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Development of a Three-Axis Trim Program

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Calspan Corporation/AEDC Operations

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This report describes the development and validation of a three-axis trim capability computer program which has been added to the Aerodynamic Data Analysis Program currently in use at the Arnold Engineering Development Center. Appendixes provided with the report describe the information requested by the prompting program, show prompting session lists, plots, and files, and include a description and listing of example case output.

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PREFACE

The work reported herein was conducted by the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC), at the request of AEDC/DOFA, AEDC Project Number CL63PW. The AEDC/DOFA project manager was Mr. James McComb. The results were obtained by Calspan Corporation/AEDC Operations, operating contractor for the aerospace flight dynamics testing effort at the AEDC, AFSC, Arnold Air Force Base, TN. The work was conducted during the period June 1988 through May 1989, and the manuscript was submitted for publication on August 3, 1989.

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1.0 INTRODUCTION

During the 1980's Arnold Engineering Development Center (AEDC) personnel have become more directly involved in the analysis of aerodynamic data obtained in the Center's wind tunnels. As a result, a computer program has been developed for use in the analysis of aerodynamic performance data. This program, referred to as the Aerodynamic Data Analysis Program, is a collection of automated techniques for performing operations that are frequently required when using wind tunnel data, such as interpolation of pitch sweep data to even increments of pitch angle, center-of-gravity transformations, changes in reference length and area, and axis transformations. In addition to these data manipulation options, there are options that perform analysis of the data to determine stability characteristics. For example, options are included to determine static stability characteristics, control effectiveness parameters, and trim aerodynamics.

The analysis program included a single-axis (longitudinal) trim option prior to the present effort. However, a flight vehicle can experience significant yawing and rolling moments at the longitudinal trim condition. To determine the control budget remaining for maneuvering after trimming, a complete trim analysis of such a vehicle must include a three-axis trim study. For this reason, the present effort was undertaken to add a three-axis trim capability to the analysis program.

The appendixes of this report are provided to demonstrate the use of the three-axis trim option for an example case. Appendix A includes a description of the information requested by the prompting program. Plots of the original data and a listing of the prompting session are included as Appendix B. The files created by the prompting program are listed in Appendix C. A description and listing of the example case output are included as Appendix D.

2.0 AERODYNAMIC DATA ANALYSIS PROGRAM

The Aerodynamic Data Analysis Program was developed at the AEDC to automate several operations that are frequently performed during the analysis of aerodynamic data for flight vehicles. The automation of these operations enables the analysis engineer to provide support to the test user/sponsor while the test is still in the wind tunnel. The on-line analysis support can reduce the time and cost of defining the vehicle configuration required to achieve aerodynamic performance goals. In post-test applications the program greatly reduces the time required to define the boundaries of the flight envelope compared to manual calculations.

The specific data manipulation options incorporated into the program were established by a survey of AEDC personnel who frequently analyze wind tunnel data. These data manipulation options include variable bias corrections, independent variable interpolation and extrapolation, center-of-gravity transfer, axis transformation, reference dimension changes, skin friction and base drag corrections, and variable sign change. Additional options provided for analysis support include determination of stability and control effectiveness characteristics and longitudinal trim. The operations available through the analysis program are listed in Table 1. The data manipulation options are shown with a typical application. The original analysis options are listed with the output generated by the option. The remainder of this report documents the addition of the three-axis trim (eleventh) option.

3.0 THREE-AXIS TRIM OPTION

3.1 DATA REQUIREMENTS

The three-axis trim option requires data for pitching moment, rolling moment, and yawing moment at various combinations of equivalent pitch, roll, and yaw control surface deflections. As a minimum, sweeps of the independent variable (usually pitch angle) with a single nonzero equivalent deflection per data run are required. Each deflection type (pitch, roll, and yaw) must be selected for control deflection sweeps for a set of runs in the matrix. A data matrix of this type is shown symbolically in Table 2 and is referred to hereafter as "Group A" data. When Group A data are used, there is an implicit assumption that the effectiveness of each equivalent deflection is independent of the value of the other two deflections. In general, effectiveness of each deflection is not independent. In the case of a missile, for example, a single control surface may be positioned near the stall angle as a result of pitch trim. Any additional deflection of the same surface for roll or yaw trim could drive that surface beyond the stall angle. In this example the initial value of pitch deflection reduced roll and yaw effectiveness of that surface.

Some of the dependencies among the deflections can be taken into account if the additional data shown in Table 3 are available (Group B data). The Group B data are independent variable sweeps with pitch deflection and one other deflection being nonzero. The additional information can be used to estimate the roll and yaw control effectiveness at nonzero pitch deflection and the pitch control effectiveness at nonzero roll and yaw deflections. Still more data would be required to evaluate the effect of roll deflection on yaw control and vice versa. The present three-axis trim method assumes only Group A or Group A and Group B data are available.

3.2 COMPUTATIONAL APPROACH

The goal of three-axis trim is to set control surface angles such that the three aerodynamic moments about the vehicle center of gravity are simultaneously zero. Knowing the control deflections required for trim, the other aerodynamic coefficients at trim can then be determined. The moment equations to be solved can be written as follows:

$$
\begin{aligned}
0 &= C_{m_I} + M_Q(\delta_{Q_{trim}} - \delta_{Q_I}) + M_{P^2}(\delta^2{}_{P_{trim}} - \delta^2{}_{P_I}) + M_{R^2}(\delta^2{}_{R_{trim}} - \delta^2{}_{R_I}) \\
0 &= C_{l_I} + L_Q(\delta_{Q_{trim}} - \delta_{Q_I}) + L_P(\delta_{P_{trim}} - \delta_{P_I}) + L_R(\delta_{R_{trim}} - \delta_{R_I}) \qquad (1) \\
0 &= C_{n_I} + N_Q(\delta_{Q_{trim}} - \delta_{Q_I}) + N_P(\delta_{P_{trim}} - \delta_{P_I}) + N_R(\delta_{R_{trim}} - \delta_{R_I})
\end{aligned}
$$

where C_{m_I}, C_{l_I}, and C_{n_I} are moments resulting from the flight condition of the vehicle. M_x, L_x, and N_x are control effectiveness derivatives of pitching, rolling, and yawing moments with subscripts Q, P, and R indicating pitch, roll, and yaw deflection, respectively. The $(\delta_{x_{trim}} - \delta_{x_I})$ terms represent differences between current and trim values of the deflections.

The control effectiveness terms are calculated as divided differences between input data runs. For example,

$$M_Q = (C_{m_2} - C_{m_1})/(\delta_{Q_2} - \delta_{Q_1})$$

The pitching-moment derivatives with respect to roll and yaw deflections are calculated differently because of the even-function nature of the variation of pitching moment with those deflections. (See Section 3.3 for more details on even- and odd-function moment variations.) The moment difference is divided by the difference between the squares of the deflection angles. Therefore,

$$M_{P^2} = (C_{m_2} - C_{m_1})/(\delta^2{}_{P_2} - \delta^2{}_{P_1})$$

and

$$M_{R^2} = (C_{m_2} - C_{m_1})/(\delta^2{}_{R_2} - \delta^2{}_{R_1})$$

The special treatment of pitching-moment derivatives with roll and yaw deflection is a carry-over from the control effectiveness option. Squaring the deflections causes a problem in calculating trim values of roll and yaw deflections. When the control effectiveness matrix is inverted and multiplied by the moment vector, the product of pitching moment and the special derivatives results in a $(\delta^2 - \delta^2{}_{trim})$ term instead of $(\delta - \delta_{trim})^2$. The program uses the square root of $(\delta^2 - \delta^2{}_{trim})$ as though it were $(\delta - \delta_{trim})^2$. The approximation introduces error unless the roll and yaw deflections at trim are zero.

The error introduced by approximating $\sqrt{(\delta - \delta_{trim})^2}$ with $\sqrt{\delta^2 - \delta^2{}_{trim}}$ affects intermediate values of the yaw and roll control deflections during the Newton iteration described below. The equation for the yaw deflection increment used to update the deflection angle is

$$\delta_R - \delta_{R_{trim}} = \sqrt{\frac{\delta^2_{R_2} - \delta^2_{R_1}}{C_{m_2} - C_{m_1}} C_m} + \frac{\delta_{R_2} - \delta_{R_1}}{C_{n_2} - C_{n_1}} C_n + \frac{\delta_{R_2} - \delta_{R_1}}{C_{\ell_2} - C_{\ell_1}} C_\ell \tag{2}$$

where C_m, C_n, and C_ℓ are untrimmed moments at the previous deflection values. The error is introduced through the first term on the right-hand side of Eq. (2). Therefore, the error occurs only when cross coupling exists in the control effectiveness data (i.e., when $M_R{}^2$ and $M_P{}^2$ are not zero), and the error diminishes as the untrimmed pitching moment approaches zero. The untrimmed pitching moments, $\sqrt{(\delta_R - \delta_{R_{trim}})^2}$ and $\sqrt{\delta^2_R - \delta^2_{R_{trim}}}$, are shown in Table 4 for a typical iteration sequence. The calculated yaw and roll control deflections at trim are not affected by the approximation.

The three moment equations are solved using Newton's method for nonlinear systems of equations (Ref. 1). (Newton's method was chosen because of its rapid convergence.) Rewriting the moment equations [Eq. (1)] in matrix form and solving for the deflection term gives

$$[C_{m_I}\ C_{\ell_I}\ C_{n_I}] \begin{bmatrix} M_Q & M_P{}^2 & M_R{}^2 \\ L_Q & L_P & L_R \\ N_Q & N_P & N_R \end{bmatrix}^{-1} = [(\delta_{Q_I} - \delta_{Q_{trim}})(\delta_{P_I} - \delta_{P_{trim}})(\delta_{R_I} - \delta_{R_{trim}})] \tag{3}$$

At each iteration the moment vector and control effectiveness matrix is updated to the values at the latest estimate of the trim deflection values. The update is based on linear interpolation within the control deflection data supplied as input. The interpolation is required because the estimate of trim deflections usually will not match data deflection values.

Two interpolation procedures are required—one for Group A data only and one for Group A and Group B data. The moment and control effectiveness updating procedure for Group A data will be described first. At each iteration, approximations (δ_{Q_I}, δ_{P_I}, and δ_{R_I}) to the trim deflection angles are known. A typical case for which δ_{Q_I} is bounded by Q_2 and Q_3, δ_{P_I} is bounded by P_1 and P_2, and δ_{R_I} is bounded by R_1 and R_2 is illustrated in Fig. 1. The objective is to find the best possible estimate of the moments and control effectiveness at (δ_{Q_I}, δ_{P_I}, δ_{R_I})(point D of the figure). The estimate is made by first linearly interpolating all three moments to δ_{Q_I}, δ_{P_I}, and δ_{R_I} on the respective axes. Then the moments at the origin of the figure are subtracted from the values at δ_{P_I} and δ_{R_I}. The two differences are then added to the moments at (δ_{Q_I}, 0, 0) (point A) to give moments at point D. The control derivatives are simply the divided differences obtained from the bounding deflection data on each axis. Each pair of bounding deflections provides one column of the control effectiveness matrix.

If Group B data are available, the effects of pitch deflection on roll and yaw control effectiveness, and vice versa, can be included in the trim calculations. The current deflections (δ_{x_I}) and the Group B data bounding them are shown in Fig. 2. As before, the objective is to obtain moments and control effectiveness estimates at point D. Each corner of the boxes enclosing points B and C represents a combination of deflections (one data run) from the Group B data. Point B indicates the combination of δ_{Q_I} and δ_{P_I}, and point C represents the combination of δ_{Q_I} and δ_{R_I}. The moments at point B are calculated by interpolation to δ_{Q_I} on the P_1 and P_2 lines and then interpolating these results to δ_{P_I}. The same process is applied at point C. Moments at (δ_{Q_I}, 0, 0) (point A) are obtained by linear interpolation between Q_2 and Q_3. The moments at point A are subtracted from those at point B, and the differences are added to the moments at C to give the approximation of moments at D.

Control effectiveness derivatives at points B and C are computed as divided differences using the four bounding runs. At point B, roll control derivatives are calculated at Q_2 and Q_3 and then interpolated to δ_{Q_I}. Pitch control derivatives are computed at P_1 and P_2 and interpolated to δ_{P_I}. The same technique is used at point C to get yaw control derivatives and pitch control derivatives. The roll and yaw derivatives go directly into the control effectiveness matrix. The pitch control derivatives at (δ_{Q_I}, 0, 0) (point A) are subtracted from the values at (δ_{Q_I}, δ_{P_I}, 0) (point B) and the differences are added to the values at (δ_{Q_I}, 0, δ_{R_I}) (point C) to obtain values at (δ_{Q_I}, δ_{P_I}, δ_{R_I}) (point D). The approximations to control derivatives at point D do not include the effects of roll deflection on yaw control effectiveness or vice versa.

The next approximation of the trim deflections is made using the moment vector and control effectiveness matrix corresponding to the current estimate of the deflections. A new $[\delta]$ is calculated by solving Eq. (2) and the new deflections are given by

$$[\delta]_{I+1} = [\delta]_I - [\Delta\,\delta]_I \tag{4}$$

where the elements of the $[\Delta\,\delta]$ vector are the ($\delta_{x_I} - \delta_{x_{trim}}$) terms. The new moment vector and control effectiveness matrix is calculated as before. The iteration continues until the untrimmed moments are less than user-supplied tolerances. The values of other data parameters at trim are determined by the method used for moments after the iteration converges.

Newton's method performs well when the control effectiveness matrix is diagonally dominant. However, the method may fail to converge if the diagonal dominance is lost. The control effectiveness matrix is diagonally dominant when the absolute value of the main diagonal term (i.e., M_Q, L_P, or N_R) is greater than the sum of the absolute values of the other terms on the same row. In the three-axis trim application, diagonal dominance is lost when there is strong cross coupling in the control effectiveness derivatives. For example, if the derivative of yawing moment with respect to roll deflection is greater than or equal to the derivative of rolling moment with respect to roll deflection, then diagonal dominance has been lost. Any untrimmed yawing moment would cause a large roll deflection increment in the example case. The large roll deflection would generate additional untrimmed yawing moments and the process would diverge.

The impact of cross coupling can be reduced by adding a relaxation technique to the basic Newton method. Successive over- and under-relaxation is used in the three-axis trim option. (See Ref. 2 for a discussion of over- and under-relaxation.) The relaxation technique multiplies each element of $[\Delta\ \delta]$ in Eq. (4) by a relaxation factor before calculating the new $[\delta]$. The relaxation factor for a given deflection is determined by comparing the signs of the corresponding element of $[\Delta\ \delta]$ on successive iterations. If the two signs are the same (the previous iteration under-predicted the trim value), then a relaxation factor greater than 1.0 is used. A relaxation factor less than 1.0 is used when the two signs are opposite (the previous iteration over-predicted the trim value). The relaxation factor has the effect of adjusting the size of the deflection increment that Newton's method would add to the current deflection. The relaxation factors are accumulative. At each iteration the factor for a given deflection is multiplied by either 1.1 or 2/3. Therefore, repeated under-prediction of trim values would lead to increasing relaxation factors, and repeated over-prediction would reduce the relaxation factors. The factors are limited to a maximum of 2.0 and a minimum of 1/9 to avoid extreme adjustments.

3.3 PROGRAM RESTRICTIONS

Several restrictions are placed on the data used as input to the computer program that performs the three-axis trim calculations. The most severe restriction is that each independent variable sweep have the same values of independent variable. When wind tunnel data runs are used as input, all sweeps may not have the same number of points because of balance limits, model support system limits, or other test-related limitations. The impact of this restriction can be minimized by the careful selection of the independent variable range requested, by extrapolation of existing data, or both. (See Appendix A for more details.)

The determination of control effectiveness and aerodynamic moments at each iteration requires data with deflections bounding the current estimates. The pitch deflection must be bounded absolutely or be within 0.1 deg of the highest or lowest data value to be considered bounded. The roll and yaw deflections are not required to be bounded absolutely.

Because it is difficult to determine before a test what the sign of the trim values of roll and yaw deflection will be, data are often taken with the same sign for each deflection value. The data analysis assumes the control effectiveness and the magnitude of moment increments are independent of the direction of the control deflection. Therefore, if the roll and yaw deflections in the data do not bound the estimate, the data are mirrored by changing the sign of the deflections and attempting the bounding again. If the second attempt at bounding succeeds, then the moments are interpolated to the negative of the current deflection estimate. If the mirroring is not required, then linear interpolation gives the moments directly. When the mirroring is required, the character of the variation of moment with deflection must be considered in the calculation of moments and control effectiveness.

When mirroring is required and the moment is an even function of the deflection, as in Fig. 3a, the final moment value is the result of interpolation only and the control effectiveness changes sign. (This is the case for lift, drag, and pitching-moment variations with roll or yaw deflections.) When the moments vary as odd functions of the deflections, as in Fig. 3b, the control effectiveness does not change sign. However, for odd-function parameters the final moment value is determined according to the following equation.

$$\begin{aligned}\text{Final Moment} = {} & \text{Moment at 0 deflection} \\ & + \text{RMIR} \times (\text{Moment at nonzero deflection} \\ & - \text{Moment at 0 deflection})\end{aligned}$$

where RMIR is 1.0 when mirroring is not required and -1.0 when mirroring is required.

In iterating toward a trim deflection that is very near one of the extreme data values, the calculations can produce an estimate that is not bounded. For example, if the actual trim deflection is 4.93 deg, the maximum data deflection is 5.0 deg, and the current estimate is 5.3 deg, then none of the bounding criteria described above is met. When this happens the program changes the current estimate to the nearest data value (5.0 deg in the example case) and continues the iteration. The resetting of the estimate is allowed only once for each deflection (pitch, roll, and yaw) at each value of the independent variable. If any one of the deflections is unbounded a second time, the trim fails at that value of the independent variable and calculations begin for the next value.

The program limits the number of iterations to 20 at each independent variable value. If the program reaches 20 iterations, a warning message and the final moment values are printed. The deflections at the final iteration are used to calculate values of the other trim parameters. The line of program output for that value of the independent variable is flagged with an asterisk (*).

3.4 PROGRAM VALIDATION

The three-axis trim program was developed in steps. Since a control effectiveness option already existed in the Aerodynamic Data Analysis Program, the control effectiveness calculations were programmed first. The second step was the development of the technique used to update the control effectiveness and moments at each estimate of the trim deflections. The updating technique was implemented for Group A data and then for the case with Group

A and Group B data. The method of solving for trim deflection angles was added next. Finally, the calculation of other parameters at the trim deflections was implemented. At each step of the development, the program was checked by hand calculations and by comparison with a "pilot" program.

After developing the approach for updating moments and control effectiveness (step 2), the author wrote a simplified computer program to perform the basic calculations. After the pilot program results were validated by hand calculations, the program was used as a guide by the programmer assigned responsibility for the Aerodynamic Data Analysis Program in the implementation of the method. The pilot program process was also applied to the calculation of trim deflections with control effectiveness and moment data as input.

The check cases used to validate the three-axis trim option came from actual wind tunnel data and a generic data generator program. The experimental data included axisymmetric and nonaxisymmetric vehicles. Control surface arrangements included both cruciform fins and one vertical and two horizontal control surfaces. The generic data generator is a group of equations used to produce curves that have characteristics similar to actual aerodynamic data. This generic program was used to produce input data with characteristics required to test particular sections of the trim program. Specific examples of characteristics generated are multiple trim points at a fixed deflection within the angle-of-attack range (See Appendix B), varying degrees of cross coupling in the control effectiveness, and varying control effectiveness with deflection angle. The data used for the example case described in the next section were generated with the generic program to test the mirroring of yaw deflection data.

3.5 PROGRAM EXAMPLE CASE

The Group A control effectiveness data for the example case are shown in Figs. 4–6. A close look at the data can give some anticipated results from the trim calculations. The pitching-moment data of Fig. 4a indicate enough pitch deflection is available for trim from 0 to about 25-deg angle of attack. However, the yawing moment may not be trimmable at the extremes of the angle-of-attack range. The trim values of pitch deflection should be between 0 and −10 deg at angles of attack less than 14 deg and between 0 and +5 deg at angles of attack greater than 14 deg. Cross coupling of pitch deflection into the yaw and roll planes is also indicated in Fig. 4a. The normal force at trim should vary from near −2 to just over +2 between angles of attack of 0 and 14 deg, according to Fig. 4b. At angles greater than 14 deg, the normal force at trim should range from about 2 to 4.5.

