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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:

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

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

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

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

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

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

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

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

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

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

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

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:

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

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

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

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

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

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

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:

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

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

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

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

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

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

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

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

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

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

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

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

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

Item	Variable name	Type	Variable description
(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).

Item	Variable name	Type	Variable description
(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).
(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) ≧ YDIH(I - 1), 2 ≦ I ≦ 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 $\neq$ 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 $\neq$ 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.

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.

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.

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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)

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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

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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

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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

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

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Labeled common	Variable name	Variable type	Definition
XYZRAY	IYX	Integer	Wing ray segment equation definition flag in the XY plane for $Y = m_y X + b_y$ 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 $Z = m_z Y + b_z$
	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 $X = m_x Z + b_x$

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

Lofting line 2 in XZ plane

Lofting line 3 in XY plane

Fuselage card set 4

APPENDIX C

```
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

Fuselage card set 4

Lofting line 5 in XZ plane

Lofting line 6 in XY plane

Lofting line 6 in XZ plane

```
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

APPENDIX C

```
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

Fuselage card set 4

Slope control line 4 in XY plane

Slope control line 4 in XZ plane

Slope control line 5 in XY plane

```
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

Fuselage card set 4

Fin input (ICOMP = 5)

```
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= 360.25, 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                               520.0000 ON THE
             A=  0.                                                D=  -.40000E+01   E=  -.51700E+03   F=
                                                8 BETWEEN X=   520.0000 AND X=   600.0000 ON THE X-Z PLANE
ST                                0.            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.
```

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

```
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 LINE                                                           X-Z PLANE
             A=  0.                                                                                            E+03         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        ON 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=  -.80000F+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 FO    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	.22901068E+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	.92612343E-07	-.30000000E+01	14	.46406228E-07	-.30000000E+01	15
.11368684E-12	-.30000000E+01	16	0.	-.30000000E+01	17	0.	-.30000000E+01	18
[illegible]	-.30000000E+01	19	0.	[illegible]	[illegible]	[illegible]	[illegible]	21

(Generated cross-section points)

…0000E+02 YMAX= .12684115E+…

Y	Z	N	Y	Z	N	Y	Z	N
[illegible]	[illegible]	[illegible]	…5290E+02	.19986383E+01	14	.54206904E+02	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	.42881658E+02	-.99721883E+01	17	.32281150E+02	-.11932934E+02	[illegible]
.21…	…9369E+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+02	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	.64826816E+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	.200000E+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	-.7077[illegible]				.184833E+01	8
	.200000E+01	.160000E+01	.100000E+01					[illegible]	9
	.200000E+01	.193502E+01	[illegible]						
1[illegible]	[illegible]00000E+01	.17004[illegible]		[illegible]	.858875E+00	-.512154E+00	[illegible]		
12			[illegible]	.167836E-01	.340167E+00	-.940215E+00	.175340E+03	.4920[illegible]	
13			[illegible]2574E+01	.182807E-01	.182979E+00	-.982947E+00	.110394E+04	.156330E+05	13
14	[illegible]	[illegible]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

(Element characteristics)

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	.340168E+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

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,
NDEBUG   = 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

IMERGS=-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

(Final 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	-.6738	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

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------------------------------------

IHPUT =1 D
        ******************   BW  =  .23250E+03     SWEDB=  .54500E+02
        AUTOMATIC GEOMETRY   CRW =  .19690E+03     SWELG=  .54500E+02
        GENERATION CHOSEN    BIBW= 0.          D   SWI  = 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
```

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

```
          **************   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
```

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	108.6883	77.5000	.2337	2	108.6883	77.5000	-.2337
	3	108.7966	77.5000	.4440	3	108.7966	77.5000	-.4440
	4	108.9650	77.5000	.6102	4	108.9650	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	181.8186	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

(Final generated geometry)

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	572.5635	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

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 *
**************************
```

```
****************************
* E N T E R   W I N G E X *                    (Wing generation)
****************************

$WING
INPUT   = 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
```

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

```
INPUT FOR GEOMETRY GENERATION OF          WING

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

IHPUT =1 D
         ******************    BW   =  .33544E+03     SWEOB=  .59390E+02
         AUTOMATIC GEOMETRY    CRW  =  .40400E+03     SWELG=  .59390E+02
         GENERATION CHOSEN     B1BW= 0.           D   SWI  = 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
```

(Wing geometry before translation and rotation)

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	94.6860	55.9067	1.1909	3	94.6860	55.9067	.1917
	4	94.9008	55.9067	1.3819	4	94.9008	55.9067	.0496
	5	95.1609	55.9067	1.4905	5	95.1609	55.9067	.0000
	6	133.8920	55.9067	[illegible]	6	[illegible]	55.9067	[illegible]
	7	172.6231	55.9067					
	8	211.3542	55.9067					
	9	250.0853	55.9067					
	10	288.8164	55.9067					
	11	327.5475	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	243.7488	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
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	299.5184	167.7200	4.2165	6	299.5184	167.7200	0.0000
	7	314.8771	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	7.3919	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	3.1003	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	19.0642
	9	534.3765	90.3277	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	95.8332	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	145.2498	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 *
*************************
```

```
**************************
* 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    .83805E+02    .97575E+01
      5    .40162E+03    .83332E+02    .11161E+02    .40114E+03    .83816E+02    .97102E+01
      6    .43086E+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    .829[illegible]E+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    .52812E+02
      3    .49666E+03    .56117E+02    .53405E+02    .49614E+03    .56625E+02    .52616E+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
```

(Wing: IMERGE = 1)

(Horizontal tail: IMERGE = 1)

```
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
         Y =   0.          X   0.
         Z =  -.1000E-58 Y  -.1000E-58
         X =    .1294E+01 Z    .4018E+03
```

The most outboard ray segment is tested first. The coordinates of the ray segment end points (PT1,PT2) are (X,Y,Z)1 and (X,Y,Z)2, respectively. The ray segment is described by Y = DYDX*X + BY; Z = DZDY*Y + BZ; etc. 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 $\neq$ 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.       ,  .6651E+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
```

$\left\{\begin{matrix} X(K) \leq XI \leq X(K+1) \\ 520.0 \leq 486.7 \leq 600.0 \end{matrix}\right\}$ No - continue to next fuselage panel

```
 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
          X =   .1294E+01  Z   .4018E+03
```

(Iteration continues until correct limits are found.)

```
        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 RAY
```

```
                                              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
   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.
      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   .4918E+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   .4910E+02,  .6310E+02   .5045E+02,  .6071E+02
 4    .5200E+03,  .6000E+03   .5045E+02,  .6071E+02   .4910E+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
```

```
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
CORNER 2, YT,ZT=     0.        .65623E+02     II=1
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
```

(YI,ZI lies within triangle 1,2,3)

```
               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 FOUND.
 INTERSECTION CANNOT BE FOUND FOR RAY  9 OF LOWER SURFACE     FIN

              RETURN
               END


--- BEGIN SEARCH FOR POINT OF INTERSECTION 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 OF FUSELAGE CROSS-SECTIONS CANNOT BE FOUND.
 INTERSECTION CANNOT BE FOUND FOR RAY 10 OF LOWER SURFACE     FIN

              RETURN
               END
```

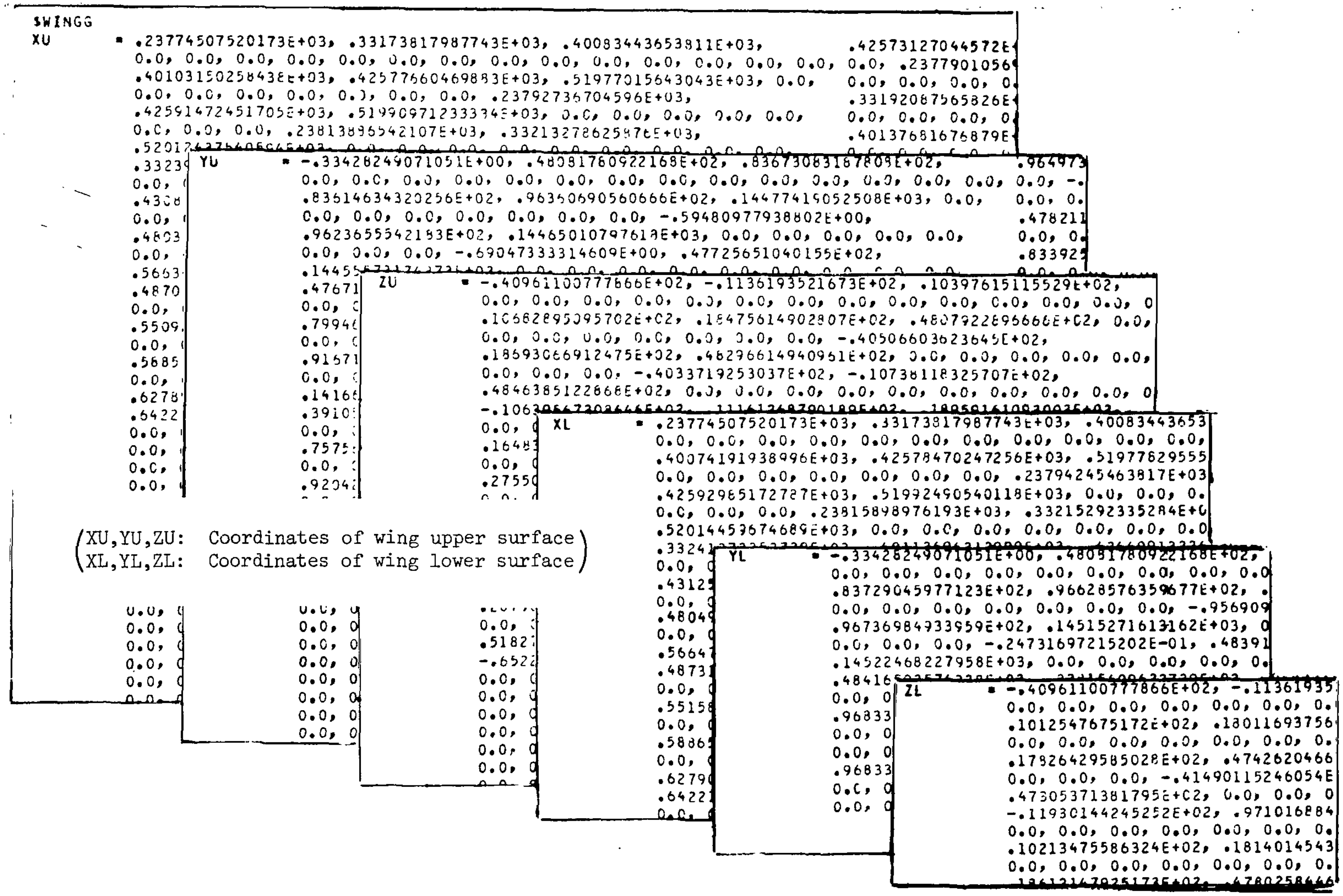
```
LOWER SURFACE      FIN

