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GEMPAK: An Arbitrary Aircraft Geometry Generator

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CONTENTS

SUMMARY

A computer program, "GEMPAK," has been developed to aid in the generation of detailed configuration geometry. The program was written to allow the user as much flexibility as possible in his choices of configurations and the detail of description desired and at the same time keep input requirements and program turnaround and cost to a minimum. The program consists of routines that generate fuselage and planar-surface (winglike) geometry and a routine that will determine the true intersection of all components with the fuselage. This paper describes the methods by which the various geometries are generated and provides input description with sample input and output. Also included are descriptions of the primary program variables and functions performed by the various routines. The FORTRAN program GEMPAK has been used extensively on the Control Data Corporation 6000 series computers in conjunction with interfaces to several aerodynamic and plotting computer programs and has proven to be an effective aid in the preliminary design phase of aircraft configurations.

INTRODUCTION

The computer has become indispensable as a tool to the aeronautical researcher engaged in design, analysis, and experimental work. Programs of varying levels of sophistication have been written to expedite the study of every field of technology. As the researcher examines the available computer programs in his field of interest, he finds the detail and amount of input information that he must provide usually depends upon the depth of analysis he desires and the scope of application of the program. This is particularly true of geometry definition. Sketchy configuration definitions and approximate solutions are often sufficient for parametric studies. But, as the field of study narrows and more accurate results are desired, the problem of supplying a more detailed geometry input definition becomes very time consuming and the element of human error becomes a prime factor in program turnaround and cost.

Generally, configuration analyses require the use of more than one computer program. This tends to compound the geometry input problem, for although much of the information required by each of the programs is the same, the amount and location of detail may vary. For example, a thermal analysis of a configuration would require a greater degree of detail, especially in areas of high heat stress, than would a force analysis of the same configuration in order to obtain results at the same level of reliability. In addition to having to redefine the configuration geometry according to the priority of each program, the user is called upon to repeat this process for any perturbation of his vehicle. In the preliminary design phase of a configuration, subtle changes in the configuration can require gross input modifications.

The main objective of this paper was to develop a system that would (1) provide rapid turnaround from drawing board to detailed aircraft geometry definition, (2) offer a wide choice of configuration types and degree of detail, and (3) allow geometry to be modified quickly and easily.

Out of this concept has evolved the FORTRAN computer program "GEMPAK," consisting of routines that generate geometry for fuselage, wings, canards, horizontal tails, fins, and elevons. The program executes at 65000_8 storage and a typical configuration of good detail requires a running time of 20_{10} seconds on a Control Data 6000 Series Computer. GEMPAK has been used extensively in the preliminary design phase of the National Hypersonic Flight Research Facility (NHFRF) (hypersonic research airplane, formerly the X-24C), references 1 and 2, and has proved effective in greatly reducing the effort in geometry definition.

In appendix A, a summary of the program routines and their functions is presented. The major program variable descriptions are given in appendix B. Appendix C presents inputs and outputs for sample cases.

DESCRIPTION OF COMPUTER PROGRAM "GEMPAK"

The computer program GEMPAK consists of three major parts: the fuselage generator, the generator for planar surfaces, and the module for integrating the configuration components with the fuselage. The program logic flow is illustrated in figure 1. The geometry routines of GEMPAK generate the geometries specified by the user and store the resulting coordinates in their respective component arrays. The configuration may be internally defined by the program with very little input information or the user may input a point-by-point description of a component of arbitrary geometry. Each component is input and generated independently; thus, the user is able to make isolated changes more readily. The program will scale the resulting geometries for compatibility and will merge the components into an integrated configuration.

The fuselage can be defined analytically by three to eleven lofting curves. These curves may be continuous or discontinuous and the user need input only the minimum number of points that can be fitted with conic sections for a good reproduction of his configuration. The number of cross sections and points per cross section can easily be controlled or altered in this input mode. Cross-section and point-by-point input options are also provided which yield a lesser degree of subsequent control over the fuselage geometry.

The wing, canard, horizontal tail, fin, and elevon are all generated by a single type of calculation. A one- or two-panel surface can be generated with basic input parameters such as aspect ratio, taper ratio, and sweep angles. A slab-sided airfoil or a circular-arc airfoil can be input with a minimum of input or an arbitrary airfoil may be input with a point-by-point description. Changes in dihedral, twist, coordinate translation, angle of attack, and roll angle are program options available to the user.

The ease with which GEMPAK can be used and the wide range of configuration types to which it may be applied have proven it to be an effective tool in engineering design. Figure 2 illustrates some configurations generated by GEMPAK.

The remainder of this text will concentrate on a more detailed description of the computer program, GEMPAK, its routines, capabilities, and use.

FUSELAGE GEOMETRY GENERATION

Formulation

The information about the fuselage geometry of a given configuration may become available to the analysis in a variety of forms. Drawings or sketches showing planforms, profiles, or area distributions (with or without cross-section definitions) are the usual forms of initial data. In some cases tabulated data may be the most readily available form. The fuselage geometry scheme described here was developed to accommodate input data from each of these forms. Three basic modes to input controlling data were formulated for versatility and user ease. These input modes are denoted as

(1) Complete lofting or analytic modeling

(2) Cross-section lofting

(3) Point by point

The degree of user control of the basic numerical model depends on the input mode utilized. Input mode 1 (complete lofting) was developed to generate a completely analytic numerical model from a minimum of longitudinal and cross-sectional input data. The total number of points, cross-section locations, and point distribution are easily varied by very simple input modifications. Input mode 2 (cross-section lofting) is structured around lofting data input for discrete prescribed cross-section locations. The numerical model is not analytic in the longitudinal direction and subsequent control of the numerical model is limited to the initial set of cross-section input. However, the number of points per cross section and their distribution can still be controlled by simple inputs. Input mode 3 (point-by-point) requires all surface points to be input at discrete longitudinal locations. The resulting numerical model is completely nonanalytic. No interpolation routines are provided in either the longitudinal or cross-sectional directions so that the initial input must contain all the user-desired cross sections and their point distribution. The amount of input is usually the least for input mode 1 and the greatest for input mode 3. Symmetry about the XZ or longitudinal-vertical plane has been assumed so that only half of the fuselage is required as input in all three modes. The following section contains a discussion of the analytic methods employed to control the numerical model of the fuselage geometry.

Analytic Curve Definition

All longitudinal and cross-sectional curves used in input modes 1 and 2 are formed by a chain of second-degree curve segments. The three-dimensional space curves describing the outer mold line of the fuselage are defined by their projections into the coordinate planes. All cross sections are taken perpendicular to the longitudinal axis. The reference or input coordinate axes is a right-handed system made up of the longitudinal or X-axis defined as positive from nose to tail; the lateral or Y-axis defined as positive from the fuselage center line outboard, and the vertical or Z-axis defined as positive upward. The longitudinal curve segments in this coordinate system are represented by two general second-degree equations

$$A_1x^2 + B_1xy + C_1y^2 + D_1x + E_1y + F_1 = 0 \tag{1}$$

and

$$A_2x^2 + B_2xz + C_2z^2 + D_2x + E_2z + F_2 = 0 \tag{2}$$

The cross-sectional curve segments are represented by the single general second-degree equation

$$A_3y^2 + B_3yz + C_3z^2 + D_3y + E_3z + F_3 = 0 \tag{3}$$

It is assumed that the basic information available to determine the coefficients for each segment contains the end points and their slopes as illustrated for the XY projection plane in figure 3. These four pieces of information are not sufficient to determine the six coefficients (A, B, C, D, E, and F) of equations (1) to (3). In the reference coordinates, however, a rotation and translation of the coordinates can be employed to reduce the number of required coefficients. The usual angle of rotation employed to eliminate the B coefficient is defined by

$$\cot 2\Phi = \frac{A - C}{B} \tag{4}$$

where A, B, and C are the second-degree term coefficients and Φ is the angle of rotation. A suitable translation can then be used to determine one of the other five coefficients if the type of conic section to be fitted is known a priori. This required foreknowledge of type of conic for each segment (both longitudinally and in cross section) did not seem consistent with the overall purpose of the geometry package which is to provide rapid and simple input capability. The requirement of prior knowledge of conic section could be relieved by supplying an additional piece of curve information such as an intermediate set of segment coordinates between the end points. Again, this additional input was not desirable. The approach here was to assume all curved segments to be sections of an ellipse. Within this limitation, the rotation angle was altered from that shown in equation (4) to a more convenient form which is determined in the following manner. Two straight lines are determined, each of which contains one of the end points and its respective slope. If the two slopes are not parallel, the intersection of these straight lines is determined and denoted as the slope control point at each end point (fig. 4). The distances d_{13} and d_{23} between this slope control point and each end point of the segment are calculated. The rotation angle is chosen so that the abscissa of the rotated coordinates x' and y' is parallel to the straight line containing the longest straight-line segment (fig. 5). A translation is then performed to place the origin coincident with the segment end point contained in the longest of the straight-line segments d_{13} and d_{23}. The new coordinate axes are denoted by X" and Y" in figure 5. If the slopes at the end points are nonorthogonal, the equation of the elliptical segment in transformed coordinates becomes

$$(x'')^2 + \bar{C}(y'')^2 + \bar{E}(y'') + \bar{F} = 0 \tag{5}$$

The coordinates at the end point and the slope of the shortest side are used to solve for the three unknown coefficients $\bar{C}$, $\bar{E}$, and $\bar{F}$. If the slopes at the end points are orthogonal, the origin of the ordinate axis (Y" in this case) is translated to become coincident with the ordinate of the end point nearest the slope control point. The equation for the elliptical segment in these coordinates (x''' and y''') becomes

$$(x''')^2 + \bar{C}(y''')^2 + \bar{F} = 0 \tag{6}$$

The two unknown coefficients $\bar{C}$ and $\bar{F}$ are then determined from the segment end points. The forms of equations (5) and (6) are particularly useful in constructing cross-sectional segments since the ordinates are always single-valued and intermediate values along the segment can be easily determined.

If the slopes of the segment end points are parallel and a straight line will contain both end points and end slopes, two possibilities occur which cannot be fitted in this manner (fig. 6). If the two slopes are parallel to each other and perpendicular to the straight line formed by the two end points, the entire family of ellipses matches the input data. Therefore, the total meridional angle subtended by the elliptical segments must always be less than 180°. If the two slopes are parallel to each other and are not perpendicular to the straight line connecting the end points, the single curve which matches both the slope and end-point conditions contains an inflection and cannot be fitted with a second-degree curve segment. If either of the two conditions listed is encountered in the formulation described here, an error message is printed and the calculation is continued by creating a straight-line segment between the end points. This default option, which is the correct solution in figure 6(c), was incorporated so that the remaining geometry could be viewed for errors as early as possible.

Auxiliary Fuselage Geometry

Since the basic purpose for developing this geometry package was for use as an aerodynamic design tool, several geometric calculations most often required in the design process have been incorporated directly into the basic numerical model definition for convenience. The basic formulation creates an equal number of points per cross section. This characteristic results in a quadrilateral for the primary surface elements. Therefore, the method described by Arvel E. Gentry in reference 3 for treating irregular surface quadrilaterals has been incorporated into this formulation to provide surface normals, areas, centroids of elements, and fuselage volumes. Additional capability has been added here to include cross-sectional areas, coordinates of the maximum span (planform) point at each cross section, and effective fineness ratio of the fuselage. The longitudinal and vertical centers of volume are also calculated for use in the initial estimates of fuselage center of gravity.

An additional highly specialized capability related to fuselage-mounted propulsion systems has also been incorporated into the fuselage geometry package. The scramjet propulsion systems proposed for hypersonic air-breathing aircraft are highly integrated with the aerodynamic surfaces to enhance propulsion system performance (ref. 4). The bookkeeping between aero and propulsion forces tends to become a difficult chore for subsequent calculation under these conditions. To facilitate the bookkeeping process, those portions of the fuselage subtended by the engine and/or exhaust plume are identified and supplied as a separate aerodynamic surface. The method used to generate this surface requires defining the planform of the propulsion system and/or its exhaust plume by the same longitudinal lofting techniques employed for the basic fuselage. This planform (represented by the shaded area in fig. 7) is projected onto the already formed fuselage to extract the three-dimensional surface that is common to both the aerodynamic vehicle and the propulsion system. The running lengths along the fuselage surface ahead of this new geometry are also calculated to make appropriate skin-friction corrections.

PLANAR-SURFACE GEOMETRY GENERATION (WINGS, TAILS, ETC.)

The planar-surface generation routine will compute, from simple input, winglike surfaces of varying degrees of complexity. The wing planform is developed first and then airfoil sections selected. This basic wing may then have flap surfaces delineated and deflected and/or twisted, translated, and rotated to any desired position. The end product of the program is a set of geometric points describing the wing surface in detail. This set of coordinates is loaded into one of four user-selected arrays identified as either a wing, canard, horizontal tail, or fin.

The planar-surface package is organized in a modularized step-by-step fashion as illustrated in figure 8. User input also follows the same logic flow. By keeping in mind this logical order, it should be relatively easy to visualize how input at one stage of the program will be modified by input at a later stage. In general, only a small portion of the input is required for any single case, and extensive default options allow the user to skip nonapplicable areas. Input values are checked at the beginning of the program to eliminate any obvious inconsistencies. In the case of an input conflict, the program will select a value, print a warning message, and attempt to continue.

Two basic methods of inputting a wing surface can be used. First, an automatic procedure in which a one- or two-panel wing can be constructed with such basic parameters as aspect ratio, taper ratio, and sweep angles (fig. 8). Three airfoil options are available for this automatic procedure. A second input method requires a detailed hand input of every chord surface. Such an input would be needed if airfoil sections were not similar between chords or if leading or trailing edges are curved in planform. Once the basic wing has been input by either of these methods, it can be manipulated by subsequent wing options (fig. 8).

The remainder of this section will be devoted to a detailed discussion of the various input and manipulative options available to the user.

Automatic Planar-Surface Option

This option is designed for the user who wishes to characterize a wing type with basic parameters such as aspect ratio, taper ratio, and sweep angles. The coordinate system and surface plan parameters are shown in figure 9. With reference to this figure the plan area can be specified by inputting wing area and aspect ratio. The root- and tip-chord lengths are calculated by the program. Alternately, the root chord and taper ratio can be specified.

Slab-sided airfoil.- Many supersonic and hypersonic aircraft wing sections feature wedge, diamond, and trapezoidal shaped airfoils of types shown in figure 10. These sections can be input easily with this option and automatically adjusted for variable spanwise camber and thickness distribution. In order not to lose geometric definition, the program will locate a spanline at each airfoil breakpoint.

Leading-edge radii may be easily incorporated into the slab-sided airfoil by means of a leading-edge option. Leading-edge radius (R) may be specified as a constant or it may be specified proportional to chord length. With reference to figures 10 and 11, the leading-edge surface is described by the following equations:

$$X \square R(1 - \cos \delta)$$

$$Z = R(\sin \delta)$$

$$\delta = n(\delta_e) \qquad (n = 1 \text{ to } N)$$

$$\delta_e = \frac{OM}{N} \qquad (N \text{ is equal to the largest integer for } \delta_e \leqq 22.5^{\circ})$$

OM is the angle to the leading-edge tangent point on chord
= the larger of OML and OMU

$$\mathrm{OMU} = 90. + \beta + \alpha \qquad \text{(Upper surface)}$$

$$\mathrm{OML} = 90. - \beta - \alpha \qquad \text{(Lower surface)}$$

$$\alpha = \sin^{-1}\left(\frac{R \cos \beta}{\mathrm{XWD1} - \frac{R}{\mathrm{XC}}}\right)$$

$$\beta = \tan^{-1}\left[\frac{\mathrm{TCD} - (J)\left(\frac{\mathrm{TWRD}}{2}\right)}{\mathrm{XWD1} - \frac{R}{\mathrm{XC}}}\right]$$

$$J = 1 \qquad \text{(Upper surface)}$$

$$J = -1 \qquad \text{(Lower surface)}$$

TCD, XWD1, and TWRD are defined in figure 10. Points are calculated around the leading edge at increments no greater than 22.5°. If a leading-edge diameter is calculated to be larger than a maximum chord thickness, the program will automatically increase local wing thickness ratios to match leading-edge diameter. (See fig. 11.)

Circular-arc airfoil.- Airfoil families consisting of circular arcs are also typical of supersonic and hypersonic designs (fig. 12). As with the slab-sided airfoil, this option allows the user to specify spanwise camber and thickness ratio distributions. With reference to figure 12, the airfoil surface equations are as follows for a cambered airfoil:

$$Z = (J)(\mathrm{XC})\left\{\left[A^2 - 0.25 - \left(\frac{X}{\mathrm{XC}}\right)^2 + \frac{X}{\mathrm{XC}}\right]^{1/2} - \left(A^2 - 0.25\right)^{1/2}\right\}$$

$$+ (\mathrm{XC})\left\{\left[B^2 - 0.25 - \left(\frac{X}{\mathrm{XC}}\right)^2 + \frac{X}{\mathrm{XC}}\right]^{1/2} - \left(B^2 - 0.25\right)^{1/2}\right\}$$

$$J = 1 \qquad \text{(Upper surface)}$$

$$J = -1 \qquad \text{(Lower surface)}$$

$$A = 0.25\left(\frac{TWRD^2 + 1}{TWRD}\right)$$

$$B = 0.5\left(\frac{TCD^2 + 0.25}{TCD}\right)$$

X coordinate, origin at leading edge

XC, TWRD, and TCD are defined in figure 12.

Leading-edge radii are incorporated into the circular-arc airfoil in a manner different from that used on the slab-sided airfoils. With reference to figure 13, the leading-edge radius is first fitted to an uncambered circular-arc airfoil of the proper thickness. A constant radius arc with a maximum displacement at the maximum thickness point is then constructed as a mean camber line. The coordinates of the symmetrical airfoil are then displaced by an amount equal to this mean camber line. The resulting cambered airfoil approximates leading-edge geometries proposed for hypersonic applications. The leading-edge geometry generation method for a symmetrical airfoil is as follows:

$$X = R(1 - \cos \delta)$$

$$Z = R(\sin \delta)$$

$$\delta = n*\delta_e \qquad (n = 1 \text{ to } N)$$

$$\delta_e = \frac{OM}{N} \qquad (\text{For } N \text{ equal to the largest integer for which } \delta_e \leqq 22.5^\circ)$$

$$OM = 90^\circ - \tan^{-1}\left(\frac{BC}{RC - \frac{TWRD}{2}}\right)$$

$$BC = \left(\frac{R}{XC} - \frac{TWRD}{2}\right)\left(\frac{R}{XC} + \frac{TWRD}{2} - 2RC\right)^{1/2}$$

$$RC = \frac{(FC)\left(\frac{R}{XC}\right) - (EC)^2(DC) - GC}{2\left(\frac{R}{XC}\right)^2}$$

$$GC = \left\{\left[(EC)^2(DC) - (FC)\left(\frac{R}{XC}\right)\right]^2 - \left(\frac{R}{XC}\right)^2 \left[(FC)^2 - 4(EC)^2(CC)\right]\right\}^{1/2}$$

$$CC = \left(\frac{R}{XC}\right)^2 - \left(\frac{TWRD}{2}\right)^2$$

$$DC = 2\left(\frac{R}{XC} - \frac{TWRD}{2}\right)$$

$$EC = \frac{R}{XC} - 1$$

$$FC = 2\left(\frac{R}{XC}\right)^2 - 2\left(\frac{R}{XC}\right) + 1$$

R = Leading-edge radius

Arbitrary airfoil.- By specifying the upper and lower surface coordinates of any airfoil as shown in figure 14, the program will scale these coordinates to fit all wing chords. Although upper and lower surface Z values need not be input in pairs at specific X stations, the program will interpolate to find paired upper and lower surface Z values at specific X stations. These X stations will be averaged from input values or will be spaced equally along the chord depending on user preference.

The user may find this a convenient program input location in which to read in airfoil coordinates generated by an airfoil geometry generation program such as those of references 5 and 6.

Manual Planar-Surface Generation

For those cases where the automatic input options are unsatisfactory, an option is provided by which every chord surface may be specified. Figure 15 illustrates the input method. Note that both upper and lower surface points must be paired to lie on the same chord stations for a given airfoil. Chordwise points can remain within the program as they were input, or they may be equally respaced chordwise, depending on user input.

Automatic Manipulations of Generated Planar-Surface Geometry

Leading-edge geometry enrichment.- Some aerodynamic programs may require greater geometry definition at chord leading edges than is normally given by typical panel points. Accordingly, a very detailed set of geometry points are calculated and stored for a typical chord, which is chosen as that chord which lies nearest the middle of a surface semispan. Thirty geometry points between the 0- and 0.1-chord locations for both the upper and lower surfaces are stored. The X coordinate values (in percentage of chord lengths) are determined through the following geometric progression:

$$K^{NO-1} - \left(\frac{XX2}{XX1}\right)(K) + \left(\frac{XX2}{XX1} - 1\right) = 0$$

with

$NO = 30$

$XX1 = 0.001$

$XX2 = 0.1$

and K is the geometric progression constant. A solution for K is obtained and the following equation solved for leading-edge Ith + 1 X values:

$$X(I + 1) + \left[K^{(I-1)}\right](XX1) + X(I)$$

Leading-edge values of Z are linearly interpolated from calculated or input chord points.

Control surface deflections.- A flap option is provided that allows the user to create a full-span flap surface on any wing planform and to deflect this flap to a given angle. The option is also available which allows the user to store the newly created flap in a separate array. This array is then available to other application programs to calculate trimmed aerodynamic calculations. The flap surface is defined by specifying a linear hinge line (fig. 16(a)) across the full wing span with the wing in its original input position. Subsequent translations and rotations will affect the wing and flap equally. The hinge line is assumed to be centered within the wing root and tip chord airfoils (fig. 16(b)). Span lines over the wing surface are automatically redistributed to coincide with the input hinge-line location and flap geometry. This redistribution of span lines can, however, destroy the close spacing of points needed for leading-edge detail; therefore, an additional user input is provided whereby a specified number of leading-edge points will be left undisturbed during the spanwise point redistribution process. In the case of the slab-sided airfoil or circular-arc airfoil, the leading-edge points are automatically left undisturbed.

Flap deflection angles are specified as the incremental angle through which the flap surface must move in a plane normal to the hinge line. This deflection is measured relative to a line connecting the hinge line with the flap trailing edge (fig. 16(b)). The rotation is accomplished by rotating the hinge line parallel to the Y-axis by means of a roll and yaw rotation and then deflecting the flap through an angle of attack. The flap is then rotated back to its original hinge-line position through a yaw and roll transformation. As shown in figure 16, upper and lower flap surfaces may be deflected independently to simulate a speed brake.

Situations often develop where an all-movable control surface is required. An option is provided therefore to designate a surface as an all-movable surface and to designate the hinge line about which the surface pivots. The input is similar to that required for the flap option with the addition of Z values required for the hinge-line location. An input deflection angle will cause the surface to rotate in a plane perpendicular to the hinge line. Unlike the flap array, respacing of span lines is not required.

Dihedral.- Dihedral can be added to any automatically generated or hand input wing surface. For the purposes of this paper, dihedral is defined as a vertical translation of wing points to a specified dihedral angle or curvature. This nomenclature is defined in figure 17(c) and can be contrasted to the concept of wing roll, in which all wing points are rotated about a common X-axis (fig. 17(c)). Roll will be discussed in a subsequent section. Note that the dihedral option will leave all chords in their original input plane. Dihedral angles can be specified at root and tip leading edges (fig. 17(b)). A second-order curve is fitted between the root and tip chord as follows:

$$Z = \frac{\tan\ (AWT) - \tan\ (AWR)}{BW} Y^2 + \left[\tan\ (AWR)\right] Y$$

If AWT and AWR (see fig. 17) are input identically, the leading-edge curve is linear. Alternately, leading-edge dihedral may be input point by point as illustrated in figure 17(a).

Twist.- Wing twist is computed as a rotation of the wing chords about their leading edges in the XZ plane (fig. 18). Twist is specified in this program as a tip deflection angle. Positive twist results in a wing-tip trailing edge deflected downward. Twist angle is linearly decreased to zero at the wing root.

Translation and rotation.- All wing surfaces may be translated as complete units to any desired location as illustrated in figure 19(a). The program user must bear in mind that translation occurs before rotation and that subsequent rotation will alter the translational position.

Rotation is the last operation performed on wing geometry. Figures 19(b), 19(c), and 19(d) illustrate how three rotation angles and axes must be specified. The order in which rotation occurs will uniquely define the final coordinate values. In this program rotation occurs in the order (1) roll, (2) pitch, and (3) yaw. This order is specified in the "calls" to the rotation subroutine, and may be easily changed by modifying the argument list of these calls. Rotation is computed by the following equations:

Roll:

```
XR=X
YR=(Y-YROTAT) cos(THETA)-(Z-ZROTAT) sin(THETA)+YROTAT
ZR=(Z-ZROTAT) cos(THETA)-(Y-YROTAT) sin(THETA)+ZROTAT
```

Pitch:

```
XR=(X-XROTAT) cos(ALPHA)+(Z-ZROTAT) sin(ALPHA)+XROTAT
YR=Y
ZR=(Z-ZROTAT) cos(ALPHA)-(X-XROTAT) sin(ALPHA)+ZROTAT
```

Yaw:

```
XR=(X-XROTAT) cos(BETA)-(Y-YROTAT) sin(BETA)+XROTAT
YR=(Y-YROTAT) cos(BETA)-(X-XROTAT) sin(BETA)+YROTAT
ZR=Z
```

where XR, YR, and ZR represent the rotated values.

COMPONENT INTEGRATION

After all geometry chosen by the user has been generated, control passes to the overlay MERGE. The primary function of MERGE is to exercise the user option for program calculation of the intersection of any surface (wing, tail, etc.) with the fuselage. (See input description of IMERGE in Namelist WING.) To insure compatibility of all planar-surface and fuselage geometry arrays with each other and with any program analytical operations on the geometry, MERGE scales all the geometries to a common reference length. In addition, an array arrangement of planar-surface geometry data is prescribed and expected. Figure 20 illustrates this array arrangement. Chord locations are numbered from inboard to outboard (root to tip) and surface stations along each chord are numbered from fore to aft (leading to trailing edge). The upper and lower surface arrays will always be positioned as shown. Because there are relatively few restrictions on the user as to what manipulations he may perform on a set of planar-surface geometry, the final form of the generated arrays may no longer be arranged in the prescribed fashion. For example, in generating a planar surface, the user may have requested that the surface be rolled 180°, and may thus reverse not only the upper and lower geometries, but the numbering of the chord locations as well. In order to prevent any such inconsistencies in data arrangement, MERGE inspects all planar-surface geometry arrays and reverses and/or renumbers geometry locations as necessary. The program then continues to merge these surfaces with the fuselage, as required. Figure 21 shows in diagram form the operations performed by MERGE.

Components are merged with the fuselage by finding the intersection of each surface ray of the component with a fuselage panel, a surface ray being a surface span line and panels being the smallest four-sided elements in the fuselage geometry description. The locus of points containing all the ray intersections for both the upper and lower surfaces is added to the definition of the component and the array location is defined so that all geometry inboard should be deleted.

The following paragraphs describe in more detail the methods used in MERGE to find the intersection of a surface ray with the fuselage.

Limits of Search for Intersection

In finding the intersection of a surface ray with the fuselage, MERGE first sets the search limits of intersection in order to avoid unnecessary iterations. The most outboard limit of the surface ray is that segment shown in figure 22 that intersects the fuselage planform and the search along the ray continues inboard for each segment. The range of fuselage cross sections that are spanned by this segment limits the fuselage geometry that will be searched for intersection and only those panels on the fuselage segment that are spanned by the ray segment in the YZ plane are tested. If after exhausting this set of search limits without finding an intersection, a new set of limits corresponding to the next inboard ray segment are obtained and the iteration procedure is repeated.

Intersection Estimation

The order of search through the fuselage segment is dependent upon the slope of the ray segment. For a positive slope in the XY plane, the fuselage segment is searched from forward to aft. For a negative slope this order is reversed. Fuselage panels are always searched from the uppermost panel to the lower. Panels are discarded until one is found such that at least two of its sides are intersected by the surface ray segment vector in the YZ plane at P_1 and P_2. Figure 22 indicates with a sample fuselage segment the panels where this would occur and numbers them in the order in which they would be found. The values of X corresponding to the Y and Z values of the two intersection points P_1 and P_2 are $X_{R,1}$ and $X_{R,2}$, respectively, on the ray segment and $X_{F,1}$ and $X_{F,2}$, respectively, on the fuselage panel. There are now two sets of X values for each of the intersections P_1 and P_2 (fig. 23). By assuming that the relationship between the two sets of X values is linear, the point at which the fuselage and the ray segment vector would share a common X value, X_i, can be determined. The Y and Z coordinates corresponding to X_i

on the ray segment vector are found. Thus, the point (X_i,Y_i,Z_i) is an estimated point of intersection. It is necessary to determine whether this point still lies within the fuselage panel maximum and minimum limits as well as on the surface ray segment. After this information has been verified, the program checks for irregularly shaped panels, such as those shown in figure 24, which violate the previous tests and would have allowed an erroneous intersection point.

Intersection Verification

To account for the possibility of irregularly shaped panels as viewed in the YZ plane, the fuselage panel with which a ray segment has been found to intersect is assigned more specific boundary limits. The fuselage panel is divided into two triangles according to the location of the intersection of the fuselage panel diagonals. Figure 25 shows the four possible locations of the diagonal intersections and the corresponding panel divider that will divide the panel into two triangles. After the two sets of triangle limits for the candidate intersection point (Y_i,Z_i) have been assigned, the "triangle check" is applied to determine whether this point lies within one of these two triangles. From each vertex of a triangle, a line is drawn to include the intersection point and a point of the opposite side (fig. 26). If for one of the two panel triangles the point (Y_i,Z_i) lies between each vertex and the point on its opposite side, it is assumed to lie on the fuselage panel.

Finally, the normals of the fuselage panel that contains the ray intersection point and of the surface ray segment are computed to determine the angle of direction of intersection. This final test is applied in order to insure that the entry point of the surface ray with the fuselage has been found rather than the exit point.

If a candidate intersection point is not verified within the fuselage limits of a search, a new set of fuselage limits is assigned corresponding to the next inboard ray segment and the entire iteration procedure is repeated.

Surface Ray of No Intersection

If, after exhausting the limits of the surface ray, no intersection is found, MERGE estimates an intersection for this ray by extrapolating the intersection of the previous ray. If the leading-edge ray is found to have no intersection with the fuselage, a diagnostic message is issued and further attempt at merging the component with the fuselage is abandoned. Figure 27 illustrates the cutoff of surface rays that do not touch the fuselage.

Intersection Geometry Definition

After the intersection points of all the surface rays for both the upper and lower surfaces of a component have been found, these points are added to the geometry definition of the component and the array or chord location of the intersection is identified by array NST. Figure 28 indicates how the geometry arrays are renumbered to include this additional chord location. Note that the intersection location is given its most outboard chord position of 4 in order to maintain monotonicity of array positions. This is done for both the upper and lower surfaces and the larger value of NST defines the array position. Chord locations NST through the tip chord location define the component outboard of the fuselage. After all components have been merged with the fuselage, the resulting geometry arrays are written onto TAPE38 in FORTRAN Namelist form.

GEMPAK INPUT DESCRIPTION

The geometry generation options specified by the user are the main control parameters of GEMPAK. These options dictate the flow of execution, the information that must be specified by the user, and the order in which this input must be arranged. Figure 29 illustrates the input flow of GEMPAK and the option flags that control the flow path in figure 1. Samples of GEMPAK input and output are found in appendix C. A description of these inputs and a discussion of how they are applied follow.

GEMPAK TITLE CARD

Variable name	Column(s)	Format	Variable description
TITLE	1 to 80	80A1	Job identification using any acceptable alphanumeric characters

GEMPAK GEOMETRY OPTION CARD

Variable name	Column(s)	Format	Variable description
ICOMP	1 to 30	10I3	Geometry generation options. Any or all the following options may be chosen; however, no option may be chosen more then once in a run. 1: Fuselage 2: Wing 3: Canard 4: Horizontal tail 5: Fin 6-10: Not used at present The component geometries are generated in the same order in which the options are chosen.

INPUT FOR FUSELAGE GEOMETRY GENERATION

The fuselage input requirements have been divided into eight basic sets of information as illustrated in figure 29. The several possible paths of data flow illustrated are all user options. The centermost vertical path represents the default options in lieu of any user preferences. The minimum number of card sets required to run any problem is two (card sets 1 and 7) and the maximum number of card sets required is five (card sets 1, 2, 3, 8, and 4, or 5, or 6). However, these maximums and minimums on card sets do not reflect any corresponding maximum and minimum on the magnitude of input data. The contents and influence of each of these card sets are included in the following discussions.

Card Set 1: Title, Geometry Limits, Program Option Flags

This card set is always required. Three types of card input are utilized as shown in figure 30.

One of card type 1A is required. The purpose of this card is to provide the user with an 80-column free field input to identify the computer run or problem. The data on this card are simply read in and subsequently printed out as the first item in the fuselage output data.

The information on card type 1B controls the length of the fuselage (BDYL), the limits of input lofting data for input modes 1 and 2 (LOFMX), the number of fuselage cross sections (NXS), the number of points per cross section (NSS), the choice of fuselage input mode and subsequent calculations desired (INC(I),I = 1,5), the printed output desired (NP(I),I = 1,5), and a preliminary data input check (IDACHK).

The influence of most of these parameters depends on the choice of the surface data input mode. BDYL is independent of input mode and is simply the length of the fuselage from nose to tail. The units, however, must be consistent with fuselage coordinate inputs.

LOFMX controls the number of lofting and slope control lines to be used in the complete lofting input mode or the number of cross-section segment end points and slope control points to be supplied in the cross-section lofting input mode. LOFMX lofting lines or segment end points at each cross section will be provided for the two longitudinal projection planes (XY and XZ). LOFMX - 1 slope control lines or slope control points at each cross section will be provided in the two longitudinal projection planes. The maximum number of lofting lines or segment end points at each cross section that can be defined is 11. A minimum number of two are required to run any case. LOFMX has no effect on the point-by-point input mode and may be omitted when that option is chosen.

NXS defines the number of cross sections that will be utilized in this case. The longitudinal locations of these NXS cross sections must be provided on card type 1C.

NSS defines the number of points per cross section that will be utilized. NSS cross-section points will be generated when either the complete lofting or cross-section lofting input modes are employed. When the point-by-point input mode is utilized, card set 7 must contain NSS points for each of the NXS cross-section locations.

The choice of input mode is controlled by INC(1). If INC(1) = 0, the complete lofting input mode will be utilized and card set 4 must be provided. If INC(1) = 1, the data are provided in a streamwise or longitudinal manner and card set 5 is required. If INC(1) = 3, the data are provided cross section by cross section and card set 6 is required. If INC(1) = 2, the point-by-point input mode is employed and card set 7 is required.

INC(2) controls the distribution for the NSS points on each cross section for the complete lofting (INC(1) = 0) and the cross-section lofting (INC(1) = 1 or 3) input modes. If INC(2) = 0, the curve length of the cross section is calculated and the NSS points are evenly distributed over this length. If INC(2) = 1, an uneven distribution of cross-section points based on the LOFMX - 1 cross-section segments is employed. The exact distribution of points on each segment is controlled by card set 3 which must be supplied when INC(2) = 1.

INC(3) controls all major auxiliary calculations defined in "Auxiliary Fuselage Geometry" with the exception of the aero/propulsion geometry surface. If INC(3) = 0, only the lateral and vertical coordinates of the maximum spanwise (planform) cross-section points are determined. If INC(3) = 1, all areas (surface and cross-section), surface normals, volumes, centroids (surface element and volumetric), and effective fuselage fineness ratio are calculated.

INC(4) controls the calculation of the aerodynamic surface subtended by the propulsion system as previously described in "Auxiliary Fuselage Geometry." If INC(4) = 0, the aero/propulsion surface will not be generated. If INC(4) = 1, the aero/propulsion surface will be generated and card set 8 which controls this surface must be provided.

INC(5) defines the type of control that is used to govern the initial and final slopes of each cross-section segment generated when either the complete lofting (INC(1) = 0) or the cross-section lofting (INC(1) = 1 or 3) input modes are chosen. If INC(5) = 0, the slope control is governed by lofted slope control lines supplied in card set 4 for the complete lofting (INC(1) = 0) input mode or by slope control points supplied in card sets 5 and 6 for the cross-section lofting (INC(1) = 1 or 3) input mode. If INC(5) = 1, the slope control of prescribed cross-section segments is controlled through card set 2 which must be supplied.

Five print options, controlled by NP(I),I = 1,5, are available to the user. NP(1) controls the output of the cross-section coordinates of the final numerical model. If NP(1) = 0, this print option is bypassed. If NP(1) = 1, all Y and Z coordinates on each cross section are printed. The cross-section points are presented in a clockwise fashion beginning at the upper center line of the fuselage. The planform point (lateral and vertical coordinates of the maximum spanwise point) is presented separately for each cross section along with the longitudinal location of the cross section.

NP(2) controls the output of the longitudinal distributions of surface area, cross-section areas, fineness ratio, the volumes and their centers contained between successive cross sections, and complete fuselage volume and its center. If NP(2) = 0, this print option is bypassed and exercised when NP(2) = 1.

NP(3) controls the output of individual surface quadrilateral data for the final numerical model. If NP(3) = 0, this output option is bypassed. If NP(3) = 1, the direction cosines of the surface normals, the coordinates of the centroids of the surface element, element surface areas, and the delta volume associated with each element are printed. The delta volumes are those contained within the parallelpiped formed when the surface elements are projected onto the YZ plane. The delta volumes have an associated sign for volume summations, where the sign of each delta volume is the same as that of the lateral direction cosine N_Y calculated for its element of surface area. Therefore, those surface elements facing away from the YZ plane have a positive sign and those elements facing toward the YZ plane have a negative sign. All surface element data are presented in a clockwise fashion beginning at the top center line of the fuselage for each segment of volume contained between successive cross sections.

NP(4) controls the output for the coefficients of equations (1) and (2) in reference coordinates. These coefficients define the longitudinal segments of the lofting lines and slope control lines used in the complete lofting input mode. A sign SG is also printed which is valid only when the longitudinal coordinate is taken as the independent variable, that is, when

$$Y = \frac{-B_1X - E_1 + SG\sqrt{(B_1X + E_1)^2 - 4C_1\left(A_1X^2 + D_1X + F_1\right)}}{2C_1} \tag{7}$$

or

$$Z = \frac{-B_2X - E_2 + SG\sqrt{(B_2X + E_2)^2 - 4C_2\left(A_2X^2 + D_2X + F_2\right)}}{2C_2} \tag{8}$$

If NP(4) = 0, this output option is bypassed. If NP(4) = 1, the longitudinal values (x coordinates) of the end points of the segment, the type of curve (lofting or slope control), the coordinate plane of projection, the six coefficients (A, B, C, D, E, and F), and an associated sign (SG = ±1) are presented.

NP(5) controls the output of the coefficients of equation (3) which is used to define the cross-section segments in the complete lofting (INC(1) = 0) and cross-section lofting (INC(1) = 1 or 3) input modes. If NP(5) = 0, this print option is bypassed. If NP(5) = 1, the longitudinal location of the cross section, the cross-section segment number (counted clockwise from the upper fuselage center line), and the six coefficients (A, B, C, D, E, and F) for reference coordinates are presented. Because of the formulation of the program, these cross-section segments can be double-valued in both variables for the reference coordinates. Therefore, an associated sign is not presented in this print option.

IDACHK controls the checking of the fuselage input data for consistency and order. If IDACHK = 0, the input data are assumed correct. If IDACHK = 1, special data check options are initiated during the normal operation of the calculation requested. If no errors occur, the appropriate calculations are performed. If errors which can be detected do occur, an appropriate error message is printed which usually indicates the probable source of error. Once this data check has been successfully exercised, IDACHK should be set equal to zero.

Card type 1C controls the longitudinal locations of the cross sections and provides for the input of eight cross-section locations per card until NXS locations have been prescribed. These locations must be provided in order of increasing X. If the complete lofting input mode is chosen, then each lofting and slope control line projection must be completely defined over the region set by the initial and final cross-section locations. If the cross-section lofting input mode is chosen, then LOFMX segment end points and LOFMX - 1 slope control points must be provided at each cross-section location through card sets 5 or 6. If the point-by-point input mode is selected, then NSS points at each cross-section location must be provided through card set 7.

Card	Variable name	Column(s)	Format	Variable description
1A	TTL	1 to 80	8A10	Fuselage identification using any acceptable alphanumeric characters
1B	BDYL	1 to 15	E15.8	Body length
	LOFMX	16 to 20	I5 (Right-adjusted)	Maximum number of lofting lines ($2 \leqq \text{LOFMX} \leqq 11$)
	NXS	21 to 25	I5 (Right-adjusted)	Number of cross sections ($2 \leqq \text{NXS} \leqq 20$)
	NSS	26 to 30	I5 (Right adjusted)	Number of points per cross section ($2 \leqq \text{NSS} \leqq 50$)
	INC(1)	32	I1	Input flag. 0: Complete lofting input mode. Input card set 4. 1: Longitudinal input mode. Input card set 5. 2: Point-by-point input mode. Input card set 7. 3: Cross-section input mode. Input card set 6.

Card	Variable name	Column(s)	Format	Variable description
1B	INC(2)	34	I1	Point distribution flag. Not available for INC(1) = 2. 0: Calculate NSS evenly distributed points on each cross section. 1: Use NBTWN(I) distribution to control cross-section point spacing. Input card set 3.
	INC(3)	36	I1	Calculate geometry characteristics such as areas, normals, volumes, centroids, fineness ratio, etc. 0: No 1: Yes
	INC(4)	38	I1	Generate the aero/propulsion surface. 0: No 1: Yes (input card set 8)
	INC(5)	40	I1	Initial and final slope control of the cross-section segment. Not available for INC(1) = 2. 0: Slope control will be governed by the input lofted slope control lines. 1: Slope control will be governed through card set 2.
	NP(1)	42	I1	Print cross-section points. 0: No 1: Yes
	NP(2)	44	I1	Print segment characteristics (surface areas, cross-section areas, volumes, centers of volume, fineness ratio, etc.). 0: No 1: Yes
	NP(3)	46	I1	Print element characteristics (normals, centroids, delta areas, delta volumes). 0: No 1: Yes
	NP(4)	48	I1	Print longitudinal curve segment end points and coefficients. 0: No 1: Yes

Card	Variable name	Column(s)	Format	Variable description
1B	NP(5)	50	I1	Print cross-sectional curve segment end points and coefficients. 0: No 1: Yes
	IDACHK	52	I1	Check fuselage input data for consistency and order. 0: No 1: Yes
1C	X(I)	1 to 80	8F10.4	Prescribed cross-section locations in the longitudinal direction. Repeat card 1C for I = 1,NXS.

Card Set 2: Slope Control Flags

This card set contains information to control any or all the initial and final slopes of each cross-section segment whenever the complete lofting or cross-section lofting input modes are employed. This input supersedes any other cross-sectional slope controls and is provided primarily for ease of input in prescribing first derivative continuity along cross sections or to force straight-line curve fits on specific cross-section segments. Integer pairs are input to control the initial and final slopes of each cross-section segment for those cross sections defined on card type 1C. Since up to 10 segments can be utilized to define a cross section, card type 2A is divided into four sets of integer pairs covering 20 card columns each and representing four different cross sections as illustrated in figure 31. Thus, the first two integers, IYZIN(1,1) and IYZOT(1,1), override all other slope control inputs for the initial and final slope of the first segment on the first cross section. The segments on each cross section are numbered in a clockwise manner beginning at the top center line of the fuselage. IYZIN(I,J) and IYZOT(I,J) control the initial and final slopes, respectively, of the Ith segment on the Jth cross section.

IYZIN(I,J) and IYZOT(I,J) can be given values of 0, 1, or 2. If a zero is input or the column is left blank, the cross-section slope control at the appropriate initial or final point of the segment is governed by the slope control line for the complete lofting input mode or by the slope control point for the cross-section lofting input mode. If IYZIN(I,J) = 1, then the initial slope of the Ith segment on the Jth cross section is set equal to the final slope of the previous, (I-1)th, segment of the same cross section. If IYZOT(I,J) = 1, then the final slope of the Ith segment on the Jth cross section is set equal to the initial slope of the next, (I+1)th, segment on the Jth cross section. If either IYZIN(I,J) = 2 or IYZOT(I,J) = 2, then the Ith segment on the Jth cross section is fitted with a straight line.

Card	Variable name	Column(s)	Format	Variable description
		Omit this card set for INC(5) = 0.		
2A	[IYZIN(I,J) IYZOT(I,J)]	1 to 80	40(I1,I1)	Slope control option for the Jth segment on the Ith cross section. Repeat for I = 1,10 and J = 1,NXS.

Card Set 3: Cross-Section Point Distribution

This input controls any uneven cross-section point distribution requirements by prescribing the number of points per cross-section segment. The same distribution is held constant for each cross section so that this input option should be considered in the initial layout of lofting lines and/or cross-sectional lofting points. LOFMX - 1 nonzero values are input (fig. 32) to fix the number of points on each segment. The common point connecting segments is considered to belong to the first segment encountered so that each segment must have at least one point. NBTWN(1) applies to the first cross-section segment, NBTWN(2) applies to the second segment, etc. The sum of NBTWN(I), I = 1,LOFMX - 1 values input must equal NSS - 1. The control offered by this card set can only be applied to the complete lofting and cross-section lofting input modes. It is also omitted when INC(2) = 0.

As an example, consider the illustration of a typical cross section in figure 33. Seven cross-section segments have been used to define the cross sections. The segment end points are represented by the heavy dots. The seven values provided on card type 3 are 3, 6, 1, 6, 4, 3, and 1. Therefore, segment 1 on each cross section will contain three equally spaced subsegments over the segment length. This length can be zero, in which case all five points would be coincident. For illustration, all points are clearly distinguishable on this figure. The tick marks indicate the segment subdivisions.

Card	Variable name	Column(s)	Format	Variable description
		Omit this card set if INC(2) = 0.		
3	NBTWN(I)	1 to 50	10(3X,I2) (Right-adjusted)	Prescription for cross-section point distribution. If NBTWN(I) = N, then N evenly spaced points are distributed on cross-section segment I. The last value of I must be equal to LOFMX - 1. Each value of NBTWN(I) for I = 1,LOFMX - 1 must be greater than zero. $\sum_{I=1}^{LOFMX-1} NBTWN(I) = NSS - 1$

Card Set 4: Complete Lofting Input

This card set controls the lofting and slope control lines for the complete lofting input mode and is utilized only when INC(1) = 0. A set of longitudinal lofting lines are the primary means for creating the fuselage geometry. As previously discussed, the projections of these lofting lines are curve fitted with a chain of second-degree curve segments. An illustration of a three-dimensional space curve and the segments used to define its projections in the longitudinal coordinate planes are illustrated in figure 34. The space curve is represented by the heavy solid curve and its projections are represented by the dashed curves. The heavy dots represent the end points of the various second-degree segments used to define the projections. There is no limit to the number of segments that can be utilized to define a projection, nor do the number and/or location of the segment and points have to be the same between various projections. In this illustration, three segments were utilized to define the projection in the lateral XY plane and five segments to define the projection in the vertical XZ plane. The order of curve projection input is arbitrary; that is, the XZ projection of lofting line n can either follow or precede the XY projection of slope control line n - 1. However, the chain of segments defining any single longitudinal curve projection must be input in order of increasing X.

As stated in the section "Analytic Curve Definition," curved segments in the formulation require a slope control point. Several methods have been made available to the user for supplying the necessary information to establish the control points for the longitudinal curve segments. The XZ projection of the space curve shown in figure 34 is reproduced in figure 35 to illustrate the various options available. The first of the five segments is a straight-line segment and requires no slope control point. The input of angles is illustrated as the means to define the slopes at the ends of segment 2. Slopes are input for the ends of segment 3. The X and Z coordinates of two additional points are used to define the slopes at the ends of segment 4. The points are denoted by the two asterisks. The first point lies within the longitudinal limits of the segment and the second point does not. There is no restriction on the location of these points and both could just as well be completely inside or outside the longitudinal limits of the segment. The slopes are determined by the straight-line segment connecting each of these additional points with its appropriate segment end point. The same process can be accomplished with proper choice of a single extra point such as the asterisk beneath segment 5 which controls the slopes at both of its end points. This point is identical to the slope control point described in the section "Analytic Curve Definition." There is no restriction on the homogeneity of input for controlling the slopes at the end points of a segment and any combination of the various methods can be applied to any given segment.

A slope continuity option is also provided in which the slope at the initial point of the segment in question can be set equal to the slope at the final point of the previous segment. In addition, the slope at the final point of the segment in question can be set equal to the slope at the initial point on the next segment. If full use were made of this option, then only two additional points would have been required to generate a first derivative continuous curve for the projection shown in figure 35. These two points are indicated by the diamond ◇ for segment 3 and the asterisk beneath segment 5. However, first derivative continuity is not a requirement in either the longitudinal or cross-sectional projections.

The Y and Z coordinates of the lofting lines at the prescribed longitudinal locations of the cross sections are the end points for the cross-sectional segments. The control of the slopes at the end points of these cross-sectional segments in the complete lofting input mode is governed by an additional longitudinally lofted space curve for each pair of adjacent surface lofting lines. The curves are denoted as slope control lines and are based on the concept described in reference 7. The slope control lines are simply the locus of the cross-section segment slope control points as described in the section "Analytic Curve Definition" (fig. 4). The points to be fitted are usually determined by simple layout of the slope control points determined from sketches or drawings of the dominating cross sections.

The card types illustrated in figure 36 are the means for providing the necessary data to exercise the complete lofting option. The two similar types of input cards, 4A and 4B, are read by a single format. Card type 4A is the initial input card for each lofting and slope control line projection. IYZ defines the plane of projection where IYZ = 1 indicates the XY plane and IYZ = 2 indicates the XZ plane. NOP indicates the number of points that will be used to define this lofting or slope control line projection. This number must be provided for each new projection since unequal numbers of points may be utilized to define them.

ABCX(1) is the longitudinal coordinate (X value) of the initial point on the curve projection. This value must be less than or equal to the X value of the first cross section (X(1) on card type 1C). ORD(1) is either the lateral (Y value) or vertical (Z value) of the initial point depending upon the projection plane (that is, if IYZ = 1, it is the Y value and if IYZ = 2, it is the Z value).

ITCO(1) indicates the type of input provided through CABXO(1) and/or CORO(1) to define the initial slope of the first segment. If ITCO(1) = 0, no slope information is provided and CABXO(1) and CORO(1) are ignored. If ITCO(1) = 1, the value of the slope is set equal to CABXO(1) while CORO(1) is ignored. If ITCO(1) = 2, CABXO(1) is read as an angle (in degrees) and the slope is set equal to its tangent (CORO(1) is ignored). If ITCO(1) = 3, CABXO(1) is read as the abscissa (X value) and CORO(1) is read as the ordinate (Y or Z value, depending on the projection plane) of a point to determine the slope. The slope is set equal to the slope of the straight-line segment between this point and the initial point of the segment [CABXO(1),ORD(1)].

Card type 4B cards contain the information for the remaining points of each segment along the lofting and slope control line projection. ID identifies the type of curve projection being defined. If ID = 0, the curve is a lofting line. If ID = 1, the curve is a slope control line. LNO defines which lofting or slope control line is being considered. The lofting lines are numbered from 1 to LOFMX in a clockwise manner around the cross sections. Slope control lines are numbered from 1 to LOFMX - 1 in the same clockwise fashion. Therefore, slope control line 1 governs the slopes of the first segment at each cross section where the end points are determined from lofting lines 1 and 2; slope control line 2 governs the slopes of the second cross-section segments between lofting lines 2 and 3; and so forth. ICUR identifies the type of curve fit intended for this longitudinal segment. If ICUR = 1, the curve segment is to be a straight line. If ICUR = 0, the coefficients for an elliptical segment are to be determined.

ABCX(I) is the value of the abscissa (X coordinate) of the last point on the current (I-1)th longitudinal segment. ORD(I) is either the lateral (Y coordinate) or vertical (Z coordinate) value of the end point of the (I-1)th segment. If IYZ = 1, it is the Y coordinate and if IYZ = 2, it is the Z coordinate.

ITCI(I), CABXI(I), and CORI(I) define the slope at the last point of the (I-1)th curve segment. These parameters define the type of longitudinal slope control input provided (none, angle, slope, or point coordinates) in the same manner described for ITCO(1), CABXO(1), and CORO(1) on card type 4A with one exception. If ITCI(I) = 0, the slope at the end of this [the (I-1)th] segment will be set equal to the slope at the beginning of the next Ith segment. The use of the option forces longitudinal first derivative continuity between successive segments. The program is structured so that once a set of coefficients for this segment of the curve projection has been determined, a search is immediately conducted to find all the required cross-section locations between the end points. The segment coordinates at these cross sections are calculated and saved. Then the last point of the current segment is reset as the initial point of the next segment and the coefficients of the current segment are dropped. Therefore, no blank spaces in the longitudinal definition of the curve projections can occur and NOP - 1 type 4B cards must be furnished in order of increasing longitudinal locations (X values).

ITCO(I), CABXO(I), and CORO(I) are means of providing the data to control the initial slope of the next Ith segment. If ITCO(I) = 0, the initial slope of the Ith segment is set equal to the last slope of the (I-1)th (or current) segment and CABXO(I) and CORO(I) are ignored. Therefore, ITCO(I) has the same effect on the first derivative continuity between the (I-1)th and Ith segments as ITCI(I) = 0. However, both ITCI(I) and ITCO(I) should not be set equal to zero simultaneously unless a zero slope is intended for the continuity slope between these segments. ITCI(I) □ 0 indicates that the slope control data are contained in CABXO(I) and CORO(I) and ignores CABXI(I) and CORI(I). Conversely, ITCO(I) = 0 indicates that the slope control data are contained in CABXI(I) and CORI(I) while CABXO(I) and CORO(I) are to be ignored. Simultaneous application of these effects causes the default option of zero to be applied. If ITCO ≠ 0, its value (1, 2, or 3) identifies the type of slope information contained in CABXO(I) and CORO(I) in the same manner previously described for ITCO(1), CABXO(1), and CORO(1) on card type 4A.

Card	Variable name	Column(s)	Format	Variable description
4A	IYZ	2	I1	1: Projection in XY plane (plan view). 2: Projection in XZ plane (profile).

Card	Variable name	Column(s)	Format	Variable description
4A	NOP	4 to 5	I2	Number of points being input to define this curve projection.
	ABCX(1)	11 to 20	F10.4	Abscissa (X value) of initial point for this lofting or slope control line projection.
	ORD(1)	21 to 30	F10.4	Ordinate (Y value if IYZ = 1; Z value if IYZ = 2) of initial point for this lofting or slope control line projection.
	ITCO(1)	34 to 36	I2	Slope control flag for initial slope of the first segment in lofting direction. 0: No slope information is supplied. 1: CABXO (columns 56 to 65) contains value of slope. 2: CABXO (columns 56 to 65) contains angle in degrees, such that the Slope = tan [CABXO(1)]. 3: Slope control point is supplied (abscissa in columns 56 to 65; ordinate in columns 66 to 75).
	CABXO(1)	56 to 65	F10.4	Either slope, angle, or control point abscissa for the initial slope of the first segment of the projected curve.
	CORO(1)	66 to 75	F10.4	Control point ordinate for the initial slope of the first segment of the projected curve.
	CHKINP	80	A1	Input check symbol. An asterisk (*) must be input if IDACHK = 1 on card type 1B; otherwise, leave blank.
4B	ID	2	I1	0: Lofting line. 1: Slope control line.
	LNO	4 to 5	I2	Identification number for lofting or slope control line. Lofting lines are numbered from 1 to LOFMX in clockwise manner from top center line. Slope control lines are numbered from 1 to LOFMX - 1 in clockwise manner from top center line.

Card	Variable name	Column(s)	Format	Variable description
4B	ICUR	7	I1	Segment generation flag in lofting direction. 0: General second-degree conic. 1: Straight line.
	ABCX(I)	11 to 20	F10.4	Abscissa (X value) of end point of current lofting or slope control line projection segment [(I-1)th segment].
	ORD(I)	21 to 30	F10.4	Ordinate (Y value if IYZ = 1, Z value if IYZ = 2) of end point of current lofting or slope control line projection segment [(I-1)th segment].
	ITCI(I)	31 to 32	I2	Slope control flag for final slope of the (I-1)th segment in lofting direction. Input if ICUR = 0. 0: Use following slope or default (Slope □ 0) value. 1: Slope is supplied by CABXI(I) (columns 36 to 45). 2: Angle in degrees is supplied by CABXI(I) (columns 36 to 45) such that the Slope = tan [CABXI(I)]. 3: Slope control point is supplied. CABXI(I) (columns 36 to 45) contains the abscissa. CORI(I) (columns 46 to 55) contains the ordinate.
	ITCO(I)	34 to 35	I2	Slope control flag for initial slope of exit from the Ith segment in lofting direction. 0: Use previous slope or default (Slope = 0) value. 1: Slope is supplied by CABXO (columns 56 to 65). 2: Angle in degrees is supplied by CABXO (columns 56 to 65). 3: Slope control point is supplied (abscissa in columns 56 to 65; ordinate in columns 66 to 75).
	CABXI(I)	36 to 45	F10.4	Either slope, angle, or control point abscissa for final slope of the (I-1)th lofting or slope control line segment.

Card	Variable name	Column(s)	Format	Variable description
4B	CORI(I)	46 to 55	F10.4	Control point ordinate for the final slope of the Ith lofting or slope control line segment.
	CABXO(I)	56 to 65	F10.4	Either slope, angle, or control point abscissa for initial slope of the Ith lofting or slope control line segment.
	CORO(I)	66 to 75	F10.4	Control point ordinate for initial slope of the Ith lofting or slope control line segment.

Card Set 5: Longitudinal Lofting Input

This card set contains the information for controlling the numerical model by supplying the projection points of the lofting and/or slope control lines at each cross-section location prescribed on card type 1C. No analytic definition of the longitudinal curve projections is calculated so intermediate cross sections cannot be determined. However, the same control over the individual cross sections as that described for the complete lofting input mode can be applied. But unlike the complete lofting input mode, the lofting and slope control line projection data must be provided in the order illustrated in figure 37. The projection of the first lofting line (upper fuselage center line) in the XY plane must be defined first and the Y coordinates (planform) must be provided for each cross-section location in order of increasing X (X(I), I = 1,NXS prescribed on card type 1C). The projection of the first lofting line (still upper fuselage center line) in the XZ plane is defined next and Z coordinates (profile) must be provided for each cross section. The projections of the first slope control line in the XY and XZ planes are defined next. This order of input is maintained for the second, third, . . ., etc., lofting and slope control lines until LOFMX = 1 sets have been completed. Since the number of slope control lines is always one less than the number of lofting lines, the last set of data contains only the XY and XZ plane projections of the final lofting line. This input option is activated by setting INC(1) = 1.