Roll control deflections shown in Figs. 5a and 5b have very little effect on the pitching and yawing moments and no effect on the force coefficients. The rolling-moment data suggest that roll control will not have a limiting influence on the trim calculations.

The yaw deflection data of Fig. 6 indicate trim will not be possible above 24-deg angle of attack. The lower angle-of-attack limit with data mirroring is near 8 deg. However, the pitch deflection required for trim produces a negative increment in yawing moment and makes the 8-deg angle-of-attack limit questionable. The yaw deflection at trim should range from + 10 deg near 8-deg angle of attack to − 10 deg near 24-deg angle of attack. No yaw deflection should be required at some angle of attack near 16 deg. The side-force coefficient at trim should vary from about − 0.5 at 8-deg angle of attack through − 4 between 16 and 17 deg to − 7 at 24-deg angle of attack.

With the anticipated results as a guide, the output from the new trim option can be evaluated. Trim results are shown in Figs. 7 and 8. At angles of attack of 8 deg and less, the yawing moment could not be trimmed. Yawing moments also prevented trim at angles of attack greater than 22 deg. The control deflections at trim, shown in Fig. 7, are within the ranges anticipated. Pitch deflection is 0 just above 14-deg angle of attack, and 0 yaw deflection is required near 16-deg angle of attack. Roll trim required deflections of less than 1 deg and was not a limiting factor in the calculations.

The force coefficients at trim, plotted in Fig. 8, also follow the trends predicted from the input data. The normal force at 14-deg angle of attack is between 2.0 and 2.5 as expected. If extended to 8-deg angle of attack, the side force line would be very near − 0.5, and at an angle of attack just over 16 deg, the side force is − 4.

The example case results match hand calculations, pilot program results, and the trends predicted from analysis of the input data very well. The same level of agreement has been demonstrated for the other check cases used during the development process. These results confirm the program is working as intended.

4.0 CONCLUSION AND RECOMMENDATIONS

A computer program has been developed to perform three-axis trim calculations using control effectiveness data. The data may be experimental or computed, and two matrix types may be used. If necessary, roll and yaw control deflection data are mirrored to trim at a given angle of attack. The program has been validated by comparison with hand calculations for check cases with a wide variety of control effectiveness characteristics. Access to the program is provided through a new option in the Aerodynamic Data Analysis Program.

The three-axis trim option provides aerodynamic analysis capability for flight vehicles which experience untrimmed rolling and yawing moments at the longitudinal trim condition. With the new capability, analysts can determine whether a vehicle has enough control authority to trim all three moments simultaneously at each point in the flight envelope. The aerodynamic coefficients at the three-axis trim condition can be used to estimate range, endurance, turning performance, and other vehicle performance parameters.

The three-axis trim program is applicable to the most common control effectiveness data matrices. However, an extension to a data matrix without separate independent variable sweeps for each equivalent deflection type should be investigated. Such an extension may be required, for example, for a missile that is allowed to roll in flight. Data with roll control deflection would probably not be obtained for that missile. The current program could not perform the pitch and yaw trim calculations without the roll control data.

Another restriction that should be removed is the requirement that each data run contain the same number of points. The program uses point number to step across the independent variable range to be consistent with other Aerodynamic Data Analysis Program options. The user-supplied independent variable increment should be used to step across the range with trim calculations based on the data available at each independent variable value. However, the option of extrapolating all data to the full range should be retained.

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1. Burden, Richard L. and Faires, J. Douglas. *Numerical Analysis*. Prindle, Weber, and Schmidt, Boston, 1985 (Third Edition).

2 Buckingham, R.A. *Numerical Methods*. Pitman and Sons, Ltd., London, 1957.

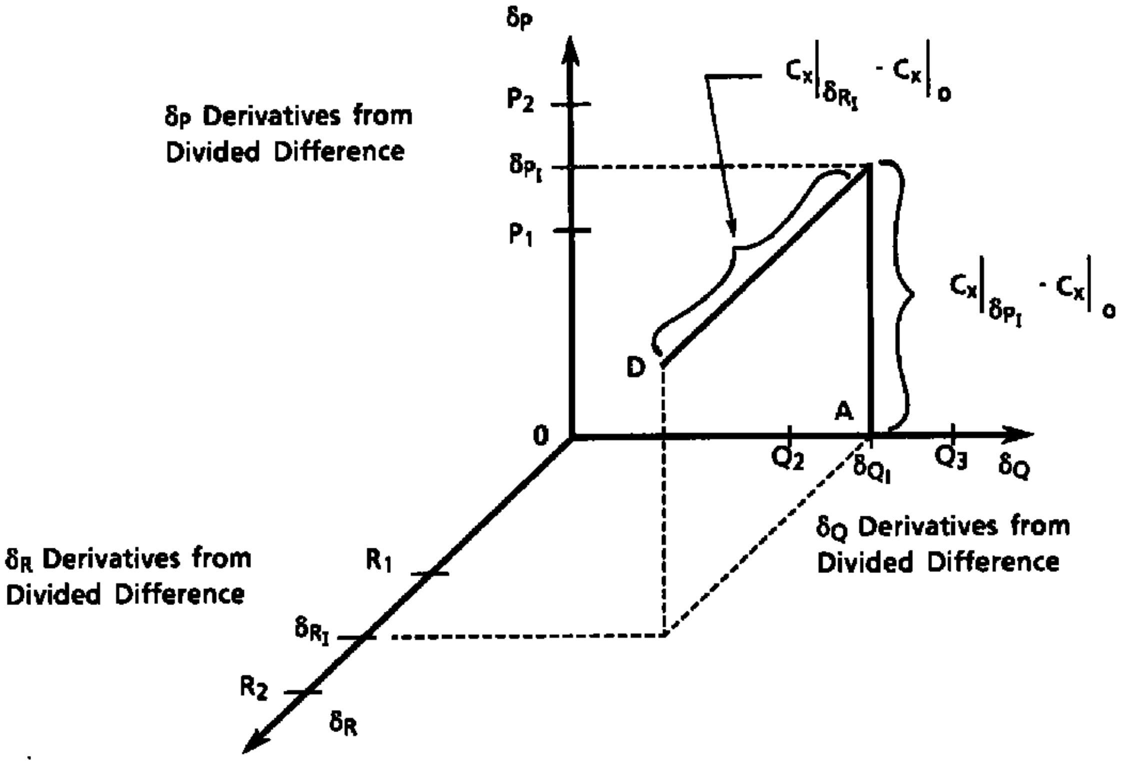
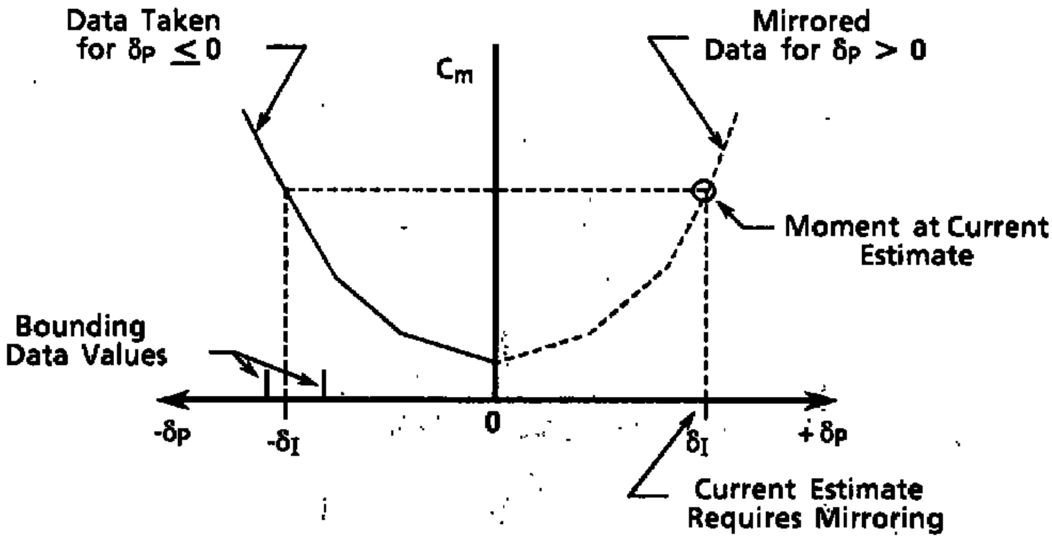
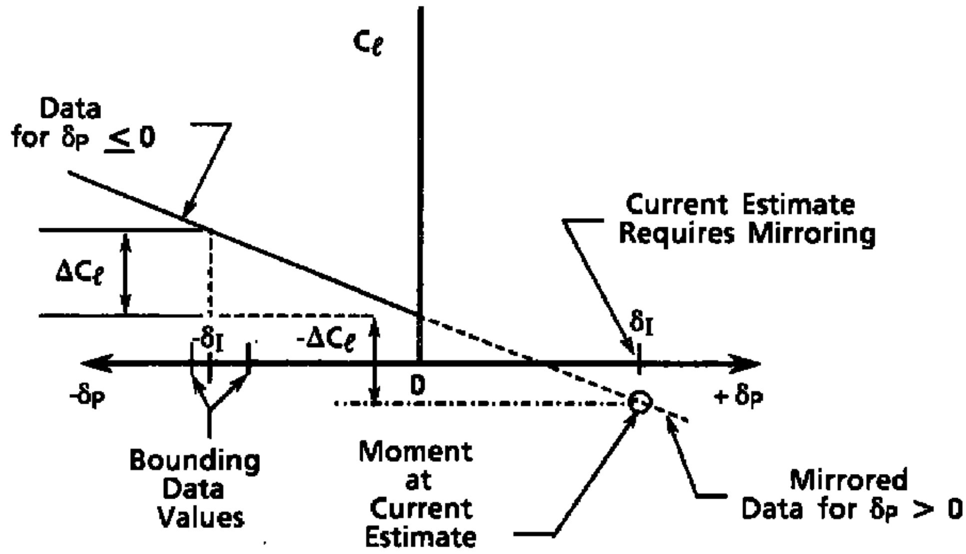


Figure 1. Determination of moments and control effectiveness from Group A data.

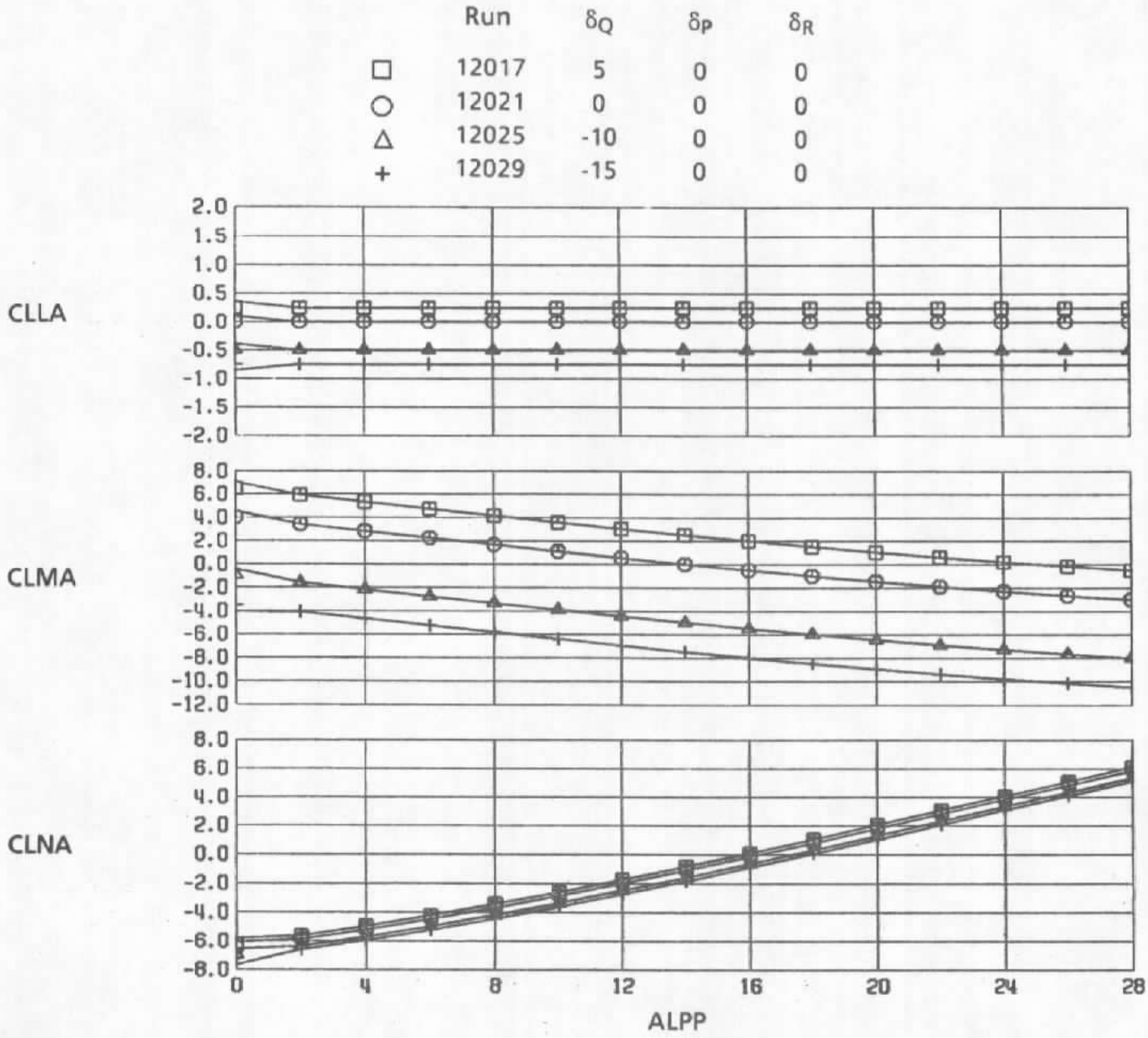


a. Moment is even function of deflection

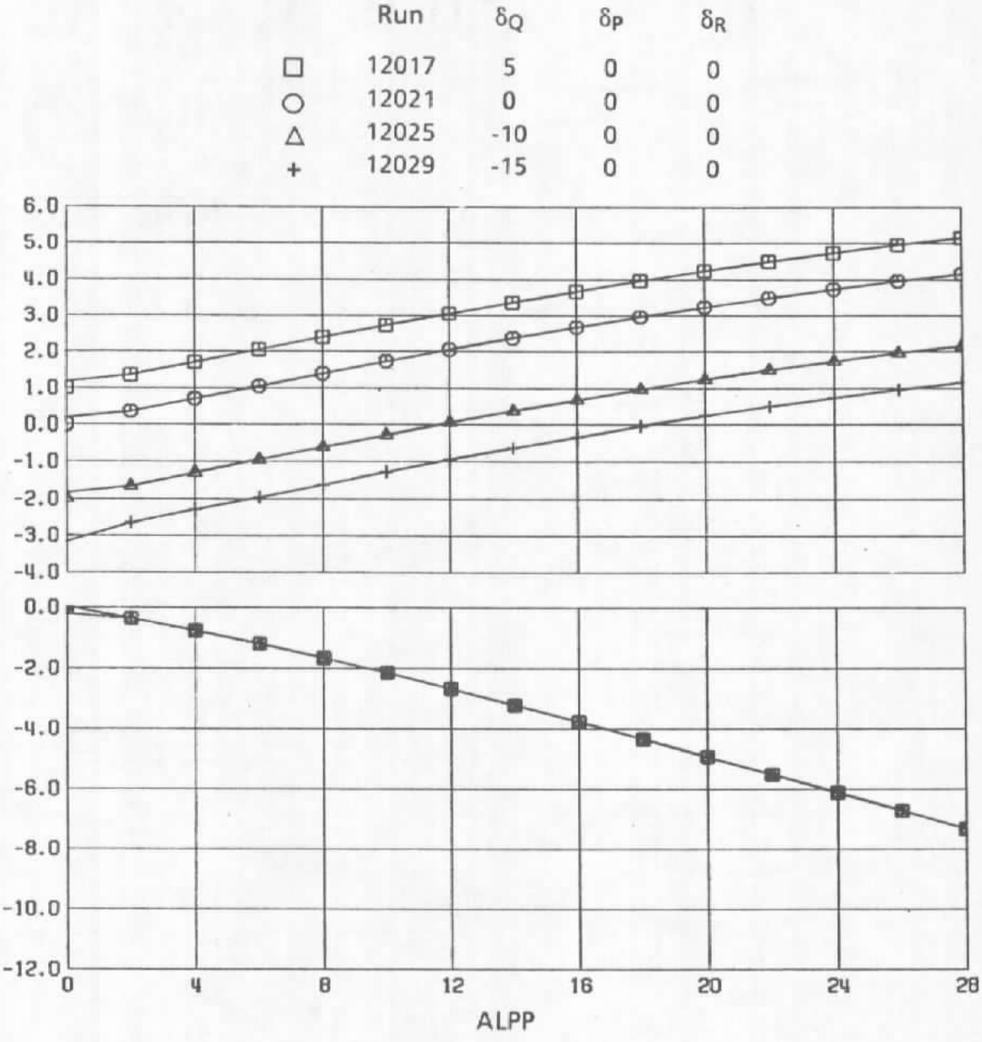


b. Moment is odd function of deflection

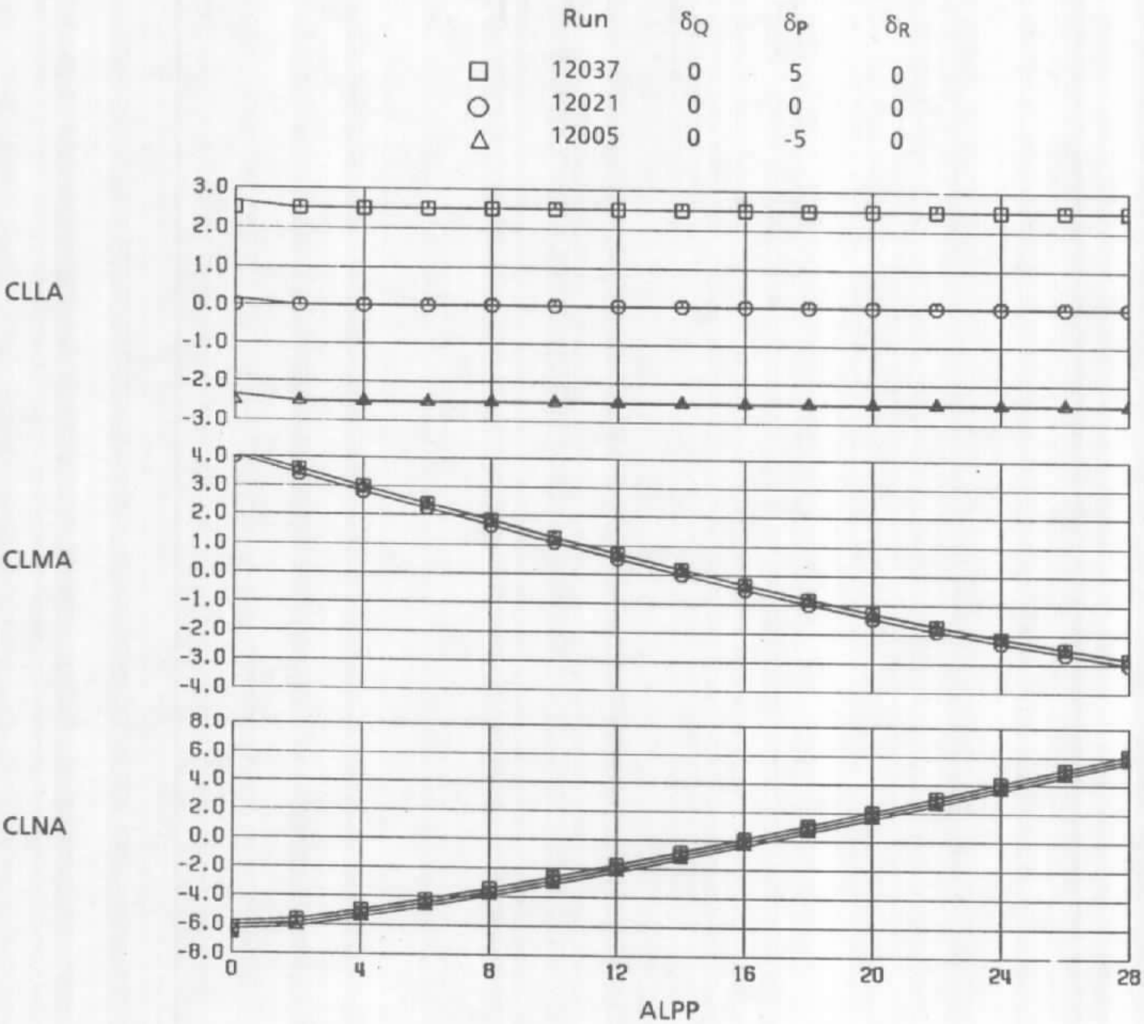
Figure 3. Mirroring of control deflection data.



