5^\circ$ 44303		$\alpha_o = 12.5^\circ$ 48304		$\alpha_o = 17.2^\circ$ 69213	
		$\alpha_o = 15.5^\circ$ 44217					
k = 0.20							
$\alpha_o = 13.5^\circ$ 29223		$\alpha_o = 12.0^\circ$ 23219		$\alpha_o = 12.3^\circ$ 38201		$\alpha_o = 12.5^\circ$ 44304	
$\alpha_o = 14.5^\circ$ 29304		$\alpha_o = 14.0^\circ$ 23305		$\alpha_o = 14.0^\circ$ 38119		$\alpha_o = 12.5^\circ$ 48308	
$\alpha_o = 16.0^\circ$ 31302		$\alpha_o = 16.0^\circ$ 23310		$\alpha_o = 16.0^\circ$ 38110		$\alpha_o = 13.0^\circ$ 48200	
						$\alpha_o = 15.0^\circ$ 63222	
$\alpha_o = 16.5^\circ$ 29309						$\alpha_o = 16.4^\circ$ 63208	
						$\alpha_o = 17.0^\circ$ 63215	

^aSee table 24.

TABLE 22.- NO SEPARATION: $M_{\infty} = 0.30$, $\alpha = 5^{\circ} + 5^{\circ} \sin \omega t$

k	NACA 0012	A-01	FX-098	SC-1095	HH-02	VR-7	NLR-1 ^a	NLR-7301 ^a
0.01	10218							
.10	10221	25301	23107					
.20	10222	25303	23109					68211

^aSee table 24.

TABLE 23.- DYNAMIC BOUNDARY-LAYER TRIP DATA

M_{∞}	k	NACA 0012	A-01	FX-098	SC-1095	HH-02	VR-7	NLR-1	NLR-7301
0.18	0.05	14019 14104	29115	17100	34318	42108	47110	64107	67019
.18	.10	14021 14106	29117	17103	34321	42110	47112	64109	67021
.18	.15	14023 14108	29119	17109	34323	42113	47114	64111	
.18	.20								67023
.30	.025	14117 14200	29023	17117		42019	47020	64019 ^a	(a)
.30	.05	14119 14202	29101	17119	34306	42021	47022	64021 ^a	(a)
.30	.10	14208 14210	29106	17200	34308	42100	47100	64023 ^a	(a)

^aSee table 24.

TABLE 24.- MISCELLANEOUS DYNAMIC DATA

Airfoil	Frame	M_∞	α_0	α_1	k	Remarks
N-0012	8019	0.035	10.0	10.0	0.10	Low Reynolds number, 0.5×10^6
	8021	.035	10.0	10.0	.15	
	8023	.035	10.0	10.0	.25	↓
	8104	.035	15.0	10.0	.15	
	8106	.035	15.0	14.0	.10	Match reference 3
	8116	.07	15.0	10.0	.15	
	8118	.07	15.0	10.0	.25	Match reference 3
	8123	.07	15.0	14.0	.10	
	8203	.07	10.0	10.0	.25	Match reference 3
	8210	.11	10.0	10.0	.25	
	8222	.18	15.0	10.0	.15	Match reference 3
	8306	.18	15.0	14.0	.10	Match reference 3
	9022	.18	15.0	6.0	.24	Match reference 3
	9101	.18	15.0	5.0	.29	Variable α_0
	9106	.18	10.0	10.0	.25	
	7108	.30	8.0	5.0	.025	↓
	7110		8.0		.10	
	7111		8.0		.20	↓
	7216		8.8		.05	
	7214		8.8		.10	↓
	7212		8.8		.15	
	7104		9.0		.025	↓
	7019		9.0		.05	
	7021		9.0		.10	↓
	7101		9.0		.15	
	7023		9.0		.20	↓
			10.0		See table 17	
	7117		11.0		.025	↓
	7118		11.0		.05	
	7119		11.0		.10	↓
	7120		11.0		.15	
	7121		11.0		.20	↓
	7200		12.0		.025	
	7202		12.0		.05	↓
	7205		12.0		.10	
	7305		12.0		.15	↓
	7207		12.0		.20	
			15.0		See table 16	↓
	10309		2.8	10.0	.10	
	10305		3.8			↓
	10303		5.0			
	9302		10.0			↓
	10022		12.0			
	9217	.29	15.0			↓
	14220	.29	15.0			
	10101	.27	20.0			↓
	10104	.30	12.0	8.0	.05	Match reference 17
	10105	.30	12.0	8.0	.10	Match reference 17
	10108	.30	12.0	8.0	.13	Match reference 17
	15218	.29	15.0	10.0	.10	Pressure orifices closed

TABLE 24.- Continued.

Airfoil	Frame	M_∞	α_0	α_1	k	Remarks
N-0012	Many	Variable	Variable	10.0	0.001	Quasi-static; see table 12
W-098	23117	0.30	5.0	10.0	.10	
Ames-01	30201		11.0	5.0	.01	
Ames-01	25214				.05	
Ames-01	25216				.10	
SC-1095	39110				.01	
	37219				.05	
	37221				.10	
	37304		12.0	8.0	.05	Match reference 18
	37305		12.0	8.0	.10	Match reference 18
	37306		12.0	8.0	.13	Match reference 18
HH-02	43314		11.0	5.0	.025	
HH-02	43315		11.0	5.0	.05	
HH-02	43316		11.0	5.0	.10	
VR-7	54019	.18	10.0	10.0	.025	
	54022		10.0		.05	
	54101		10.0		.10	
	54110		10.0		.15	
	54113		10.0		.20	
	54116		10.0		.25	
	49023		15.0		.01	
	49110				.025	
	49117				.05	
	49120				.10	
	58121				.10	
	49203				.15	
	54216				.15	
	57018				.15	
	58018				.15	
	58120				.15	
	49206				.20	
NLR-1	65223	.11	7.0	5.0	.025	No separation
	65300	.11	7.0	5.0	.20	No separation
	62114	.20	15.0	10.0	.10	
	65207	.20	15.0	10.0	.10	
	62121	.20	10.0	10.0	.17	Match reference 19
	62202	.20	15.0	5.0	.17	
	62201	.20	15.0	5.0	.28	
	62403	.30	10.0	10.0	.12	
	63100		15.0	5.0	.12	
	63122		12.0	8.0	.12	
	65309		7.0	5.0	.01	No separation
	65311		7.0	5.0	.20	No separation
	65121		-2.0	10.0	.01	Stall at negative α
	65122				.025	Stall at negative α
	65123				.05	Stall at negative α
	65200				.10	Stall at negative α
NLR-1T	64212				.01	Trip; stall at negative α
NLR-1T	64213				.025	Trip; stall at negative α
NLR-1T	64214				.05	Trip; stall at negative α

TABLE 24.- Concluded.

Airfoil	Frame	M_∞	α_0	α_1	k	Remarks
NLR-1T	64215	0.30	-2.0	10.0	0.10	Trip; stall at negative α
NLR-1T	64119	.30	2.5		.01	Trip; stall suppression
NLR-1T	64121	.30	2.5		.025	Trip; stall suppression
NLR-1T	64202	.30	2.5		.05	Trip; stall suppression
NLR-1T	64204	.30	2.5		.10	Trip; stall suppression
NLR-7	67201	.11	10.0		.10	
	67208	.18	10.0		.025	
	67210	.18	10.0		.10	
	67212	.18	10.0		.20	
	67218	.18	15.0		.025	
	67220	.18	15.0		.10	
	67222	.18	15.0		.20	
	67310	.25	10.0		.10	
	68219	.30	12.0	2.0	.05	No separation
	68221	.30	12.0	2.0	.10	No separation
	68304	.30	12.0	2.0	.20	No separation
NLR-7T	67108	.30	10.0	5.0	.025	Trip
NLR-7T	67110	.30	10.0	5.0	.05	Trip
NLR-7T	67112	.30	10.0	5.0	.10	Trip

TABLE 25.- TEST CASES FOR NUMERICAL ANALYSIS (ref. 1)

Case	Frame	Airfoil	α_0	α_1	k	Case	Frame	Airfoil	α_0	α_1	k	
1	10222	NACA 0012	5	5	0.20	7	10212	NACA 0012	10	5	0.20	
2	68211	NLR-7301	5	↓	↓	8	9302	↓	10	10	.10	
3	7111	NACA 0012	8			9	10113		15	5	.01	
4	68203	NLR-7301	10			10114	↓		↓	↓	↓	.025
5	7023	NACA 0012	9			10117						.05
6	45221	VR-7	10			.025						10118
↓	45223	↓	↓	↓	.05	10120		.15				
↓	45300				.10	10123		.20				
↓	45302				.15	10		45203				.01
↓	45303				.20	45205		.025				
7	10202	NACA 0012	↓	↓	.01	45207		.05				
↓	10203	.025			45209	.10						
↓	10204	.05			45211	.15						
↓	10208	.10			45213	.20						
↓	10211	.15			↓	↓	↓	↓				

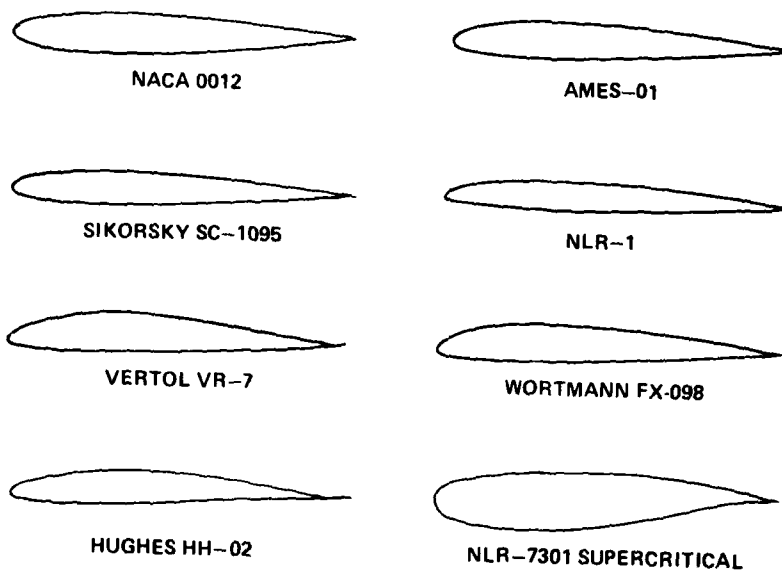


Figure 1.- Airfoils tested in the experiment.

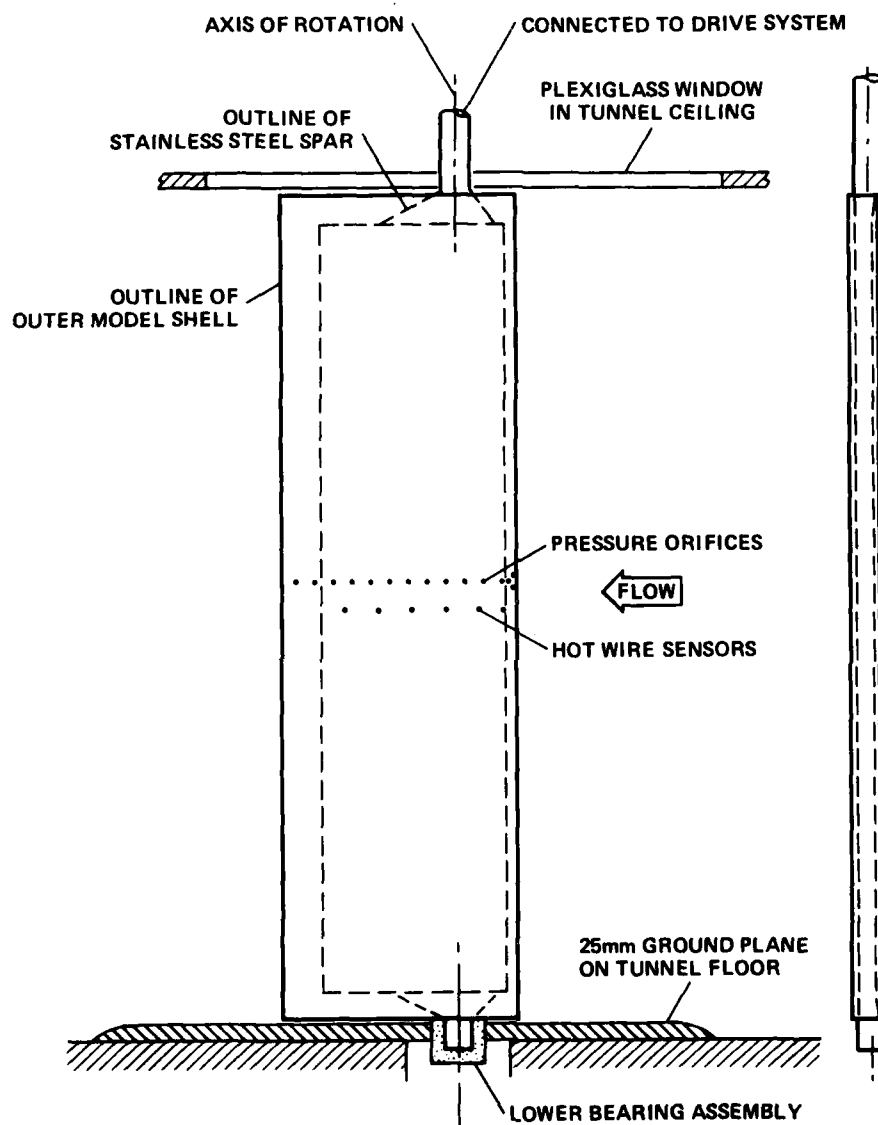


Figure 2.- Model installation in the test section.