Card	Variable name	Column(s)	Format	Variable description
		Omit this card set if INC(1) ≠ 1.		
5A	YL(I,J)	1 to 80	8F10.4	Y values of the Ith lofting line at Jth cross sections. Repeat this card until J = NXS.
5B	ZL(I,J)	1 to 80	8F10.4	Z values of the Ith lofting line at Jth cross sections. Repeat this card until J = NXS.

Card	Variable name	Column(s)	Format	Variable description
5C	YSL(I,J)	1 to 80	8F10.4	Y values of the Ith slope control line at Jth cross sections. Repeat this card until J = NXS.
5D	ZSL(I,J)	1 to 80	8F10.4	Z values of the Ith slope control line at Jth cross sections. Repeat this card until J = NXS.

Repeat card set 5 until I = LOFMX - 1. Then repeat cards 5A and 5B for I = LOFMX.

Card Set 6: Cross-Sectional Lofting Input

This input option provides the capability for accepting lofting and slope control point data from cross-section sketches. The basic difference between this option and the one described for card set 5 is simply the order of input. The data for all lofting and slope control points are provided for one cross section before proceeding to the next. Their order of input is the same as listed on card type 1C. The same clockwise from top center-line numbering of the lofting and slope control lines is retained. The input is provided in lateral and vertical (Y and Z) coordinate pairs as indicated in figure 38. For the Jth cross section, the coordinates of the first lofting point, [YL(1,J),ZL(1,J)], are input first, the coordinates of the first slope control point, [YSL(1,J),ZSL(1,J)], are input next; then the coordinates of the second lofting point, [YL(2,J),ZL(2,J)], and the second slope control point, [YSL(2,J),ZSL(2,J)], are input, respectively. The process is repeated until LOFMX lofting points and LOFMX - 1 slope control points have been provided. The entire cycle is repeated for each of the NXS cross-section locations indicated on card type 1C. This input option is activated by setting INC(1) = 3.

Card	Variable name	Column(s)	Format	Variable description
6A	[YL(I,J), ZL(I,J), YSL(I,J), ZL(I,J)]	1 to 80	2(4F10.4)	Y and Z values of the first lofting point and the first slope control point for the Jth cross section. I increases in the clockwise direction beginning at top center line. Repeat card 6A until LOFMX lofting points and LOFMX - 1 slope control points have been input.

Repeat card set 6 for J = 1,NXS.

Card Set 7: Point-by-Point Input

This card set contains the information for controlling the numerical model through the point-by-point input mode. The data are read by cross sections corresponding to the X locations prescribed on card type 1C. The cross sections are defined by lateral and vertical (XY) coordinate pairs, [YL(I,J),ZL(I,J)], as indicated in figure 39. The cross-section counter for this input is I. Four coordinate pairs per card (type 7A) are input until J = NSS number of points have been provided for the Ith cross section. The process is then repeated until the I = NXS cross sections at locations prescribed on card type 1C have been defined. Intermediate values on the numerical model cannot be determined in either the longitudinal or cross-section directions when this input mode is employed. This option is activated by setting INC(1) = 2.

Card	Variable name	Column(s)	Format	Variable description
		Omit this card set if INC(1) ≠ 2.		
7A	[YL(I,J), ZL(I,J)]	1 to 80	4(2F10.4)	Y and Z values of the Ith cross section. J increases in the clockwise direction beginning at the fuselage top center line. Repeat for J = 1,NSS.
		Repeat card set 7 for I = 1,NXS.		

Card Set 8: Aero/Propulsion Surface Input

This card set contains information to control the fuselage geometry subtended by a propulsion system mounted along the bottom center line of the fuselage. This is the specialized aero/propulsion option previously described in the section "Auxiliary Fuselage Geometry." Only the planform projection (XY plane) of the propulsion system is required as input. The true three-dimensional surface created by the projection of this planform onto the fuselage geometry is calculated. Three types of card input as illustrated in figure 40 are required for this option. Card type 8A contains the data for controlling the distribution of the elements on this new surface as well as the longitudinal and initial lateral limits of influence of the propulsion system. NESEG defines the number of evenly spaced spanwise strips to be defined on this new surface. NESEG + 1 evenly spaced fuselage surface points in the cross-section (XY) plane will be determined at each fuselage cross-section location subtended by the propulsion system. In addition, if the longitudinal location of the inlet entrance and nozzle exit plane (XINLT and XNOZ, respectively) do not coincide with established fuselage cross sections, an intermediate set of fuselage points will be determined at each of these locations. YINLT defines the spanwise limit of the planform at the inlet entrance. The remaining spanwise limits of the propulsion system planform are automatically determined from the curve coefficients.

Card type 8B contains the data to control the amount of input to be supplied, the printed output requirements, and the data required to define the initial conditions at the first point on the first segment of the propulsion planform. NOP defines the number of points being supplied to calculate the coefficients for the NOP - 1 segments which make up the projection of the planform. The same technique is employed for this projection as that described in card set 4 for the lofting and slope control lines. IPRT = 0 causes all printout for this option to be bypassed. IPRT = 1 causes a printout of the segment coefficients, the coordinates of the new surface, and the running lengths calculated along the fuselage ahead of this surface for use in skin-friction calculations. The remaining parameters on this card, ABCX(1), ORD(1), ITCO(1), CABXO(1), and CORO(1), are identical in input and influence to the same variables described for card type 4A.

Card type 8C contains the information for identifying the segment of the propulsion planform, the type of curve segment being fitted, and the point and slope data about the last point on the Ith segment. NSEG is the number of the segment counting from the inlet station toward the rear of the fuselage. ICUR, ABCX(I), ORD(I), ITCI(I), ITCO(I), CABXI(I), CORI(I), CABXO(I), and CORO(I) are completely equivalent in input and application to the same variables as listed on card type 4B.

Card	Variable name	Column(s)	Format	Variable description
		Omit this card set for INC(4) ≠ 1.		
8A	NESEG	2 to 3	I2	Number of evenly spaced spanwise strips to be defined on this new surface.
	XINLT	6 to 15	F10.4	Longitudinal location of the inlet entrance plane.
	XNOZ	16 to 25	F10.4	Longitudinal location of the nozzle exit plane.
	YINLT	31 to 40	F10.4	Spanwise limit of the planform at the inlet entrance.
8B	NOP	2 to 3	I2	Number of points being supplied to calculate coefficients.
	IPRT	5	I1	Print segment coefficients, coordinates of the new surface, and the running lengths. 0: No 1: Yes
	ABCX(1)	6 to 15	F10.4	Abscissa (X value) of initial point for the surface planform projection in the XY plane.

Card	Variable name	Column(s)	Format	Variable description
8B	ORD(1)	16 to 25	F10.4	Ordinate (Y value) of initial point for the surface planform projection in the XY plane.
	ITCO(1)	29 to 30	I2	Slope control flag for the initial slope in the curve projection. 0: No slope information is supplied. 1: CABXO(1) (columns 51 to 60) contains the value of slope. 2: CABXO(1) (columns 51 to 60) contains angle of degrees such that the Slope = tan [CABXO(1)]. 3: Slope control point is supplied. CABXO(1) (columns 51 to 60) contains the abscissa and CORO(1) (columns 61 to 70) contains the ordinate.
	CABXO(1)	51 to 60	F10.4	Either slope, angle, or control point abscissa for the initial slope of the first segment of the curve projection.
	CORO(1)	61 to 70	F10.4	Control point ordinate for initial slope of the first segment of curve projection.
8C	NSEG	2 to 3	I2	Number of the segment being fitted.
	ICUR	5	I1	Segment generation flag in lofting direction. 0: General second-degree conic. 1: Straight line.
	ABCX(I)	6 to 15	F10.4	Abscissa (X value) of end point of current lofting line projection segment [(I-1)th segment].
	ORD(I)	16 to 25	F10.4	Ordinate (Y value) of end point of current lofting line projection segment [(I-1)th segment].

Card	Variable name	Column(s)	Format	Variable description
8C	ITCI(I)	26 to 27	I2	Slope control flag for final slope of the (I-1)th segment in lofting direction. Input if ICUR = 0. 0: Use following slope or default (Slope = 0) value. 1: Slope is supplied by CABXI(I) (columns 31 to 40). 2: Angle in degrees is supplied by CABXI(I) (columns 31 to 40) such that the Slope = tan [CABXI(I)]. 3: Slope control point is supplied. CABXI(I) (columns 31 to 40) contains the abscissa, CORI (columns 41 to 50) the ordinate.
	ITCO(I)	29 to 30	I2	Slope control flag for initial slope of the Ith segment in lofting direction.
	CABXI(I)	31 to 40	F10.4	Either slope, angle, or control point abscissa for final slope of the (I-1)th segment of this lofting line projection (Ith segment).
	CORI(I)	41 to 50	F10.4	Control point ordinate for final slope of the (I-1)th approach to lofting line projection segment.
	CABXO(I)	51 to 60	F10.4	Either slope, angle, or control point abscissa for initial slope of this lofting line projection segment (Ith segment).
	CORO(I)	61 to 70	F10.4	Control point ordinate for initial slope of this lofting line projection segment (Ith segment).

INPUT FOR PLANAR-SURFACE GEOMETRY GENERATION (WINGS, TAILS, ETC.)

As previously mentioned the wing, canard, horizontal tail, and fin geometries are generated in the same manner. The following input description applies to all these components unless otherwise specified.

All input values for these components are entered through the FORTRAN Namelist WING with the exception of the arbitrary airfoil option input and the manual option input. Most of the Namelist variables are preset to nominal values, which should reduce the actual number of Namelist entries that the user must make. Figure 41 shows in flow chart form the options that are available and the input parameters associated with them.

Namelist WING

Item	Variable name	Type	Variable description
(1)	IHPUT	Integer	Geometry input flag. 1: Generate component geometry (default). 2: Component geometry will be hand input. (See description for manual input.)
Area input			
			Omit items (2) and (3) if (4) and (5) are input.
(2)	AW	Real	True surface area of component. Default: AW = 0.
(3)	ARW	Real	Aspect ratio, BW^2/AW. Default: ARW = 1.
			Refer to figure 9 for items (4) to (12).
Planform input			
			Omit items (4) and (5) if (2) and (3) have been input.
(4)	BW	Real	Total span. Exception: fin - distance from root chord to tip chord.
(5)	CRW	Real	Root chord. Default: CRW = 0.
(6)	B1BW	Real	Ratio of breakpoint to span, B1BW. Default: B1BW = 0.
(7)	TRW	Real	Taper ratio, CTW/CRW. Default: TRW = 0.
(8)	SWEOB	Real	Leading-edge sweep angle of a single-paneled surface or the second leading-edge sweep angle of a two-paneled surface, degrees. No default.
(9)	SWELG	Real	First leading-edge sweep angle of a two-paneled surface, degrees. Default: SWELG = SWEOB. Omit for a single-paneled surface.
(10)	SW1	Real	First trailing-edge sweep angle of a two-paneled surface, degrees. Omit for a single-paneled surface. Default: SW1 = 90.
(11)	ANGR	Real	Span-line deflection at the root chord, degrees. Default: ANGR = 0.

Item	Variable name	Type	Variable description
(12)	ANGT	Real	Span-line deflection at the tip chord, degrees. Default: ANGT = 0.
Airfoil			
(13)	ICHRD	Integer	Airfoil shape flag. 1: Slab-sided airfoil section. (Default) 2: Circular-arc airfoil section. 3: Arbitrary airfoil. (See description for arbitrary airfoil input.)
			Refer to figure 10 for items (14) and (15).
			Omit items (14) and (15) for ICHRD $\neq$ 1.
(14)	XWD1	Real	Start of flat section of slab airfoil. Default: XWD1 = 0.5.
(15)	XWD2	Real	End of flat section of slab airfoil. Default: XWD2 = 0.
Panel spacing			
(16)	NYU	Integer	Number of spanwise chord stations. $2 \leqq NYU \leqq 19$. Default: NYU = 10.
(17)	NXU	Integer	Number of longitudinal stations along chord. $2 \leqq NXU \leqq 30$. Default: NXU = 10.
(18)	NSPACE	Integer	Point redistribution flag. 1: Do not redistribute input or generated surface points. (Default) 2: Redistribute surface points to be equally spaced in the chordwise direction. NSPACE = 2 is not recommended for any airfoil with chordwise breakpoints as the respacing may skip over the discontinuities. This option, however, would be convenient if an arbitrary airfoil is input with a concentration of points at the leading edge. The set of leading-edge points is available for leading-edge detail, then with NSPACE = 2, NXU number of points can be equally spaced.
			Input items (19) and (20) if ICHRD = 3.
(19)	NPCU	Integer	Number of input chord used to describe the upper surface of an arbitrary airfoil. $2 \leqq NPCU \leqq 30$.

Item	Variable name	Type	Variable description
(20)	NPCL	Integer	Number of input chords used to describe the lower surface of an arbitrary airfoil. $2 \leqq \text{NPCL} \leqq 30$.
(21)	ITEETH	Integer	Define wing tip with a chord plane. 0: No (Default) 1: Yes
Leading-edge radius			
(22)	IRADE	Integer	Leading-edge radius flag. 0: Zero leading-edge radius. (Default) 1: Leading-edge radius constant for entire surface. 2: Leading-edge radius proportional to each chord. (Radius varies with chord length.)
(23)	RADE	Real	Leading-edge radius. Input for IRADE ≠ 0. (i) Input absolute value for IRADE = 1. (ii) Input fraction of chord length for IRADE = 2.
Flap and all-movable control surface			
			Refer to figure 16 for items (24) to (32).
(24)	ICON	Integer	Control surface flag. 0: Do not compute a control surface. (Default) 1: Compute a control surface. 2: This component is an all-movable control surface. Omit items (25) to (32) if ICON = 0.
(25)	NPHX	Integer	Number of leading-edge points not to be respaced. The control surface option will not relocate the first NPHX points in respacing spanwise points such as on the leading edge. For the automatic mode (IHPUT = 1) and ICHRD = 1 or 2, NPHX is automatically set equal to the number of leading-edge points. Use this option only for ICON = 1.

Item	Variable name	Type	Variable description
(26)	IFLAP	Integer	Control surface array flag. 0: Control surface array will not be saved in a separate array. (Default) 1: Control surface array generated. Flaps are set to 0°. DELFU = DELFL = 0.
(27)	XCOR	Real	Hinge-line position along root chord as a fraction of chord length.
(28)	XCOT	Real	Hinge-line position along tip chord as a fraction of chord length.
(29)	DELFU	Real	Upper control surface deflection, degrees, normal to the hinge line in the wing surface plane. Positive deflection is with trailing edge down. Default: DELFU = DELFL.
(30)	DELFL	Real	Lower control surface deflection, degrees, normal to the hinge line in the wing surface plane. Positive deflection is with trailing edge down. Default: DELFL = DELFU.
(31)	ZCOR	Real	Vertical distance to hinge line at root chord.
(32)	ZCOT	Real	Vertical distance to hinge line at tip chord.

Thickness and camber

Refer to figure 12 for items (33) and (35).

Item	Variable name	Type	Variable description
(33)	TWRD	Real-array	Section thickness ratio at span location YTHK(I), I = 1,20. If TWRD is constant, only one value must be input. Default: TWRD = 0.05.
(34)	YTHK	Real-array	Spanwise locations of input thickness and camber ratios, TWRD and TCD. Table must be in ascending order. If TWRD and TCD are input as constants, omit YTHK.
(35)	TCD	Real-array	Mean camber line thickness ratio at station YTHK(I). If TCD is constant, only one value must be input. Default: TCD = 0.

Dihedral

Refer to figure 17 for items (36) to (40).

Item	Variable name	Type	Variable description
(36)	IDIHE	Integer	Dihedral flag. 1: Compute leading-edge dihedral. Input AWR, AWT. (Default) 2: Input leading-edge dihedral. Input YDIH, ZDIH.
			Omit items (37) and (38) if IDIHE = 2.
(37)	AWR	Real	Dihedral angle at surface root, degrees. Default: AWR = 0.
(38)	AWT	Real	Dihedral angle at surface tip, degrees. Default: AWT = 0.
			Omit items (39) and (40) if IDIHE = 1.
(39)	YDIH	Real-array	Leading-edge dihedral Y coordinates in ascending order; that is, YDIH(I) $\geqq$ YDIH(I - 1), 2 $\leqq$ I $\leqq$ 20.
(40)	ZDIH	Real-array	Leading-edge dihedral Z coordinates corresponding to YDIH.
Twist			
(41)	TWISTX	Real	Twist angle, degrees. Positive trailing edge rotated down at tip. Default: TWISTX = 0. See figure 18.
Translation and rotation			
			Translation occurs before rotation.
			Refer to figure 19 for items (42) to (50).
(42)	XW1	Real	Translation in X direction (longitudinal). Default: XW1 = 0.
(43)	YBR	Real	Translation in Y direction (lateral). Default: YBR = 0.
(44)	ZBR	Real	Translation in Z direction (vertical). Default: ZBR = 0.
(45)	THETA	Real	Roll angle, degrees, about the rotation point (XROTAT, YROTAT, ZROTAT). Positive roll, wing tip up. Defaults: THETA = 0. (Wing, canard, horizontal tail) THETA = 90. (Fin)

Item	Variable name	Type	Variable description
(46)	ALPHA	Real	Pitch angle, degrees, about the rotation point (XROTAT, YROTAT, ZROTAT). Positive leading edge up. Default: ALPHA = 0.
(47)	BETA	Real	Yaw angle, degrees, about the rotation point (XROTAT, YROTAT, ZROTAT). Positive is counterclockwise rotation in the XY plane. Default: BETA = 0.
			The rotation point is the point about which any roll, yaw, or pitch will occur.
(48)	XROTAT	Real	X coordinate of rotation point. Default: XROTAT = XW1.
(49)	YROTAT	Real	Y coordinate of rotation point. Default: YROTAT = YBR.
(50)	ZROTAT	Real	Z coordinate of rotation point. Default: ZROTAT = ZBR.
Reference length			
(51)	REFLW	Real	Reference length of fuselage. This input is used to internally scale all sets of component geometries to common units. Default: REFLW = 0. (An input of zero indicates that the units of the surface are the same as for the fuselage.)
Merge with fuselage			
(52)	IMERGE	Integer	Surface-fuselage intersection flag. 0: Do not merge component with fuselage. -1,1: Find intersection of component with fuselage. Default: IMERGE = 1. Negative input of IMERGE results in debug printing of merging iterations.
(53)	NDEBUG	Integer	MERGE debug print flag. Omit if IMERGE ≧ 0. 0: Debug printing for all intersections for this component. 1: Debug printing for any ray with no intersection. (Default)
Print output			

Item	Variable name	Type	Variable description
(54)	IPRNT	Integer	Output control flag. 1: Do not print output. 2: Print input and final geometry. (Default) 3: Print input, calculated parameters, geometry after intermediate manipulations, and final geometry.

Arbitrary Airfoil Input

Omit items (55) to (58) if ICHRD ≠ 3. These input items must be inserted immediately after the Namelist WING. Refer to figure 14.

Item	Variable name	Type or format	Variable description
(55)	XAU	7F10.3	X coordinates of upper airfoil surface. Repeat item (55) format until NPCU values of XAU have been input.
(56)	ZAU	7F10.3	Z coordinates of upper airfoil surface. Repeat item (56) format until NPCU values of ZAU have been input.
(57)	XAL	7F10.3	X coordinates of lower airfoil surface. Repeat item (57) format until NPCL values of XAL have been input.
(58)	ZAL	7F10.3	Z coordinates of lower airfoil surface. Repeat item (58) format until NPCL values of ZAL have been input.

Manual Input

Omit items (59) to (62) if IHPUT ≠ 2. Items (59) to (62) must be inserted directly after Namelist WING. Refer to figure 15.

Item	Variable name	Format	Variable description
(59)	YW	F10.3	Y coordinate of chord station.
(60)	XW	7F10.3	X coordinates of chord station Y = YW from leading to trailing edge. Repeat item (60) format until NXU values of XW have been input.
(61)	ZWU	7F10.3	Z coordinates of upper surface corresponding to each XW for chord station Y = YW. Repeat item (61) format until NXU values of ZWU have been input.

Item	Variable name	Format	Variable description
(62)	ZWL	7F10.3	Z coordinates of lower surface corresponding to each XW for chord station Y = YW. Repeat item (62) format until NXU values of ZWL have been input.

Repeat sequences of items (59) to (62) until NYU values of chord stations (YW) have been input.

CONCLUDING REMARKS

The FORTRAN program GEMPAK has been used extensively on the Control Data 6000 Series computers in conjunction with interfaces to several aerodynamic and plotting computer programs. There is little restriction on the type of configuration that can be input and the user has a wide choice of the amount and location of geometry detail desired. A minimum of geometry definition input is required and subsequent modifications or reorientations of component geometry can be accomplished independently of all other components with a minimum of input changes. These capabilities have proven GEMPAK to be an effective aid in the preliminary design phase of aircraft configurations.

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APPENDIX A

SUMMARY OF PROGRAM ROUTINES AND THEIR FUNCTIONS

The overlay structure of GEMPAK is illustrated in figure 42. The functions of each of these routines are briefly outlined here.

Routine name	Identification	Function
Overlay (GEM,0,0) GEMPAK	GMA	Executive routine by which all geometry generation routines are called. The GEMPAK TITLE CARD and the GEOMETRY OPTION CARD are read in this routine.
SCALE	GMB	Scales all existing geometry to a common reference length. Generated geometry is read from TAPE28 one component at a time, scaled, and temporarily stored on TAPE38. After all components have been scaled, the resulting geometries are rewritten on TAPE28.
TOLER	GMC	This routine computes a tolerance given two variables R1 and R2 with the number of significant digits set by the routine variable ISIG. The magnitude of the tolerance is controlled by the argument R1. If the absolute difference of R1 and R2 is within tolerance, R2 is set equal to R1. This routine is used primarily by overlay MERGE.
IUNI	IUNI	NASA Langley Research Center Library Subroutine. To interpolate a univariate function using conventional first- or second-order Lagrangian interpolation.
SECBI	SECB	NASA Langley Research Center Library Subroutine. To determine a root of the real-valued function F(x) = 0 given a specified interval by employing a front end seeker and a combination bisection/linear interpolation inverse quadratic interpolation iteration technique.
ZBRENT	ZBRE	NASA Langley Research Center Library Subroutine. To find a zero of a function which changes sign in a given interval. Called by subroutine SECBI.

APPENDIX A

Routine name	Identification	Function
ERROR	ERRO	NASA Langley Research Center Library Subroutine. To test the convergence of a computed result based on a relative convergence criterion or an absolute convergence criterion. Called by subroutine ZBRENT.
Overlay (GEM,1,0) FUS2	F2A	Generates fuselage geometry. Fuselage input card sets 1, 2, 3, 4, 5, 6, and 7 are read in FUS2. This routine has made use of the lofted slope control method described in a Grumman geometry package (QUICK) (ref. 7) and the basic element definition scheme defined in a Douglas (HABS) Hypersonic Arbitrary-Body System (ref. 3). The resulting fuselage geometry is written in the form of Namelist FUSE onto TAPE28 and TAPE38. All fuselage geometry printout occurs here.
SLPDET	F2B	Determines the necessary slope control point (X_3,Y_3) for a segment from the input information.
SECDEG	F2C	Determines the coefficients (A,B,C,D,E,F) for the basic second-degree segment equation $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$
Overlay (GEM,1,1) GOODY	F2D	Determines surface areas, cross-sectional areas, volumes, centers of volume, surface normals, centroids of area, and fineness ratio from the basic point data array for the fuselage and prints these element characteristics, if required.
Overlay (GEM,1,2) ENGOUT	F2E	Generates the geometry to be deleted from the fuselage to accommodate a scramjet and nozzle. Fuselage input card set 8 is read in ENGOUT. The resulting geometry is written in Namelist ENGHOL onto TAPE28 and TAPE38.
FORD	F2F	Determines spanwise coordinates of the scramjet engine and nozzle geometry from second-degree curve coefficients.

APPENDIX A

Routine name	Identification	Function
CROSXD	F2G	Creates engine geometry cross sections by interpolation of the fuselage data over the projected scramjet package boundary.
Overlay (GEM,2,0) WINGEX	WGA	Executive routine for planar-surface geometry generation. All printout occurs here with the exception of input printout, intermediate geometry printout, and diagnostics. Resulting geometries are written in the Namelist form, according to the option chosen by user (WINGG, CANARD, HT, FIN, FLAP) onto TAPE28.
Overlay (GEM,2,1) INITL	WGB	Sets input defaults and reads all input for planar-surface generation.
DFALT	WGC	Determines values of the default array printed along with each planar-surface input parameter. A "D" following an input indicates the user has chosen the default input value, a blank indicates the value was input by user.
PRNTIN	WGD	Prints all input parameters for planar-surface generation.
Overlay (GEM,2,2) WINGF	WGE	Generates all planar-surface geometry.
FOFX	WGF	Solves the exponent for the geometric progression used in the leading-edge enrichment.
ATAK	WGG	Rotates a given point in space (x,y,z) about the given point (x_o,y_o,z_o).
Overlay (GEM,3,0) MERGE	MGA	Executive routine by which all routines necessary to find the intersection of a planar surface with the fuselage are called.
Overlay (GEM,3,1) RTAP28	MGB	Reads selected component geometry from TAPE28.
Overlay (GEM,3,2) RENUM	MGC	Insures that the first chord in a planar-surface geometry definition is the most inboard.

APPENDIX A

Routine name	Identification	Function
Overlay (GEM,3,3) REVERS	MGD	Reverses upper and lower surface geometries, as required.
Overlay (GEM,3,4) PTINT	MGE	Determines the intersection of a planar-surface ray segment with the fuselage.
CROSS	MGF	Finds the two-dimensional intersection of two given line segments and determines whether the intersection lies within the end points of each of the line segments.
RAYORD	MGG	Given one or two coordinates of a point on a linear line or vector, solves for the unknown coordinate. Also given are the slopes and intercepts of the line.
TRICHK	MGH	Determines whether the given point (y_i, z_i) lies within a given triangle.
NORMAL	MGI	Computes the normals of the fuselage panel that contains the surface ray intersection point and of the surface ray segment and determines the angle of direction of intersection.
Overlay (GEM,3,5) NOINT	MGJ	Attempts to approximate a ray intersection point that does not touch the body by using the intersection of the preceding ray. A leading-edge ray of no intersection will cause an error message to be issued and no further attempt at merging the component with the fuselage will be made.
Overlay (GEM,3,6) ADCHRD	MGK	Adds the chord that defines the component intersection with the fuselage to the component geometry definition, computes the running lengths of a component with a control surface for use in Gentry's hypersonic arbitrary-body Mark III skin-friction routine (ref. 3) and writes the generated geometry in final form onto TAPE38.

APPENDIX B

MAJOR PROGRAM VARIABLE DESCRIPTIONS

Listed here are the major program variables and their definitions grouped according to the Labeled Common in which they appear. Any reference to a "wing" applies to a planar surface (fins, tails, etc.).

Labeled common	Variable name	Variable type	Definition
ANG	SWELR	Real	First leading-edge angle of two-paneled wing surface, radians
	SWEOR	Real	Leading-edge sweep angle of a single-paneled surface or the second leading-edge sweep angle of a two-paneled surface, radians
	SW1R	Real	First trailing-edge sweep angle of a two-paneled surface, radians
	AWRR	Real	Spanwise deflection at root chord, radians
	AWTR	Real	Spanwise deflection at tip chord, radians
ARF	NPCU	Integer	Number of input points describing the upper surface of an arbitrary airfoil (user defined)
	NPCL	Integer	Number of input points describing the lower surface of an arbitrary airfoil (user defined)
	ZAU ZAL XAU XAL	Real-array	X and Z coordinates of the upper and lower surfaces of an arbitrary airfoil (user defined)
	ZDUMU ZDUML XDUMU	Real-array	Temporary wing surface X and Z coordinates
CONTRL	ICON	Integer	Control surface flag (user defined)
	DELFU	Real	Upper control surface deflection, degrees (user defined)
	DELFL	Real	Lower control surface deflection, degrees (user defined)

APPENDIX B

Labeled common	Variable name	Variable type	Definition
CONTRL	XCOR	Real	Hinge-line position along root chord as a fraction of chord length (user defined)
	XCOT	Real	Hinge-line position along tip chord as a fraction of chord length (user defined)
	IFLAP	Integer	Control surface array flag (user defined)
	NHNG	Integer	Point along wing streamwise chord that identifies the control surface hinge line
	NXFL	Integer	Number of span lines on flap
	ZCOR	Real	Vertical distance to hinge line at root chord (user defined)
	ZCOT	Real	Vertical distance to hinge line at tip chord (user defined)
CORD	XU	Real-array	Longitudinal coordinates of wing upper surface geometry
	Y	Real-array	Spanwise coordinates of wing upper surface leading-edge geometry
	ZU	Real-array	Z coordinates of wing upper surface geometry
	ZL	Real-array	Z coordinates of wing lower surface geometry
	YU	Real-array	Spanwise coordinates of wing upper surface geometry
	YL	Real-array	Spanwise coordinates of wing lower surface geometry
	NXW	Integer	Number of points describing each wing streamwise chord
	NYW	Integer	Number of streamwise chords describing wing
	XL	Real-array	Longitudinal coordinates of wing lower surface geometry
	RFL	Real	Reference length (usually fuselage length) in wing geometry units
DBUG	IDBUG	Integer	MERGE debug print flag

APPENDIX B

Labeled common	Variable name	Variable type	Definition
DUMXYZ	YD	Real-array	Same as Y in Labeled Common CORD
	YU YL XU XL ZU ZL	Real-array	Same as for Labeled Common CORD
	NY	Integer	Number of streamwise chords describing wing
	NX	Integer	Number of points describing each wing streamwise chord
	NAMPRT	Alphanumeric array	Array containing component identification for printout clarification
	EDGE	Alphanumeric array	Array containing surface edge identification (leading and trailing)
	ASURF	Alphanumeric	Surface identifier for geometry array (upper, lower)
ELEV	NHNG	Integer	Point along wing streamwise chord that identifies the control surface hinge line
	XO YO ZO	Real	Coordinates of point about which a control surface will be rotated
	DX2 DY2 DZ2	Real	Distance between tip and root chord hinge-line position in the X, Y, and Z planes
ENGINE	XE YE ZE	Real-array	X, Y, and Z coordinates describing the engine hole geometry
	FLOI	Real-array	Temporary array of longitudinal lengths up to the element of interest
	SOIL	Real-array	Temporary array of lengths of element sides in the longitudinal direction
	NESEG	Integer	Number of segments in each cross section of engine hole geometry

APPENDIX B

Labeled common	Variable name	Variable type	Definition
ENGINE	IXT	Integer	Total number of cross sections in engine hole geometry
ER	IERROR	Integer	WINGEX error flag
ERROR	IERR	Integer	GEMPAK error flag
EX	TWISTX	Real	Twist angles, degrees (user defined)
	YDIH ZDIH	Real	Y and Z coordinates of leading-edge dihedral (user defined)
	YROTAT	Real	Y coordinate of wing rotation point (user defined)
	BETA	Real	Yaw angle, degrees (user defined)
	NDIH	Integer	Counter for number of points in YDIH and ZDIH arrays
FINSTA	MID	Integer	Flag for center-line component
FUSGEM	X	Real-array	Fuselage cross-sectional longitudinal locations
	Y Z	Real-array	Y and Z coordinates of fuselage cross sections
	NXS	Integer	Number of cross sections describing fuselage geometry (user defined)
	NSS	Integer	Number of points describing each fuselage cross section (user defined)
FUSMAX	YMX	Real-array	Maximum span at each fuselage cross-section station
	ZMAX	Real-array	Z coordinate at each fuselage YMX
GARG	NP2	Integer	Same as NP(2) in FUS2
	NP3	Integer	Same as NP(3) in FUS2
KEEP	CRW	Real	Root chord length (user defined)
	CT	Real	Tip chord length
	SWOR	Real	Wing trailing-edge sweep angle, radians

APPENDIX B

Labeled common	Variable name	Variable type	Definition
KEEP	BW	Real	Wing total span (exception: fin semispan)
	B1	Real	Wing span to leading-edge breakpoint
	ACT	Real	Total computed wing area
LEAD	XLE	Real-array	Longitudinal coordinates of wing leading-edge enrichment
	ZLEU	Real-array	Z coordinates of wing upper surface leading-edge enrichment
	ZLEL	Real-array	Z coordinates of wing lower surface leading-edge enrichment
	XX1	Real	Longitudinal coordinate of second wing leading-edge station for enrichment
	XX2	Real	Longitudinal coordinate of final wing leading-edge station for enrichment
	NO	Integer	Number of wing longitudinal leading-edge stations for enrichment
	II	Integer	Chord number at which wing leading-edge enrichment is computed
NAME	SURF	Alphanumeric array	Array identifying wing geometry surface (upper, lower)
OVLARG	ICODE	Integer	Flags geometry to be read from TAPE28
	ID	Integer	Index of component name array
	IGO2	Integer	Upper and lower geometry reverse flag
	N	Integer	Array position of wing ray
	XI YI ZI	Real	Coordinates of wing ray N intersection with the fuselage
	NINT	Integer	Intersection flag
	Y1	Real	Known Y or Z coordinate of ray preceding ray JJ

Labeled common	Variable name	Variable type	Definition
OVLARG	Y2	Real	Y or Z coordinate of ray JJ
	JJ	Integer	Array position of wing ray JJ for which no intersection was found
	ISURF	Integer	Wing surface orientation flag
	IERR	Integer	Routine NOINT error flag
	NSST	Integer	Index pointer of intersecting chord position in wing spanwise geometry array
	IDENT	Integer	Index of the name printing array (NAMPRT) corresponding to the component
PANL			This Labeled Common contains wing surface input parameters found in the Namelist WING description with the following exceptions: TWRDX, TCX, and SWO
	TWRDX	Real	Same as TWRD(1)
	TCX	Real	Same as TCD(1)
	SWO	Real	Wing trailing-edge sweep angle, degrees
RADIUS	IRADE	Integer	Wing leading-edge radius flag (user defined)
	RADE	Real	Wing leading-edge radius (user defined)
	NPHX	Integer	Number of wing leading-edge points not to be respaced (user defined)
SAVE	TITLE	Alphanumeric array	Job identification (user defined)
	J0	Integer	Not used
	J1	Integer	Wing geometry data control flag
	J2	Integer	Fuselage geometry data control flag
	J3	Integer	Not used
	J4	Integer	Fin data control flag
	J5	Integer	Not used
	J6	Integer	Not used

APPENDIX B

Labeled common	Variable name	Variable type	Definition
SAVE	IHT	Integer	Horizontal-tail data control flag
	ICAN	Integer	Canard data control flag
	JFLAP	Integer	Control surface data control flag
	NST	Integer array	Array identifying the locations of the intersection chords of all components with fuselage
	NYF	Integer array	Array containing fuselage and wing array limits
	REFL	Real	Configuration reference length
	ICO	Integer	Component array identification index
	MERG	Integer array	Array containing the MERGE option flag for each wing surface
	NDBUG	Integer array	Array containing the MERGE debug printout option flags for each wing surface
	JENG	Integer	Auxiliary fuselage geometry flag
T28	XLE ZLEU ZLEL XX1 XX2 NO II		Same as for Labeled Common LEAD
	RFL	Real	Configuration reference length
	IFLAP	Integer	Control surface data control flag
TEMPCO	YY ZZ	Real-array	Coordinates of cross-section points between successive lofting lines
THICK	NTHK	Integer	Counter for number of thickness and/or camber ratio input points
	TWRD	Real-array	Section thickness ratios corresponding to YTHK (user defined)
	YTHK	Real-array	Spanwise locations of input thickness and/or camber ratios (user defined)

Labeled common	Variable name	Variable type	Definition
THICK	TCD	Real-array	Mean camber line thickness ratio corresponding to YTHK (user defined)
TIP	ITEETH	Integer	Wing tip chord plane flag (user defined)
	ANGR	Real	Spanwise deflection at wing root chord, degrees (user defined)
	ANGT	Real	Spanwise deflection at wing tip chord, degrees (user defined)
TMPY	YTMP ZTMP	Real-array	Coordinates of one fuselage cross section
	RUNL	Real-array	Surface length in feet from nose to centroid of element of interest for skin-friction calculations
XPRNT	IMERGE	Integer	Wing MERGE flag (user defined)
	NDEBUG	Integer	Wing MERGE debug print flag (user defined)
	REFLW	Real	Wing reference length (user defined)
	R	Real-array	Array that flags all wing input parameters as either input by user or default
XYZINT	XIU YIU ZIU	Real-array	X, Y, and Z coordinates of the wing upper surface chord defining its intersection with the fuselage
	NIU	Integer	Number of points in the wing upper surface intersection chord
	XIL YIL ZIL	Real-array	X, Y, and Z coordinates of the wing lower surface chord defining its intersection with the fuselage
	NIL	Integer	Number of points in the wing lower surface intersection chord

APPENDIX B

Labeled common	Variable name	Variable type	Definition
XYZRAY	IYX	Integer	Wing ray segment equation definition flag in the XY plane for $Y = m_yX + b_y$ 0: $m_y \neq 0$ 1: $m_y = 0$ 2: $m_y = \infty$
	AMY	Real	Segment slope (m_y) in XY plane
	BY	Real	Segment intercept (b_y) in XY plane
	IXY AMXY BYX		Same as above but for $X = m_{xy}Y + b_{xy}$
	IZY AMZ BZ		Same as above but for $Z = m_zY + b_z$
	IYZ AMYZ BYZ		Same as above but for $Y = m_{yz}Z + b_{yz}$
	IZX AMZX BZX		Same as above but for $Z = m_{zx}X + b_{zx}$
	IXZ AMX BX		Same as above but for $X = m_xZ + b_x$

APPENDIX C

SAMPLE INPUT AND OUTPUT

The following sample cases represent the same configuration using different GEMPAK input options. Figure 43 shows the basic layout for the fuselage input of sample case 1.

Sample case	Description
1	Fuselage (Complete lofting, INC(1) = 0) wing, horizontal tail, fin (Automatic input, IHPUT = 1)
2	Fuselage (Point-by-point, INC(1) = 2)
3	Fuselage (Longitudinal lofting, INC(1) = 1)
4	Fuselage (Cross-sectional lofting, INC(1) = 3)
5	Fuselage (With aero/propulsion surface, INC(4) = 1)
6	Wing (Manual input, IHPUT = 2)
7	Wing (Arbitrary airfoil, ICHRD = 3)
8	Wing (With deflected control surface, ICON = 1)

The final generated geometry arrays and codes necessary to fully describe the configuration reside on the program file TAPE38 and are therefore described here along with the output (TAPE6). If no fuselage is generated, such as in sample cases 6, 7, and 8, all final geometry will reside on TAPE28 instead of TAPE38. Figure 44 is a computer drawing of the generated geometry for sample case 1.

Sample Case 1 Input

```
COLUMN          1         2         3         4         5         6         7         8
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
       GEMPAK SAMPLE CASE 1  (FUSELAGE, WING, HORIZONTAL TAIL, FIN)
         1  5  4  2
       FUSELAGE (COMPLETE LOFTING, INC(1)=0)
         600.             9   12   21 0 1 1 0 1 1 1 1 1 1 1
       0.        3.        50.       128.      152.      164.      176.      200.
       300.      400.      520.      600.
       22      22          22      22          22      22          22  22  22
       22  22  22          22  22  22          22  22  22          22  22  22
       22  22  22          22  22  22          22  22  22          22  22  22
           1    3    1    3    1    3    3    5
        1  2      0.        0.                                                        *
        0  1 1    600.      0.
        2  6      0.        0.                                                        *
        0  1 1    3.        3.
        0  1 1    128.      39.4
        0  1 1    152.      52.          1                     .525
        0  1      164.      56.       1    .02982
        0  1 1    600.      69.
        1  4      0.        0.                                                        *
        0  2 1    200.      0.
        0  2 1    400.      39.906
        0  2 1    600.      36.532
        2  6      0.        0.                                                        *
        0  2 1    3.        3.
        0  2 1    128.      39.4
        0  2 1    152.      52.          1                     .525
        0  2      164.      56.       1    .02982
        0  2 1    600.      69.
        1  6      0.        0.                                                        *
        0  3 1    118.      0.
        0  3 1    152.      3.6         1                     .10588
        0  3      200.      17.1      1    .435
        0  3 1    400.      57.006
        0  3 1    600.      53.632
        2  7      0.        0.                                                        *
```

GEMPAK title card

GEMPAK geometry option card

Fuselage card set 1

Fuselage card set 2

Fuselage card set 3

Lofting line 1 in XY plane

Lofting line 1 in XZ plane

Lofting line 2 in XY plane

Fuselage card set 4

Lofting line 2 in XZ plane

Lofting line 3 in XY plane

```
COLUMN         1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
       0  3 1    3.        3.
       0  3 1    128.      39.4
       0  3 1    152.      49.2         1                     .40833
       0  3      168.      53.2      1  1 0.                  0.
       0  3      200.      45.7      1    -.375
       0  3 1    600.      57.627
       1  6      0.        0.                                                        *
       0  4 1    118.      0.
       0  4 1    128.      1.06
       0  4 1    200.      17.1
       0  4 1    400.      57.006
       0  4 1    600.      53.632
       2  5      0.        0.                                                        *
       0  4 1    3.        3.
       0  4 1    128.      39.4
       0  4 1    200.      45.7
       0  4 1    600.      57.627
       1  6      0.        0.                                                        *
       0  5 1    3.        2.7
       0  5 1    128.      8.942
       0  5 1    200.      17.1
       0  5 1    400.      57.006
       0  5 1    600.      53.632
       2  5      0.        0.                                                        *
       0  5 1    3.        1.5
       0  5 1    128.      34.
       0  5 1    200.      45.7
       0  5 1    600.      57.627
       1  4      0.        0.                                                        *
       0  6 1    3.        2.7
       0  6 1    400.      83.6
       0  6 1    600.      84.
       2  4      0.        0.                                                        *
       0  6 1    3.        1.5
       0  6 1    400.      10.743
```

Lofting line 3 in XZ plane

Lofting line 4 in XY plane

Lofting line 4 in XZ plane

Lofting line 5 in XY plane

Lofting line 5 in XZ plane

Lofting line 6 in XY plane

Lofting line 6 in XZ plane

[Fuselage card set 4]

```
COLUMN         1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
       0  6 1    600.      10.90
       1  4      0.        0.                                                        *
       0  7 1    3.        0.
       0  7 1    400.      81.
       0  7 1    600.      84.
       2  3      0.        0.                                                        *
       0  7 1    3.       -3.
       0  7 1    600.      10.9
       1  5      0.        0.                                                        *
       0  8 1    3.        0.
       0  8 1    200.       36.6        1                     .18579
       0  8      400.      60.       1    0.
       0  8 1    600.      60.
       2  4      0.        0.                                                        *
       0  8 1    3.       -3.
       0  8 1    520.     -7.
       0  8 1    600.      10.
       1  2      0.        0.                                                        *
       0  9 1    600.      0.
       2  4      0.        0.                                                        *
       0  9 1    3.       -3.
       0  9 1    520.     -22.
       0  9 1    600.      9.1
       1  3   2  0.        0.                                                        *
       1  1 1 2  200.      0.0
       1  1 1 2  600.      20.
       2  6   2  0.        0.                                                        *
       1  1 1 2   3.       3.
       1  1 1 2  128.      39.4
       1  1 1 2  152.      52.          1                     .525
       1  1   2  164.      56.       1    .02982
       1  1 1 2  600.      69.
       1  5      0.        0.                                                        *
       1  2 1    118.      0.0
       1  2 1    163.5     2.5
```

Lofting line 7 in XY plane

Lofting line 7 in XZ plane

Lofting line 8 in XY plane

Lofting line 8 in XZ plane

Lofting line 9 in XY plane

Lofting line 9 in XZ plane

Slope control line 1 in XY plane

Slope control line 1 in XZ plane

Slope control line 2 in XY plane

Fuselage card set 4

```
COLUMN         1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
       1  2 1    400.      49.614
       1  2 1    600.      46.241
       2  6      0.        0.                                                        *
       1  2 1    3.        3.
       1  2 1    128.      39.4
       1  2 1    152.      52.          1                     .525
       1  2      164.      56.       1    .02982
       1  2 1    600.      69.
       1  7      0.        0.                                                        *
       1  3 1    118.      0.0
       1  3 1 2  128.      1.0595
       1  3 1 2  162.5     7.
       1  3 1 2  200.      17.1
       1  3 1 2  400.      57.006
       1  3 1 2  600.      53.632
       2  6      0.        0.                                                        *
       1  3 1    3.        3.
       1  3 1 2  128.      39.4
       1  3 1 2  162.5     47.5
       1  3 1 2  200.      45.7
       1  3 1 2  600.      57.627
       1  6      0.        0.                                                        *
       1  4 1    3.        1.725
       1  4 1    128.      5.433
       1  4 1    200.      17.1
       1  4 1    400.      57.006
       1  4 1    600.      53.632
       2  5      0.        0.                                                        *
       1  4 1    3.        3.
       1  4 1    128.      39.4
       1  4 1    200.      45.7
       1  4 1    600.      57.627
       1  4   2  0.        0.                                                        *
       1  5 1 2  3.        2.7
       1  5 1 2  400.      70.303
```

Slope control line 2 in XZ plane

Slope control line 3 in XY plane

Slope control line 3 in XZ plane

Slope control line 4 in XY plane

Slope control line 4 in XZ plane

Slope control line 5 in XY plane

Fuselage card set 4

```
COLUMN   1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 1  5 1 2  600.      68.816
 2  4   2  0.        0.                                                        *
 1  5 1 2  3.        1.5
 1  5 1 2  400.      31.203
 1  5 1 2  600.      34.264
 1  4      0.        0.                                                        *
 1  6 1    3.        5.625
 1  6 1    400.      86.525
 1  6 1    600.      84.
 2  3      0.        0.                                                        *
 1  6 1    3.       -3.
 1  6 1    600.      10.9
 1  6      0.        0.                                                        *
 1  7 1    3.        0.
 1  7 1    200.      38.824       1                     .19708
 1  7      400.      64.482    1    0.
 1  7 1    520.      65.837
 1  7 1    600.      60.328
 2  3      0.        0.                                                        *
 1  7 1    3.       -3.
 1  7 1    600.      10.9
 1  6      0.        0.                                                        *
 1  8 1    3.        0.
 1  8 1    200.      34.52        1                     .17523
 1  8      400.      55.808    1    0.
 1  8 1    520.      54.54
 1  8 1    600.      59.672
 2  4      0.        0.                                                        *
 1  8 1    3.       -3.
 1  8 1    520.     -22.
 1  8 1    600.      9.1
 $WING  CRW= 152.95, BW= 100., SWEOB= 52.3, TPW= .363, NYU= 4, NXU= 6,
   TWRD= .175, XWD1= .9999, XWD2= 0., XW1= 471.7, ZBR= 54., IPRNT= 3,
   IMERGE=-3,NDEBUG=0, IRADE= 1, RADE= .75,
 $END OF FIN INPUT (SAMPLE CASE 1)
```

Slope control line 5 in XZ plane

Slope control line 6 in XY plane

Slope control line 6 in XZ plane

Slope control line 7 in XY plane

Slope control line 7 in XZ plane

Slope control line 8 in XY plane

Slope control line 8 in XZ plane

Fin input (ICOMP = 5)

Fuselage card set 4

```
COLUMN          1         2         3         4         5         6         7         8
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
        $WING  CRW= 196.9, BW= 232.5, SWEOB= 54.5, TRW= .3750, NYU= 4, NXU= 6,
          TWRD= .06, XWD1= .5, XWD2= 0., TCD= .03, XW1= 380.25, ZBR= 45.,
          XROTAT= 597., YROTAT= 64.3, ZROTAT= 45., THETA= 60., ALPHA= -5.,
          BETA= 10., IPRNT= 3, IMERGE=-3, IRADE= 1, RADE= .75  ,
        $END OF HORIZONTAL TAIL INPUT (SAMPLE CASE 2)
        $WING  CRW= 404.00, BW= 335.44, SWEOB= 59.39, TRW= .3058, NYU= 4, NXU= 9,
          ICHRD= 2, TWRD= .06, TCD= .03, XW1= 237.70, ZBR= -35.217, THETA= 30.,
          ALPHA= -1., IPRNT= 3, IMERGE= 3, IRADE= 1, RADE= .75, XROTAT= 600.  ,
        $END OF WING INPUT (SAMPLE CASE 1)
```

} Horizontal tail input (ICOMP = 4)

} Wing input (ICOMP = 2)

Sample Case 1 Output

```
GEMPAK - RAPID AIRCRAFT GEOMETRY GENERATION FOR ENGINEERING DESIGN

CASE TITLE - GEMPAK SAMPLE CASE 1  (FUSELAGE, WING, HORIZONTAL TAIL, FIN)

GEOMETRY OPTIONS CHOSEN

     1  FUSELAGE

     5  FIN

     4  HORIZ.TAIL

     2  WING



************************
* E N T E R   F U S 2 *
************************



FUSELAGE (COMPLETE LOFTING, INC(1)=0)
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  1 BETWEEN X=      0.0000 AND X=   600.0000 ON THE X-Y PLANE
ST LINE      A=  0.             B=  0.              C=  0.              D=  0.              E=  -.60000E+03   F=  0.                SG=  1.
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  1 BETWEEN X=      0.0000 AND X=     3.0000 ON THE X-Z PLANE
ST LINE      A=  0.             B=  0.              C=  0.              D=  .30000E+01  E=  -.30000E+01   F=  0.                SG=  1.
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  1 BETWEEN X=
ST LINE      A=  0.             B=  0.                                                                                              1.
 EFFS FOR PROJECTION OF LOFTING CURVE
             A=  0.
```

(Longitudinal curve segment end points
and coefficients for lofting curves 1 to 9)

```
                                                                    D=  -.40000E+01  E=  -.51700E+03  F=  -.15
                                            6 BETWEEN X=   520.0000 AND X=   600.0000 ON THE X-Z PLANE
ST                                                  C=  0.              D=   .17000E+02  E=  -.80000E+02  F=  -.94000E+04   SG=  1.
COEFFS               OF LOFTING CURVE NO.  9 BETWEEN X=      0.0000 AND X=   600.0000 ON THE X-Y PLANE
ST LINE      A=  0.             B=  0.              C=  0.              D=  0.              E=  -.60000E+03   F=  0.                SG=  1.
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  9 BETWEEN X=      0.0000 AND X=     3.0000 ON THE X-Z PLANE
ST LINE      A=  0.             B=  0.              C=  0.              D=  -.30000E+01  E=  -.30000E+01  F=  0.                SG=  1.
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  9 BETWEEN X=      3.0000 AND X=   520.0000 ON THE X-Z PLANE
ST LINE      A=  0.             B=  0.              C=  0.              D=  -.19000E+02  E=  -.51700E+03  F=  -.14940E+04   SG=  1.
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  9 BETWEEN X=    520.0000 AND X=   600.0000 ON THE X-Z PLANE
ST LINE      A=  0.             B=  0.              C=  0.              D=   .31100E+02  E=  -.80000E+02  F=  -.17932E+05   SG=  1.
```

```
COEFFS FOR PROJECTION OF SLOPE CONTROL LINE NO.  1 BETWEEN X=     0.0000 AND X=   200.0000 ON THE X-Y PLANE
ST LINE      A=  0.              B=  0.            C=  0.              D=  0.              E=  -.20000E+03   F=  0.                 SG=  1.
COEFFS FOR PROJECTION OF SLOPE CONTROL LINE NO.  1 BETWEEN X=   200.0000 AND X=   600.0000 ON THE X-Y PLANE
ST LINE      A=  0.              B=  0.            C=  0.              D=   .20000E+02   E=  -.40000E+03   F=  -.40000E+04        SG=  1.
COEFFS FOR PROJECTION OF SLOPE CONTROL LINE NO.  1 BETWEEN X=     0.0000 AND X=     3.0000 ON THE X-Z PLANE
ST LINE      A=  0.              B=  0.            C=  0.              D=   .30000E+01   E=  -.30000E+01   F=  0.                 SG=  1.
COEFFS FOR PROJECTION OF SLOPE CONTROL LINE NO.  1 BETWEEN X=     3.0000 AND X=   120.0000 ON THE X-Z PLANE
T LINE       A=  0.              B=  0.            C=  0.                                E=  -.12500E+03   F=   .26580E+03        SG=  1.
ES FOR PROJECTION OF SLOPE CONTROL                                                                      PLANE
             A=  0.                                                                                                                SG=  1.
```

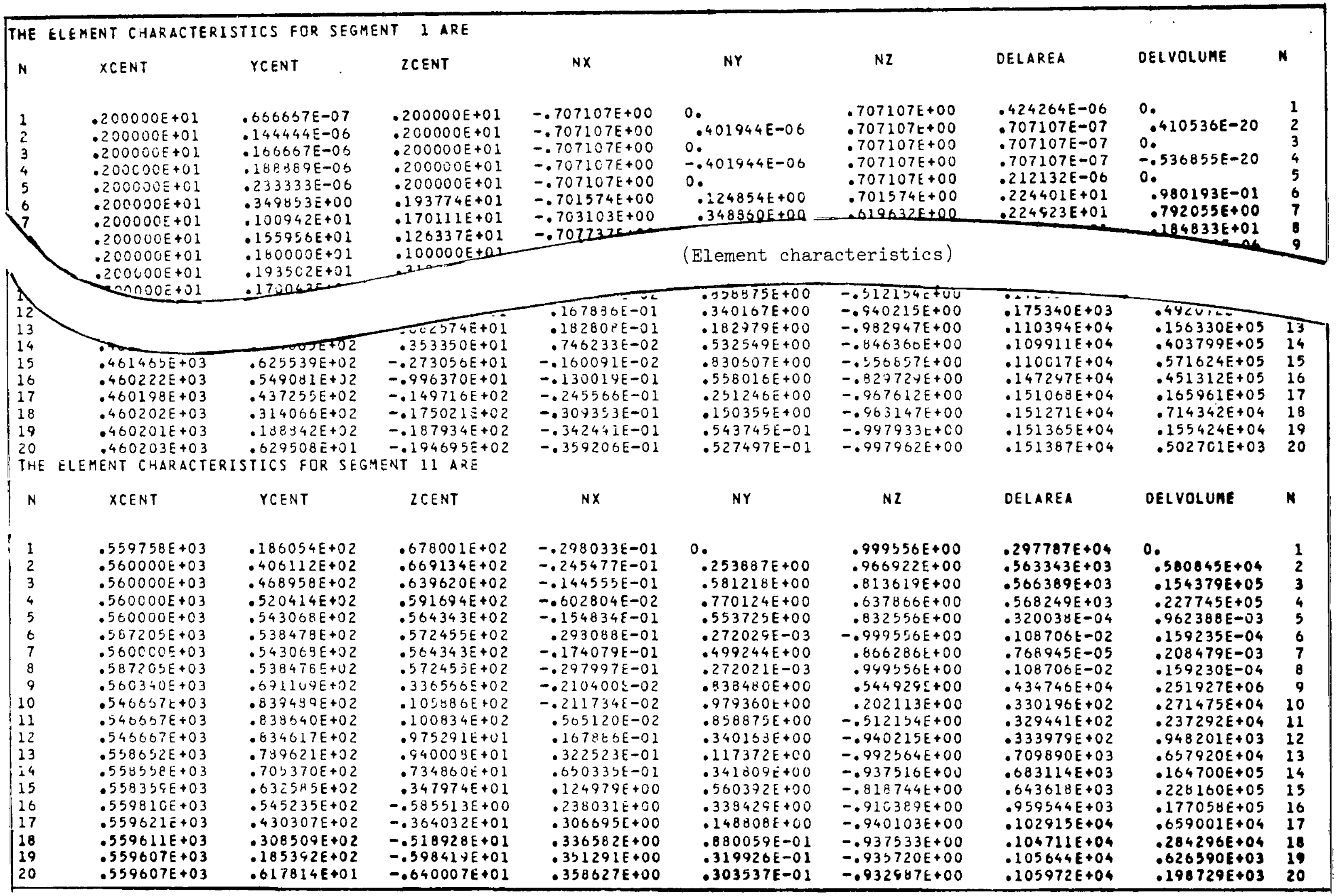
(Longitudinal curve segment end points and coefficients
for slope control lines 1 to 8)

```
                                                  8 BETWEEN X=   400.0000 AND X=
ST                                                 C=  0.              D=  -.12680E+01   E=  -.12000E+03
COEFFS FOR PROJECTION OF SLOPE CONTROL LINE NO.  8 BETWEEN X=   520.0000 AND X=   600.0000 ON THE X-Y PLANE
ST LINE      A=  0.              B=  0.            C=  0.              D=   .51320E+01   E=  -.80000E+02   F=   .16946E+04
COEFFS FOR PROJECTION OF SLOPE CONTROL LINE NO.  8 BETWEEN X=     0.0000 AND X=     3.0000 ON THE X-Z PLANE
ST LINE      A=  0.              B=  0.            C=  0.              D=  -.30000E+01   E=  -.30000E+01   F=  0.                 SG=  1.
COEFFS FOR PROJECTION OF SLOPE CONTROL LINE NO.  8 BETWEEN X=     3.0000 AND X=   520.0000 ON THE X-Z PLANE
ST LINE      A=  0.              B=  0.            C=  0.              D=  -.19000E+02   E=  -.51700E+03   F=  -.14940E+04        SG=  1.
COEFFS FOR PROJECTION OF SLOPE CONTROL LINE NO.  8 BETWEEN X=   520.0000 AND X=   600.0000 ON THE X-Z PLANE
ST LINE      A=  0.              B=  0.            C=  0.              D=   .31100E+02   E=  -.80000E+02   F=  -.17932E+05        SG=  1.
 COEFFS FOR CROSS-SECTION SEGMENT NO.  1 AT X=      0.0000
DEGEN SEG    A=  0.              B=  0.            C=  0.              D=  0.              E=  0.              F=   .10000E+01        SG=  0.
 COEFFS FOR CROSS-SECTION SEGMENT NO.  2 AT X=      0.0000
DEGEN SEG    A=  0.              B=  0.            C=  0.              D=  0.              E=  0.              F=   .10000E+01        SG=  0.
 COEFFS FOR CROSS-SECTION SEGMENT NO.  3 AT X=      0.0000
DEGEN SEG    A=  0.              B=  0.            C=  0.              D=  0.              E=  0.              F=   .10000E+01        SG=  0.
 COEFFS FOR CROSS-SECTION SEGMENT NO.  4 AT X=      0.0000
GEN SEG      A=  0.              B=  0.                                                                                   10000E+01        SG=  0.
EFS FOR CROSS-SECTION SEGMENT NO
             A=  0.
```