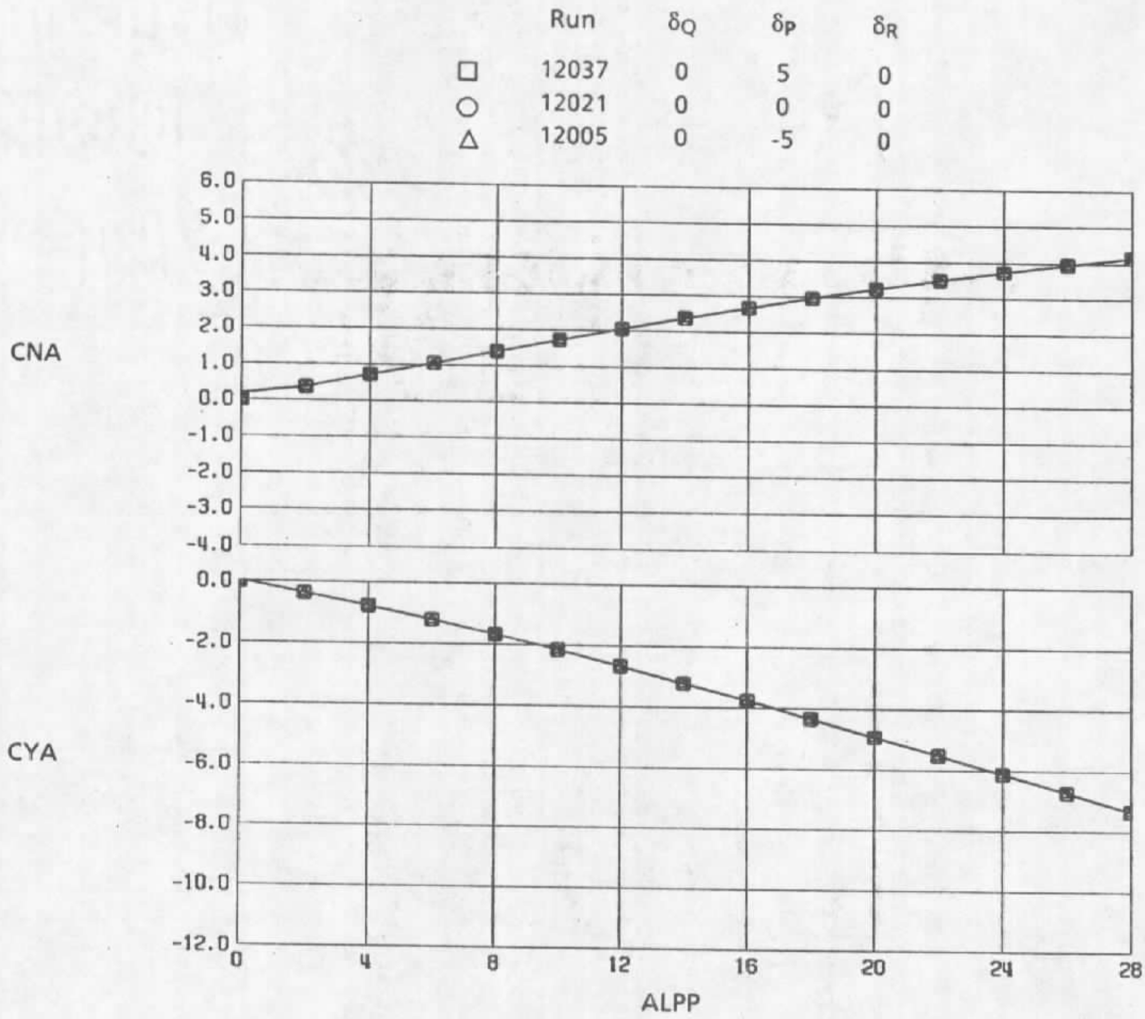
a. Moment coefficients
Figure 4. Pitch control deflection data for example case.



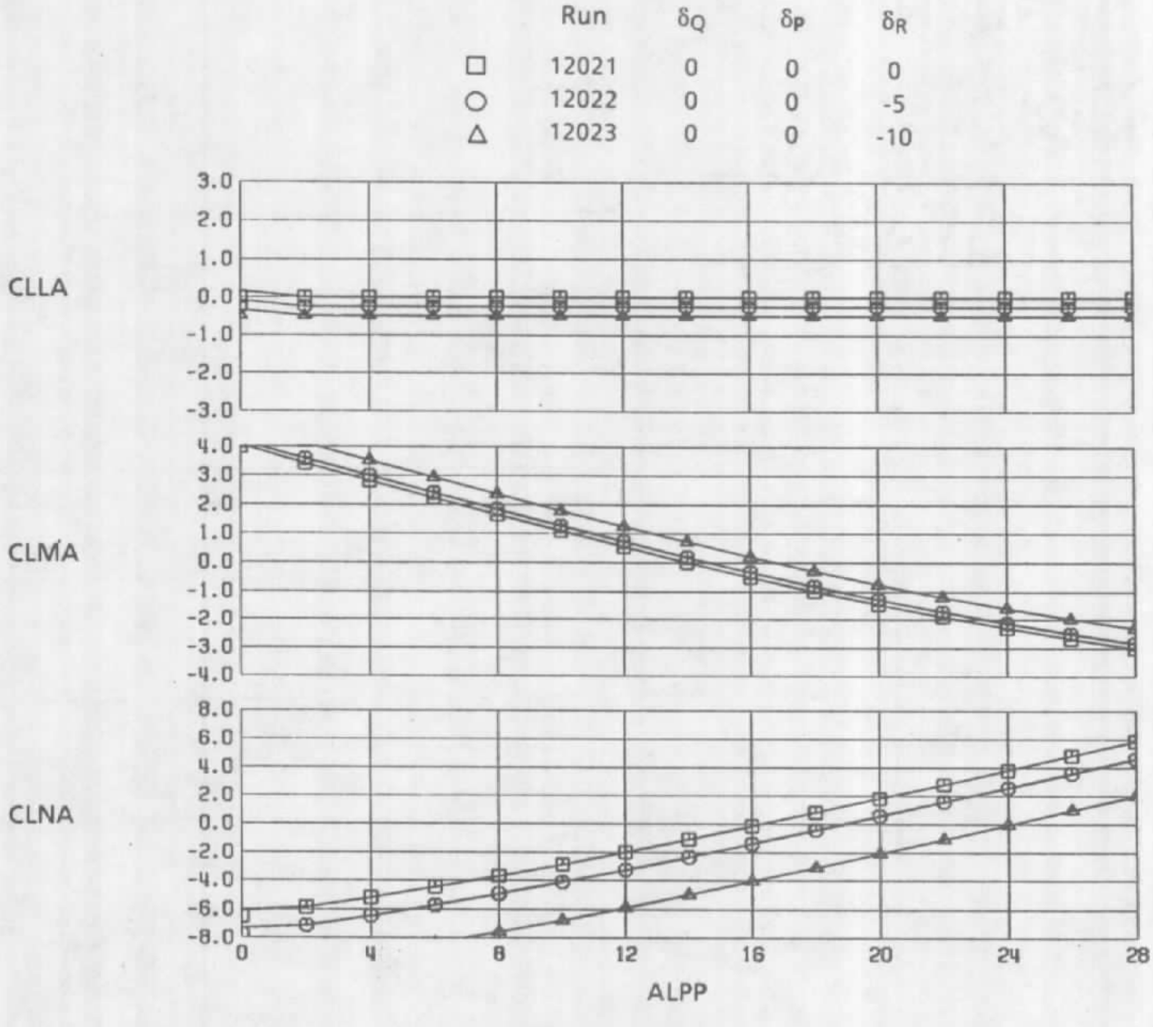
b. Force coefficients
Figure 4. Concluded.



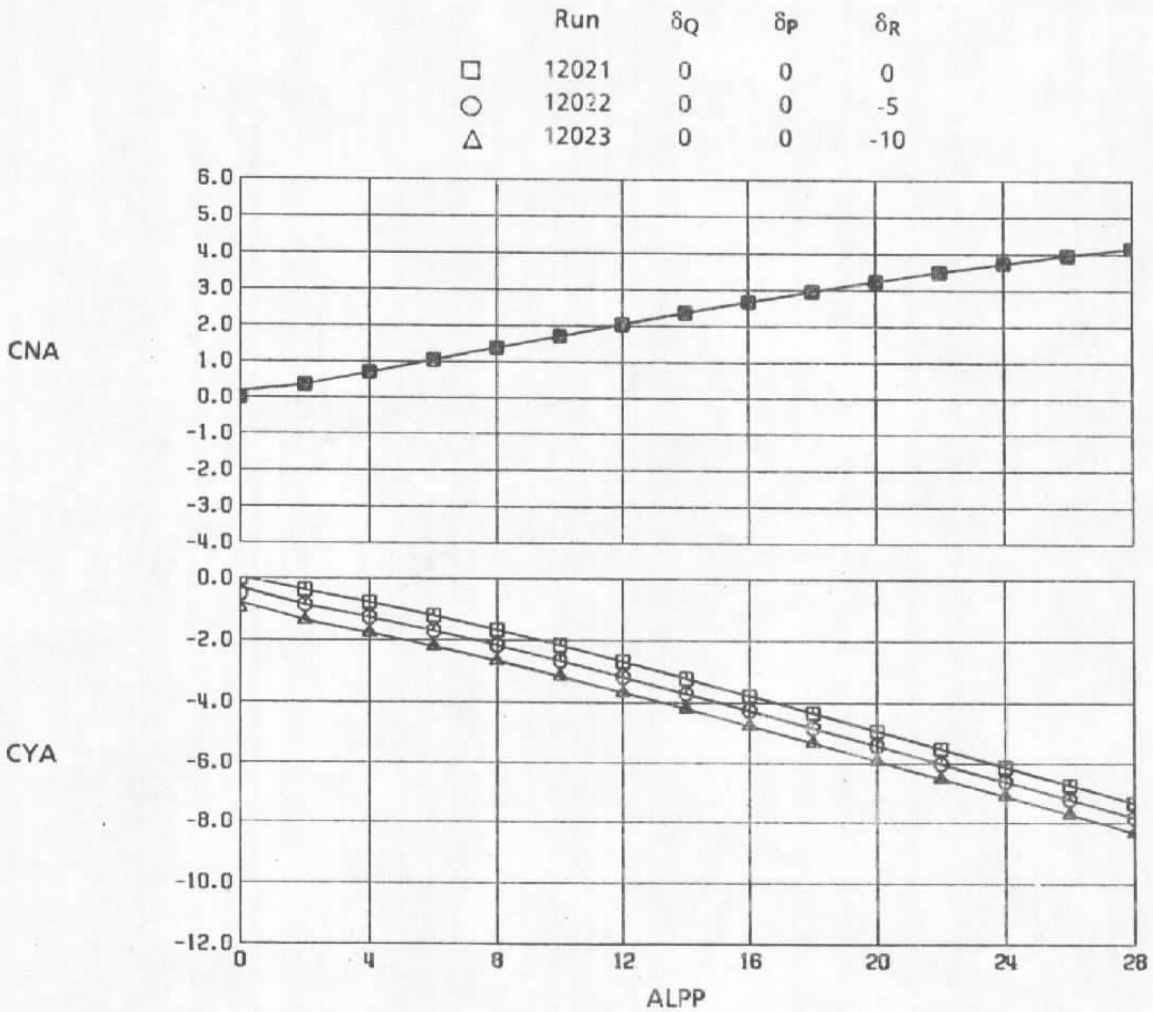
a. Moment coefficients
Figure 5. Roll control deflection data for example case.



b. Force coefficients
Figure 5. Concluded.



a. Moment coefficients
Figure 6. Yaw control deflection data for example case.



b. Force coefficients
FIgure 6. Concluded.

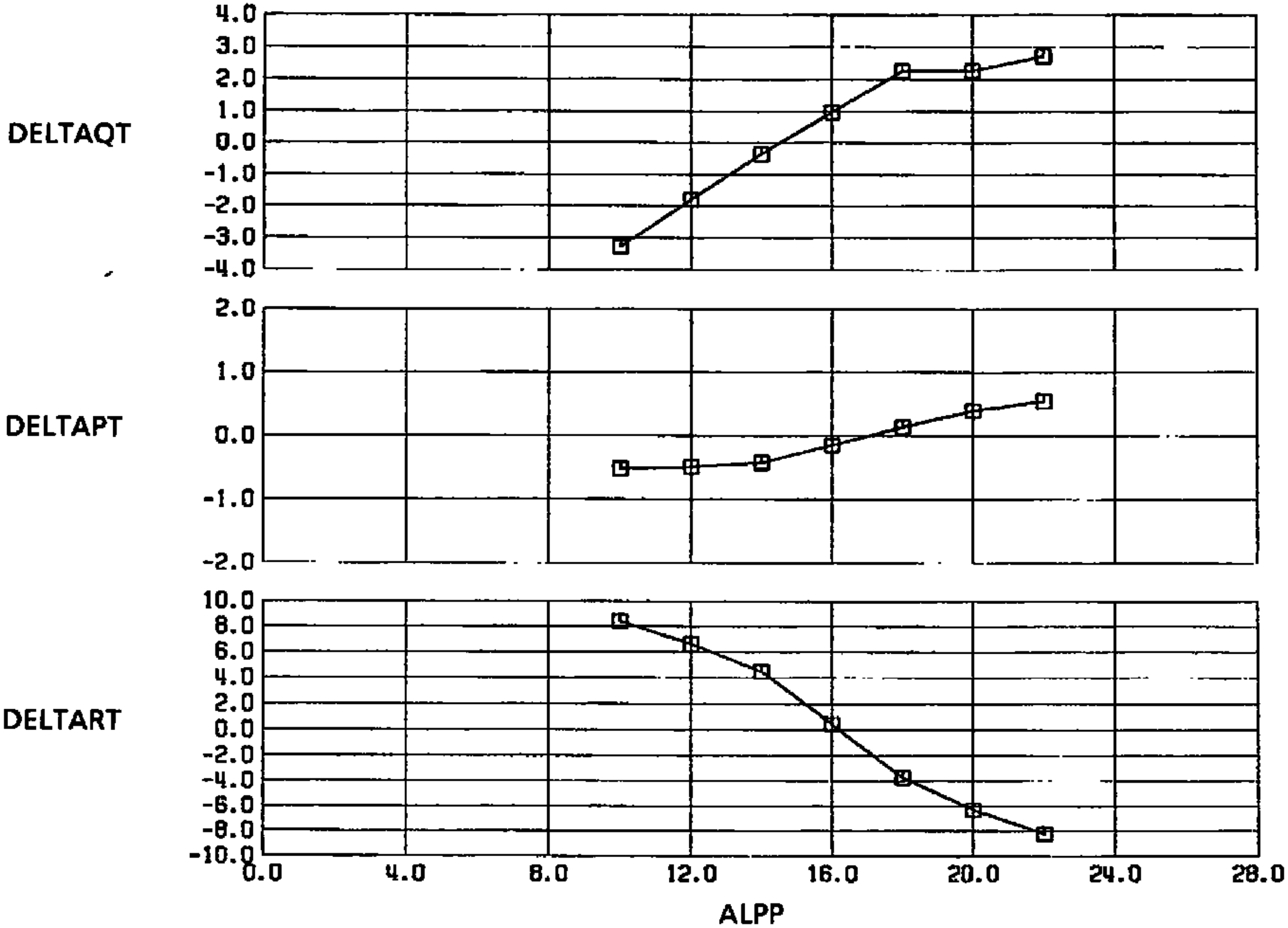


Figure 7. Deflection angles required to trim example case.

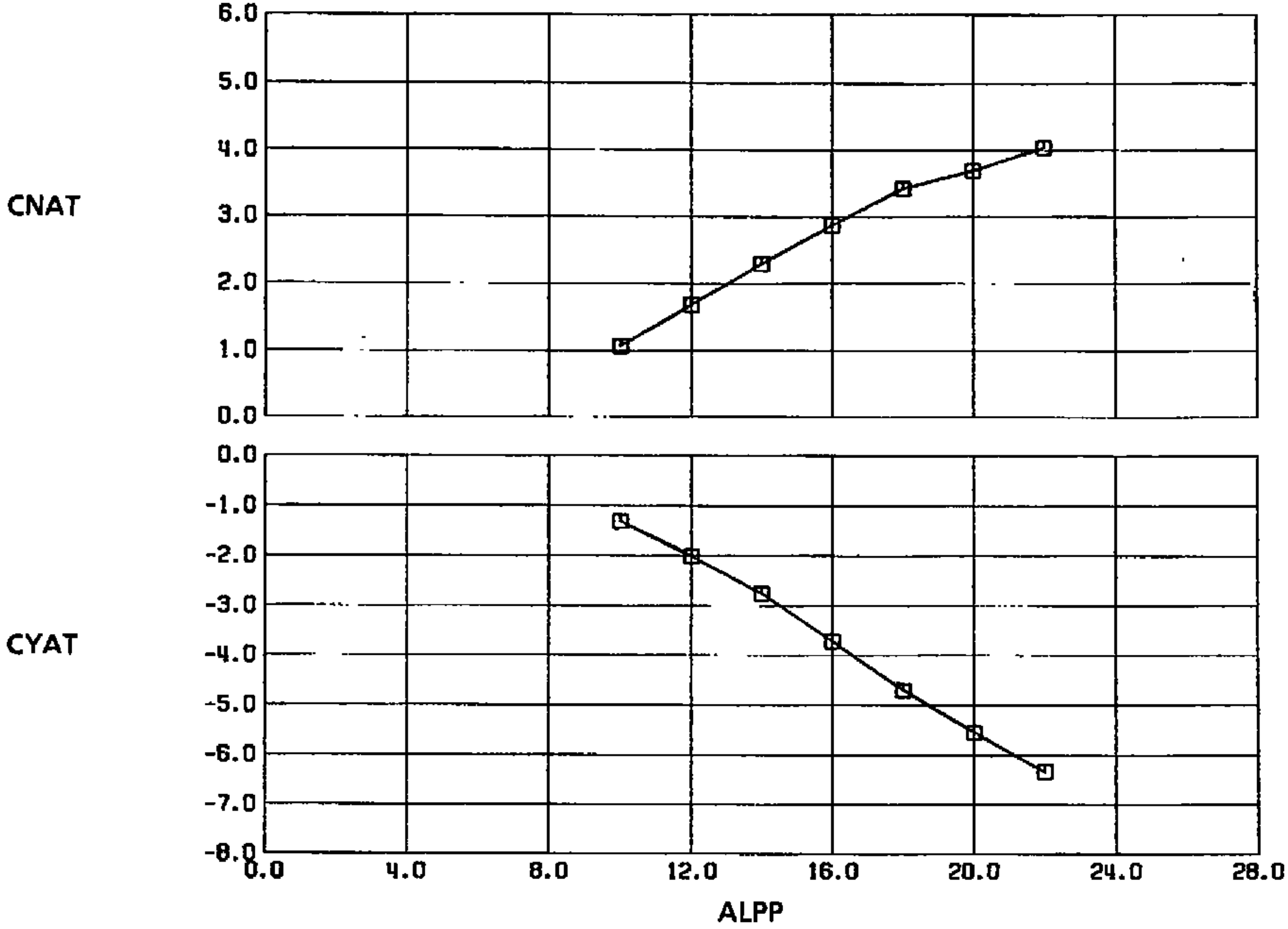


Figure 8. Force coefficients at trim for example case.