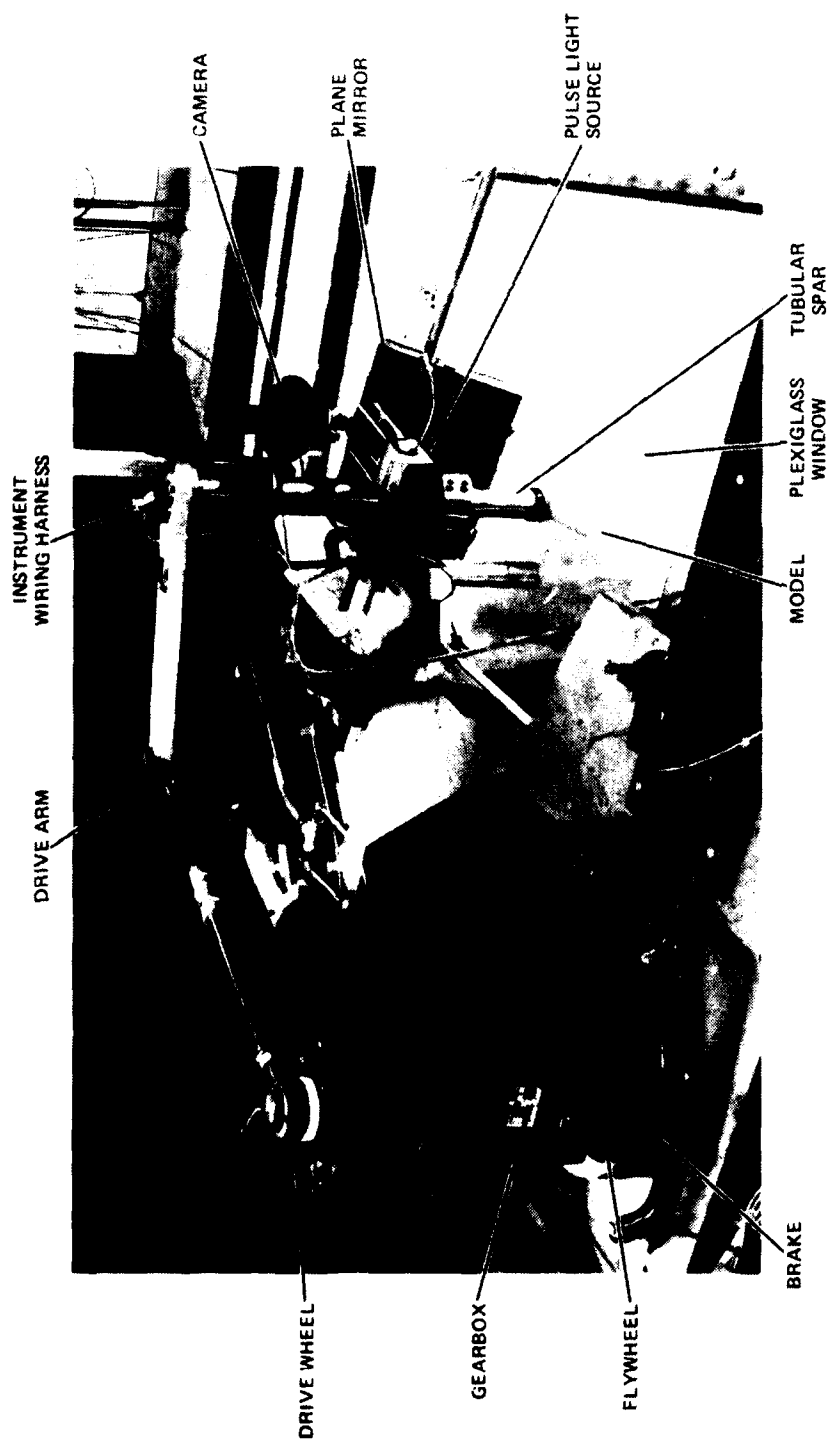


Figure 3.- Photograph of the oscillation mechanism.

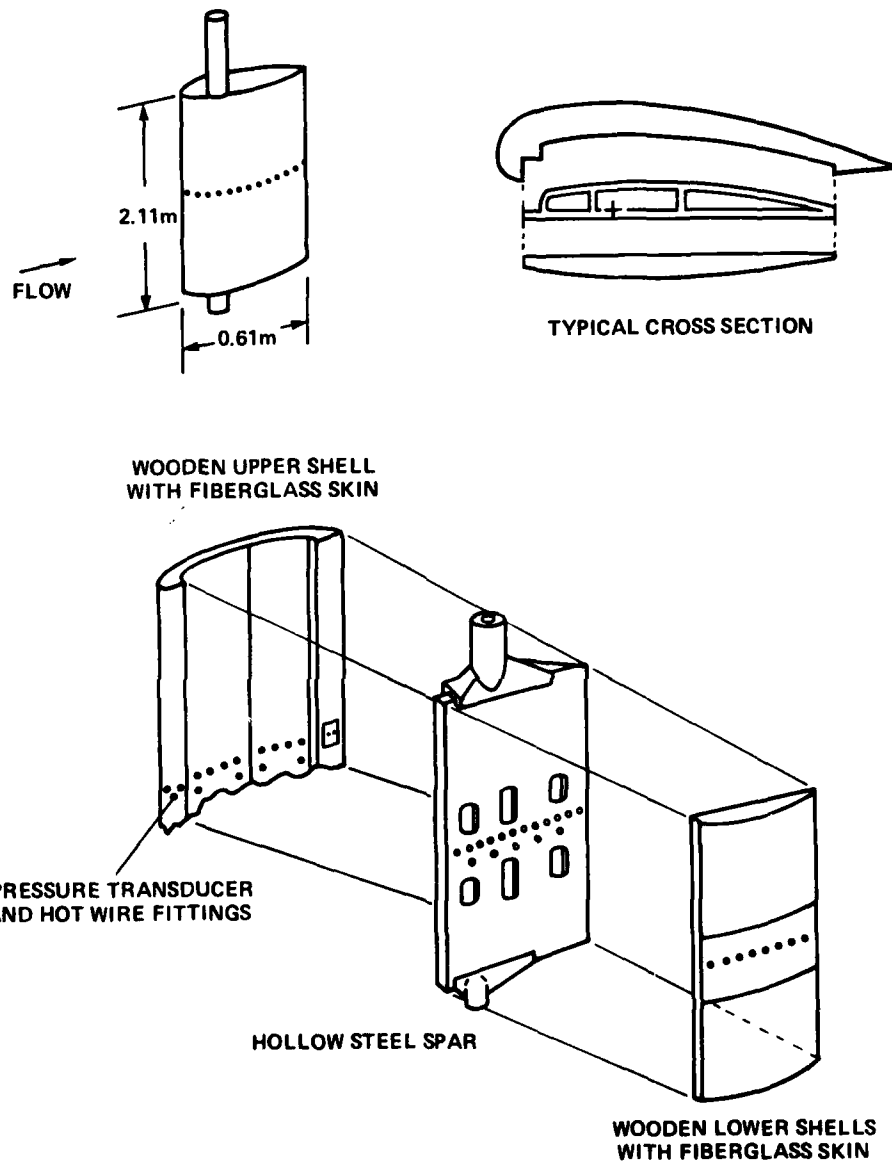


Figure 4.- Sketch of the wooden model shells surrounding the steel spar.

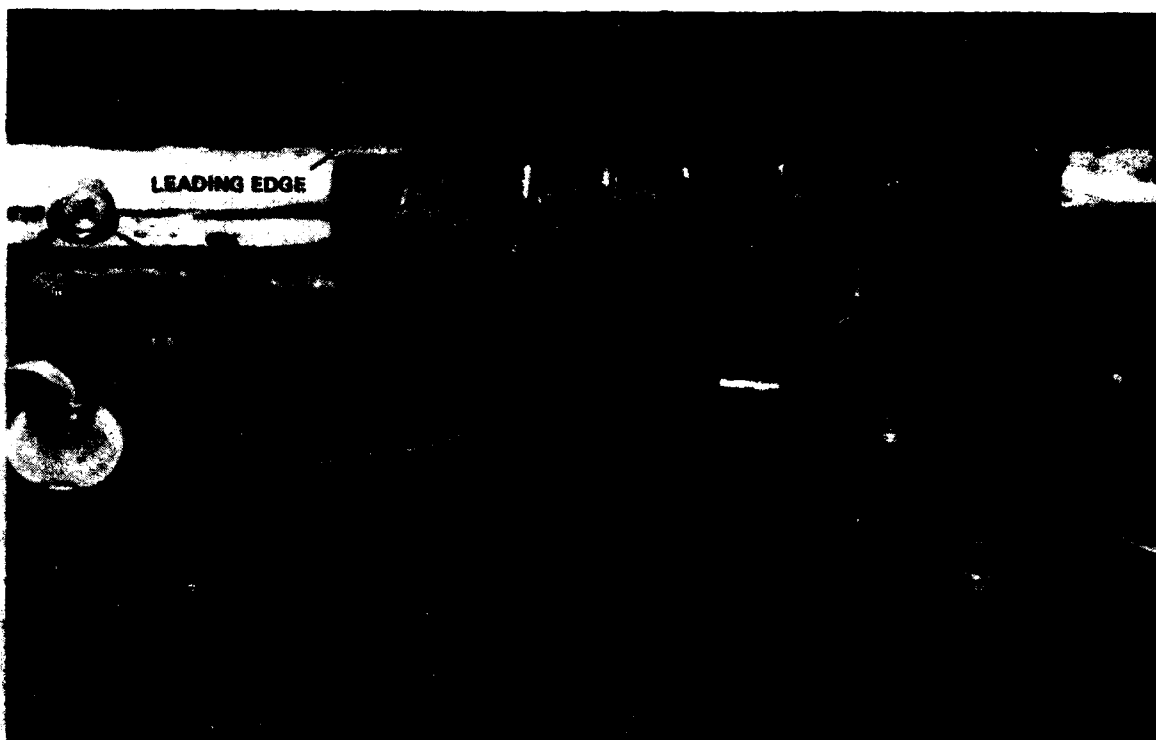


Figure 5.- Pressure transducer and hot-wire installation: view from inside the upper-surface shell.

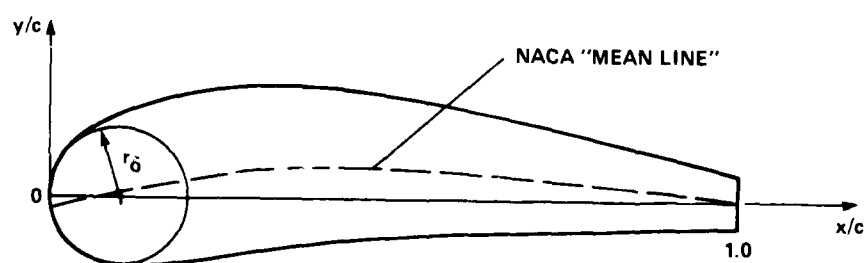


Figure 6.- Coordinate axes for the airfoils.

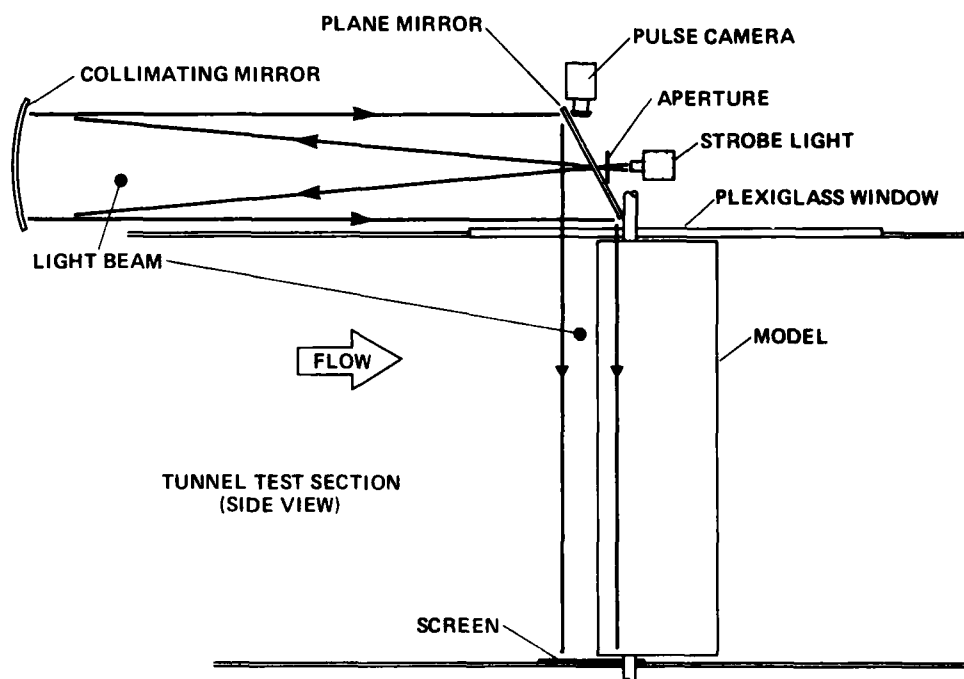


Figure 7.- Sketch of the shadowgraph system for visualizing the leading-edge region.

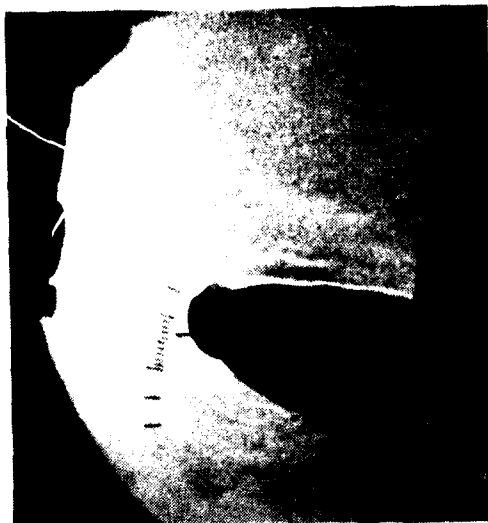


Figure 8.- Representative shadowgraphs before (upper) and during (lower) dynamic stall: Sikorsky SC-1095 airfoil, $M_\infty = 0.30$, $\alpha = 10^\circ + 10^\circ \sin \omega t$, $k = 0.10$.

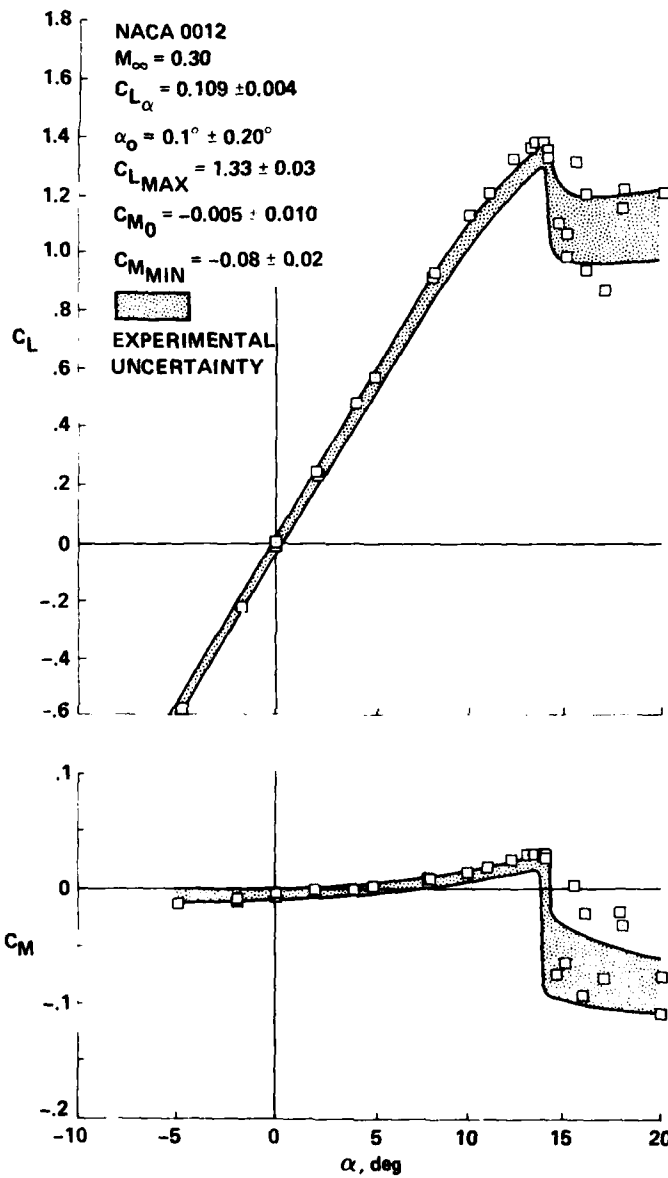


Figure 9.- Static lift and moment data on the NACA 0012 airfoil at $M_\infty = 0.3$; shaded bands represent uncertainty limits of data corrected for wind-tunnel-wall effects.