(Cross-sectional curve segment end points and coefficients
for segments 1 to 8 from X = 0.0 to X = 600.0)

```
                                                     0.              D=  -.22152E-06   E=  -.33306E-06   F=
                                           AT X=    600.0000
ST LI                            B=  0.            C=  0.              D=  -.55379E-07   E=  -.83266E-07   F=   .77684E-05   SG=  1.
 COEFFS FOR CROSS-SECTION SEGMENT NO.  5 AT X=    600.0000
ST LINE      A=  0.              B=  0.            C=  0.              D=  -.46727E+02   E=  -.30368E+02   F=   .42561E+04   SG=  1.
 COEFFS FOR CROSS-SECTION SEGMENT NO.  6 AT X=    600.0000
ST LINE      A=  0.              B=  0.            C=  0.              D=  -.58694E-06   E=  -.38145E-06   F=   .53461E-04   SG=  1.
 COEFFS FOR CROSS-SECTION SEGMENT NO.  7 AT X=    600.0000
ELLIPSE      A=   .10000E+01     B=   .34250E-04   C=   .69167E+03     D=  -.16800E+03   E=  -.13816E+05   F=   .75472E+05   SG=  1.
 COEFFS FOR CROSS-SECTION SEGMENT NO.  8 AT X=    600.0000
ELLIPSE      A=   .10000E+01     B=  0.            C=   .43959E+04     D=  0.              E=  -.87961E+05   F=   .43642E+06   SG= -1.
```

```
DATA FROM MAIN STORAGE ARRAYS
X= 0.              YMAX= 0.               ZMAX= 0.               NX=  1
        Y                Z          N         Y                Z          N         Y                Z          N
   0.               0.              1    0.               0.              2    0.               0.              3
   0.               0.              4    0.               0.              5    0.               0.              6
   0.               0.              7    0.               0.              8    0.               0.              9
   0.               0.             10    0.               0.             11    0.               0.             12
   0.               0.             13    0.               0.             14    0.               0.             15
   0.               0.             16    0.               0.             17    0.               0.             18
   0.               0.             19    0.               0.             20    0.               0.             21
X=  .30000000E+01 YMAX=  .31050743E+01 ZMAX= -.54509858E+00 NX=  2
        Y                Z          N         Y                Z          N         Y                Z          N
   0.                .30000000E+01  1     .20000000E-06    .30000000E+01  2     .23333333E-06    .30000000E+01  3
    .26666667E-06    .30000000E+01  4     .30000000E-06    .30000000E+01  5     .40000000E-06    .30000000E+01  6
    .10495583E+01    .28132180E+01  7     .19786874E+01    .22901066E+01  8     .27000000E+01    .15000000E+01  9
    .27000005E+01    .14999997E+01 10     .31050743E+01   -.54509858E+00 11     .19962138E+01   -.23070549E+01 12
    .10000011E-06   -.30000000E+01 13     .92812343E-07   -.30000000E+01 14     .46406228E-07   -.30000000E+01 15
    .11368684E-12   -.30000000E+01 16    0.               -.30000000E+01 17    0.               -.30000000E+01 18
                    -.30000000E+01 19    0.                                                     -.30000000E+01 21
     0000E+02 YMAX=  .12684115E+
                                  (Generated cross-section points)
                                                  290E+02    .19986383E+01 14     .54206904E+02
                                          .42881658E+02   -.99721883E+01 17     .32281150E+02   -.11932934E+02
    .21             369E+02 19     .10778796E+02   -.13495131E+02 20    0.               -.13914694E+02 21
X=  .40000000E+03 YMAX=  .84017113E+02 ZMAX=  .87218695E+01 NX= 10
        Y                Z          N         Y                Z          N         Y                Z          N
   0.                .63036697E+02  1     .39906000E+02    .63036697E+02  2     .46714804E+02    .61248707E+02  3
    .52475065E+02    .57133678E+02  4     .57006000E+02    .51663500E+02  5     .57006000E+02    .51663500E+02  6
    .57005922E+02    .51663500E+02  7     .57005922E+02    .51663500E+C2  8     .57006000E+02    .51663500E+02  9
    .83600000E+02    .10743000E+02 10     .84017113E+02    .87218695E+01 11     .82962554E+02    .69534403E+01 12
    .81000000E+02    .62433836E+01 13     .72511497E+02    .48903555E+01 14     .65001253E+02    .80484696E+00 15
    .60000000E+02   -.60715667E+01 16     .49487559E+02   -.12189503E+02 17     .37309256E+02   -.14868010E+02 18
    .24934066E+02   -.16453553E+02 19     .12467033E+02   -.17021746E+02 20    0.               -.17589942E+02 21
X=  .52000000E+03 YMAX=  .84006845E+02 ZMAX=  .10028748E+02 NX= 11
        Y                Z          N         Y                Z          N         Y                Z          N
   0.                .66614679E+02  1     .37881600E+02    .66614679E+02  2     .44690447E+02    .64826616E+02  3
    .50450741E+02    .60711851E+02  4     .54981600E+02    .55241600E+02  5     .54981600E+02    .55241600E+02  6
    .54981614E+02    .55241600E+02  7     .54981615E+02    .55241600E+02  8     .54981600E+02    .55241600E+02  9
    .83840000E+02    .10837200E+02 10     .84006845E+02    .10028748E+02 11     .83565034E+02    .93213761E+01 12
    .82800000E+02    .90373534E+01 13     .73203312E+02    .70237655E+01 14     .65209390E+02    .13537610E+01 15
    .60000000E+02   -.70000000E+01 16     .50143014E+02   -.14581072E+02 17     .37958823E+02   -.18226435E+02 18
    .25420949E+02   -.20433724E+02 19     .12712669E+02   -.21237258E+02 20    0.               -.22000000E+02 21
X=  .60000000E+03 YMAX=  .84000000E+02 ZMAX=  .10899999E+02 NX= 12
        Y                Z          N         Y                Z          N         Y                Z          N
   0.                .69000000E+02  1     .36532000E+02    .69000000E+02  2     .43340875E+02    .67212222E+02  3
    .49101198E+02    .63097300E+02  4     .53632000E+02    .57627000E+02  5     .53632000E+02    .57627000E+02  6
    .53631959E+02    .57627000E+02  7     .53631959E+02    .57627000E+02  8     .53632000E+02    .57627000E+02  9
    .84000000E+02    .10900000E+02 10     .83999997E+02    .10900000E+02 11     .83999997E+02    .10899999E+02 12
    .84000000E+02    .10899999E+02 13     .75981405E+02    .10830564E+02 14     .67964568E+02    .10663201E+02 15
    .60000000E+02    .10000000E+02 16     .48018045E+02    .94626453E+01 17     .36014440E+02    .92813424E+01 18
    .24009868E+02    .91828384E+01 19     .12004934E+02    .91414192E+01 20    0.                .91000000E+01 21
```



```
THE ELEMENT CHARACTERISTICS FOR SEGMENT  1 ARE

N        XCENT           YCENT           ZCENT            NX              NY              NZ             DELAREA         DELVOLUME     N


1     .200000E+01     .666667E-07     .200000E+01    -.707107E+00    0.              .707107E+00     .424264E-06     0.              1
2     .200000E+01     .144444E-06     .200000E+01    -.707107E+00     .401944E-06    .707107E+00     .707107E-07      .410536E-20    2
3     .200000E+01     .166667E-06     .200000E+01    -.707107E+00    0.              .707107E+00     .707107E-07     0.              3
4     .200C00E+01     .188889E-06     .200000E+01    -.707107E+00    -.401944E-06    .707107E+00     .707107E-07     -.536855E-20    4
5     .200000E+01     .233333E-06     .200000E+01    -.707107E+00    0.              .707107E+00     .212132E-06     0.              5
6     .200000E+01     .349853E+00     .193774E+01    -.701574E+00     .124854E+00    .701574E+00     .224401E+01      .980193E-01    6
7     .200000E+01     .100942E+01     .170111E+01    -.703103E+00     .348860E+00    .619632E+00     .224923E+01      .792055E+00    7
      .200000E+01     .155956E+01     .126337E+01    -.70773                                                          .184833E+01    8
      .200000E+01     .160000E+01     .100000E+01                                                                                   9
      .200000E+01     .193502E+01
      .200000E+01     .17004
                                                                      .858875E+00    -.512154E+00
12                                                    .167836E-01     .340167E+00    -.940215E+00     .175340E+03     .49
13                                    .562574E+01     .182808E-01     .182979E+00    -.982947E+00     .110394E+04     .156330E+05   13
14                      E+02          .353350E+01     .746233E-02     .532549E+00    -.846366E+00     .109911E+04     .403799E+05   14
15    .461465E+03     .625539E+02    -.273056E+01    -.160091E-02     .830607E+00    -.556657E+00     .110017E+04     .571624E+05   15
16    .460222E+03     .549081E+02    -.996370E+01    -.130019E-01     .558016E+00    -.829729E+00     .147297E+04     .451312E+05   16
17    .460198E+03     .437255E+02    -.149716E+02    -.245566E-01     .251246E+00    -.967612E+00     .151068E+04     .165961E+05   17
18    .460202E+03     .314066E+02    -.175021E+02    -.309353E-01     .150359E+00    -.963147E+00     .151271E+04     .714342E+04   18
19    .460201E+03     .188342E+02    -.187934E+02    -.342441E-01     .543745E-01    -.997933E+00     .151365E+04     .155424E+04   19
20    .460203E+03     .629508E+01    -.194695E+02    -.359206E-01     .527497E-01    -.997962E+00     .151387E+04     .502701E+03   20
THE ELEMENT CHARACTERISTICS FOR SEGMENT 11 ARE

N        XCENT           YCENT           ZCENT            NX              NY              NZ             DELAREA         DELVOLUME     N


1     .559758E+03     .186054E+02     .678001E+02    -.298033E-01    0.              .999556E+00     .297787E+04     0.              1
2     .560000E+03     .406112E+02     .669134E+02    -.245477E-01     .253887E+00    .966922E+00     .563343E+03      .580845E+04    2
3     .560000E+03     .468958E+02     .639620E+02    -.144555E-01     .581218E+00    .813619E+00     .566389E+03      .154379E+05    3
4     .560000E+03     .520414E+02     .591694E+02    -.602804E-02     .770124E+00    .637866E+00     .568249E+03      .227745E+05    4
5     .560000E+03     .543068E+02     .564343E+02    -.154834E-01     .553725E+00    .832556E+00     .320038E-04      .962388E-03    5
6     .587205E+03     .538478E+02     .572455E+02     .293088E-01     .272029E-03   -.999556E+00     .108706E-02      .159235E-04    6
7     .560000E+03     .543068E+02     .564343E+02    -.174079E-01     .499244E+00    .866286E+00     .768945E-05      .208479E-03    7
8     .587205E+03     .538476E+02     .572455E+02    -.297997E-01     .272021E-03    .999556E+00     .108706E-02      .159230E-04    8
9     .560340E+03     .691109E+02     .336566E+02    -.210400E-02     .838480E+00    .544929E+00     .434746E+04      .251927E+06    9
10    .546667E+03     .839489E+02     .105886E+02    -.211734E-02     .979360E+00    .202113E+00     .330196E+02      .271475E+04   10
11    .546667E+03     .838640E+02     .100834E+02     .565120E-02     .858875E+00   -.512154E+00     .329441E+02      .237292E+04   11
12    .546667E+03     .834617E+02     .975291E+01     .167866E-01     .340163E+00   -.940215E+00     .333979E+02      .948201E+03   12
13    .558652E+03     .789621E+02     .940008E+01     .322523E-01     .117372E+00   -.992564E+00     .709890E+03      .657920E+04   13
14    .558558E+03     .705370E+02     .734860E+01     .650335E-01     .341809E+00   -.937516E+00     .683114E+03      .164700E+05   14
15    .558359E+03     .632585E+02     .347974E+01     .124979E+00     .560392E+00   -.818744E+00     .643618E+03      .228160E+05   15
16    .559810E+03     .545235E+02    -.585513E+00     .238031E+00     .338429E+00   -.910389E+00     .959544E+03      .177058E+05   16
17    .559621E+03     .430307E+02    -.364032E+01     .306695E+00     .148808E+00   -.940103E+00     .102915E+04      .659001E+04   17
18    .559611E+03     .308509E+02    -.518928E+01     .336582E+00     .880059E-01   -.937533E+00     .104711E+04      .284296E+04   18
19    .559607E+03     .185392E+02    -.598419E+01     .351291E+00     .319926E-01   -.935720E+00     .105644E+04      .626590E+03   19
20    .559607E+03     .617814E+01    -.640007E+01     .358627E+00     .303537E-01   -.932987E+00     .105972E+04      .198729E+03   20
```

(Element characteristics)

```
THE GOODIES ARE.....

SURFACE AREA=   .17364548E+06
VOLUME=   .37174177E+07
THE CENTER-OF-VOLUME COORDINATES (XCG,YCG,ZCG) =    .40094009E+03   0.                .23574518E+02
FINENESS RATIO=   .50554465E+01


    *** CROSS-SECTIONAL INFORMATION ***       *********** LONGITUDINAL SEGMENT INFORMATION ***********

           X                  AREAS               SURFACE AREAS          VOLUMES         CENTERS-OF-VOLUME



     0.                   0.
                                                 .39720337E+02      .27720274E+02      .20000000E+01
      .30000000E+01        .27720274E+02
                                                 .21819592E+04      .78180152E+04      .30864164E+02
      .50000000E+02        .36550566E+03
                                                 .92539571E+04      .75174066E+05      .93673199E+02
      .12800000E+03        .17294584E+04
                                                 .43660536E+04      .48855875E+05      .14023339E+03
      .15200000E+03        .23736752E+04
                                                 .24957880E+04      .30707532E+05      .15805185E+03
      .16400000E+03        .27502980E+04
                                                 .26371748E+04      .35151520E+05      .17003103E+03
      .17600000E+03        .31084373E+04
                                                 .55811517E+04      .82813112E+05      .18806197E+03
      .20000000E+03        .37902422E+04
                                                 .28357466E+05      .53665660E+06      .25098968E+03
      .30000000E+03        .70027755E+04
                                                 .36768244E+05      .86535260E+06      .35104977E+03
      .40000000E+03        .10324509E+05
                                                 .49341459E+05      .12832347E+07      .46030558E+03
      .52000000E+03        .11063011E+05
                                                 .32622508E+05      .75162555E+06      .55980782E+03
      .60000000E+03        .77175456E+04

*********************
* E X I T   F U S 2 *
*********************
```

(Fin generation)

```
****************************
* E N T E R   W I N G E X *
****************************


$WING
IHPUT    = 1,
AW       = .1E-59,
ARW      = .1E+01,
BW       = .1E+03,
CRW      = .15295E+03,
B1BW     = 0.0,
TRW      = .363E+00,
SWEOB    = .523E+02,
SWELG    = -.1001E+04,
SW1      = 0.0,
ANGR     = 0.0,
ANGT     = 0.0,
ICHRD    = 1,
XWD1     = .9999E+00,
XWD2     = 0.0,
NYU      = 4,
NXU      = 6,
NSPACE   = 1,
NPCU     = -1001,
NPCL     = -1001,
IRADE    = 1,
RADE     = .75E+00,
TWRD     = .175E+00, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,      .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
           .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
YTHK     = .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,        .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
           .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
TCD      = 0.0, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,  .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
           .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
IDIHE    = 1,
AWR      = 0.0,
AWT      = 0.0,
YDIH     = .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,        .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
           .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
ZDIH     = .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,        .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
           .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
TWISTX   = 0.0,
XW1      = .4717E+03,
YBR      = 0.0,
ZBR      = .54E+02,
THETA    = .1E+04,
ALPHA    = 0.0,
BETA     = 0.0,
```

```
XROTAT   = -.1001E+04,
YROTAT   = -.1001E+04,
ZROTAT   = -.1001E+04,
IPRNT    = 3,
IMERGE   = -3,
NOEBUG   = 0,
ITEETH   = 0,
ICON     = 0,
NPHX     = 0,
IFLAP    = 0,
XCOR     = .1E-59,
XCOT     = .1E-59,
DELFU    = .1E-59,
DELFL    = .1E-59,
ZCOR     = .1E-59,
ZCOT     = .1E-59,
REFLW    = 0.0,
$END
```

```
INPUT FOR GEOMETRY GENERATION OF           FIN

-----N A M E L I S T   W I N G   I N P U T-------------------------------------

IHPUT =1 D
          ******************   BW   =   .10000E+03     SWEOB=   .52300E+02
          AUTOMATIC GEOMETRY   CRW  =   .15295E+03     SWELG=   .52300E+02
          GENERATION CHOSEN    B1BW= 0.            D   SW1   = 0.
          ******************   TRW  =   .36300E+00     ANGR  = 0.           D
                                                       ANGT  = 0.           D

ICHRD =1 D
          *************************
          SLAB-SIDED AIRFOIL CHOSEN   XWD1=  .99990E+00     NYU= 4
          *************************   XWD2= 0.          D   NXU= 6

IRADE =1
          ****************************
          LEADING-EDGE RADIUS CONSTANT
          FOR ENTIRE SURFACE              RADE=  .75000E+00
          ****************************

          ************************
          CONSTANT THICKNESS RATIO   TWRD=  .17500E+00
          ************************

          *****************************************
          CONSTANT MEAN CAMBER LINE THICKNESS RATIO   TCD= 0.          D
          *****************************************

IDIHE =1 D
          **************************************
          LEADING-EDGE DIHEDRAL WILL BE COMPUTED   AWR= 0.          D
          **************************************   AWT= 0.          D

TWISTX= 0.          D

          ********************   XW1=  .47170E+03
          TRANSLATION IN X,Y,Z   YBR= 0.           D
          ********************   ZBR=  .54000E+02

          **************************
          ROTATION IN ROLL,PITCH,YAW   NONE D
          **************************
```

(The letter "D" following some of
the input values indicates that
the default was chosen)

```
IPRNT =3

IMERGE=-3
          *****************************
          THIS COMPONENT WILL BE MERGED
          WITH THE FUSELAGE                   NDEBUG=0
          *****************************

ITEETH=0 D

ICON  =0 D

REFLW = 0.          D

-----E N D   N A M E L I S T   W I N G   I N P U T-----

END OF INPUT FOR GEOMETRY GENERATION OF           FIN
```

```
          BASIC GENERATED GEOMETRY

          PT       XU          YU          ZU            PT       XL          YL          ZL

CHORD  1
           1     0.0000      0.0000      0.0000           1     0.0000      0.0000      0.0000
           2      .0513      0.0000       .2726           2      .0513      0.0000      -.2726
           3      .1982      0.0000       .5079           3      .1982      0.0000      -.5079
           4      .4205      0.0000       .6738           4      .4205      0.0000      -.6738
           5      .6880      0.0000       .7474           5      .6880      0.0000      -.7474
           6    38.7497      0.0000      3.9064           6    38.7497      0.0000     -3.9064
           7    76.8113      0.0000      7.0653           7    76.8113      0.0000     -7.0653
           8   114.8730      0.0000     10.2242           8   114.8730      0.0000    -10.2242
           9   152.9347      0.0000     13.3831           9   152.9347      0.0000    -13.3831
          10   152.9500      0.0000       .0000          10   152.9500      0.0000      -.0000
CHORD  2
           1    43.1283     33.3333      0.0000           1    43.1283     33.3333      0.0000
           2    43.1797     33.3333       .2728           2    43.1797     33.3333      -.2728
           3    43.3268     33.3333       .5083           3    43.3268     33.3333      -.5083
           4    43.5494     33.3333       .6741           4    43.5494     33.3333      -.6741
           5    43.8172     33.3333       .7475           5    43.8172     33.3333      -.7475
           6    73.7603     33.3333      3.1960           6    73.7603     33.3333     -3.1960
           7   103.7035     33.3333      5.6445           7   103.7035     33.3333     -5.6445
           8   133.6467     33.3333      8.0930           8   133.6467     33.3333     -8.0930
           9   163.5899     33.3333     10.5414           9   163.5899     33.3333    -10.5414
          10   163.6019     33.3333       .0000          10   163.6019     33.3333      -.0000
CHORD  3
           1    86.2566     66.6667      0.0000           1    86.2566     66.6667      0.0000
           2    86.3081     66.6667       .2732           2    86.3081     66.6667      -.2732
           3    86.4556     66.6667       .5088           3    86.4556     66.6667      -.5088
           4    86.6788     66.6667       .6746           4    86.6788     66.6667      -.6746
           5    86.9471     66.6667       .7476           5    86.9471     66.6667      -.7476
           6   108.7715     66.6667      2.4857           6   108.7715     66.6667     -2.4857
           7   130.5960     66.6667      4.2237           7   130.5960     66.6667     -4.2237
           8   152.4205     66.6667      5.9617           8   152.4205     66.6667     -5.9617
           9   174.2450     66.6667      7.6998           9   174.2450     66.6667     -7.6998
          10   174.2538     66.6667       .0000          10   174.2538     66.6667      -.0000
CHORD  4
           1   129.3849    100.0000      0.0000           1   129.3849    100.0000      0.0000
           2   129.4367    100.0000       .2740           2   129.4367    100.0000      -.2740
           3   129.5851    100.0000       .5101           3   129.5851    100.0000      -.5101
           4   129.8095    100.0000       .6757           4   129.8095    100.0000      -.6757
           5   130.0788    100.0000       .7479           5   130.0788    100.0000      -.7479
           6   143.7842    100.0000      1.7754           6   143.7842    100.0000     -1.7754
           7   157.4895    100.0000      2.8030           7   157.4895    100.0000     -2.8030
           8   171.1948    100.0000      3.8305           8   171.1948    100.0000     -3.8305
           9   184.9002    100.0000      4.8581           9   184.9002    100.0000     -4.8581
          10   184.9057    100.0000       .0000          10   184.9057    100.0000      -.0000
```

(Fin geometry before rotation and translation)

```
CALCULATED PARAMETERS

CRW  =   152.950  AW     =      .000
CT   =    55.521  ACT    =     0.000
BW   =   200.000  XBARW  =     0.000
B1   =     0.000  SWO    =    17.722
```

```
          FIN        GENERATED GEOMETRY

         PT        XU          YU          ZU          PT        XL          YL          ZL

CHORD  1
          1    471.7000      0.0000     54.0000         1    471.7000      0.0000     54.0000
          2    471.7513      -.2726     54.0000         2    471.7513       .2726     54.0000
          3    471.8982      -.5079     54.0000         3    471.8982       .5079     54.0000
          4    472.1205      -.6733     54.0000         4    472.1205       .6738     54.0000
          5    472.3880      -.7474     54.0000         5    472.3880       .7474     54.0000
          6    510.4497     -3.9064     54.0000         6    510.4497      3.9064     54.0000
          7    548.5113     -7.0653     54.0000         7    548.5113      7.0653     54.0000
          8    586.5730    -10.2242     54.0000         8    586.5730     10.2242     54.0000
          9    624.6347    -13.3831     54.0000         9    624.6347     13.3831     54.0000
         10    624.6500      0.0000     54.0000        10    624.6500      0.0000     54.0000
CHORD  2
          1    514.8283      0.0000
          2    514.8797      -.2728
          3    515.0268      -.5083
          4    515.2494      -.6741
          5    515.5172      -.7475
          6    545.4603     -3.1960
          7    575.4035     -5.6445
          8    605.3467     -8.0930
          9    635.2899    -10.5414
         10    635.3019      0.0000
CHORD  3
          1    557.9566      0.0000
          2    558.0081      -.2732
          3    558.1556      -.5088
          4    558.3788      -.6746
          5    558.6471      -.7476
          6    580.4715     -2.4857
          7    602.2960     -4.2237
          8    624.1205     -5.9617
          9    645.9450     -7.6998
         10    645.9538      0.0000    120.6667        10    645.9538      0.0000    120.6667
CHORD  4
          1    601.0849      0.0000    154.0000         1    601.0849      0.0000    154.0000
          2    601.1367      -.2740    154.0000         2    601.1367       .2740    154.0000
          3    601.2851      -.5101    154.0000         3    601.2851       .5101    154.0000
          4    601.5095      -.6757    154.0000         4    601.5095       .6757    154.0000
          5    601.7788      -.7479    154.0000         5    601.7788       .7479    154.0000
          6    615.4842     -1.7754    154.0000         6    615.4842      1.7754    154.0000
          7    629.1895     -2.8030    154.0000         7    629.1895      2.8030    154.0000
          8    642.8948     -3.8305    154.0000         8    642.8948      3.8305    154.0000
          9    656.6002     -4.8581    154.0000         9    656.6002      4.8581    154.0000
         10    656.6057      0.0000    154.0000        10    656.6057      0.0000    154.0000
```

(Final generated geometry)

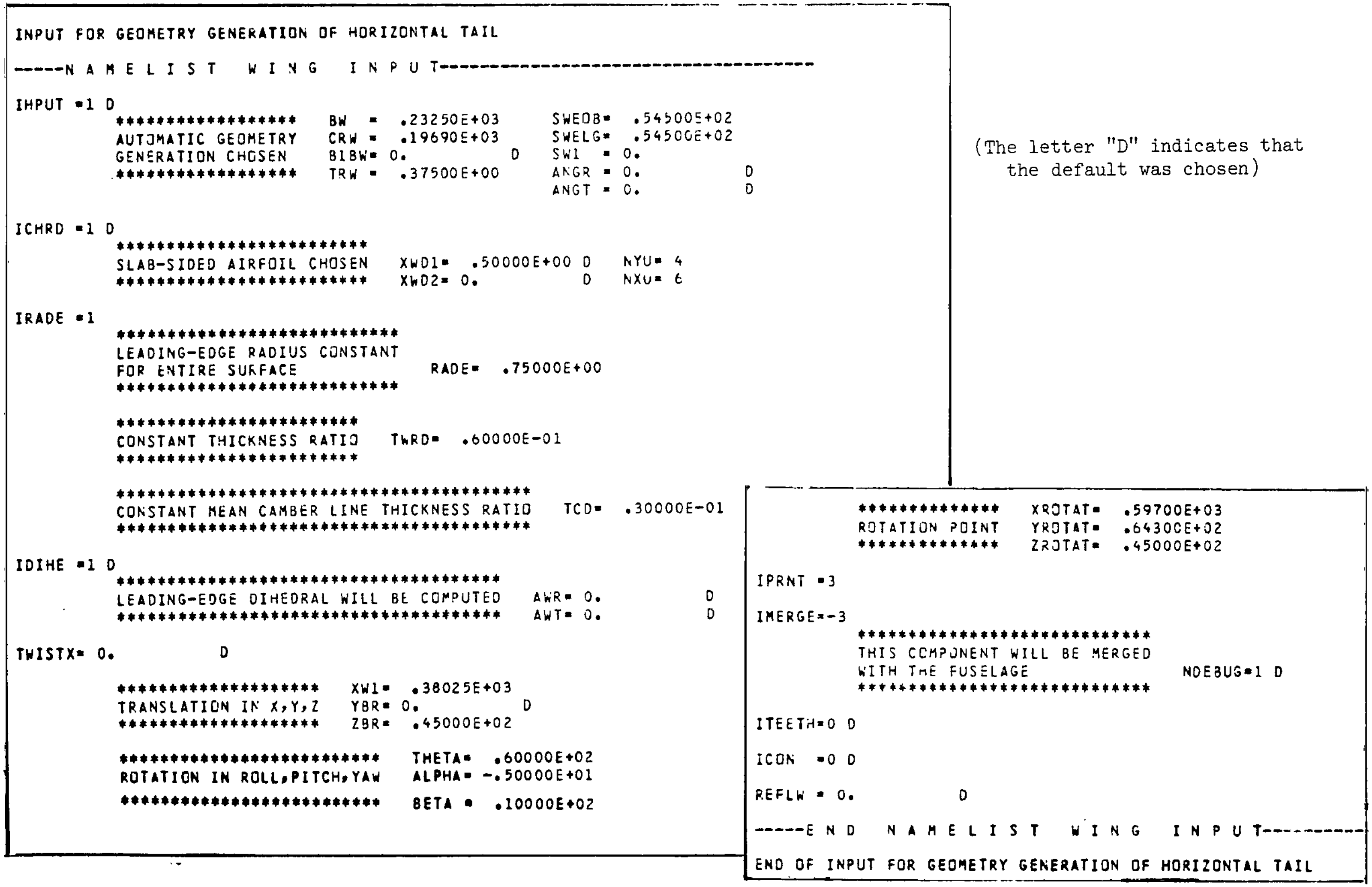
```
     LEADING EDGE  FINE DETAIL HAS BEEN TAKEN FROM CHORD NO. 3
            XLE             ZLEU            ZLEL                 XLE            ZLEU           ZLEL
 1     0.00000000      0.00000000      0.00000000     2      .00100000      .00462321     -.00462321
 3      .00207778       .00593818      -.00593818     4      .00323940      .00681788     -.00681788
 5      .00449137       .00749575      -.00749575     6      .00584072      .00812595     -.00812595
 7      .00729503       .00846186      -.00846186     8      .00886245      .00876962     -.00876962
 9      .01055180       .00922090      -.00922090    10      .01237255      .00970238     -.00970238
11      .01433492       .01021561      -.01021561    12      .01644993      .01076215     -.01076215
13      .01872945       .01134350      -.01134350    14      .02118627      .01196114     -.01196114
15      .02383420       .01261645      -.01261645    16      .02668809      .01331068     -.01331068
17      .02976396       .01404492      -.01404492    18      .03307908      .01482000     -.01482000
19      .03665206       .01563648      -.01563648    20      .04050296      .01649452     -.01649452
21      .04465339       .01739382      -.01739382    22      .04912666      .01833346     -.01833346
23      .05394786       .01931179      -.01931179    24      .05914407      .02032628     -.02032628
25      .06474446       .02137326      -.02137326    26      .07078046      .02244777     -.02244777
27      .07728596       .02354324      -.02354324    28      .08429747      .02465118     -.02465118
29      .09185436       .02576081      -.02576081    30      .09999904      .02685858     -.02685858
***************************
* E X I T   W I N G E X *
***************************
```

```
****************************
* E N T E R   W I N G E X *
****************************
```

(Horizontal tail generation)

```
$WING
IHPUT   = 1,
AW      = .1E-59,
ARW     = .1E+01,
BW      = .2325E+03,
CRW     = .1969E+03,
B1BW    = 0.0,
TRW     = .375E+00,
SWEOB   = .545E+02,
SWELG   = -.1001E+04,
SW1     = 0.0,
ANGR    = 0.0,
ANGT    = 0.0,
ICHRD   = 1,
XWD1    = .5E+00,
XWD2    = 0.0,
NYU     = 4,
NXU     = 6,
NSPACE  = 1,
NPCU    = -1001,
NPCL    = -1001,
IRADE   = 1,
RADE    = .75E+00,
TWRD    = .6E-01, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,       .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
          .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
YTHK    = .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,       .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
          .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
TCD     = .3E-01, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,       .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
          .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
IDIHE   = 1,
AWR     = 0.0,
AWT     = 0.0,
YDIH    = .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,       .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
          .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
ZDIH    = .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,       .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
          .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
TWISTX  = 0.0,
XW1     = .38025E+03,
YBR     = 0.0,
ZBR     = .45E+02,
THETA   = .6E+02,
ALPHA   = -.5E+01,
BETA    = .1E+02,
```

```
XROTAT  = .597E+03,
YROTAT  = .643E+02,
ZROTAT  = .45E+02,
IPRNT   = 3,
IMERGE  = -3,
NDEBUG  = 1,
ITEETH  = 0,
ICON    = 0,
NPHX    = 0,
IFLAP   = 0,
XCOR    = .1E-59,
XCOT    = .1E-59,
DELFU   = .1E-59,
DELFL   = .1E-59,
ZCOR    = .1E-59,
ZCOT    = .1E-59,
REFLW   = 0.0,
$END
```



```
INPUT FOR GEOMETRY GENERATION OF HORIZONTAL TAIL

-----N A M E L I S T   W I N G   I N P U T------------------------------------

IMPUT =1 D
          ******************   BW   =  .23250E+03     SWEDB=  .54500E+02
          AUTJMATIC GEOMETRY   CRW  =  .19690E+03     SWELG=  .54500E+02
          GENERATION CHOSEN    BIBW= 0.            D  SW1   = 0.
          ******************   TRW  =  .37500E+00     ANGR  = 0.          D
                                                      ANGT  = 0.          D

ICHRD =1 D
          **************************
          SLAB-SIDED AIRFOIL CHOSEN   XWD1=  .50000E+00 D   NYU= 4
          **************************  XWD2= 0.          D   NXU= 6

IRADE =1
          *****************************
          LEADING-EDGE RADIUS CONSTANT
          FOR ENTIRE SURFACE               RADE=  .75000E+00
          *****************************

          *************************
          CONSTANT THICKNESS RATIO   TWRD=  .60000E-01
          *************************

          *******************************************
          CONSTANT MEAN CAMBER LINE THICKNESS RATIO   TCD=  .30000E-01
          *******************************************

IDIHE =1 D
          ****************************************
          LEADING-EDGE DIHEDRAL WILL BE COMPUTED   AWR= 0.          D
          ****************************************   AWT= 0.          D

TWISTX= 0.          D

          *********************   XW1=  .38025E+03
          TRANSLATION IN X,Y,Z    YBR= 0.           D
          *********************   ZBR=  .45000E+02

          ***************************   THETA=  .60000E+02
          ROTATION IN ROLL,PITCH,YAW    ALPHA= -.50000E+01
          ***************************   BETA =  .10000E+02

          **************   XROTAT=  .59700E+03
          ROTATION POINT   YROTAT=  .64300E+02
          **************   ZROTAT=  .45000E+02

IPRNT =3

IMERGE=-3
          ****************************
          THIS COMPONENT WILL BE MERGED
          WITH THE FUSELAGE                NDEBUG=1 D
          ****************************

ITEETH=0 D

ICON  =0 D

REFLW = 0.          D

-----E N D   N A M E L I S T   W I N G   I N P U T----------

END OF INPUT FOR GEOMETRY GENERATION OF HORIZONTAL TAIL
```

(The letter "D" indicates that
the default was chosen)

```
          BASIC GENERATED GEOMETRY

          PT      XU         YU         ZU           PT      XL         YL         ZL

CHORD  1
           1    0.0000     0.0000     0.0000          1    0.0000     0.0000     0.0000
           2     .0371     0.0000      .2329          2     .0371     0.0000     -.2329
           3     .1446     0.0000      .4427          3     .1446     0.0000     -.4427
           4     .3120     0.0000      .6088          4     .3120     0.0000     -.6088
           5     .5226     0.0000      .7147          5     .5226     0.0000     -.7147
           6     .7558     0.0000      .7554          6     .7558     0.0000     -.7500
           7   49.6029     0.0000     6.2847          7   49.6029     0.0000     -.3750
           8   98.4500     0.0000    11.8140          8   98.4500     0.0000     -.0000
           9  131.2667     0.0000     7.8760          9  131.2667     0.0000     -.0000
          10  164.0833     0.0000     3.9380         10  164.0833     0.0000     -.0000
          11  196.9000     0.0000      .0000         11  196.9000     0.0000     0.0000
CHORD  2
           1   54.3255    38.7500     0.0000          1   54.3255    38.7500     0.0000
           2   54.3627    38.7500      .2331          2   54.3627    38.7500     -.2331
           3   54.4705    38.7500      .4432          3   54.4705    38.7500     -.4432
           4   54.6382    38.7500      .6093          4   54.6382    38.7500     -.6093
           5   54.8493    38.7500      .7151          5   54.8493    38.7500     -.7151
           6   55.0828    38.7500      .7555          6   55.0828    38.7500     -.7500
           7   93.6739    38.7500     5.0541          7   93.6739    38.7500     -.3750
           8  132.2651    38.7500     9.3528          8  132.2651    38.7500     0.0000
           9  158.2449    38.7500     6.2352          9  158.2449    38.7500     -.0000
          10  184.2248    38.7500     3.1176         10  184.2248    38.7500     -.0000
          11  210.2047    38.7500      .0000         11  210.2047    38.7500     0.0000
CHORD  3
           1  108.6510    77.5000     0.0000          1  108.6510    77.5000     0.0000
           2  108.6383    77.5000      .2337          2  108.6883    77.5000     -.2337
           3  108.7956    77.5000      .4440          3  108.7966    77.5000     -.4440
           4  108.9650    77.5000      .6102          4  108.9550    77.5000     -.6102
           5  109.1768    77.5000      .7157          5  109.1768    77.5000     -.7157
           6  109.4109    77.5000      .7555          6  109.4109    77.5000     -.7499
           7  137.7455    77.5000     3.8235          7  137.7455    77.5000     -.3750
           8  166.0802    77.5000     6.8915          8  166.0802    77.5000     -.0000
           9  185.2232    77.5000     4.5943          9  185.2232    77.5000     -.0000
          10  204.3663    77.5000     2.2972         10  204.3663    77.5000     0.0000
          11  223.5093    77.5000      .0000         11  223.5093    77.5000     0.0000
CHORD  4
           1  162.9765   116.2500     0.0000          1  162.9765   116.2500     0.0000
           2  163.0142   116.2500      .2347          2  163.0142   116.2500     -.2347
           3  163.1234   116.2500      .4459          3  163.1234   116.2500     -.4459
           4  163.2932   116.2500      .6122          4  163.2932   116.2500     -.6122
           5  163.5066   116.2500      .7170          5  163.5066   116.2500     -.7170
           6  163.7420   116.2500      .7554          6  163.7420   116.2500     -.7498
           7  161.8186   116.2500     2.5928          7  181.8186   116.2500     -.3749
           8  199.8952   116.2500     4.4303          8  199.8952   116.2500      .0000
           9  212.2015   116.2500     2.9535          9  212.2015   116.2500     -.0000
          10  224.5077   116.2500     1.4768         10  224.5077   116.2500     -.0000
          11  236.8140   116.2500      .0000         11  236.8140   116.2500     0.0000
```

(Horizontal tail geometry
before translation and
rotation)

```
CALCULATED PARAMETERS

CRW  =    196.900  AW     =      .000
CT   =     73.838  ACT    =     0.000
BW   =    232.500  XBARW  =     0.000
B1   =      0.000  SWO    =    18.950
```

```
 HORIZONTAL TAIL     GENERATED GEOMETRY

        PT        XU          YU          ZU            PT        XL          YL          ZL

CHORD  1
         1    394.7175    -4.0138    -29.3645           1    394.7175    -4.0138    -29.3645
         2    394.7789    -4.2078    -29.2453           2    394.7289    -3.8070    -29.4773
         3    394.9070    -4.3697    -29.1314           3    394.8118    -3.6079    -29.5724
         4    395.0890    -4.4837    -29.0341           4    394.9582    -3.4360    -29.6406
         5    395.3071    -4.5384    -28.9630           5    395.1535    -3.3085    -29.6750
         6    395.5402    -4.5331    -28.9224           6    395.3764    -3.2378    -29.6722
         7    444.0564     -.8407    -21.9110           7    443.3407     4.8895    -25.2281
         8    492.5726     2.8516    -14.8495           8    491.3029    13.0168    -20.7841
         9    524.3445    11.9169    -14.0009           9    523.4981    18.6937    -17.9239
        10    556.1164    20.9821    -13.1022          10    555.6932    24.3705    -15.0637
        11    587.8883    30.0474    -12.2036          11    587.8883    30.0474    -12.2036
CHORD  2
         1    441.7693    23.9566
         2    441.8308    23.7624
         3    441.9592    23.6003
         4    442.1416    23.4864
         5    442.3600    23.4319
         6    442.5935    23.4376
         7    480.9157    26.4146
         8    519.2379    29.3917
         9    544.3906    36.5684
        10    569.5434    43.7450
        11    594.6962    50.9217
CHORD  3
         1    488.8211    51.9270
         2    488.8828    51.7324
         3    489.0116    51.5701
         4    489.1947    51.4562
         5    489.4139    51.4021
         6    489.6478    51.4084
         7    517.7755    53.6701
         8    545.9032    55.9318
         9    564.4368    61.2199
        10    582.9704    66.5079     56.4529          10    582.7235    68.4845     55.3087
        11    601.5040    71.7960     56.9771          11    601.5040    71.7960     56.9771
CHORD  4
         1    535.8729    79.8973     85.1321           1    535.8729    79.8973     85.1321
         2    535.9351    79.7019     85.2523           2    535.8846    80.1058     85.0185
         3    536.0649    79.5391     85.3670           3    535.9691    80.3064     84.9229
         4    536.2494    79.4254     85.4647           4    536.1178    80.4789     84.8548
         5    536.4700    79.3721     85.5355           5    536.3159    80.6060     84.8212
         6    536.7051    79.3798     85.5752           6    536.5433    80.6750     84.8254
         7    554.6368    80.9258     88.0658           7    554.3179    83.4794     86.5876
         8    572.5685    82.4719     90.5565           8    572.0924    86.2338     88.3498
         9    584.4830    85.8714     90.8935           9    584.1656    88.4126     89.4224
        10    596.3974    89.2703     91.2305          10    596.2387    90.5415     90.4950
        11    608.3119    92.6703     91.5675          11    608.3119    92.6703     91.5675
```

(Final generated geometry)

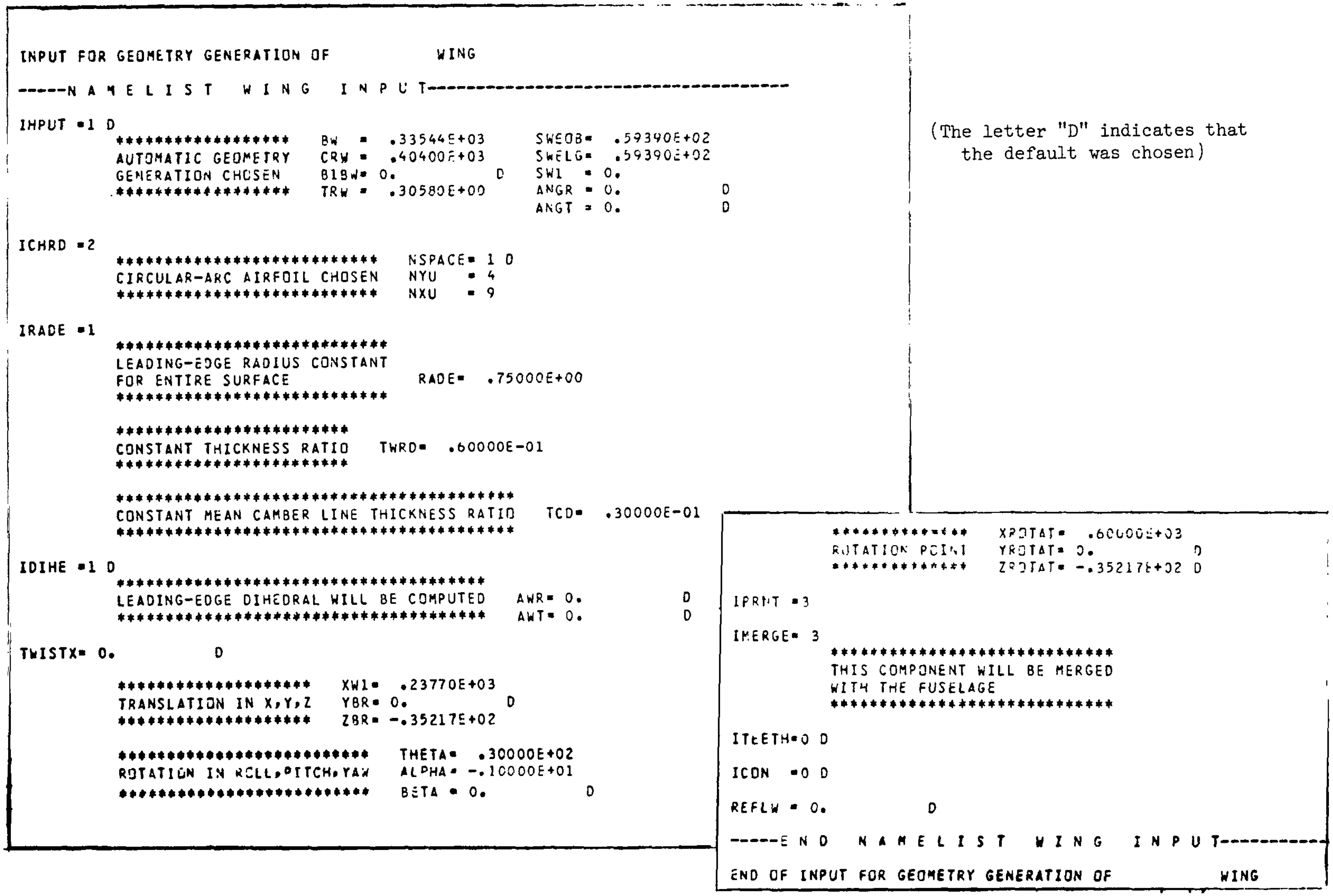
```
     LEADING EDGE  FINE DETAIL HAS BEEN TAKEN FROM CHORD NO. 2
            XLE             ZLEU             ZLEL                  XLE             ZLEU             ZLEL
 1     0.00000000       0.00000000       0.00000000      2     .00100000       .00295081       -.00295081
 3      .00207778        .00396338       -.00396338      4     .00323940       .00454396       -.00454519
 5      .00449137        .00483068       -.00480752      6     .00584072       .00501569       -.00495645
 7      .00729503        .00526540       -.00516920      8     .00886245       .00553337       -.00539547
 9      .01055180        .00582083       -.00563582     10     .01237255       .00612907       -.00589078
11      .01433492        .00645944       -.00616084     12     .01644993       .00681339       -.00644638
13      .01872945        .00719238       -.00674774     14     .02118627       .00759799       -.00706510
15      .02383420        .00803180       -.00739851     16     .02668809       .00849548       -.00774782
17      .02976396        .00899072       -.00811265     18     .03307908       .00951924       -.00849232
19      .03665206        .01008280       -.00888579     20     .04050296       .01068312       -.00929160
21      .04465339        .01132194       -.00970776     22     .04912666       .01200091       -.01013164
23      .05394786        .01272163       -.01055986     24     .05914407       .01348554       -.01098812
25      .06474446        .01429394       -.01141106     26     .07078046       .01514786       -.01182202
27      .07728596        .01604805       -.01221282     28     .08429747       .01699484       -.01257345
29      .09165436        .01798808       -.01289179     30     .09999904       .01902698       -.01315318
*************************
* E X I T   W I N G E X *
*************************
```

(Wing generation)

```
****************************
* E N T E R   W I N G E X *
****************************

$WING
IMPUT    = 1,
AW       = .1E-59,
APW      = .1E+01,
BW       = .33544E+03,
CRW      = .404E+03,
B1BW     = 0.0,
TRW      = .3058E+00,
SWEOB    = .5939E+02,
SWELG    = -.1001E+04,
SW1      = 0.0,
ANGR     = 0.0,
ANGT     = 0.0,
ICHRD    = 2,
XWD1     = .5E+00,
XWD2     = 0.0,
NYU      = 4,
NXU      = 9,
NSPACE   = 1,
NPCU     = -1001,
NPCL     = -1001,
IRADE    = 1,
RADE     = .75E+00,
TWRD     = .6E-01, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,      .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
           .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
YTHK     = .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,      .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
           .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
TCD      = .3E-01, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,      .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
           .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
IDIHE    = 1,
AWR      = 0.0,
AWT      = 0.0,
YDIH     = .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,      .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
           .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
ZDIH     = .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,      .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
           .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59, .1E-59,
TWISTX   = 0.0,
XW1      = .2377E+03,
YBR      = 0.0,
ZBR      = -.35217E+02,
THETA    = .3E+02,
ALPHA    = -.1E+01,
BETA     = 0.0,
```

```
XROTAT   = .6E+03,
YROTAT   = -.1001E+04,
ZROTAT   = -.1001E+04,
IPRNT    = 3,
IMERGE   = 3,
NDEBUG   = 1,
ITEETH   = 0,
ICON     = 0,
NPHX     = 0,
IFLAP    = 0,
XCOR     = .1E-59,
XCOT     = .1E-59,
DELFU    = .1E-59,
DELFL    = .1E-59,
ZCOR     = .1E-59,
ZCOT     = .1E-59,
REFLW    = 0.0,
$END
```



```
INPUT FOR GEOMETRY GENERATION OF          WING

-----N A M E L I S T   W I N G   I N P U T------------------------------------

INPUT =1 D
          ******************   BW  =  .33544E+03     SWEOB=  .59390E+02
          AUTOMATIC GEOMETRY   CRW =  .40400E+03     SWELG=  .59390E+02
          GENERATION CHOSEN    B1BW= 0.          D   SW1  = 0.
          ******************   TRW =  .30580E+00     ANGR = 0.           D
                                                     ANGT = 0.           D

ICHRD =2
          ***************************   NSPACE= 1 D
          CIRCULAR-ARC AIRFOIL CHOSEN   NYU   = 4
          ***************************   NXU   = 9

IRADE =1
          ****************************
          LEADING-EDGE RADIUS CONSTANT
          FOR ENTIRE SURFACE              RADE=  .75000E+00
          ****************************

          ************************
          CONSTANT THICKNESS RATIO   TWRD=  .60000E-01
          ************************

          *****************************************
          CONSTANT MEAN CAMBER LINE THICKNESS RATIO   TCD=  .30000E-01
          *****************************************

IDIHE =1 D
          **************************************
          LEADING-EDGE DIHEDRAL WILL BE COMPUTED   AWR= 0.          D
          **************************************   AWT= 0.          D

TWISTX= 0.          D

          ********************   XW1=  .23770E+03
          TRANSLATION IN X,Y,Z   YBR= 0.          D
          ********************   ZBR= -.35217E+02

          **************************   THETA=  .30000E+02
          ROTATION IN ROLL,PITCH,YAW   ALPHA= -.10000E+01
          **************************   BETA = 0.          D
```

```
          **************   XROTAT=  .60000E+03
          ROTATION POINT   YROTAT= 0.           D
          **************   ZROTAT= -.35217E+02 D

IPRNT =3

IMERGE= 3
          ******************************
          THIS COMPONENT WILL BE MERGED
          WITH THE FUSELAGE
          ******************************

ITEETH=0 D

ICON  =0 D

REFLW = 0.          D

-----E N D   N A M E L I S T   W I N G   I N P U T----------

END OF INPUT FOR GEOMETRY GENERATION OF          WING
```

(The letter "D" indicates that
the default was chosen)

```
        BASIC GENERATED GEOMETRY

        PT      XU         YU          ZU           PT       XL         YL          ZL

CHORD  1
         1    0.0000     0.0000       .6686          1     0.0000     0.0000       .6686
         2     .0492     0.0000       .9413          2      .0492     0.0000       .4072
         3     .1902     0.0000      1.1896          3      .1902     0.0000       .1914
         4     .4046     0.0000      1.3809          4      .4046     0.0000       .0495
         5     .6643     0.0000      1.4902          5      .6643     0.0000      0.0000
         6   51.0813     0.0000     11.5983          6    51.0813     0.0000       .0000
         7  101.4982     0.0000     18.7474          7   101.4982     0.0000       .0000
         8  151.9152     0.0000     22.9558          8   151.9152     0.0000       .0000
         9  202.3322     0.0000     24.2342          9   202.3322     0.0000       .0000
        10  252.7491     0.0000     22.5856         10   252.7491     0.0000       .0000
        11  303.1661     0.0000     18.0061         11   303.1661     0.0000       .0000
        12  353.5830     0.0000     10.4840         12   353.5830     0.0000       .0000
        13  404.0000     0.0000      0.0000         13   404.0000     0.0000      0.0000
CHORD  2
         1   94.4954    55.9067       .6696          1    94.4954    55.9067       .6696
         2   94.5446    55.9067       .9426          2    94.5446    55.9067       .4079
         3   94.6360    55.9067      1.1909          3    94.6360    55.9067       .1917
         4   94.9058    55.9067      1.3419          4    94.9008    55.9067       .0496
         5   95.1609    55.9067      1.4905          5    95.1609    55.9067       .0000
         6  133.6920    55.9067
         7  172.5231    55.9067
         8  211.3542    55.9067
         9  250.0853    55.9067
        10  289.3164    55.9067
        11  327.8475    55.9067
        12  366.2787    55.9067
        13  405.0096    55.9067
CHORD  3
         1  188.9907   111.8133
         2  189.0402   111.8133
         3  189.1821   111.8133
         4  189.3977   111.8133
         5  189.6585   111.8133
         6  216.7037   111.8133
         7  243.7488   111.8133     10.3226          7   243.7468   111.8133       .0000
         8  270.7939   111.8133     12.4315          8   270.7939   111.8133       .0000
         9  297.8390   111.8133     13.0105          9   297.8390   111.8133       .0000
        10  324.8842   111.8133     12.0610         10   324.8842   111.8133       .0000
        11  351.9293   111.8133      9.5807         11   351.9293   111.8133      0.0000
        12  378.9744   111.8133      5.5636         12   378.9744   111.8133       .0000
        13  406.0195   111.8133      -.0000         13   406.0195   111.8133      0.0000
```

(Wing geometry before translation and rotation)

```
CHORD   4
         1   283.4861   167.7200      .6768         1   283.4861   167.7200      .6768
         2   283.5361   167.7200      .9512         2   293.5361   167.7200      .4127
         3   283.6794   167.7200     1.1993         3   283.6794   167.7200      .1941
         4   283.8970   167.7200     1.3881         4   283.8970   167.7200      .0502
         5   284.1597   167.7200     1.4922         5   284.1597   167.7200      .0000
         6   299.5154   167.7200     4.2165         6   299.5154   167.7200     0.0000
         7   314.3771   167.7200     6.1055         7   314.8771   167.7200      .0000
         8   330.2358   167.7200     7.1631         8   330.2358   167.7200     0.0000
         9   345.5945   167.7200     7.3019         9   345.5945   167.7200      .0000
        10   360.9532   167.7200     6.7921        10   360.9532   167.7200     0.0000
        11   376.3119   167.7200     5.3626        11   376.3119   167.7200      .0000
        12   391.6706   167.7200     3.1903        12   391.6706   167.7200     0.0000
        13   407.0293   167.7200     -.0000        13   407.0293   167.7200      .0000
```

```
CALCULATED PARAMETER.

CRW  =    404.000   AW     =      .000
CT   =    123.543   ACT    =     0.000
BW   =    335.440   XBARW  =     0.000
BI   =      0.000   SWO    =     1.035
```

```
          WING       GENERATED GEOMETRY

          PT       XU           YU          ZU              PT       XL           YL          ZL

CHORD  1
           1    237.7451      -.3343    -40.9611            1    237.7451      -.3343    -40.9611
           2    237.7901      -.4707    -40.7241            2    237.7982      -.2036    -41.1866
           3    237.9274      -.5948    -40.5066            3    237.9425      -.0957    -41.3710
           4    238.1389      -.6905    -40.3372            4    238.1590      -.0247    -41.4901
           5    238.3969      -.7451    -40.2381            5    238.4194      0.0000    -41.5284
           6    288.6534     -5.7992    -30.6056            6    288.8287      0.0000    -40.6485
           7    338.9546     -9.3737    -23.5353            7    339.2380      0.0000    -39.7686
           8    389.3003    -11.4779    -19.0114            8    389.6472      0.0000    -38.8887
           9    439.6902    -12.1171    -17.0246            9    440.0565      0.0000    -38.0088
          10    490.1244    -11.2928    -17.5722           10    490.4658      0.0000    -37.1289
          11    540.6029     -9.0031    -20.6576           11    540.8751      0.0000    -36.2490
          12    591.1259     -5.2420    -26.2911           12    591.2844      0.0000    -35.3691
          13    641.6936      0.0000    -34.4892           13    641.6936      0.0000    -34.4892
CHORD  2
           1    331.7382     48.0818    -11.3619            1    331.7382     48.0818    -11.3619
           2    331.7833     47.9453    -11.1247            2    331.7914     48.2127    -11.5877
           3    331.9209     47.8212    -10.9073            3    331.9360     48.3207    -11.7724
           4    332.1328     47.7257    -10.7381            4    332.1529     48.3918    -11.8918
           5    332.3912     47.6714    -10.6396            5    332.4137     48.4166    -11.9301
           6    371.0008     43.8472     -3.3410            6    371.1389     48.4166    -11.2542
           7    409.6445     41.1488      2.0080            7    409.8642     48.4166    -10.5782
           8    448.3219     39.5694      5.4192            8    448.5894     48.4166     -9.9023
           9    487.0331     39.1050      6.8993            9    487.3146     48.4166     -9.2263
          10    525.7779     39.7545      6.4505           10    526.0398     48.4166     -8.5504
          11    564.5565     41.5196      4.0698           11    564.7650     48.4166     -7.8744
          12    603.3689     44.4045      -.2504           12    603.4902     48.4166     -7.1985
          13    642.2154     48.4166     -6.5225           13    642.2154     48.4166     -6.5225
CHORD  3
           1    425.7313     96.4974     18.2380            1    425.7313     96.4974     18.2380
           2    425.7766     96.3607     18.4756            2    425.7847     96.6286     18.0117
           3    425.9147     96.2366     18.6931            3    425.9299     96.7370     17.8264
           4    426.1274     96.1414     18.8617            4    426.1476     96.8083     17.7067
           5    426.3366     96.0877     18.9592            5    426.4091     96.8332     17.6681
           6    453.3492     93.4939     23.9732            6    453.4501     96.8332     18.1401
           7    480.3351     91.6719     27.5504            7    480.4911     96.8332     18.6121
           8    507.3443     90.6174     29.2465            8    507.5321     96.8332     19.0842
           9    534.3765     90.3271     30.3219            9    534.5731     96.8332     19.5562
          10    561.4319     90.8027     30.4717           10    561.6142     96.8332     20.0282
```