Table 1. List of Analysis Program Options

Data Option	Typical Application
1. Variable Bias Corrections	1. Correct data for model asymmetry such as bent or misaligned control surface.
2. Independent Variable Range	2. Interpolate data to even increments of the independent variable. For example, angles of attack of 0.1, 1.97, 3.95 would be interpolated/extrapolated to 0, 2, 4.
3. Center-of-Gravity Transfer	3. Correct data from different sources (i.e., current test and earlier test or prediction and experiment) to the same center-of-gravity location for direct comparison.
4. Axis Transformation	4. Transform data drom different sources to the same axis system for direct comparison.
5. Change in Reference Dimensions	5. Correct coefficients based on different reference dimensions for configuraiton synthesis (i.e., missile fin data based on root chord added to body data based on diameter) or for comparison of data from different sources.
6. Skin Friction and Base Drag Correction	6. Scale drag data from model to full-scale flight vehicle.
7. Variable Sign Change	7. Change between sign conventions for control surface deflection.
Analysis Option	**Output**
8. Determination of Stability Characteristics	8. Lift-to-drag ratio, static margin, neutral point, and a departure correlation function $(C_{n_\beta})_{dynamic}$.
9. Determination of Control Effectiveness	9. Divided difference approximations to the partial derivative of each aerodynamic coefficient with respect to each control surface deflection.
10. Single-Axis Trim	10. The values of trim deflection for each independent variable value where trim is possible and the values of any other parameter at trim. Typically, the two untrimmed moments and the force coefficients are requested for output.

Table 2. Generalized Group A Data Matrix

Pitch Deflection	Roll Deflection	Yaw Deflection
0	0	0
Q_1	0	0
Q_2	0	0
.	.	.
.	.	.
.	.	.
Q_n	0	0
----	----	----
0	P_1	0
0	P_2	0
.	.	.
.	.	.
.	.	.
0	P_m	0
----	----	----
0	0	R_1
0	0	R_2
.	.	.
.	.	.
.	.	.
0	0	R_i

Table 3. Generalized Group B Data Matrix

Pitch Deflection	Roll Deflection	Yaw Deflection	
Q_1	P_1	0	
Q_1	P_2	0	
.	.	.	
.	.	.	
.	.	.	
Q_1	P_n	0	Roll Deflection
Q_2	P_1	0	at Fixed Pitch
Q_2	P_2	0	Deflection
.	.	.	
.	.	.	
.	.	.	
Q_2	P_n	0	
.	.	.	
.	.	.	
.	.	.	
Q_m	P_n	0	
Q_1	0	R_1	
Q_1	0	R_2	
.	.	.	
.	.	.	
.	.	.	
Q_1	0	R_i	
Q_2	0	R_1	Yaw Deflection
Q_2	0	R_2	at Fixed Pitch
.	.	.	Deflection
.	.	.	
.	.	.	
Q_2	0	R_i	
.	.	.	
.	.	.	
.	.	.	
Q_m	0	R_i	

Table 4. Comparison of $\sqrt{(\delta_R - \delta_{R_{trim}})^2}$ and $\sqrt{\delta^2_R - \delta^2_{R_{trim}}}$ for a Typical Iteration

Iteration	C_m	$\sqrt{[\delta_R - \delta_{R_{trim}})^2}$	$\sqrt{\delta^2_R - \delta^2_{R_{trim}}}$
0	1.791	6.61	*
1	0.127	0.78	3.30
2	−0.084	0.23	1.75
3	−0.051	0.053	0.839
4	−0.020	0.0013	0.1299
5	−0.006	0.004	*
6	−0.002	0	0

* Term under the radical is negative.

APPENDIX A
PROGRAM USER'S GUIDE

This appendix provides an example of a typical session with the prompting program that creates files required as input by the three-axis trim option. The prompting program is a modified version of the program used with the original Aerodynamic Data Analysis Program. Before initiating a session with the prompting program, the user should establish TEKPLOT (TEKPLOT is an AEDC plotting software package based on the PLOT10® graphics language) files for aerodynamic data input and output. (The output file is optional.) The menu of these files may be of arbitrary length up to 300 variables. A copy of the input file menu should be available during the prompting session because the program prompts for variable names from the menu. The menu of the input file used for the example session is shown in Table B-1. The output TEKPLOT file menu must contain a variable name for each parameter of interest at trim conditions with a "T" appended to the end of the original variable name. For example, body axis normal force is stored as CN in the example input file. If CN at trim is to be written to an output TEKPLOT file, then the output file menu must include a variable "CNT".

The number of prompts generated by the program depends on the combination of data manipulation options requested by the user. The example described in this appendix shows only the prompts for Options 2 and 11 (the minimum number of options for three-axis trim).

STARTING A PROMPT SESSION

Log on to the Amdahl 5860 and issue the following command:

EX 'C60126.DATAPROG.CLIST'

The program responds with a prompt to determine whether the session is classified or unclassified. At the next prompt the user has the option of editing the responses from a previous session or continuing with entry of a new set of inputs. The example session demonstrates the entry of a new set of inputs. The axis system of the input data is requested next. Body, aeroballistic, wind, and stability axis systems are available. These four axis systems are defined in Figs. A-1 through A-4. The program next prompts for the variable names of angle of attack and sideslip on the input TEKPLOT file.

OPTIONS SELECTION

A list of the 11 options available through the analysis program is presented next. (See Table 1 for a brief explanation of the ten original options.) Option 11 is the three-axis trim option. Any combination of Options 1 through 7 may be used to manipulate the data before trim calculations begin. The results from the data manipulation options will be printed before output from the analysis option. Option 2 should always be performed so that the data will have exactly the same values of the independent variable. In the example session the four prompts following the selection of Options 2 and 11 relate to Option 2.

INDEPENDENT VARIABLE RANGE

The tolerance requested for testing the independent variable range is used to determine whether angle of attack or sideslip is the independent variable of the input data. The differences between three consecutive data values of both angle of attack and sideslip are compared to the tolerance value. The variable which has differences larger than the tolerance is used as the independent variable.

The ranges of angle of attack and sideslip desired for trim calculations are entered as minimum value, maximum value, and a step size to use between the extremes. Trim calculations are performed at each step in the range. The range and step size for the independent variable must not result in more than 100 steps between the minimum and maximum. If data are not available over the entire independent variable range, then linear extrapolation can be used to extend the range of the data. Each input run must have a data point at every step in the range when the three-axis trim option is used. An example of data that would require careful selection of the independent variable range and some options for its use is presented in Fig. A-5. The degree of extrapolation can be restricted by the response to the next prompt.

THREE-AXIS TRIM

The next set of prompts interrogates the user for information required by the three-axis trim option. A tolerance is required for each moment coefficient as a stopping condition for the iteration. Specific values of the tolerances cannot be recommended because of the wide variety of moment values for different flight vehicles. However, the following technique, based on vehicle geometry, should give a reasonable upper limit for the tolerances.

$$C_m \text{ Tolerance} = \left| \frac{(XHL - XMR)}{S*d} * S_t \left(\frac{dC_N}{d\delta}\right)(\epsilon) \right|$$

where XHL = Distance from the vehicle nose to control surface hinge line

XMR = Distance from the vehicle nose to the moment reference point

S_t = Planform area of the control surface

S = Reference area

d = Reference length

$(dC_N/d\delta)$ = Change in normal force with respect to control deflection

ϵ = Maximum allowable error in trim deflection angles (actual trim value — calculated trim value)

The same equation with appropriate substitutions will give rolling- and yawing-moment tolerances. The numbers used in the equation do not have to be very precise because the order of magnitude of the result will be used to select the final tolerance values. The tolerances resulting from these calculations should be tested by running one set of data twice — once with the tolerances from the equation and again with tolerances one or more orders of magnitude smaller than the first case. If the trim deflections from the two cases differ by more than ϵ, then the larger tolerance is too large. Reduce the tolerances until the calculated trim deflections change by less than ϵ between cases. The tolerance determination should only be required once for a given vehicle.

The largest value of tolerance consistent with required accuracy should be used to reduce the number of iterations required for a solution. The number of iterations is limited to 20 at each independent variable value. If any of the three moments is not required to be trimmed, then a very large value of the tolerance for that moment should be used.

VARIABLE NAMES

After tolerances are entered, the prompting program asks for the variable names of the force and moment coefficients of the input TEKPLOT file. The responses should be consistent with the "axis of original data" chosen earlier.

Test condition variable names entered at the next prompt identify parameters that are constant and are not calculated at the trim condition. These names will not have the "T" appended to the name in the print of final trim results.

LOAD FACTOR

The load factor option is not demonstrated here. If the load factor at the trim conditions is required, the vehicle weight and the desired altitudes must be input.

DATA INPUT

The next prompt is for the variable names on the input TEKPLOT file of equivalent pitch, roll, and yaw control deflections. All three deflection types are required for three-axis trim. (A missing deflection causes Newton's method to fail because of the singular control effectiveness matrix.) The names may be entered in any order because the next prompts ask the user to specify the deflection type for each variable name. The user is then prompted for run numbers for each equivalent deflection from Group A data (See Section 3.1). Each run on a line represents a different value of the deflection. The deflection values should decrease from left to right on a line of run numbers. Each line of runs represents a different test condition (i.e., Mach number, roll angle, configuration, etc.).

The next two prompts request Group B data (See Section 3.1). These runs are entered with constant pitch deflection and decreasing roll or yaw deflection on each line. In the example, two roll and yaw deflections were available at four values of pitch deflection. On each line the runs are ordered with maximum roll or yaw deflection first and minimum deflection last. The lines are ordered with the maximum pitch deflection as the first line and minimum pitch deflection as the last line. If Group B data are not available, enter a RETURN after each of the "FIXED DELTAQ" prompts.

TYPE OF OUTPUT

The user may choose output to a TEKPLOT file only, printer only, or both. If TEKPLOT output is required, the output file must be created before the batch job to perform the trim calculations is submitted. Printed output is identified by the response to the prompt for a title. The original TEKPLOT file is the file to be searched for the input run numbers, and the new TEKPLOT file will receive the output.

VARIABLE NAMES FOR OUTPUT

The variables specified here will be printed upon completion of all the selected data manipulation options (1 through 7) and again after the trim calculations are completed. The first print shows the results of all the data manipulation for each run entered. The second print gives the value of each variable at the trim deflections for each independent variable value where trim was accomplished. Any variable in this list that was not in the Test Condition Variables list will have a "T" appended to the original name in the second print. If TEKPLOT output was requested, the variable with "T" added must have a corresponding variable name in the output TEKPLOT menu.

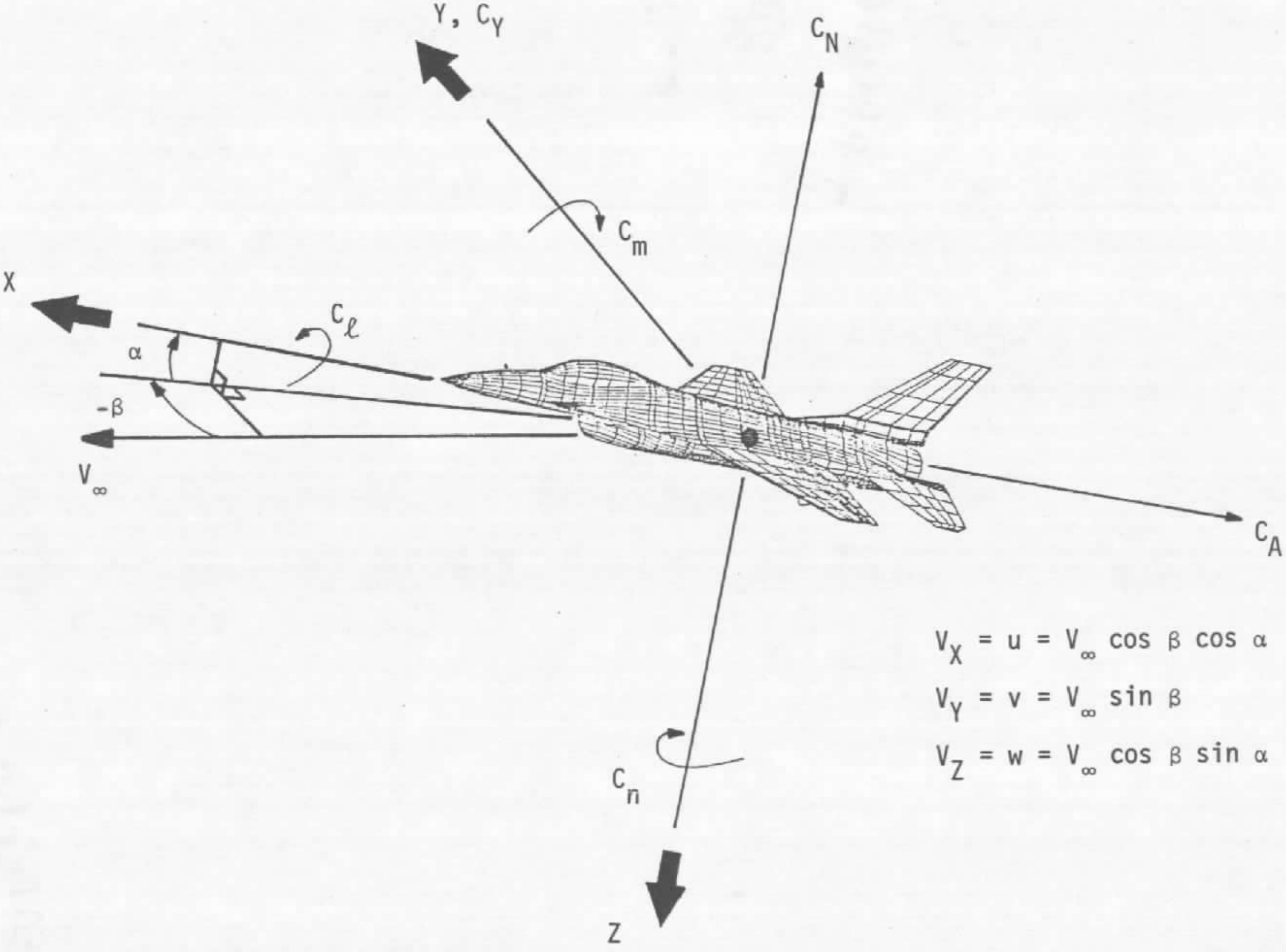
EDITING AND JOB CONTROL LANGUAGE

The program provides opportunity to correct any mistakes by going through the editing option. The remaining prompts provide information for building a Job Card for an Amdahl batch job. See the Amdahl User's Guide for an explanation of the information requested.

Upon completion of the prompting session, four files should appear in the user's catalogue of disk files. The file names are:

userid.TEKJCL.CNTL
userid.FILEINFO.DATA
userid.RUNNAMES.DATA
userid.OPTIONS.DATA

To check for these files, issue the command LISTC in TSO or in SPF option (3.4) and look at the files which begin with "userid". To execute the three-axis trim job, submit the TEKJCL file.



$$V_X = u = V_\infty \cos \beta \cos \alpha$$

$$V_Y = v = V_\infty \sin \beta$$

$$V_Z = w = V_\infty \cos \beta \sin \alpha$$

Figure A-1. Definition of body axis system.

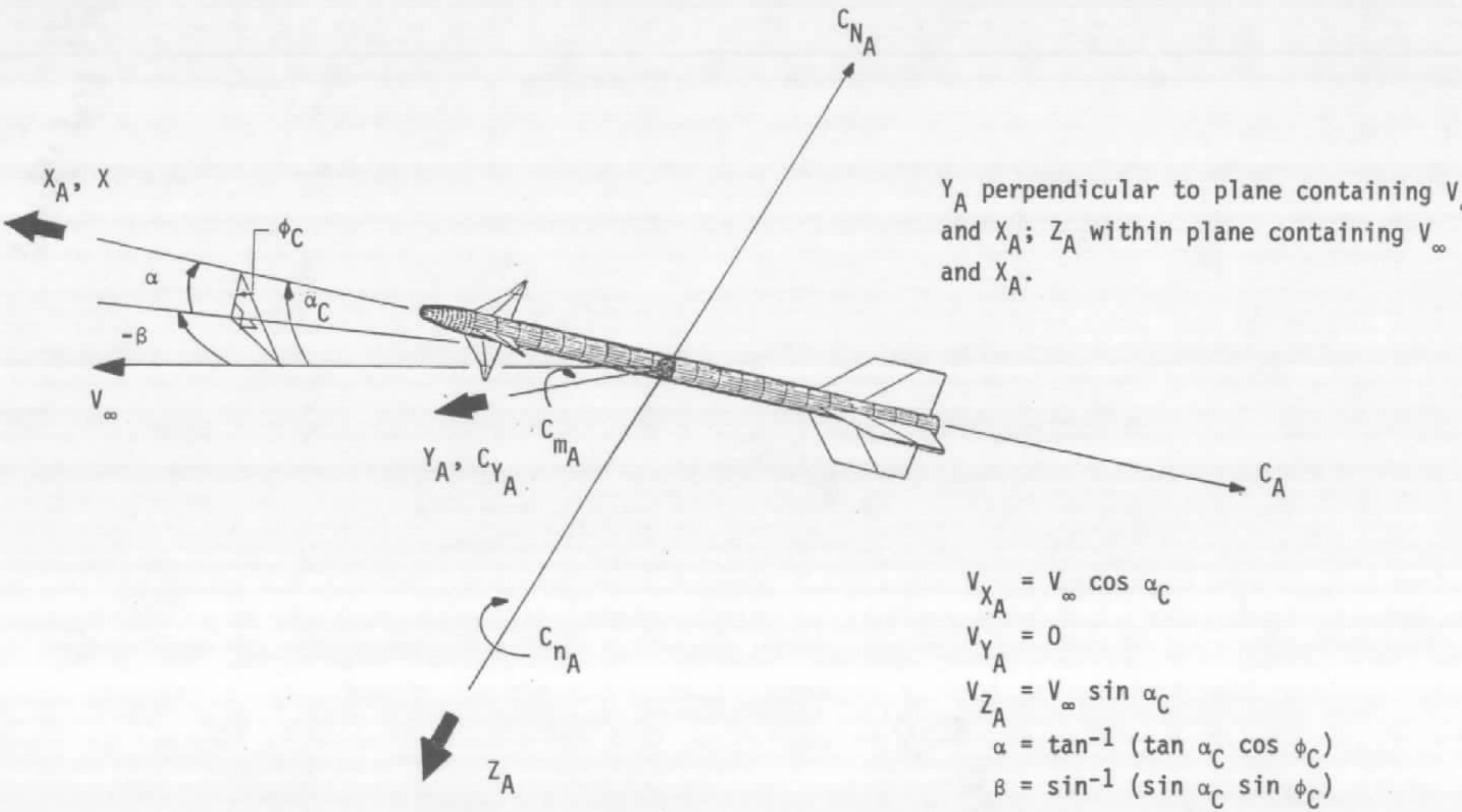


Figure A-2. Definition of aeroballistic axis system.

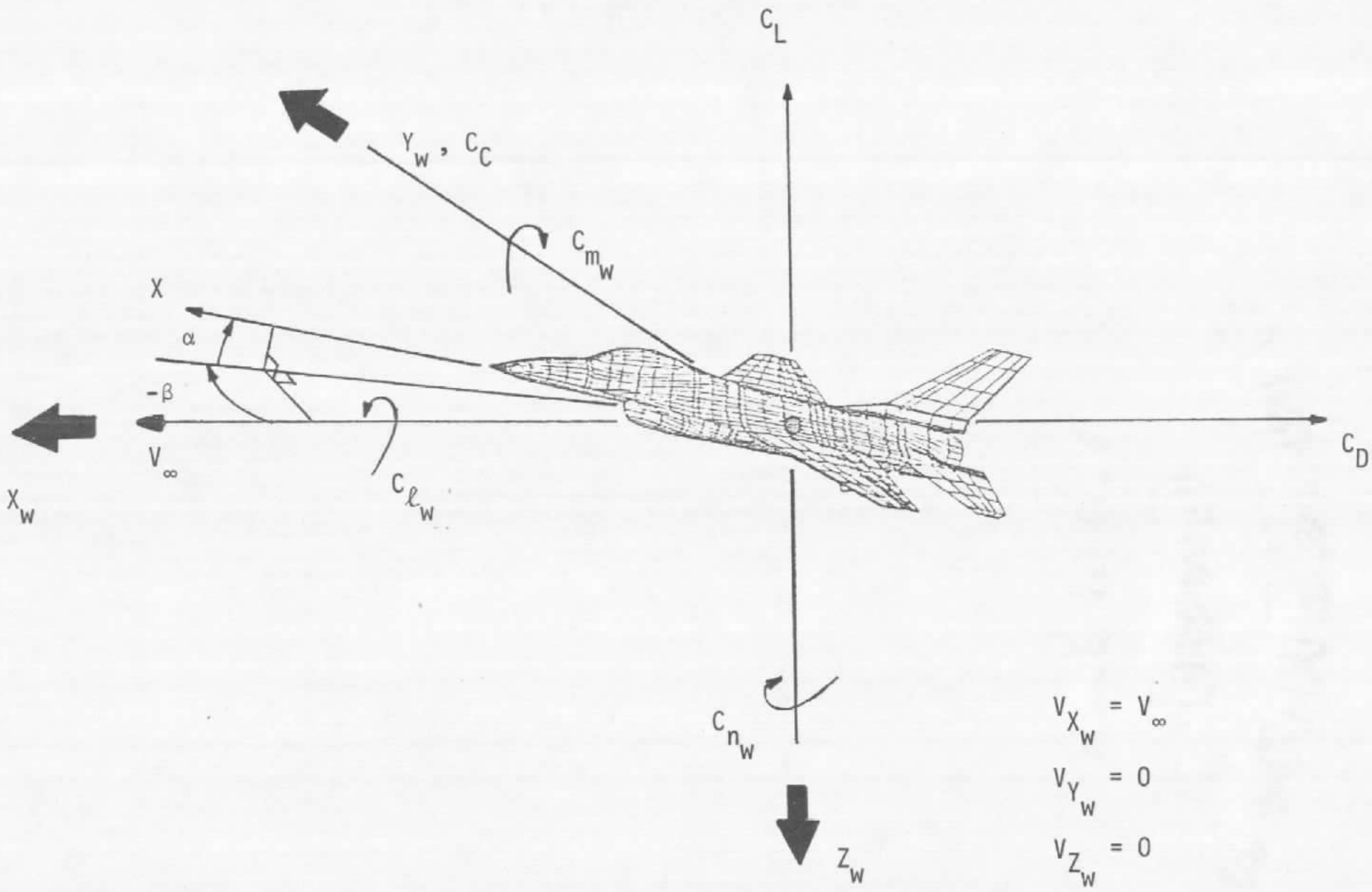


Figure A-3. Definition of wind axis system.