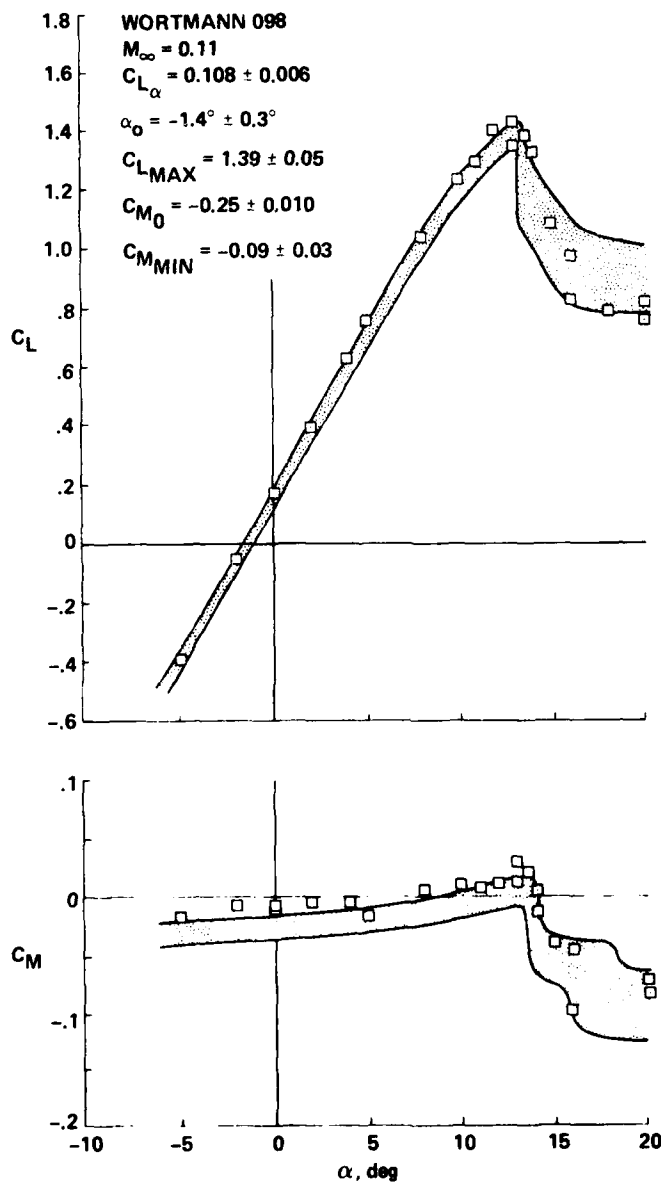


Figure 10.- Static lift and moment data on the Wortmann FX-098 airfoil at $M_{\infty} \approx 0.11$.

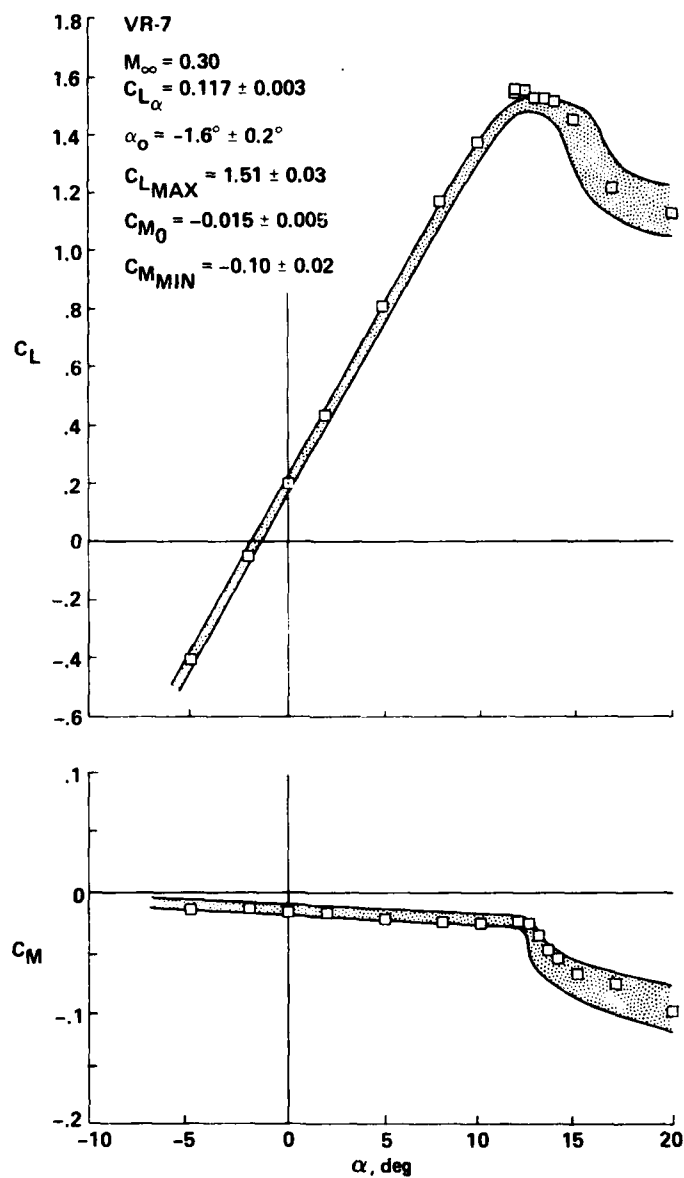


Figure 11.- Static lift and moment data on the Vertol VR-7 airfoil
 at $M_\infty = 0.30$.

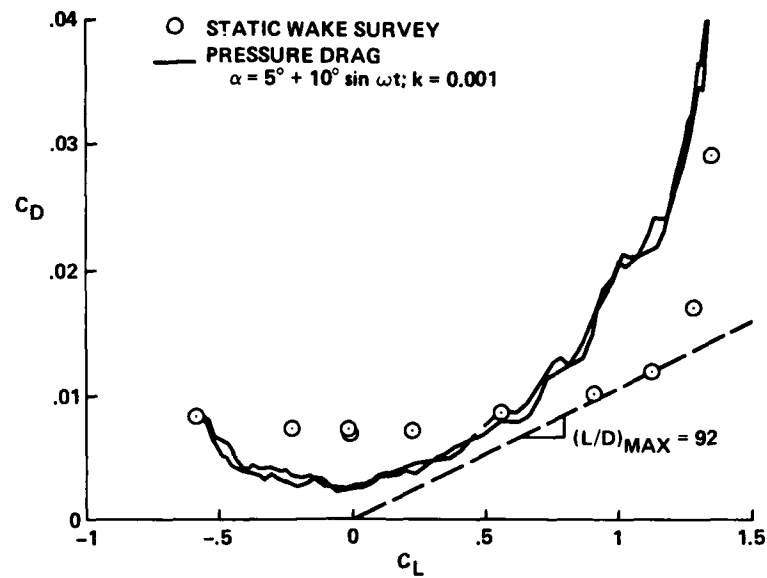


Figure 12.- Comparison of measured lift-drag polars for the NACA 0012 airfoil at $M_\infty = 0.30$, including wind-tunnel-wall corrections.

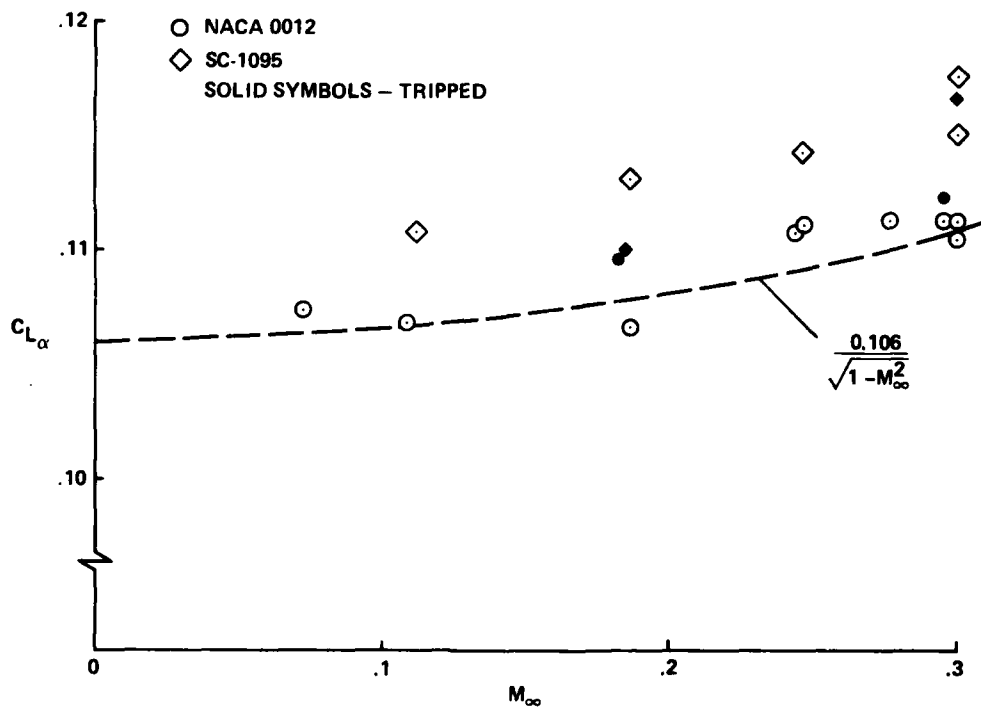


Figure 13.- Comparison of lift-curve slopes on the NACA 0012 and SC-1095 airfoils, including wind-tunnel-wall corrections.

NACA 0012 AIRFOIL
 FRAME : 9302 $A_0 = 9.82^\circ$ $k = 0.096$
 $Re = 3.66 E6$ $A_1 = 9.88^\circ$ $M = 0.302$
 $C_{Lmax} = 1.84$ $C_{Mmin} = -0.25$ $C_{Dmax} = 0.53$
 $\alpha_{Lmax} = 18.2^\circ$ $\xi = 0.272$ $M_{max} = 1.227$
 $\alpha_{Cmin} = 9.4^\circ$ $-C_{Pmax} = 9.1$ $\alpha_{Mmax} = 14.8^\circ$

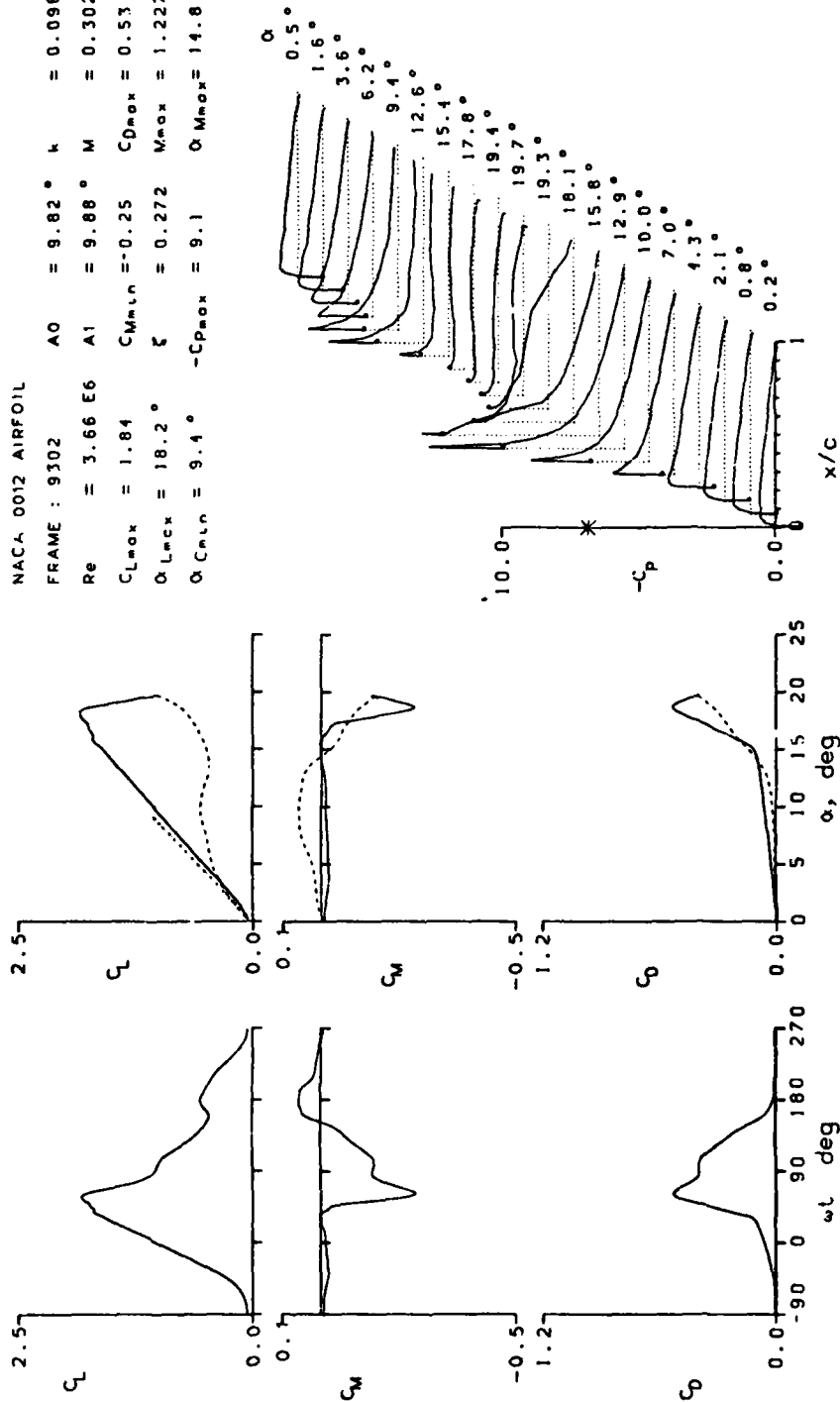
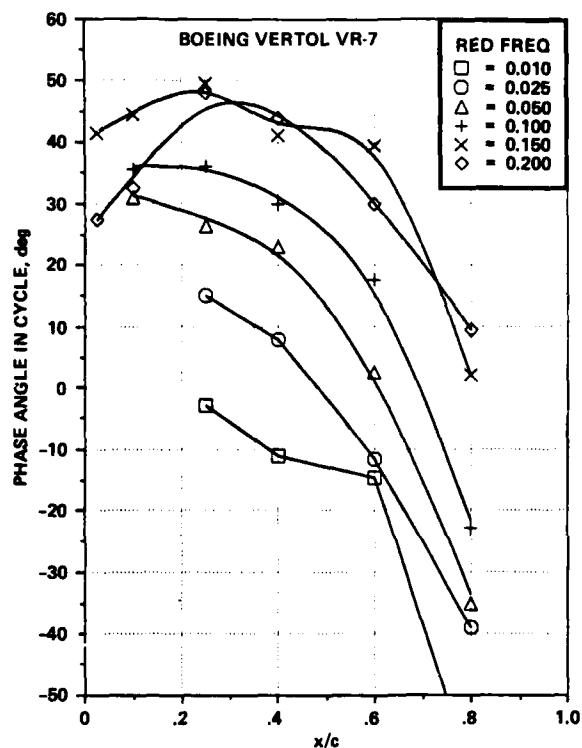
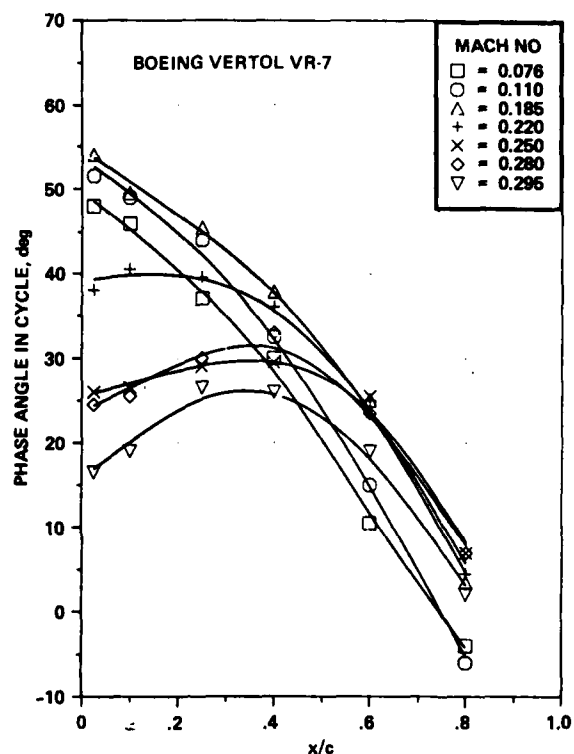