(Final generated geometry)

```
         11   588.5104     92.0428     28.7960           11   582.6552     96.8332     20.5002
         12   615.6121     94.0514     25.7296           12   615.6962     96.8332     20.9722
         13   642.7372     96.8332     21.4442           13   642.7372     96.8332     21.4442
CHORD  4
          1   519.7243    144.9114     47.8407            1   519.7243    144.9114     47.8407
          2   519.7702    144.7742     48.0792            2   519.7783    145.0434     47.6129
          3   519.9097    144.6501     48.2966            3   519.9249    145.1527     47.4262
          4   520.1244    144.5557     48.4639            4   520.1446    145.2247     47.3054
          5   520.3855    144.5037     48.5586            5   520.4061    145.2498     47.2665
          6   535.7007    143.1415     51.1356            6   535.7644    145.2498     47.5345
          7   551.0285    142.1971     53.0893            7   551.1208    145.2498     47.8026
          8   566.3689    141.6682     54.2731            8   566.4771    145.2498     48.0706
          9   581.7218    141.5539     54.7392            9   581.8335    145.2498     48.3387
         10   597.0872    141.8537     54.4880           10   597.1899    145.2498     48.6067
         11   612.4652    142.5685     53.5182           11   612.5462    145.2498     48.8748
         12   627.8557    143.6997     51.8273           12   627.9026    145.2498     49.1428
         13   643.2589    145.2499     49.4109           13   643.2589    145.2498     49.4109


     LEADING EDGE  FINE DETAIL HAS BEEN TAKEN FROM CHORD NO. 2
           XLE               ZLEU              ZLEL                   XLE               ZLEU               ZLEL
 1      0.00000000        .00215650         .00215650      2       .00100000         .00426784          .00027263
 3       .00207778        .00478821        -.00000311      4       .00323940         .00525377         -.00020562
 5       .00449137        .00576698        -.00043603      6       .00584072         .00631396         -.00067904
 7       .00729503        .00689635        -.00093475      8       .00886245         .00751574         -.00120318
 9       .01055180        .00817367        -.00148413     10       .01237255         .00887158         -.00177724
11       .01433492        .00961077        -.00208188     12       .01644993         .01039235         -.00239714
13       .01872945        .01121719        -.00272171     14       .02118627         .01208578         -.00305368
15       .02383420        .01299827        -.00339137     16       .02668809         .01395423         -.00373129
17       .02976396        .01495260        -.00406997     18       .03307908         .01599152         -.00440285
19       .03665206        .01706813        -.00472428     20       .04050296         .01817842         -.00502732
21       .04465339        .01931689        -.00530356     22       .04912666         .02047634         -.00554274
23       .05394786        .02164750        -.00573253     24       .05914407         .02281857         -.00585811
25       .06474446        .02397481        -.00590170     26       .07078046         .02509797         -.00584212
27       .07728596        .02616557        -.00565409     28       .08429747         .02715020         -.00530764
29       .09185436        .02801859        -.00476719     30       .09999904         .02873051         -.00399065
*****************************
* E X I T   W I N G E X *
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*************************
* E N T E R   M E R G E *
*************************
INTERSECTION CANNOT BE FOUND FOR RAY 12 OF UPPER SURFACE    WING
INTERSECTION CANNOT BE FOUND FOR RAY 13 OF UPPER SURFACE    WING
INTERSECTION CANNOT BE FOUND FOR RAY 12 OF LOWER SURFACE    WING
INTERSECTION CANNOT BE FOUND FOR RAY 13 OF LOWER SURFACE    WING
THE FOLLOWING CHORD DESCRIBES THE UPPER AND LOWER INTERSECTIONS OF THE    WING    WITH THE FUSELAGE.
CHORD PT       XIU            YIU            ZIU            XIL            YIL            ZIL
  3
       1    .40083E+03     .83673E+02     .10398E+02     .40083E+03     .83673E+02     .10398E+02
       2    .40103E+03     .83615E+02     .10683E+02     .40074E+03     .83729E+02     .10125E+02
       3    .40118E+03     .83498E+02     .10905E+02     .40077E+03     .83775E+02     .99023E+01
       4    .40138E+03     .83393E+02     .11067E+02     .40090E+03     .83605E+02     .97575E+01
       5    .40162E+03     .83332E+02     .11161E+02     .40114E+03     .83616E+02     .97102E+01
       6    .43066E+03     .79947E+02     .16484E+02     .43125E+03     .83777E+02     .10213E+02
       7    .46049E+03     .77439E+02     .20380E+02     .46139E+03     .83733E+02     .10717E+02
       8    .49041E+03     .75967E+02     .22637E+02     .49137E+03     .83569E+02     .11143E+02
       9    .52057E+03     .75388E+02     .23945E+02     .52144E+03     .83376E+02     .11556E+02
      10    .55092E+03     .75756E+02     .23392E+02     .55156E+03     .83153E+02     .11971E+02
      11    .58142E+03     .77081E+02     .21474E+02     .58182E+03     .82965E+02     .12366E+02
      12    .61143E+03     .77081E+02     .16889E+02     .61221E+03     .82980E+02     .12917E+02
      13    .64252E+03     .77081E+02     .10035E+02     .64259E+03     .829[illegible]E+02     .13447E+02
THE FOLLOWING CHORD DESCRIBES THE UPPER AND LOWER INTERSECTIONS OF THE HORIZ.TAIL WITH THE FUSELAGE.
CHORD PT       XIU            YIU            ZIU            XIL            YIL            ZIL
  4
       1    .49629E+03     .56365E+02     .53022E+02     .49629E+03     .56365E+02     .53022E+02
       2    .49645E+03     .56232E+02     .53226E+02     .49618E+03     .56501E+02     .52612E+02
       3    .49666E+03     .56117E+02     .53405E+02     .49614E+03     .56625E+02     .52516E+02
       4    .49689E+03     .56030E+02     .53539E+02     .49617E+03     .56732E+02     .52456E+02
       5    .49712E+03     .55980E+02     .53616E+02     .49628E+03     .56804E+02     .52346E+02
       6    .49732E+03     .55970E+02     .53633E+02     .49644E+03     .56836E+02     .52298E+02
       7    .52052E+03     .55700E+02     .54138E+02     .51846E+03     .58036E+02     .50459E+02
       8    .54537E+03     .55398E+02     .54698E+02     .54253E+03     .59474E+02     .48416E+02
       9    .56165E+03     .57796E+02     .51072E+02     .56001E+03     .60649E+02     .46675E+02
      10    .57937E+03     .60404E+02     .47127E+02     .57869E+03     .61906E+02     .44814E+02
      11    .59872E+03     .63252E+02     .42819E+02     .59872E+03     .63252E+02     .42819E+02
ADCHRD-CHORD(S)  3 THROUGH  3 HAVE BEEN SET TO CHORD  2 FOR UPPER SURF HORIZ.TAIL
ADCHRD-CHORD(S)  3 THROUGH  3 HAVE BEEN SET TO CHORD  2 FOR THE LOWER SURFACE HORIZ.TAIL
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(Wing: IMERGE = 1)

(Horizontal tail:
IMERGE = 1)

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BEGIN SEARCH FOR INTERSECTION OF FUSELAGE WITH     FIN   ...        ◀ (fin:  IMERGE = -1,  NDEBUG = 1)
    FIN     IS ON FUSELAGE CENTERLINE.  MID=1  (MID=1 VERTICAL, MID=2 VENTRAL)
HAS LEADING-EDGE RAY GEOMETRY OF      FIN     BEEN SHIFTED.--0--(0-NO,1-YES)



 --- BEGIN SEARCH FOR POINT OF INTERSECTION OF      FIN     RAY  1 WITH FUSELAGE.


         MAXIMUM FUSELAGE WIDTH =  .8402E+02

         THE TEST-RANGE OF THE      FIN     SPANS CHORDS  1 TO  4 BY  3. ◀ (surface ray limits of search)

         RAY  1 SPANS FUSELAGE CROSS-SECTIONS 10 TO 12.                  ◀ (fuselage limits of search)

IYX,IZY,IZX,IXZ,IXY,IYZ=     1     2     0     0     2     1
DYDX,DZDY,DZDX,DXDZ,DXDY,DYDZ=     0.                -.99999E-59      .77289E+00      .12938E+01      -.99999E-59      0.
BY,BZ,BZX,BX ,BXY,BYZ=             0.                -.99999E-59     -.31057E+03      .40183E+03      -.99999E-59      0.
IYX,IZY,IZX,IXZ,IXY,IYZ=     1     2     0     0     2     1
DYDX,DZDY,DZDX,DXDZ,DXDY,DYDZ=     0.                -.99999E-59      .77289E+00      .12938E+01      -.99999E-59      0.
BY,BZ,BZX,BX ,BXY,BYZ=             0.                -.99999E-59     -.31057E+03      .40183E+03      -.99999E-59      0.
PT1= 3 PT2= 4 (X,Y,Z)1=  .5580E+03, 0.        ,  .1207E+03 (X,Y,Z)2=  .6011E+03, 0.        ,  .1540E+03
   FOR RAY  1 ON LOWER     FIN              ▼
         LINEAR EQUATIONS DESCRIBING RAY  1 - - /The most outboard ray segment is tested first.  The coordinates of the   \
           Y =  0.           X  0.           |  ray segment end points (PT1,PT2) are (X,Y,Z)1 and (X,Y,Z)2, respectively.\
           Z =  -.1000E-58 Y  -.1000E-58     |  The ray segment is described by  Y = DYDX*X + BY;  Z = DZDY*Y + BZ; etc. |
           X =   .1294E+01 Z   .4018E+03     |  The variables IYX, IZY, . . ., IYZ describe the ray equations in the     |
                                             |  YX plane, ZY plane, . . ., YZ plane.  Each is flagged as follows:       |
                                             |                   IYX = 0;  slope ≠ 0  in YX plane                        |
                                             |                         1;  slope = 0  in YX plane                        |
                                              \                        2;  slope = ∞  in YX plane                       /


          RAY  1 SPANS FUSELAGE CROSS-SECTIONS 11 TO 12.
                                                                   ◀ (first fuselage cross-section segment to be tested)
 J          X(K), X(K+1)              Y,Z(K,J)-1               Y,Z(K+1,J)-2              Y,Z(K+1,J+1)-3            Y,Z(K,J+1)-4
 1    .5200E+03,  .6000E+03    0.         ,  .6661E+02   0.         ,  .6900E+02    .3653E+02,  .6900E+02    .3788E+02,  .6661E+02
                     ▼
                       (These are the four corner points of the fuselage panel:  K = 11,  J = 1)

       LINE 14 INTERSECTS RAY  1 AT XI,YI,ZI=   .5200E+03  0.          .6661E+02  FROM RAY EQS AT YI, XITEST=  .4880E+03
       LINE 23 INTERSECTS RAY  1 AT XI,YI,ZI=   .6000E+03  0.          .6900E+02  FROM RAY EQS AT YI, XITEST=  .4911E+03
                     ▼  (This is the first occurrence of the ray segment intersecting two fuselage panel sides.  LINE 14
                           is the panel side connecting corner points 1 and 4.  LINE 23 connects points 2 and 3.
                           XITEST is the corresponding X at YI on the ray segment.)
DOES EXTRAPOLATED XI LIE WITHIN CROSS-SECTION RANGE   XI=  .4867E+03 ◀ /X(K) ≤ XI ≤ X(K+1)   \   No - continue to next \
                                                                      \520.0 ≤ 486.7 ≤ 600.0 /     fuselage panel      /
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 2   .5200E+03,  .6000E+03   .3788E+02,  .6661E+02    .3653E+02,  .6900E+02    .4334E+02,  .6721E+02    .4469E+02,  .6483E+02
       RAY  1 SPANS FUSELAGE CROSS-SECTIONS 10 TO 11.

 J        X(K), X(K+1)           Y,Z(K,J)-1             Y,Z(K+1.J)-2           Y,Z(K+1,J+1)-3          Y,Z(K,J+1)-4
 1   .4000E+03,  .5200E+03   0.        ,  .6304E+02  0.        ,  .6661E+02   .3788E+02,  .6661E+02    .3991E+02,  .6304E+02
     LINE 14 INTERSECTS RAY  1 AT XI,YI,ZI=   .4000E+03  0.          .6304E+02  FROM RAY EQS AT YI, XITEST=  .4934E+03
     LINE 23 INTERSECTS RAY  1 AT XI,YI,ZI=   .5200E+03  0.          .6661E+02  FROM RAY EQS AT YI, XITEST=  .4880E+03
DOES EXTRAPOLATED XI LIE WITHIN CROSS-SECTION RANGE   XI=  .4867E+03
DOES EXTRAPOLATED ZI LIE WITHIN Z-RANGE OF FUSE PANEL ZI=  .6562E+02
DOES EXTRAPOLATED YI LIE WITHIN Y-RANGE OF FUSE PANEL YI= 0.
     LINE  0 INTERSECTS RAY  1 AT XI,YI,ZI=   .4867E+03  0.          .6562E+02  FROM RAY EQS AT YI, XITEST=  .4867E+03
IS YI WITHIN Y-TEST RANGE OF RAY  1
IS XI WITHIN X-TEST RANGE OF RAY  1


 2   .4000E+03,  .5200E+03   .3991E+02,  .6304E+02    .3788E+02,  .6661E+02    .4469E+02,  .6483E+02    .4671E+02,  .6125E+02
       RAY  1 SPANS FUSELAGE CROSS-SECTIONS  9 TO 10.

 J        X(K), X(K+1)           Y,Z(K,J)-1             Y,Z(K+1,J)-2           Y,Z(K+1,J+1)-3          Y,Z(K,J+1)-4
 1   .3000E+03,  .4000E+03   0.        ,  .6006E+02  0.        ,  .6304E+02   .3991E+02,  .6304E+02    .1995E+02,  .6006E+02
     LINE 14 INTERSECTS RAY  1 AT XI,YI.ZI=   .3000E+03  0.          .6006E+02  FROM RAY EQS AT YI, XITEST=  .4795E+03
     LINE 23 INTERSECTS RAY  1 AT XI,YI,ZI=   .4000E+03  0.          .6304E+02  FROM RAY EQS AT YI, XITEST=  .4834E+03
DOES EXTRAPOLATED XI LIE WITHIN CROSS-SECTION RANGE   XI=  .4867E+03
 2   .3000E+03,  .4000E+03   .1995E+02,  .6006E+02    .3991E+02,  .6304E+02    .4671E+02,  .6125E+02    .2676E+02,  .5827E+02
BACK UP ONE POINT ON RAY  1 AND REPEAT ITERATION. ◀ (After testing through the fuselage limits of search, no
                                                       intersection is found.  Ray limits of search are set to
                                                       next inboard ray segment.)
       THE TEST-RANGE OF THE     FIN    SPANS CHORDS  1 TO  3 BY  2.

       RAY  1 SPANS FUSELAGE CROSS-SECTIONS 10 TO 12.

IYX,IZY,IZX,IXZ,IXY,IYZ=    1    2    0    0    2    1
DYDX,DZDY,DZDX,DXDZ,DXDY,DYDZ=    0.               -.99999E-59      .77289E+00      .12938E+01      -.99999E-59     0.
BY,BZ,BZX,BX ,BXY,BYZ=            0.               -.99999E-59     -.31057E+03      .40183E+03      -.99999E-59     0.
IYX,IZY,IZX,IXZ,IXY,IYZ=    1    2    0    0    2    1
DYDX,DZDY,DZDX,DXDZ,DXDY,DYDZ=    0.               -.99999E-59      .77289E+00      .12938E+01      -.99999E-59     0.
BY,BZ,BZX,BX ,BXY,BYZ=            0.               -.99999E-59     -.31057E+03      .40183E+03      -.99999E-59     0.
PT1= 2 PT2= 3 (X,Y,Z)1=  .5148E+03, 0.        ,  .8733E+02 (X,Y,Z)2=  .5530E+03, 0.        ,  .1207E+03
    FOR RAY  1 ON LOWER      FIN
       LINEAR EQUATIONS DESCRIBING RAY  1 - -
         Y =  0.         X  0.
         Z =  -.1000E-58 Y  -.1000E-58                ◀ (Iteration continues until correct limits are found.)
         X =   .1294E+01 Z   .4018E+03

       RAY  1 SPANS FUSELAGE CROSS-SECTIONS 11 TO 12.

 J        X(K), X(K+1)           Y,Z(K,J)-1
 1   .5200E+03,  .6000E+03   0.
     LINE 14 INTERSECTS RAY  1 AT
     LINE 23 INTERSECTS
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                                                                      EQS AT YI, XITEST=  .4867E+03

                                                 .3788E+02,  .6661E+02    .4469E+02,  .6483E+02    .4671E+02,  .6125E+02
                                              10.

                                 Z(K,J)-1                 Y,Z(K+1,J)-2               Y,Z(K+1,J+1)-3             Y,Z(K,J+1)-4
                                     ,  .6006E+02   0.        ,  .6304E+02    .3991E+02,  .6304E+02    .1995E+02,  .6006E+02
                        RAY  1 AT XI,YI,ZI=   .3000E+03  0.            .6006E+02  FROM RAY EQS AT YI, XITEST=  .4795E+03
       LI       INTERSECTS RAY  1 AT XI,YI,ZI=   .4000E+03  0.            .6304E+02  FROM RAY EQS AT YI, XITEST=  .4834E+03
DOES EXTRAPOLATED XI LIE WITHIN CROSS-SECTION RANGE   XI=  .4867E+03
 2     .3000E+03,  .4000E+03    .1995E+02,  .6006E+02    .3991E+02,  .6304E+02    .4671E+02,  .6125E+02    .2676E+02,  .5827E+02
BACK UP ONE POINT ON RAY  1 AND REPEAT ITERATION.
        THE TEST-RANGE OF THE     FIN    SPANS CHORDS  1 TO  2 BY  1.

        RAY  1 SPANS FUSELAGE CROSS-SECTIONS 10 TO 11.



IYX,IZY,IZX,IXZ,IXY,IYZ=    1    2    0    0    2    1
DYDX,DZDY,DZDX,DXDZ,DXDY,DYDZ=      0.              -.99999E-59      .77289E+00      .12938E+01      -.99999E-59      0.
BY,BZ,BZX,BX ,BXY,BYZ=              0.              -.99999E-59     -.31057E+03      .40183E+03      -.99999E-59      0.
PT1= 1 PT2= 2 (X,Y,Z)1=  .4717E+03, 0.          ,  .5400E+02 (X,Y,Z)2=  .5149E+03, 0.          ,  .6733E+02
   FOR RAY  1 ON LOWER     FIN
        LINEAR EQUATIONS DESCRIBING RAY  1 - -
          Y =  0.          X  0.
          Z =  -.1000E-58 Y  -.1000E-58
          X =   .1294E+01 Z   .4018E+03

        RAY  1 SPANS FUSELAGE CROSS-SECTIONS 11 TO 12.

 J          X(K), X(K+1)            Y,Z(K,J)-1                Y,Z(K+1,J)-2               Y,Z(K+1,J+1)-3             Y,Z(K,J+1)-4
 1     .5200E+03,  .6000E+03   0.         ,  .6661E+02   0.         ,  .6900E+02    .3653E+02,  .6900E+02    .3788E+02,  .6661E+02
       LINE 14 INTERSECTS RAY  1 AT XI,YI,ZI=   .5200E+03  0.            .6661E+02  FROM RAY EQS AT YI, XITEST=  .4880E+03
       LINE 23 INTERSECTS RAY  1 AT XI,YI,ZI=   .6000E+03  0.            .6900E+02  FROM RAY EQS AT YI, XITEST=  .4911E+03
DOES EXTRAPOLATED XI LIE WITHIN CROSS-SECTION RANGE   XI=  .4867E+03
 2     .5200E+03,  .6000E+03    .3788E+02,  .6661E+02    .3653E+02,  .6900E+02    .4334E+02,  .6721E+02    .4469E+02,  .6483E+02
 3     .5200E+03,  .6000E+03    .4469E+02,  .6483E+02    .4334E+02,  .6721E+02    .4710E+02,  .6310E+02    .5045E+02,  .6071E+02
 4     .5200E+03,  .6000E+03    .5045E+02,  .6071E+02    .4710E+02,  .6310E+02    .5363E+02,  .5763E+02    .5498E+02,  .5524E+02
 5     .5200E+03,  .6000E+03    .5498E+02,  .5524E+02    .5363E+02,  .5763E+02    .5363E+02,  .5763E+02    .5498E+02,  .5524E+02
 6     .5200E+03,  .6000E+03    .5498E+02,  .5524E+02    .5363E+02,  .5763E+02    .5363E+02,  .5763E+02    .5498E+02,  .5524E+02
 7     .5200E+03,  .6000E+03    .5498E+02,  .5524E+02    .5363E+02,  .5763E+02    .5363E+02,  .5763E+02    .5498E+02,  .5524E+02
 8     .5200E+03,  .6000E+03    .5498E+02,  .5524E+02    .5363E+02,  .5763E+02    .5363E+02,  .5763E+02    .5498E+02,  .5524E+02
 9     .5200E+03,  .6000E+03    .5498E+02,  .5524E+02    .5363E+02,  .5763E+02    .8400E+02,  .1090E+02    .8384E+02,  .1084E+02
10     .5200E+03,  .6000E+03    .8384E+02,  .1084E+02    .8400E+02,  .1090E+02    .8400E+02,  .1090E+02    .8401E+02,  .1003E+02
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        RAY  1 SPANS FUSELAGE CROSS-SECTIONS 10 TO 11.

 J         X(K), X(K+1)            Y,Z(K,J)-1                Y,Z(K+1,J)-2              Y,Z(K+1,J+1)-3            Y,Z(K,J+1)-4
 1     .4000E+03,  .5200E+03   0.         ,  .6304E+02   0.         ,  .6661E+02    .3788E+02,  .6661E+02    .3991E+02,  .6304E+02
       LINE 14 INTERSECTS RAY  1 AT XI,YI,ZI=   .4000E+03  0.              .6304E+02  FROM RAY EQS AT YI, XITEST=  .4834E+03
       LINE 23 INTERSECTS RAY  1 AT XI.YI,ZI=   .5200E+03  0.              .6661E+02  FROM RAY EQS AT YI, XITEST=  .4860E+03
DOES EXTRAPOLATED XI LIE WITHIN CROSS-SECTION RANGE   XI=  .4867E+03
               ▼ (400.0 ≦ XI ≦ 520.0; yes)
DOES EXTRAPOLATED ZI LIE WITHIN Z-RANGE OF FUSE PANEL ZI=  .6562E+02
               ▼ (63.04 ≦ ZI ≦ 66.61; yes)
DOES EXTRAPOLATED YI LIE WITHIN Y-RANGE OF FUSE PANEL YI= 0.
               ▼ (0. ≦ YI ≦ 39.91; yes)
       LINE  C INTERSECTS RAY  1 AT XI,YI,ZI=   .4867E+03  0.              .6562E+02  FROM RAY EQS AT YI, XITEST=  .4867E+03
               ▼ (These are the coordinates of the candidate intersection point)
IS YI WITHIN Y-TEST RANGE OF RAY  1
               ▼ (0. ≦ YI ≦ 0.; yes)
IS XI WITHIN X-TEST RANGE OF RAY  1
               ▼ (471.7 ≦ XI ≦ 514.8; yes)
FINAL TEST FOR PANEL LIMITS.
          INITIALIZE FUSE PANEL CORNER POINTS.
Y1,Y2,Y3,Y4=     0.              0.               .37882E+02      .39906E+02
Z1,Z2,Z3,Z4=      .63037E+02      .66615E+02      .66615E+02      .63037E+02
          DETERMINE INTERSECTION OF L-24 AND L-13          YT,ZT=     .19434E+02      .64872E+02     I13,I24= 1 1
               ▼ /YT,ZT is the intersection of the fuselage panel diagonals L-24 and L-13. \
                 (  I13(I24) = 0;  YT,ZT does not lie within corner points 1 and 3 (2 and 4))
                  \           = 1;  YT,ZT lies within corner points 1 and 3 (2 and 4)      /
TRICHK-Y1,Y2,Y3,YI=      0.                .37882E+02      .39906E+02      0.
       Z1,Z2,Z3,ZI=       .63037E+02       .66615E+02      .63037E+02      .65623E+02
CORNER 1, YT,ZT=     0.               .13357E+03     II=0
               ▼ /Fuselage diagonal L-13 is used to divide the panel into two triangles.  A line is passed\
                 (  through the YI,ZI from each vertex to its opposite side starting with corner 1.        )
                  \ YI lies between Y1 and YT and ZI lies between Z1 and ZT;  II = 0 false;  II = 1 true  /
CASE II-TRICHK,IRANGE=1      Y1,Y3,Y4,YI=     0.                 .37882E+02      .39906E+02      0.
                             Z1,Z3,Z4,ZI=      .63037E+02        .66615E+02      .63037E+02      .65623E+02
               ▼ (IRANGE = 0;  YI,ZI lies within triangle 1,3,4.
                  \      = 1;  YI,ZI does not lie within triangle 1,3,4).)
TRICHK-Y1,Y2,Y3,YI=      0.                .37882E+02      0.              0.
       Z1,Z2,Z3,ZI=       .63037E+02       .66615E+02      .66615E+02      .65623E+02
CORNER 1, YT,ZT=     0.               .66615E+02     II=1                               ◀ (YI,ZI lies within
CORNER 2, YT,ZT=     0.               .65623E+02     II=1                                  triangle 1,2,3)
CORNER 3, YT,ZT=     0.               .63037E+02     II=1
CASE II-TRICHK,IRANGE=0      Y1,Y3,Y2,YI=     0.                 .37882E+02      0.              0.
                             Z1,Z3,Z2,ZI=      .63037E+02        .66615E+02      .66615E+02      .65623E+02
```

```
               INTERSECTION HAS BEEN FOUND.
THETA=  .1260E+03  IF THETA IS GREATER THAN 90DEG- TRUE INT -- LESS THAN 90DEG- NO INT.

              RETURN
               END


--- BEGIN SEARCH FOR POINT OF INTERSECTION OF     FIN    RAY  2 WITH FUSELAGE.
```

(Repeat iteration procedure for all fin rays)

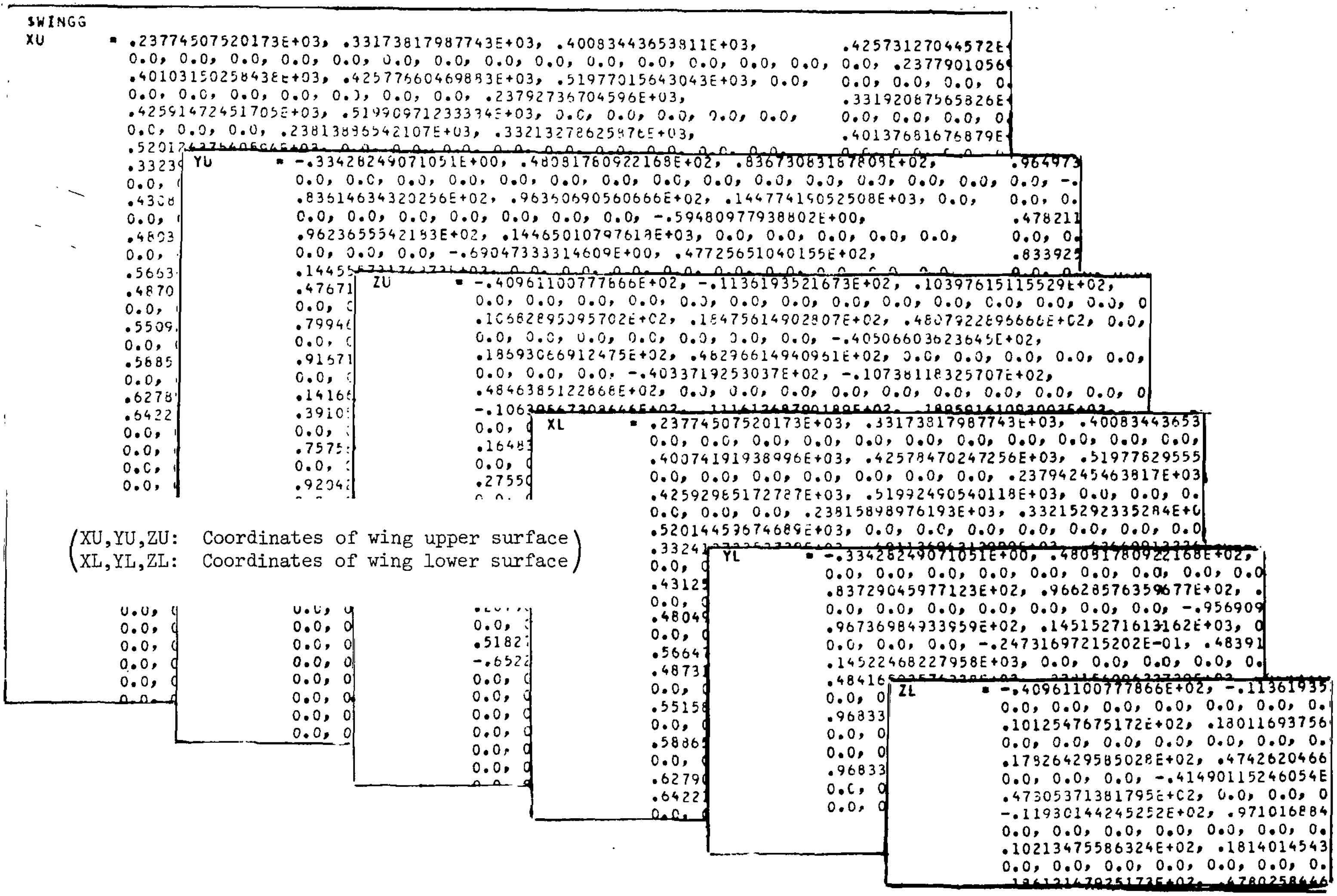
```
        RANGE OF FUSELAGE CROSS-SECTIONS CANNOT BE F3UND.
 INTERSECTION CANNOT BE FOUND F3R RAY  9 OF L3WER SUPFACE     FIN

              RETURN
               END


--- BEGIN SEARCH F3R POINT OF INTERSECTI3N OF     FIN    RAY 10 WITH FUSELAGE.

        MAXIMUM FUSELAGE WIDTH =  .8402E+02

        THE TEST-RANGE OF THE     FIN    SPANS CHORDS  1 TO  4 BY  3.

        RANGE CF FUSELAGE CPCSS-SECTIONS CANNOT BE F3UND.
 INTERSECTION CANNCT BE FOUND FOR RAY 10 OF LOWER SURFACE     FIN

              RETUFN
               END
```

```
          LOWER SURFACE      FIN

                XI          YI          ZI
          486.7383      0.0000     65.6229
          486.7917       .2727     65.6245
          486.9446       .5060     65.6291
          487.1760       .6739     65.6360
          487.4542       .7475     65.6443
          523.8187      3.6351     66.7245
          559.6420      6.4772     67.7967
          594.9361      9.2748     68.8490
          629.3813     12.1172     68.8490
          629.3951      0.0000     68.8490
THE FOLLOWING CHORD DESCRIBES THE UPPER AND LOWER INTERSECTIONS OF THE      FIN     WITH THE FUSELAGE.
CHORD PT        XIU              YIU              ZIU              XIL              YIL              ZIL
  2
       1    .48674E+03   0.                  .65623E+02    .48674E+03   0.                  .65623E+02
       2    .48679E+03   -.27268E+00         .65625E+02    .48679E+03    .27268E+00         .65625E+02
       3    .48694E+03   -.50804E+00         .65629E+02    .48694E+03    .50804E+00         .65629E+02
       4    .48718E+03   -.67387E+00         .65636E+02    .48718E+03    .67387E+00         .65636E+02
       5    .48745E+03   -.74746E+00         .65644E+02    .48745E+03    .74746E+00         .65644E+02
       6    .52382E+03   -.36351E+01         .66729E+02    .52382E+03    .36351E+01         .66729E+02
       7    .55964E+03   -.64772E+01         .67797E+02    .55964E+03    .64772E+01         .67797E+02
       8    .59494E+03   -.92748E+01         .68849E+02    .59494E+03    .92748E+01         .68849E+02
       9    .62938E+03   -.12117E+02         .68849E+02    .62938E+03    .12117E+02         .68849E+02
      10    .62940E+03   0.                  .68849E+02    .62940E+03   0.                  .68849E+02
ADCHRD-CHORD(S)  1 THROUGH  1 HAVE BEEN SET TO CHORD  2 FOR UPPER SURF      FIN
ADCHRD-CHORD(S)  1 THROUGH  1 HAVE BEEN SET TO CHORD  2 FOR THE LOWER SURFACE      FIN
***********************
* E X I T   M E R G E *
***********************
```

Sample Case 1 Output (TAPE38)

```
$FUSE
X        = 0.0, .3E+01, .5E+02, .128E+03, .152E+03, .164E+03, .176E+03, .2E+03,  .3E+03, .4E+03, .52E+03, .6E+03, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
Y        = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           .2E-06, .2E-06, .2E-06, .2E-06, .2E-06, .2E-06, .2E-06, .19953E+02,   .39905999999999E+02, .37881599999999E+02,
           .36531999999999E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,   .23333333333333E-06, .23333333333312E-06,
           .35294130330391E+00, .14646161379596E+01, .20787884902605E+01,       .31457864550101E+01, .68149921808022E+01,
           .26764699411746E+02, .46714804183061E+02, .44690446561744E+02,       .43340874612815E+02, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .26666666666667E-06,                  .26666666666698E-06, .70588241960783E+00,
           .26475264041908E+01, .39021661135267E+01, .60261081514575E+01,       .12579542442615E+02, .32527293855838E+02,
           .52475055018788E+02, .50450740976678E+02, .49101196262968E+02, 0.0,  0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, .3E-06, .3E-06, .10588235294117E+01, .36000000000016E+01,       .54890283806542E+01, .84453920576667E+01,
           .171E+02, .37052999999999E+02, .57005999999996E+02,                  .54981599999996E+02, .53631999999999E+02,
           C.0,  Z        = 0.0, .3E+01, .166864E+02, .39399999999999F+02, .52000000000007E+02,   .56E+02, .56357798165137E+02, .
           .907           .60055045871566E+02, .63036697247706E+02, .66614678899082E+02,      .69E+02, 0.0, 0.0, 0.0, 0.0, 0.
           .54            0.0, 0.0, 0.0, .3E+01, .166864E+02, .39399999999999E+02,             .52000000000007E+02, .56E+02, .
           .19            .57073394495413E+02, .60055045871566E+02, .63036697247706E+02,       .66614678899082E+02, .69E+02, 0
           .17            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .3E+01, .166864E+02,         .39399999999999E+02, .514829488
           0.0,           .55448478935463E+02, .55874651034203E+02, .55295720401838E+02,       .58272220688207E+02, .612487068
           .1C            .64826816168456E+02, .67212222355969E+02, 0.0, 0.0, 0.0, 0.0, 0.0,  0.0, 0.0, 0.0, 0.0, .3E+01, .16
           .57            .39399999999999E+02, .50452831341572E+02, .54265422185206F+02,       .54518486973712E+02, .511825094
           0.C            .54158094152301E+02, .57133677571762E+02, .60711650959991E+02,       .63097299885233E+02, 0.0, 0.0,
           .17            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .3E+01, .166864E+02,                   .39399999999999E+02, .492000000
           C.0            .52608540361288E+02, .52436677614334E+02, .457E+02, .4868175E+02,    .516635E+02, .552416E+02, .5762
           .33            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .3E+01, .166864E+02,    .394E+02, .415E+02, .4254999999
           .83            .436E+02, .45599999778478E+02, .46681749778448E+02,                  .51563499778431E+02, .552415997
           0.C            .57626999778483E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,    .28132180195499E+01, .162883296
           .3P            .39519543050381E+02, .40913028700254E+02, .42109771525195E+02,       .43306514350127E+02, .456999997
           .35            .48681749774785E+02, .51663499774787E+02, .55241599774785E+02,       .57626999774786E+02, 0.0, 0.0,
           .27            0.C  YMAX     = 0.0, .31050742776858E+01, .12684115392959F+02, .26561227772727E+02,    .33472641364314E+02, .
           .62            .39            .38364053549839E+02, .43255462826405E+02, .63636308817688E+02,       .84017112722684E+02, .
           C.C            .51            .84000000381446E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           .32            0.0  ZMAX     = 0.0, -.54509858180791E+00, .55200940575662E+00, .23727164443945E+01,    .29329365139999E+01, .
           .84            .51            .34931564505953E+01, .40533762810998E+01, .63876241075962E+01,       .87218694670002E+01, .1
           .24            C.0.           .10899999413059E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           .56            .55  NXS      = 12,
           C.C            0.C  NSS      = 21,
           .26            .29  RFL      = .6E+03,
           .65            .87  ICO      = 1,
           0.0            0.0  $END
           .32            .17
           .5C            .13
           .22            -.5
```

X,Y,Z: Fuselage cross-section coordinates
YMAX,ZMAX: Fuselage planform coordinates
NXS: Number of cross sections describing fuselage
NSS: Number of points describing each half cross section
RFL: Reference length
ICO: Component identifier flag
1: fuselage; 2: wing; 3: canard; 4: horizontal tail; 5: fin



```
$WINGG
XU       = .23774507520173E+03, .33173817987743E+03, .40083443653811E+03,          .42573127044572E
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,  0.0, .2377901056
           .40103150258438E+03, .42577660469883E+03, .51977015643043E+03, 0.0,     0.0, 0.0, 0.0, 0
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .23792736704596E+03,                 .33192087565826E
           .42591472451705E+03, .51990971233334E+03, 0.0, 0.0, 0.0, 0.0, 0.0,     0.0, 0.0, 0.0, 0
           0.C, 0.0, 0.0, .23813896542107E+03, .33213272625876E+03,                .40137681676879E
```

```
YU       = -.33428249071051E+00, .48081760922168E+02, .83673083167809E+02,         .964973
           0.0, 0.C, 0.0, 0.0, 0.0, 0.0, 0.0, 0.C, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,  0.0, -.
           .83514634320256E+02, .96350690560666E+02, .14477419052508E+03, 0.0,     0.0, 0.
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.59480977938802E+00,                .478211
           .96236555421 53E+02, .14465010797618E+03, 0.0, 0.0, 0.0, 0.0, 0.0,     0.0, 0.
           0.0, 0.0, 0.0, -.69047333314609E+00, .47725651040155E+02,               .833925
```

```
ZU       = -.40961100777666E+02, -.11361935216 73E+02, .10397615115529E+02,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0
           .10682895095702E+02, .18475614902807E+02, .48079228966666E+02, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.40506603623645E+02,
           .18693066912475E+02, .46296614940961E+02, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, -.40337192530 37E+02, -.10738118325707E+02,
           .48463851226668E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0
```

```
XL       = .23774507520173E+03, .33173817987743E+03, .40083443653
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           .40074191938996E+03, .42578470247256E+03, .51977629555
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .23794245463817E+03
           .42592985172727E+03, .51992490540118E+03, 0.0, 0.0, 0.
           0.C, 0.0, 0.0, .23815898976193E+03, .33215292335284E+0
           .52014459674689E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
```

```
YL       = -.33428249071051E+00, .48081780922168E+02,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
           .83729045977123E+02, .96628576359677E+02, .
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.956909
           .96736984933959E+02, .14515271613162E+03, 0
           0.0, 0.0, 0.0, -.24731697215202E-01, .48391
           .14522468227958E+03, 0.0, 0.0, 0.0, 0.0, 0.
```

```
ZL       = -.40961100777866E+02, -.11361935
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.
           .10125476751 72E+02, .18011693756
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.
           .17826429585028E+02, .4742620466
           0.0, 0.0, 0.0, -.41490115246054E
           .47305371381795E+02, 0.0, 0.0, 0
           -.11930144245252E+02, .971016884
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.
           .10213475586324E+02, .1814014543
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.
```

(XU,YU,ZU: Coordinates of wing upper surface)
(XL,YL,ZL: Coordinates of wing lower surface)

```
NYU    = 5,
NXU    = 13,
XLE    = 0.0, .1E-02, .20777827324534E-02, .32393983508231E-02,              .44913676060605E-02, .58407184509125E-02,
         .72950254915154E-02, .88624525075627E-02, .10551798279839E-01,      .12372545982342E-01, .14334916416254E-01,
         .16449925384601E-01, .1872944552967E-01, .21186272980305E-01,       .23834199183216E-01, .26688083321525E-01,
         .29763960755131E-01, .330790829513E-01, .36652064410305E-01,        .40502962130196E-01, .44653393197139E-01,
         .49126656133328E-01, .53947361683677E-01, .59144073775451E-01,      .6474446144213E-01, .70780462564322E-01,
         .77265960346891E-01, .84297473522956E-01, .91854361352489E-01,      .99999044566247E-01,
ZLEU   = .21565032222301E-02, .42678447163435E-02, .47882065343429E-02,      .5253773059376E-02, .57569835424453E-02,
         .63139645899037E-02, .69953492992524E-02, .75157372023019E-02,      .81736657000915E-02, .88715750813242E-02,
         .96107659473095E-02, .10392347665303E-01, .11217176237653E-01,      .1208577970091E-01, .1299826865063E-01,
         .13954230716679E-01, .14952601781777E-01, .15991517433005E-01,      .17068133550202E-01, .18178415453405E-01,
         .19316883637978E-01, .20476344802522E-01, .2164749560026E-01,       .22818565294495E-01, .23974812044458E-01,
         .25097965856559E-01, .26165569268688E-01, .27150204547499E-01,      .28018588518271E-01, .28730513053613E-01,
ZLEL   = .21565032222301E-02, .27262595721243E-03, -.31051003709263E-05,     -.20562256276648E-03, -.43603115390738E-03,
         -.67903549617971E-03, -.93475454725923E-03, -.1203177403109E-02,    -.14841307138947E-02, -.17772399318021E-02,
         -.20318833237373E-02, -.23971375039823E-02, -.27217130348019E-02,   -.30538784019882E-02, -.33913703918606E-02,
         -.37312885700934E-02, -.40699711825668E-02, -.44026493579766E-02,   -.47242759769181E-02, -.50273249759364E-02,
         -.53035561598304E-02, -.55427397878901E-02, -.57325342605399E-02,   -.58581091409031E-02, -.59017044763226E-02,
         -.58421159909121E-02, -.56540933503848E-02, -.53076369965321E-02,   -.4767188150705E-02, -.39906536172209E-02,
XX1    = .1E-02,
XX2    = .1E+00,
NC     = 30,
II     = 2,
RFL    = .6E+03,
IFLAP  = 0,
ICO    = 2,
$END
```

NYU: Number of chord locations describing wing

NXU: Number of points per chord location

XLE,ZLEU,ZLEL: Coordinates of leading-edge point enrichment

XX1: Longitudinal coordinate of second wing leading-edge enrichment station

XX2: Longitudinal coordinate of final wing leading-edge enrichment station

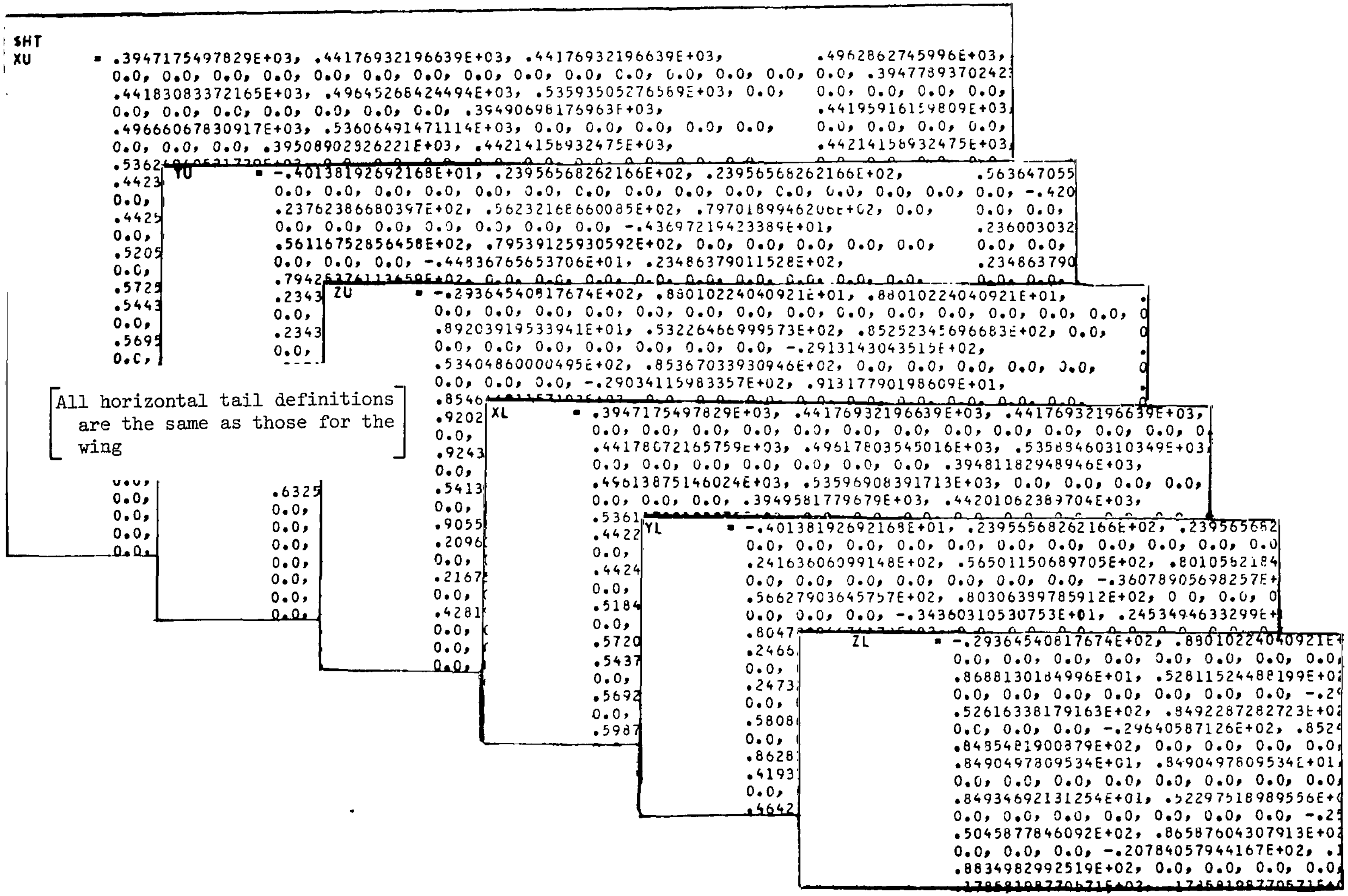
NO: Number of wing leading-edge enrichment longitudinal stations

II: Chord number at which leading-edge enrichment is computed

RFL: Wing reference length

IFLAP: Control surface flag; (=0: no control surface; ≠0: wing has or is a control surface)

ICO: Component identifier flag



```
$HT
XU       = .3947175497829E+03, .44176932196639E+03, .44176932196639E+03,           .4962862745996E+03,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, C.0, 0.0, 0.0, 0.0, 0.0, .3947789370242
           .44183083372165E+03, .4964526842449 4E+03, .53593505276569E+03, 0.0,   0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.C, 0.0, 0.0, 0.0, 0.0, .39490698176963F+03,                .44195916159809E+03
           .49666067830917E+03, .53606491471114E+03, 0.0, 0.0, 0.0, 0.0, 0.0,     0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, .3950890292 6221E+03, .44214156932475E+03,              .44214156932475E+03
           .5362
           .4423
           0.0,
           .4425
           0.0,
           .5205
           0.0,
           .5725
           .5443
           0.0,
           .5695
           0.C,
           0.0,
           0.0,
           0.0,
           0.0,
```

```
YU       = -.40138192692168E+01, .23956568262166E+02, .23956568262166E+02,         .563647055
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, C.0, 0.0, 0.0, 0.0, C.0, 0.0, 0.0, 0.0, 0.0, -.420
           .23762386680397E+02, .56232168660085E+02, .79701899462 06E+02, 0.0,    0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.43697219423389E+01,               .236003032
           .56116752856458E+02, .79539125930592E+02, 0.0, 0.0, 0.0, 0.0, 0.0,     0.0, 0.0,
           0.0, 0.0, 0.0, -.44836765653706E+01, .23486379011528E+02,              .234863790
           .7942
           .2343
           0.0,
           .2343
           0.0,
           .6325
           0.0,
           0.0,
           0.0,
           0.0,
           0.0,
           0.0,
```

```
ZU       = -.29364540817674E+02, .88010224040921E+01, .88010224040921E+01,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, C.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           .89203919533941E+01, .53226466999573E+02, .85252345696683E+02, 0.0,
           0.0, 0.C, 0.0, 0.0, 0.0, 0.0, 0.0, -.29131430435 15E+02,
           .53404860000495E+02, .85367033930946E+02, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, -.29034115983357E+02, .91317790198609E+01,
           .8546
           .9202
           0.0,
           .9243
           0.0,
           .5413
           0.0,
           .9055
           .2096
           0.0,
           .2167
           0.0,
           .4281
           0.0,
           0.0,
           0.0,
```

```
XL       = .3947175497829E+03, .44176932196639E+03, .44176932196639E+03,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0
           .44178072165759E+03, .49617803545016E+03, .53589460310349E+03,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .39481182948946E+03,
           .49613875146024E+03, .53596908391713E+03, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, .39495817796 79E+03, .44201062389704E+03,
           .5361
           .4422
           0.0,
           .4424
           0.0,
           .5184
           0.0,
           .5720
           .5437
           0.0,
           .5692
           0.0,
           .5987
```

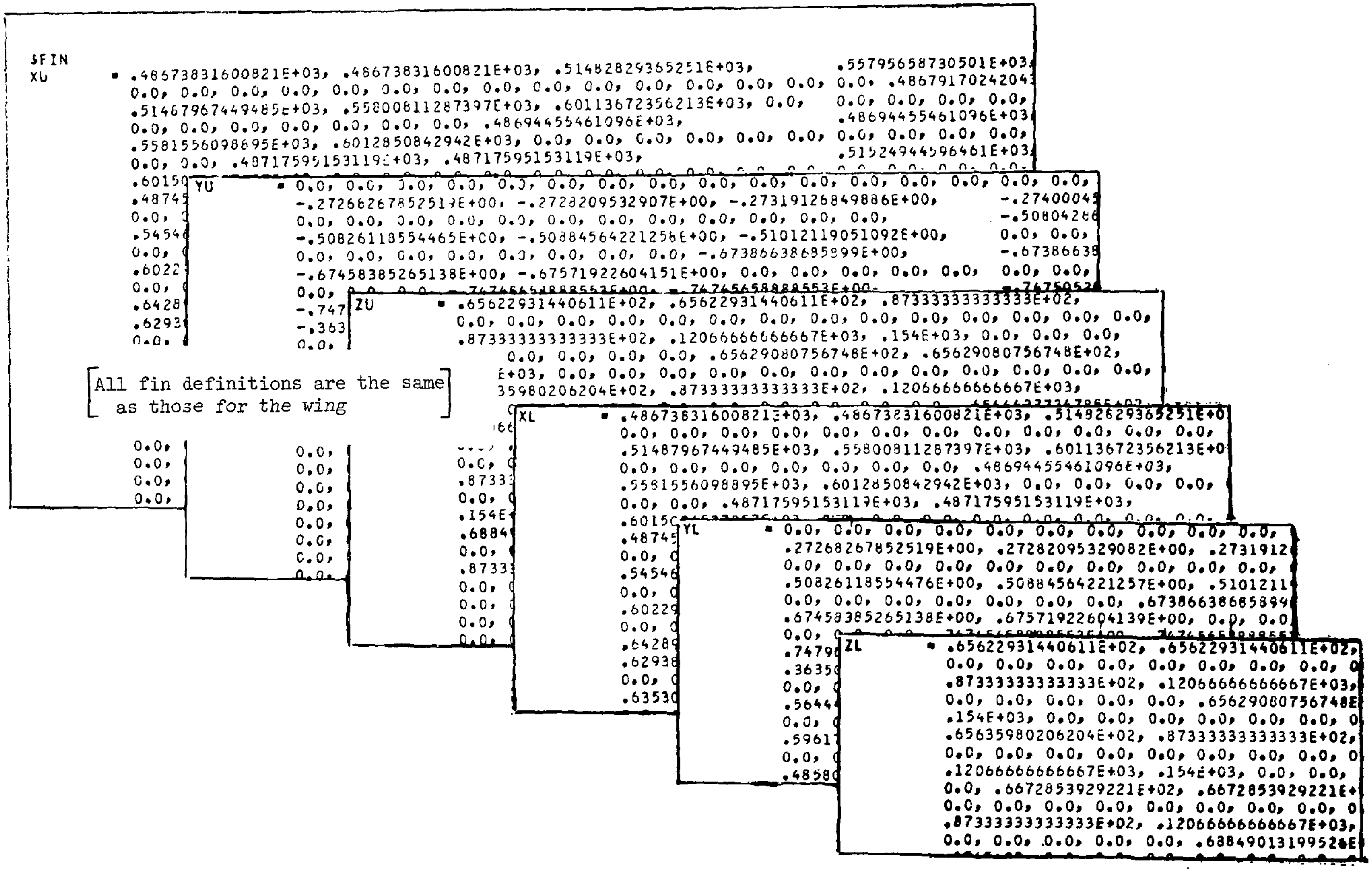
```
YL       = -.40138192692168E+01, .23956568262166E+02, .239565662
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
           .24163606099148E+02, .56501150689705E+02, .8010562184
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.36078905698257E+
           .56627903645757E+02, .80306399785912E+02, 0 0, 0.0, 0
           0.0, 0.0, 0.0, -.34360310530753E+01, .24534946332 99E+
           .8047
           .2466
           0.0,
           .2473
           0.0,
           .5808
           0.0,
           .8628
           .4193
           0.0,
           .4642
```

```
ZL       = -.29364540817674E+02, .88010224040921E+
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           .86881301 84996E+01, .52811524488199E+0
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.2
           .52616338179163E+02, .84922872827 23E+0
           0.C, 0.0, 0.0, -.29640587126E+02, .852
           .84854819008 79E+02, 0.0, 0.0, 0.0, 0.0,
           .84904978095 34E+01, .84904978095 34E+01,
           0.0, 0.C, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           .84934692131254E+01, .52297518989556E+
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.2
           .50458778460 92E+02, .86587604307913E+0
           0.0, 0.0, 0.0, -.20784057944167E+02, .
           .88349829925 19E+02, 0.0, 0.0, 0.0, 0.0,
```

All horizontal tail definitions
are the same as those for the
wing

```
NYU     = 5,
NXU     = 11,
XLE     = 0.0, .1E-02, .20777827324534E-02, .32393983508281E-02,            .44913676060605E-02, .58407184509125E-02,
          .72950254915154E-02, .88624525075627E-02, .10551798279839E-01,      .12372545982342E-01, .14334916416254E-01,
          .16449925384601E-01, .1872944552967E-01, .21186272980305E-01,       .23834199183216E-01, .26688088321525E-01,
          .29763960755131E-01, .330790829513E-01, .36652064410305E-01,        .40502962130196E-01, .44653393197139E-01,
          .49126656133328E-01, .53947861683677E-01, .59144073775451E-01,      .64744461144213E-01, .70780462564322E-01,
          .77285960346891E-01, .84297473522956E-01, .91854361352489E-01,      .99959044566247E-01,
ZLEU    = 0.0, .29508088844335E-02, .39633786669573E-02, .45439588341737E-02, .48306798605072E-02, .50156865527692E-02,
          .52654038678464E-02, .55333747317161E-02, .58208298413605E-02,      .61290650569715E-02, .64594415309444E-02,
          .68133850485869E-02, .71923843902149E-02, .75979664836445E-02,      .80318021142663E-02, .84954797710836E-02,
          .89907174292285E-02, .95192416534965E-02, .10082795607665E-01,      .10683121323802E-01, .11321937518197E-01,
          .12000912110679E-01, .12721626458208E-01, .13435544143409E-01,      .14293940960171E-01, .15147864506979E-01,
          .16048051528823E-01, .16994842834053E-01, .17959079246253E-01,      .19026977624453E-01,
ZLEL    = 0.0, -.29508088844335E-02, -.39633786669573E-02, -.45451865014232E-02, -.48075223181313E-02, -.49564533972143E-02,
          -.51691996602883E-02, -.5395467557536E-02, -.56358197329436E-02,    -.58907835473663E-02, -.61608355588743E-02,
          -.6446382731222E-02, -.67477397823414E-02, -.70651019849312E-02,    -.73985126151764E-02, -.77478241102814E-02,
          -.81126518379099E-02, -.84923191971267E-02, -.88657925567732E-02,   -.92916042835051E-02, -.97077618622626E-02,
          -.10131640635077E-01, -.10559857572194E-01, -.10988122683462E-01,   -.1141106442751E-01, -.11822024719232E-01,
          -.12212818458468E-01, -.1257345166327E-01, -.12891791320695E-01,    -.13153178939711E-01,
XX1     = .1E-02,
XX2     = .1E+00,
NO      = 30,
II      = 2,
RFL     = .6E+03,
IFLAP   = 0,
ICO     = 4,
$END
```

[All horizontal tail definitions are the same as those for the wing]



```
$FIN
XU      = .48673831600821E+03, .48673831600821E+03, .51482829365251E+03,          .55795658730501E+03,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .4867917024204
          .51467967449485E+03, .55800811287397E+03, .60113672356213E+03, 0.0,   0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .48694455461096E+03,                .48694455461096E+03,
          .55815560988695E+03, .6012850842942E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, .48717595153119E+03, .48717595153119E+03,                    .51524944596461E+03,
```

```
YU      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          -.27266267852519E+00, -.2728209532907E+00, -.27319126849886E+00,        -.27400045
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,             -.50804286
          -.50826118554465E+00, -.50884564221256E+00, -.51012119051092E+00,       0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.67386638685899E+00,           -.67386638
          -.67458385265138E+00, -.67571922604151E+00, 0.0, 0.0, 0.0, 0.0, 0.0,    0.0, 0.0,
```

```
ZU      = .65622931440611E+02, .65622931440611E+02, .87333333333333E+02,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          .87333333333333E+02, .12066666666667E+03, .154E+03, 0.0, 0.0, 0.0,
             0.0, 0.0, 0.0, 0.0, .65629080756748E+02, .65629080756748E+02,
            E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            35980206204E+02, .87333333333333E+02, .12066666666667E+03,
```

```
XL      = .48673831600821E+03, .48673831600821E+03, .51482829365251E+0
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          .51487967449485E+03, .55800811287397E+03, .60113672356213E+0
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .48694455461096E+03,
          .55815560988895E+03, .60128508842942E+03, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, .48717595153119E+03, .48717595153119E+03,
```

```
YL      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          .27268267852519E+00, .27282095329082E+00, .2731912
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          .50826118554476E+00, .50884564221257E+00, .5101211
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .67386638685899
          .67458385265138E+00, .67571922604139E+00, 0.0, 0.0
```

```
ZL      = .65622931440611E+02, .65622931440611E+02,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0
          .87333333333333E+02, .12066666666667E+03,
          0.0, 0.0, 0.0, 0.0, 0.0, .65629080756748E
          .154E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0
          .65635980206204E+02, .87333333333333E+02,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0
          .12066666666667E+03, .154E+03, 0.0, 0.0,
          0.0, .66728539292211E+02, .66728539292211E+
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0
          .87333333333333E+02, .12066666666667E+03,
          0.0, 0.0, .0.0, 0.0, 0.0, .68849013199526E
```