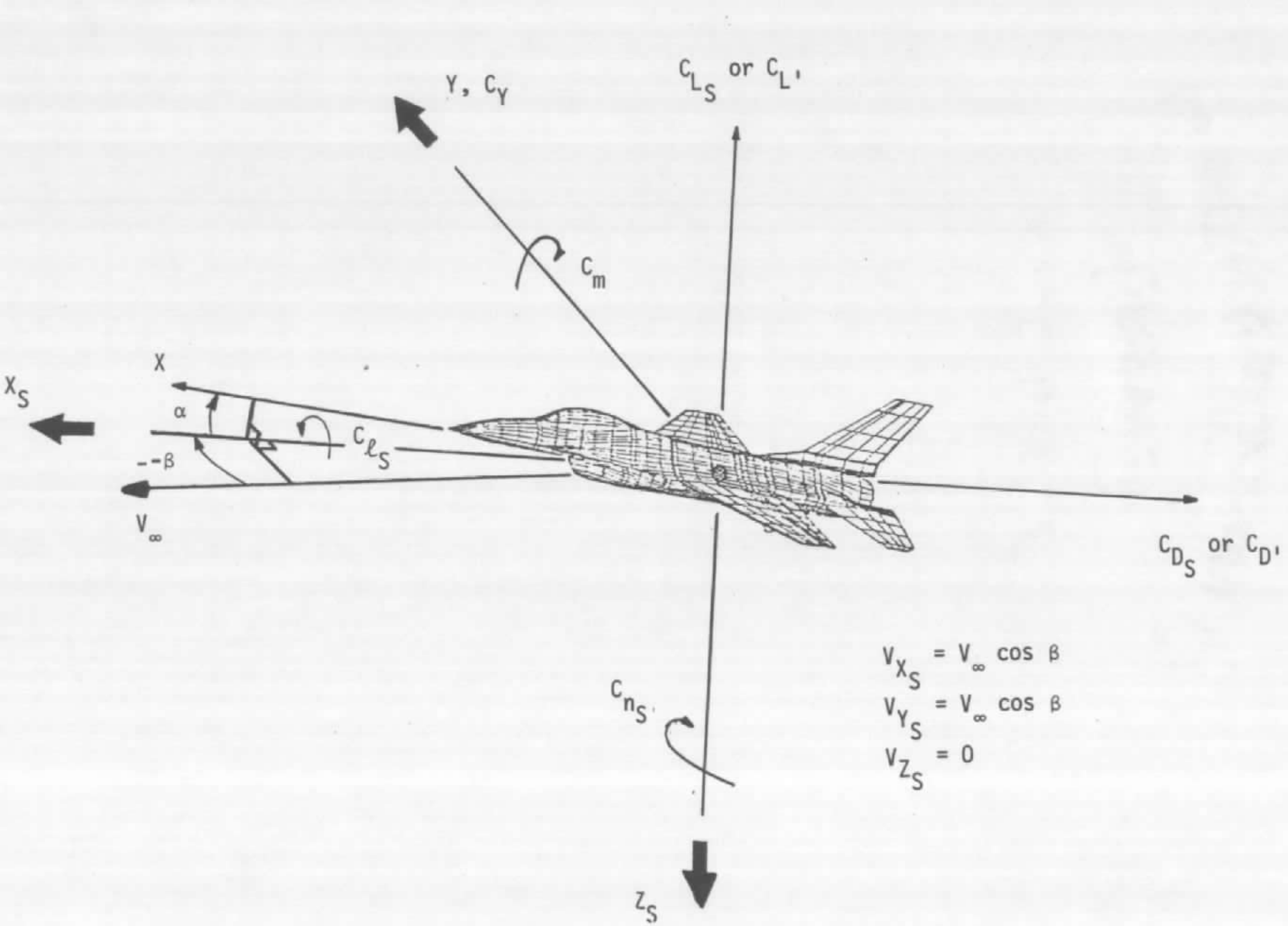
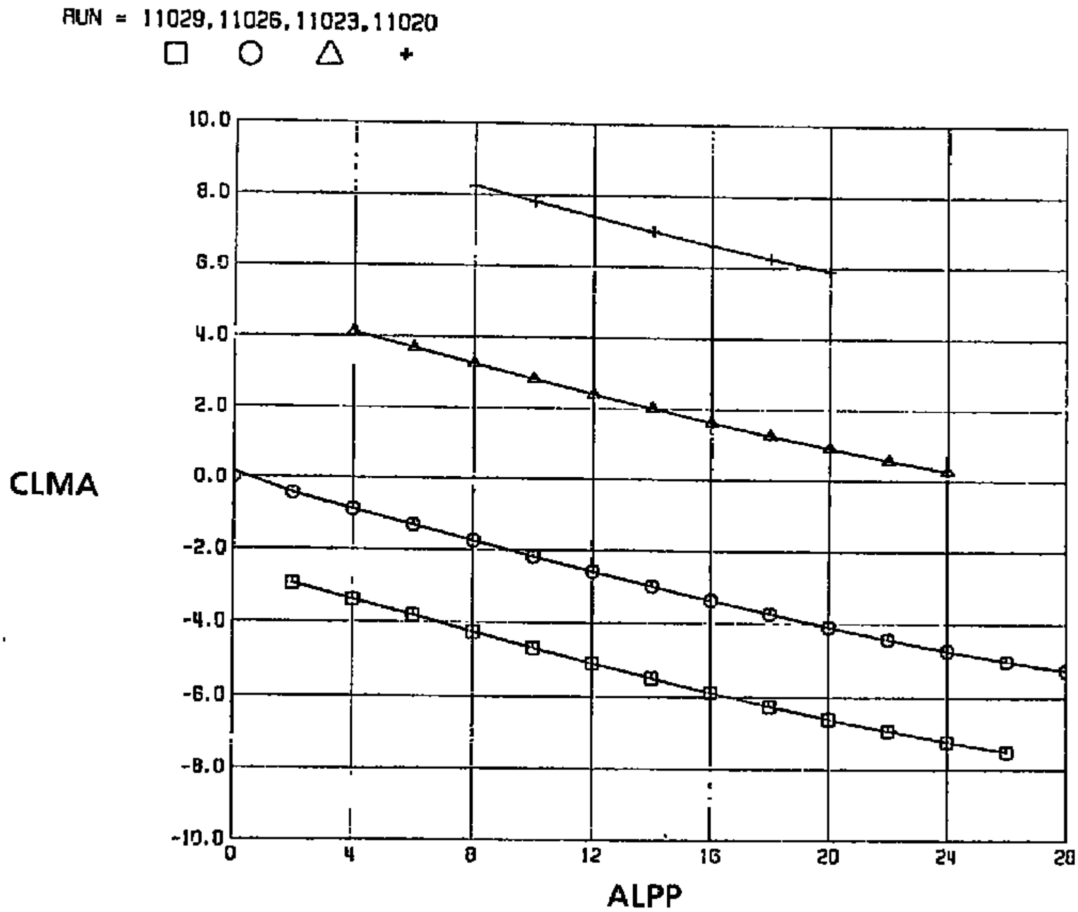


Figure A-4. Definition of stability axis system.

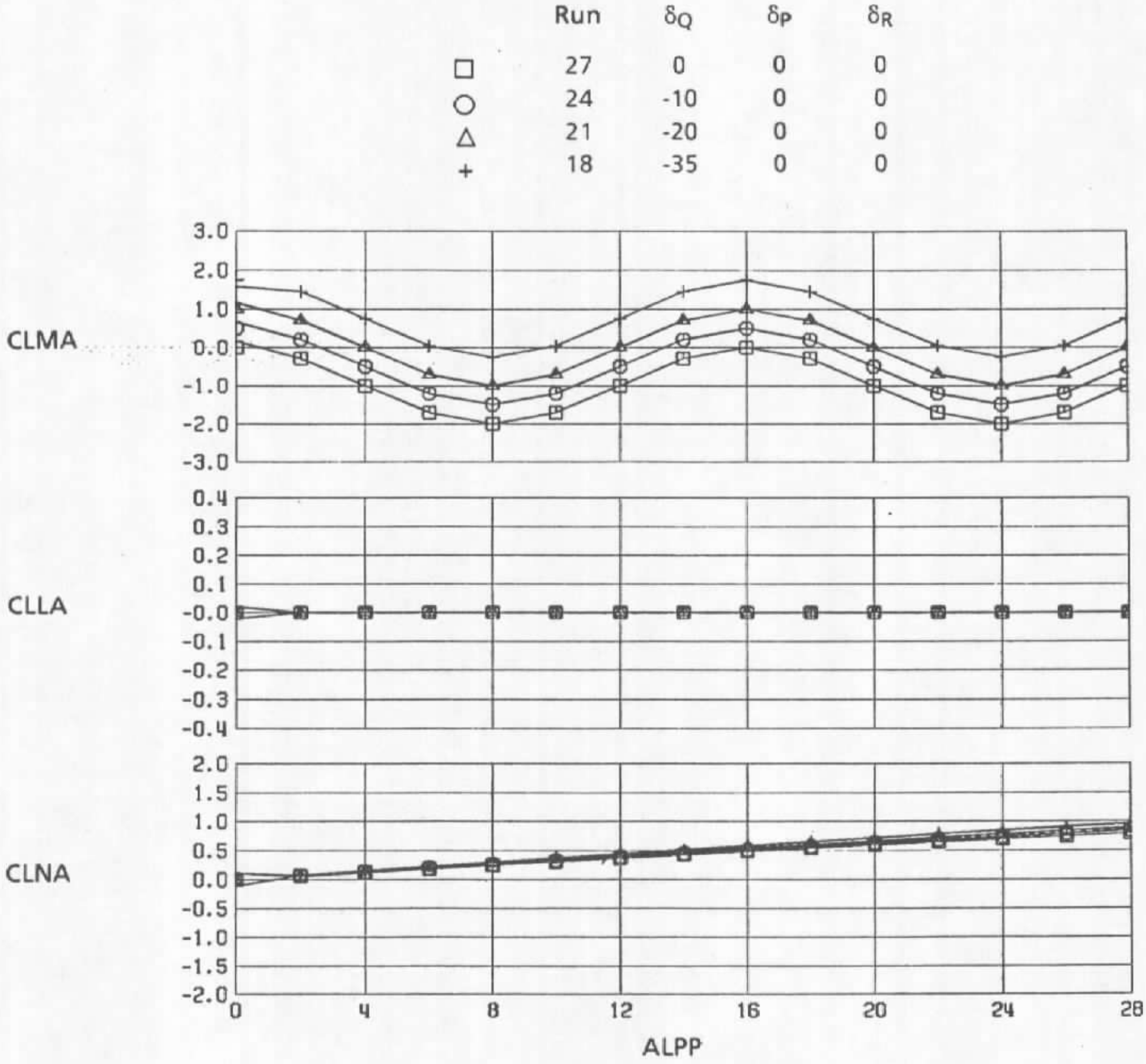


OPTIONS

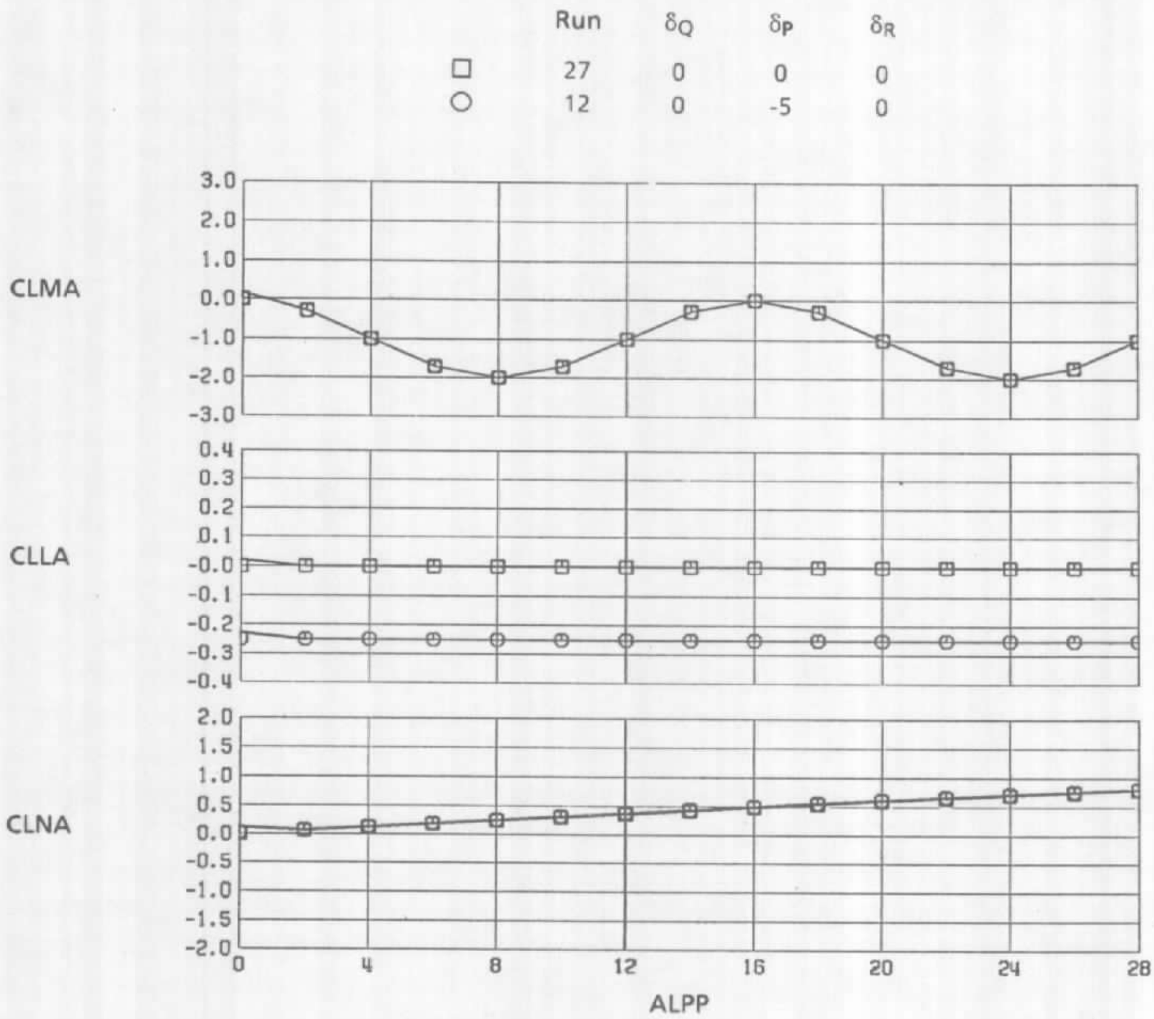
1. Extrapolate all runs to desired ALPP range.
2. Use 8 deg to 20 deg as ALPP range.
3. Exclude run 11020 and use 4 deg to 24 deg as ALPP range without extrapolating.
4. Exclude runs 11020 and 11023 and use 2 deg to 26 deg as ALPP range without extrapolation.

Figure A-5. Options for variable number of points.

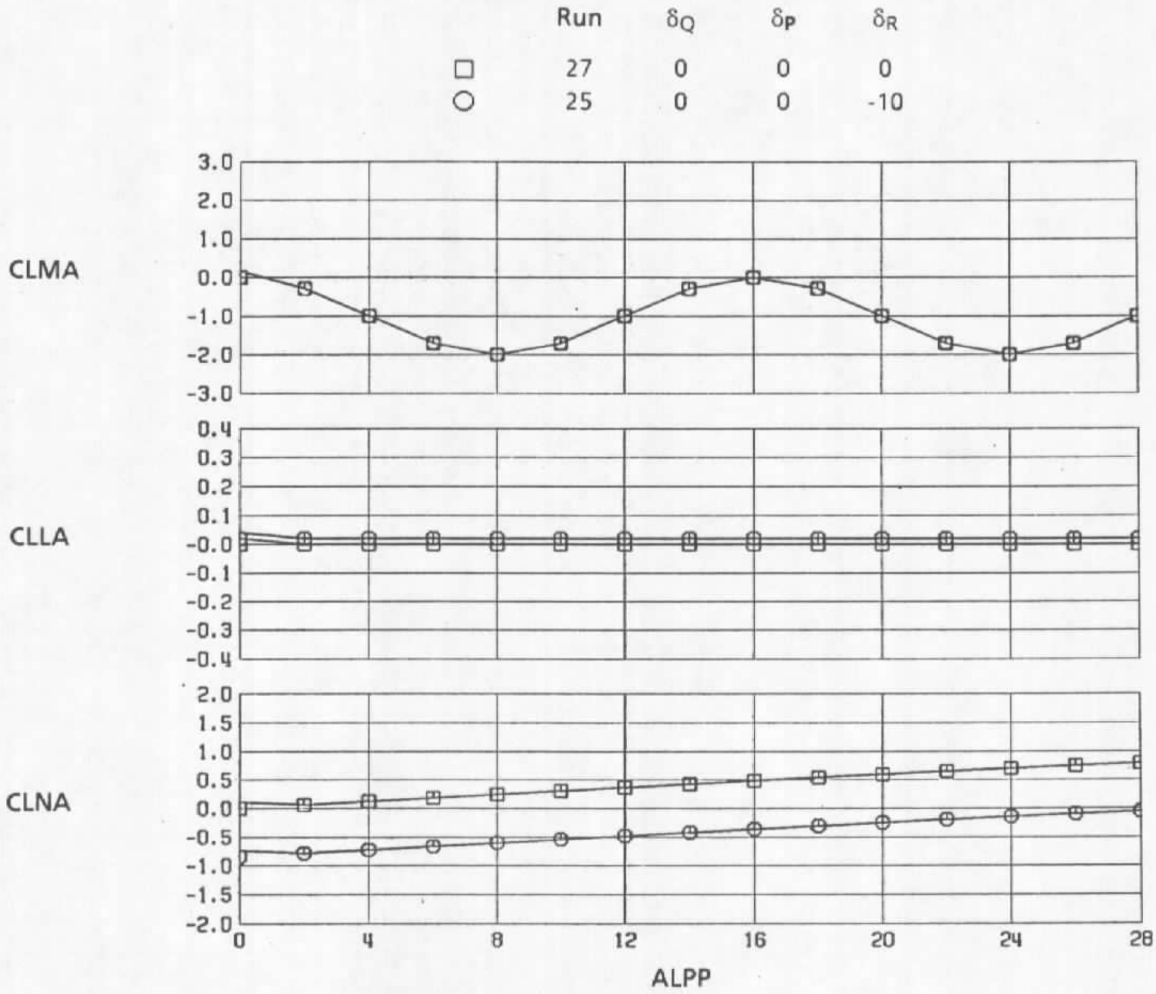
APPENDIX B
EXAMPLE DATA AND PROMPTING SESSION



a. Pitch deflection data
Figure B-1. Group A data for example case.