Figure 14.- Typical data presentation from volume 2; no wall corrections.



(a) Reduced frequency sweep:
light stall.



(b) Mach number sweep:
deep stall.

Figure 15.- Typical data presentation from volume 3.

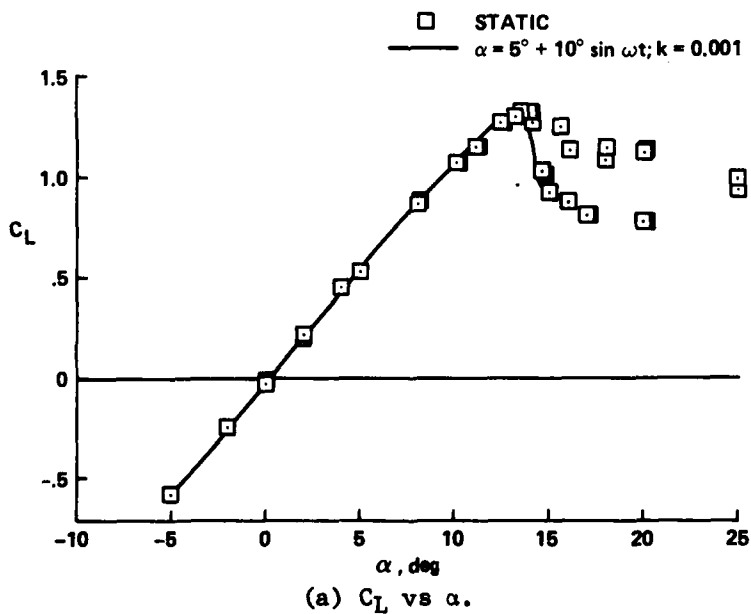
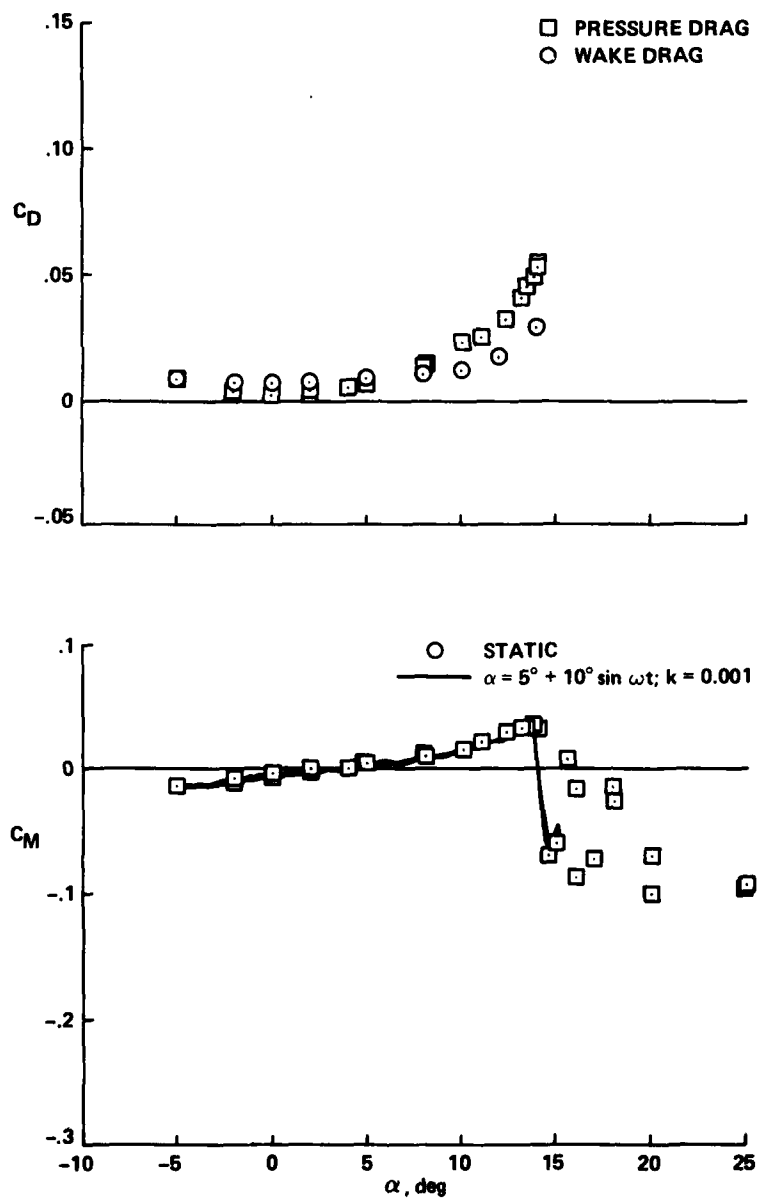
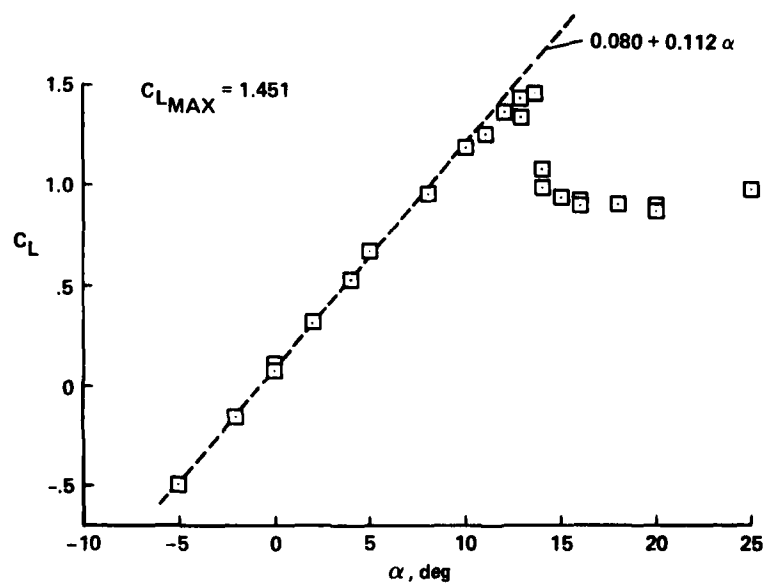


Figure 16.- Static characteristics of the NACA 0012 airfoil at $M_\infty = 0.30$, including wind-tunnel-wall corrections.



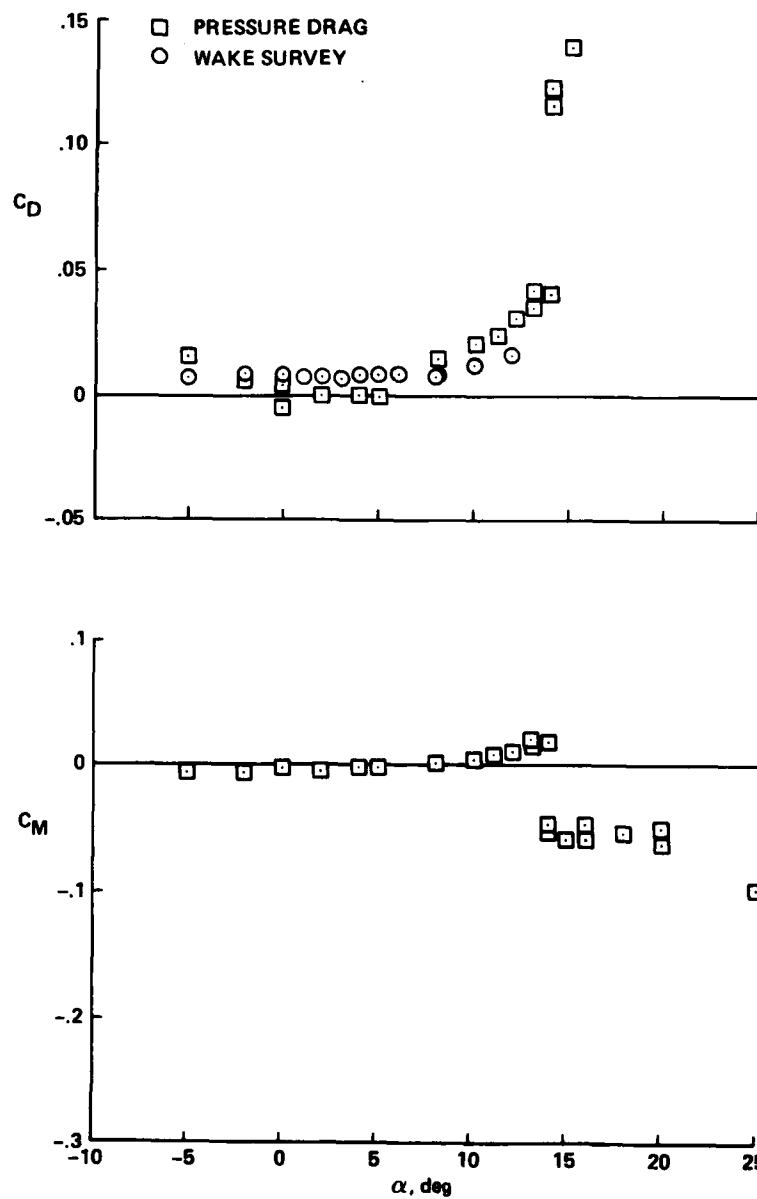
(b) C_D and C_M vs α .

Figure 16.- Concluded.



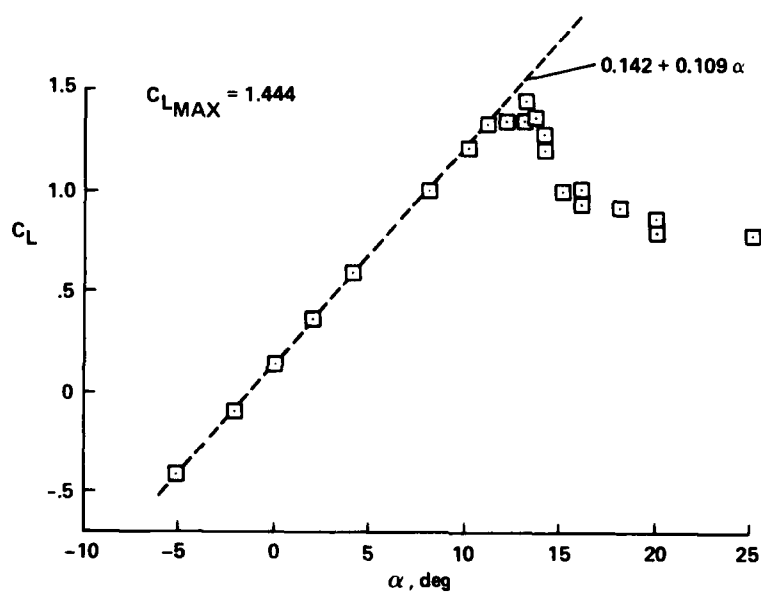
(a) C_L vs α .

Figure 17.- Static characteristics of the Ames A-01 airfoil at $M_\infty = 0.30$, including wind-tunnel-wall corrections.