[All fin definitions are the same as those for the wing]

```
NYU      = 5,
NXU      = 10,
XLE      = 0.0, .1E-02, .20777827324534E-02, .32393983508281E-02,                     .44913676060605E-02, .58407184509125E-02,
           .72950254915154E-02, .88624525075627E-02, .10551798279839E-01,               .12372545982342E-01, .14334916416254E-01,
           .16449925334601E-01, .18729445529967E-01, .21186272960305E-01,               .23834199183216E-01, .26688088321525E-01,
           .29763960755131E-01, .33079082951 3E-01, .36652064410305E-01,                .40502962130196E-01, .44653393197139E-01,
           .49126656133328E-01, .53947861683677E-01, .59144073775451E-01,               .64744461442 13E-01, .70780462564322E-01,
           .77285960346891E-01, .84297473522956E-01, .91854361352489E-01,               .99999044566247E-01,
ZLEU     = 0.0, .46232134164016E-02, .59381828244502E-02, .68178792940213E-02,        .74957539255067E-02, .81259479566871E-02,
           .8461856367152E-02, .87696239171294E-02, .92209049943 14E-02,                .97023827850974E-02, .10215613321635E-01,
           .10762145547612E-01, .11343500060552E-01, .11961142854153E-01,               .12616453130959E-01, .13310684095812E-01,
           .14044915454397E-01, .14819996123914E-01, .15636475409814E-01,               .16494520607 58E-01, .17393818644916E-01,
           .18333458979425E-01, .19311794500866E-01, .20326276644337E-01,               .21373260289246E-01, .22447773283381E-01,
           .23543244576238E-01, .24651183949832E-01, .25760805177232E-01,               .26858583091514E-01,
ZLEL     = 0.0, -.46232134164016E-02, -.59381828244502E-02,                             -.68178792940213E-02, -.74957539255067E-02,
           -.81259479566871E-02, -.8461856367152E-02, -.87696239171294E-02,             -.92209049943 14E-02, -.97023827850974E-02,
           -.10215613321635E-01, -.10762145547612E-01, -.11343500060552E-01,            -.11961142854153E-01, -.12616453130959E-01,
           -.13310684095812E-01, -.14044915454397E-01, -.14819996123914E-01,            -.15636475409814E-01, -.16494520607 58E-01,
           -.17393818644916E-01, -.18333458979425E-01, -.19311794500866E-01,            -.20326276644337E-01, -.21373260289246E-01,
           -.22447773283381E-01, -.23543244576238E-01, -.24651183949832E-01,            -.25760805177232E-01, -.26858583091514E-01,
XX1      = .1E-02,
XX2      = .1E+00,
NO       = 30,
II       = 3,
RFL      = .6E+03,
IFLAP    = 0,               [All fin definitions are the same as those for the wing]
ICO      = 5,
$END
```

```
$CONST
TITLE    = .57202374148088-145, .16810266916175-183, .22538883006315E-29,      .70739430816307E+28, .14517629854422-260,
           .66235824119418E-68, -.71738305547276E+58, .44403860393731E+86,      .14517629854422-260, .22538883006315E-29,
           .70739430816307E+26, .12218352960421E-48, .16810266916175-183,      -.71738305547276E+58, .49400934489447-222,
           .14517629854422-260, .44403860393731E+86, .16810266916175-183,      -.71738305547276E+58, .10982424618137+260,
           -.71738305547276E+58, -.71738305547276E+58, -.5306728277664+135,    .31009469161343-164, .15109850715206+125,
           .44403860393731E+86, .16810266916175-183, .12218352960421E-48,      .14517629854422-260, .57202374148088-145,
           .16810266916175-183, -.38889413362393E+39, -.71738305547276E+58,    .51416157651922+163, .19464959268609-106,
           .41576900652477E-10, .57202374148088-145, -.38889413362393E+39,     -.71738305547276E+58, .10551975563164-125,
           .76695844571428E+09, .24071380952813E+67, .19464959266609-106,      .32274445242386+221, .76695844571428E+09,
           .41576900652477E-10, .81910664856738+105, .14517629854422-260,      .12218352960421E-48, -.71738305547276E+58,
           .81910664856788+105, .14517629854422-260, .19464959268609-106,      .12218352960421E-48, -.38889413362393E+39,
           -.71738305547276E+58, .31009469161343-164, .19464959268609-106,     .41576900652477E-10, -.45030864224451+116,
           -.71738305547276E+58, -.71738305547276E+58, -.71738305547276E+58,   -.71738305547276E+58, -.71738305547276E+58,
           -.71738305547276E+58, -.71738305547276E+58, -.71738305547276E+58,   -.71738305547276E+58, -.71738305547276E+58,
           -.71738305547276E+58, -.71738305547276E+58, -.71738305547276E+58,   -.71738305547276E+58, -.71738305547276E+58,
           -.71738305547276E+58, -.71738305547276E+58, -.71738305547276E+58,   -.71738305547276E+58, -.71738305547276E+58,
J0       = 1, Not used           ⎫
J1       = 1, Fuselage           ⎪
J2       = 1, Wing               ⎪
J3       = 0, Not used           ⎪
J4       = 1, Not used           ⎬ (Component geometry has been generated.  0: No; 1: Yes)
J5       = 1, Fin                ⎪
J6       = 0, Not used           ⎪
ICAN     = 0, Canard             ⎪
IHT      = 1, Horizontal tail    ⎪
JFLAP    = 0, Flap               ⎭
NST      = 1, 3, 1, 4, 2, 1, 1, 1, 1, 1, ◀ Array containing intersection chord locations of components:
NYF      = 20, 50, 20, 30, ◀
$END
```

Maximum limits of geometry arrays

NYF(1): Maximum number of fuselage stations

NYF(2): Maximum number of points per fuselage cross section

NYF(3): Maximum number of chord stations for a planar surface

NYF(4): Maximum number of points per chord

NST(1): Not used

NST(2): Wing

NST(3): Canard

NST(4): Horizontal tail

NST(5): Fin

NST(6): Flap

NST(7)-(10): Not used

Sample Case 2 Input

```
COLUMN          1         2         3         4         5         6         7         8
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
       GEMPAK SAMPLE CASE 2  (FUSELAGE ONLY)
         1
       FUSELAGE (POINT-BY-POINT, INC(1)=2)
       600.                   17   34 2 0 1 0 0 1 1 1 0 0 0
          0.00000   3.00000  50.00000 100.00000 128.00000 152.00000 164.00000 176.00000
        200.00000 250.00000 300.00000 350.00000 400.00000 460.00000 520.00000 560.00000
        600.00000
          0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
          0.00000   0.00000   0.00000   0.00000
          0.00000   3.00000    .00000   3.00000    .00000   3.00000    .00000   3.00000
           .00000   3.00000    .00000   3.00000    .00000   3.00000    .00000   3.00000
           .63796   2.93098   1.24856   2.73411   1.80644   2.41762   2.27440   1.98190
          2.70000   1.50000   2.70000   1.50000   3.13116    .30413   2.99487   -.95655
          2.32439  -2.03570   1.23841  -2.66735    .00000  -3.00000    .00000  -3.00000
           .00000  -3.00000    .00000  -3.00000    .00000  -3.00000    .00000  -3.00000
          0.00000  -3.00000   0.00000  -3.00000   0.00000  -3.00000   0.00000  -3.00000
          0.00000  -3.00000   0.00000  -3.00000   0.00000  -3.00000   0.00000  -3.00000
          0.00000  -3.00000   0.00000  -3.00000
          0.00000  16.68640    .00000  16.68640    .00000  16.68640    .00000  16.68640
           .00000  16.68640    .00000  16.68640    .00000  16.68640    .00000  16.68640
          1.20557  16.53671   2.34830  16.12416   3.38312  15.48774   4.25033  14.64109
          5.04699  13.72000  12.27758   2.59426  12.70871   1.40015  12.57510    .14082
         11.90842   -.93666  10.62590  -1.57248   9.58942  -1.90570   9.33476  -2.12553
          9.15263  -2.41838   8.99620  -2.72592   8.86409  -3.04478   8.73198  -3.36364
          8.00607  -3.85652   7.14531  -4.10918   6.26505  -4.28589   5.37672  -4.41687
          4.48417  -4.51491   3.58986  -4.59505   2.69239  -4.62811   1.79493  -4.66116
           .89746  -4.69422   0.00000  -4.72727
          0.00000  31.24640    .00000  31.24640    .00000  31.24640    .00000  31.24640
```

GEMPAK title card

GEMPAK geometry option card

Fuselage card set 1

Cross section Y and Z coordinates at X = 0.0

at X = 3.0

at X = 50.0

Fuselage card set 7

```
COLUMN           1         2         3         4         5         6         7         8
        12345678901234567890123456789012345678901234567890123456789012345678901234567890
            .00000  31.24640    .00000  31.24640    .00000  31.24640    .00000  31.24640
           1.80932  31.01014   3.51760  30.36769   5.05972  29.39144   6.35211  28.10823
           7.54379  26.72000  22.46650   3.75837  22.89760   2.56612  22.76681   1.30824
          22.10419    .22841  21.02535   -.40772  19.79093   -.74154  19.26536  -1.19524   at  X = 100.0
          18.88948  -1.79964  18.56662  -2.43435  18.29397  -3.09242  18.02132  -3.75048
          16.52317  -4.76771  14.74671  -5.28916  12.93001  -5.65387  11.09663  -5.92419
           9.25457  -6.12651   7.40886  -6.29191   5.55664  -6.36013   3.70443  -6.42835
           1.85221  -6.49658   0.00000  -6.56480
           0.00000  39.40000    .00000  39.40000    .21176  39.40000    .42353  39.40000
            .63529  39.40000    .84706  39.40000   1.05882  39.40000   1.06000  39.40000
           3.00131  39.05001   4.77947  38.18642   6.35679  36.99351   7.68648  35.53265
           8.94200  34.00000  28.17229   4.41026  28.60338   3.21906  28.47416   1.96199
          27.81382    .88198  26.73704    .24455  25.50378   -.08961  24.82650   -.67427   at  X = 128.0
          24.34211  -1.45314  23.92605  -2.27107  23.57470  -3.11909  23.22335  -3.96712
          21.29275  -5.27797  19.00350  -5.94995  16.66238  -6.41993  14.29978  -6.76828
          11.92599  -7.02901   9.54750  -7.24216   7.16062  -7.33007   4.77375  -7.41798
           2.38687  -7.50590   0.00000  -7.59381
           0.00000  52.00000    .00000  52.00000    .91234  51.78343   1.72373  51.30426
           2.43136  50.65072   3.02852  49.95170   3.60000  49.20000   6.40667  41.50000
           7.70087  41.26667   8.88631  40.69095   9.93786  39.89567  10.82432  38.92176
          11.66133  37.90000  33.06297   4.96904  33.49404   3.77873  33.36618   2.52236
          32.70778   1.44218  31.63277    .80364  30.40050    .46918  29.59319   -.22773   at  X = 152.0
          29.01580  -1.15615  28.51986  -2.13112  28.10104  -3.14196  27.68223  -4.15280
          25.38096  -5.71535  22.65217  -6.51634  19.86156  -7.07656  17.04534  -7.49179
          14.21578  -7.80258  11.38062  -8.05665   8.53546  -8.16144   5.69031  -8.26624
           2.64515  -8.37103   0.00000  -8.47582
           0.00000  56.00000    .00000  56.00000   1.27543  55.77315   2.46435  55.25020
           3.55654  54.54620   4.53691  53.69467   5.48903  52.80854   9.08000  42.55000
          10.05065  42.37501  10.93974  41.94321  11.72839  41.34675  12.39324  40.61632
          13.02100  39.85000  35.50831   5.24842  35.93937   4.05856  35.81218   2.80254
          35.15476   1.72228  34.08064   1.08318  32.84887    .74858  31.97653   -.00446   at  X = 164.0
          31.35264  -1.00765  30.81676  -2.06114  30.36422  -3.15339  29.91168  -4.24565
          27.42506  -5.93403  24.47650  -6.79953  21.46115  -7.40487  18.41812  -7.85355
          15.36067  -8.18936  12.29718  -8.46390   9.22288  -8.57713   6.14859  -8.69036
           3.07429  -8.80360   0.00000  -8.91683
```

Fuselage card
set 7

APPENDIX C

```
COLUMN         1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
         0.00000  56.35780    .00000  56.35780   1.90582  56.17925   3.75058  55.66953
         5.47890  54.84843   7.00745  53.70436   8.44538  52.43668  11.75333  43.60000
        12.40044  43.48334  12.99316  43.19547  13.51893  42.79784  13.96216  42.31088
        14.38067  41.80000  37.95365   5.52781  38.38470   4.33840  38.25819   3.08272
        37.60174   2.00239  36.52651   1.36273  35.29723   1.02797  34.35987    .21881   at  X = 176.0
        33.68949   -.85915  33.11366  -1.99116  32.62739  -3.16483  32.14112  -4.33849
        29.46917  -6.15272  26.30084  -7.08273  23.06073  -7.73318  19.79090  -8.21530
        16.50557  -8.57615  13.21374  -8.87114   9.91030  -8.99282   6.60687  -9.11449
         3.30343  -9.23616   0.00000  -9.35783
         0.00000  57.07339    .00000  57.07339   4.18955  56.37627   8.05831  54.60880
        11.50033  52.10731  14.39003  48.99176  17.10000  45.70000  17.10000  45.70000
        17.10000  45.70000  17.10000  45.70000  17.10000  45.70000  17.10000  45.70000
        17.10000  45.70000  42.84433   6.08658  43.27536   4.89806  43.15019   3.64308
        42.49569   2.56259  41.42424   1.92182  40.19395   1.58677  39.12656    .66535   at  X = 200.0
        38.36317   -.56215  37.70746  -1.85121  37.15373  -3.18769  36.60000  -4.52418
        33.55737  -6.59009  29.94951  -7.64912  26.25991  -8.38981  22.53645  -8.93881
        18.79536  -9.34972  15.04686  -9.68564  11.28514  -9.82419   7.52343  -9.96274
         3.76171 -10.10129   0.00000 -10.23985
         0.00000  58.56422   9.97650  58.56422  14.16531  57.86575  18.03283  56.09656
        21.47410  53.59475  24.36464  50.48048  27.07650  47.19088  27.07650  47.19087
        27.07653  47.19087  27.07656  47.19087  27.07656  47.19087  27.07653  47.19087
        27.07650  47.19087  53.03325   7.25068  53.46424   6.06403  53.34186   4.81051
        52.69143   3.72970  51.62369   3.08660  50.39547   2.75092  48.82205   1.75504   at  X = 250.0
        47.68127    .23031  46.72490  -1.41842  45.95671  -3.16334  45.19410  -4.91103
        41.45092  -7.48942  36.99969  -8.82034  32.44382  -9.75090  27.84478 -10.44127
        23.22319 -10.95834  18.59212 -11.38156  13.94409 -11.55551   9.29606 -11.72946
         4.64803 -11.90342   0.00000 -12.07737
         0.00000  60.05505  19.95300  60.05505  24.14108  59.35522  28.00735  57.58432
        31.44768  55.08219  34.33925  51.96920  37.05300  48.68175  37.05300  48.68175
        37.05302  48.68175  37.05304  48.68175  37.05304  48.68175  37.05302  48.68175
        37.05300  48.68175  63.22217   8.41479  63.65311   7.23000  63.53352   5.97794
        62.88714   4.89681  61.82313   4.25138  60.59698   3.91508  58.18005   3.07700   at  X = 300.0
        56.22504   1.38482  54.65392   -.67488  53.45076  -2.96707  52.31354  -5.29787
        48.02243  -8.36281  42.88166  -9.97219  37.60845 -11.09675  32.28115 -11.93293
        26.92540 -12.56032  21.55759 -13.07537  16.16819 -13.28525  10.77880 -13.49513
```

Fuselage card
set 7

```
COLUMN        1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
         5.38940 -13.70501   0.00000 -13.91489
         0.00000  61.54587  29.92950  61.54587  34.11684  60.84469  37.98187  59.07207
        41.42167  56.56964  44.31386  53.45792  47.02950  50.17263  47.02950  50.17262
        47.02945  50.17262  47.02940  50.17262  47.02940  50.17262  47.02945  50.17262
        47.02950  50.17262  73.41108   9.57889  73.84198   8.39596  73.72516   7.14537
        73.08285   6.06394  72.02258   5.41616  70.79849   5.07923  67.26528   4.45391   at  X = 350.0
        64.07150   2.81138  61.38121    .42946  59.36839  -2.53658  57.61123  -5.68472
        52.96389  -9.20315  47.32462 -11.09889  41.51818 -12.42271  35.64437 -13.41049
        29.73477 -14.15359  23.80985 -14.76642  17.85739 -15.01292  11.90493 -15.25942
         5.95246 -15.50592   0.00000 -15.75242
         0.00000  63.03670  39.90600  63.03670  44.09261  62.33416  47.95639  60.55982
        51.39545  58.05708  54.28848  54.94664  57.00600  51.66350  57.00600  51.66350
        57.00595  51.66350  57.00591  51.66350  57.00591  51.66350  57.00595  51.66350
        57.00600  51.66350  83.60000  10.74300  84.03085   9.56192  83.91679   8.31280
        83.27853   7.23108  82.22202   6.58095  81.00000   6.24338  75.89546   5.47453   at  X = 400.0
        70.90764   4.26656  66.36828   1.84631  62.57848  -1.62859  60.00000  -6.07157
        55.31880  -9.99617  49.48756 -12.18950  43.44102 -13.72036  37.30926 -14.86801
        31.13161 -15.73453  24.93407 -16.45355  18.70055 -16.73765  12.46703 -17.02175
         6.23352 -17.30584   0.00000 -17.58994
         0.00000  64.82569  38.89380  64.82569  43.08042  64.12318  46.94422  62.34889
        50.38330  59.84617  53.27631  56.73571  55.99380  53.45255  55.99380  53.45255
        55.99377  53.45255  55.99374  53.45255  55.99374  53.45255  55.99377  53.45255
        55.99380  53.45255  83.72000  10.79010  84.02159   9.96335  83.94176   9.06896
        83.49497   8.33175  82.75542   7.87667  81.90000   7.64037  76.43562   6.71966   at  X = 460.0
        71.14624   5.20817  66.44669   2.30874  62.62565  -1.67808  60.00000  -6.53578
        55.55724 -10.84165  49.81382 -13.40795  43.77693 -15.20354  37.62638 -16.56325
        31.41289 -17.59792  25.17113 -18.46434  18.87856 -18.79918  12.58571 -19.13111
         6.29285 -19.46304   0.00000 -19.79497
         0.00000  66.61468  37.88160  66.61468  42.06822  65.91221  45.93204  64.13796
        49.37114  61.63525  52.26414  58.52479  54.98160  55.24160  54.98160  55.24160
        54.98161  55.24160  54.98162  55.24160  54.98162  55.24160  54.98161  55.24160
        54.98160  55.24160  83.84000  10.83720  84.01234  10.36477  83.96672   9.86512
        83.71141   9.43243  83.28881   9.17238  82.80000   9.03735  76.93689   8.29547   at  X = 520.0
        71.42265   6.17127  66.61096   2.74552  62.99821  -1.88891  60.00000  -7.00000
        55.78224 -11.64474  50.14301 -14.58107  44.12370 -16.64711  37.95882 -18.22844
```

Fuselage card
set 7

```
COLUMN          1         2         3         4         5         6         7         8
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
          31.71101 -19.44188  25.42095 -20.43372  19.06903 -20.85589  12.71269 -21.23726
           6.35634 -21.61863   0.00000 -22.00000
           0.00000  67.80734  37.20680  67.80734  41.39343  67.10489  45.25726  65.33067
          48.69637  62.82798  51.58936  59.71751  54.30680  56.43430  54.30680  56.43430
          54.30684  56.43430  54.30688  56.43430  54.30688  56.43430  54.30684  56.43430
          54.30680  56.43430  83.92000  10.86860  84.00617  10.63238  83.98336  10.38256
          83.85571  10.16622  83.64440  10.03619  83.40000   9.96868  78.22606   9.50949
          73.06969   8.93900  63.06366   7.57287  63.40645   5.30793  60.00000   1.50000
          54.60711  -1.48550  48.95336  -2.92586  42.80868  -3.93808  36.72464  -4.68327
          30.62050  -5.23609  24.50812  -5.68738  18.38109  -5.87804  12.25406  -6.06869
           6.12703  -6.25935   0.00000  -6.45000
           0.00000  69.00000  36.53200  69.00000  40.71863  68.29757  44.58248  66.52339
          48.02160  64.02071  50.91459  60.91023  53.63200  57.62700  53.63200  57.62700
          53.63195  57.62700  53.63195  57.62700  53.63195  57.62700  53.63198  57.62700
          53.63200  57.62700  84.00000  10.90000  84.00000  10.90000  84.00000  10.90000
          84.00000  10.90000  84.00000  10.90000  84.00000  10.90000  79.18884  10.85834
          74.37769  10.81665  69.56748  10.71604  64.75975  10.53213  60.00000  10.00000
          54.01861   9.61374  48.01805   9.46265  42.01642   9.36032  36.01444   9.28134
          30.01219   9.22596  24.00987   9.18284  18.00740   9.16213  12.00493   9.14142
           6.00247   9.12071   0.00000   9.10000
```

at X = 560.0

at X = 600.0

[Fuselage card set 7]

Sample Case 3 Input

```
COLUMN   1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
GEMPAK SAMPLE CASE 3  (FUSELAGE ONLY)
  1
FUSELAGE (LONGITUDINAL LOFTING, INC(1)=1)
600.               9   17   34 1 1 1 0 1 1 1 1 1 1 0
 0.        3.        50.       100.      128.      152.      164.      176.
 200.      250.      300.      350.      400.      460.      520.      560.
 600.
22      22          22      22          22      22          22      22
22  22  22          22  22  22          22  22  22          22  22  22
22  22  22          22  22  22          22  22  22          22  22  22
22  22  22          22  22  22          22  22  22          22  22  22
22  22  22
    1    5    1    5    1    5    5   10
 0.        0.        0.        0.        0.        0.        0.        0.
 0.        0.        0.        0.        0.        0.        0.        0.
 0.
 0.        3.        16.686    31.246    39.4      52.       56.       56.358
 57.073    58.564    60.055    61.546    63.037    64.826    66.615    67.807
 69.
 0.        0.        0.        0.        0.        0.        0.        0.
 0.        2.5       5.        7.5       10.       13.       16.       18.
 20.
 0.        3.        16.686    31.246    39.4      52.       56.       56.358
 57.073    58.564    60.055    61.546    63.037    64.826    66.615    67.807
 69.
 0.        0.        0.        0.        0.        0.        0.        0.
 0.        9.977     19.953    29.93     39.906    38.894    37.882    37.207
 36.532
 0.        3.        16.686    31.246    39.4      52.       56.       56.358
 57.073    58.564    60.055    61.546    63.037    64.826    66.615    67.807
 69.
 0.        0.        0.        0.        .549      1.868     2.6       4.99
 9.771     19.732    29.693    39.653    49.614    48.602    47.59     46.916
 46.241
 0.        3.        16.606    31.246    39.4      52.       56.       56.358
```

GEMPAK title card

GEMPAK geometry option card

Fuselage card set 1

Fuselage card set 2

Fuselage card set 3

Y coordinates
Z coordinates
for lofting line 1

Y coordinates
Z coordinates
for slope control line 1

Fuselage card set 5

Y and Z coordinates for lofting line 2

Y and Z coordinates for slope control line 2

```
COLUMN         1         2         3         4         5         6         7         8
      123456789012345678901234567890C12345678901234567890123456789012345678901234567890
       57.073    58.564    60.055    61.546    63.037    64.826    66.615    67.807
       69.
       0.        0.        0.        0.        1.059     3.6       5.488     8.444
       17.1      27.077    37.053    47.03     57.006    55.995    54.983    54.308
       53.632
       0.        3.        16.686    31.246    39.4      49.2      52.803    52.413      Lofting line 3
       45.7      47.192    48.683    50.174    51.665    53.454    55.243    56.435
       57.627
       0.        0.        0.        0.        1.0595    5.192     7.403     10.635
       17.1      27.077    37.053    47.03     57.006    55.995    54.983    54.308
       53.632
       0.        3.        16.686    31.246    39.4      45.035    47.429    46.853      Slope control line 3
       45.7      47.192    48.683    50.174    51.665    53.454    55.243    56.435
       57.627
       0.        0.        0.        0.        1.06      6.407     9.08      11.753
       17.1      27.077    37.053    47.03     57.006    55.995    54.983    54.308
       53.632
       0.        3.        16.686    31.246    39.4      41.5      42.55     43.6        Lofting line 4
       45.7      47.192    48.683    50.174    51.665    53.454    55.243    56.435
       57.627
       0.        1.725     3.119     4.602     5.433     9.322     11.267    13.211
       17.1      27.077    37.053    47.03     57.006    55.995    54.983    54.308
       53.632
       0.        3.        16.686    31.246    39.4      41.5      42.55     43.6        Slope control line 4
       45.7      47.192    48.683    50.174    51.665    53.454    55.243    56.435
       57.627
       0.        2.7       5.047     7.544     8.942     11.661    13.021    14.381
       17.1      27.077    37.053    47.03     57.006    55.995    54.983    54.308
       53.632                                                                         Lofting line 5
       0.        1.5       13.72     26.72     34.       37.9      39.85     41.8
       45.7      47.192    48.683    50.174    51.665    53.454    55.243    56.435
       57.627
       0.        2.7       10.703    19.218    23.986    28.072    30.116    32.159
       36.246    44.76     53.275    61.7d9    70.303    69.855    69.409    69.111      Slope control line 5
       68.816
```

Fuselage card
set 5

```
COLUMN         1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
       0.        1.5       5.016     8.757     10.852    12.648    13.546    14.444
       16.239    19.98     23.721    27.462    31.203    32.121    33.04     33.652
       34.264
       0.        2.7       12.278    22.466    28.172    33.063    35.508    37.954
       42.844    53.033    63.222    73.411    83.6      83.72     83.84     83.92
       84.
       0.        1.5       2.594     3.758     4.41      4.969     5.248     5.528
       6.087     7.251     8.415     9.579     10.743    10.79     10.837    10.869
       10.9
       0.        5.625     15.203    25.391    31.097    35.988    38.433    40.879
       45.769    55.958    66.147    76.336    86.525    85.768    85.01     84.505
       84.
       0.       -3.       -1.906    -.742     -.09       .469      .749     1.028
       1.587     2.751     3.915     5.079     6.243     7.64      9.037     9.969
       10.9
       0.        0.        9.589     19.791    25.504    30.401    32.849    35.297
       40.194    50.395    60.597    70.798    81.       81.9      82.8      83.4
       84.
       0.       -3.       -1.906    -.742     -.09       .469      .749     1.028
       1.587     2.751     3.915     5.079     6.243     7.64      9.037     9.969
       10.9
       0.        0.        9.263     19.116    24.635    29.364    31.729    34.094
       38.624    46.       55.741    61.665    64.482    65.159    65.837    63.082
       60.328
       0.       -3.       -1.906    -.742     -.09       .469      .749     1.028
       1.587     2.751     3.915     5.079     6.243     7.64      9.037     9.969
       10.9
       0.        0.        8.732     18.021    23.223    27.682    29.912    32.141
       36.6      45.194    52.314    57.611    60.       60.       60.       60.
       60.
       0.       -3.       -3.364    -3.75     -3.967    -4.153    -4.246    -4.338
      -4.524    -4.911    -5.298    -5.685    -6.072    -6.536    -7.        1.5
       10.
       0.        0.        8.236     16.997    21.904    26.109    28.212    30.315
       34.52     42.564    49.092    53.799    55.808    55.174    54.54     57.107
```

Lofting line 6

Slope control line 6

Lofting line 7

Slope control line 7

Lofting line 8

Fuselage card set 5

```
COLUMN         1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
        59.672
        0.        -3.       -4.727    -6.565    -7.594    -8.476    -8.917    -9.358
       -10.24     -12.077   -13.915   -15.752   -17.59    -19.795   -22.      -6.45
        9.1
        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.
        0.
        0.        -3.       -4.727    -6.565    -7.594    -8.476    -8.917    -9.358
       -10.24     -12.077   -13.915   -15.752   -17.59    -19.795   -22.      -6.45
        9.1
```

Slope control line 8

Lofting line 9

Fuselage card set 5

Sample Case 4 Input

```
COLUMN         1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
      GEMPAK SAMPLE CASE 4  (FUSELAGE ONLY)
        1
      FUSELAGE (CROSS-SECTIONAL LOFTING, INC(1)=3)
      600.               9   17   34 3 1 1 0 1 1 1 1 1 1 0
       0.        3.        50.       100.      128.      152.      164.      176.
       200.      250.      300.      350.      400.      460.      520.      560.
       600.
      22      22          22      22          22      22          22      22
      22  22  22          22  22  22          22  22  22          22  22  22
      22  22  22          22  22  22          22  22  22          22  22  22
      22  22  22          22  22  22          22  22  22          22  22  22
      22  22  22
          1    5    1    5    1    5    5   10
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.
       0.        3.        0.        3.        0.        3.        0.        3.
       0.        3.        0.        3.        0.        3.        1.725     3.
       2.7       1.5       2.7       1.5       2.7       1.5       5.625    -3.
       0.       -3.        0.       -3.        0.       -3.        0.       -3.
       0.       -3.
       0.        16.686    0.        16.686    0.        16.686    0.        16.686
       0.        16.686    0.        16.686    0.        16.686    3.119     16.686
       5.047     13.720    10.703    5.016     12.278    2.594     15.203   -1.906
       9.589    -1.906     9.263    -1.9 06    8.732    -3.364     8.236    -4.727
       0.       -4.727
       0.        31.246    0.        31.246    0.        31.246    0.        31.246
       0.        31.246    0.        31.246    0.        31.246    4.602     31.246
       7.544     26.720    19.218    8.757     22.466    3.758     25.391   -0.742
       19.791   -0.742     19.116   -0.742     18.021   -3.750     16.997   -6.565
       0.       -6.565
       0.        39.4      0.        39.4      0.        39.4      0.549     39.4
       1.059     39.4      1.0595    39.4      1.06      39.4      5.433     39.4
```

GEMPAK title card

GEMPAK geometry option card

Fuselage card set 1

Fuselage card set 2

Fuselage card set 3

Y and Z coordinates of
lofting lines 1-9 and
slope control lines 1-8
at X = 0.0

at X = 3.0

Fuselage card set 6

at X = 50.0

at X = 100.0

```
CCLUMN   1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 8.942     34.       23.986    10.852    28.172    4.410     31.097    -0.090
 25.504   -0.090     24.635   -0.090     23.223   -3.967     21.904   -7.594
 0.       -7.594
 0.        52.       0.        52.       0.        52.       1.868     52.
 3.6       49.2      5.192     45.035    6.407     41.5      9.322     41.5
 11.661    37.9      28.072    12.648    33.063    4.969     35.988    0.469
 30.401    0.469     29.364    0.469     27.682   -4.153     26.109   -8.476
 0.       -8.476
 0.        56.       0.        56.       0.        56.       2.600     56.
 5.468     52.803    7.403     47.429    9.080     42.55     11.267    42.550
 13.021    39.85     30.116    13.546    35.508    5.248     38.433    0.749
 32.849    0.749     31.729    0.749     29.912   -4.246     28.212   -8.917
 0.       -8.917
 0.        56.358    0.        56.358    0.        56.358    4.990     56.358
 8.444     52.413    10.635    46.853    11.753    43.6      13.211    43.6
 14.381    41.8      32.159    14.444    37.954    5.528     40.879    1.028
 35.297    1.028     34.094    1.028     32.141   -4.338     30.315   -9.358
 0.       -9.358
 0.        57.073    0.        57.073    0.        57.073    9.771     57.073
 17.1      45.7      17.1      45.7      17.1      45.7      17.1      45.7
 17.1      45.7      32.246    16.239    42.844    6.087     45.769    1.587
 40.194    1.587     38.824    1.587     36.6     -4.524     34.52    -10.240
 0.       -10.240
 0.        58.564    2.5       58.564    9.977     58.564    19.732    58.564
 27.077    47.192    27.077    47.192    27.077    47.192    27.077    47.192
 27.077    47.192    44.760    19.980    53.033    7.251     55.958    2.751
 50.395    2.751     48.000    2.751     45.194   -4.911     42.564   -12.077
 0.       -12.077
 0.        60.055    5.0       60.055    19.953    60.055    29.693    60.055
 37.053    48.683    37.053    48.683    37.053    48.683    37.053    48.683
 37.053    48.683    53.275    23.721    63.222    8.415     66.147    3.915
 60.597    3.915     55.741    3.915     52.314   -5.298     49.092   -13.915
 0.       -13.915
 0.        61.546    7.5       61.546    29.930    61.546    39.653    61.546
 47.030    50.174    47.030    50.174    47.030    50.174    47.030    50.174
```

at X = 125.0

at X = 152.0

at X = 164.0

at X = 176.0

at X = 200.0

at X = 250.0

at X = 300.0

Fuselage card set 6

APPENDIX C

```
COLUMN           1         2         3         4         5         6         7         8
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
        47.030    50.174    61.789    27.462    73.411    9.579     76.336    5.079
        70.798    5.079     61.665    5.079     57.611   -5.685     53.799   -15.752
        0.       -15.752
        0.        63.037    10.0      63.037    39.906    63.037    49.614    63.037
        57.006    51.665    57.006    51.665    57.006    51.665    57.006    51.665
        57.006    51.665    70.303    31.203    83.6      10.743    86.525    6.243
        81.       6.243     64.482    6.243     60.      -6.072     55.808   -17.590
        0.       -17.590
        0.        64.826    13.0      64.826    38.894    64.826    48.602    64.826
        55.995    53.454    55.995    53.454    55.995    53.454    55.995    53.454
        55.995    53.454    69.855    32.121    83.72     10.79     85.768    7.640
        81.9      7.640     65.159    7.640     60.      -6.536     55.174   -19.795
        0.       -19.795
        0.        66.615    16.0      66.165    37.882    66.615    47.590    66.615
        54.983    55.243    54.983    55.243    54.983    55.243    54.983    55.243
        54.983    55.243    69.409    33.040    83.846    10.837    85.010    9.037
        82.8      9.037     65.837    9.037     60.      -7.        54.54    -22.
        0.       -22.
        0.        67.807    18.0      67.807    37.207    67.807    46.916    67.807
        54.308    56.435    54.308    56.435    54.308    56.435    54.308    56.435
        54.308    56.435    69.111    33.652    83.92     10.869    84.505    9.969
        83.4      9.969     63.082    9.969     60.       1.5       57.107   -6.45
        0.       -6.45
        0.        69.       20.       69.       36.532    69.       46.241    69.
        53.632    57.627    53.632    57.627    53.632    57.627    53.632    57.627
        53.632    57.627    68.816    34.264    84.       10.90     84.       10.9
        84.       10.9      60.328    10.9      60.       10.       59.672     9.1
        0.        9.1
```

at X = 350.0

at X = 400.0

at X = 460.0

at X = 520.0

at X = 560.0

at X = 600.0

Fuselage card set 6

Sample Case 5 Input

```
COLUMN          1         2         3         4         5         6         7         8
       12345678901234567890123456789012345678901234567890123456789012345678901234567890
       GEMPAK SAMPLE CASE 5  (FUSELAGE ONLY)
         1
       FUSELAGE WITH AUXILIARY GEOMETRY, INC(4)=1
         600.                9   17   34 0 1 1 1 1 1 1 1 1 1 1
        0.        3.        50.       100.      128.      152.      164.      176.
        200.      250.      300.      350.      400.      460.      520.      560.
        600.
       22      22          22      22          22      22          22      22
       22  22  22          22  22  22          22  22  22          22  22  22
       22  22  22          22  22  22          22  22  22          22  22  22
       22  22  22          22  22  22          22  22  22          22  22  22
       22  22  22
           1    5    1    5    1    5    5   10
        1  2       0.        0.
        0  1  1    600.      0.
        2  6       0.        0.
        0  1  1    3.        3.
        0  1  1    128.
        0  1  1
        0  1
        0
        1
                             0.
                             0.
                   200.      34.52         1                       .17523
                   400.      55.608     1     0.
              1    520.      54.54
           8  1    600.      59.672
           4       0.        0.
        1  8  1    3.       -3.
        1  8  1    520.     -22.
        1  8  1    600.      9.1
         7  429.18    517.30         39.92
         3 1 429.18   39.92
         1 1 517.30   40.49
         2 1 600.00   40.49
```

GEMPAK title card

GEMPAK geometry option card

Fuselage card set 1

Fuselage card set 2

Fuselage card set 3

Fuselage card set 4
(Same as for sample case 1)

Fuselage card set 8

Sample Case 5 Output

```
                    GEMPAK - RAPID AIRCRAFT GEOMETRY GENERATION FOR ENGINEERING DESIGN

                    CASE TITLE - GEMPAK SAMPLE CASE 5  (FUSELAGE ONLY)

                    GEOMETRY OPTIONS CHOSEN

                        1  FUSELAGE

*************************
* E N T E R   F U S 2 *
*************************


FUSELAGE WITH AUXILIARY GEOMETRY, INC(4)=1
COEFFS FOR PROJECTICN OF LOFTING CURVE NO.  1 BETWEEN X=     0.0000 AND X=   600.0000 ON THE X-Y PLANE
ST LINE     A=  0.             B=  0.             C=  0.             D=  0.             E=  -.60000E+03   F=  0.             SG=  1.
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  1 BETWEEN X=     0.0000 AND X=     3.0000 ON THE X-Z PLANE
ST LINE     A=  0.             B=  0.             C=  0.             D=   .30000E+01   E=  -.30000E+01   F=  0.             SG=  1.
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  1 BETWEEN X=     3.0000 AND X=   128.0000 ON THE X-Z PLANE
ST LINE     A=  0.             B=  0.             C=  0.             D=   .36400E+02   E=  -.12500E+03   F=   .26580E+03
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  1 BETWEEN X=   128.0000 AND X=   152.0000 ON THE X-Z PLANE
ST LINE     A=  0.             B=  0.             C=  0.             D=   .12600E+02   E=  -.24000E+02   F=
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  1 BETWEEN X=   152.0000 AND X=   164.0000 ON THE X-Z
ELLIPSE     A=   .34706E+01   B=  -.94118E+01   C=   .99636E+01   D=  -.61299E+03   E=
COEFFS FOR PROJECTION OF LOFTING CURVE NO.  1 BETWEEN X=   164.0000 AND X=   600.
ST LINE     A=  0.             B=  0.             C=  0.
COEFFS FOR PROJECTION
ST LINE     A
COEFFS FOR
ST LINE
COEFF
ST
CO
                                                                                                 .32526264E+03
                                                          .19480709E+05      .47571503E+06      .37526835E+03
           E+05      .10338341E+05
                                                          .24611786E+05      .63139752E+06      .43007400E+03
     0000E+03        .10708298E+05
                                                          .24819693E+05      .65352504E+06      .49007660E+03
 .52000000E+03       .11075993E+05
                                                          .16595413E+05      .40952801E+06      .53991884E+03
 .56000000E+03       .93990751E+04
                                                          .16179709E+05      .34248122E+06      .57998535E+03
 .60000000E+03       .77210649E+04
```

(Same as for sample case 1)

```
LIST OF THE BOTTOM   8  FUSELAGE POINTS AT X=   429.1800


   YF              ZF

   0.0000        -18.6623
   6.2624        -18.3550
  12.5247        -18.0476
  18.7871        -17.7402
  25.0494        -17.4315
  31.2684
  37.4635
  39.920



          THE    8  ENGINE/NOZZLE POINTS AT X=   600.0000


    YE              ZE              RUNL

   0.0000         9.1000         638.2649
   5.7844         9.1200         636.1849
  11.5698         9.1399         638.2128
  17.3532         9.1599         638.3484
  23.1375         9.1798         638.5812
  28.9218         9.2181         638.7889
  34.7006         9.2693         639.0029
  40.4900         9.3402         639.2459


 SKIN FRICTION LENGTHS


   FLOI           SOIL

  595.3487       42.9162
  595.4117       42.8584
  595.6041       42.8011
  595.6931       42.7443
  596.2151       42.6881
  596.5793       42.5739
  597.0092       42.4236
THERE ARE  6 TOTAL CROSS-SECTIONS DEFINING ENGINE/NOZZLE CUTOUT
***********************
* E X I T   F U S 2 *
***********************
```

Sample Case 5 Output (TAPE38)

```
$FUSE
        (Same as for sample case 1)
$END
```

```
$ENGHOL
XE      = .42918E+03, .46E+03, .5173E+03, .52E+03, .56E+03, .6E+03, 0.0, 0.0,   0.0, 0.0, 0.0, 0
          0.0, 0.0, 0.0, 0.C, 0.0,
YE      = .39919999999999E+02, .40119357694053E+02, .40489999999999E+02,        .40489999999999E
          .4049E+02. 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,      0.0, 0.0, 0.0, .3
          .34457456357181E+02, .34799270328902E+02, .34800290079576E+02,         .34730408320422E
          0.0, C.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .28600393612866E+
          .29058566232E6E+02, .29060096982805E+02, .28955890774422E+02,          .28921830862868E
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,                 .22899751396979E
          .2327
          0.0,
          .1745
          0.0,
          .1163
          0.C,
          .5819
          0.0,
          0.0,
          0.0,
          0.0,
```

```
ZE      = -.15192116454114E+02, -.16012123317715E+02, -.17504453238301E+02,      -.1757
          .93402348924693E+01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,     0.0, 0
          -.17C90939055439E+02, -.18760342053d9E+02, -.18841881841732E+02,       -.4864
          0.0, 0.0, 0.0, 0.0, 0.0, C.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.1697
          -.19772806059143E+02, -.19859886263l9E+02, -.53604457796917E+01,       .92181
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,                 -.1753
          -.204
          0.0,
          -.208
          0.0,
          -.212
          0.0,
          -.215
          0.0,
          -.219
```

```
FLOI    = .46398479865055E+03, .49481634993728E+03, .55213697819893E+03,
          .63924590460313E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          .49418092C04587E+03, .55150625251906E+03, .55420748367853E+03,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.
          .55096668586972F+03, .55366809017938E+03, .59621505991012E+03,
          0.0, 0.0, 0.0, G.0, 0.G, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          .5505
          0.0,
          .5501
          0.0,
          .5499
          0.0,
```

```
SOIL    = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
          .57325332473195E+02, .27012311594 71E+01, .42371822542728E+
          0.0, 0.0, 0.0, 0.0, C.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
          .27017534574273E+01, .42855312003601E+02, .42858403155602E
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .30840805693162E+02,
          .42916226534 96E+02, .42916226534 96E+02, 0.0, 0.0, 0.0, 0.0
          0.0,
          0.0,
          0.0,
```

```
NESEG   = 7,
IXT     = 6,
$END
```

```
$CONST
        (Same as for sample case 1)
$END
```

XE,YE,ZE: X, Y, and Z coordinates of engine hole geometry
FLOI: Longitudinal lengths up to element of interest
SOIL: Lengths of element sides in longitudinal direction
NESEG: Number of segments in each cross section
IXT: Number of cross sections

Sample Case 6 Input

```
COLUMN            1         2         3         4         5         6         7         8
         12345678901234567890123456789012345678901234567890123456789012345678901234567890
         GEMPAK SAMPLE CASE 6  (WING ONLY - MANUAL INPUT)
           2
          $WING
               IHPUT=2, NYU=4, NXU=9, XW1=237.7, ZBR=-35.217, THETA=30., ALPHA=-1.,
               XROTAT=600., REFLW=600.,
          $END WING (SAMPLE CASE 6)
         0.
         0.        50.5      101.      151.5     202.      252.5     303.
         353.5     404.
         0.        10.6265   18.1963   22.7301   24.24     22.7301   18.1963
         10.6265   0.
         0.        0.        0.        0.        0.        0.        0.
         0.        0.
         55.9067
         94.4954   133.3097  172.1240  210.9383  249.7526  288.5669  327.3812
         366.1955  405.0098
         0.        8.1675    13.9857   17.4704   18.6309   17.4704   13.9857
         8.1675    0.
         0.        0.        0.        0.        0.        0.        0.
         0.        0.
         111.8133
         188.9907  216.1193  243.2479  270.3765  297.5051  324.6337  351.7623
         378.8909  406.0195
         0.        5.7085    9.7751    12.2106   13.0217   12.2106   9.7751
         5.7085    0.
         0.        0.        0.        0.        0.        0.        0.
         0.        0.
         167.72
         283.4861  298.9290  314.3719  329.8148  345.2577  360.7006  376.1435
         391.5864  407.0293
         0.        3.2496    5.5644    6.9509    7.4126    6.9509    5.5644
         3.2496    0.
         0.        0.        0.        0.        0.        0.        0.
         0.        0.
```

GEMPAK title card

GEMPAK geometry option card

Namelist input for wing

Chord station 1

X coordinates at Y = 0

Upper surface Z coordinates at Y = 0

Lower surface Z coordinates at Y = 0

Chord station 2

Coordinates at Y = 55.9067

Chord station 3

Coordinates at Y = 111.8133

Chord station 4

Coordinates at Y = 167.72

Wing manual input

Sample Case 7 Input

```
COLUMN     1         2         3         4         5         6         7         8
  12345678901234567890123456789012345678901234567890123456789012345678901234567890
  GEMPAK SAMPLE CASE 7  (WING ONLY - ARBITRARY AIRFOIL, ICHRD=3)
    2
   $WING
       CRW=404., BW=335.44, SWEOB=59.39, TRW=.3058, NYU=4, NXU=9, ICHRD=3,
       NPCU=9, NPCL=2, XW1=237.7, ZBR=-35.217, THETA=30., ALPHA=-1., XROTAT=600.,
   $END WING (SAMPLE CASE 7)
  0.        .125      .25       .375      .5        .625      .75
  .875      1.0
  0.        .0263     .0450     .05626    .06       .05626    .0450
  .0263     0.
  0.        1.
  0.        0.
```

GEMPAK title card

GEMPAK geometry option card

Namelist input for wing

X coordinates of upper surface*

Z coordinates of upper surface

X coordinates of lower surface

Z coordinates of lower surface

Arbitrary airfoil input

---

*All coordinates are input as a fraction of chord length.

Sample Case 8 Input

```
COLUMN         1         2         3         4         5         6         7         8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
      GEMPAK SAMPLE CASE 8  (WING ONLY WITH DEFLECTED FLAP, ICON=1)
        2
       $WING
            CRW=404., BW=335.44, SWEDB=59.39, TRW=.3058, NYU=4, NXU=9, ICHRD=2,
            TWRD=.06, TCD=.03, XW1=237.70, ZBR=-35.217,  IPRNT=3,
            IMERGE=0, IRADE=1, RADE=.75, XROTAT=600.,
            ICON=1, XCOR=.75, XCOT=.75, DELFU=20., DELFL=20., IFLAP=1,
       $END WING (SAMPLE CASE 8)
```

GEMPAK title card

GEMPAK geometry option card

Same as for sample 1, but with an elevon deflected 20°

Sample Case 8 Output

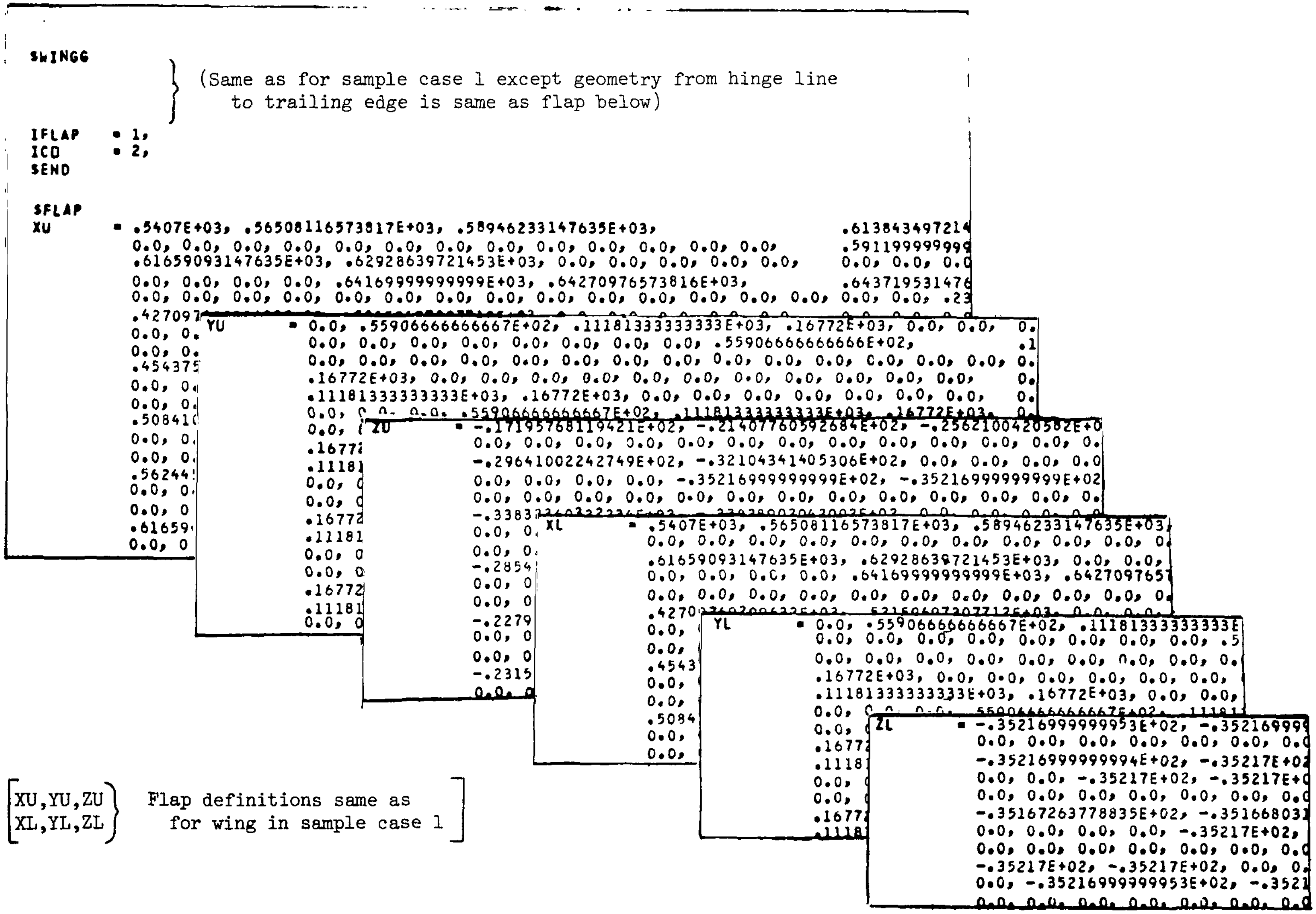
```
                    GEMPAK - RAPID AIRCRAFT GEOMETRY GENERATION FOR ENGINEERING DESIGN


                    CASE TITLE - GEMPAK SAMPLE CASE 8  (WING ONLY WITH DEFLECTED FLAP, ICON=1)

                    GEOMETRY OPTIONS CHOSEN

                         2  WING




*************************** 
* E N T E R   W I N G E X *
***************************
```

(Same as for sample case 1)

```
          BASIC GEOMETRY AFTER CONTROL SURFACE GENERATION.  THE HINGELINE IS AT POSITION 12

           PT        XU          YU          ZU           PT        XL          YL          ZL

CHORD  1
            1     0.0000      0.0000       .6686           1     0.0000      0.0000       .6686
            2      .0492      0.0000       .9413           2      .0492      0.0000       .4072
            3      .1902      0.0000      1.1896           3      .1902      0.0000       .1914
            4      .4046      0.0000      1.3609           4      .4046      0.0000       .0495
            5      .6643      0.0000      1.4902           5      .6643      0.0000      0.0000
            6    51.0536      0.0000     11.5928           6    51.0536      0.0000       .0000
            7   101.4429      0.0000     18.7396           7   101.4429      0.0000       .0000
            8   151.8322      0.0000     22.9489           8   151.8322      0.0000       .0000
            9   202.2214      0.0000     24.2313           9   202.2214      0.0000
           10   252.6107      0.0000     22.5902          10   252.6107      0.00
           11   303.0000      0.0000     18.0212          11   303.0000
           12   353.5000       .0000     10.4964          12   353.
           13   404.0000       .0000       .0000          13
CHORD  2
            1    94.4954     55.9067       .6696
                 94.5446     55.9067       .94
                 94.6860     55.9067
                   9008      55.
```

```
      629.2864   167.7200   -32.1043                               167.7200   -35.2170
   13   644.7293   167.7200   -35.2170        13   644.7293   167.7200   -35.2170


    LEADING EDGE  FINE DETAIL HAS BEEN TAKEN FROM CHORD NO. 2
          XLE              ZLEU             ZLEL                 XLE              ZLEU             ZLEL
  1    0.00000000        .00215650        .00215650     2     .00100000        .00426784        .00027263
  3     .00207778        .00478821       -.00000311     4     .00323940        .00525377       -.00020562
  5     .00449137        .00576698       -.00043603     6     .00584072        .00631396       -.00067904
  7     .00729503        .00689635       -.00093475     8     .00886245        .00751574       -.00120318
  9     .01055180        .00817367       -.00148413    10     .01237255        .00887158       -.00177724
 11     .01433492        .00961077       -.00208188    12     .01644993        .01039235       -.00239714
 13     .01872945        .01121718       -.00272171    14     .02118627        .01208578       -.00305388
 15     .02383420        .01299827       -.00339137    16     .02668809        .01395423       -.00373129
 17     .02976396        .01495260       -.00406997    18     .03307908        .01599152       -.00440285
 19     .03665206        .01706813       -.00472428    20     .04050296        .01817842       -.00502732
 21     .04465339        .01931689       -.00530356    22     .04912666        .02047634       -.00554274
 23     .05394786        .02164750       -.00573253    24     .05914407        .02281857       -.00585811
 25     .06474446        .02397481       -.00590170    26     .07078046        .02509797       -.00584212
 27     .07728596        .02616557       -.00565409    28     .08429747        .02715020       -.00530764
 29     .09185436        .02801859       -.00476719    30     .09999904        .02873051       -.00399065


       FLAP GENERATED GEOMETRY

       PT         XU          YU          ZU            PT         XL          YL          ZL


 CHORD  1
        1    540.7000      0.0000    -17.1958          1    540.7000      0.0000    -35.2170
        2    591.2000      0.0000    -24.7206          2    591.2000      0.0000    -35.2170
        3    641.7000      0.0000    -35.2170          3    641.7000      0.0000    -35.2170
 CHORD  2
        1    565.0812     55.9067    -21.4078          1    565.0812     55.9067    -35.2170
        2    603.8955     55.9067    -27.1804          2    603.8955     55.9067    -35.2170
        3    642.7098     55.9067    -35.2170          3    642.7098     55.9067    -35.2170
 CHORD  3
        1    589.4623    111.8133    -25.6210          1    589.4623    111.8133    -35.2170
        2    616.5909    111.8133    -29.6410          2    616.5909    111.8133    -35.2170
        3    643.7195    111.8133    -35.2170          3    643.7195    111.8133    -35.2170
 CHORD  4
        1    613.8435    167.7200    -29.8387          1    613.8435    167.7200    -35.2170
        2    629.2864    167.7200    -32.1043          2    629.2864    167.7200    -35.2170
        3    644.7293    167.7200    -35.2170          3    644.7293    167.7200    -35.2170
************************
* E X I T   W I N G E X *
************************
```

Sample Case 8 Output (TAPE28)



```
$WINGG
              (Same as for sample case 1 except geometry from hinge line
                 to trailing edge is same as flap below)
IFLAP    = 1,
ICO      = 2,
$END

$FLAP
XU       = .5407E+03, .56508116573817E+03, .58946233147635E+03,                        .613843497214
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,           .591199999999
           .61659093147635E+03, .62928639721453E+03, 0.0, 0.0, 0.0, 0.0, 0.0,          0.0, 0.0, 0.0
           0.0, 0.0, 0.0, 0.0, .64169999999999E+03, .64270976573816E+03,               .643719531476
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .23
           .427097
           0.0, 0.
           0.0, 0.
           .454375
           0.0, 0.
           0.0, 0.
           .508410
           0.0, 0.
           0.0, 0.
           .56244
           0.0, 0.
           0.0, 0
           .61659
           0.0, 0
```

```
YU       = 0.0, .55906666666667E+02, .11181333333333E+03, .16772E+03, 0.0, 0.0,  0.
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .55906666666666E+02,          .1
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, C.0, 0.0, 0.0, 0.
           .16772E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,    0.
           .11181333333333E+03, .16772E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,   0.
           0.0,
           0.0,
           .1677
           .1118
           0.0,
           0.0,
           .16772
           .11181
           0.0, 0
           0.0, 0
           .16772
           .11181
           0.0, 0
```

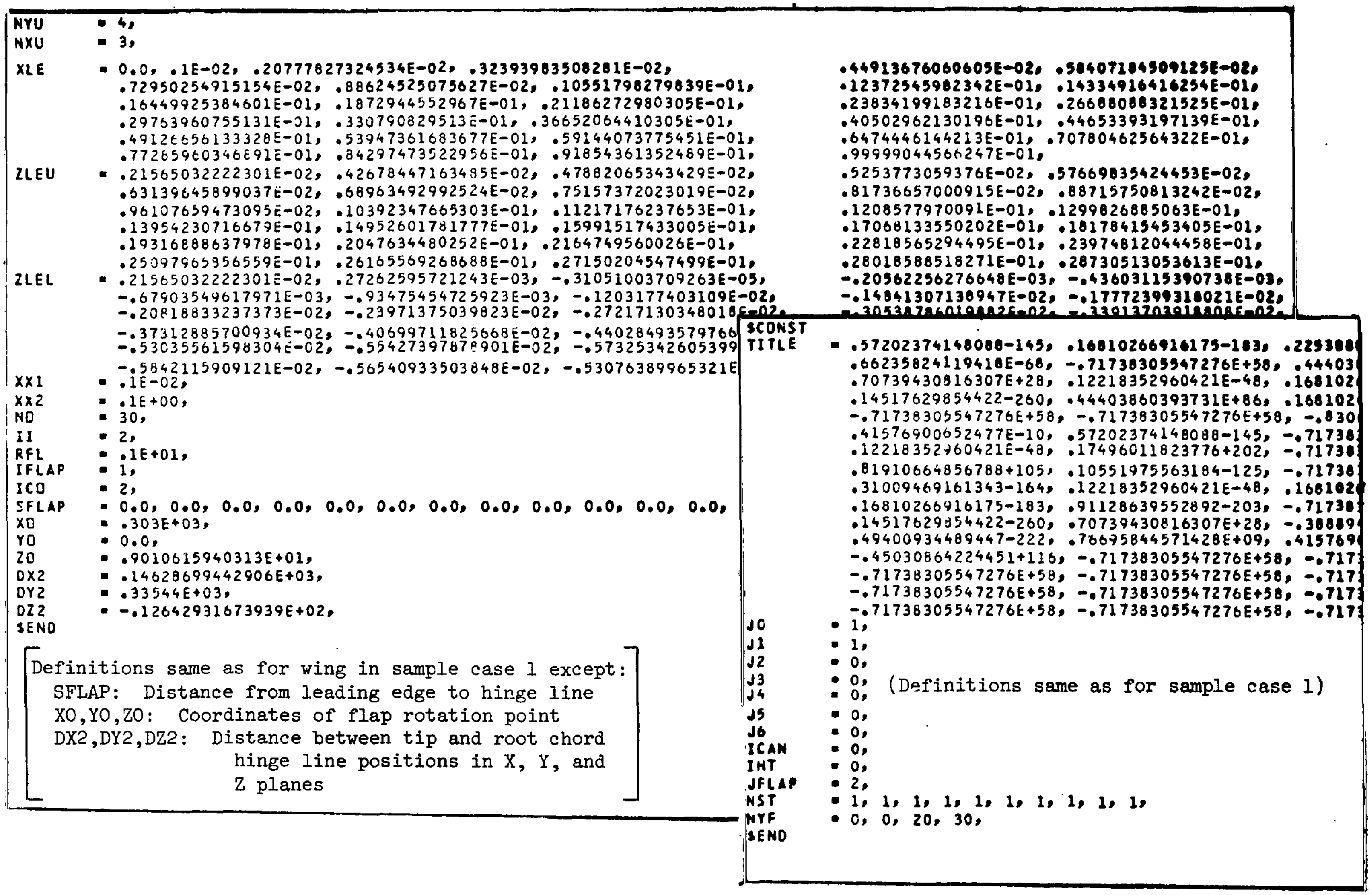
```
ZU       = -.17195768119421E+02, -.21407760592684E+02, -.25621004205B2E+0
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.
           -.29641002242749E+02, -.32104341405306E+02, 0.0, 0.0, 0.0, 0.0
           0.0, 0.0, 0.0, 0.0, -.35216999999999E+02, -.35216999999999E+02
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.
           -.3383
           0.0, 0.
           0.0, 0.
           -.2854
           0.0, 0
           0.0, 0
           -.2279
           0.0, 0
           0.0, 0
           -.2315
```

```
XL       = .5407E+03, .56508116573817E+03, .58946233147635E+03,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0
           .61659093147635E+03, .62928639721453E+03, 0.0, 0.0,
           0.0, 0.0, 0.C, 0.0, .64169999999999E+03, .642709765
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0
           .4270
           0.0,
           0.0,
           .4543
           0.0,
           0.0,
           .5084
           0.0,
           0.0,
```

```
YL       = 0.0, .55906666666667E+02, .11181333333333E
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .5
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, n.0, 0.0, 0.
           .16772E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           .11181333333333E+03, .16772E+03, 0.0, 0.0,
           0.0,
           0.0,
           .1677
           .1118
           0.0,
           0.0,
           .1677
```

```
ZL       = -.35216999999953E+02, -.35216999
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
           -.35216999999994E+02, -.35217E+02
           0.0, 0.0, -.35217E+02, -.35217E+0
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
           -.35167263778835E+02, -.35166803
           0.0, 0.0, 0.0, 0.0, -.35217E+02,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
           -.35217E+02, -.35217E+02, 0.0, 0.
           0.0, -.35216999999953E+02, -.3521
```

[XU,YU,ZU / XL,YL,ZL] Flap definitions same as for wing in sample case 1



```
NYU      = 4,
NXU      = 3,
XLE      = 0.0, .1E-02, .20777827324534E-02, .32393983508281E-02,          .44913676060605E-02, .58407184509125E-02,
           .72950254915154E-02, .88624525075627E-02, .10551798279839E-01,   .12372545982342E-01, .14334916416254E-01,
           .16449925384601E-01, .18729445529679E-01, .21186272980305E-01,   .23834199183216E-01, .26688088321525E-01,
           .29763960755131E-01, .33079082951 3E-01, .36652064410305E-01,    .40502962130196E-01, .44653393197139E-01,
           .49126656133328E-01, .53947361683677E-01, .59144073775451E-01,   .64744461442l3E-01, .70780462564322E-01,
           .77265960346891E-01, .84297473522956E-01, .91854361352489E-01,   .99999044566247E-01,
ZLEU     = .21565032222301E-02, .42678447163485E-02, .47882065343429E-02,   .52537730593 76E-02, .57669835424453E-02,
           .63139645899037E-02, .68963492992524E-02, .75157372023019E-02,   .81736657000915E-02, .88715750813242E-02,
           .96107659473095E-02, .10392347665303E-01, .11217176237653E-01,   .12085779700 91E-01, .12998268850 63E-01,
           .13954230716679E-01, .14952601781777E-01, .15991517433005E-01,   .17068133550202E-01, .18178415453405E-01,
           .19316888637978E-01, .20476344802 52E-01, .2164749560026E-01,    .22818565294495E-01, .23974812044458E-01,
           .25097965956559E-01, .26165569268688E-01, .27150204547499E-01,   .28018588518271E-01, .28730513053613E-01,
ZLEL     = .21565032222301E-02, .27262595721243E-03, -.31051003709263E-05,  -.20562256276648E-03, -.43603115390738E-03,
           -.67903549617971E-03, -.93475454725923E-03, -.1203177403109E-02, -.14841307138947E-02, -.17772399318021E-02,
           -.20818833237373E-02, -.23971375039823E-02, -.27217130348018E-02, -.30538786019882E-02, -.33913703918808E-02,
           -.37312885700934E-02, -.40699711825668E-02, -.44028493579766
           -.53035561598304E-02, -.55427397878901E-02, -.57325342605399
           -.5842115909121E-02, -.56540933503848E-02, -.53076389965321E
XX1      = .1E-02,
XX2      = .1E+00,
NO       = 30,
II       = 2,
RFL      = .1E+01,
IFLAP    = 1,
ICO      = 2,
SFLAP    = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
XO       = .303E+03,
YO       = 0.0,
ZO       = .9010615940313E+01,
DX2      = .14628699442906E+03,
DY2      = .33544E+03,
DZ2      = -.12642931673939E+02,
$END
```

Definitions same as for wing in sample case 1 except:
SFLAP: Distance from leading edge to hinge line
XO,YO,ZO: Coordinates of flap rotation point
DX2,DY2,DZ2: Distance between tip and root chord hinge line positions in X, Y, and Z planes

```
$CONST
TITLE    = .57202374148088-145, .16810266916175-183, .22538
           .66235824119418E-68, -.71738305547276E+58, .44403
           .70739430816307E+28, .12218352960421E-48, .168102
           .14517629854422-260, .44403860393731E+86, .168102
           -.71738305547276E+58, -.71738305547276E+58, -.830
           .41576900652477E-10, .57202374148088-145, -.71738
           .12218352960421E-48, .17496011823776+202, -.71738
           .81910664856788+105, .10551975563184-125, -.71738
           .31009469161343-164, .12218352960421E-48, .168102
           .16810266916175-183, .91128639552892-203, -.71738
           .14517629854422-260, .70739430816307E+28, -.38889
           .49400934489447-222, .76695844571428E+09, .415769
           -.45030864224451+116, -.71738305547276E+58, -.717
           -.71738305547276E+58, -.71738305547276E+58, -.717
           -.71738305547276E+58, -.71738305547276E+58, -.717
           -.71738305547276E+58, -.71738305547276E+58, -.717
J0       = 1,
J1       = 1,
J2       = 0,
J3       = 0,
J4       = 0,
J5       = 0,
J6       = 0,
ICAN     = 0,
IHT      = 0,
JFLAP    = 2,
NST      = 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
NYF      = 0, 0, 20, 30,
$END
```

(Definitions same as for sample case 1)

REFERENCES

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2. Weidner, J. P.; Small, W. J.; and Penland, J. A.: Scramjet Integration on Hypersonic Research Airplane Concepts. AIAA Paper No. 76-755, July 1976.