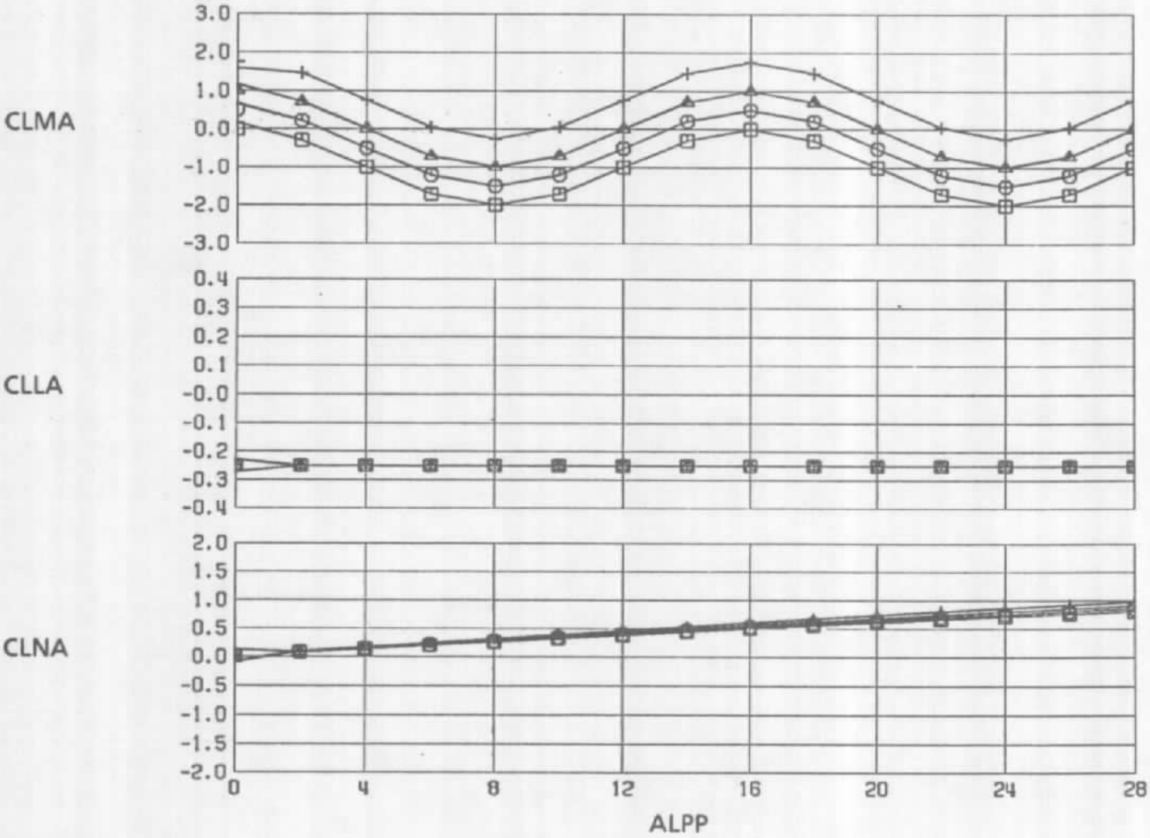


b. Roll deflection
Figure B-1. Continued.

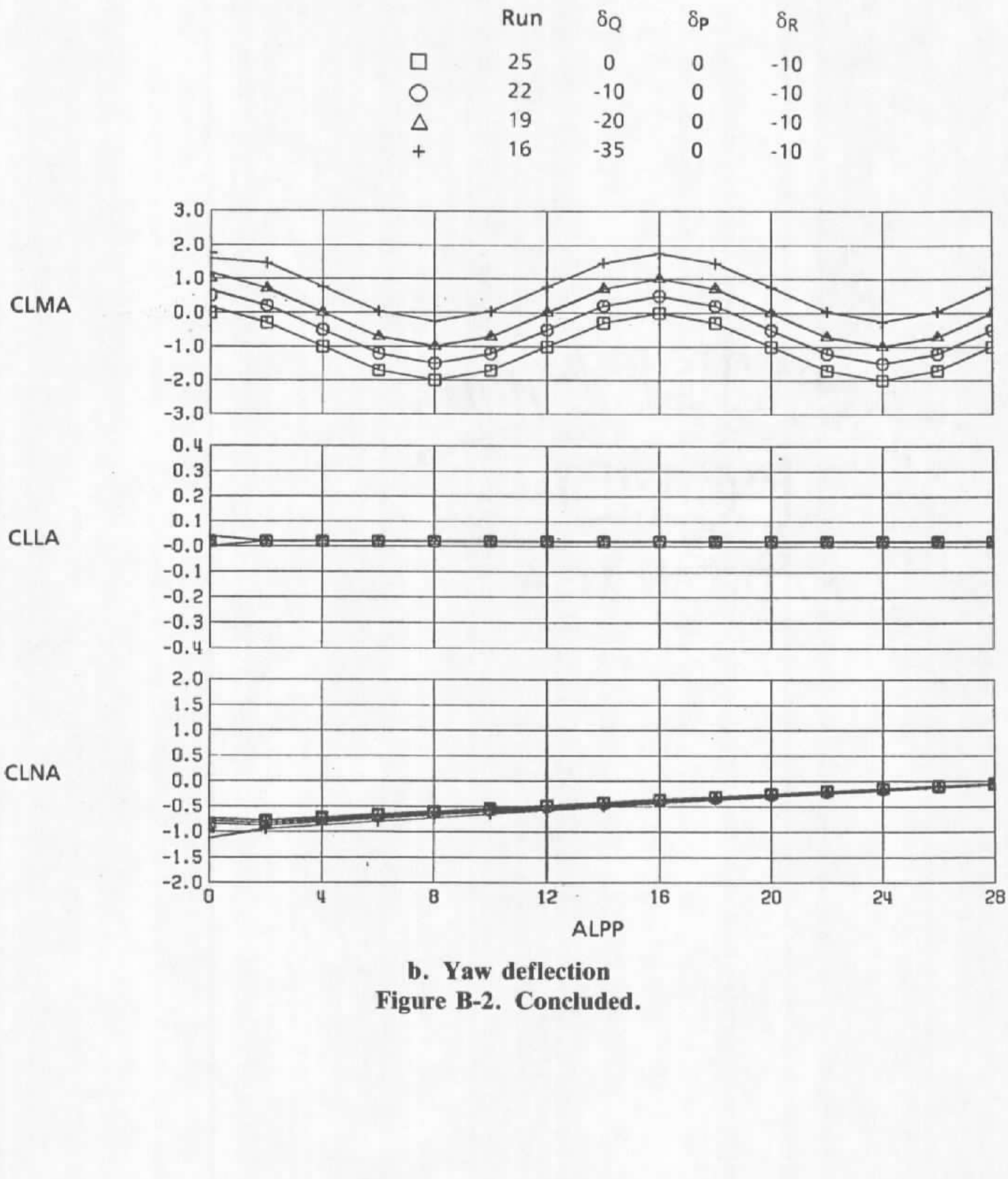


c. Yaw deflection
Figure B-1. Concluded.

	Run	δ_Q	δ_P	δ_R
□	12	0	-5	0
○	9	-10	-5	0
△	6	-20	-5	0
+	3	-35	-5	0



a. Roll deflection
Figure B-2. Group B data for example case.



b. Yaw deflection
Figure B-2. Concluded.

Table B-1. Input File Menu

RECORDS = 1 TO 15

ID = 1

ID	RE*10-6	DELTAQ	CNF3	CHM3/S
TIME	SH*10+3	DELTAR	CNF4	CHM4/S
TEST NO	TT	CAT	CBM1	CNF1/S
PART NO	TBAL	CAF	CBM2	CNF2/S
POINT NO	ZRP	CAB	CBM3	CNF3/S
RUN	ALPP	CNA	CBM4	CNF4/S
SAMPLE	PHI	CLMA	CAT/S	CBM1/S
	ALPHA	CYA	CAF/S	CBM2/S
	BETA	CLLA	CAB/S	CBM3/S
	DELV	CLNA	CNA/S	CBM4/S
TEST	DELH	CHM1	CLMA/S	
RUN	DELTA1	CHM2	CYA/S	
POINT	DELTA2	CHM3	CLLA/S	
CONFIG	DELTA3	CHM4	CLNA/S	
M	DELTA4	CNF1	CHM1/S	
Q	DELTAP	CNF2	CHM2/S	

Table B-2. Example Prompting Session

```
EX 'C60126.DATAPROG.CLIST'
ENTER  U  FOR UNCLASSIFIED RUN
ENTER  C  FOR CLASSIFIED RUN
U

           ******************************
           * AERODYNAMIC DATA ANALYSIS *
           ******************************


WOULD YOU LIKE TO:
 1) ESTABLISH NEW DATA FILE
 2) EDIT EXISTING DATA FILE

(ENTER 1 OR 2)
1

*** AXIS OF ORIGINAL DATA ***

1) BODY
2) AEROBALLISTIC
3) WIND
4) STABILITY

ENTER CHOICE OF 1 THRU 4
2

*** INDEPENDENT VARIABLE NAMES ***

ENTER THE VARIABLE NAME USED IN TEKPLOT FOR ANGLE OF ATTACK
ALPP

ENTER THE VARIABLE NAME USED IN TEKPLOT FOR SIDESLIP
PHI
```

Table B-3. Example Prompting Session, Continued

```
THE FOLLOWING OPTIONS ARE AVAILABLE:
 1) VARIABLE BIAS CORRECTIONS
 2) INDEPENDENT VARIABLE RANGE
 3) CENTER OF GRAVITY TRANSFER
 4) AXIS TRANSFORMATION
 5) CHANGE IN REFERENCE DIMENSIONS
 6) SKIN FRICTION AND BASE DRAG CORRECTIONS
 7) VARIABLE SIGN CHANGE
 8) DETERMINATION OF STABILITY CHARACTERISTICS
 9) CONTROL EFFECTIVENESS
10) TRIM
11) TRIM3D

ENTER THE NUMBERS, SEPARATED BY COMMAS, OF THE OPTIONS
YOU WOULD LIKE. (ENTER D TO DISPLAY THE OPTIONS AGAIN)
2,11

*** INDEPENDENT VARIABLE RANGE ***
ENTER DELTA USED FOR TESTING THE INDEPENDENT VARIABLE
                                 THE (TOLERANCE)
.2

ENTER MINIMUM, MAXIMUM, DELTA FOR ALPHA (ANGLE OF ATTACK)
0,24,4

ENTER MINIMUM, MAXIMUM, DELTA FOR BETA (SIDESLIP)
0,0,10
```

Table B-4. Example Prompting Session, Continued

```
ENTER EXTRAPOLATION OPTION.
 1) NO EXTRAPOLATION BEYOND ACTUAL DATA (DEFAULT)
 2) EXTRAPOLATION TO THE NEXT VALUE THAT THE INCREMENT
    WOULD EXTEND THE INDEPENDENT VARIABLE TO
    EXTRAPOLATIONS ARE LINEAR AFTER THE DATA POINTS
 3) EXTRAPOLATION OF ALL DATA TO ABOVE SPECIFIED
    MINIMUM AND MAXIMUM
    EXTRAPOLATIONS ARE LINEAR AFTER THE DATA POINTS

ENTER CHOICE OF 1 THRU 3:
1

***         TRIM3D          ***

*** NOTE: TO PREVENT ERROR, MAKE CERTAIN INDEPENDENT ***
***       VARIABLE RANGE OPTION IS ALSO CHOSEN.      ***

ENTER MOMENT TOLERANCES IN PITCH, ROLL, YAW ORDER

.01,.001,.01

ENTER THE VARIABLE NAME USED IN TEKPLOT FOR AXIAL FORCE
CAT

ENTER THE VARIABLE NAME USED IN TEKPLOT FOR NORMAL FORCE
CNA

ENTER THE VARIABLE NAME USED IN TEKPLOT FOR SIDE FORCE
CYA
```

Table B-5. Example Prompting Session, Continued

```
ENTER THE VARIABLE NAME USED IN TEKPLOT FOR ROLLING MOMENT
CLLA

ENTER THE VARIABLE NAME USED IN TEKPLOT FOR PITCHING MOMENT
CLMA

ENTER THE VARIABLE NAME USED IN TEKPLOT FOR YAWING MOMENT
CLNA

ENTER THE VARIABLE NAMES, SEPARATED BY COMMAS,FOR THE
TEST CONDITION VARIABLES FOR THE TRIM OPTION.
PRESS RETURN ON A NEW LINE WHEN FINISHED.
RUN,M,ALPP,PHI


DO YOU WISH TO DETERMINE LOAD FACTOR? (Y/N)
N

ENTER THE VARIABLE NAME FOR CONTROL DEFLECTION,
SEPARATED BY COMMAS. (MAXIMUM OF 3)
DELTAQ,DELTAP,DELTAR

ENTER THE DEFLECTION OF DELTAQ
(1) PITCH, (2) ROLL, (3) YAW
ENTER CHOICE OF 1 THRU 3
1

ENTER THE DEFLECTION OF DELTAP
(1) PITCH, (2) ROLL, (3) YAW
ENTER CHOICE OF 1 THRU 3
2
```

Table B-6. Example Prompting Session, Continued

```
ENTER THE DEFLECTION OF DELTAR
(1) PITCH, (2) ROLL, (3) YAW
ENTER CHOICE OF 1 THRU 3
3

ENTER THE RUN NUMBERS DESIRED FOR DELTAQ,
SEPARATED BY COMMAS.  INPUT IN DECREASING ORDER
OF DELTAS, MAXIMUM 6 PER LINE.
PRESS RETURN ON A NEW LINE WHEN FINISHED.
27,24,21,18

ENTER THE RUN NUMBERS DESIRED FOR DELTAP,
SEPARATED BY COMMAS.  INPUT IN DECREASING ORDER
OF DELTAS, MAXIMUM 6 PER LINE.
PRESS RETURN ON A NEW LINE WHEN FINISHED.
27,12

ENTER THE RUN NUMBERS DESIRED FOR DELTAR,
SEPARATED BY COMMAS.  INPUT IN DECREASING ORDER
OF DELTAS, MAXIMUM 6 PER LINE.
PRESS RETURN ON A NEW LINE WHEN FINISHED.
27,25
```

Table B-7. Example Prompting Session, Continued

```
ENTER THE RUN NUMBERS WITH
FIXED DELTAQ WITH VARYING DELTAP VALUES
SEPARATED BY COMMAS.  INPUT IN DECREASING ORDER
OF DELTAS, MAXIMUM 6 PER LINE MAXIMUM 6 LINES
PRESS RETURN ON A NEW LINE WHEN FINISHED.
27,12
24,9
21,6
18,3

ENTER THE RUN NUMBERS WITH
FIXED DELTAQ WITH VARYING DELTAR VALUES
SEPARATED BY COMMAS.  INPUT IN DECREASING ORDER
OF DELTAS, MAXIMUM 6 PER LINE MAXIMUM 6 LINES
PRESS RETURN ON A NEW LINE WHEN FINISHED.
27,25
24,22
21,19
18,16
```

Table B-8. Example Prompting Session, Continued

```
SPECIFY TYPE OF OUTPUT:
 1) NEW TEKPLOT FILE ONLY
 2) PRINTED OUTPUT ONLY
 3) BOTH NEW TEKPLOT FILE AND PRINTED OUTPUT

(ENTER CHOICE OF 1 THRU 3)
3

ENTER TITLE FOR PRINTOUT (60 CHARACTER LIMIT)
EXAMPLE CASE

ENTER THE FULLY QUALIFIED NAME OF THE ORIGINAL TEKPLOT FILE.
PWT.B30098.CHEKTEK

ENTER THE FULLY QUALIFIED NAME OF THE NEW TEKPLOT FILE
PWT.B30098.AEROPRED

*** VARIABLE NAMES FOR PRINTOUT ***

INPUT INDIVIDUAL VARIABLE NAMES TO BE PRINTED ON THE
1-7 OPTIONS PRINTOUT AND THE TRIM OPTION PRINTOUT
*****  NOTE MUST BE ORIGINAL TEKPLOT FILE NAMES  ****
INPUT VARIABLE NAMES SEPARATED BY COMMAS.
TERMINATE LIST BY PRESSING RETURN ON A NEW LINE.
ALPP,PHI,DELTAQ,DELTAP,DELTAR,CLMA,CLLA,CLNA,CNA,CYA
CHM1,CHM2,CHM3,CHM4

WOULD YOU LIKE TO EDIT THIS PROMPT DATA FILE? (Y OR N)
N
```

Table B-9. Example Prompting Session, Concluded

```
WOULD YOU LIKE TO:
   1) BUILD NEW JCL FILE
   2) SUBMIT EXISTING JCL FILE
   3) QUIT
ENTER CHOICE OF 1,2 OR 3: 1


TEKPLOT DATA WILL BE READ FROM PWT.B30098.CHEKTEK
IS THIS CORRECT? (Y OR N)
Y
TEKPLOT DATA WILL BE WRITTEN TO PWT.B30098.AEROPRED
IS THIS CORRECT? (Y OR N)
Y
IS THIS TEKPLOT FILE(S) PROTECTED? (ENTER Y OR N)
N

ENTER THE FOLLOWING INFORMATION FOR THE OUTPUT.
ENTER ACCOUNT NUMBER (AWD):56019604
ENTER NAME (FOR PRINTOUT BANNER):USERNAME
IS THIS TO BE PRINTED AT CCF? (Y OR N)
Y
DO YOU WANT TO PRINT THIS ON THE XEROX PRINTER?
(Y OR N)
Y
CLASS: 1) X - TIME = 5 SECONDS
       2) C - TIME = 2 MINUTES (DEFAULT)
       3) D - TIME = 4 MINUTES
       4) E - TIME = 30 MINUTES
ENTER 1 THRU 4: 1

ENTER PRIORITY (8 DEFAULT):
ENTER COURIER STOP NUMBER (4 DEFAULT): 4A
WOULD YOU LIKE TO SUBMIT THIS JOB? (Y OR N)
N
TO RUN THIS JOB FROM TSO, TYPE: SUBMIT TEKJCL
READY
```

APPENDIX C
LISTING OF INPUT FILES

```
//B30098T JOB (CAL,ANALYSIS,01,56019604),
//    B30098USERNAME,MSGLEVEL=1,MSGCLASS=2,
//    USER=B30098,PASSWORD=XXXXXXXX,REGION=9800K,
//    NOTIFY=B30098,PRTY=8,
//    CLASS=X,TIME=(,5)
/*JOBPARM ROOM=4A
//*
//STEP2 EXEC FORTXPDS,PGMNO=BDC05313
//GO.FT56F001 DD DISP=SHR,
//    DSN=B30098.OPTIONS.DATA
//GO.FT57F001 DD DISP=SHR,
//    DSN=B30098.RUNNAMES.DATA
//GO.FT58F001 DD DISP=SHR,
//    DSN=B30098.FILEINFO.DATA
//GO.FT71F001 DD DISP=SHR,
//    DSN=PWT.B30098.CHEKTEK
//GO.FT72F001 DD DISP=(NEW,DELETE),
//    DCB=OPTCD=C,
//    UNIT=WORK,
//    SPACE=(CYL,(3,1))
//GO.FT73F001 DD DISP=SHR,
//    DSN=PWT.B30098.AEROPRED
//GO.FT74F001 DD DISP=MOD,
//    DSN=PWT.B30098.AEROPRED
/*
```

a. TEKJCL file

```
3   TP    64   0      0      0
       5     0      0      0      0
       8     0      0      0      0
  1     1     1
  1     1     1
  0     0     0
  0     0     0
PWT.B30098.CHEKTEK
PWT.B30098.AEROPRED
```

b. FILEINFO file

Figure C-1. Listing of input files for example case.

```
.2
IVRANGNE
TRIM3D
.01       .001       .01
RUN       M          ALPP       PHI

DELTAQ    1
      27        24         21         18

DELTAP    2
      27        12

DELTAR    3
      27        25

ROLL
      27        12
      24         9
      21         6
      18         3

YAW
      27        25
      24        22
      21        19
      18        16

ENDCE
END
```

c. OPTIONS file
Figure C-1. Continued.

```
      PROJECT: B30098                                                         DATE: 89/04/25
      GROUP:   RUNNAMES                                                       TIME: 15:28
      TYPE:    DATA                                                           PAGE: 1
START
 COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8

   1  EXAMPLE CASE

  56                                                         ALPMIN






  12            BETINC


  67                                                                   BETMAX



  34                                   BETMIN










  34                                   IAXIS1

```

d. RUNNAMES file
Figure C-1. Continued.

```
      PROJECT: 830098                                                 DATE: 89/04/25
      GROUP:   RUNNAMES                                               TIME: 15:28
      TYPE:    DATA                                                   PAGE: 2
START
 COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8












  45                                          ALPINC



  23                     ALPMAX




   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.1000E+02 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
```

d. Continued

Figure C-1. Continued.

```
PROJECT: 830098                                                    DATE: 89/04/25
GROUP:   RUNNAMES                                                  TIME: 15:28
TYPE:    DATA                                                      PAGE: 3
START
 COL    ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
```

START COL							
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.2000E+01	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

d. Continued

Figure C-1. Continued.

```
      PROJECT:  B30098                                              DATE: 89/04/25
      GROUP:    RUNNAMES                                            TIME: 15:28
      TYPE:     DATA                                                PAGE: 4
START
 COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8

   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0 0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.4000E+01 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.2400E+02 0.0000E+00 0.0000E+00 0.0000E+00 0 0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0 0000E+00 0.0000E+00
   1  0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
   1  0.0000E+00






  67                                                                  ALPHA



   1  CA

  67                                                                  CN

  45                                                  CY
  34                                        CLL       CLM       CLN

  12            BETA
```

d. Continued

Figure C-1. Continued.

```
        PROJECT: B30098                                                            DATE: 89/04/25
        GROUP:   RUNNAMES                                                          TIME: 15:28
        TYPE:    DATA                                                              PAGE: 5
 START
  COL   ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
```

d. Continued
Figure C-1. Continued.

```
        PROJECT: B30098                                                            DATE: 89/04/25
        GROUP:   RUNNAMES                                                          TIME: 15:28
        TYPE:    DATA                                                              PAGE: 6
 START
  COL   ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8



  67                                                                  ALPP


   1    CAT

  67                                                                  CNA


  45                                            CYA
  34                                 CLLA       CLMA       CLNA

  12               BETA
```

d. Continued
Figure C-1. Continued.

```
      PROJECT: B30098                                                          DATE: 89/04/25
      GROUP:   RUNNAMES                                                        TIME: 15:28
      TYPE:    DATA                                                            PAGE: 7
START
 COL  ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8

   7        27        24        21        18
   7        27        12
   7        27        25
   7        27        12
   7        24         9
   7        21         6
   7        18         3
   7        27        25
   7        24        22
   7        21        19
   7        18        16

   7        27        24        21        18
   7        27        12
   7        27        25
   7        27        12
   7        24         9
   7        21         6
   7        18         3
   7        27        25
   7        24        22
   7        21        19
   7        18        16

   1  ALPP      PHI       DELTAQ    DELTAP    DELTAR    CLMA      CLLA      CLNA
   1  CNA       CYA       CHM1      CHM2      CHM3      CHM4
```

d. Concluded

Figure C-1. Concluded.