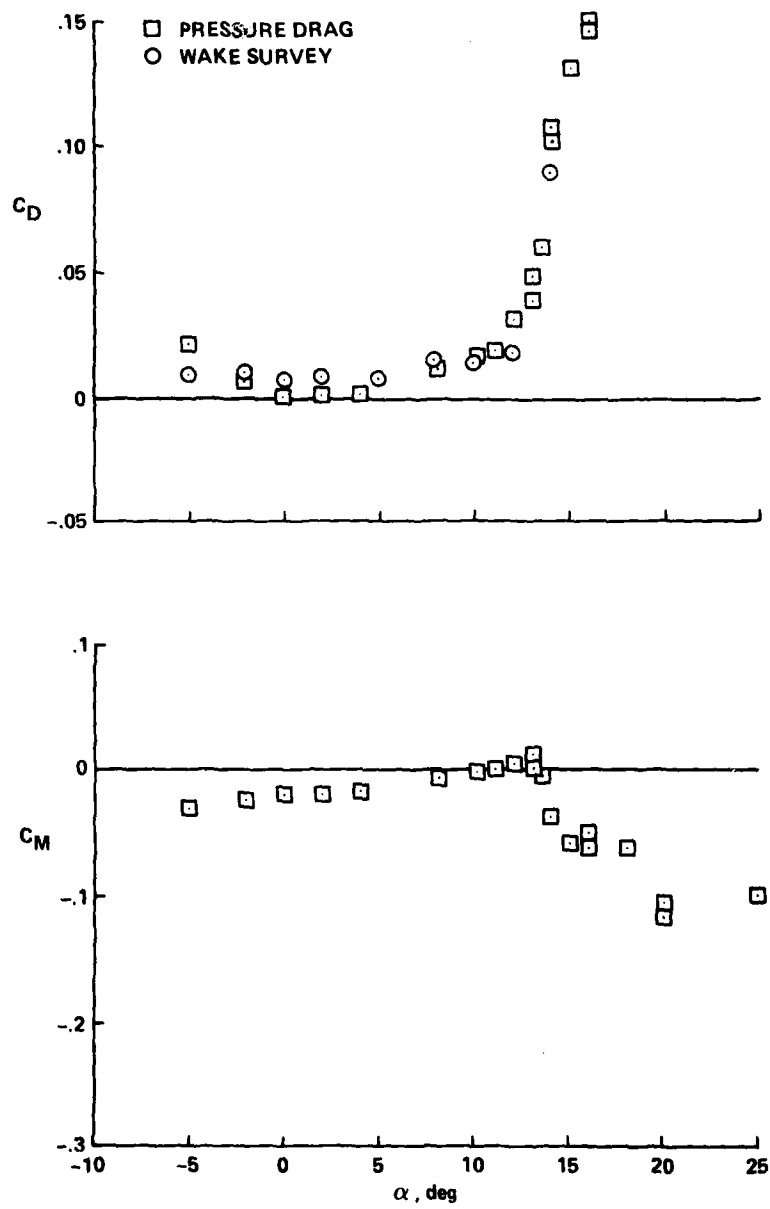
(b) C_D and C_M vs α .

Figure 17.- Concluded.



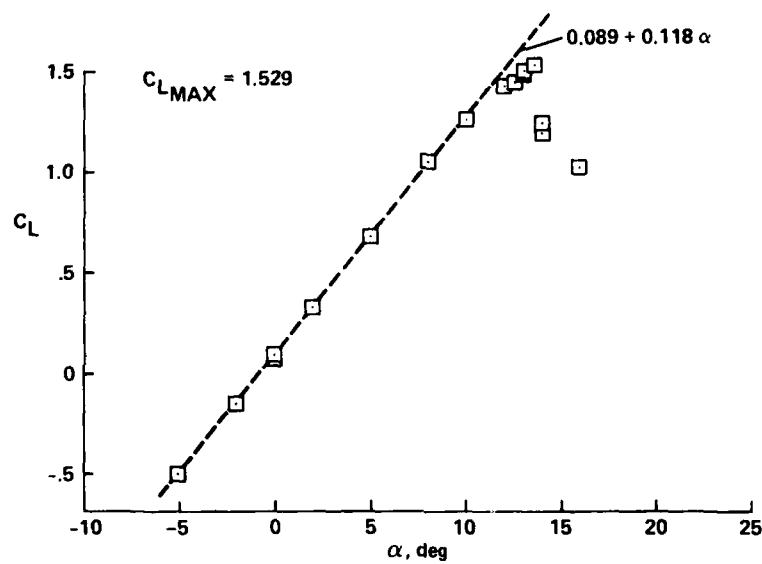
(a) C_L vs α .

Figure 18.- Static characteristics of the Wortmann FX-098 airfoil at $M_\infty = 0.30$, including wind-tunnel-wall corrections.



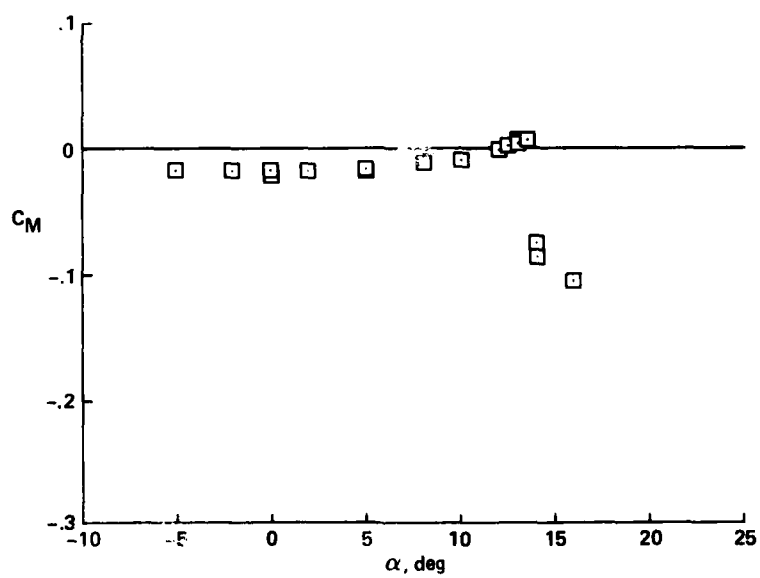
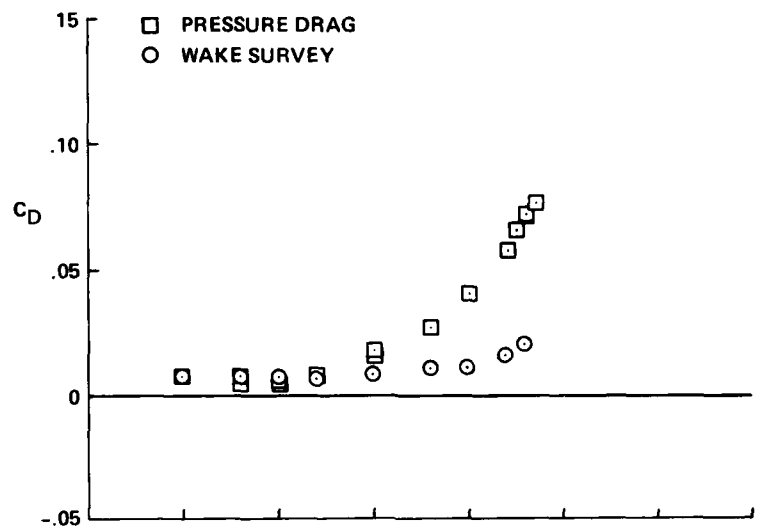
(b) C_D and C_M vs α .

Figure 18.- Concluded.



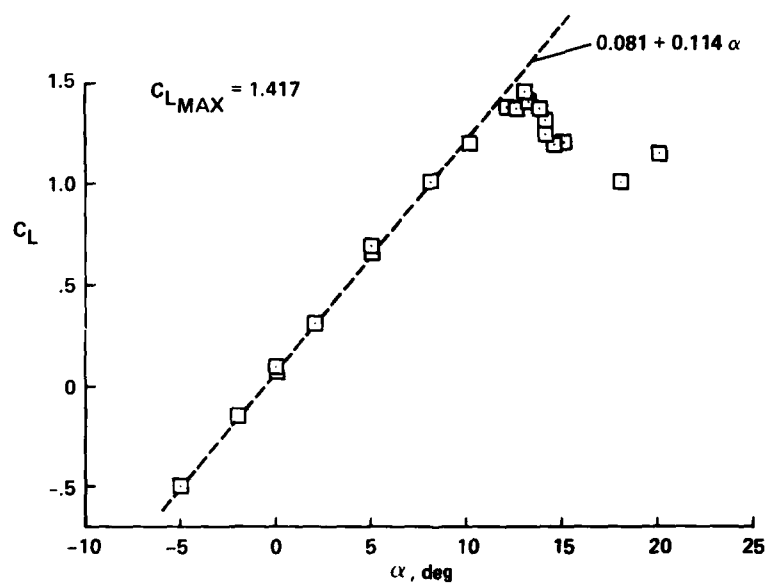
(a) C_L vs α .

Figure 19.- Static characteristics of the Sikorsky SC-1095 airfoil at $M_\infty = 0.30$, including wind-tunnel-wall corrections.



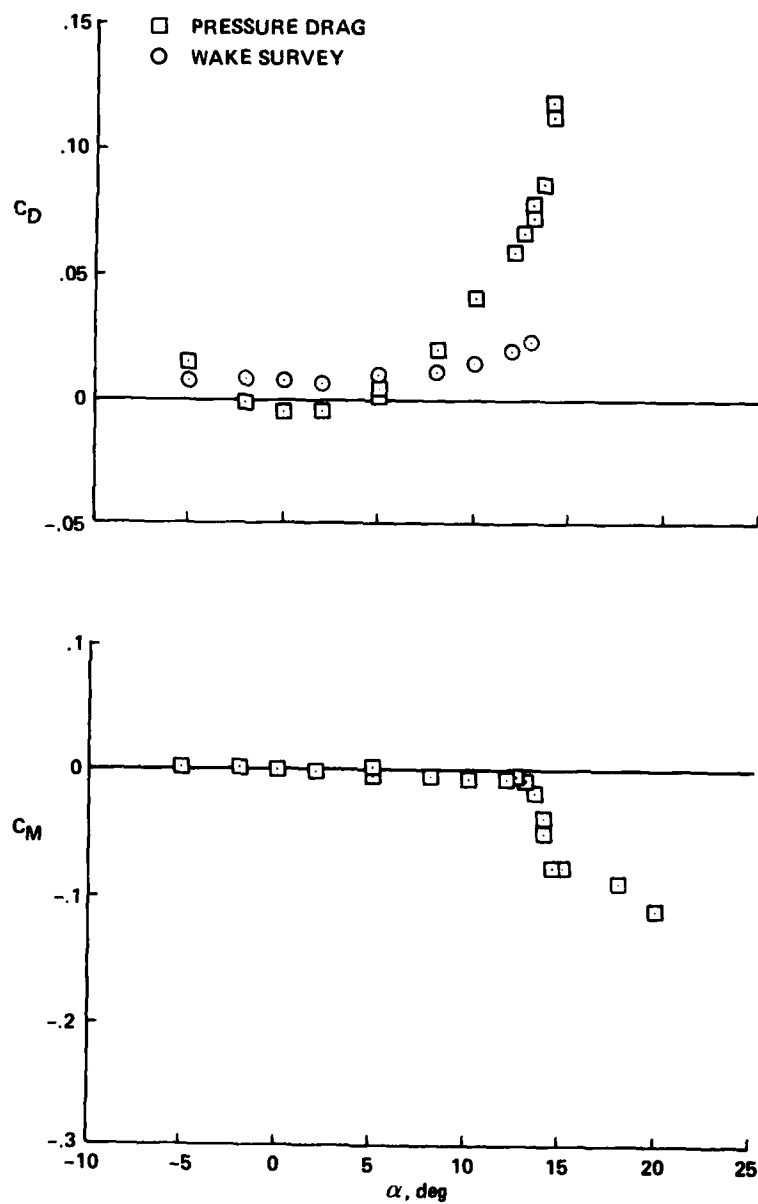
(b) C_D and C_M vs α .

Figure 19.- Concluded.



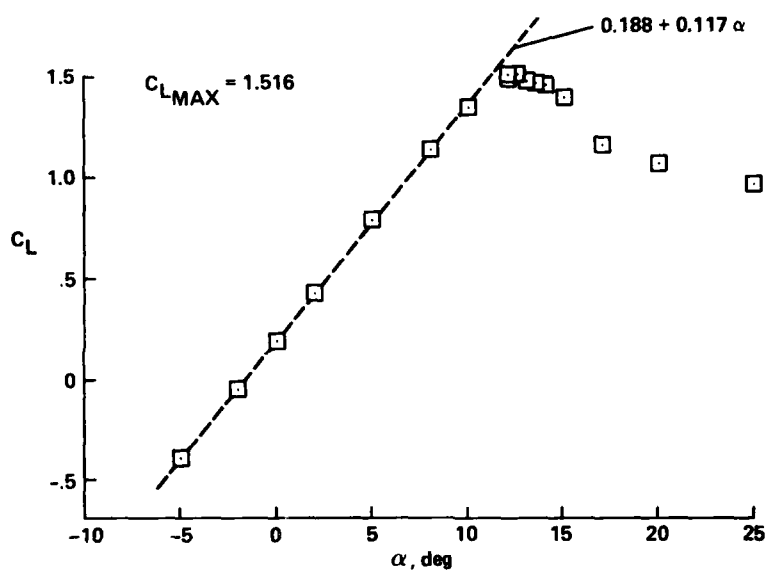
(a) C_L vs α .

Figure 20.- Static characteristics of the Hughes HH-02 airfoil at $M_\infty = 0.30$, including wind-tunnel-wall corrections.



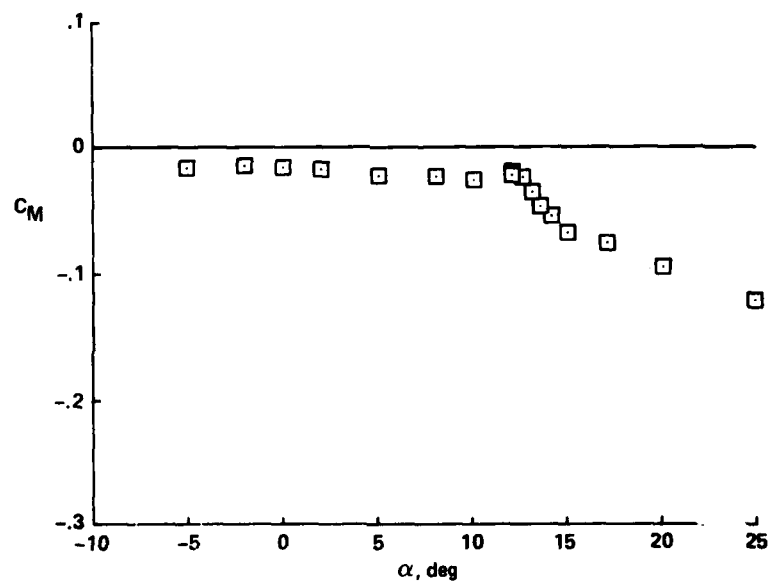
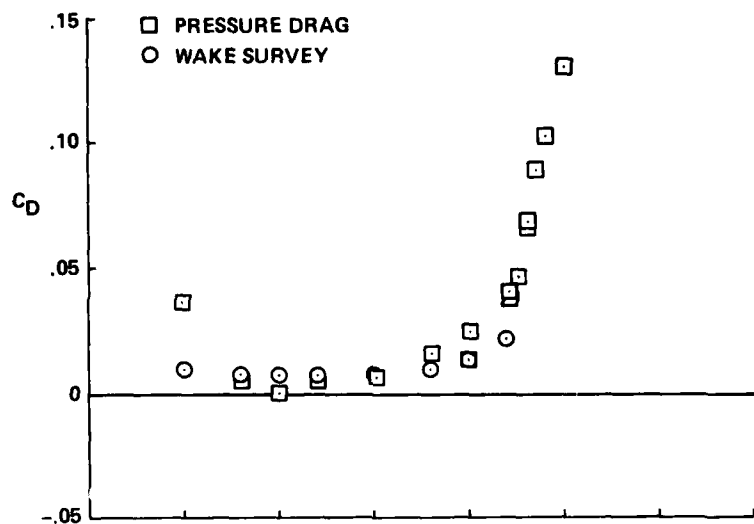
(b) C_D and C_M vs α .