           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
     523.9187       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    .62936E+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 *
***********************
```

APPENDIX C

Sample Case 1 Output (TAPE38)

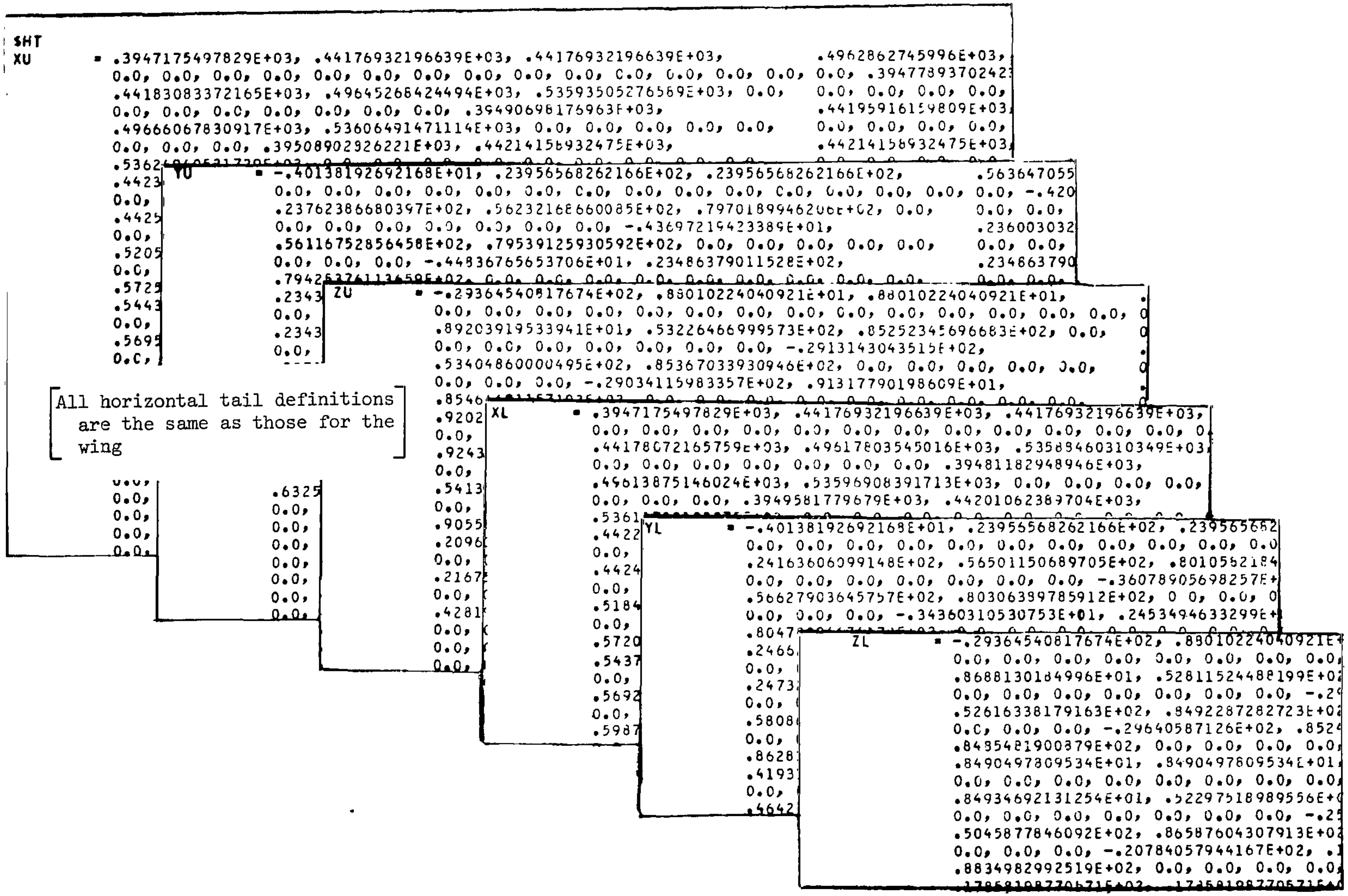
```
$FUSE
X      = 0.0, .3E+01, .5E+02, .128E+03, .152E+03, .164E+03, .176E+03, .2E+03,  .3E+03, .4E+03, .52E+03, .6E+03, 0.0,
         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
Y      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
         .2E-06, .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,
         .35294130930391E+00, .14646161379596E+01, .20757884902605E+01,       .31457864550101E+01, .68149921808022E+01,
         .26764699411746E+02, .46714804183061E+02, .44690446561744E+02,       .43340874012815E+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,        .54890263806542E+01, .84453920576670E+01,
         .171E+02, .37052999999999E+02, .57005999999996E+02,                  .54981599999996E+02, .53631999999999E+02,

Z      = 0.0, .3E+01, .166864E+02, .39399999999999E+02, .52000000000007E+02,     .56E+02, .56357798165137E+02,
         .60055045871568E+02, .63036697247706E+02, .66614678899082E+02,          .69E+02, 0.0, 0.0, 0.0, 0.0, 0.
         0.0, 0.0, 0.0, .3E+01, .166864E+02, .39399999999999E+02,                .52000000000007E+02, .56E+02,
         .57073394495413E+02, .60055045871568E+02, .63036697247706E+02,          .66614678899082E+02, .69E+02, 0
         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .3E+01, .166864E+02,             .39399999999999E+02, .514829488
         .55448478935463E+02, .55874651034203E+02, .55295720401838E+02,          .58272220688207E+02, .612487068
         .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
         .39399999999999E+02, .50452831341572E+02, .54265422185206E+02,          .54518486973712E+02, .511825094
         .54158094152301E+02, .57133677571762E+02, .60711650959991E+02,          .63097299885233E+02, 0.0, 0.0,
         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .3E+01, .166864E+02,                      .39399999999999E+02, .492000000
         .52608540361228E+02, .52436677614334E+02, .457E+02, .48681755E+02,      .516635E+02, .552416E+02, .5762
         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
         .436E+02, .45599999778478E+02, .46681749778448E+02,                     .51563499778431E+02, .552415997
         .57626999778483E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,        .28132180195499E+01, .162883296
         .38519543050381E+02, .40913028700254E+02, .42109771525195E+02,          .43306514350127E+02, .456999997
         .48661749774785E+02, .51663499774787E+02, .55241599774785E+02,          .57626999774786E+02, 0.0, 0.0,