APPENDIX D
EXAMPLE OUTPUT

This appendix provides an explanation of the output from the three-axis trim option for the example case used in Appendixes A through C.

The initial output from the analysis program is a print of the axis system chosen for input data. The inputs for each data manipulation option are printed for verification by the user.

Beginning with the page numbered 1 (upper right corner of the page), the program prints the results of the data manipulation options. The variables printed are those entered under " *** VARIABLE NAMES FOR PRINTOUT ***" in Table B-8. Each run in both the Group A and Group B data is printed. Any runs duplicated in the entries in Tables B-6 and B-7 will also be duplicated in the printout. The runs are printed in the order entered.

Following the print of the data manipulation results, any diagnostic messages from the three-axis trim option are printed. In the example case the estimated pitch deflections for trim at 8- and 24-deg angle of attack were not bounded by experimental data. These messages may be verified by examination of the input data plot of Fig. B-1a.

The summary of three-axis trim results is printed after the diagnostic messages. The summary does not include independent variable values at which the iteration failed. Therefore, angles of attack of 8 and 24 deg do not appear in the example output. An asterisk(*) at any line indicates a problem occurred during the iteration at that independent variable value. The problem will be identified in the diagnostic messages. The variables printed are the same as in the data manipulation results, except the variables that are not test conditions have "T" appended to the name to indicate trim values.

The final page of output from the three-axis trim option is a list of angles of attack where either the maximum pitch-only deflection (first run entered) or the minimum pitch-only deflection (last run entered) crosses 0 pitching moment. The list identifies local minimum and maximum angles for trim and is useful in determining at what values the trim program should succeed. Because this list is based on pitch-only deflection data, these points are not three-axis trim points.

****
* SUMMARY OF OPTIONS TO BE PERFORMED *
****

*** ORIGINAL TEKPLOT DATA IS IN MISSILE AXIS ***

*** INDEPENDENT VARIABLE RANGE ***

ALPP:
MINIMUM = 0.0000; MAXIMUM = 24.0000; DELTA = 4.0000

BETA:
MINIMUM = 0.0000; MAXIMUM = 0.0000; DELTA = 10.0000

EXTRAPOLATION OPTION:
NO EXTRAPOLATION BEYOND ACTUAL DATA (DEFAULT)

EXAMPLE CASE

RUN NUMBER 27 PAGE 1

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00182	0.00206	-0.00108	0.00150	0.00000
4.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.12160	0.70042	-0.07209	0.00150	-0.00105
8.00000	0.00000	0.00000	0.00000	0.00000	-2.00000	0.00000	0.24354	1.38851	-0.14437	0.00150	-0.00209
12.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.36487	2.05054	-0.21630	0.00150	-0.00312
16.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.48287	2.67146	-0.28626	0.00150	-0.00413
20.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.59493	3.23736	-0.35269	0.00150	-0.00513
24.00000	0.00000	0.00000	0.00000	0.00000	-2.00000	0.00000	0.69864	3.73585	-0.41416	0.00150	-0.00610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.00150
4.00000	0.00000	-0.00101
8.00000	0.00000	-0.00053
12.00000	0.00000	-0.00004
16.00000	0.00000	0.00043
20.00000	0.00000	0.00089
24.00000	0.00000	0.00135

EXAMPLE CASE

RUN NUMBER 24 PAGE 2

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-10.00000	0.00000	0.00000	0.50000	0 00000	0.00193	-1 49794	-0.00108	0.00150	-0.20000
4.00000	0.00000	-10.00000	0.00000	0.00000	-0.50000	0 00000	0.12881	-0.79958	-0.07209	0.00150	-0.20105
8.00000	0.00000	-10.00000	0.00000	0.00000	-1.50000	0.00000	0.25798	-0.11149	-0.14437	0.00150	-0.20209
12.00000	0.00000	-10.00000	0.00000	0.00000	-0.50000	0.00000	0.38651	0.55054	-0.21630	0.00150	0.20312
16.00000	0.00000	-10.00000	0.00000	0.00000	0.50000	0.00000	0.51150	1.17146	-0.28626	0.00150	-0 20413
20.00000	0.00000	-10.00000	0.00000	0.00000	-0.50000	0.00000	0.63020	1.73736	-0.35269	0.00150	0.20513
24.00000	0.00000	-10.00000	0.00000	0.00000	-1.50000	0.00000	0 74006	2.23585	-0.41416	0.00150	-0.20610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.20150
4.00000	0.00000	-0.20101
8.00000	0.00000	-0.20053
12.00000	0.00000	-0.20004
16.00000	0.00000	-0.19957
20.00000	0.00000	-0.19911
24.00000	0.00000	-0.19865

EXAMPLE CASE

RUN NUMBER 21 PAGE 3

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-20.00000	0.00000	0.00000	1.00000	0.00000	0.00204	2.99794	-0 00108	0.00150	-0 40000
4.00000	0.00000	-20.00000	0.00000	0.00000	0.00000	0.00000	0.13601	-2.29958	-0 07209	0.00150	-0.40105
8.00000	0.00000	-20.00000	0.00000	0 00000	-1.00000	0.00000	0.27242	-1.61149	-0.14437	0.00150	0.40209
12.00000	0.00000	-20.00000	0 00000	0.00000	0.00000	0.00000	0.40814	-0.94946	-0.21630	0.00150	-0.40312
16.00000	0.00000	-20.00000	0.00000	0.00000	1.00000	0.00000	0.54012	-0.32854	-0.28626	0.00150	-0.40413
20.00000	0.00000	-20.00000	0.00000	0.00000	0.00000	0.00000	0.66547	0 23736	-0.35269	0.00150	-0.40513
24.00000	0.00000	-20.00000	0.00000	0.00000	-1.00000	0.00000	0.78147	0.73585	0.41416	0.00150	-0 40610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.40150
4.00000	0.00000	-0.40101
8.00000	0.00000	-0.40053
12.00000	0.00000	-0.40004
16.00000	0.00000	-0.39957
20.00000	0.00000	-0.39911
24.00000	0.00000	-0.39865

EXAMPLE CASE

RUN NUMBER 18 PAGE 4

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-35.00000	0.00000	0.00000	1.75000	0.00000	0.00220	-5.24794	-0.00108	0.00150	-0.70000
4.00000	0.00000	-35.00000	0.00000	0.00000	0.75000	0.00000	0.14683	-4.54958	-0.07209	0.00150	-0.70105
8.00000	0.00000	-35.00000	0.00000	0.00000	-0.25000	0.00000	0.29407	-3.86149	-0.14437	0.00150	-0.70209
12.00000	0.00000	-35.00000	0.00000	0.00000	0.75000	0.00000	0.44058	-3.19946	-0.21630	0.00150	-0.70312
16.00000	0.00000	-35.00000	0.00000	0.00000	1.75000	0.00000	0.58306	-2.57854	-0.28626	0.00150	-0.70413
20.00000	0.00000	-35.00000	0.00000	0.00000	0.75000	0.00000	0.71837	-2.01264	-0.35269	0.00150	-0.70513
24.00000	0.00000	-35.00000	0.00000	0.00000	-0.25000	0.00000	0.84360	-1.51415	-0.41416	0.00150	-0.70610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.70150
4.00000	0.00000	-0.70101
8.00000	0.00000	-0.70053
12.00000	0.00000	-0.70004
16.00000	0.00000	-0.69957
20.00000	0.00000	-0.69911
24.00000	0.00000	-0.69865

EXAMPLE CASE

RUN NUMBER 27 PAGE 5

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00182	0.00206	-0.00108	0.00150	0.00000
4.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.12160	0.70042	-0.07209	0.00150	-0.00105
8.00000	0.00000	0.00000	0.00000	0.00000	-2.00000	0.00000	0.24354	1.38851	-0.14437	0.00150	-0.00209
12.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.36487	2.05054	-0.21630	0.00150	-0.00312
16.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.48287	2.67146	-0.28626	0.00150	-0.00413
20.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.59493	3.23736	-0.35269	0.00150	-0.00513
24.00000	0.00000	0.00000	0.00000	0.00000	-2.00000	0.00000	0.69864	3.73585	-0.41416	0.00150	-0.00610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.00150
4.00000	0.00000	-0.00101
8.00000	0.00000	-0.00053
12.00000	0.00000	-0.00004
16.00000	0.00000	0.00043
20.00000	0.00000	0.00089
24.00000	0.00000	0.00135

EXAMPLE CASE

RUN NUMBER 12 PAGE 6

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	0.00000	-5.00000	0.00000	0.00000	-0.25000	0.01869	0.01324	-0.01108	0.10150	-0.10000
4.00000	0.00000	0.00000	-5.00000	0.00000	-1.00000	-0.25000	0.13847	0.71160	-0.08209	0.10150	-0.10105
8.00000	0.00000	0.00000	-5.00000	0.00000	-2.00000	-0.25000	0.26041	1.39969	-0.15437	0.10150	-0.10209
12.00000	0.00000	0.00000	-5.00000	0.00000	-1.00000	-0.25000	0.38174	2.06172	-0.22630	0.10150	-0.10312
16.00000	0.00000	0.00000	-5.00000	0.00000	0.00000	-0.25000	0.49974	2.68264	-0.29625	0.10150	-0.10413
20.00000	0.00000	0.00000	-5.00000	0.00000	-1.00000	-0.25000	0.61180	3.24854	-0.36269	0.10150	-0.10513
24.00000	0.00000	0.00000	-5.00000	0.00000	-2.00000	-0.25000	0.71551	3.74703	-0.42416	0.10150	-0.10610

ALPP	CHM3	CHM4
0.00000	-0.10000	0.09850
4.00000	-0.10000	0.09899
8.00000	-0.10000	0.09947
12.00000	-0.10000	0.09995
16.00000	-0.10000	0.10043
20.00000	-0.10000	0.10089
24.00000	-0.10000	0.10135

EXAMPLE CASE

RUN NUMBER 27 PAGE 7

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00182	0.00206	-0.00108	0.00150	0.00000
4.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.12160	0.70042	-0.07209	0.00150	-0.00105
8.00000	0.00000	0.00000	0.00000	0.00000	-2.00000	0.00000	0.24354	1.38851	-0.14437	0.00150	-0.00209
12.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.36487	2.05054	-0.21630	0.00150	-0.00312
16.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.48287	2.67146	-0.28626	0.00150	-0.00413
20.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.59493	3.23736	-0.35269	0.00150	-0.00513
24.00000	0.00000	0.00000	0.00000	0.00000	-2.00000	0.00000	0.69864	3.73585	-0.41416	0.00150	-0.00610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.00150
4.00000	0.00000	-0.00101
8.00000	0.00000	-0.00053
12.00000	0.00000	-0.00004
16.00000	0.00000	0.00043
20.00000	0.00000	0.00089
24.00000	0.00000	0.00135

EXAMPLE CASE

RUN NUMBER 25 PAGE 8

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	0.00000	0.00000	-10.00000	0.00000	0.02000	-0.84660	-0.09794	0.49892	-0.19850	0.00000
4.00000	0.00000	0.00000	0.00000	-10.00000	-1.00000	0.02000	-0.72611	0.60042	0.42791	-0.19850	-0.00105
8.00000	0.00000	0.00000	0.00000	-10.00000	-2.00000	0.02000	-0.60345	1.28851	0.35563	-0.19850	-0.00209
12.00000	0.00000	0.00000	0.00000	-10.00000	-1.00000	0.02000	-0.48139	1.95054	0.28370	-0.19850	-0.00312
16.00000	0.00000	0.00000	0.00000	-10.00000	0.00000	0.02000	-0.36270	2.57146	0.21374	-0.19850	-0.00413
20.00000	0.00000	0.00000	0.00000	-10.00000	-1.00000	0.02000	-0.24997	3.13736	0.14731	-0.19850	-0.00513
24.00000	0.00000	0.00000	0.00000	-10.00000	-2.00000	0.02000	-0.14565	3.63585	0.08584	-0.19850	-0.00610

ALPP	CHM3	CHM4
0.00000	-0.20000	-0.00150
4.00000	-0.20000	-0.00101
8.00000	-0.20000	-0.00053
12.00000	-0.20000	-0.00004
16.00000	-0.20000	0.00043
20.00000	-0.20000	0.00089
24.00000	-0.20000	0.00135

EXAMPLE CASE

RUN NUMBER 27 PAGE 9

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00182	0.00208	-0.00108	0.00150	0.00000
4.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.12160	0.70042	-0.07209	0.00150	-0.00105
8.00000	0.00000	0.00000	0.00000	0.00000	-2.00000	0.00000	0.24354	1.38851	-0.14437	0.00150	-0.00209
12.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.36487	2.05054	-0.21630	0.00150	-0.00312
16.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.48287	2.67146	-0.28626	0.00150	-0.00413
20.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.59493	3.23736	-0.35269	0.00150	-0.00513
24.00000	0.00000	0.00000	0.00000	0.00000	-2.00000	0.00000	0.69864	3.73585	-0.41416	0.00150	-0.00610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.00150
4.00000	0.00000	-0.00101
8.00000	0.00000	-0.00053
12.00000	0.00000	-0.00004
16.00000	0.00000	0.00043
20.00000	0.00000	0.00089
24.00000	0.00000	0.00135

EXAMPLE CASE

RUN NUMBER 12 PAGE 10

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	0.00000	-5.00000	0.00000	0.00000	-0.25000	0.01869	0 01324	-0.01108	0.10150	-0.10000
4.00000	0.00000	0.00000	-5.00000	0.00000	-1.00000	-0.25000	0.13847	0.71160	-0.08209	0.10150	-0.10105
8.00000	0.00000	0.00000	-5.00000	0.00000	-2 00000	-0.25000	0.26041	1.39969	-0.15437	0.10150	-0.10209
12.00000	0.00000	0.00000	-5.00000	0.00000	-1.00000	-0.25000	0.38174	2.06172	-0.22630	0.10150	-0.10312
16.00000	0.00000	0.00000	-5.00000	0.00000	0 00000	-0.25000	0.49974	2.68264	-0.29625	0.10150	-0.10413
20.00000	0.00000	0.00000	-5.00000	0.00000	-1.00000	-0.25000	0.61180	3.24854	-0.36269	0.10150	-0.10513
24.00000	0.00000	0.00000	-5.00000	0.00000	-2.00000	-0.25000	0.71551	3.74703	-0.42416	0.10150	-0.10610

ALPP	CHM3	CHM4
0.00000	-0.10000	0.09850
4.00000	-0.10000	0.09899
8.00000	-0.10000	0.09947
12.00000	-0.10000	0.09995
16.00000	-0.10000	0.10043
20.00000	-0.10000	0.10089
24.00000	-0.10000	0.10135

EXAMPLE CASE

RUN NUMBER 24 PAGE 11

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-10.00000	0.00000	0.00000	0.50000	0.00000	0.00193	-1.49794	-0.00108	0.00150	-0.20000
4.00000	0.00000	-10.00000	0.00000	0.00000	-0.50000	0.00000	0.12881	-0.79958	-0.07209	0.00150	-0.20105
8.00000	0.00000	-10.00000	0.00000	0.00000	-1.50000	0.00000	0.25798	-0.11149	-0.14437	0.00150	-0.20209
12.00000	0.00000	-10.00000	0.00000	0.00000	-0.50000	0.00000	0.38651	0.55054	-0.21630	0.00150	-0.20312
16.00000	0.00000	-10.00000	0.00000	0.00000	0.50000	0.00000	0.51150	1.17146	-0.28626	0.00150	-0.20413
20.00000	0.00000	-10.00000	0.00000	0.00000	-0.50000	0.00000	0.63020	1.73736	-0.35269	0.00150	-0.20513
24.00000	0.00000	-10.00000	0.00000	0.00000	-1.50000	0.00000	0.74006	2.23585	-0.41416	0.00150	-0.20610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.20150
4.00000	0.00000	-0.20101
8.00000	0.00000	-0.20053
12.00000	0.00000	-0.20004
16.00000	0.00000	-0.19957
20.00000	0.00000	-0.19911
24.00000	0.00000	-0.19865

EXAMPLE CASE

RUN NUMBER 9 PAGE 12

ALPP	PHI	DELTAO	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-10.00000	-5.00000	0.00000	0.50000	-0 25000	0.01980	-1.48676	-0.01108	0.10150	-0.30000
4.00000	0.00000	-10 00000	-5.00000	0.00000	-0.50000	-0.25000	0.14667	-0.78840	-0.08209	0.10150	-0.30105
8.00000	0.00000	-10.00000	-5.00000	0.00000	-1.50000	-0.25000	0.27585	-0.10031	-0.15437	0.10150	-0.30209
12.00000	0.00000	-10.00000	-5.00000	0.00000	-0.50000	-0.25000	0.40437	0.56172	-0.22630	0.10150	-0.30312
16.00000	0.00000	-10.00000	-5.00000	0.00000	0.50000	-0.25000	0.52937	1.18264	-0.29625	0.10150	-0.30413
20.00000	0.00000	-10.00000	-5.00000	0.00000	-0.50000	-0.25000	0.64807	1.74854	-0.36269	0.10150	-0.30513
24.00000	0.00000	-10.00000	-5.00000	0.00000	-1.50000	-0.25000	0.75792	2.24703	-0.42416	0.10150	-0.30610

ALPP	CHM3	CHM4
0.00000	-0.10000	-0.10150
4.00000	-0.10000	-0.10101
8.00000	-0.10000	-0.10053
12.00000	-0.10000	-0.10004
16.00000	-0.10000	-0.09957
20.00000	-0.10000	-0.09911
24.00000	-0.10000	-0.09865