Figure 20.- Concluded.



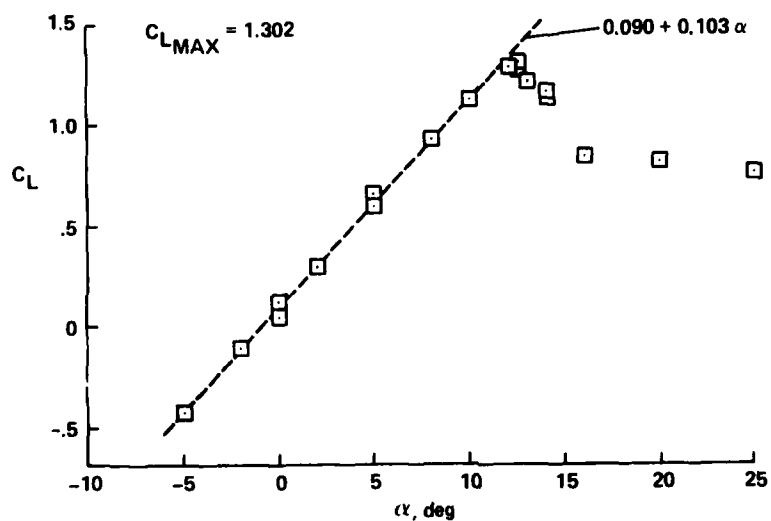
(a) C_L vs α .

Figure 21.- Static characteristics of the Vertol VR-7 airfoil at $M_\infty = 0.30$, including wind-tunnel-wall corrections.



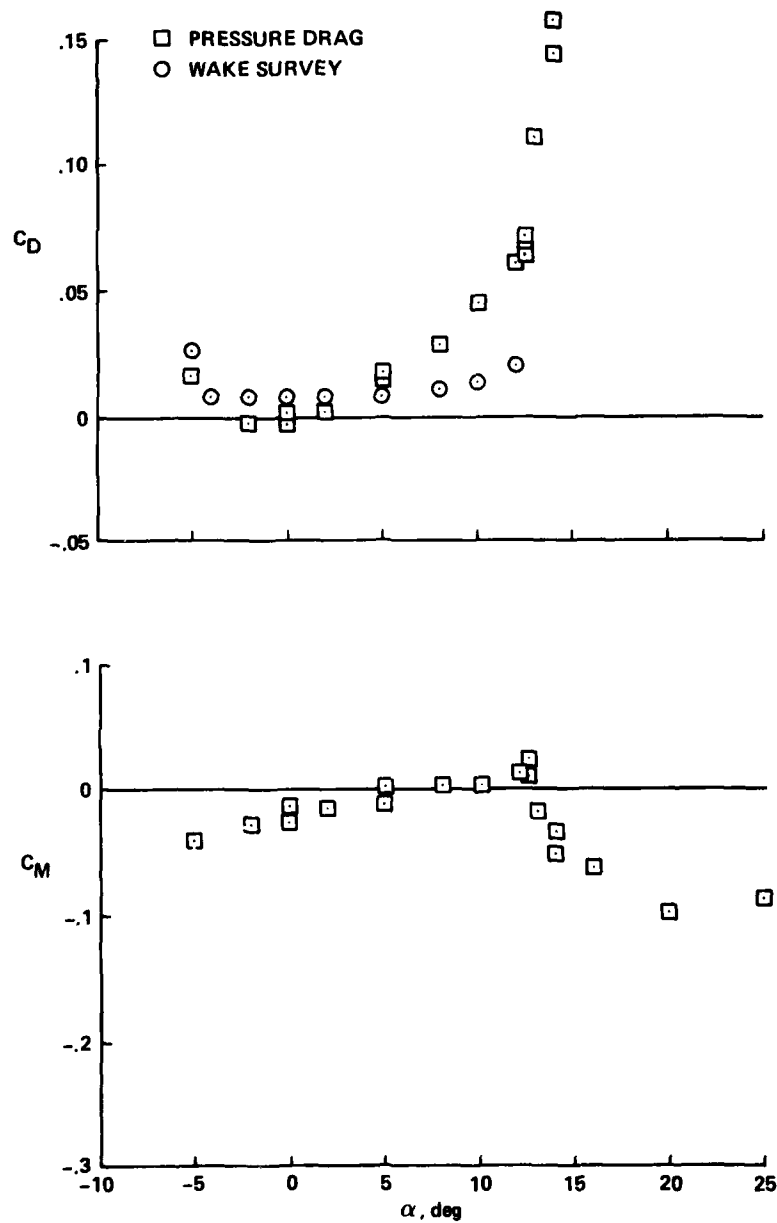
(b) C_D and C_M vs α .

Figure 21.- Concluded.



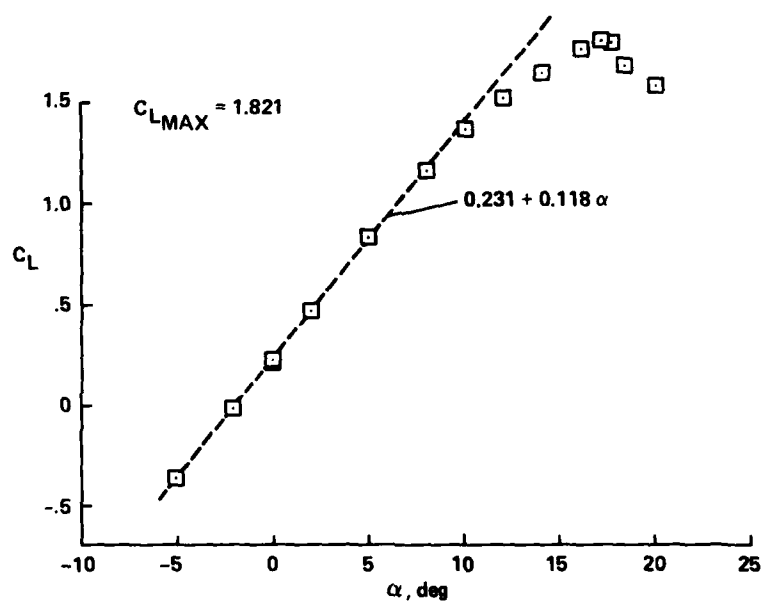
(a) C_L vs α .

Figure 22.- Static characteristics of the NLR-1 airfoil at $M_\infty = 0.30$, including wind-tunnel-wall corrections.



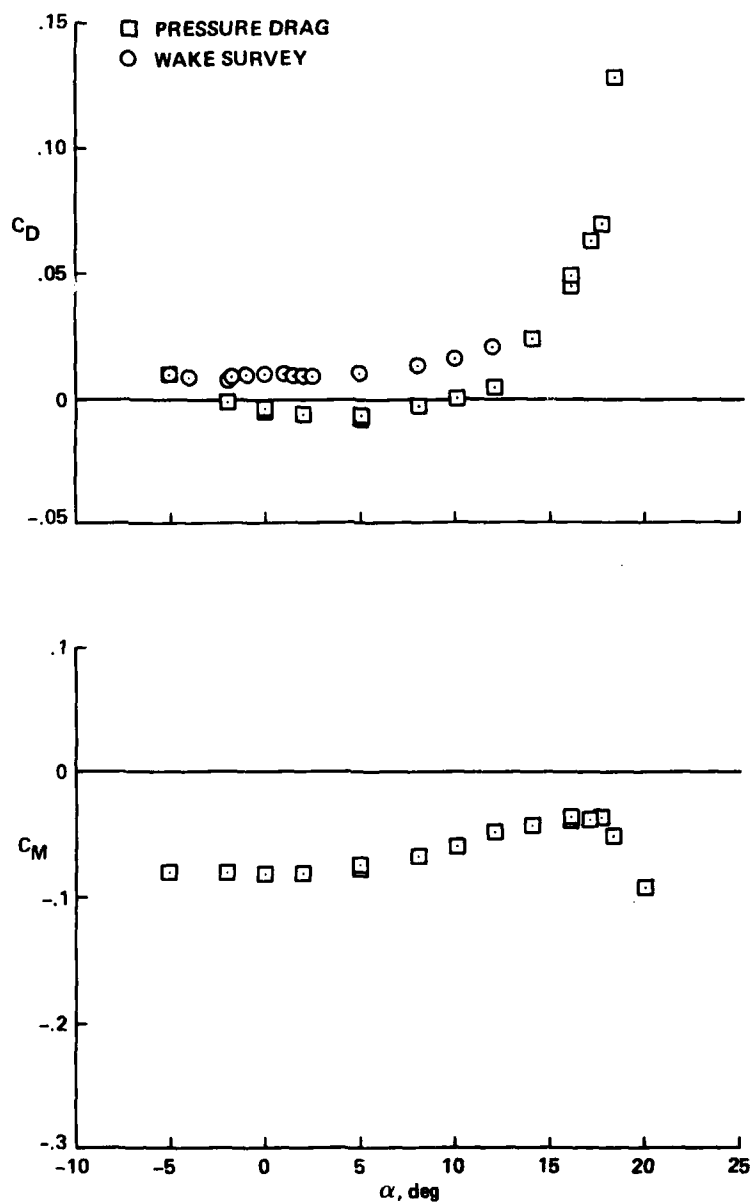
(b) C_D and C_M vs α .

Figure 22.- Concluded.



(a) C_L vs α .

Figure 23.- Static characteristics of the NLR-7301 airfoil at $M_\infty = 0.30$, including wind-tunnel-wall corrections.



(b) C_D and C_M vs α .

Figure 23.- Concluded.

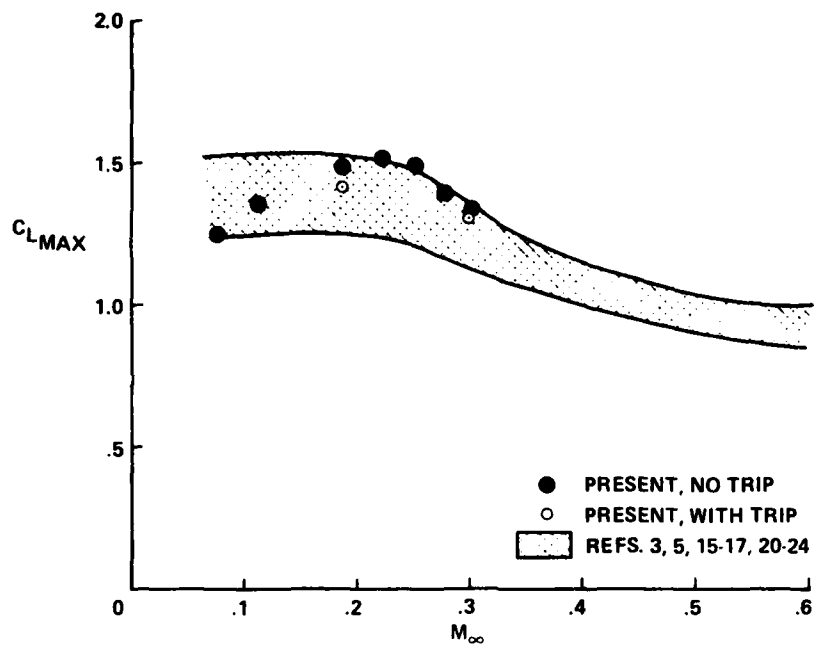


Figure 24.- Comparison of maximum static lift on the NACA 0012 airfoil.

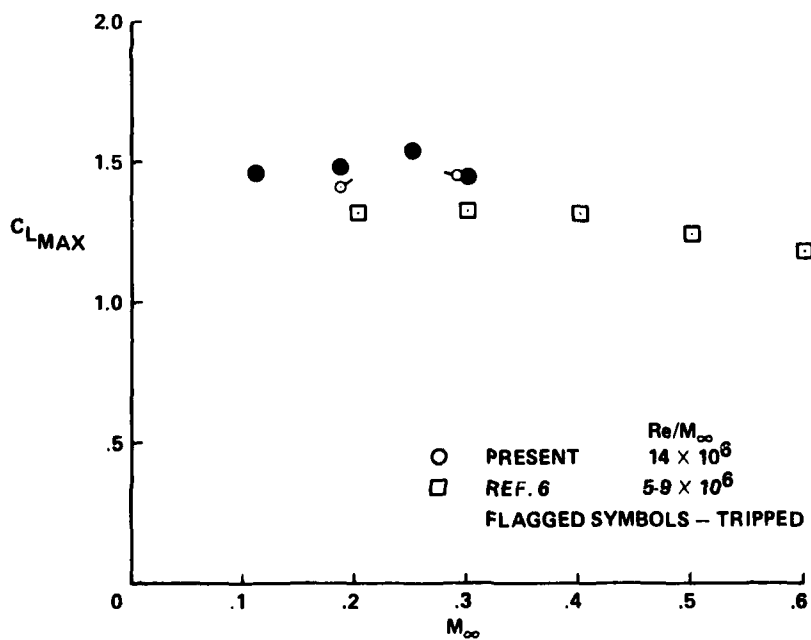


Figure 25.- Comparison of maximum static lift on the Ames A-01 airfoil.

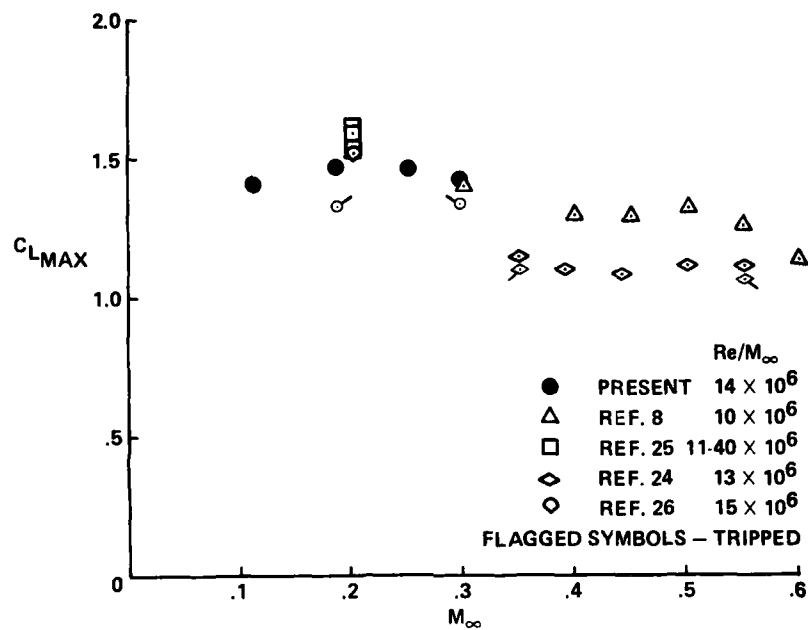


Figure 26.- Comparison of maximum static lift on the Wortmann FX-098 airfoil.