YMAX   = 0.0, .31050742776858E+01, .12684115392959E+02, .26581227772727E+02,   .33472641864314E+02,
         .38364053549839E+02, .43255462826405E+02, .63636308817688E+02,        .84017112722684E+02,
         .84000000381446E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
ZMAX   = 0.0, -.54509858160791E+00, .55200940575662E+00, .23727164443945E+01,  .29329365139999E+01,
         .34931564505953E+01, .40533762810998E+01, .63876241075962E+01,        .87218694670020E+01,
         .10899999413059E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
NXS    = 12,
NSS    = 21,
RFL    = .6E+03,
ICO    = 1,
$END
```

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


SWINGG
XU
YU
ZU
XL
YL
ZL
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, .19729445529 67E-01, .21186272980305E-01, .23834199183216E-01, .26688088321525E-01,
          .29763960755131E-01, .33079082951 3E-01, .36652064410305E-01, .40502962130196E-01, .44653393197139E-01,
          .49126656133328E-01, .53947361683677E-01, .59144073775451E-01, .64744461442 13E-01, .70780462564322E-01,
          .77265960346891E-01, .84297473522956E-01, .91854361352489E-01, .99999044566247E-01,
ZLEU    = .21565032222301E-02, .42678447163435E-02, .47882065343429E-02, .52537730593 76E-02, .57569835424453E-02,
          .63139645899037E-02, .69953492992524E-02, .75157372023019E-02, .81736657000915E-02, .88715750813242E-02,
          .96107659473095E-02, .10392347665303E-01, .11217176237653E-01, .12085779700 91E-01, .12998268650 63E-01,
          .13954230716679E-01, .14952601781777E-01, .15991517433005E-01, .17068133550202E-01, .18178415453405E-01,
          .19316883637978E-01, .20476344802522E-01, .21647495600 26E-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, -.12031774031 09E-02, -.14841307138947E-02, -.17772399318021E-02,
          -.20318833237373E-02, -.23971375039823E-02, -.27217130348019E-02, -.30538784019882E-02, -.33913703918606E-02,
          -.37312885700934E-02, -.40699711825668E-02, -.44028493579766E-02, -.47242759769181E-02, -.50273249759364E-02,
          -.53035561598304E-02, -.55427397878901E-02, -.57325342605399E-02, -.58581091409031E-02, -.59017044763226E-02,
          -.58421159091 21E-02, -.56540933503848E-02, -.53076369965321E-02, -.47671881507 05E-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, 0.0, 0.0, 0.0, 0.0, 0.0, .39477893702423
.44183083372165E+03, .49645268424494E+03, .53593505276569E+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, .39490698176963E+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, .39508902926221E+03, .44214156932475E+03, .44214156932475E+03,
YU = -.40138192692168E+01, .23956568262166E+02, .23956568262166E+02, .563647055
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, -.420
.23762386680397E+02, .56232168660085E+02, .79701899462066E+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
ZU = -.29364540817674E+02, .88010224040921E+01, .88010224040921E+01,
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,
.89203919533941E+01, .53226466999573E+02, .85252345696683E+02, 0.0,
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.29131430435151E+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,
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,
.44178072165759E+03, .49617803545016E+03, .53588460310349E+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,
YL = -.40138192692168E+01, .23956568262166E+02, .239565682
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, 0.0, -.34360310530753E+01, .24534946332996E+
ZL = -.29364540817674E+02, .88010224040921E+
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
.86881301 84996E+01, .52811524488199E+02
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, -.2
.52616338179163E+02, .84922872827 23E+02
0.0, 0.0, 0.0, -.29640587126E+02, .8524
.8485481900879E+02, 0.0, 0.0, 0.0, 0.0, 0.0,
.8490497809534E+01, .8490497809534E+01,
0.0, 0.0, 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, 0.0, -.25
.5045877846092E+02, .86587604307913E+02
0.0, 0.0, 0.0, -.20784057944167E+02, .1
.8834982992519E+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, .18729445529967E-01, .21186272980305E-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,  .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, .75979864836445E-02,  .80318021142663E-02, .84954797710836E-02,
          .89907174292285E-02, .95192416534965E-02, .10082795607665E-01,  .10683121323802E-01, .11321937518197E-01,
          .12000912110679E-01, .12721626458208E-01, .13485544143409E-01,  .14293940960171E-01, .15147864506979E-01,
          .16048051528823E-01, .16994842834053E-01, .17959079246253E-01,  .19026977624453E-01,
ZLEL    = 0.0, -.29508088844335E-02, -.39633786669573E-02, -.45451865014232E-02, -.48075223191313E-02, -.49564533972143E-02,
          -.51691996602883E-02, -.53954675575 36E-02, -.56358197329436E-02, -.58907835473663E-02, -.61608355588743E-02,
          -.64463827312 22E-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, -.11411064427 51E-01, -.11822024719232E-01,
          -.12212818458468E-01, -.12573451663 27E-01, -.12891791320695E-01, -.13153178939711E-01,
XX1     = .1E-02,
XX2     = .1E+00,
NO      = 30,
II      = 2,
RFL     = .6E+03,       [All horizontal tail definitions are the same as those for the wing]
IFLAP   = 0,
ICO     = 4,
$END
```

```
$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, .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,
       .5581556098895E+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,
       .6015
       .4874
       0.0,
       .5454
       0.0,
       .6022
       0.0,
       .6428
       .6293
       0.0,
       0.0,
       0.0,
       0.0,
       0.0,
```

```
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, -.27282095329078E+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,                -.50804286
       -.50826118554465E+00, -.50884564221258E+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,         -.67386635
       -.67458385265138E+00, -.67571922604151E+00, 0.0, 0.0, 0.0, 0.0, 0.0,  0.0, 0.0,
       0.0,
       -.747
       -.363
       0.0,
       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, 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,
       0.0,
       .8733
       0.0,
       .154E
       .6884
       0.0,
       .8733
       0.0,
       0.0,
       0.0,
       0.0,
```

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

```
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,
       .5581556098895E+03, .6012850842942E+03, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, .48717595153119E+03, .48717595153119E+03,
       .6015
       .4874
       0.0,
       .5454
       0.0,
       .6022
       0.0,
       .6428
       .6293
       0.0,
       .6353
```

```
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, .6738663868589
       .67458385265138E+00, .67571922604139E+00, 0.0, 0.0
       0.0,
       .7479
       .3635
       0.0,
       .5644
       0.0,
       .5961
       0.0,
       .4858
```

```
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, .66728539292221E+02, .66728539292221E+
       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
```

```
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,
         .77285960346691E-01, .84297473522956E-01, .91854361352489E-01,   .99990044566247E-01,
ZLEU   = 0.0, .46232134164016E-02, .59381828244502E-02, .68178792940213E-02,  .74957539255067E-02, .81259479566871E-02,
         .84618568967152E-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,   .16494520607589E-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, -.59381928244502E-02,                 -.68178792940213E-02, -.74957539255067E-02,
         -.81259479566871E-02, -.84618569867152E-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, -.16494520607589E-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,
ICO    = 5,
$END
```

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

```
$CONST
TITLE   = .57202374148088-145, .16810266916175-183, .22538883006315E-29,      .70739430816307E+28, .14517629854422-260,
          .66235824119418E-68, -.71738305547276E+58, .44403860393731E+86,     .14517629854422-260, .22538883006315E-29,
          .70739430816307E+28, .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, .19464959268609-106,      .32274445242386+221, .76695844571428E+09,
          .41576900652477E-10, .81910664856788+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
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,
NYF     = 20, 50, 20, 30,
$END
```

(Component geometry has been generated. 0: No; 1: Yes)

Array containing intersection chord locations of components:

- 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

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

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   1.24858   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  10.52590  -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

APPENDIX C

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	50.68072	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	
2.84515	-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

1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890

1	2	3	4	5	6	7	8	
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]

APPENDIX C

COLUMN	1	2	3	4	5	6	7	8
	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890
	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	68.06366	7.57287	63.40645	5.30793	60.00000	1.50000
	54.60711	-1.48550	48.85336	-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 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.        16.686    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

APPENDIX C

APPENDIX C

COLUMN 1234567890	1 1234567890	2 1234567890	3 1234567890	4 1234567890	5 1234567890	6 1234567890	7 1234567890	8	
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								Slope control line 3	
0.	3.	16.686	31.246	39.4	45.035	47.429	46.853		
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								Lofting line 4	Fuselage card set 5
0.	3.	16.686	31.246	39.4	41.5	42.55	43.6		
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								Slope control line 4	
0.	3.	16.686	31.246	39.4	41.5	42.55	43.6		
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	61.789	70.303	69.855	69.409	69.111	Slope control line 5	
68.816									

```
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
        1234567890123456789012345678901234567890123456789012345678901234567890123456789 0
         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

at X = 50.0

at X = 100.0

Fuselage card set 6

COLUMN	1	2	3	4	5	6	7	8	
1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890		
	8.942	34.	23.986	10.852	28.172	4.410	31.097	-0.090	at X = 125.0
	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	at X = 152.0
	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	at X = 164.0
	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	at X = 176.0
	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	at X = 200.0
	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	at X = 250.0
	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	at X = 300.0
	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	

[Fuselage card set 6]

APPENDIX C

COLUMN	1	2	3	4	5	6	7	8	
1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890		
47.030	50.174	61.789	27.462	73.411	9.579	76.336	5.079	at X = 350.0	
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	at X = 400.0	
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	at X = 460.0	Fuselage card set 6
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	at X = 520.0	
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	at X = 560.0	
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	at X = 600.0	
84.	10.9	60.328	10.9	60.	10.	59.672	9.1		
0.	9.1								

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
       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 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=     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.              D=
COEFFS FOR PROJECTION
ST LINE     A=
COEFFS FOR
ST LINE
COEFF
ST
CO
```

(Same as for sample case 1)

```
                                                                                           .32526264E+03
                                                .19480709E+05      .47571503E+06      .37526835E+03
                      .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
```

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	9.1796	638.5812
28.9218	9.2181	638.7889
34.7066	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
595.8931	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, 0.0, 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,        .347304083204 22E
          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, .2860039361286E+
          .29058566232 56E+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
          0.0,
          .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
          -.17090939055439E+02, -.18760342053 89E+02, -.18841881841732E+02,     -.4864
          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, -.1697
          -.19772806059143E+02, -.19859886263 19E+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,
          .49418092004587E+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.
          .55096668586972E+03, .55366809017938E+03, .59621505991012E+03,
          0.0, 0.0, 0.0, 0.0, 0.0, 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, 0.0, 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
      INPUT=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, SWEO8=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, SWEOB=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, XCCR=.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	353.5		
	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.					

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-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,
ICD     = 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, 0.0, 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, 0.0, .55906666666667E+02, .11181333333333E+03, .16772E+03,   0.
          0.0,
          .1677
          .1118
          0.0,
          0.0,
          .16772
          .11181
          0.0,
          0.0,
          .16772
          .11181
          0.0,
```

```
ZU      = -.17195768119421E+02, -.21407760592684E+02, -.25621004205582E+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
          0.0, 0
```

```
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, 0.0, 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, 0.0, 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
          .1118
```