3. Hypersonic Arbitrary-Body Aerodynamic Computer Program (Mark III Version). Rep. DAC 61552, Vols. I and II (Air Force Contract Nos. F33615 67 C 1008 and F33615 67 C 1602), McDonnell Douglas Corp., Apr. 1968.
   Gentry, Arvel E.: Volume I - User's Manual. (Available from DDC as AD 851 811.)
   Gentry, Arvel E.; and Smyth, Douglas N.: Volume II - Program Formulation and Listings. (Available from DDC as AD 851 812.)

4. Edwards, C. L. W.; Small, W. J.; Weidner, J. P.; and Johnston, P. J.: Studies of Scramjet/Airframe Integration Techniques for Hypersonic Aircraft. AIAA Paper No. 75-58, Jan. 1975.

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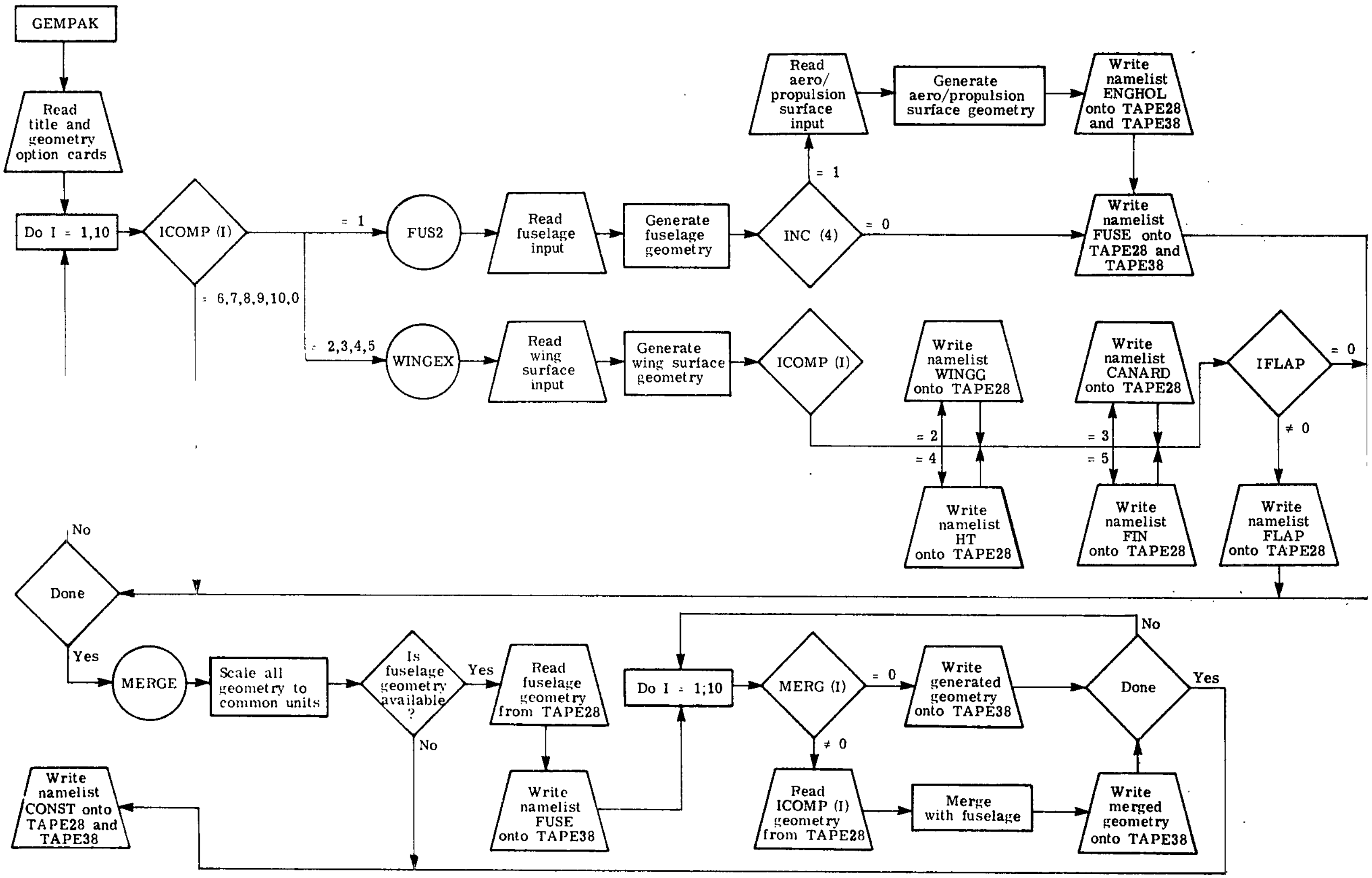
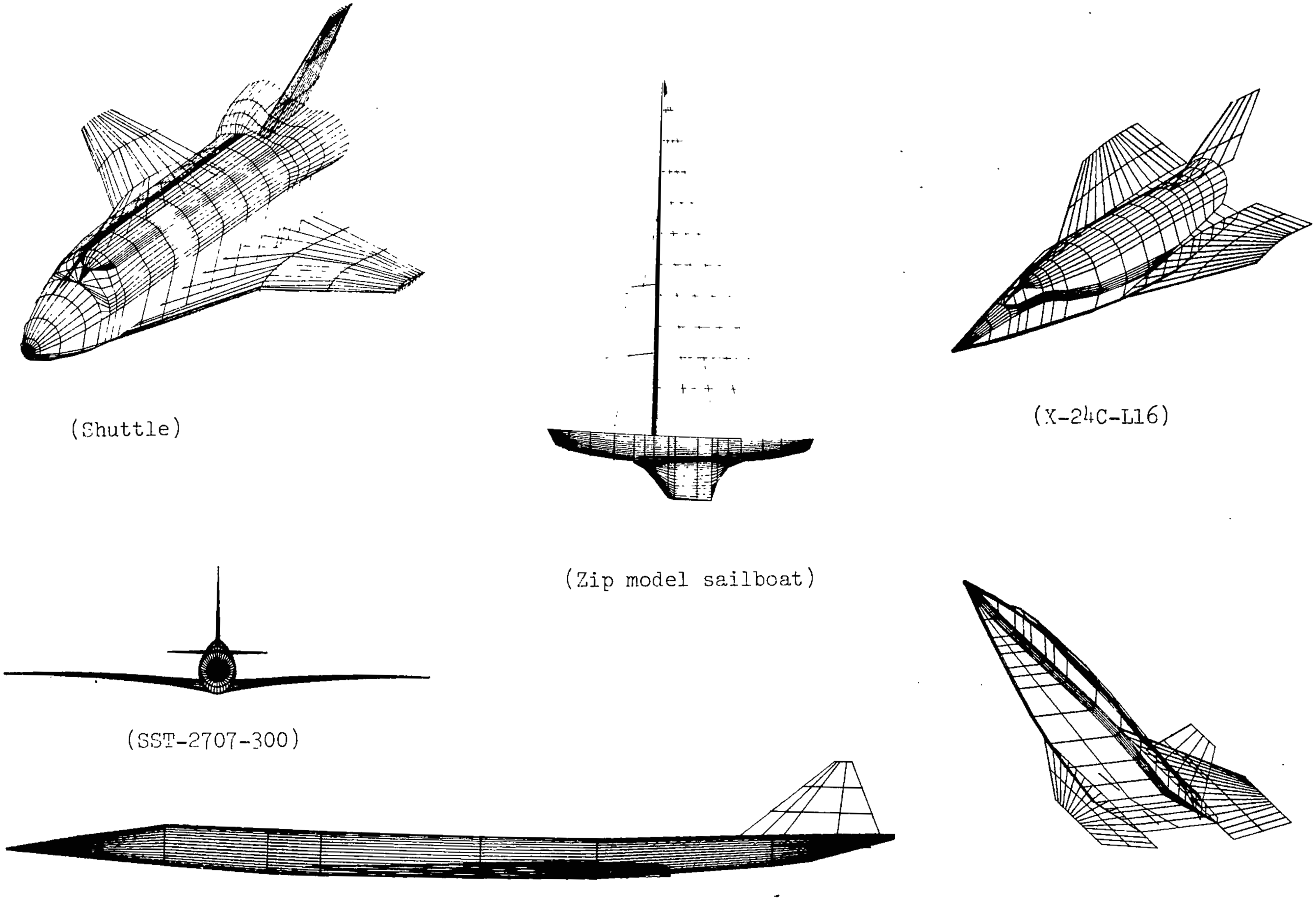


Figure 1.- Basic logic flow of GEMPAK.



(Shuttle)

(X-24C-L16)

(Zip model sailboat)

(SST-2707-300)

Figure 2.- Examples of GEMPAK-generated geometries.

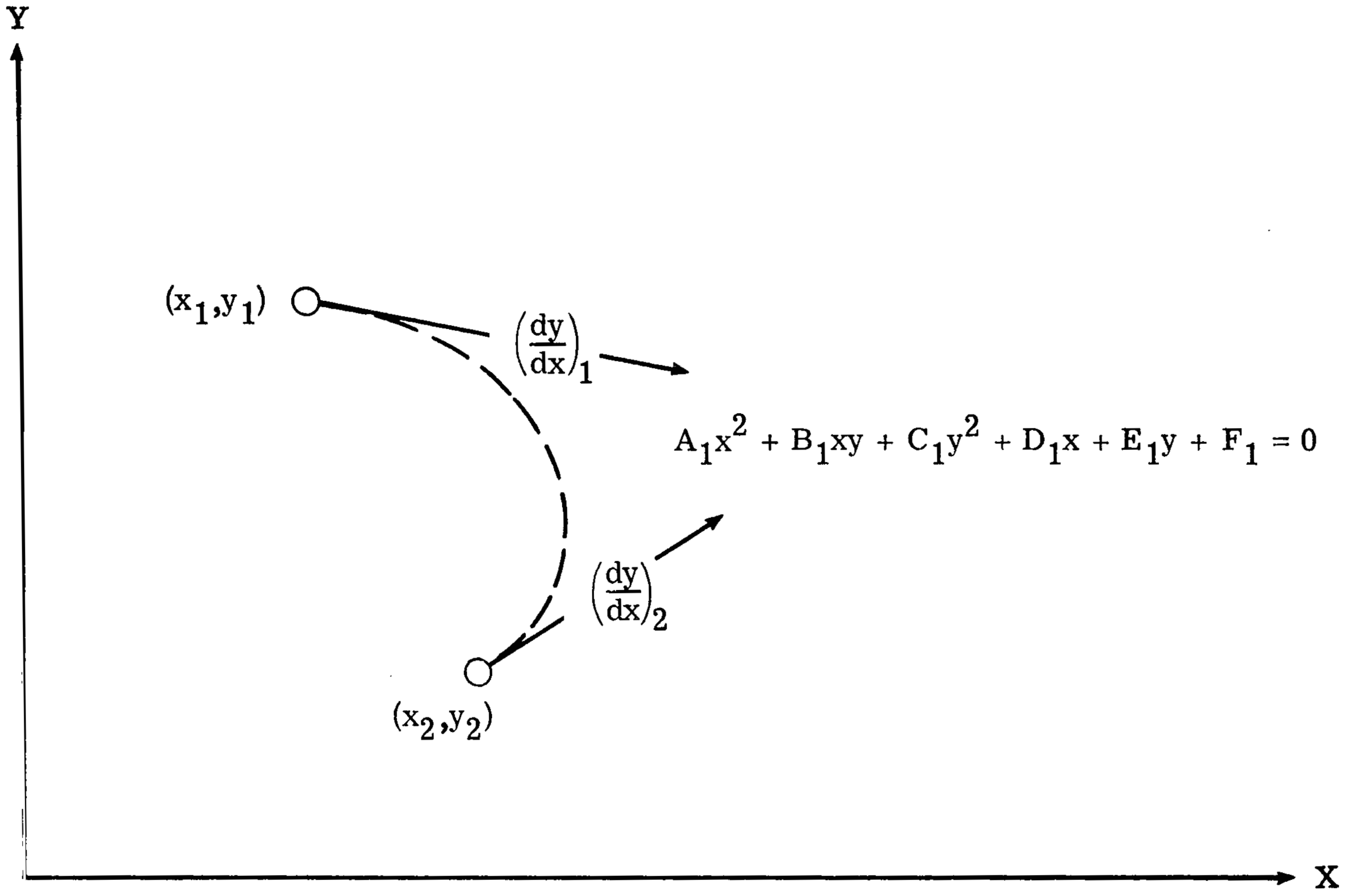


Figure 3.- Fuselage: initial conditions required to fit second-degree conic segment.

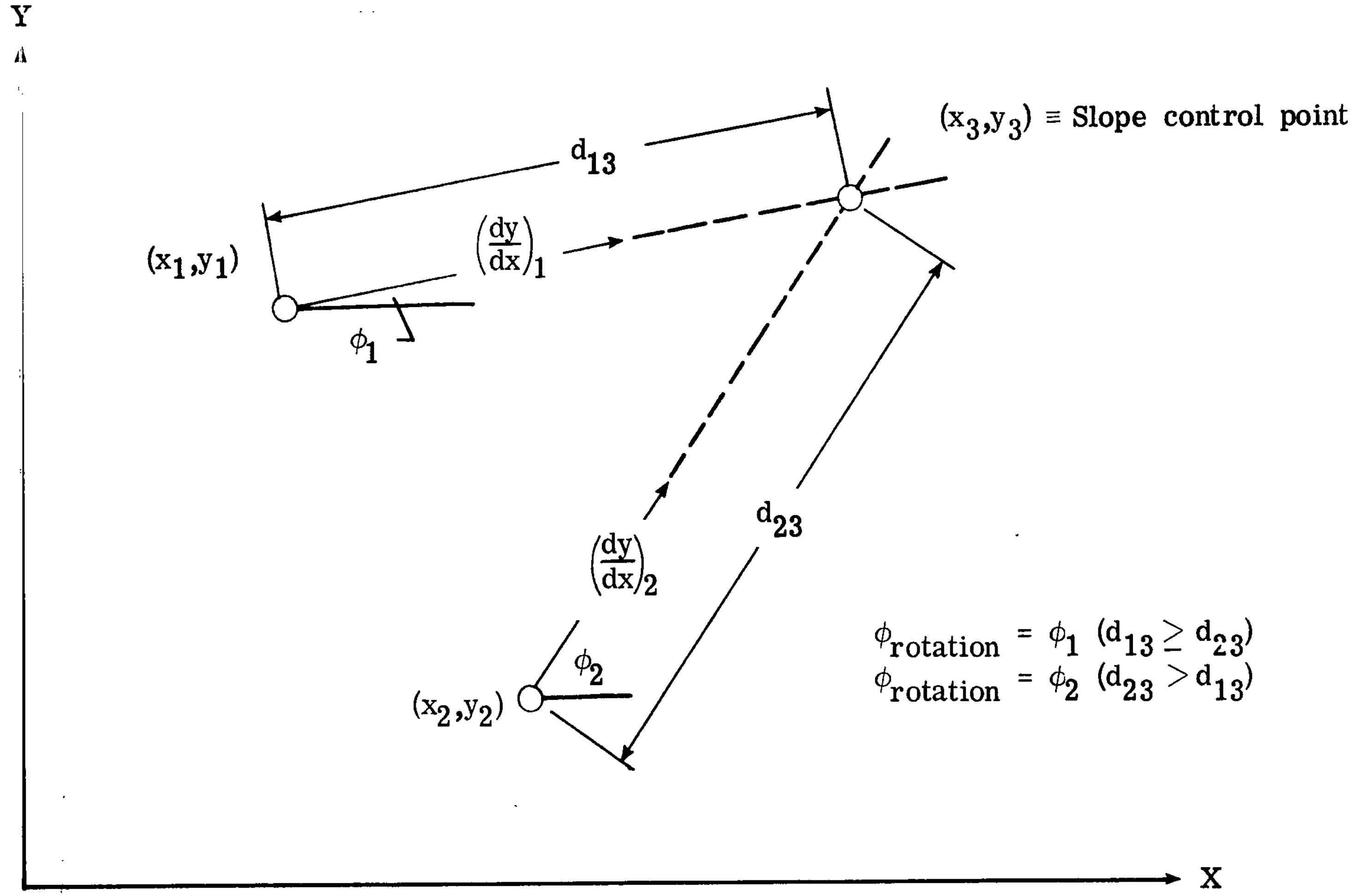
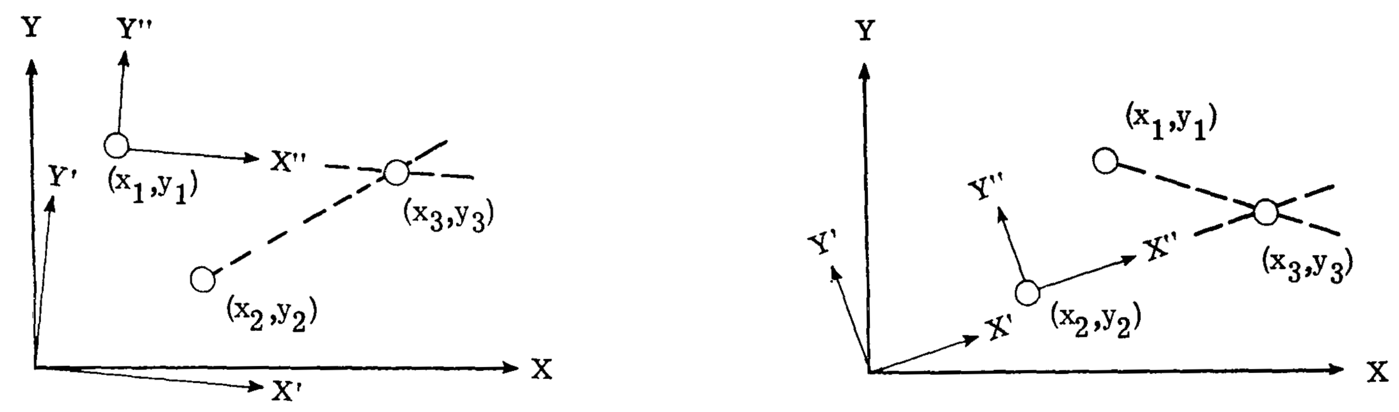
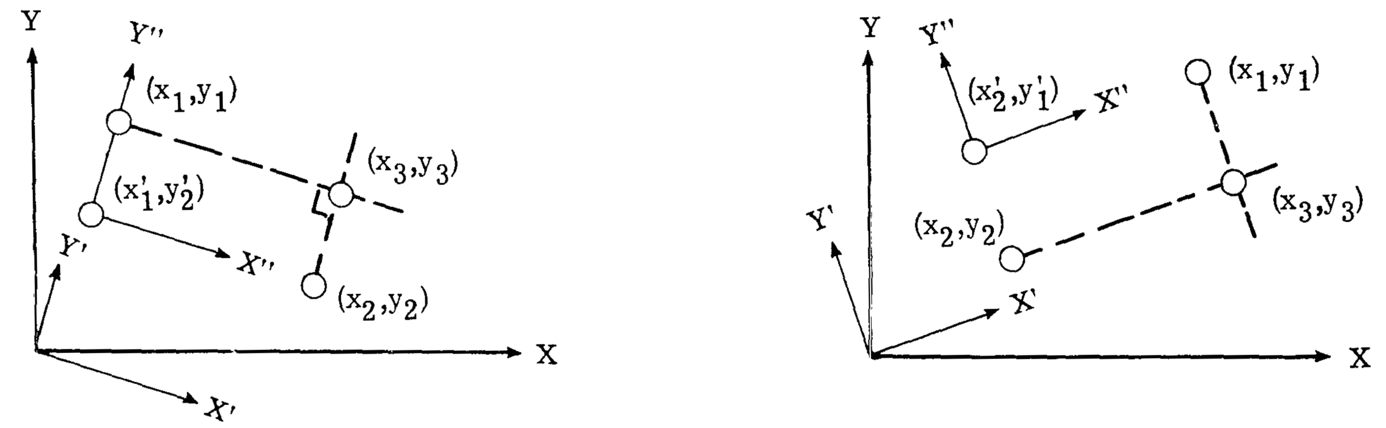


Figure 4.- Fuselage slope control point.



(a) Nonorthogonal slopes and $d_{13} \geqq d_{23}$.

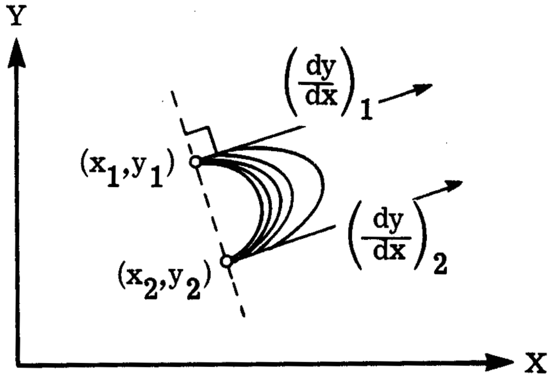
(c) Nonorthogonal slopes and $d_{23} > d_{13}$.



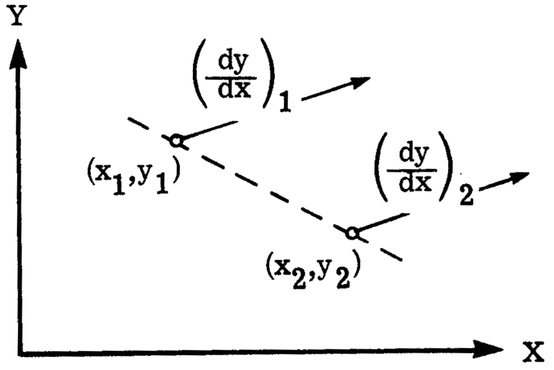
(b) Orthogonal slopes and $d_{13} \geqq d_{23}$.

(d) Orthogonal slopes and $d_{23} > d_{13}$.

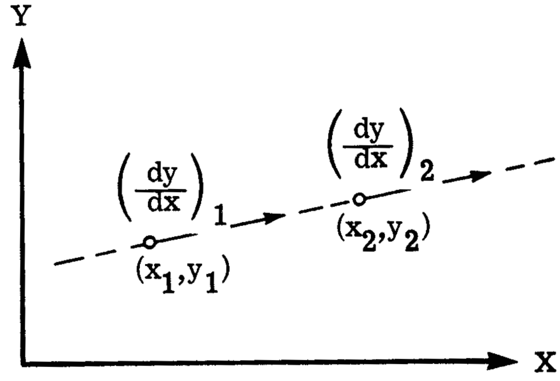
Figure 5.- Fuselage coordinate transformations.



(a) Parallel slopes orthogonal to collinear end points. Family of ellipses.

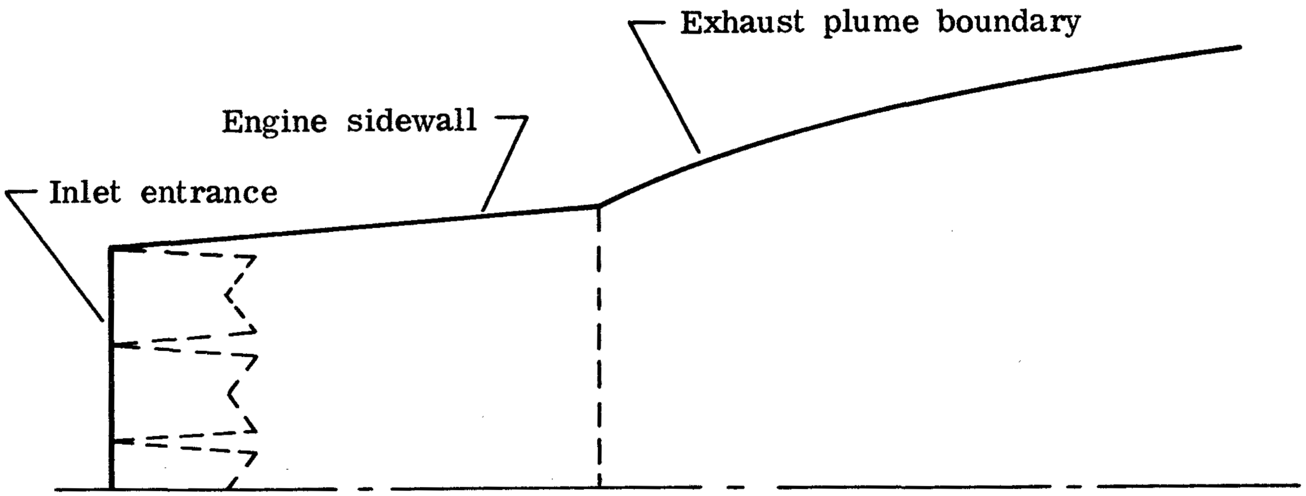


(b) Parallel slopes nonorthogonal and nonparallel to collinear end points. Inflection point (segment cannot be second degree).

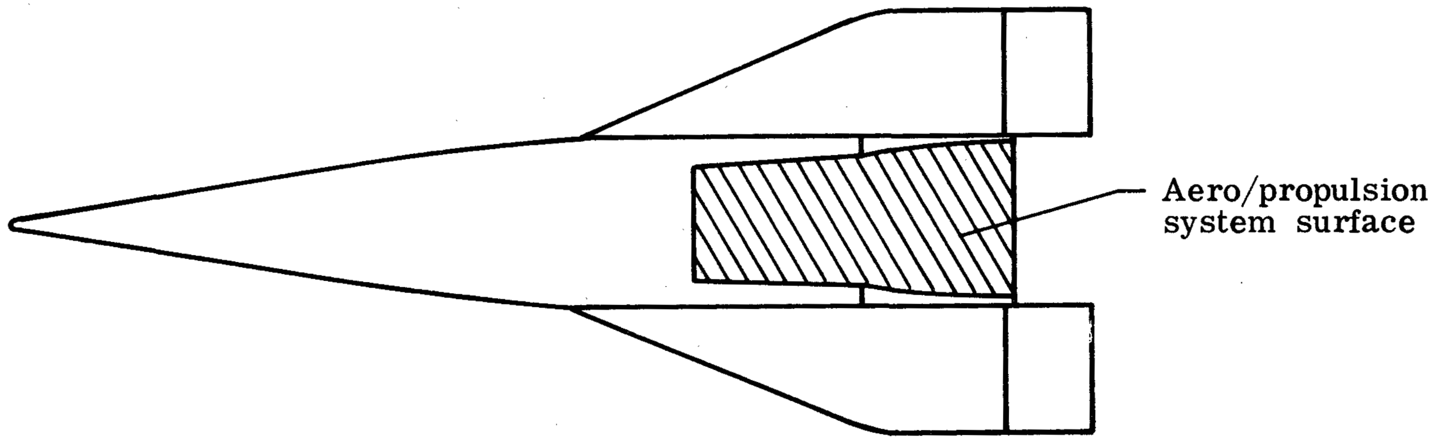


(c) Parallel slopes parallel to collinear end points. Straight-line segment.

Figure 6.- Fuselage: parallel slopes at end points.



(a) Propulsion system planform.



(b) Projection of propulsion system planform onto fuselage geometry.

Figure 7.- Fuselage geometry subtended by propulsion forces.

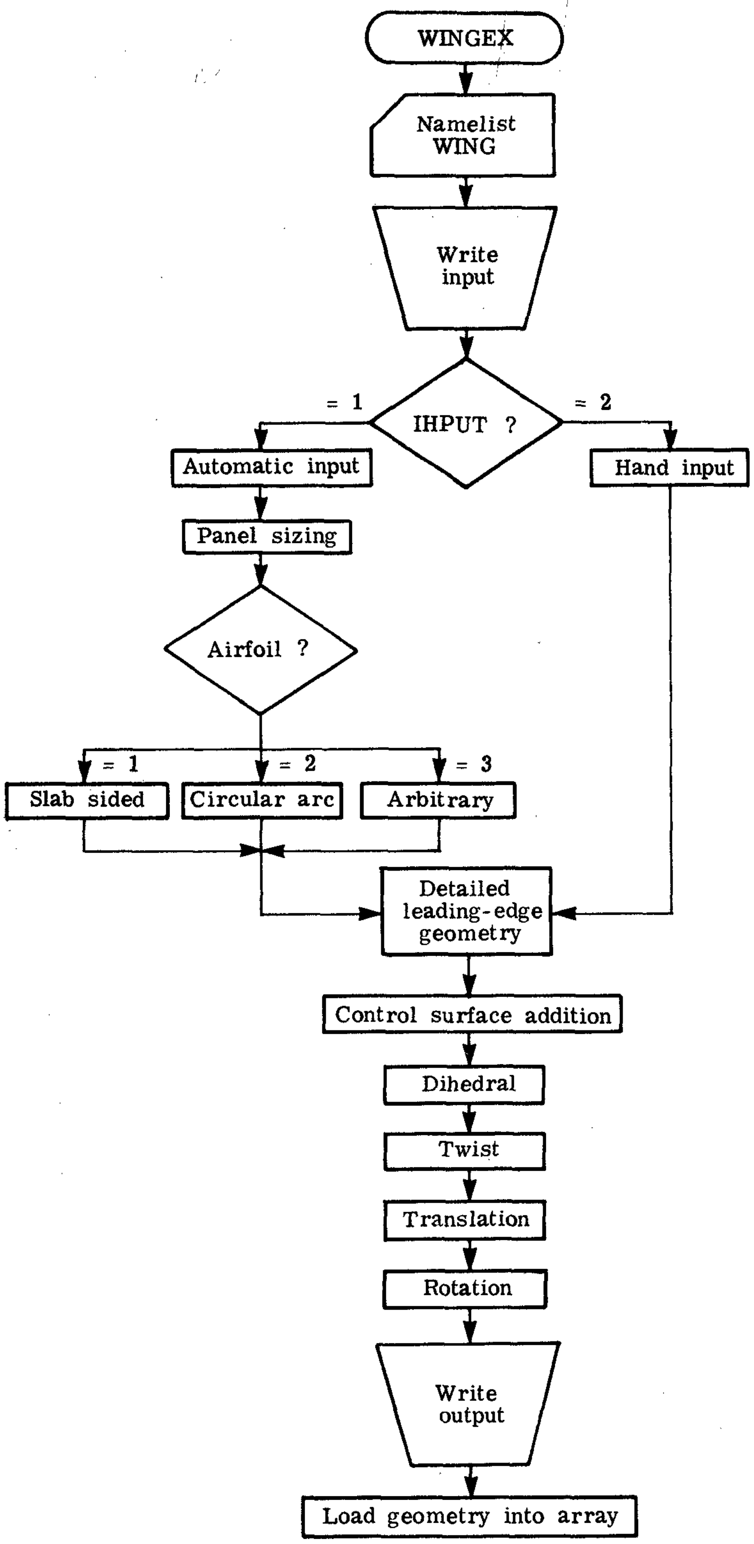


Figure 8.- Planar-surface generation logic flow.

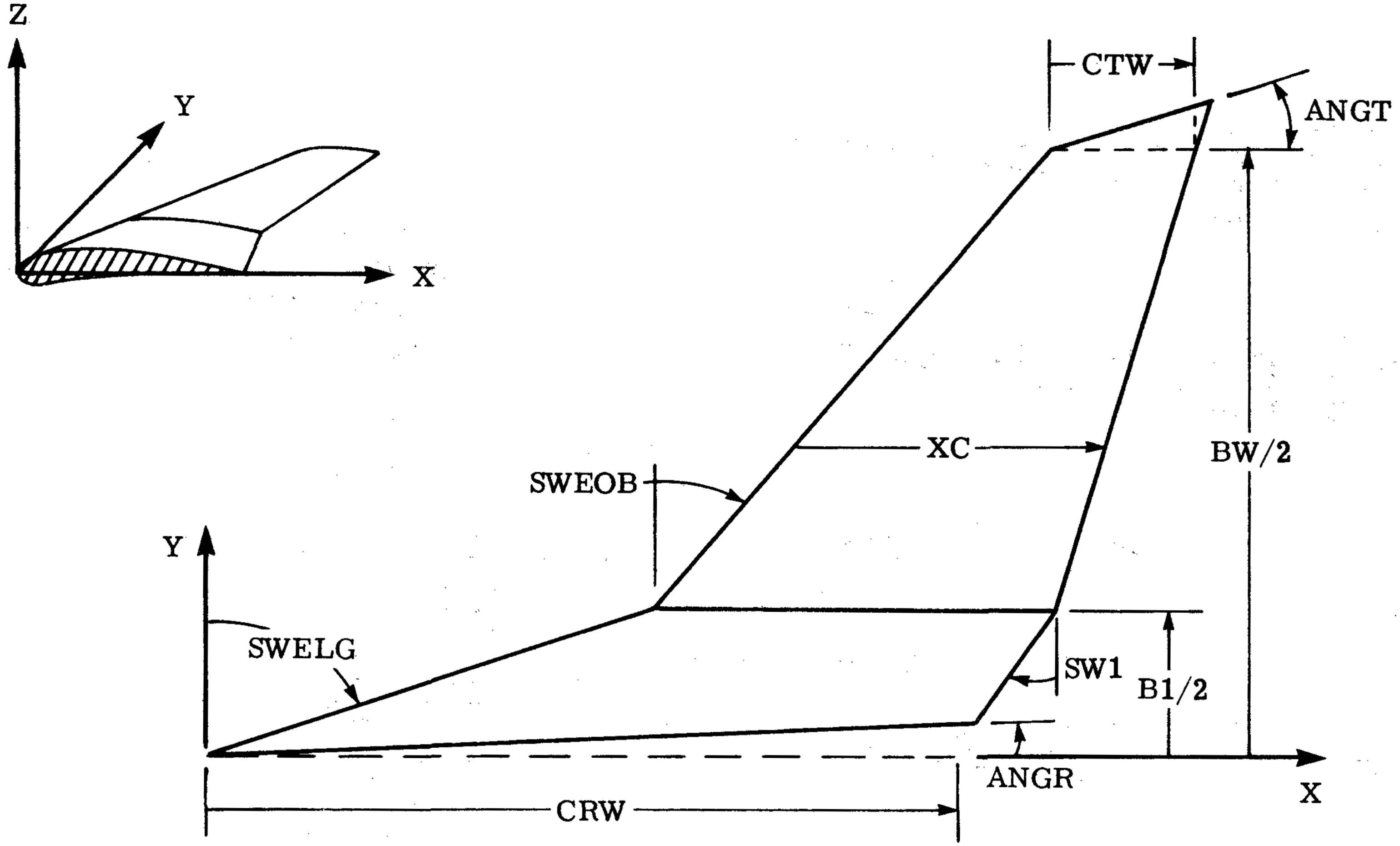


Figure 9.- Planar-surface plan parameters.

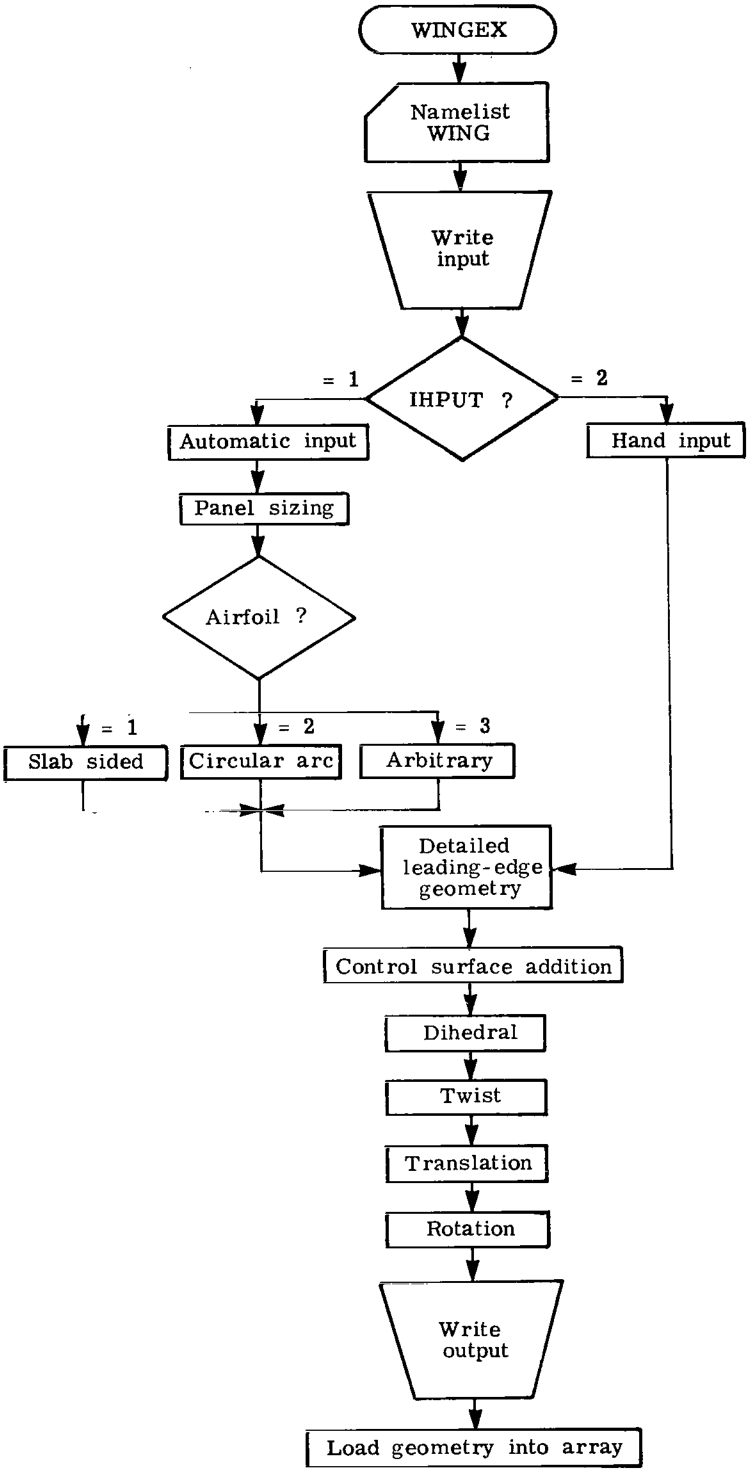


Figure 8.- Planar-surface generation logic flow.

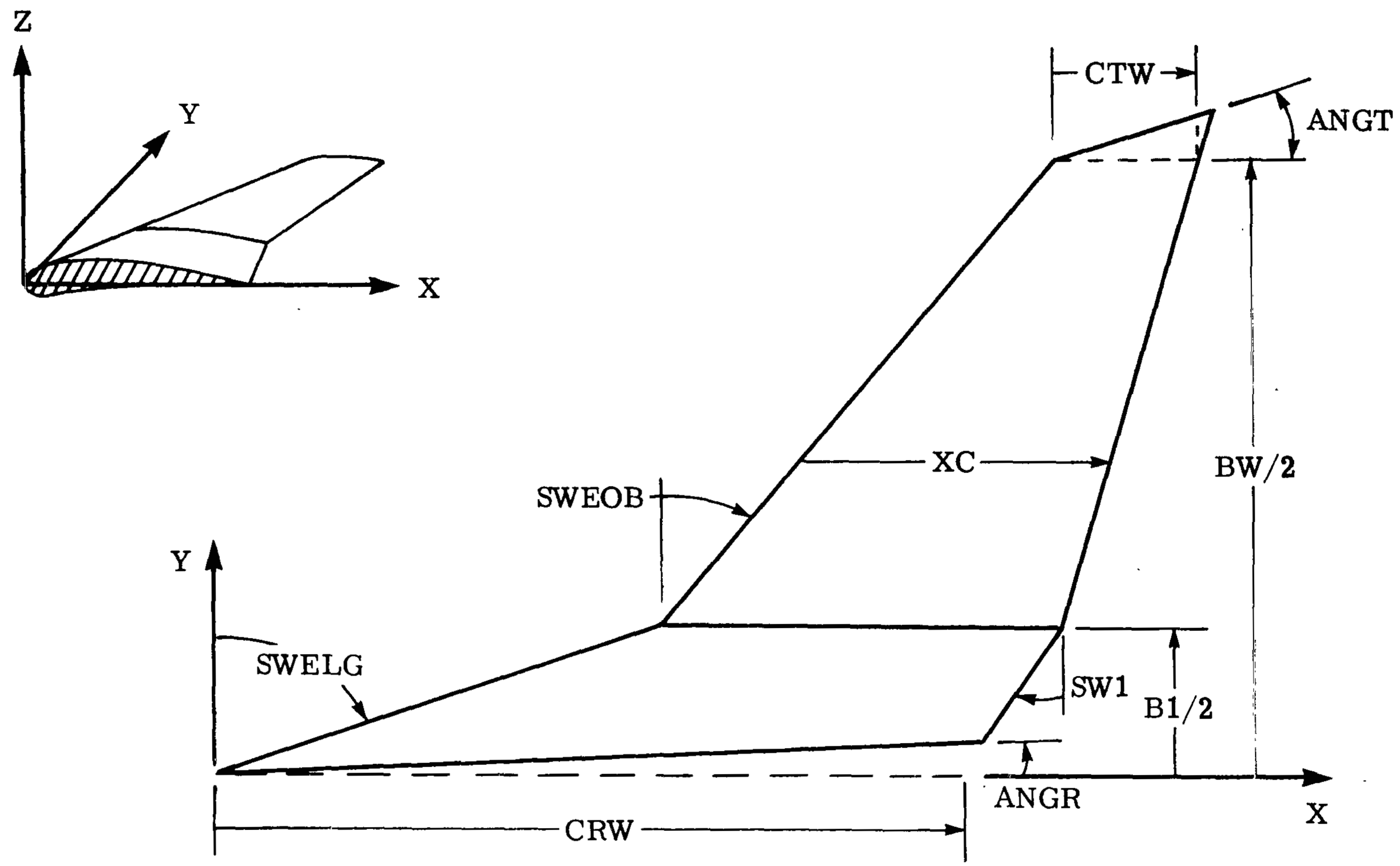
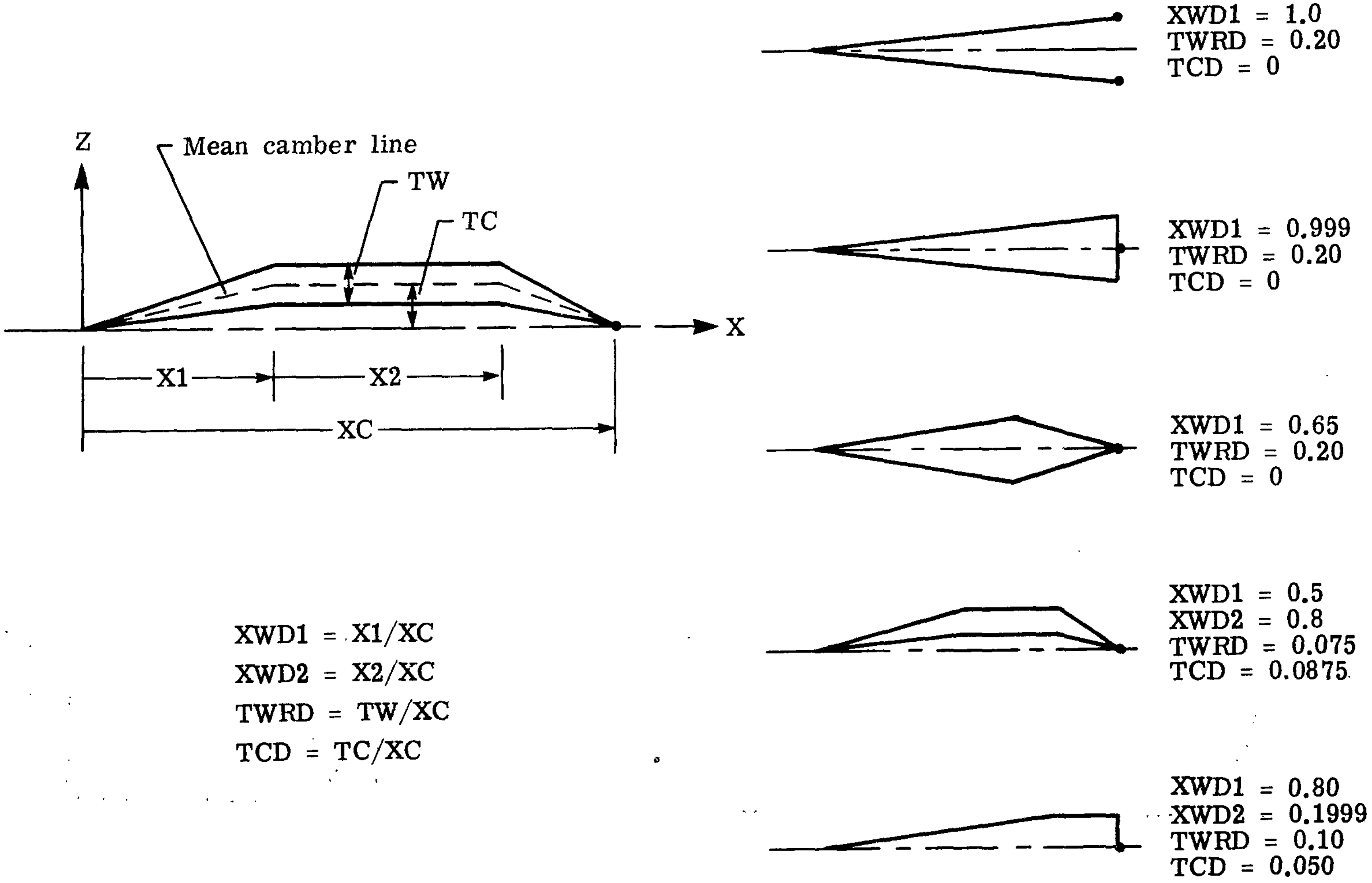


Figure 9.- Planar-surface plan parameters.



XWD1 = X1/XC

XWD2 = X2/XC

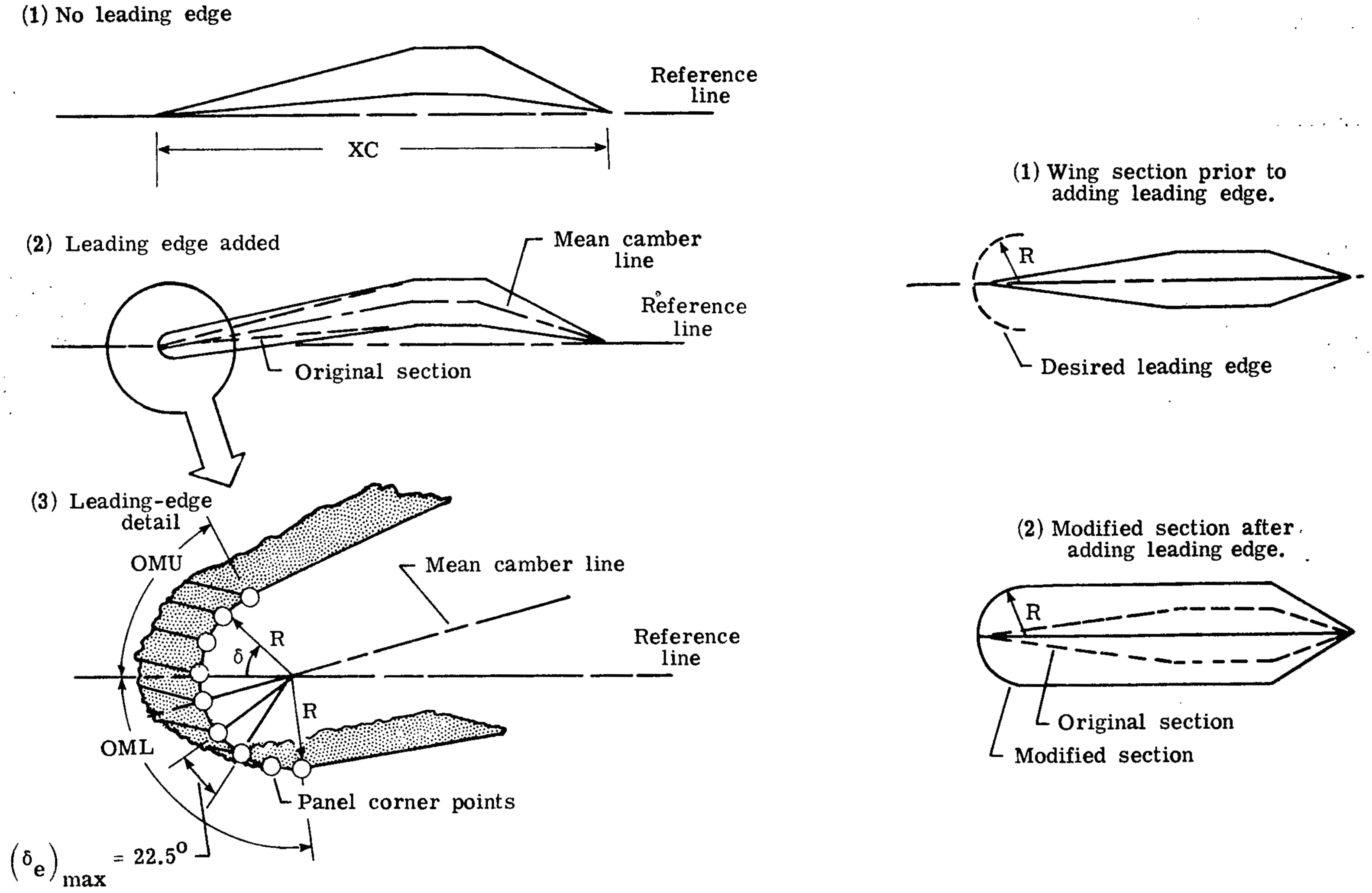
TWRD = TW/XC

TCD = TC/XC

(a) Input parameters.

(b) Shape variations.

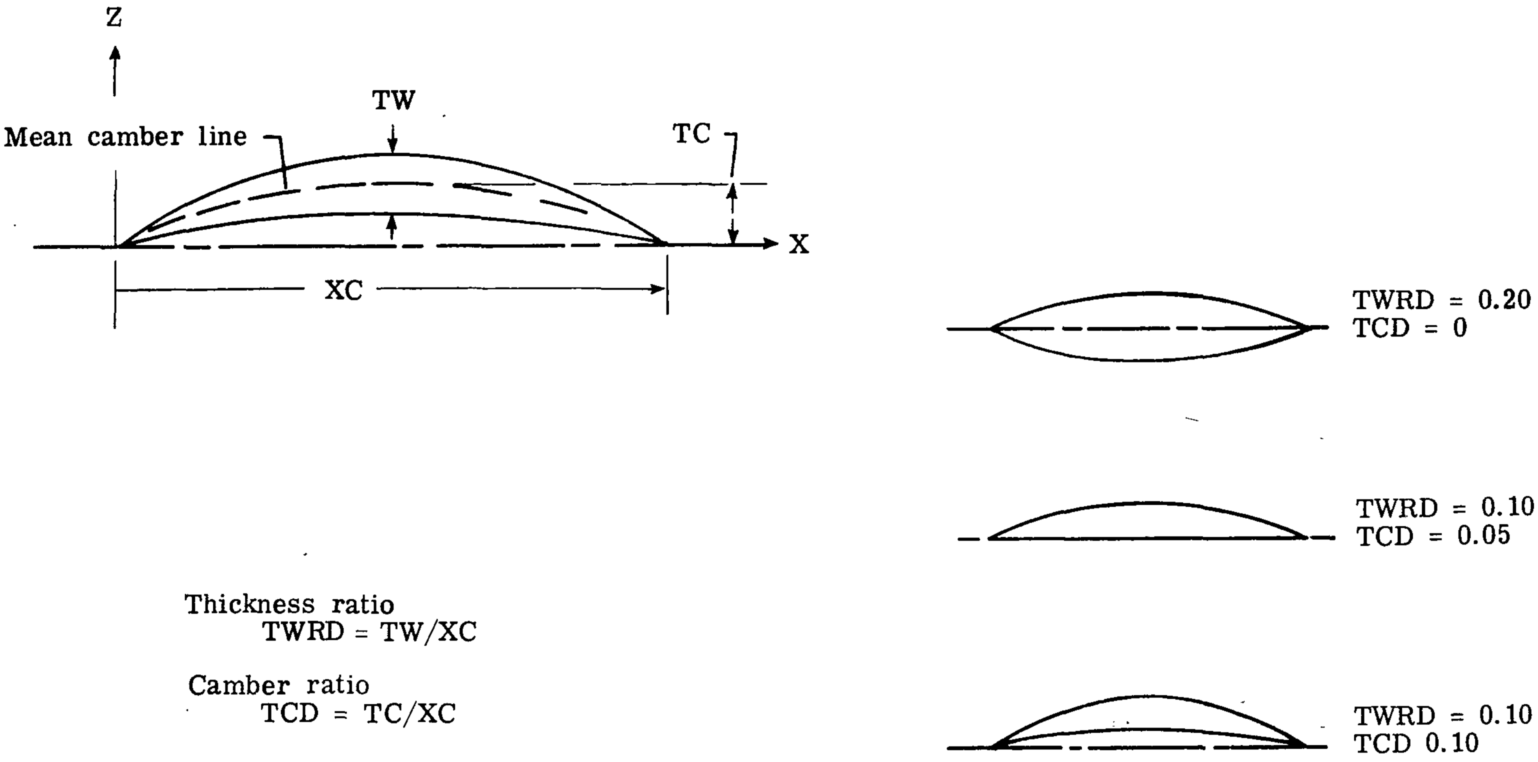
Figure 10.- Slab-sided airfoil section.