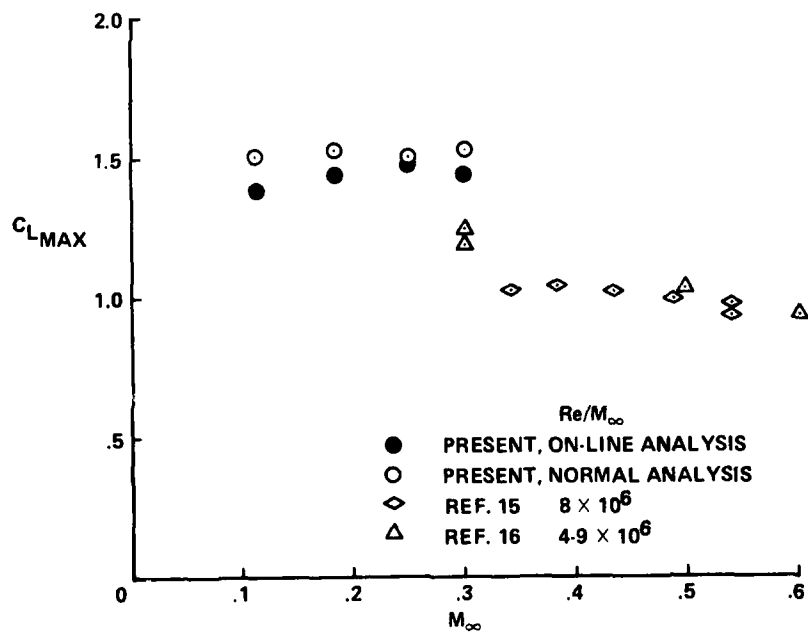


Figure 27.- Comparison of maximum static lift on the Sikorsky SC-1095 airfoil.

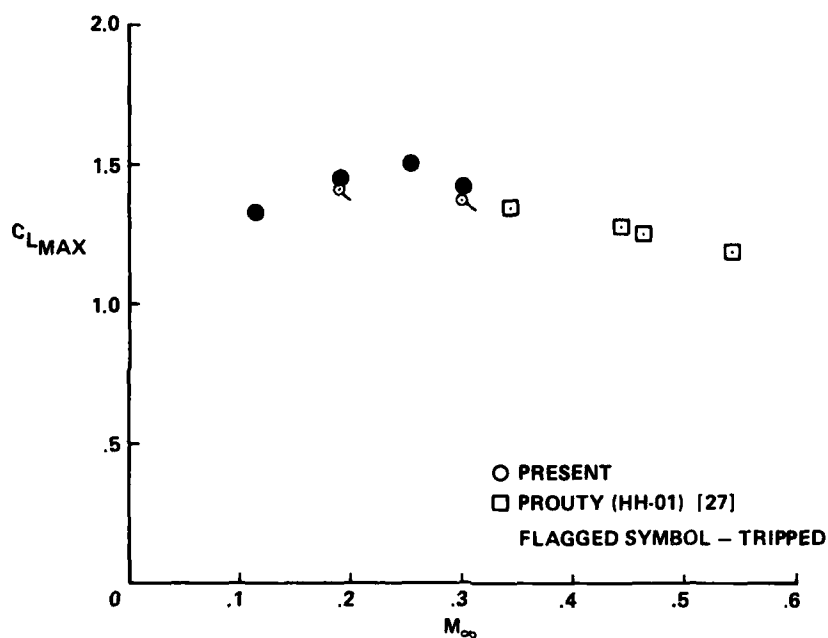


Figure 28.- Comparison of maximum static lift on the Hughes HH-02 airfoil.

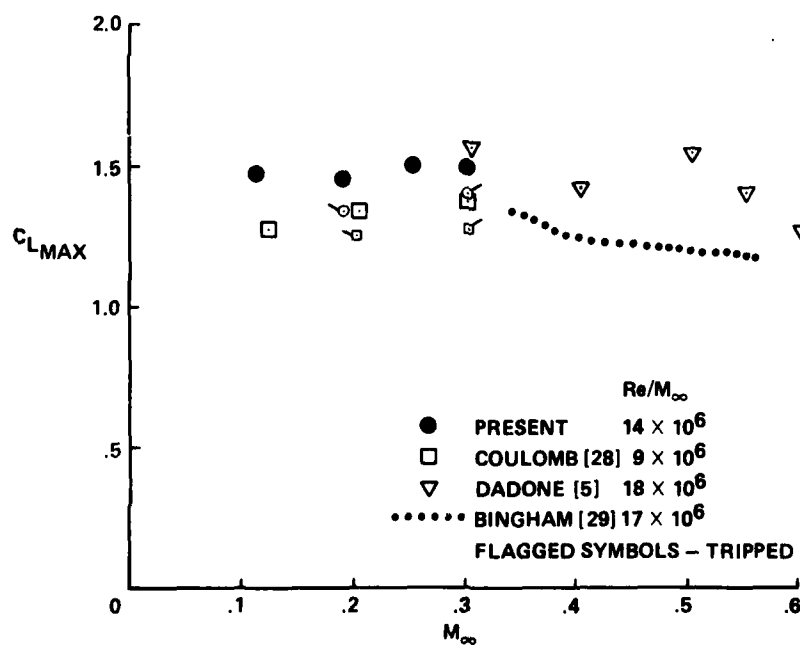


Figure 29.- Comparison of maximum static lift on the Vertol VR-7 airfoil.

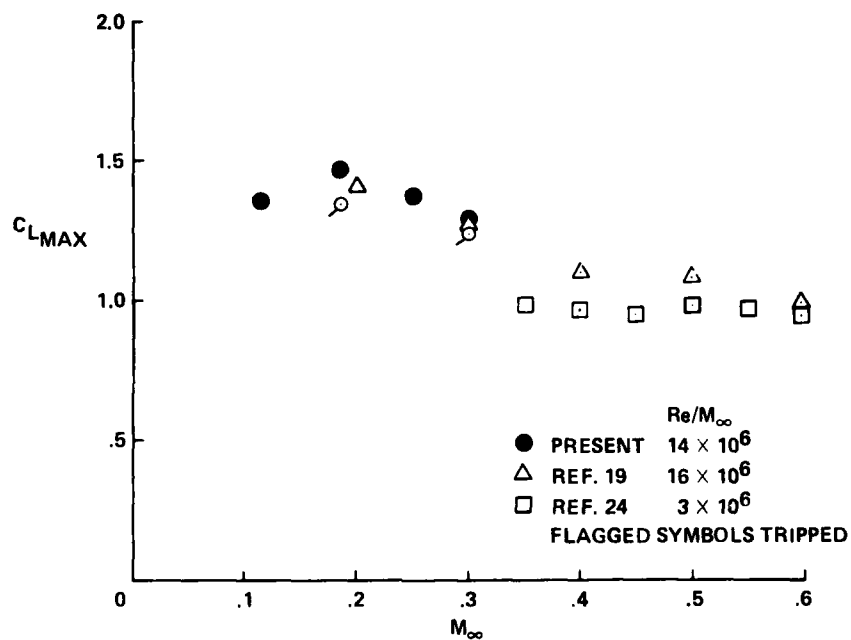


Figure 30.- Comparison of maximum static lift on the NLR-1 airfoil.

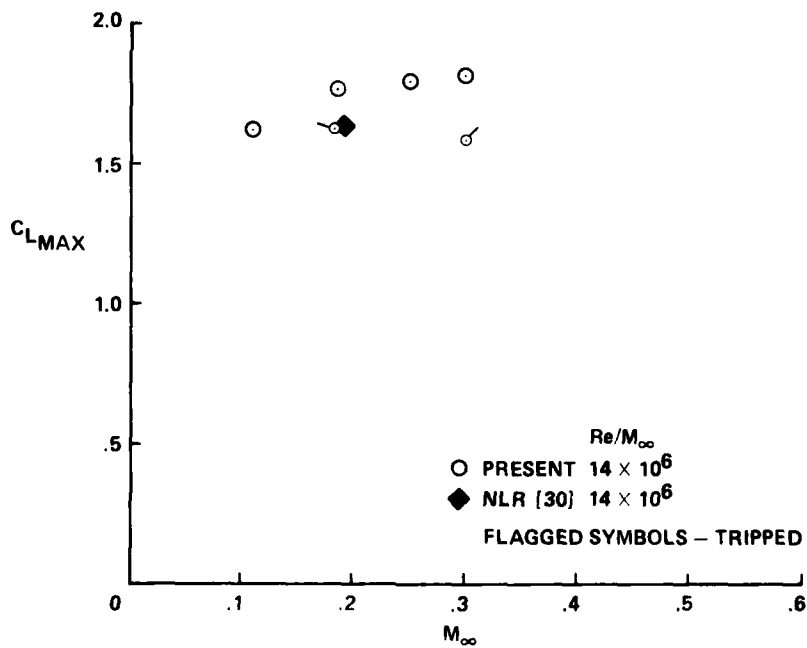


Figure 31.- Comparison of maximum static lift on the NLR-7301 airfoil.

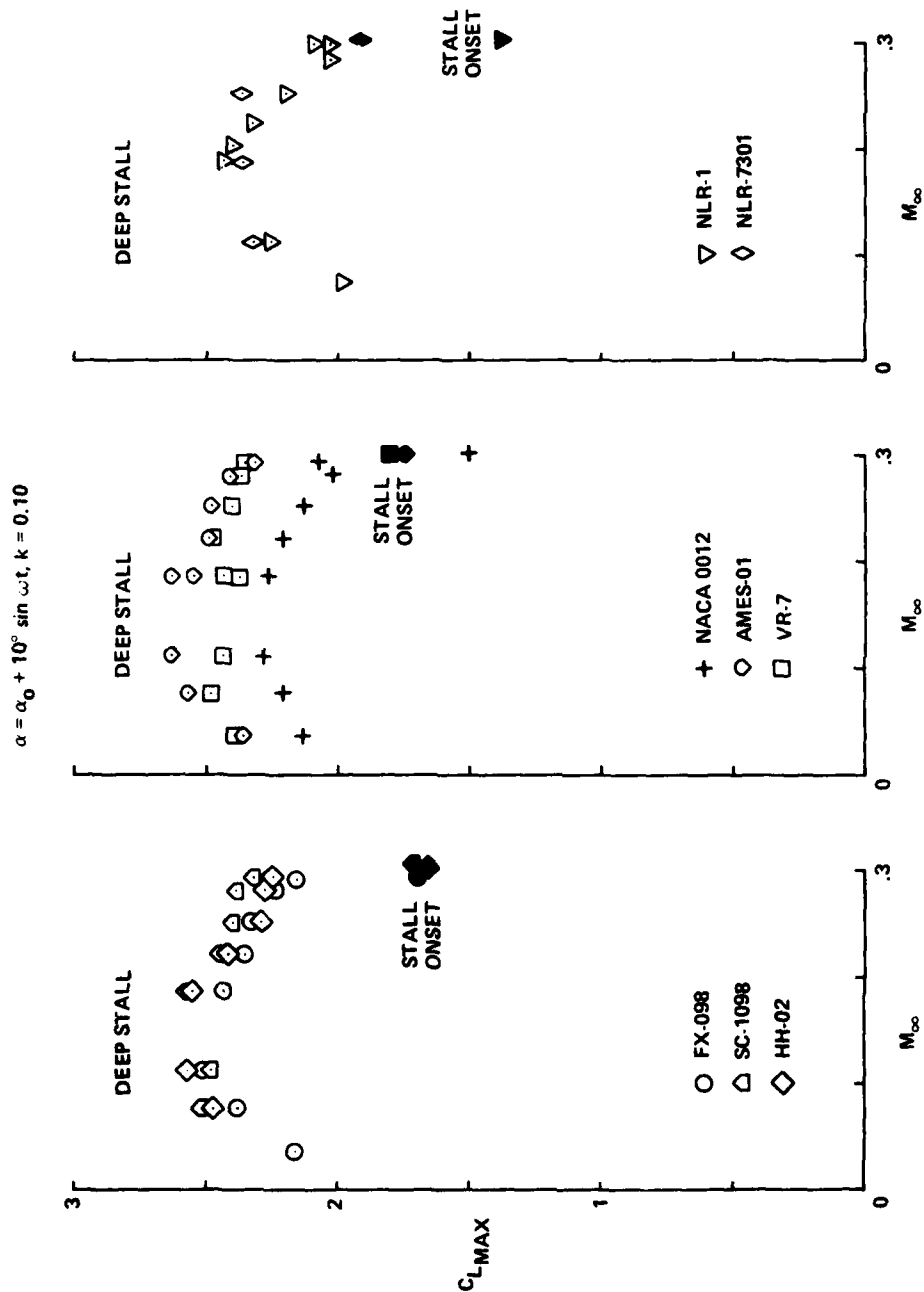


Figure 32.- Maximum unsteady lift on the eight airfoils: solid symbols = stall onset; open symbols = deep stall.