```
ZL      = -.35216999999953E+02, -.352169999
          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
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
```

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, .18729445529675E-01, .21186272980305E-01,  .23834199183216E-01, .26688088321525E-01,
          .29763960755131E-01, .33079082951 3E-01, .36652064410305E-01,   .40502962130196E-01, .44653393197139E-01,
          .49126656133328E-01, .53947361683677E-01, .59144073775451E-01,  .64744461442 13E-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, .21647495600 26E-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, -.12031774031 09E-02, -.14841307138947E-02, -.17772399318021E-02,
          -.20818833237373E-02, -.23971375039823E-02, -.27217130348018E-02,
          -.37312885700934E-02, -.40699711825668E-02, -.44028493579766
          -.53035561598304E-02, -.55427397878901E-02, -.57325342605399
          -.58421159091 21E-02, -.56540933503848E-02, -.53076389965321E
XX1     = .1E-02,
XX2     = .1E+00,
ND      = 30,
II      = 2,
RFL     = .1E+01,
IFLAP   = 1,
ICD     = 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,
XD      = .303E+03,
YO      = 0.0,
ZO      = .90106159403 13E+01,
DX2     = .14628699442906E+03,
DY2     = .33544E+03,
DZ2     = -.12642931673939E+02,
$END

$CONST
TITLE   = .57202374148088-145, .16810266916175-183, .225388
          .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 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

(Definitions same as for sample case 1)

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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.