EXAMPLE CASE

RUN NUMBER 21 PAGE 13

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-20.00000	0.00000	0.00000	1.00000	0.00000	0.00204	-2.99794	-0.00108	0.00150	-0.40000
4.00000	0.00000	-20.00000	0.00000	0.00000	0.00000	0.00000	0.13601	-2.29958	-0.07209	0.00150	-0.40105
8.00000	0.00000	-20.00000	0.00000	0.00000	-1.00000	0.00000	0.27242	-1.61149	-0.14437	0.00150	-0.40209
12.00000	0.00000	-20.00000	0.00000	0.00000	0.00000	0.00000	0.40814	-0.94946	-0.21630	0.00150	-0.40312
16.00000	0.00000	-20.00000	0.00000	0.00000	1.00000	0.00000	0.54012	-0.32854	-0.28626	0.00150	-0.40413
20.00000	0.00000	-20.00000	0.00000	0.00000	0.00000	0.00000	0.66547	0.23736	-0.35269	0.00150	-0.40513
24.00000	0.00000	-20.00000	0.00000	0.00000	-1.00000	0.00000	0.78147	0.73585	-0.41416	0.00150	-0.40610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.40150
4.00000	0.00000	-0.40101
8.00000	0.00000	-0.40053
12.00000	0.00000	-0.40004
16.00000	0.00000	-0.39957
20.00000	0.00000	-0.39911
24.00000	0.00000	-0.39865

EXAMPLE CASE

RUN NUMBER 6 PAGE 14

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-20.00000	-5.00000	0.00000	1.00000	-0.25000	0.02091	-2.98676	-0.01108	0.10150	-0.50000
4.00000	0.00000	-20.00000	-5.00000	0.00000	0.00000	-0.25000	0.15488	-2.28839	-0.08209	0.10150	-0.50105
8.00000	0.00000	-20.00000	-5.00000	0.00000	-1.00000	-0.25000	0.29128	-1.60031	-0.15437	0.10150	0.50209
12.00000	0.00000	-20.00000	-5.00000	0.00000	0.00000	-0.25000	0.42700	-0.93828	-0.22630	0.10150	-0.50312
16 00000	0.00000	-20.00000	-5.00000	0.00000	1.00000	-0.25000	0.55899	-0.31736	-0.29625	0.10150	-0.50413
20.00000	0.00000	-20.00000	-5.00000	0.00000	0.00000	-0.25000	0.68434	0.24854	-0.36269	0.10150	-0.50513
24 00000	0.00000	-20.00000	-5.00000	0.00000	-1.00000	-0.25000	0.80034	0.74703	-0.42416	0.10150	-0.50610

ALPP	CHM3	CHM4
0.00000	-0.10000	-0.30150
4.00000	-0.10000	-0.30101
8.00000	-0.10000	-0.30053
12.00000	-0.10000	-0.30004
16.00000	-0.10000	-0.29957
20.00000	-0.10000	-0.29911
24.00000	-0.10000	-0.29865

EXAMPLE CASE

RUN NUMBER 18 PAGE 15

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-35.00000	0.00000	0.00000	1.75000	0.00000	0.00220	-5.24794	-0.00108	0.00150	-0.70000
4.00000	0.00000	-35.00000	0.00000	0.00000	0.75000	0.00000	0.14683	-4.54958	-0.07209	0.00150	-0.70105
8.00000	0.00000	-35.00000	0.00000	0.00000	-0.25000	0 00000	0.29407	-3.86149	-0.14437	0.00150	-0.70209
12.00000	0.00000	-35.00000	0.00000	0.00000	0.75000	0.00000	0.44058	-3.19946	-0.21630	0.00150	-0.70312
16.00000	0.00000	-35.00000	0.00000	0.00000	1.75000	0.00000	0.58306	-2.57854	-0.28626	0.00150	-0.70413
20.00000	0.00000	-35.00000	0.00000	0.00000	0.75000	0.00000	0.71837	-2.01264	-0.35269	0.00150	-0.70513
24.00000	0.00000	-35.00000	0.00000	0.00000	-0.25000	0.00000	0.84360	-1.51415	-0.41416	0.00150	-0.70610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.70150
4.00000	0.00000	-0.70101
8.00000	0.00000	-0.70053
12.00000	0.00000	-0.70004
16.00000	0.00000	-0.69957
20.00000	0.00000	-0.69911
24.00000	0.00000	-0.69865

EXAMPLE CASE

RUN NUMBER 3 PAGE 16

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-35.00000	-5.00000	0.00000	1.75000	-0.25000	0.02257	-5.23676	-0.01108	0.10150	-0.80000
4.00000	0.00000	-35.00000	-5.00000	0.00000	0.75000	-0.25000	0.16720	-4.53839	-0.08209	0.10150	-0.80105
8.00000	0.00000	-35.00000	-5.00000	0.00000	-0.25000	-0.25000	0.31444	-3.85031	-0.15437	0.10150	-0.80209
12.00000	0.00000	-35.00000	-5.00000	0.00000	0.75000	-0.25000	0.46095	-3.18828	-0.22630	0.10150	-0.80312
16.00000	0.00000	-35.00000	-5.00000	0.00000	1.75000	-0.25000	0.60343	-2.56736	-0.29625	0.10150	-0.80413
20.00000	0.00000	-35.00000	-5.00000	0.00000	0.75000	-0.25000	0.73874	-2.00146	-0.36269	0.10150	-0.80513
24.00000	0.00000	-35.00000	-5.00000	0.00000	-0.25000	-0.25000	0.86396	-1.50297	-0.42416	0.10150	-0.80610

ALPP	CHM3	CHM4
0.00000	-0.10000	-0.60150
4.00000	-0.10000	-0.60101
8.00000	-0.10000	-0.60053
12.00000	-0.10000	-0.60004
16.00000	-0.10000	-0.59957
20.00000	-0.10000	-0.59911
24.00000	-0.10000	-0.59865

EXAMPLE CASE

RUN NUMBER 27 PAGE 17

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00182	0.00206	-0.00108	0.00150	0.00000
4.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.12160	0.70042	-0.07209	0.00150	-0.00105
8.00000	0.00000	0.00000	0.00000	0.00000	-2.00000	0.00000	0.24354	1.38851	-0.14437	0.00150	-0.00209
12.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.36487	2.05054	-0.21630	0.00150	-0.00312
16.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.48287	2.67146	-0.28626	0.00150	-0.00413
20.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	0.00000	0.59493	3.23736	-0.35269	0.00150	-0.00513
24.00000	0.00000	0.00000	0.00000	0.00000	-2.00000	0.00000	0.69864	3.73585	-0.41416	0.00150	-0.00610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.00150
4.00000	0.00000	-0.00101
8.00000	0.00000	-0.00053
12.00000	0.00000	-0.00004
16.00000	0.00000	0.00043
20.00000	0.00000	0.00089
24.00000	0.00000	0.00135

EXAMPLE CASE

RUN NUMBER 25 PAGE 18

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	0.00000	0.00000	-10.00000	0.00000	0.02000	-0.84660	-0.09794	0.49892	-0.19850	0.00000
4.00000	0.00000	0.00000	0.00000	-10.00000	-1.00000	0.02000	-0.72611	0.60042	0.42791	-0.19850	-0.00105
8.00000	0.00000	0.00000	0.00000	-10.00000	-2.00000	0.02000	-0.60345	1.28851	0.35563	-0.19850	-0.00209
12.00000	0.00000	0.00000	0.00000	-10.00000	-1.00000	0.02000	-0.48139	1.95054	0.28370	-0.19850	-0.00312
16.00000	0.00000	0.00000	0.00000	-10.00000	0.00000	0.02000	-0.36270	2.57146	0.21374	-0.19850	-0.00413
20.00000	0.00000	0.00000	0.00000	-10.00000	-1.00000	0.02000	-0.24997	3.13736	0.14731	-0.19850	-0.00513
24.00000	0.00000	0.00000	0.00000	10.00000	-2.00000	0.02000	-0.14565	3.63585	0.08584	-0.19850	-0.00610

ALPP	CHM3	CHM4
0.00000	-0.20000	-0.00150
4.00000	-0.20000	-0.00101
8.00000	-0.20000	-0.00053
12.00000	-0.20000	-0.00004
16.00000	-0.20000	0.00043
20.00000	-0.20000	0.00089
24.00000	-0.20000	0.00135

EXAMPLE CASE

RUN NUMBER 24 PAGE 19

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-10.00000	0.00000	0.00000	0.50000	0.00000	0.00193	-1.49794	-0.00108	0.00150	-0.20000
4.00000	0.00000	-10.00000	0.00000	0.00000	-0.50000	0.00000	0.12881	-0.79958	-0.07209	0.00150	-0.20105
8.00000	0.00000	-10.00000	0.00000	0.00000	-1.50000	0.00000	0.25798	-0.11149	0.14437	0.00150	-0.20209
12.00000	0.00000	-10.00000	0.00000	0.00000	-0.50000	0.00000	0.38651	0.55054	-0.21630	0.00150	-0.20312
16.00000	0.00000	-10.00000	0.00000	0.00000	0.50000	0.00000	0.51150	1.17146	-0.28626	0.00150	-0.20413
20.00000	0.00000	-10.00000	0.00000	0.00000	-0.50000	0.00000	0.63020	1.73736	-0.35269	0.00150	-0.20513
24.00000	0.00000	-10.00000	0.00000	0.00000	-1.50000	0.00000	0.74006	2.23585	-0.41416	0.00150	-0.20610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.20150
4.00000	0.00000	-0.20101
8.00000	0.00000	-0.20053
12.00000	0.00000	-0.20004
16.00000	0.00000	-0.19957
20.00000	0.00000	-0.19911
24.00000	0.00000	-0.19865

EXAMPLE CASE

RUN NUMBER 22 PAGE 20

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-10.00000	0.00000	-10.00000	0.50000	0.02000	-0.89649	-1.59794	0.49892	-0.19850	-0.20000
4.00000	0.00000	-10.00000	0.00000	-10.00000	-0.50000	0.02000	-0.76890	-0.89958	0.42791	-0.19850	-0.20105
8.00000	0.00000	-10.00000	0.00000	-10.00000	-1.50000	0.02000	-0.63901	-0 21149	0.35563	-0.19850	-0.20209
12.00000	0.00000	-10.00000	0.00000	-10.00000	-0.50000	0.02000	-0.50976	0.45054	0.28370	-0.19850	-0.20312
16.00000	0.00000	-10.00000	0.00000	-10.00000	0.50000	0.02000	-0.38407	1.07146	0.21374	-0.19850	-0.20413
20.00000	0.00000	-10.00000	0.00000	-10.00000	-0.50000	0.02000	-0.26470	1.63736	0.14731	-0.19850	-0.20513
24.00000	0.00000	-10.00000	0.00000	-10.00000	-1.50000	0.02000	-0.15424	2.13585	0.08584	-0.19850	-0.20610

ALPP	CHM3	CHM4
0.00000	-0.20000	-0.20150
4.00000	-0.20000	-0.20101
8.00000	-0.20000	-0.20053
12.00000	-0.20000	-0.20004
16.00000	-0.20000	-0.19957
20.00000	-0.20000	-0.19911
24.00000	-0.20000	-0.19865

EXAMPLE CASE

RUN NUMBER 21 PAGE 21

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-20.00000	0.00000	0.00000	1.00000	0.00000	0.00204	-2.99794	-0.00108	0.00150	-0.40000
4.00000	0.00000	-20.00000	0.00000	0.00000	0.00000	0.00000	0.13601	-2.29958	-0.07209	0.00150	-0.40105
8.00000	0.00000	-20.00000	0.00000	0.00000	-1.00000	0.00000	0.27242	-1.61149	-0.14437	0.00150	-0.40209
12.00000	0.00000	-20.00000	0.00000	0.00000	0.00000	0.00000	0.40814	-0.94946	-0.21630	0.00150	-0.40312
16.00000	0.00000	-20.00000	0.00000	0.00000	1.00000	0.00000	0.54012	-0.32854	-0.28626	0.00150	-0.40413
20.00000	0.00000	-20.00000	0.00000	0.00000	0.00000	0.00000	0.66547	0.23736	-0.35269	0.00150	-0.40513
24.00000	0.00000	-20.00000	0.00000	0.00000	-1.00000	0.00000	0.78147	0.73585	-0.41416	0.00150	-0.40610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.40150
4.00000	0.00000	-0.40101
8.00000	0.00000	-0.40053
12.00000	0.00000	-0.40004
16.00000	0.00000	-0.39957
20.00000	0.00000	-0.39911
24.00000	0.00000	-0.39865

EXAMPLE CASF

RUN NUMBER 19

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-20.00000	0.00000	-10.00000	1.00000	0.02000	-0.94638	-3.09794	0.49892	-0.19850	-0.40000
4.00000	0.00000	-20.00000	0.00000	-10.00000	0.00000	0.02000	-0.81170	-2.39958	0.42791	-0.19850	-0.40105
8.00000	0.00000	-20.00000	0.00000	-10.00000	-1.00000	0.02000	-0.67457	-1.71149	0.35563	-0.19850	-0.40209
12.00000	0.00000	-20.00000	0.00000	-10.00000	0.00000	0.02000	-0.53813	-1.04946	0.28370	-0.19850	-0.40312
16.00000	0.00000	-20.00000	0.00000	-10.00000	1.00000	0.02000	-0.40545	-0.42854	0.21374	-0.19850	-0.40413
20.00000	0.00000	-20.00000	0.00000	-10.00000	0.00000	0.02000	-0.27944	0.13736	0.14731	-0.19850	-0.40513
24.00000	0.00000	-20.00000	0.00000	-10.00000	-1.00000	0.02000	-0.16282	0.63585	0.08584	-0.19850	-0.40610

ALPP	CHM3	CHM4
0.00000	-0.20000	-0.40150
4.00000	-0.20000	-0.40101
8.00000	-0.20000	-0.40053
12.00000	-0.20000	-0.40004
16.00000	-0.20000	-0.39957
20.00000	-0.20000	-0.39911
24.00000	-0.20000	-0.39865

EXAMPLE CASE

RUN NUMBER 18

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-35.00000	0.00000	0.00000	1.75000	0.00000	0.00220	-5.24794	-0.00108	0.00150	-0.70000
4.00000	0.00000	-35.00000	0.00000	0.00000	0.75000	0.00000	0.14683	-4.54958	-0.07209	0.00150	-0.70105
8.00000	0.00000	-35.00000	0.00000	0.00000	-0.25000	0.00000	0.29407	-3.86149	-0.14437	0.00150	-0.70209
12.00000	0.00000	-35.00000	0.00000	0.00000	0.75000	0.00000	0.44058	-3.19946	-0.21630	0.00150	-0.70312
16.00000	0.00000	-35.00000	0.00000	0.00000	1.75000	0.00000	0.58306	-2.57854	-0.28626	0.00150	-0.70413
20.00000	0.00000	-35.00000	0.00000	0.00000	0.75000	0.00000	0.71837	-2.01264	0.35269	0.00150	-0.70513
24.00000	0.00000	-35.00000	0.00000	0.00000	-0.25000	0.00000	0.84360	-1.51415	-0.41416	0.00150	-0.70610

ALPP	CHM3	CHM4
0.00000	0.00000	-0.70150
4.00000	0.00000	-0.70101
8.00000	0.00000	-0.70053
12.00000	0.00000	-0.70004
16.00000	0.00000	-0.69957
20.00000	0.00000	-0.69911
24.00000	0.00000	-0.69865

EXAMPLE CASE

RUN NUMBER 16 PAGE 24

ALPP	PHI	DELTAQ	DELTAP	DELTAR	CLMA	CLLA	CLNA	CNA	CYA	CHM1	CHM2
0.00000	0.00000	-35.00000	0.00000	-10.00000	1.75000	0.02000	-1.02122	-5.34794	0.49892	-0.19850	-0.70000
4.00000	0.00000	-35.00000	0.00000	-10.00000	0.75000	0.02000	-0.87588	-4.64958	0.42791	-0.19850	-0.70105
8.00000	0.00000	-35.00000	0.00000	-10.00000	-0.25000	0.02000	-0.72792	-3.96149	0 35563	-0.19850	-0.70209
12.00000	0.00000	-35.00000	0.00000	-10.00000	0 75000	0.02000	-0.58069	-3.29946	0.28370	-0.19850	-0.70312
16.00000	0.00000	-35.00000	0.00000	-10 00000	1.75000	0.02000	-0.43751	-2.67854	0.21374	-0.19850	-0.70413
20.00000	0.00000	-35.00000	0.00000	-10.00000	0.75000	0.02000	-0.30153	-2.11264	0.14731	-0.19850	-0.70513
24.00000	0.00000	-35.00000	0.00000	-10.00000	-0.25000	0.02000	-0.17569	-1.61415	0.08584	-0.19850	-0.70610

ALPP	CHM3	CHM4
0.00000	-0.20000	-0.70150
4.00000	-0.20000	-0.70101
8.00000	-0.20000	-0.70053
12.00000	-0.20000	-0.70004
16.00000	-0.20000	-0.69957
20.00000	-0.20000	-0.69911
24.00000	-0.20000	-0.69865

DATA DOES NOT BOUND DELTA Q PRIME AT POINT 3
ALPHA VALUE OF 8.00000000
GOTO NEXT POINT

DATA DOES NOT BOUND DELTA Q PRIME AT POINT 7
ALPHA VALUE OF 24.0000000
GOTO NEXT POINT

TRIM-3D OPTION

ALPP	PHI	DELTAQT	DELTAPT	DELTAR1	CLMAT	CLLAT	CLNAT	CNAT	CYAT	CHM1T	CHM2T
0.00000	0.00000	0.00000	-0.00150	-0.02154	0.00000	-0.00003	0.00000	0.00185	-0.00001	0.00110	-0.00003
4.00000	0.00000	-20.00198	-0.07050	-1.43836	0.00010	-0.00065	-0.00003	-2 31410	-0.00031	-0.02586	-0.40250
12.00000	0.00000	-20.00497	-0.18412	-4.32131	0.00025	-0.00056	-0.00008	-0.99301	-0.00061	-0.08124	-0.40690
16.00000	0.00000	0.00658	-0.24538	-5.72088	-0.00033	-0.00083	-0.00004	2.61578	-0.00070	-0.10801	-0.00891
20.00000	0.00000	-20.00177	-0.29440	-7.05484	0.00009	-0.00061	-0.00003	0.16720	-0.00053	-0.13371	-0.41105

ALPP	CHM3T	CHM4T
0.00000	-0.00046	-0.00147
4.00000	-0.03018	-0.39964
12.00000	-0.09011	-0.39646
16.00000	-0.11932	0.00547
20.00000	-0.14698	-0.39325

PITCHING MOMENT IS 0.0 ON FIRST OR LAST
PITCH DEFLECTION CURVE AT

ALPHA= 7.00000191 CONTROL DEFLECTION= -35.0000000
ALPHA= 9.00000000 CONTROL DEFLECTION= -35.0000000
ALPHA= 23.0000000 CONTROL DEFLECTION= -35.0000000

NOMENCLATURE

ALPP	Angle of attack, deg
BETA	Angle of sideslip, deg
CHMn	Control surface hinge moment for panel n, n = 1 through 4
C_l, CLL, or CLLA	Rolling-moment coefficient
C_m, CLM, or CLMA	Pitching-moment coefficient
C_N, CN, or CNA	Normal-force coefficient
C_n, CLN, or CLNA	Yawing-moment coefficient
C_x	Generalized aerodynamic coefficient
C_Y, CY, or CYA	Side-force coefficient
DELTAP	Equivalent roll control deflection angle, deg
DELTAPT	Equivalent roll control deflection angle at trim, deg
DELTAQ	Equivalent pitch control deflection angle, deg
DELTAQT	Equivalent pitch control deflection angle at trim, deg
DELTAR	Equivalent yaw control deflection angle, deg
DELTART	Equivalent yaw control deflection angle at trim, deg
L	Derivative of rolling moment with respect to a control deflection, per deg
M	Derivative of pitching moment with respect to a control deflection, per deg
N	Derivative of yawing moment with respect to a control deflection, per deg

PHI	Roll angle, deg
P_n, Q_n, R_n	Specific value of roll, pitch, or yaw deflection angle, respectively; $n = 1, 2, 3, \ldots$
Δ	Difference between two values
δ	Equivalent control surface deflection, deg

SUBSCRIPTS

I	Current value
P	Equivalent roll deflection
Q	Equivalent pitch deflection
R	Equivalent yaw deflection
trim	Parameter value at trim condition