(a) Leading-edge construction.

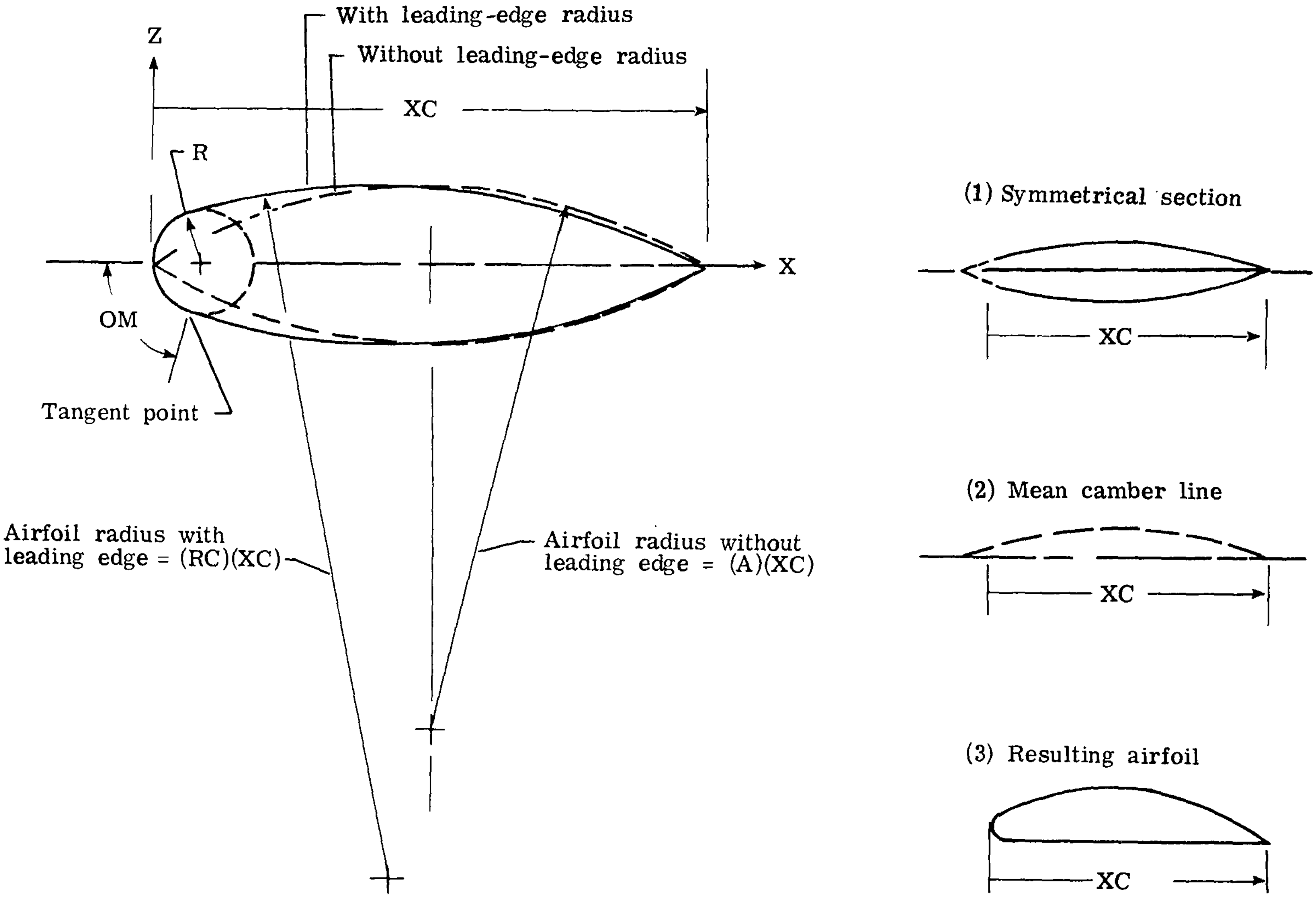
(b) Large leading-edge condition.

Figure 11.- Leading-edge slab-sided airfoil.



(a) Input parameters. (b) Shape variations.

Figure 12.- Circular-arc airfoil section.



(a) Leading-edge construction.

(b) Cambered airfoil.

Figure 13.- Leading-edge circular-arc airfoil.

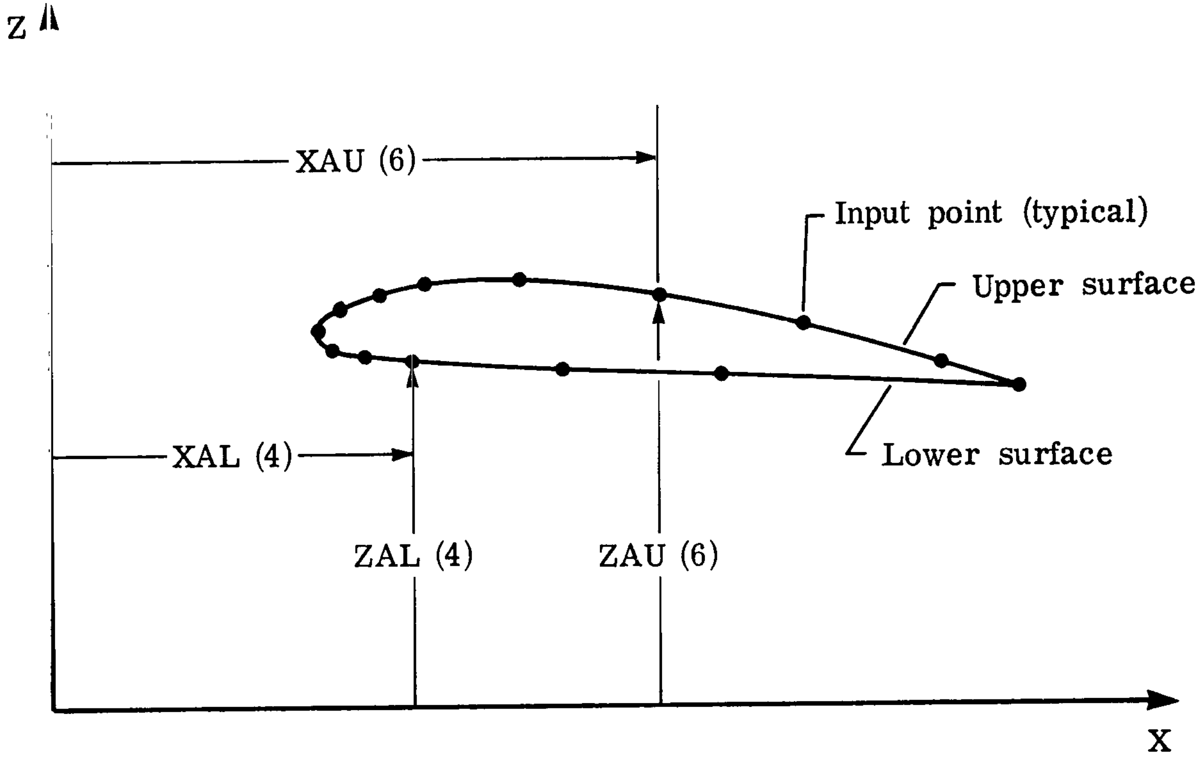
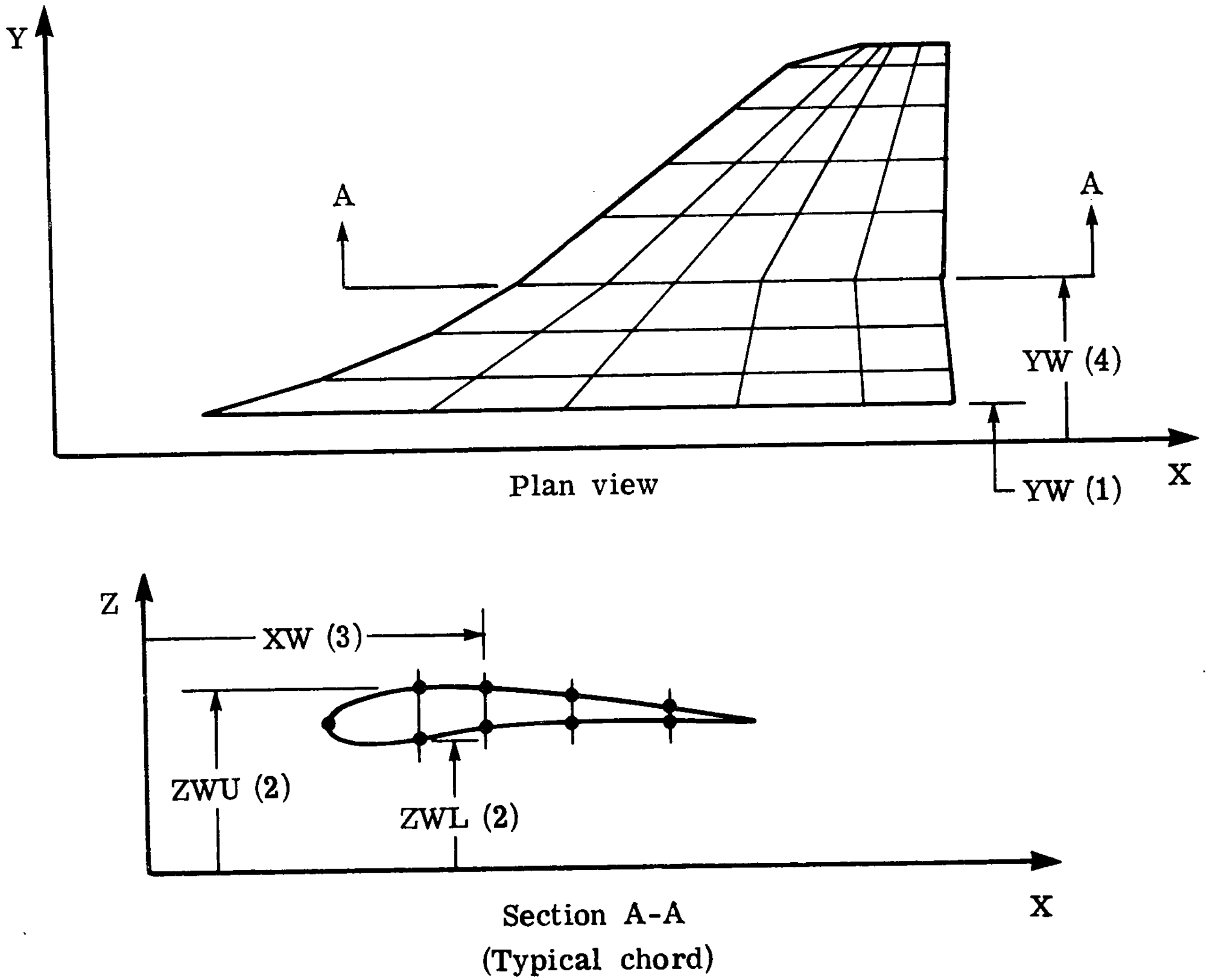


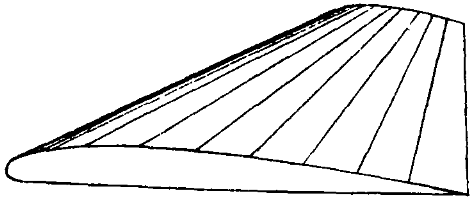
Figure 14.- Arbitrary airfoil section.



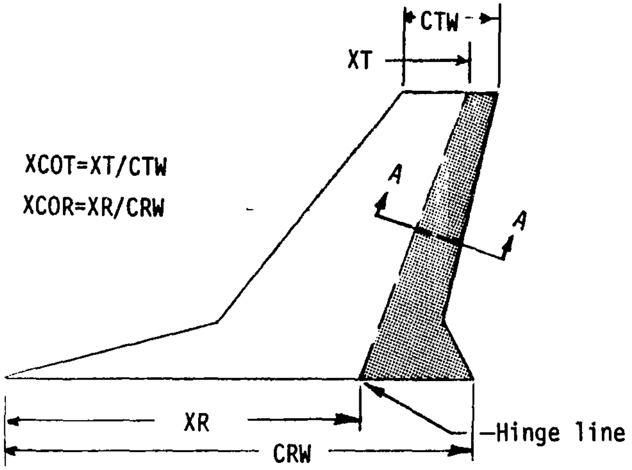
Plan view

Section A-A
(Typical chord)

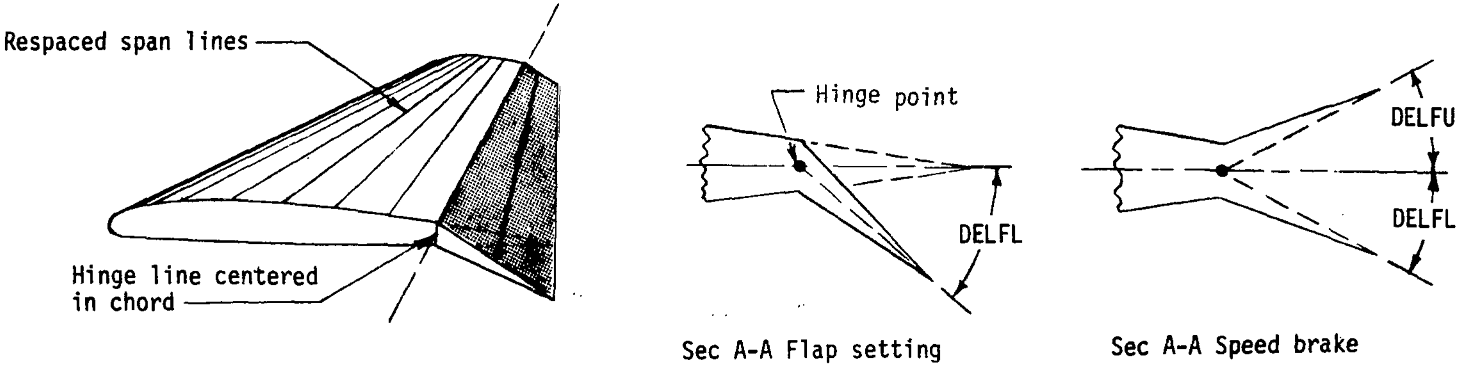
Figure 15.- Planar-surface manual input.



(a) Wing prior to flap addition.

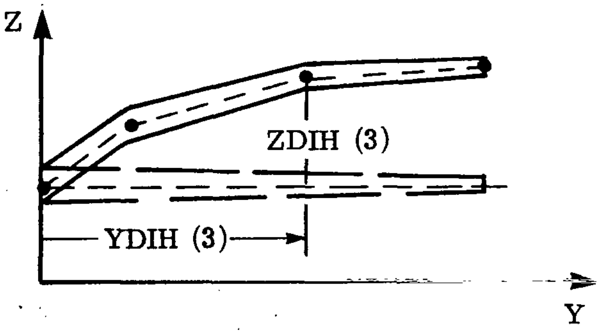


(c) Hinge-line input nomenclature.

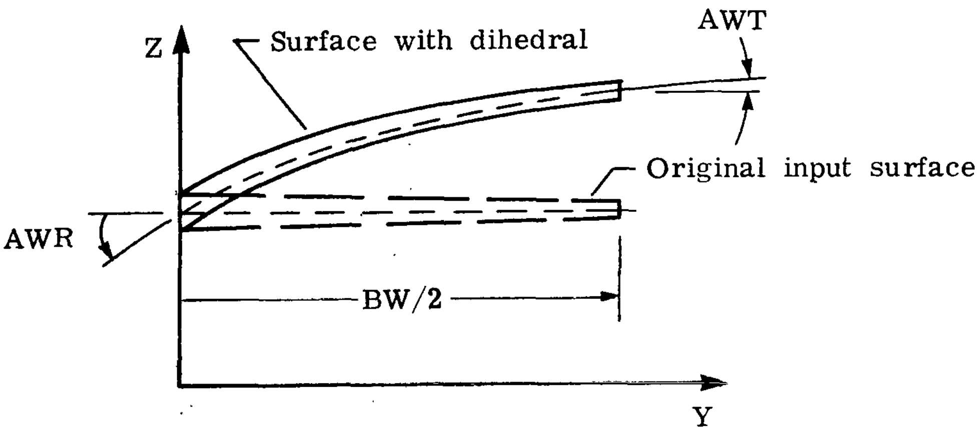


(b) Wing with flap added.

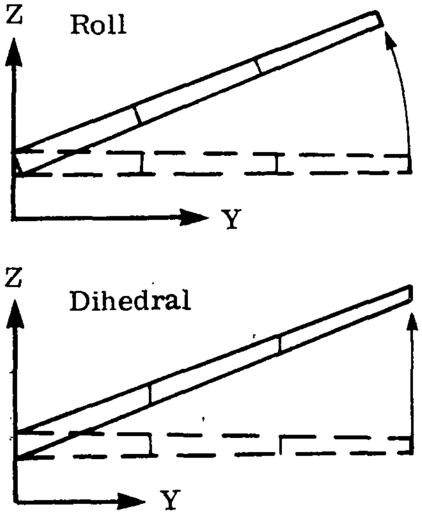
Figure 16.- Control-surface option.



(a) Dihedral hand input.



(b) Root and tip angle input.



(c) Roll and dihedral convention.

Figure 17.- Wing dihedral option.

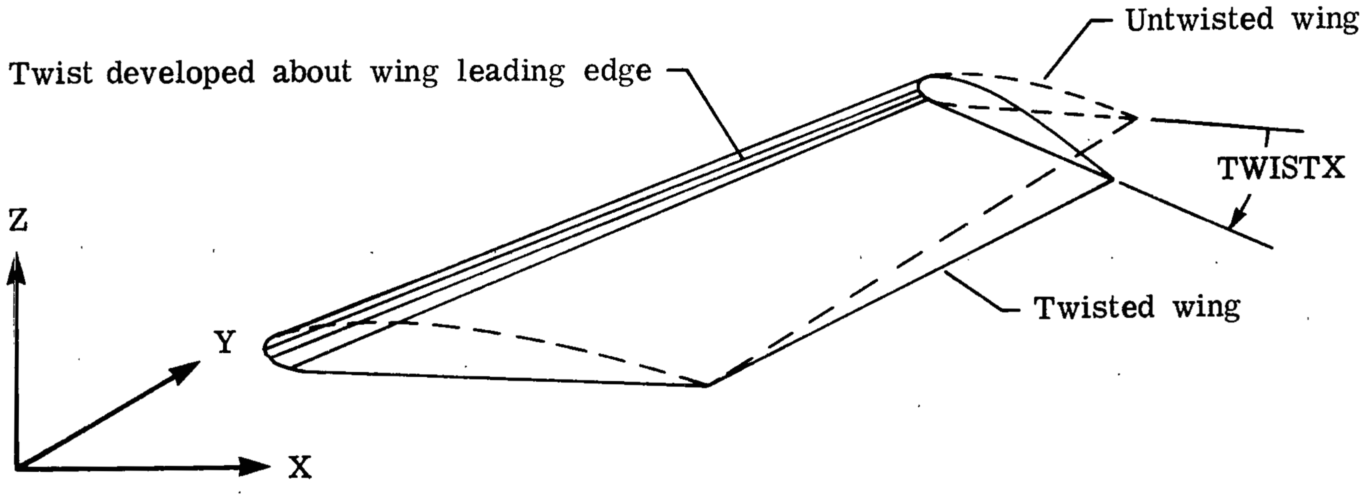
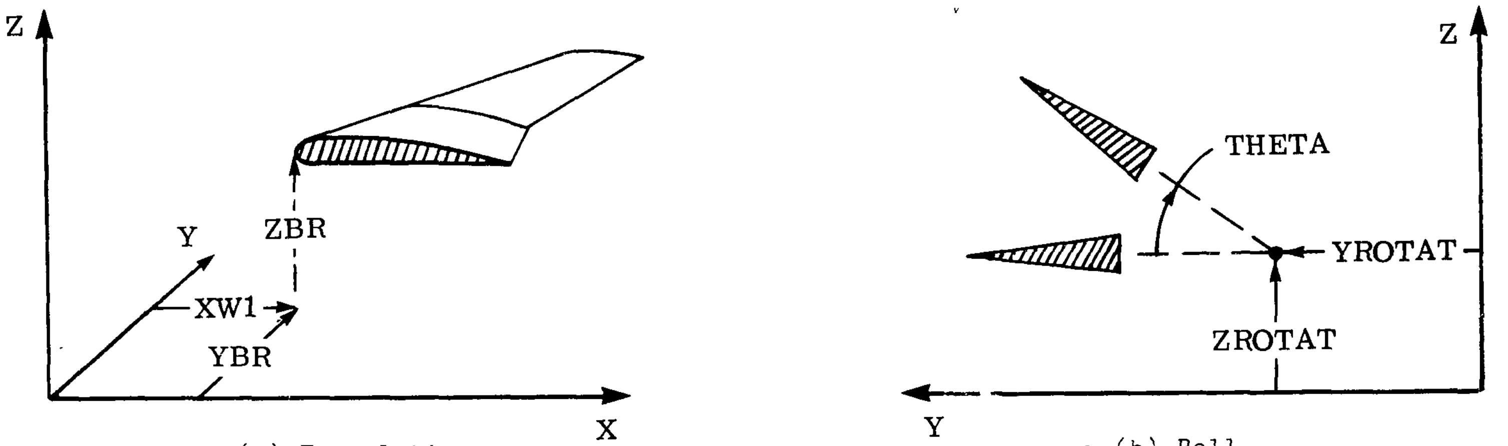
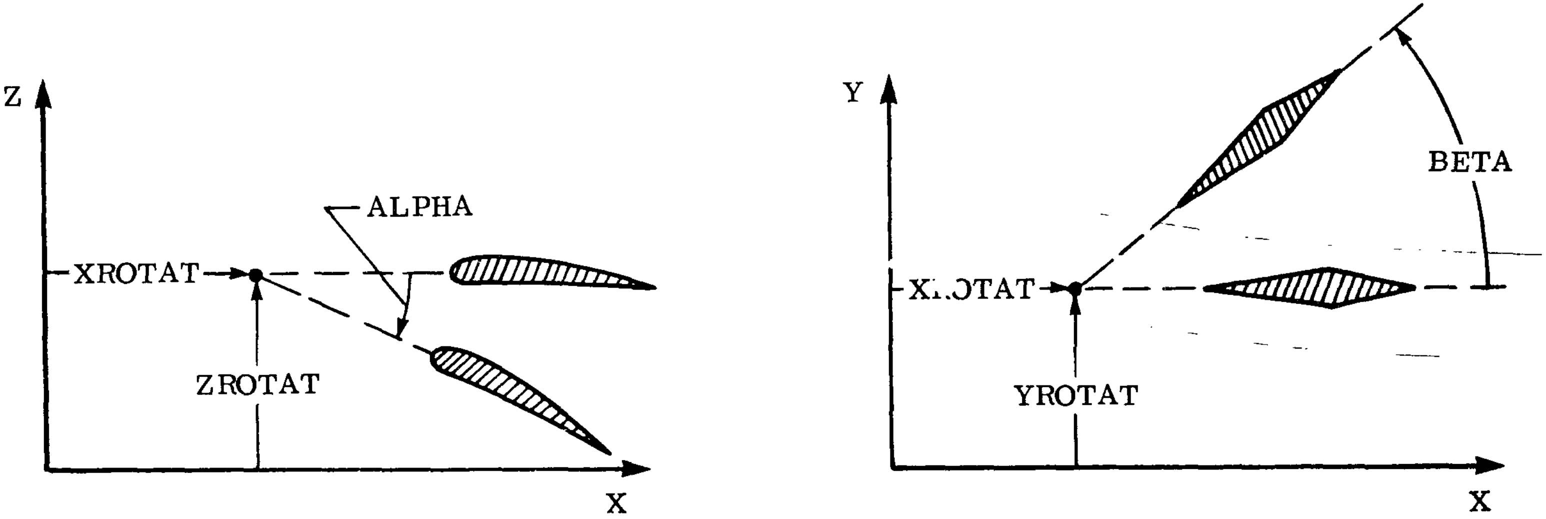


Figure 18.- Wing twist option.



(a) Translation.

(b) Roll.



(c) Pitch.

(d) Yaw.

Figure 19.- Planar-surface translation and rotation.

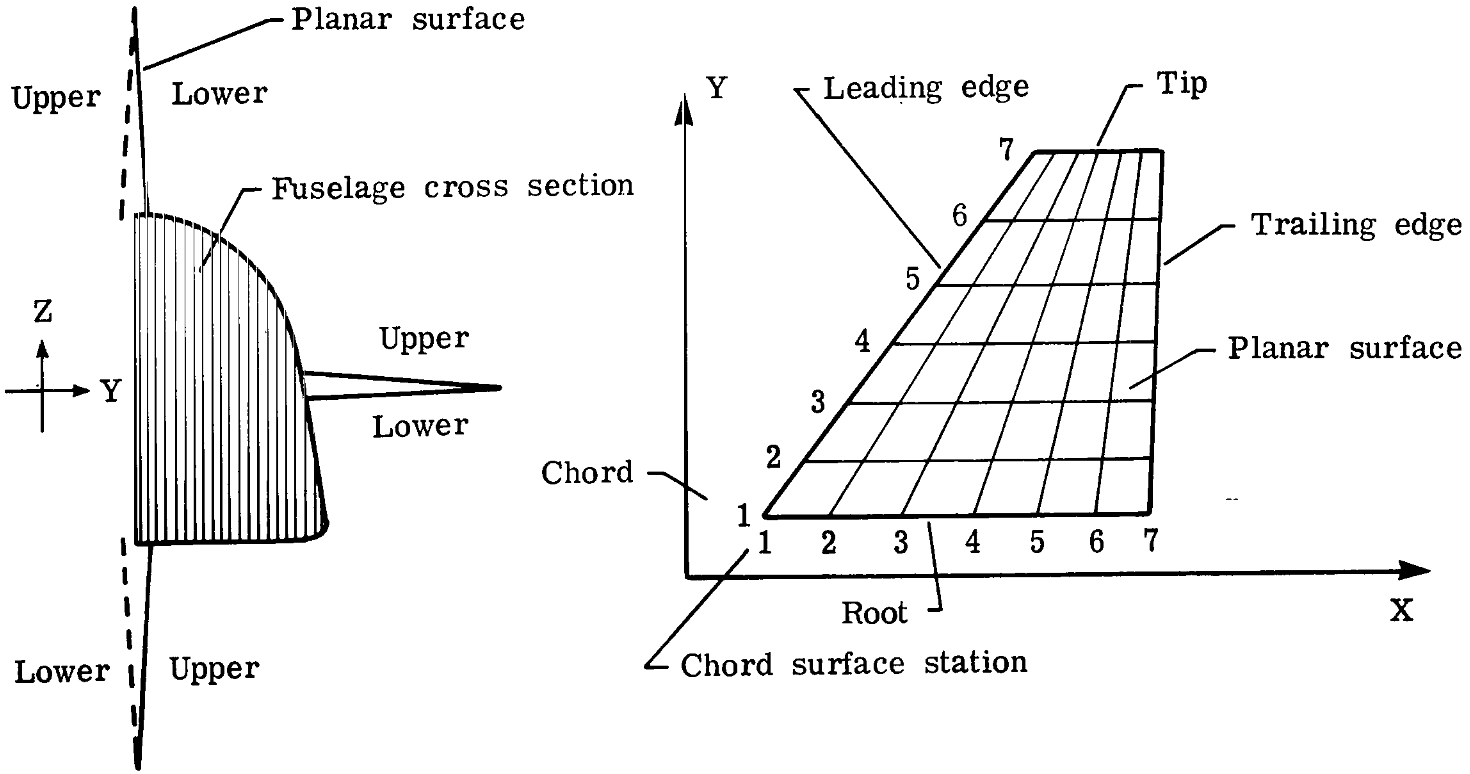


Figure 20.- Planar-surface geometry arrangement for MERGE.

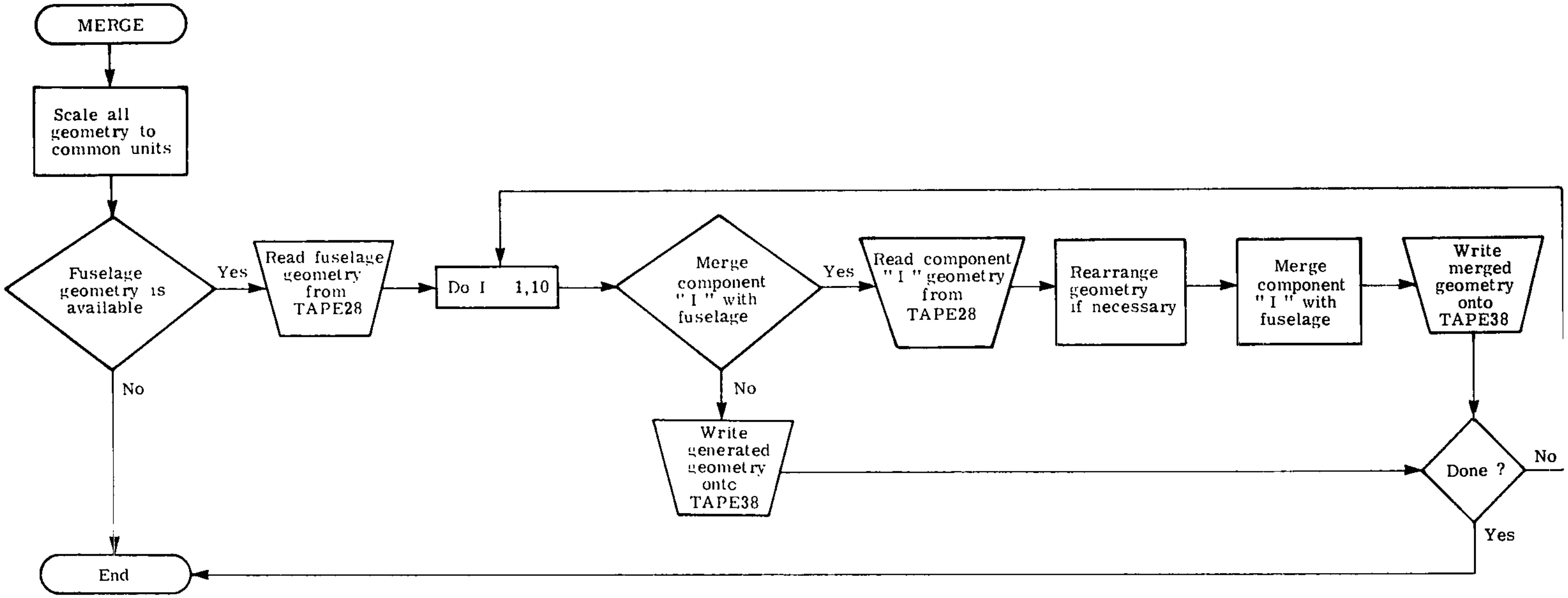


Figure 21.- Operations performed in MERGE.

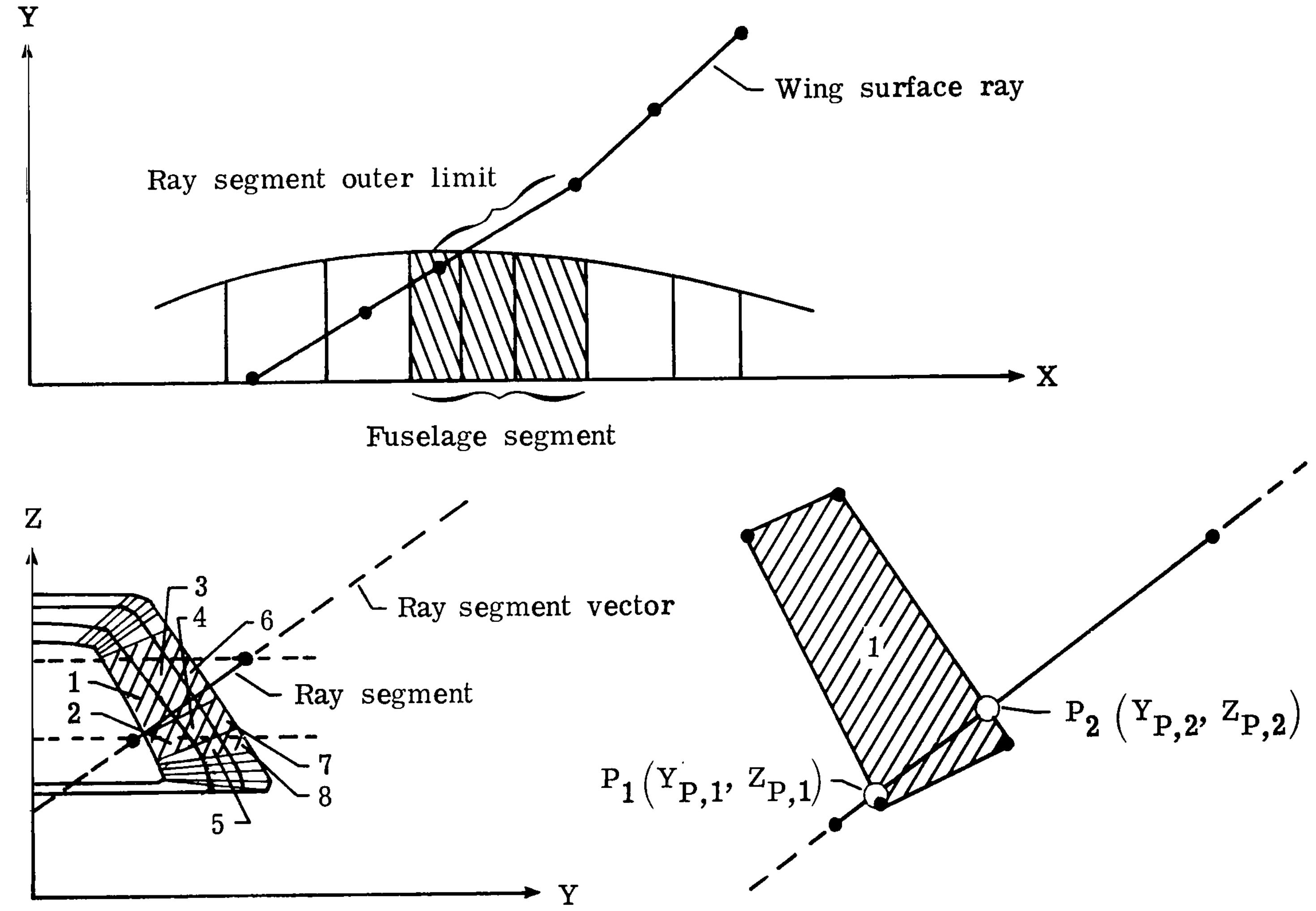
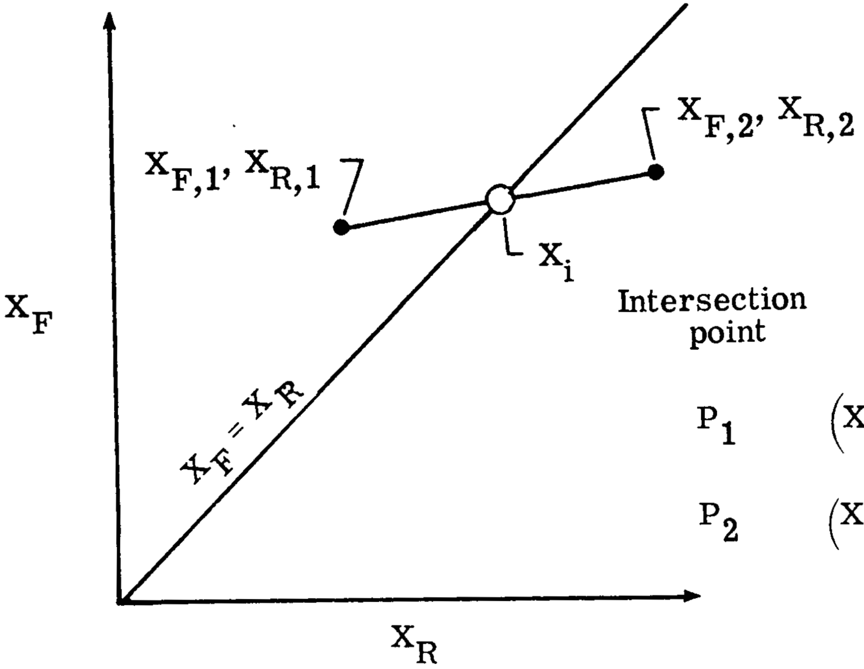


Figure 22.- Limits of search for intersection.



Intersection point	Coordinates on fuselage	Coordinates on ray
P_1	$(X_{F,1}, Y_{P,1}, Z_{P,1})$	$(X_{R,1}, X_{P,1}, Z_{P,1})$
P_2	$(X_{F,2}, Y_{P,2}, Z_{P,2})$	$(X_{R,2}, Y_{P,2}, Z_{P,2})$

Figure 23.- Estimate of intersection.

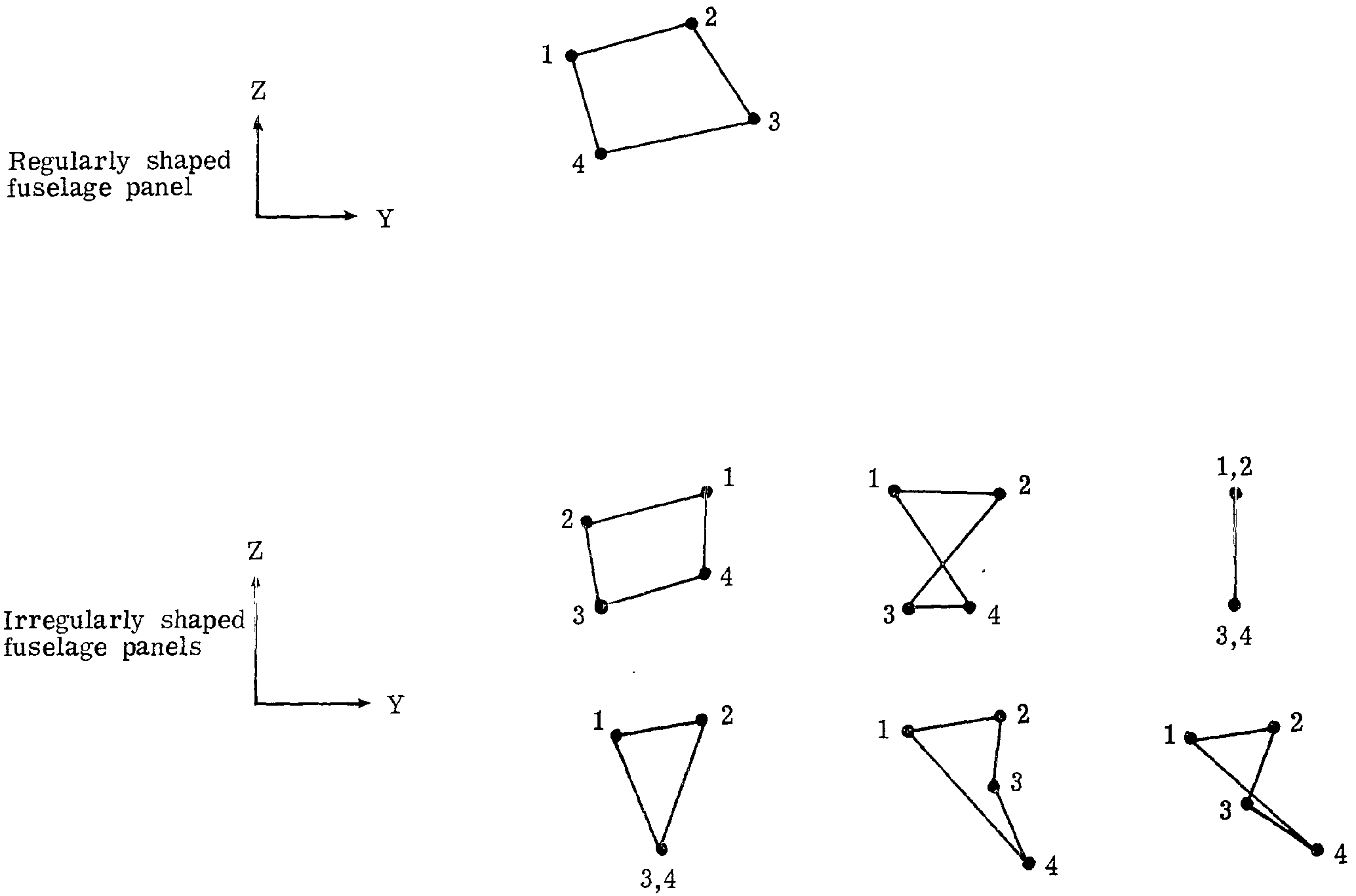
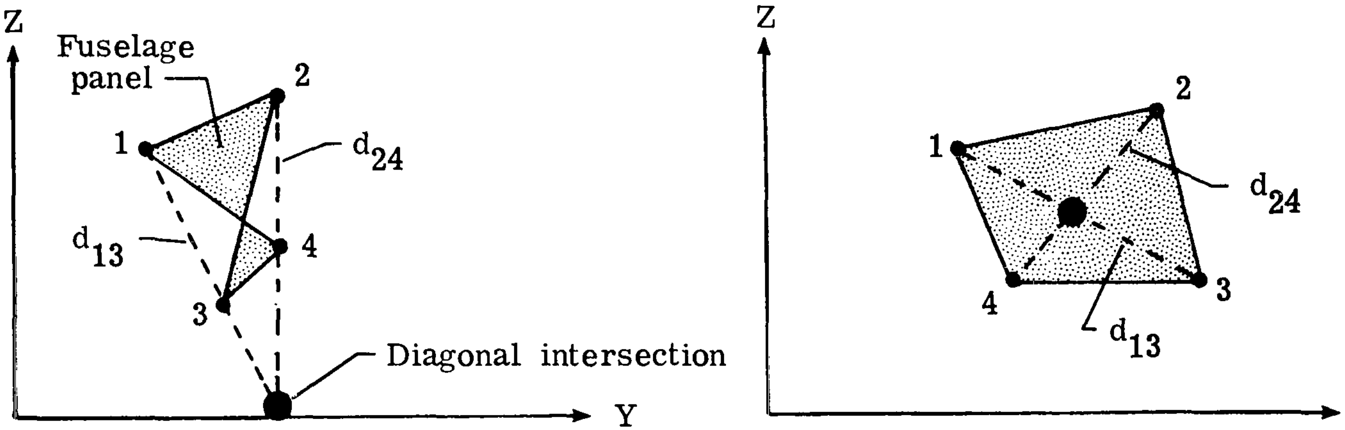
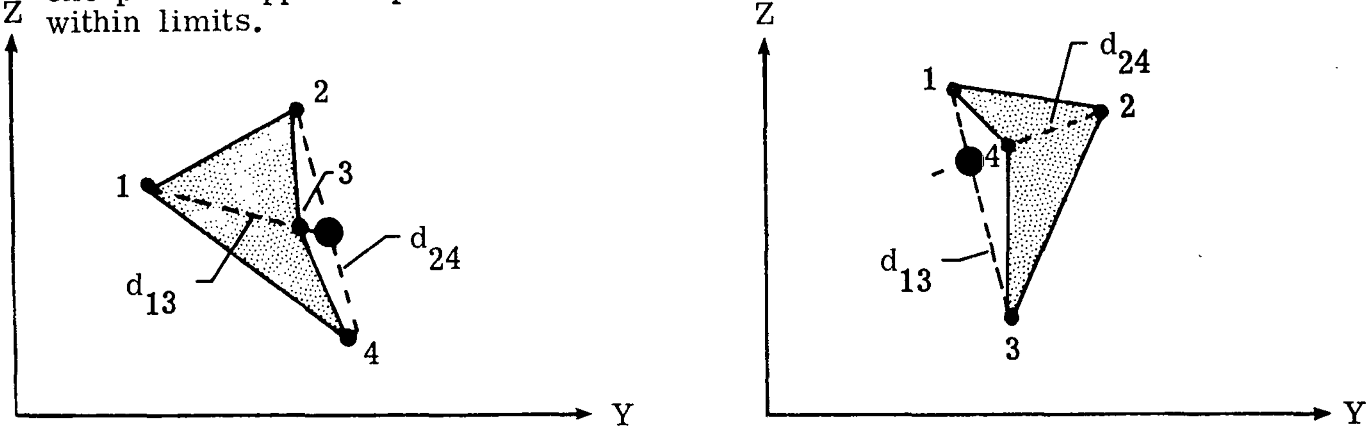


Figure 24.- MERGE: Examples of irregularly shaped fuselage panels.



Fuselage panel diagonals, d_{13} and d_{24}, do not intersect within the end points of either diagonal. Program assumes that one pair of opposite panel sides intersect within limits.

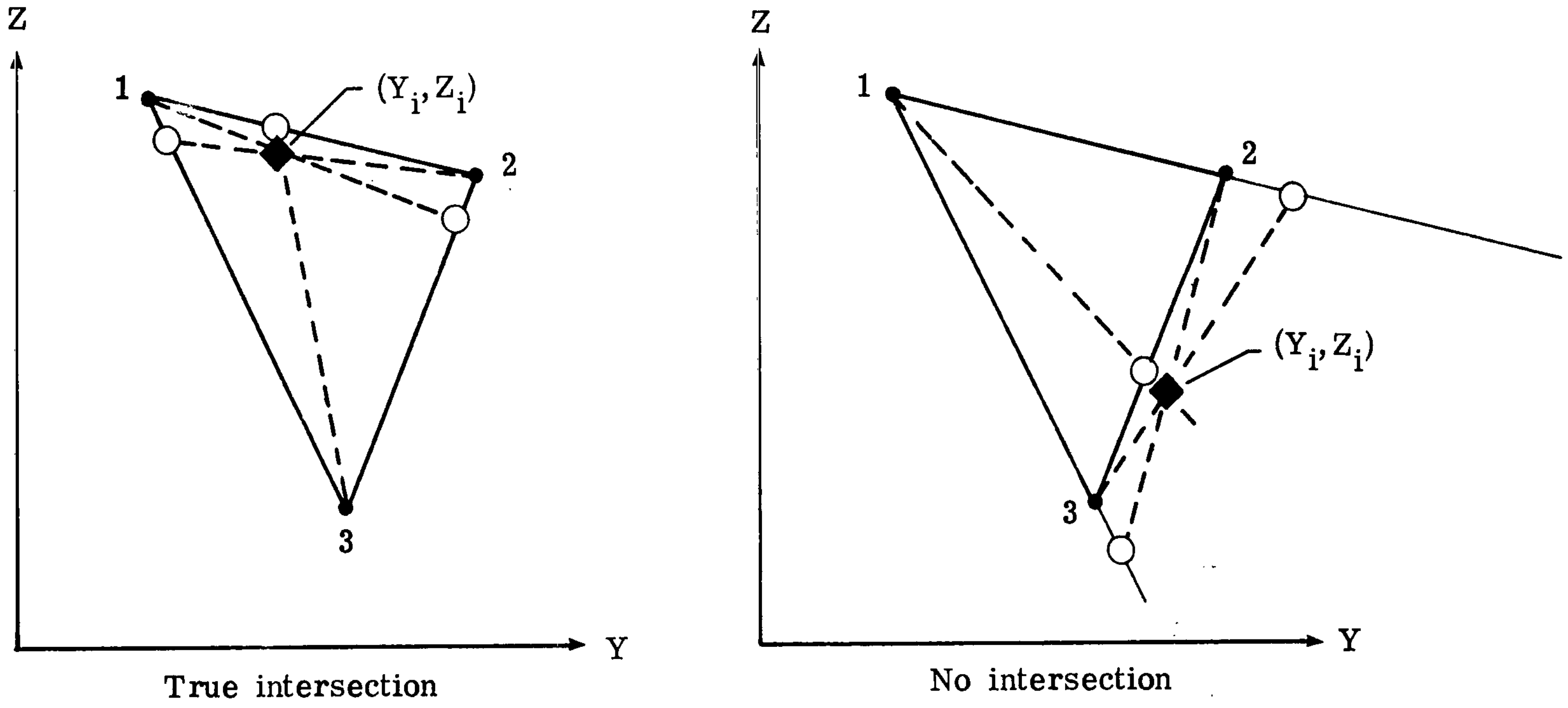
Diagonal intersection lies within end point limits of both diagonals. Diagonal d_{13} is chosen as the panel divider.



Diagonal intersection lies within end point limits of d_{24}. Diagonal d_{13} is chosen as panel divider.

Diagonal intersection lies within end point limits of d_{13}. Diagonal d_{24} is chosen as panel divider.

Figure 25.- MERGE: Possible panel diagonal intersection locations.



True intersection

No intersection

Figure 26.- Intersection "triangle check."

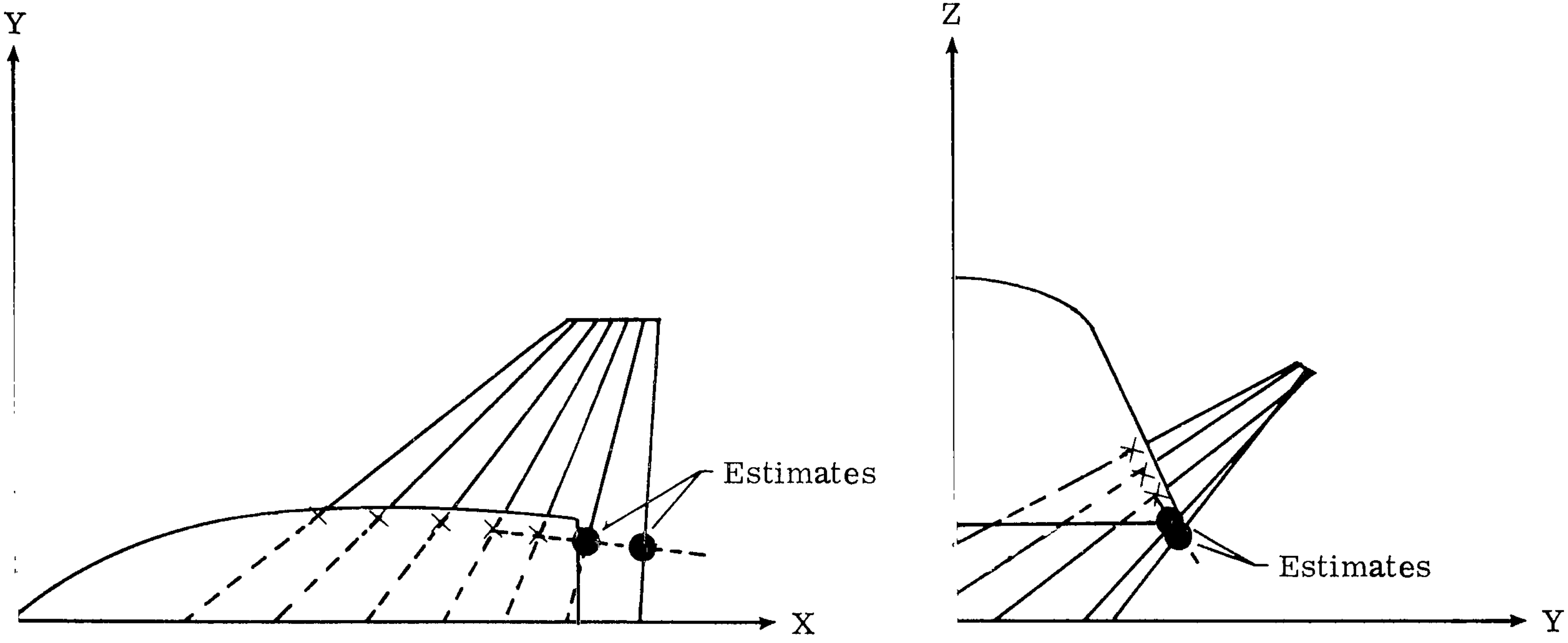


Figure 27.- Intersection extrapolation estimates.

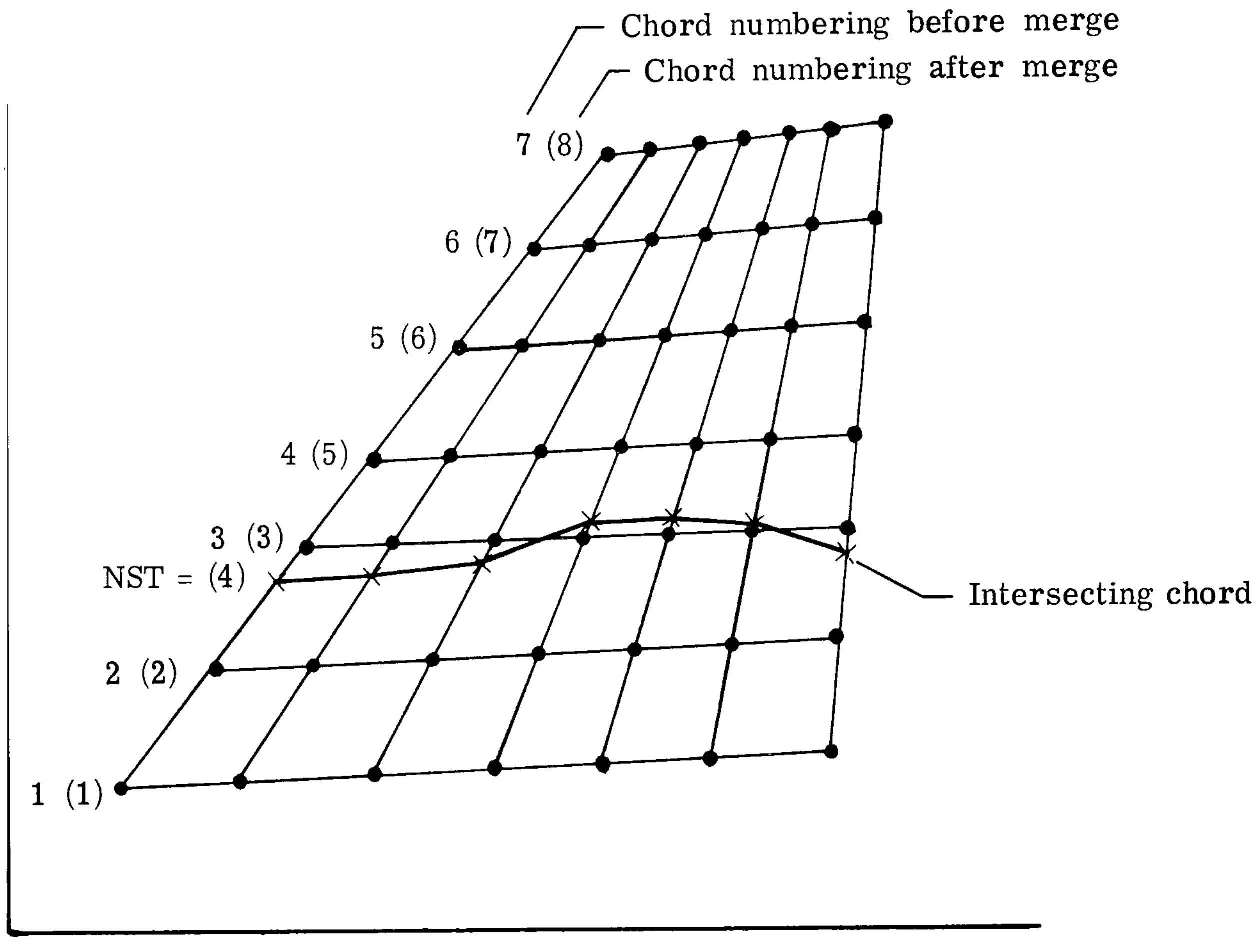


Figure 28.- Geometry redefinition for intersection.