5. Ladson, Charles L.; and Brooks, Cuyler W., Jr.: Development of a Computer Program To Obtain Ordinates for NACA 6- and 6A-Series Airfoils. NASA TM X-3069, 1974.

6. Kinsey, Don W.; and Bowers, Douglas L.: A Computerized Procedure To Obtain the Coordinates and Section Characteristics of NACA Designed Airfoils. AFFDL-TR-71-87, U.S. Air Force, Nov. 1971.

7. Vachris, Alfred F., Jr.; and Yaeger, Larry S.: QUICK-GEOMETRY - A Rapid Response Method for Mathematically Modeling Configuration Geometry. Applications of Computer Graphics in Engineering, NASA SP-390, 1975, pp. 49-73.

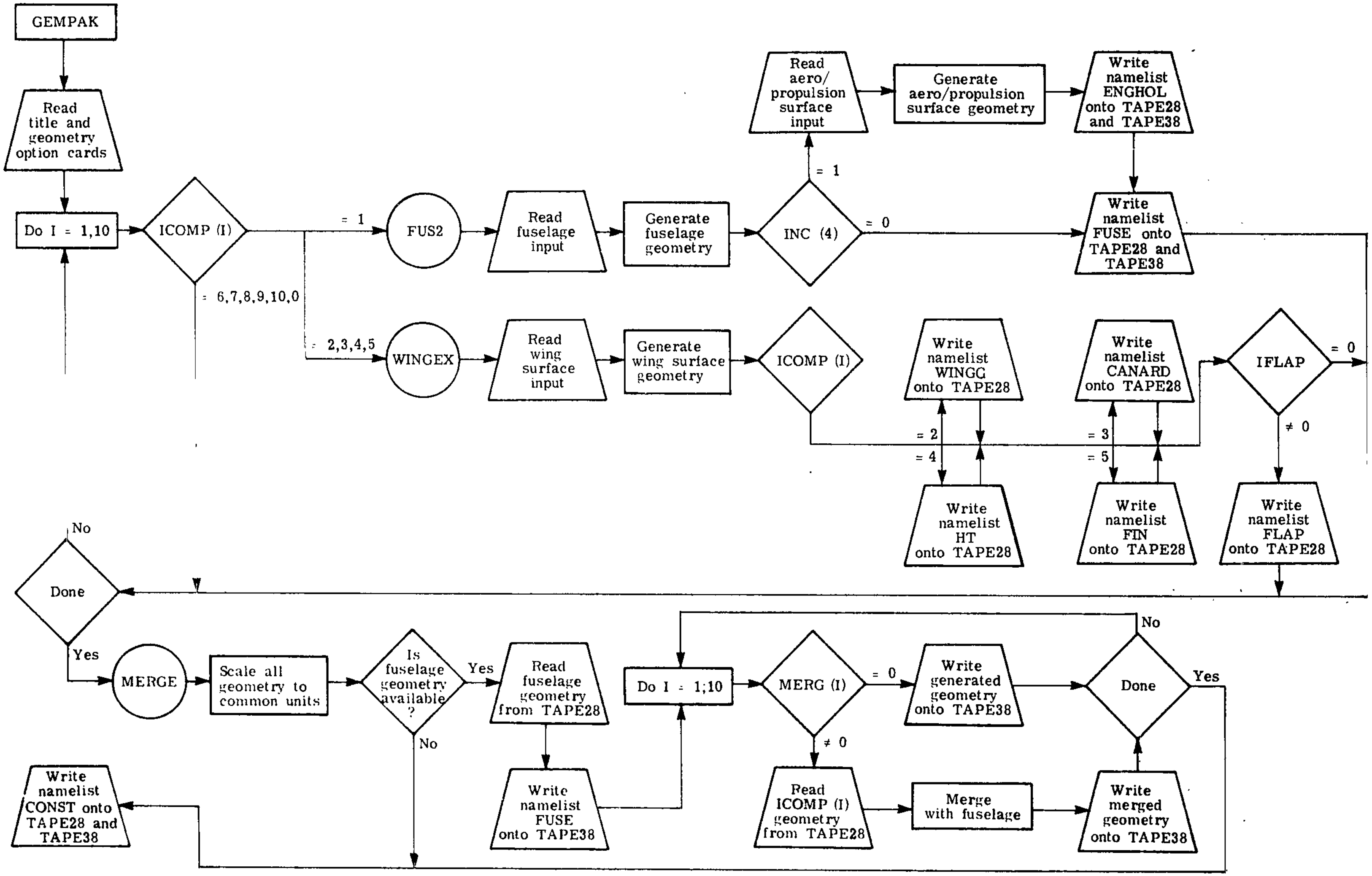


Figure 1.- Basic logic flow of GEMPAK.

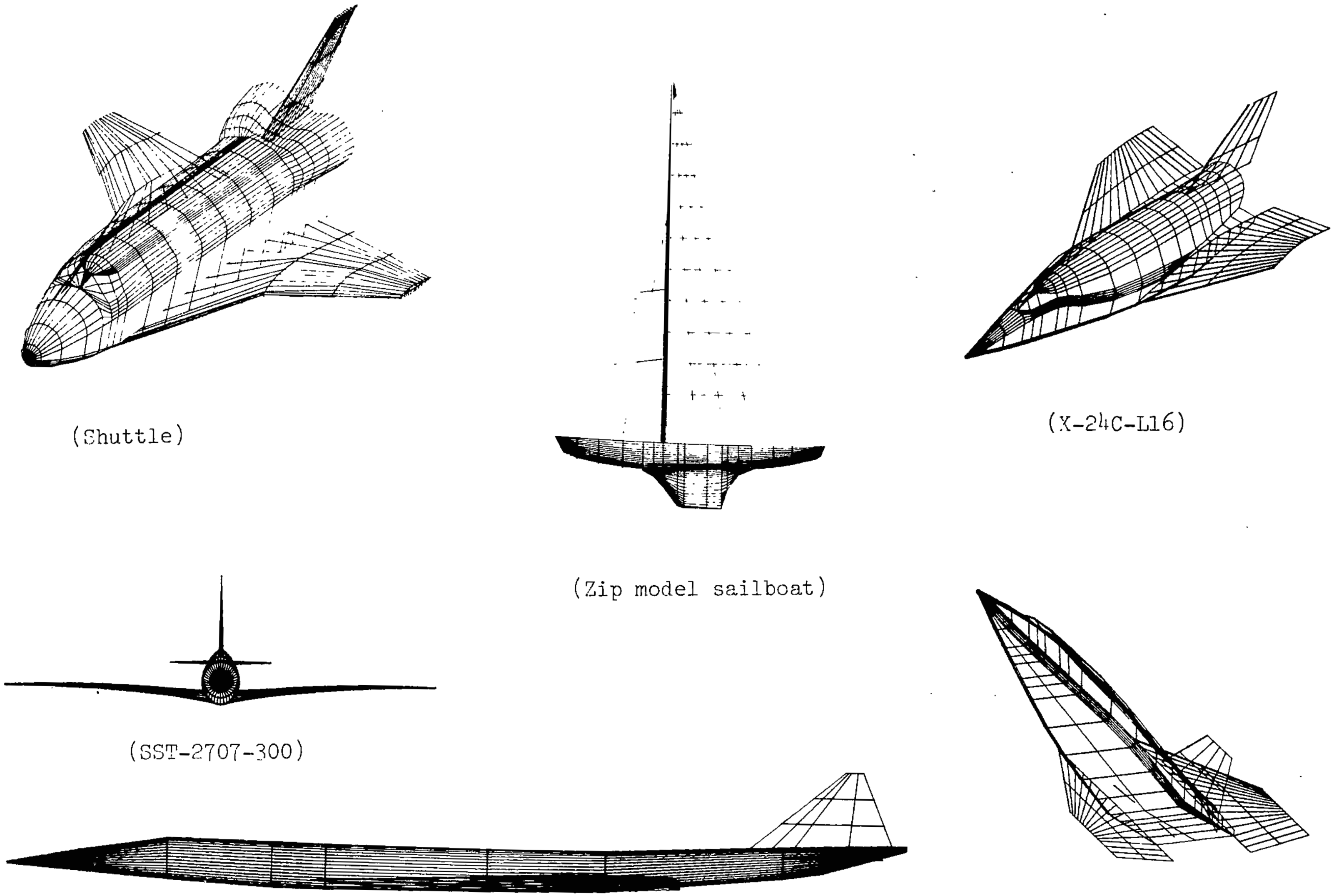


Figure 2.- Examples of GEMPAK-generated geometries.

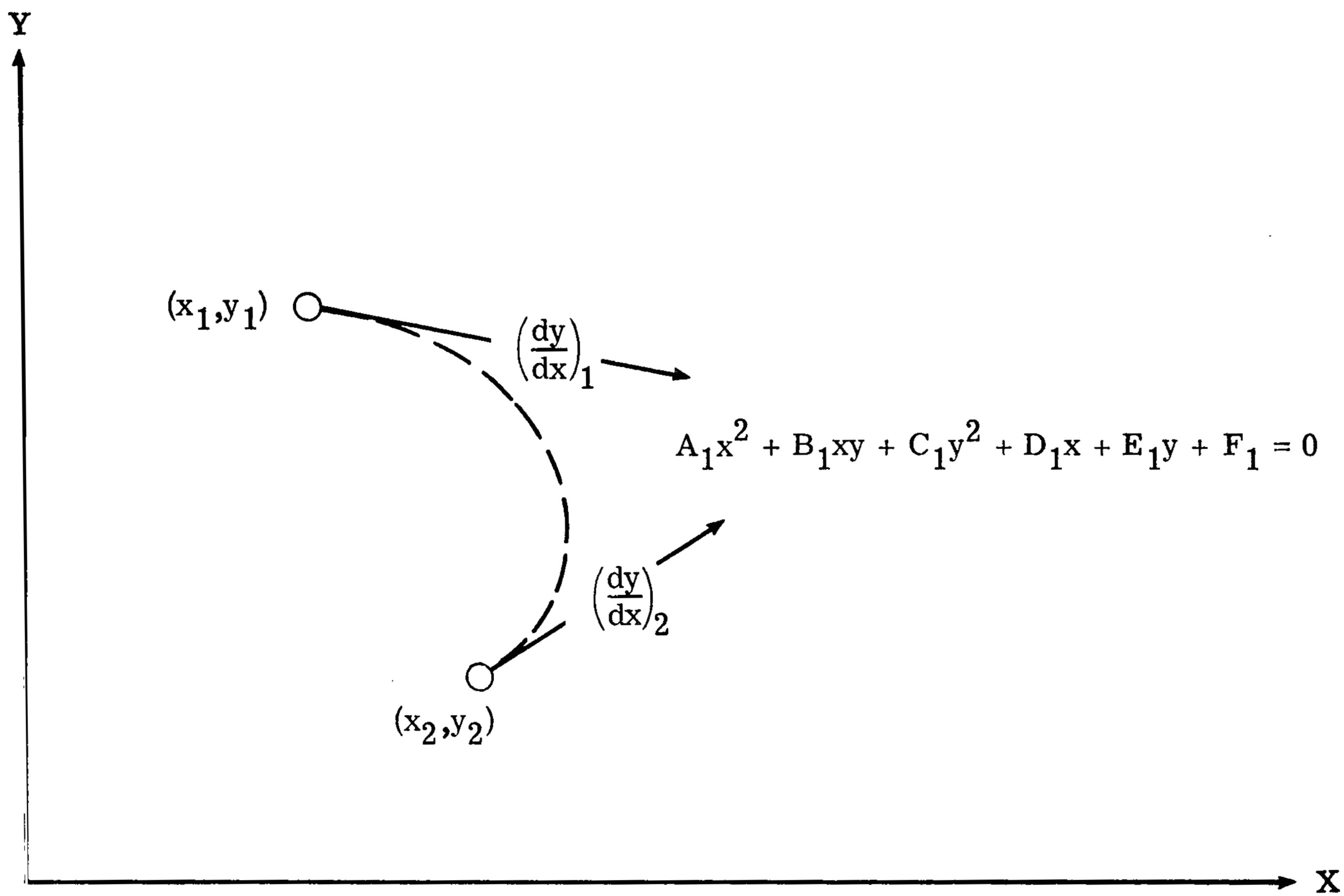