AD-A119 827 NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MOFFET--ETC F/G 20/4
AN EXPERIMENTAL STUDY OF DYNAMIC STALL ON ADVANCED AIRFOIL SECT--ETC(U)
JUL 82 W J MCCROSKEY, K W MCALISTER, L W CARR
UNCLASSIFIED NASA-A-8924-VOL-1 NASA-TN-89245-VOL-1 NL

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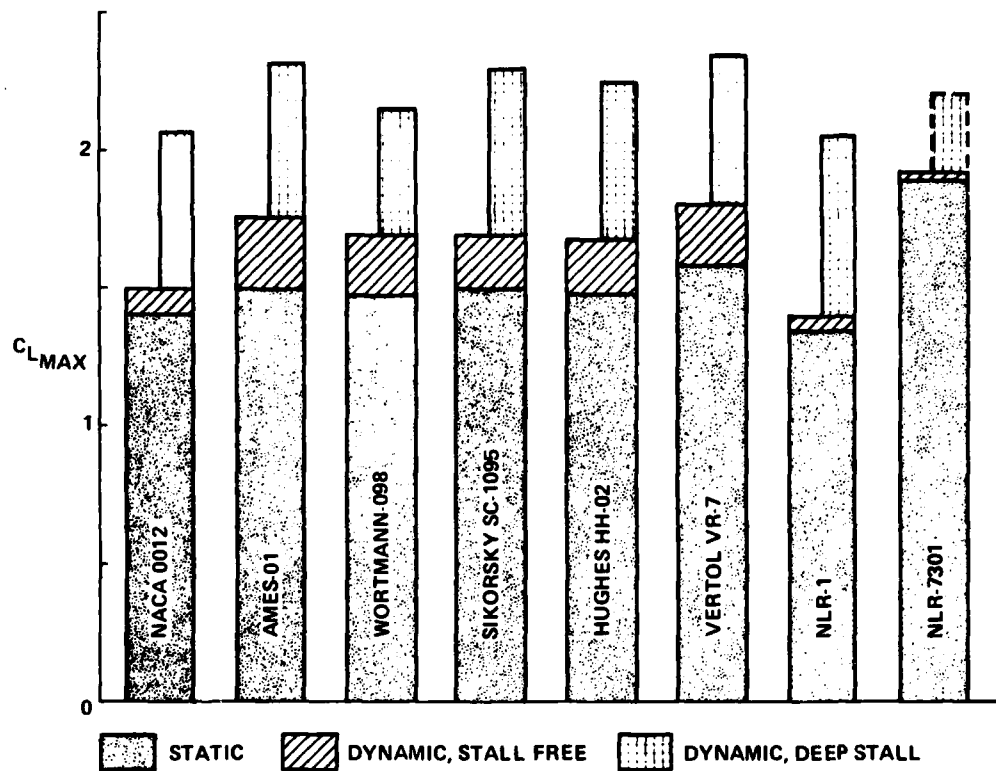


Figure 33.- Comparison of maximum lift on the eight airfoils at $M_{\infty} = 0.30$.

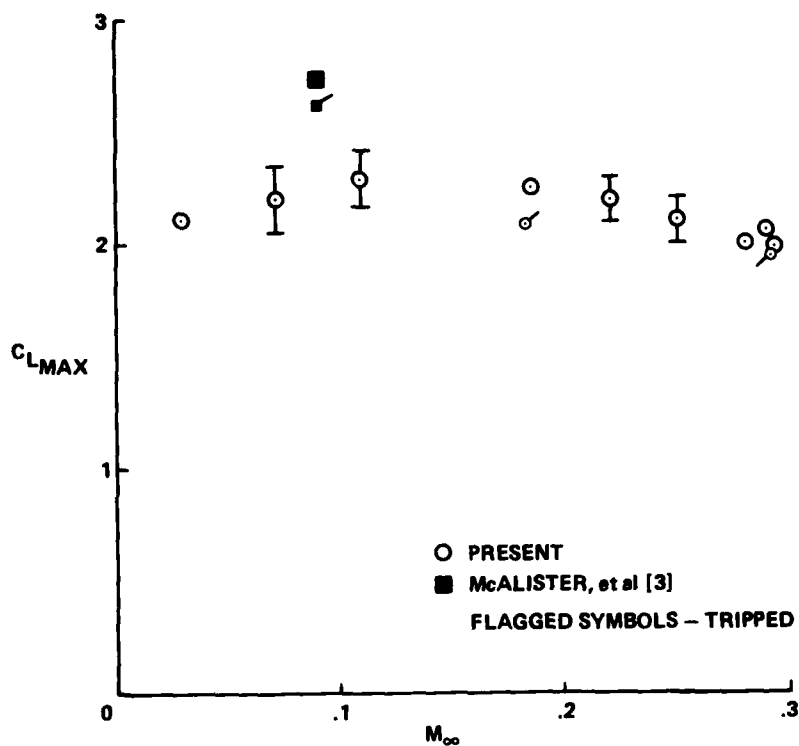


Figure 34.- Comparison of maximum lift on the NACA 0012 airfoil under deep-dynamic-stall conditions: $\alpha = 15^\circ + 10^\circ \sin \omega t$, $k = 0.10$.

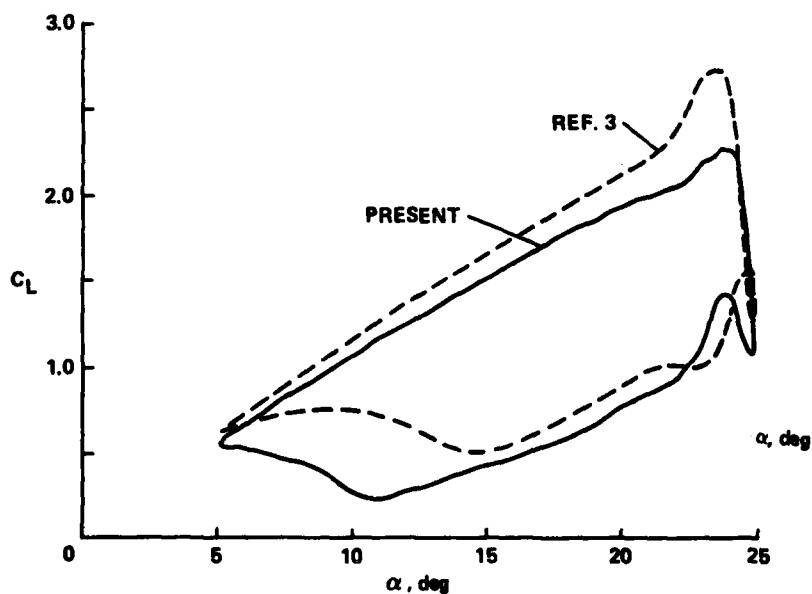


Figure 35.- Comparison of the lift hysteresis on the NACA 0012 airfoil: $M_\infty \approx 0.1$, $\alpha = 15^\circ + 10^\circ \sin \omega t$, $k = 0.10$.

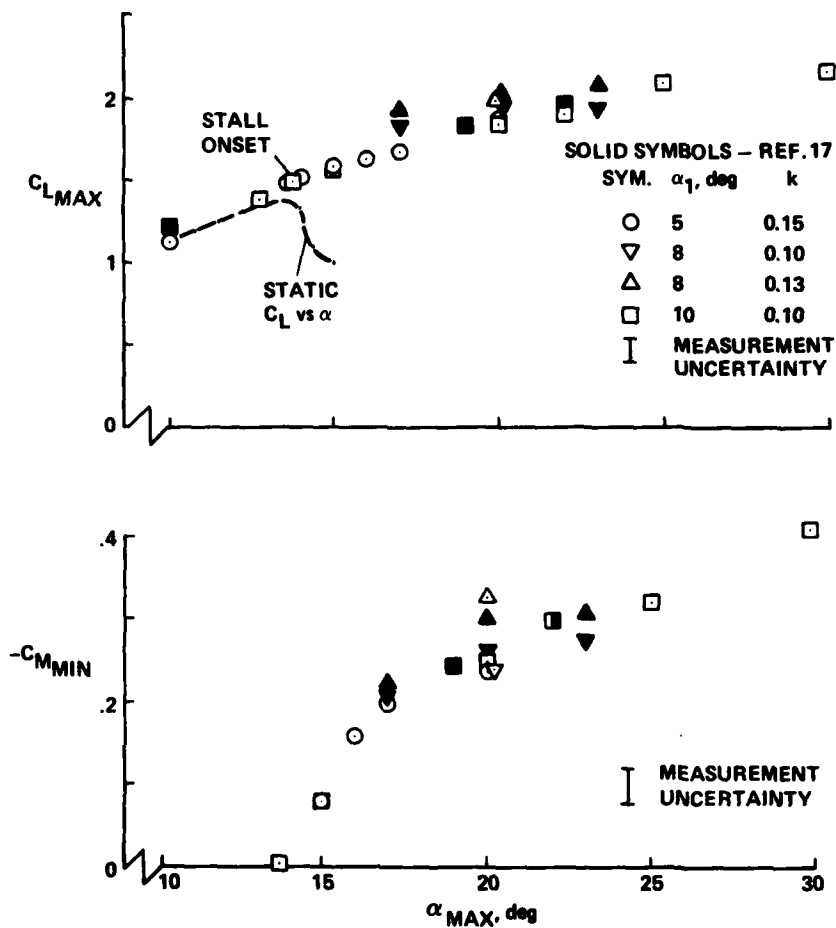


Figure 36.- Comparison of maximum airloads on the NACA 0012 airfoil at $M_\infty = 0.30$ and $\alpha_1 k^2 \approx \text{constant}$.

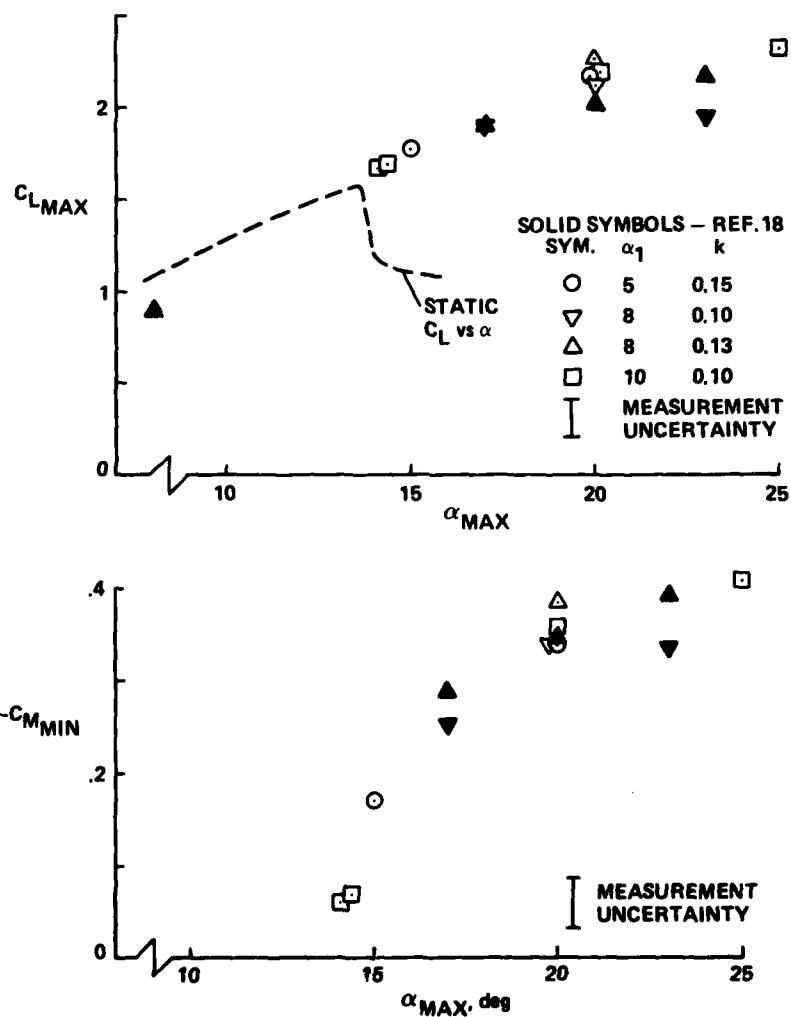


Figure 37.- Comparison of maximum airloads on the Sikorsky SC-1095 airfoil at $M_\infty = 0.30$ and $\alpha_1 k^2 = \text{constant}$.

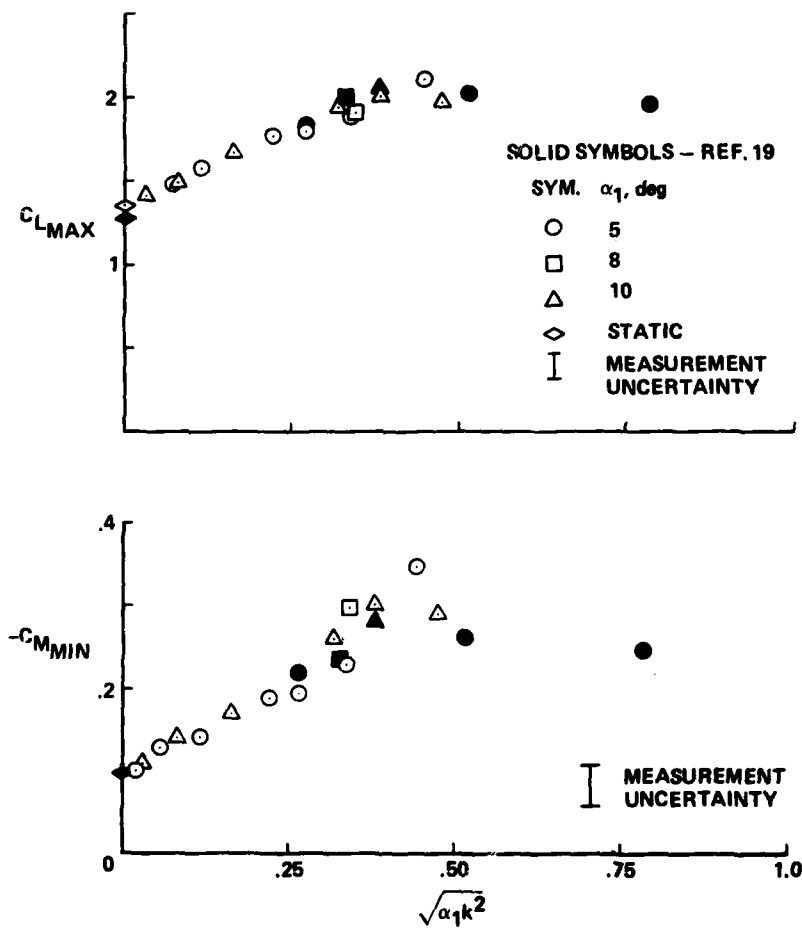


Figure 38.- Comparison of maximum airloads on the NLR-1 airfoil at $M_\infty = 0.3$ and $\alpha_{\max} = 20^\circ$.

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				14. Sponsoring Agency Code	
15. Supplementary Notes Point of Contact: W. J. McCroskey, Ames Research Center, MS 202A-1 Moffett Field, Calif. 94035 (415) 965-6428 or FTS 448-6428					
16. Abstract The static and dynamic characteristics of seven helicopter sections and a fixed-wing supercritical airfoil were investigated over a wide range of nominally two-dimensional flow conditions, at Mach numbers up to 0.30 and Reynolds numbers up to 4×10^6. Details of the experiment, estimates of measurement accuracy, and test conditions are described in this volume (the first of three volumes). Representative results are also presented and comparisons are made with data from other sources. The complete results for pressure distributions, forces, pitching moments, and boundary-layer separation and reattachment characteristics are available in graphical form in volumes 2 and 3. The results of the experiment show important differences between airfoils, which would otherwise tend to be masked by differences in wind tunnels, particularly in steady cases. All of the airfoils tested provide significant advantages over the conventional NACA 0012 profile. In general, however, the parameters of the unsteady motion appear to be more important than airfoil shape in determining the dynamic-stall airloads.					
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