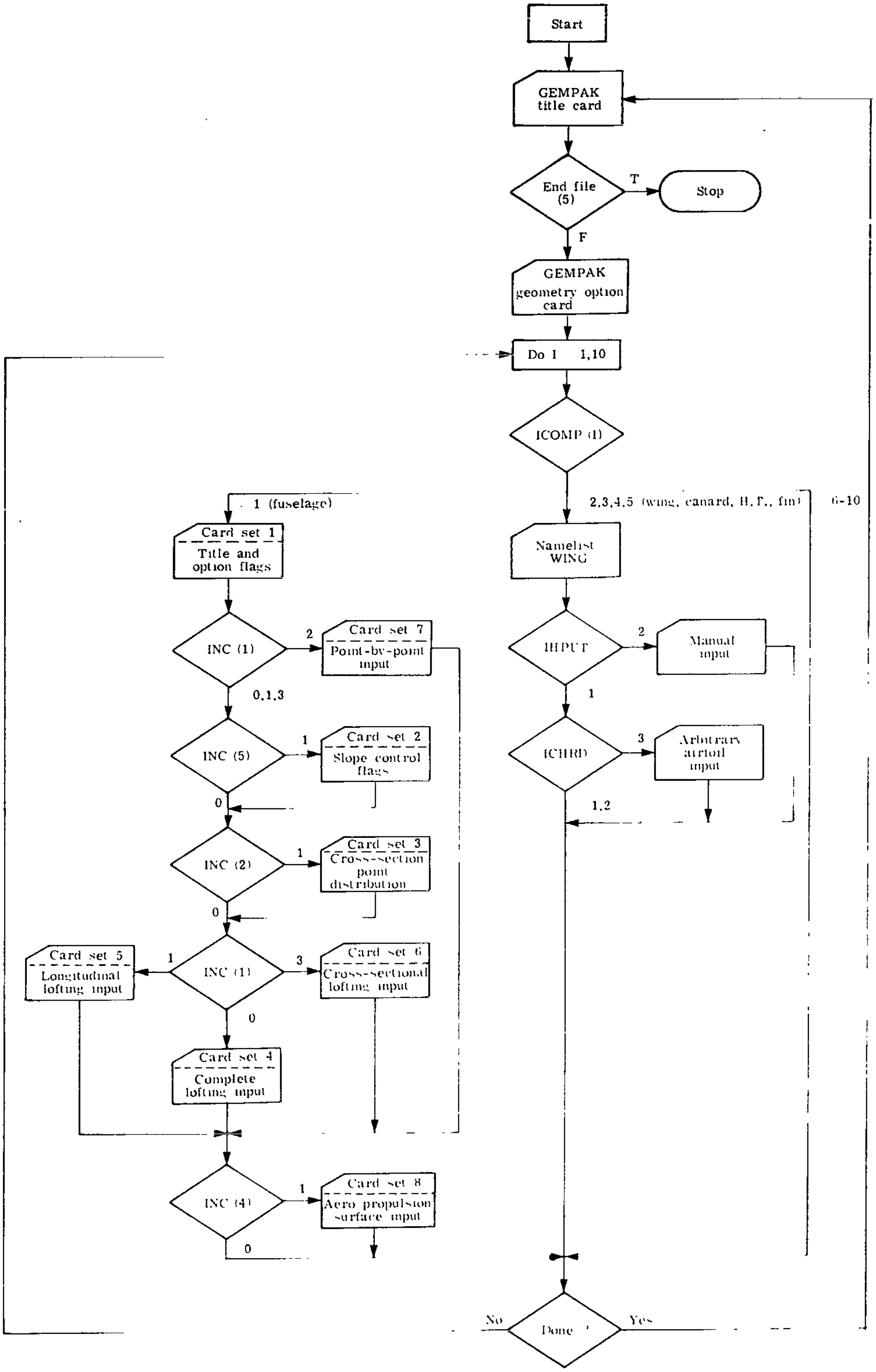


Figure 29.- GEMPAK input flow.

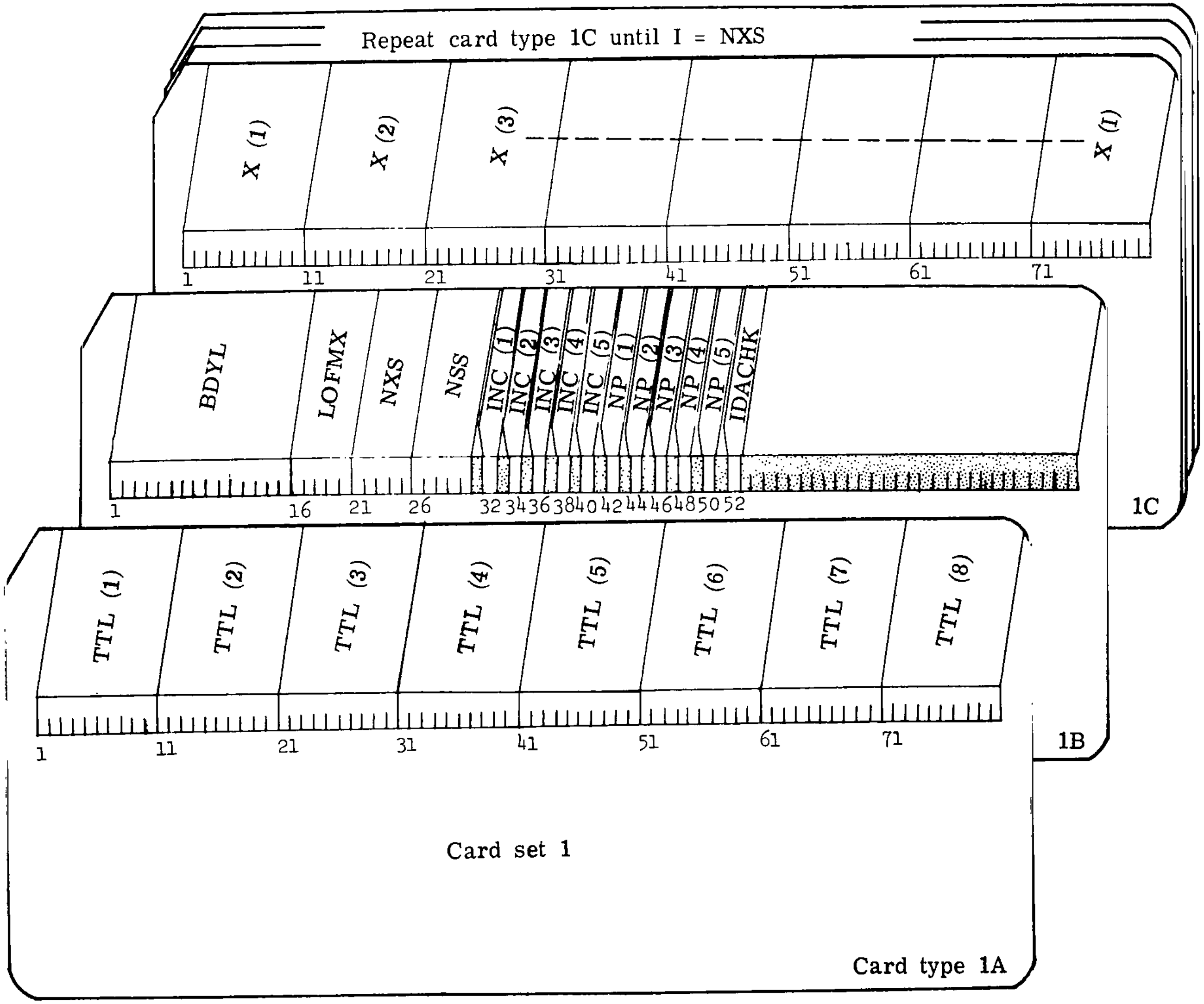


Figure 30.- Fuselage: card set 1 input.

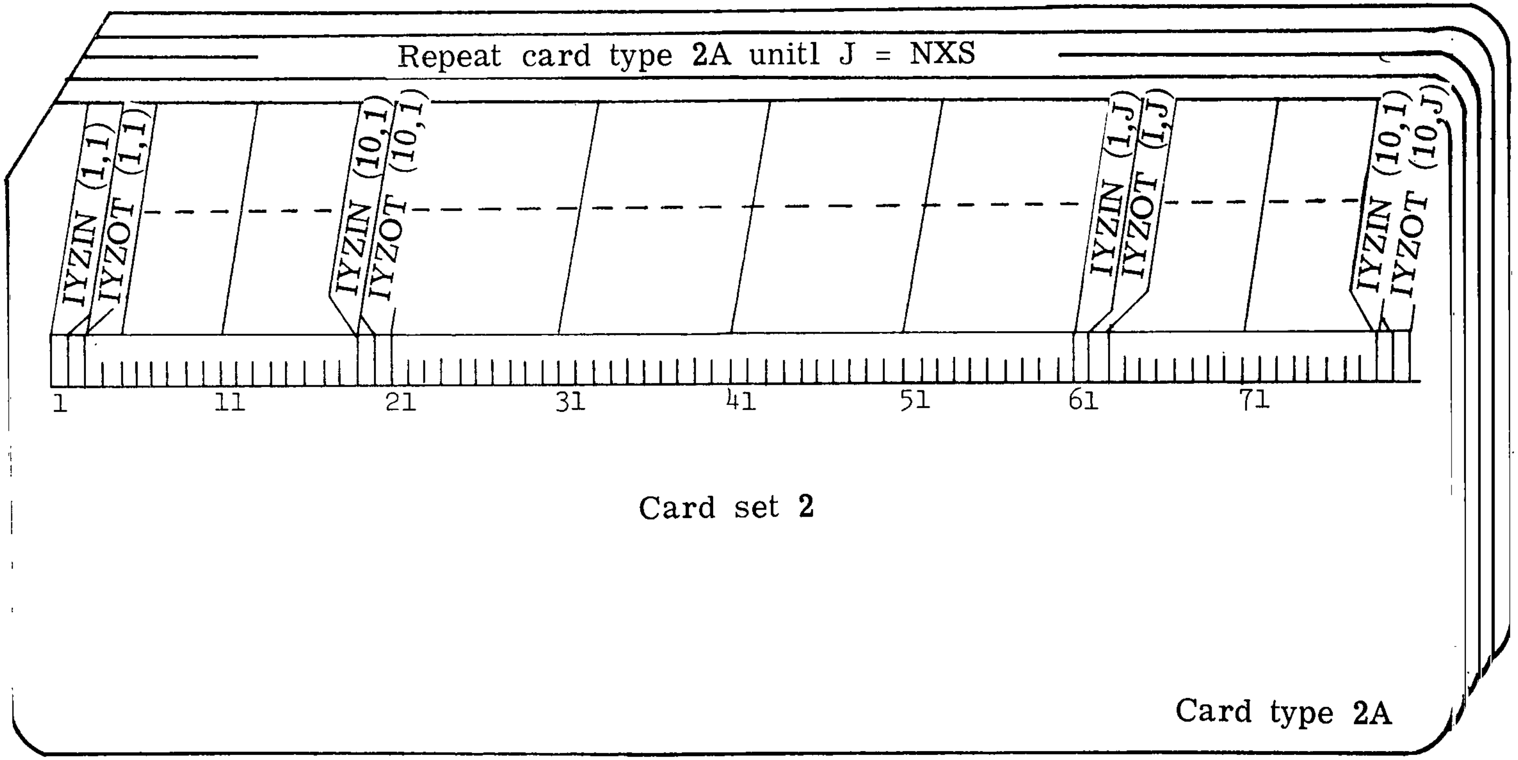


Figure 31.- Fuselage: card set 2 input.

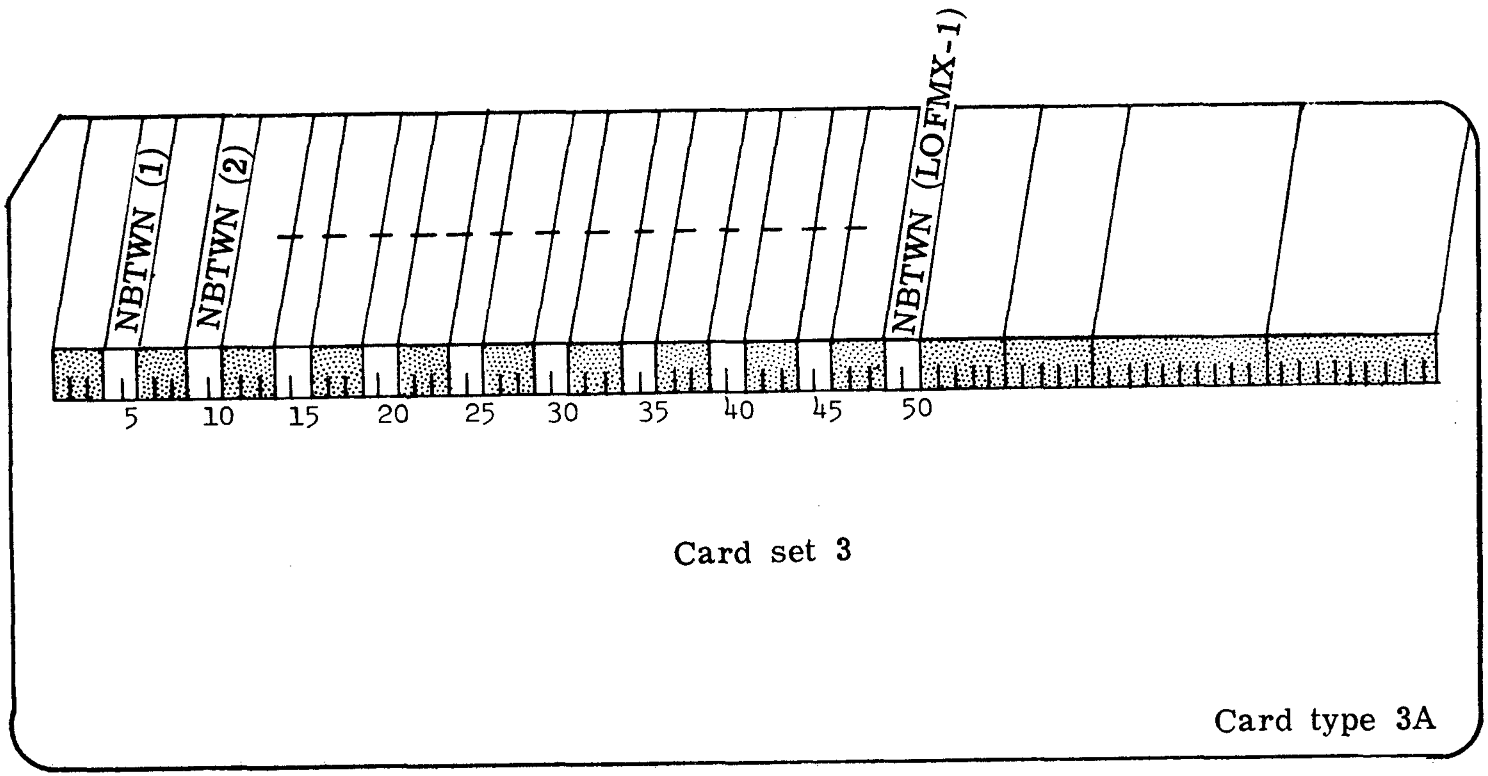


Figure 32.- Fuselage: card set 3 input.

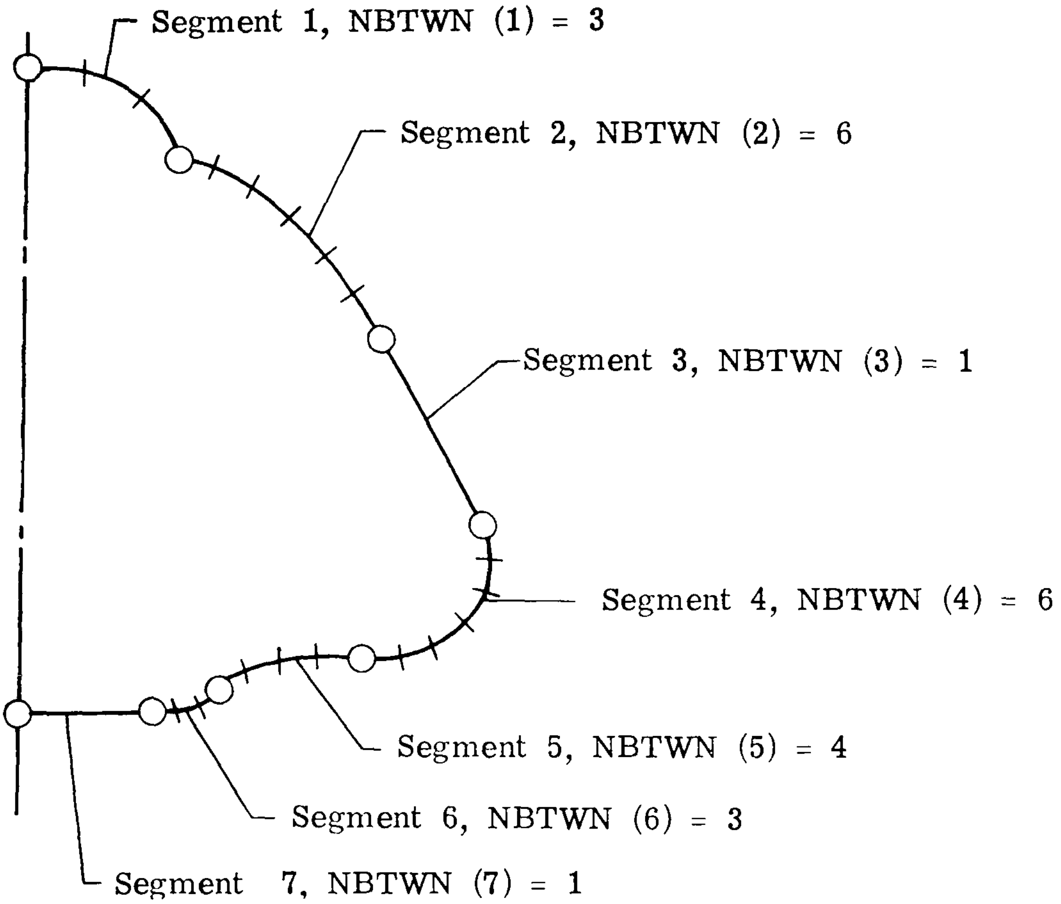


Figure 33.- Fuselage: prescribed uneven cross-section point distribution. Tick marks indicate segment subdivisions. NSS must equal 25; LOFMX must equal 8.

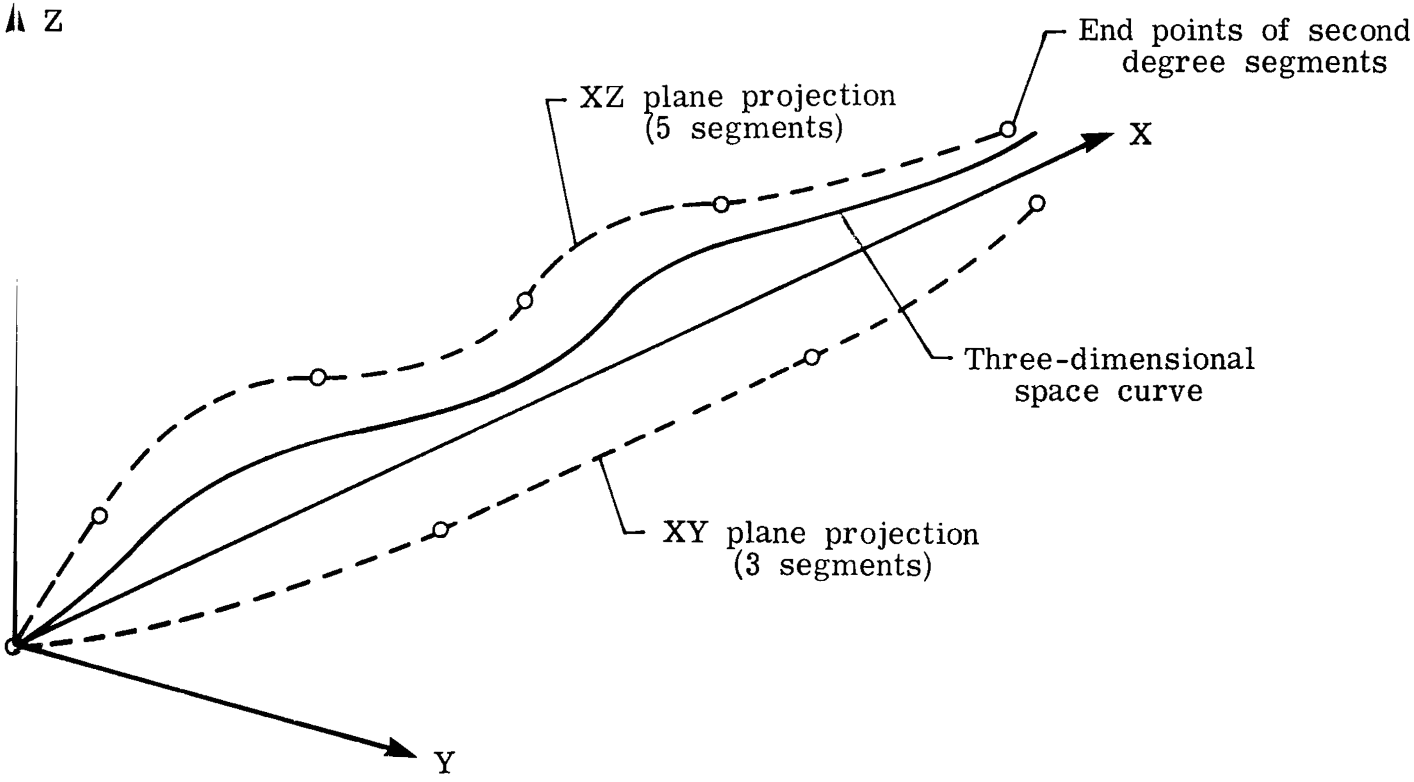


Figure 34.- Fuselage: coordinate plane projections of a three-dimensional space curve.

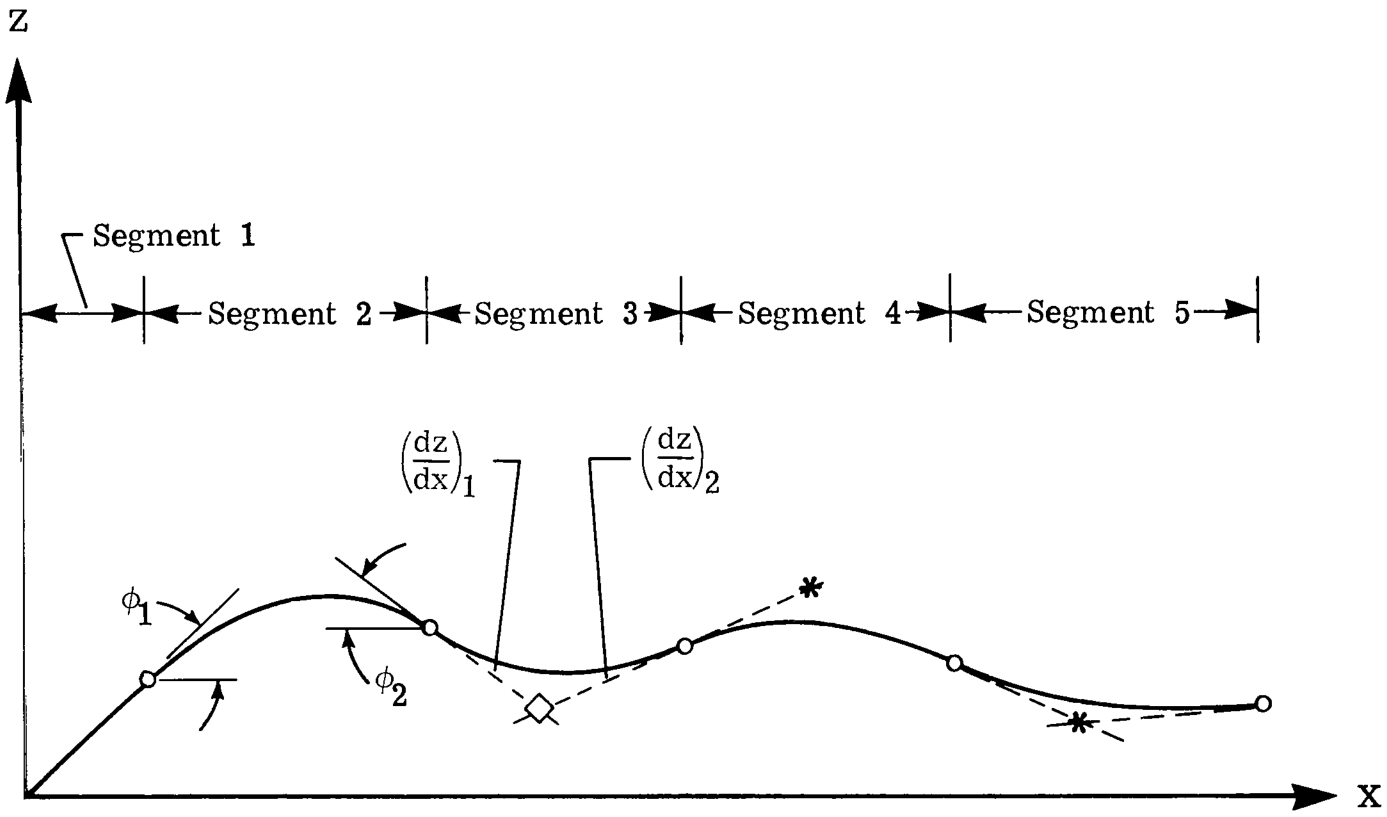
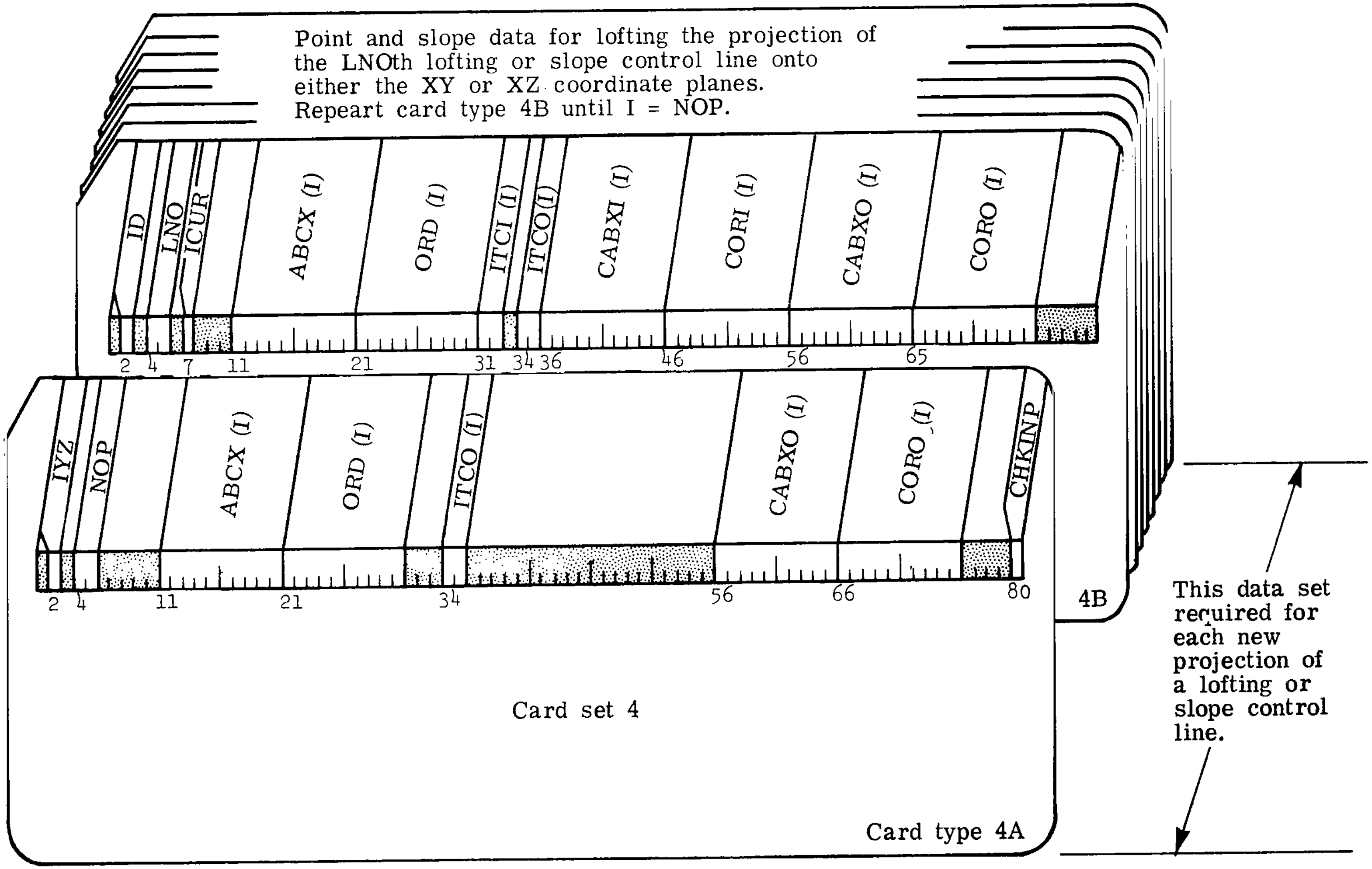


Figure 35.- Fuselage: slope control options for longitudinal segments.
◇ and * denote slope control points.



Point and slope data for lofting the projection of the LNOth lofting or slope control line onto either the XY or XZ coordinate planes. Repeart card type 4B until I = NOP.

This data set required for each new projection of a lofting or slope control line.

Figure 36.- Fuselage: card set 4 input.

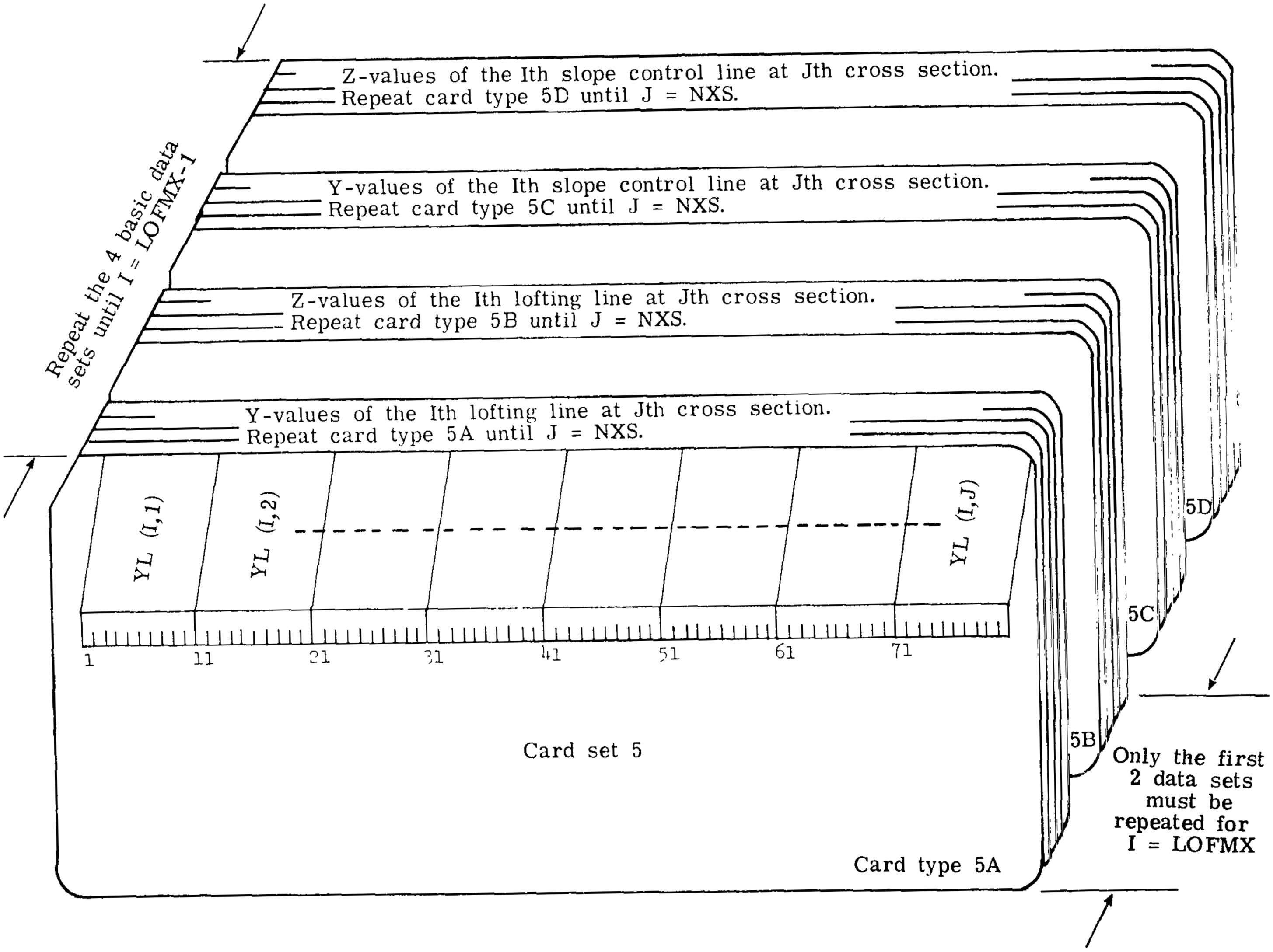


Figure 37.- Fuselage: card set 5 input.

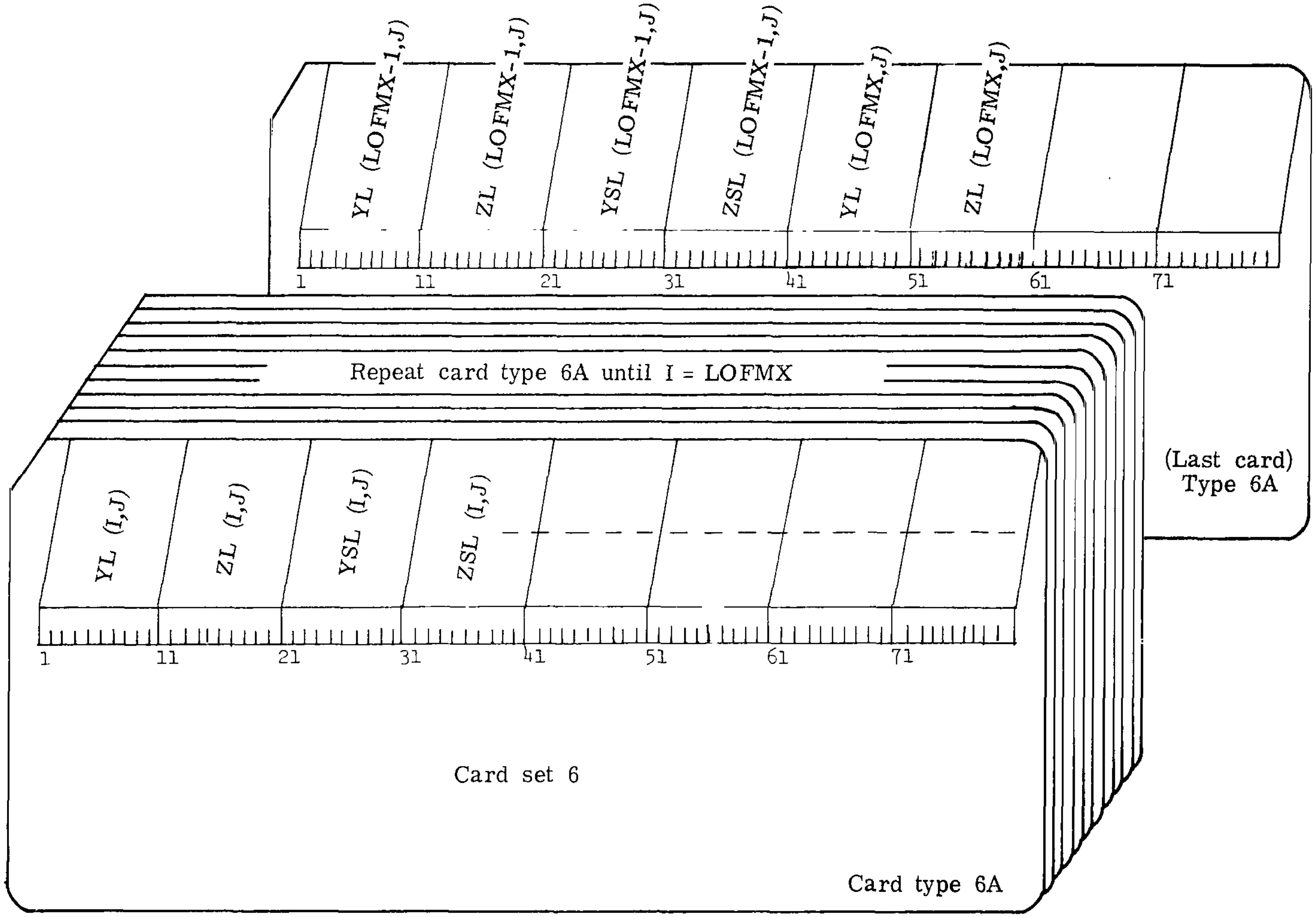


Figure 38.- Fuselage: card set 6 input.

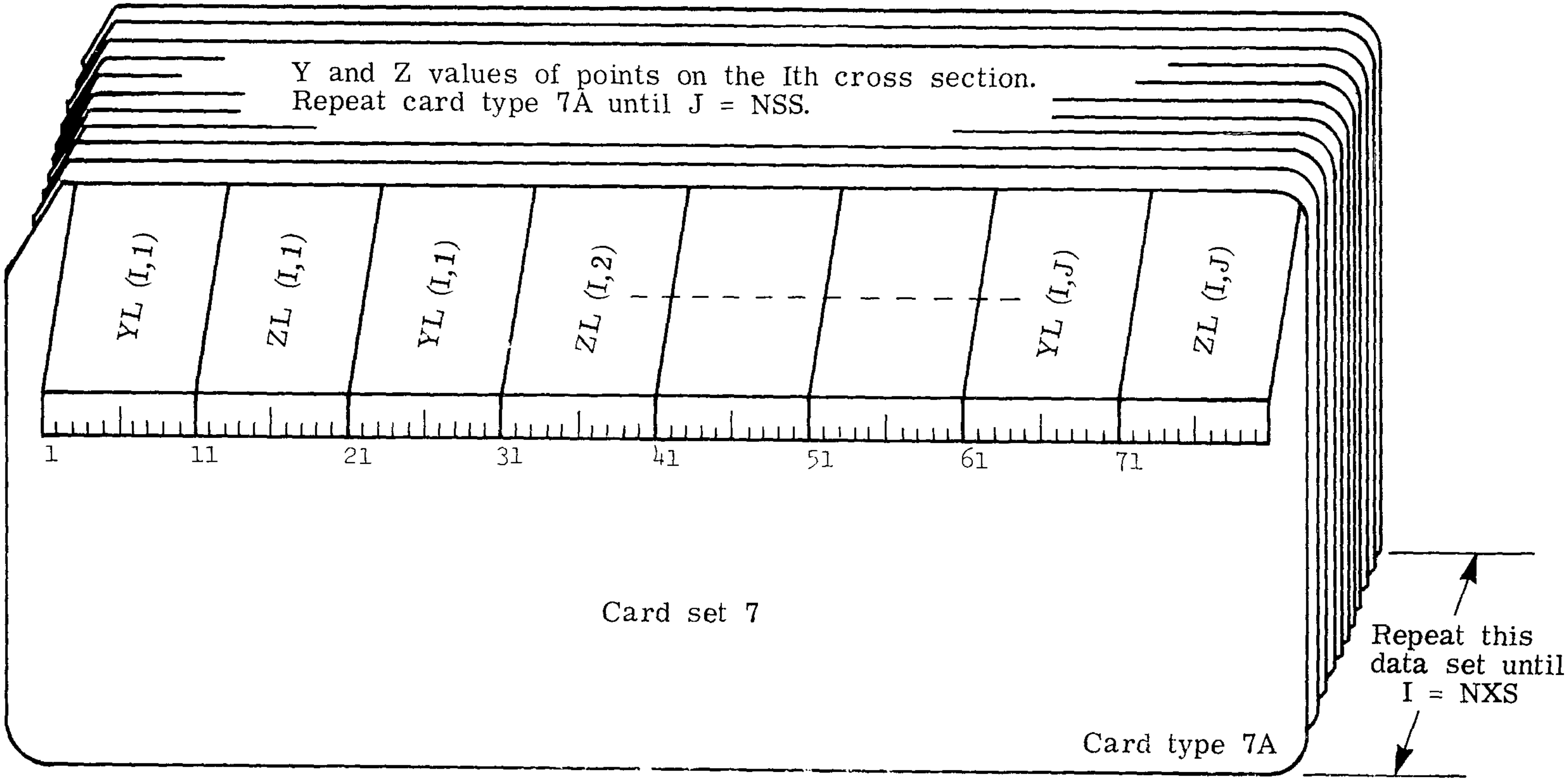
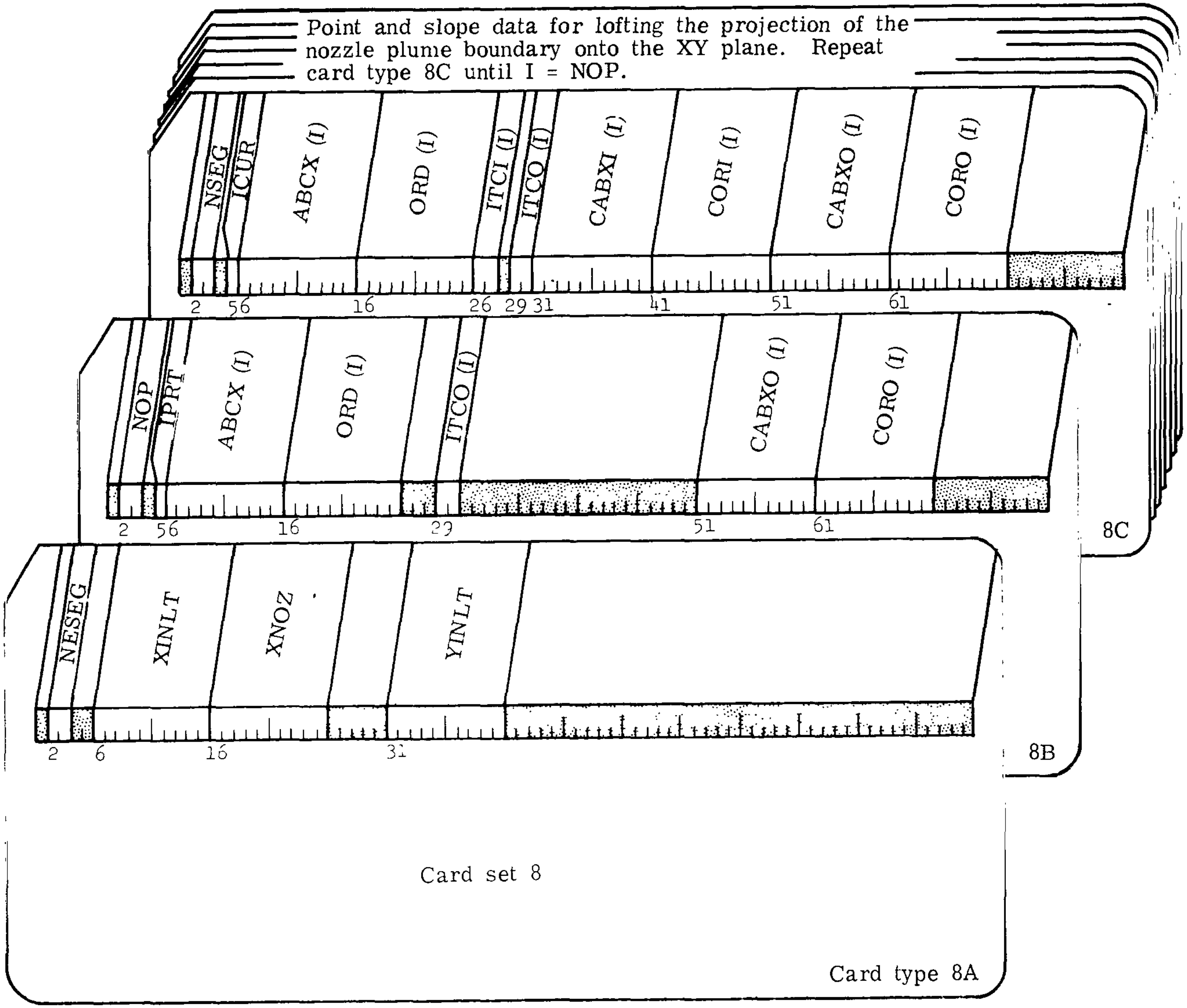


Figure 39.- Fuselage: card set 7 input.



Point and slope data for lofting the projection of the nozzle plume boundary onto the XY plane. Repeat card type 8C until I = NOP.

Figure 40.- Fuselage: card set 8 input.

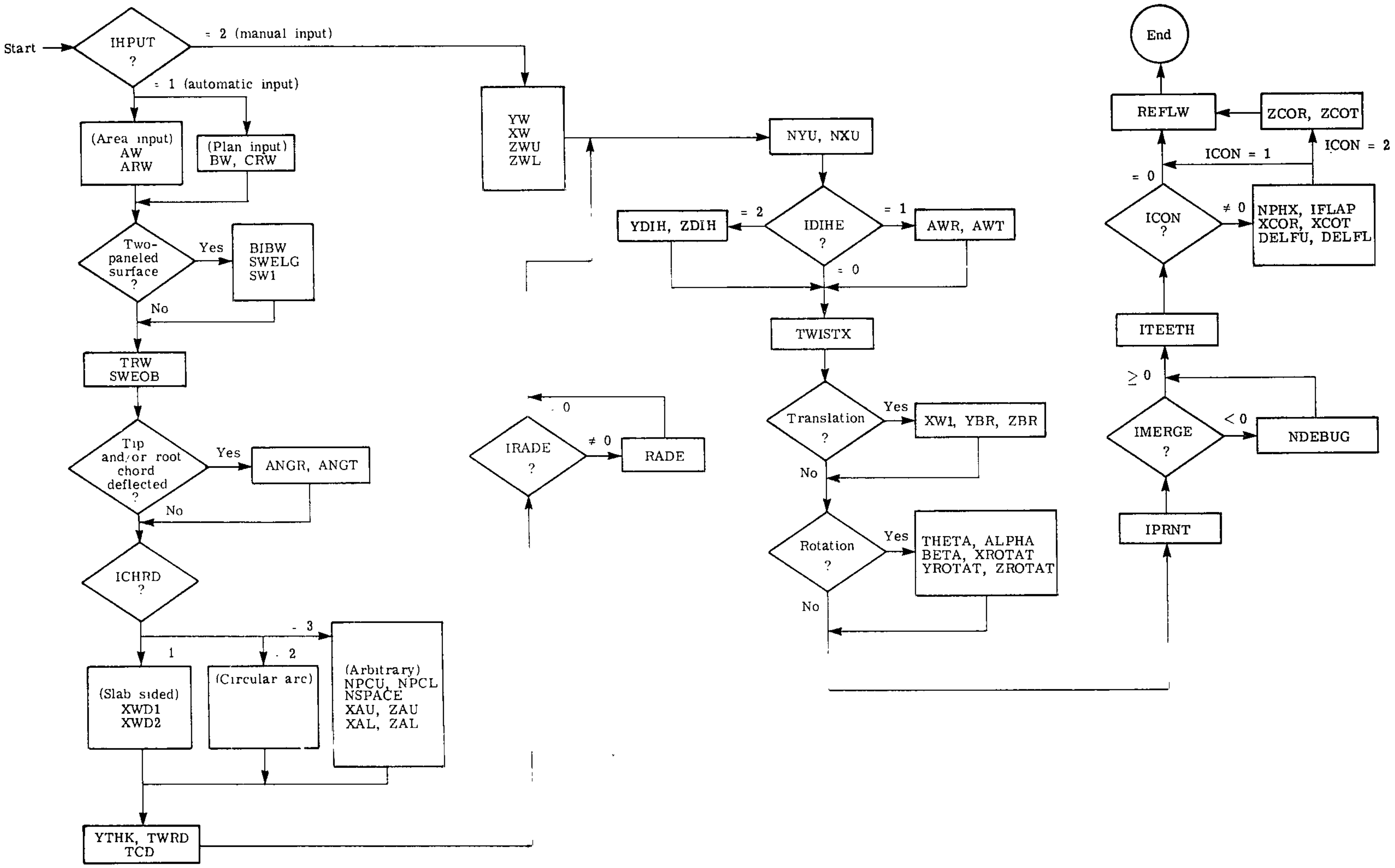


Figure 41.- Planar-surface input flow.

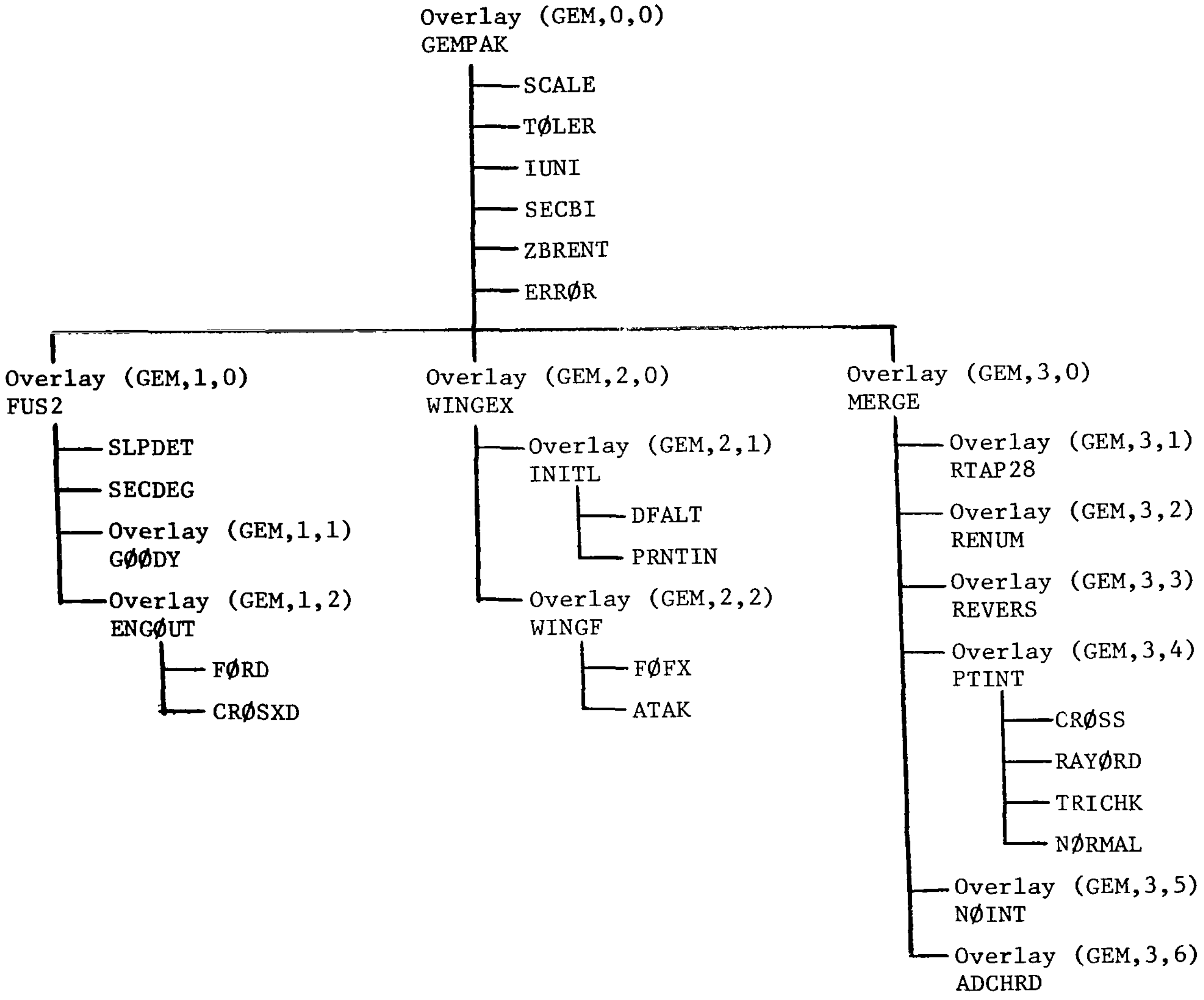


Figure 42.- GEMPAK program structure.

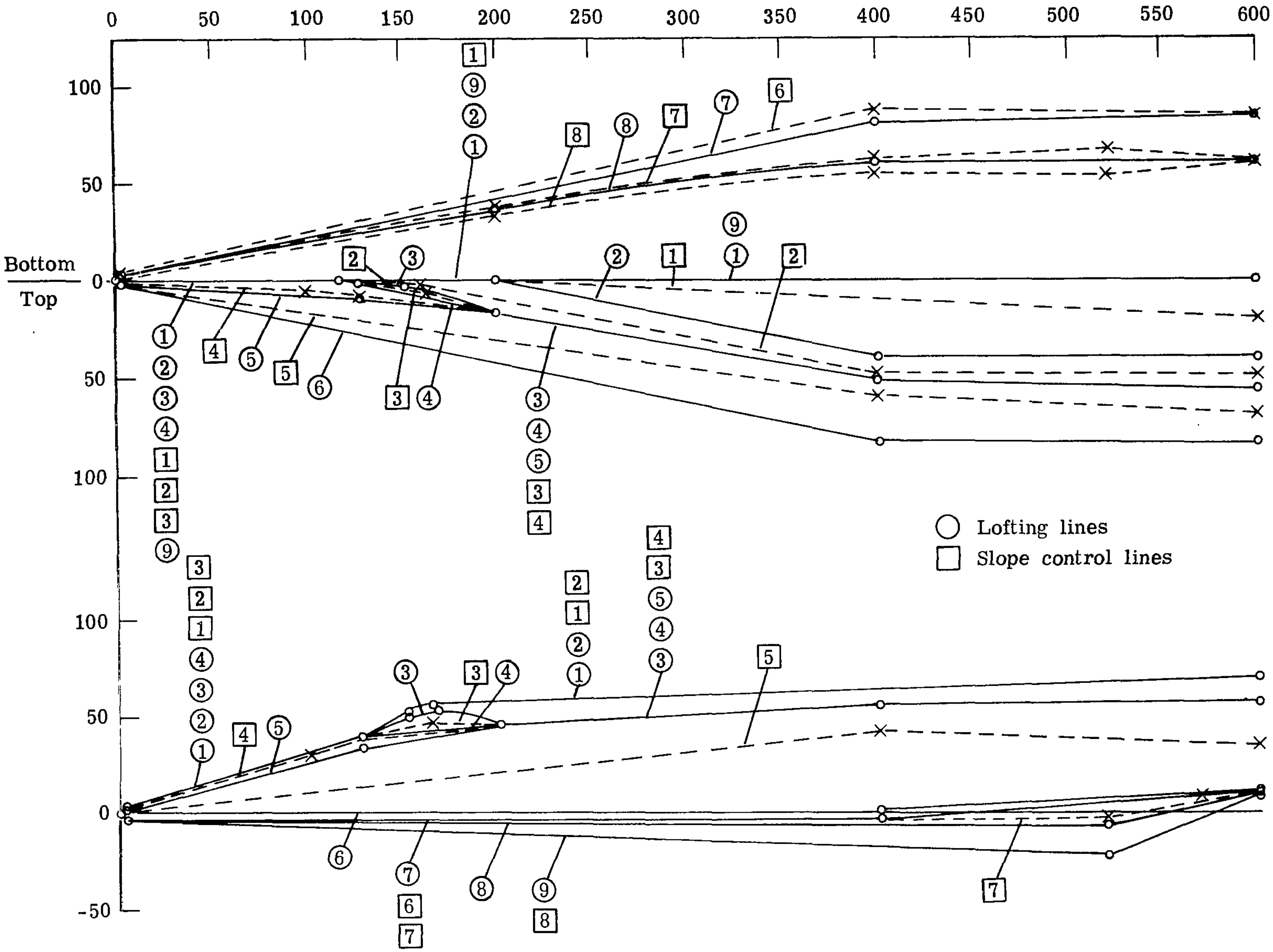


Figure 43.- Sample 1: fuselage input layout. Numbers indicate order of lofting and slope control lines. Solid lines are lofting lines and dashed lines are slope control lines.

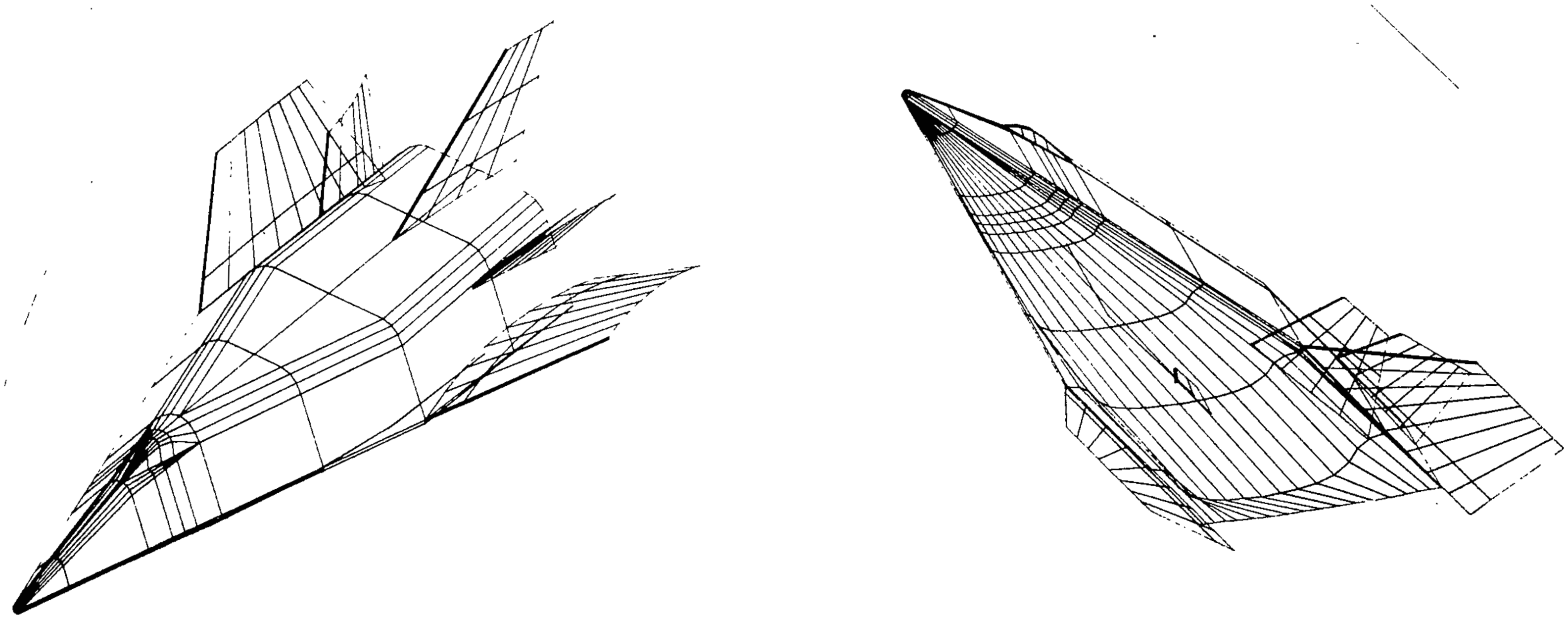


Figure 44.- Computer drawing of final generated geometry for sample case 1.

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15. Supplementary Notes

16. Abstract

A computer program, "GEMPAK," has been developed to aid in the generation of detailed configuration geometry. The program was written to allow the user as much flexibility as possible in his choices of configurations and the detail of description desired and at the same time keep input requirements and program turnaround and cost to a minimum. The program consists of routines that generate fuselage and planar-surface (winglike) geometry and a routine that will determine the true intersection of all components with the fuselage. This paper describes the methods by which the various geometries are generated and provides input description with sample input and output. Also included are descriptions of the primary program variables and functions performed by the various routines. The FORTRAN program GEMPAK has been used extensively on the Control Data Corporation 6000 series computers in conjunction with interfaces to several aerodynamic and plotting computer programs and has proven to be an effective aid in the preliminary design phase of aircraft configurations.

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