Figure 3.- Fuselage: initial conditions required to fit second-degree conic segment.

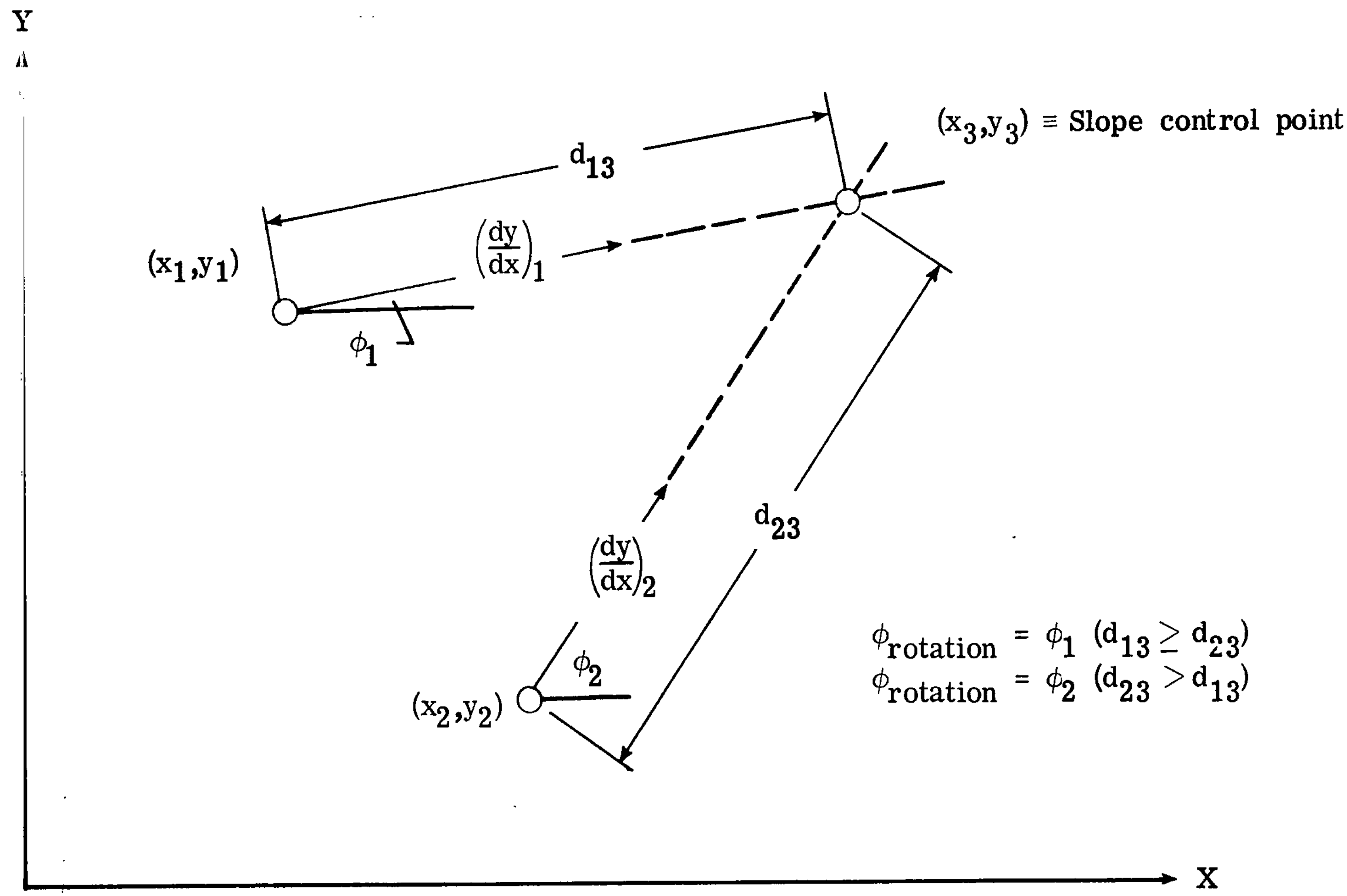
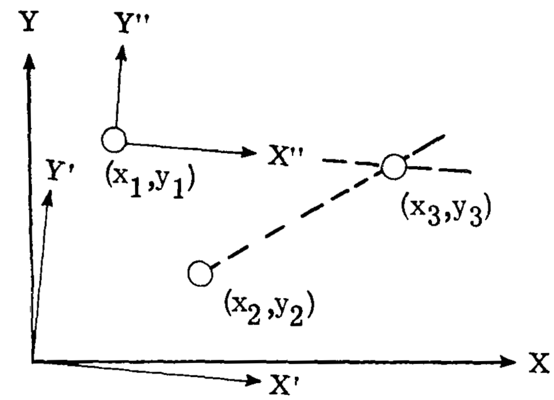
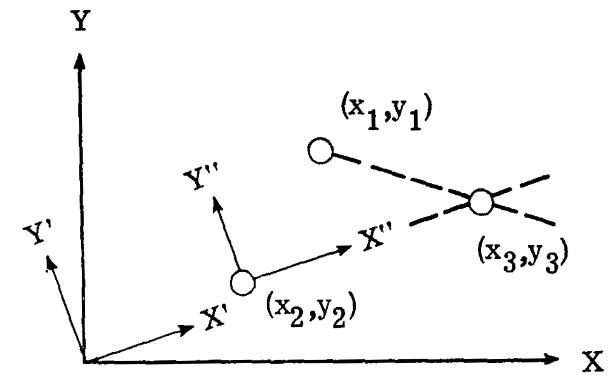


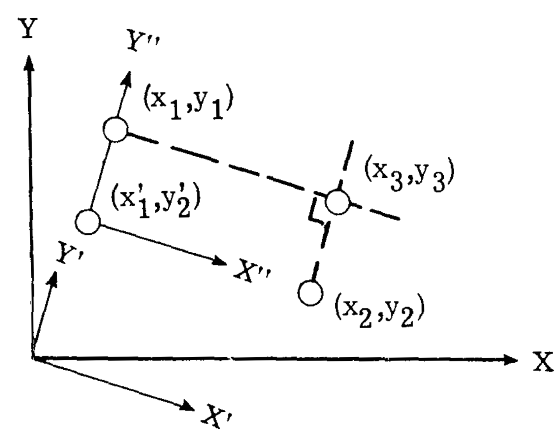
Figure 4.- Fuselage slope control point.



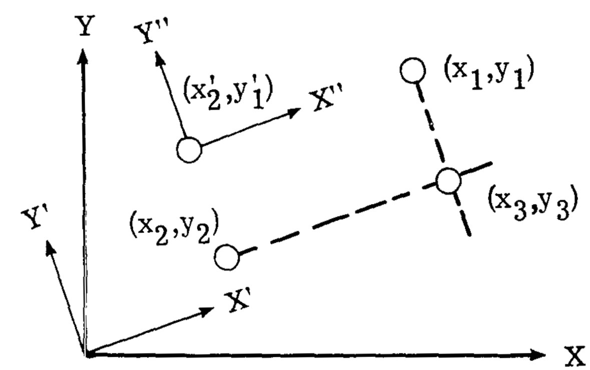
(a) Nonorthogonal slopes and $d_{13} \geqq d_{23}$.



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

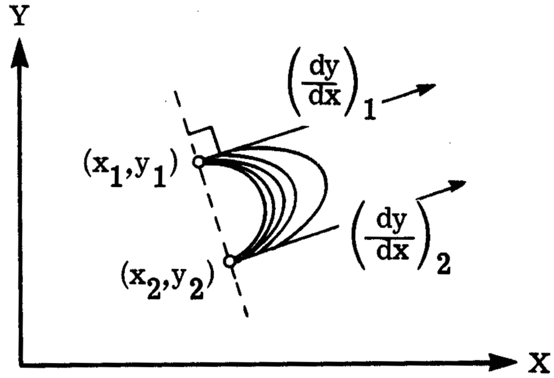


(b) Orthogonal slopes and $d_{13} \geqq d_{23}$.

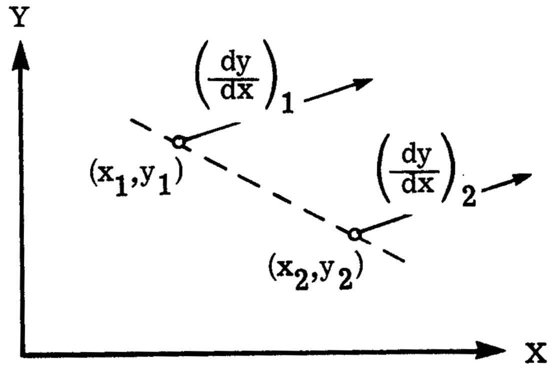


(d) Orthogonal slopes and $d_{23} > d_{13}$.

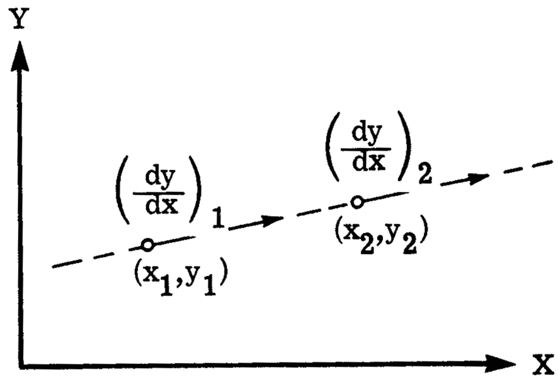
Figure 5.- Fuselage coordinate transformations.



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

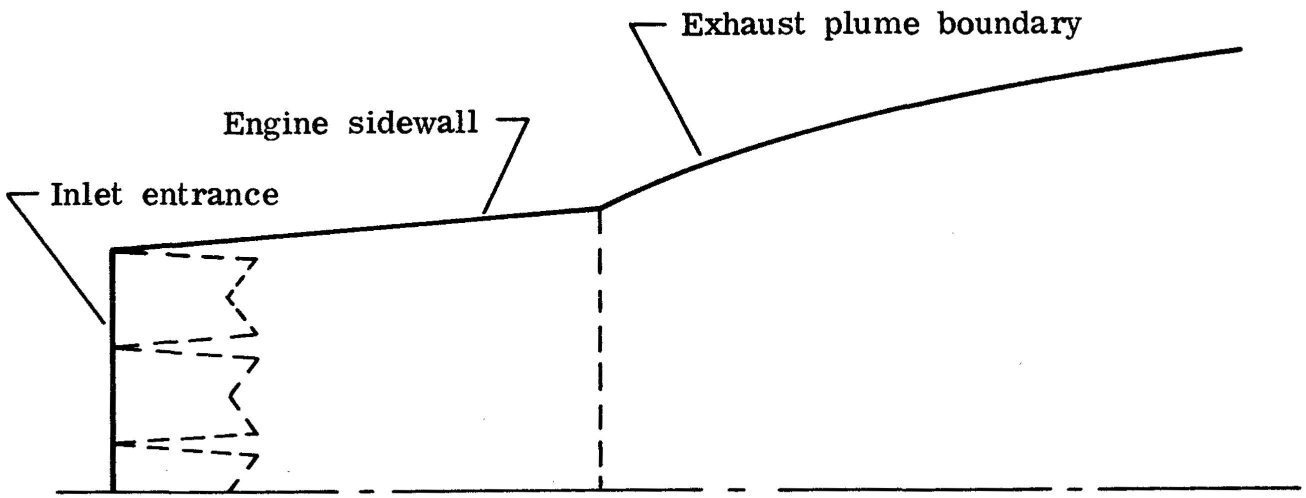


(b) Parallel slopes nonorthogonal and nonparallel to collinear end points. Inflection point (segment cannot be second degree).

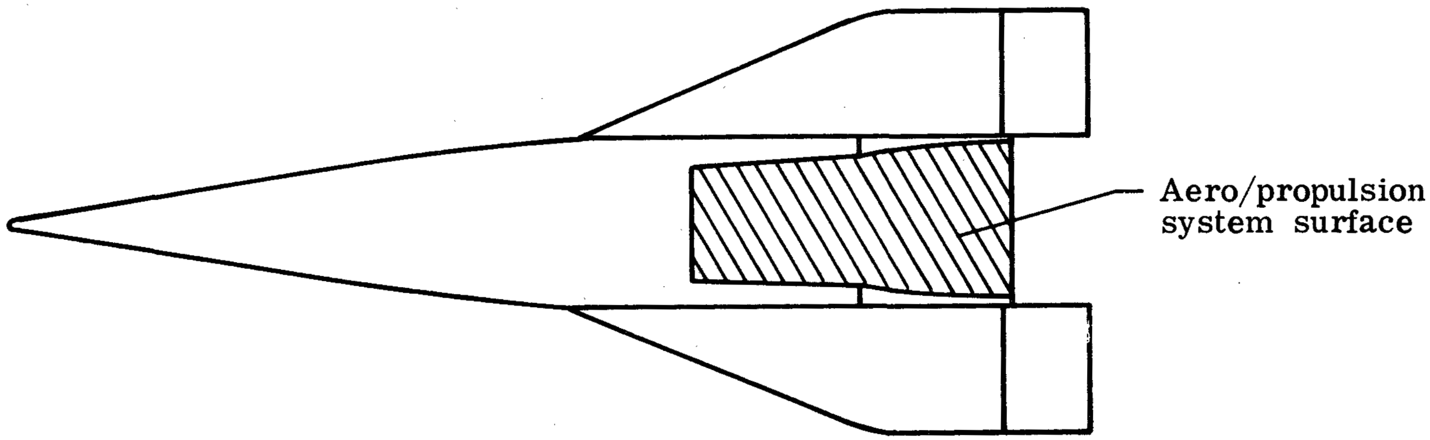


(c) Parallel slopes parallel to collinear end points. Straight-line segment.

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.

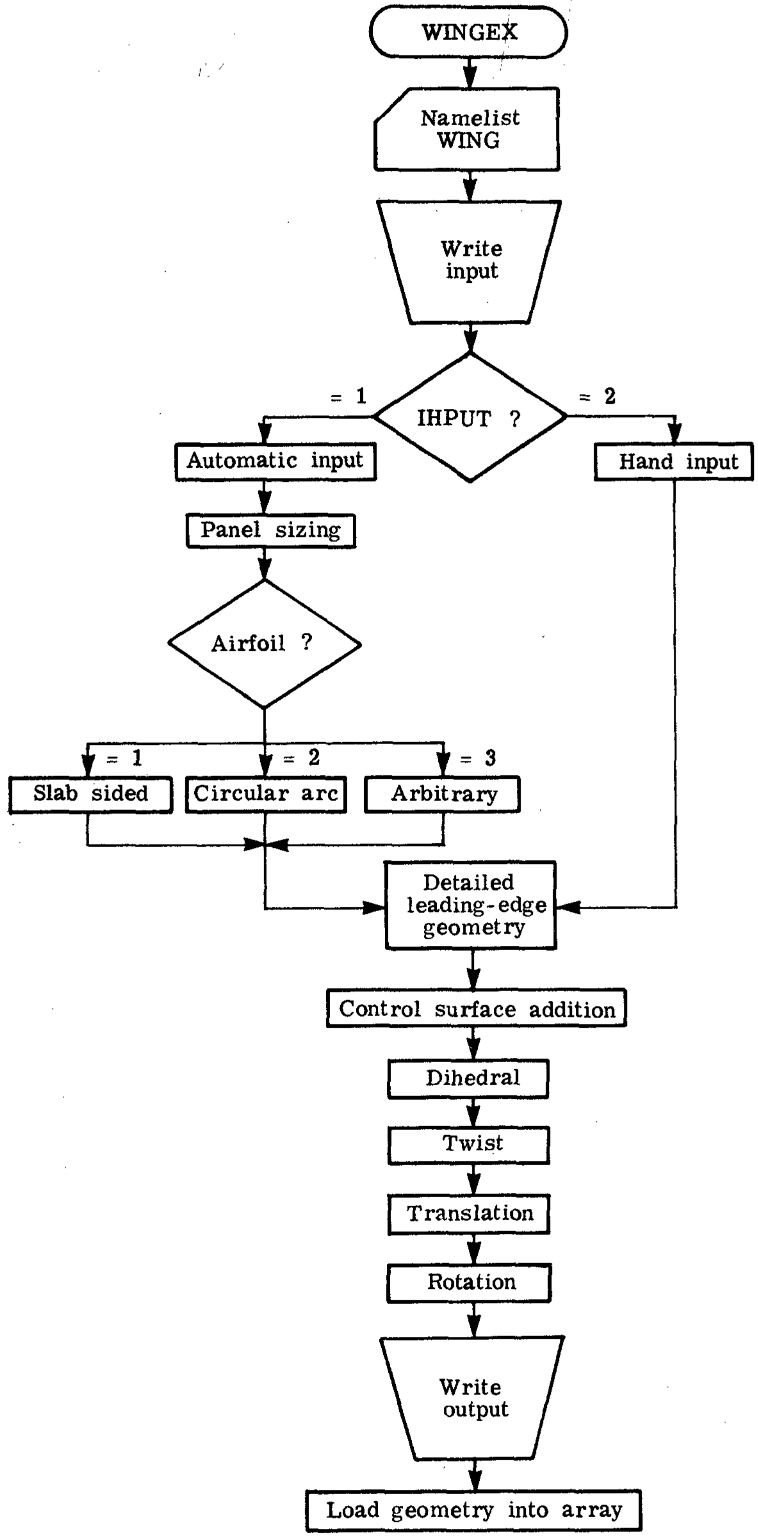


Figure 8.- Planar-surface generation logic flow.

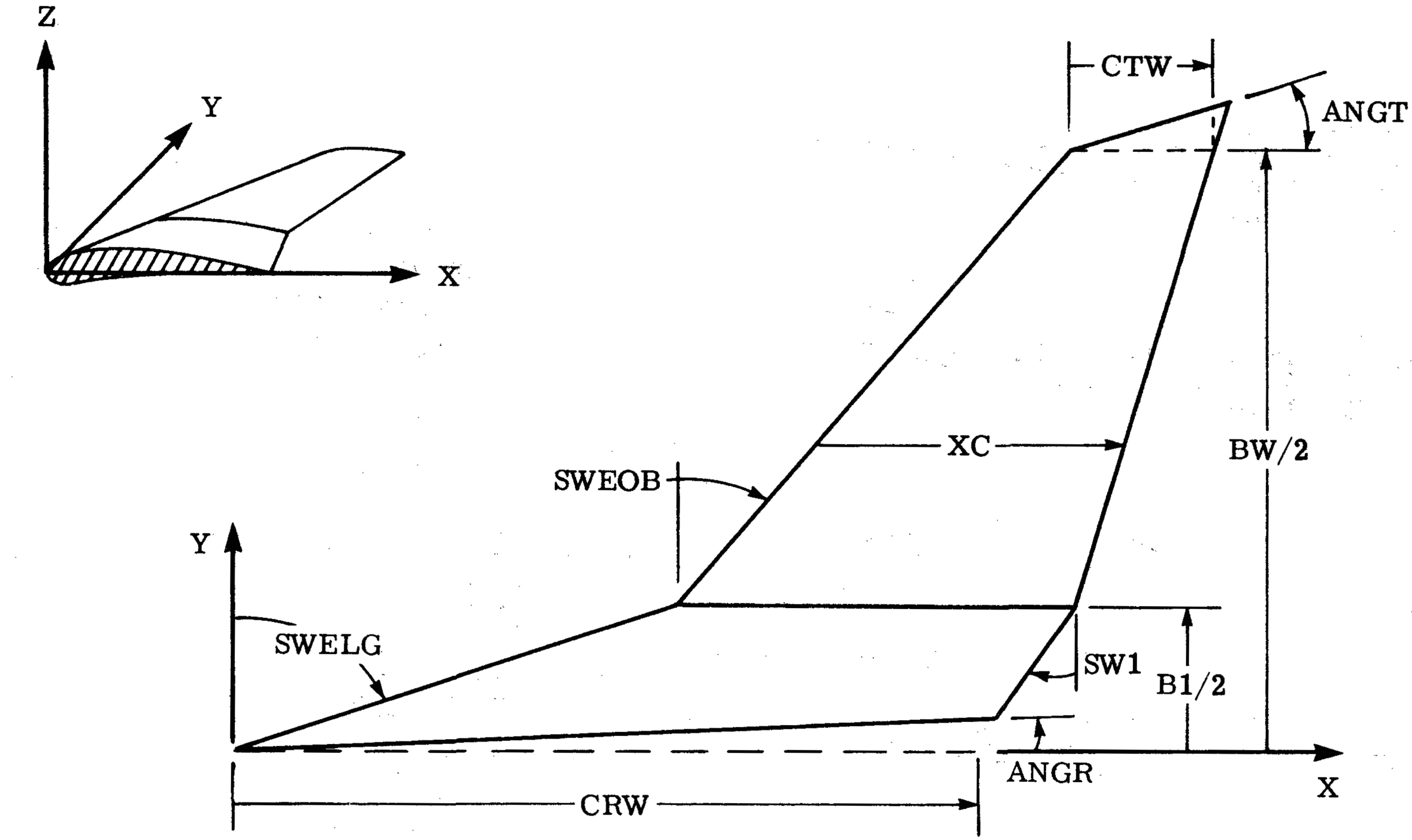


Figure 9.- Planar-surface plan parameters.

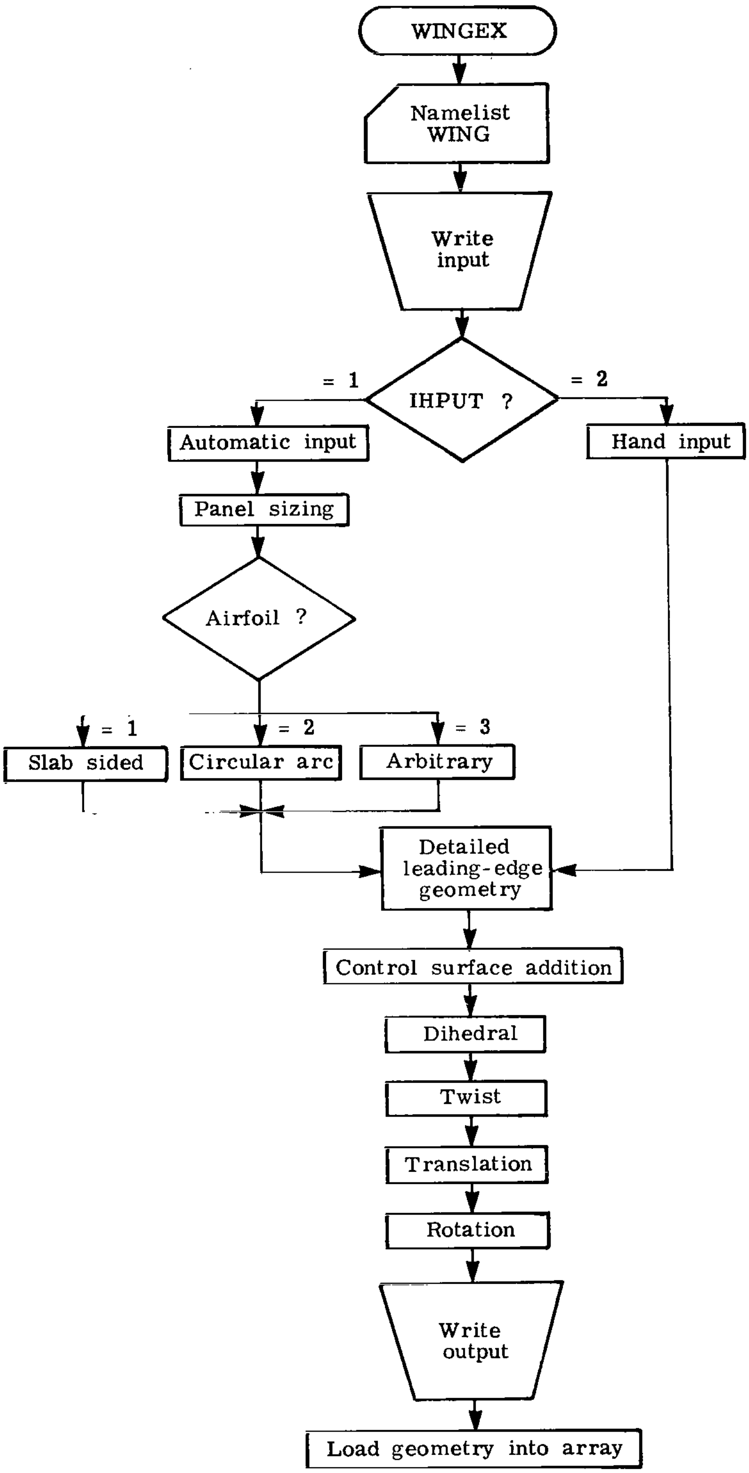


Figure 8.- Planar-surface generation logic flow.

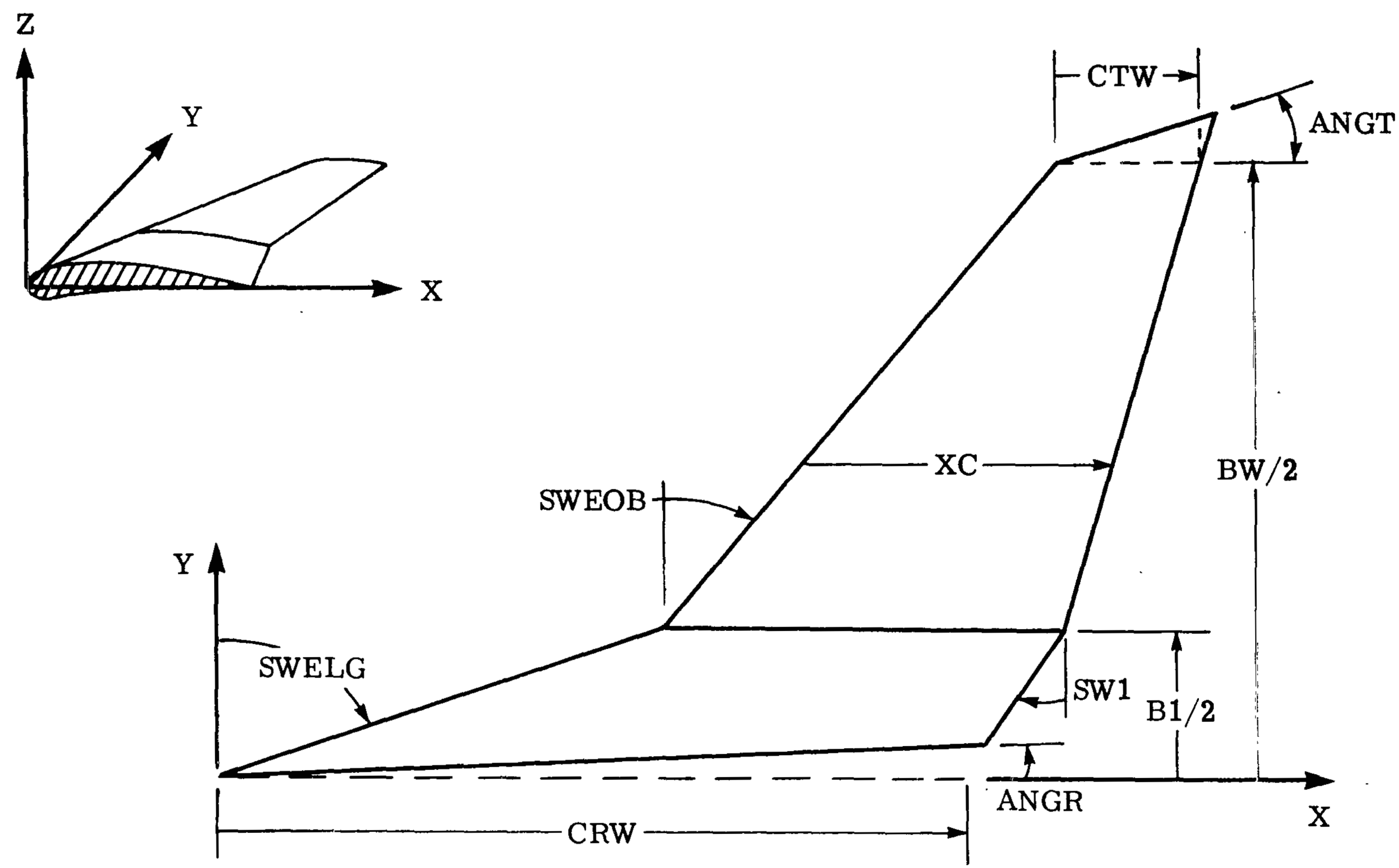
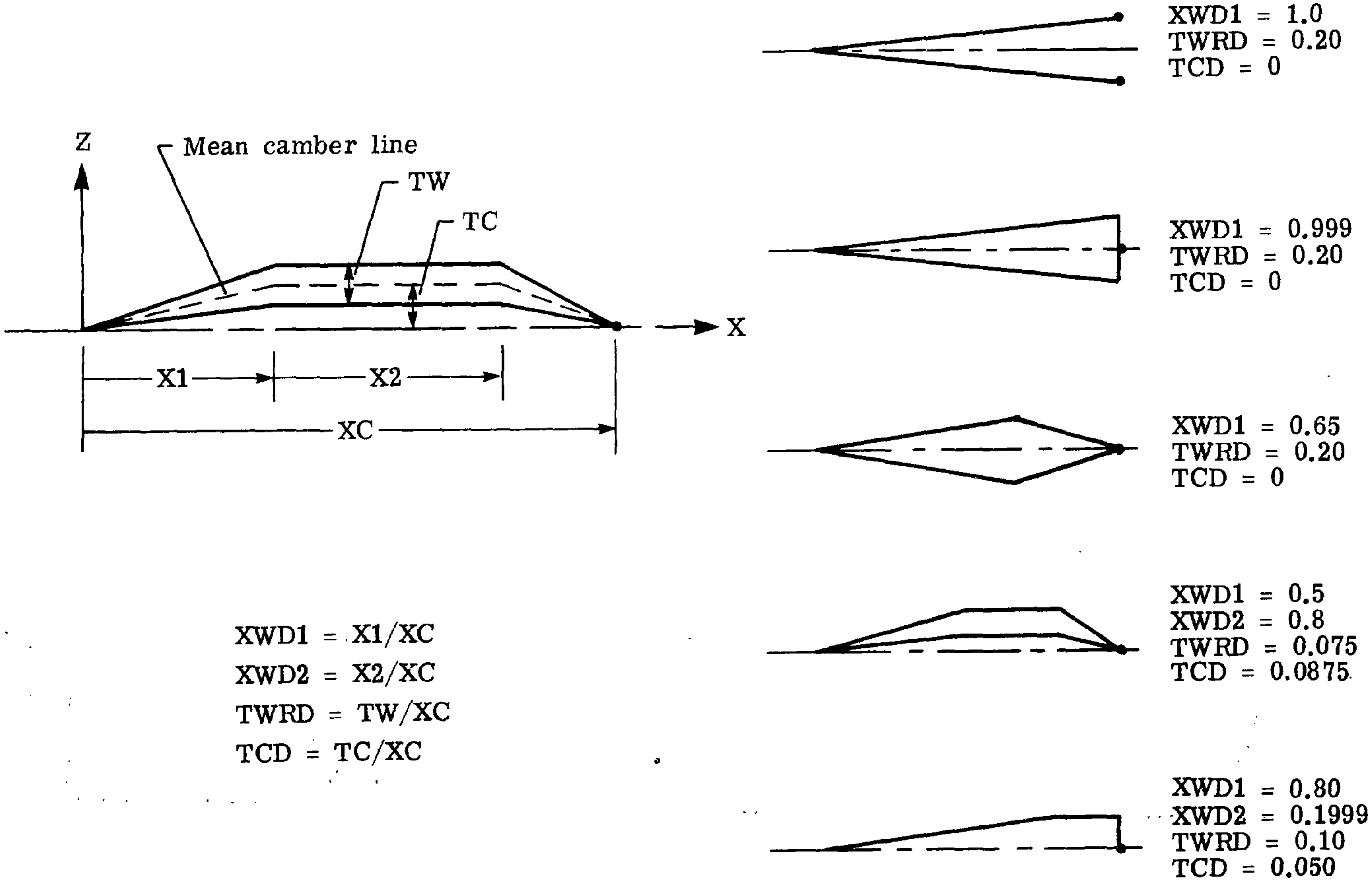


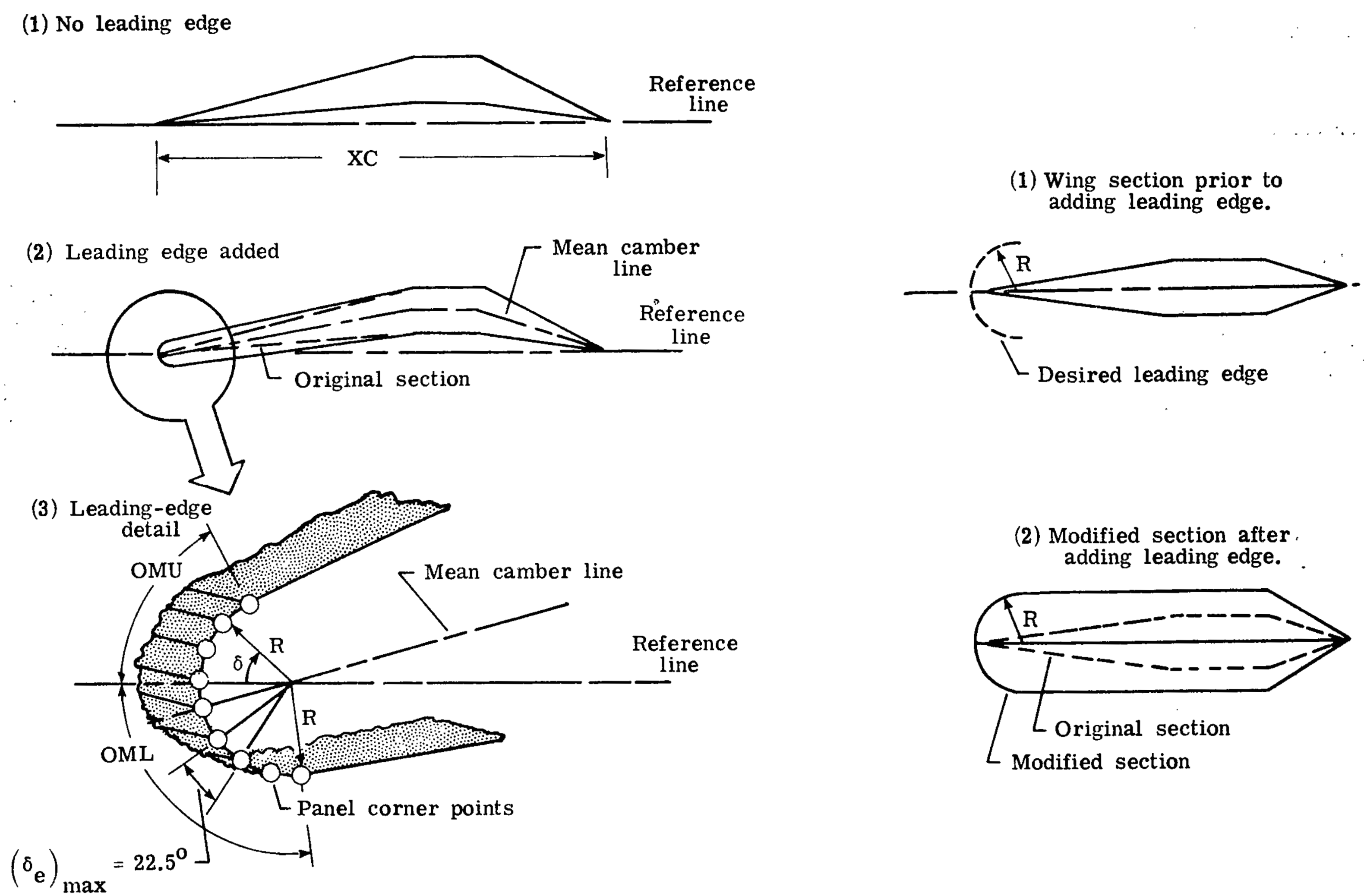
Figure 9.- Planar-surface plan parameters.



(a) Input parameters.

(b) Shape variations.

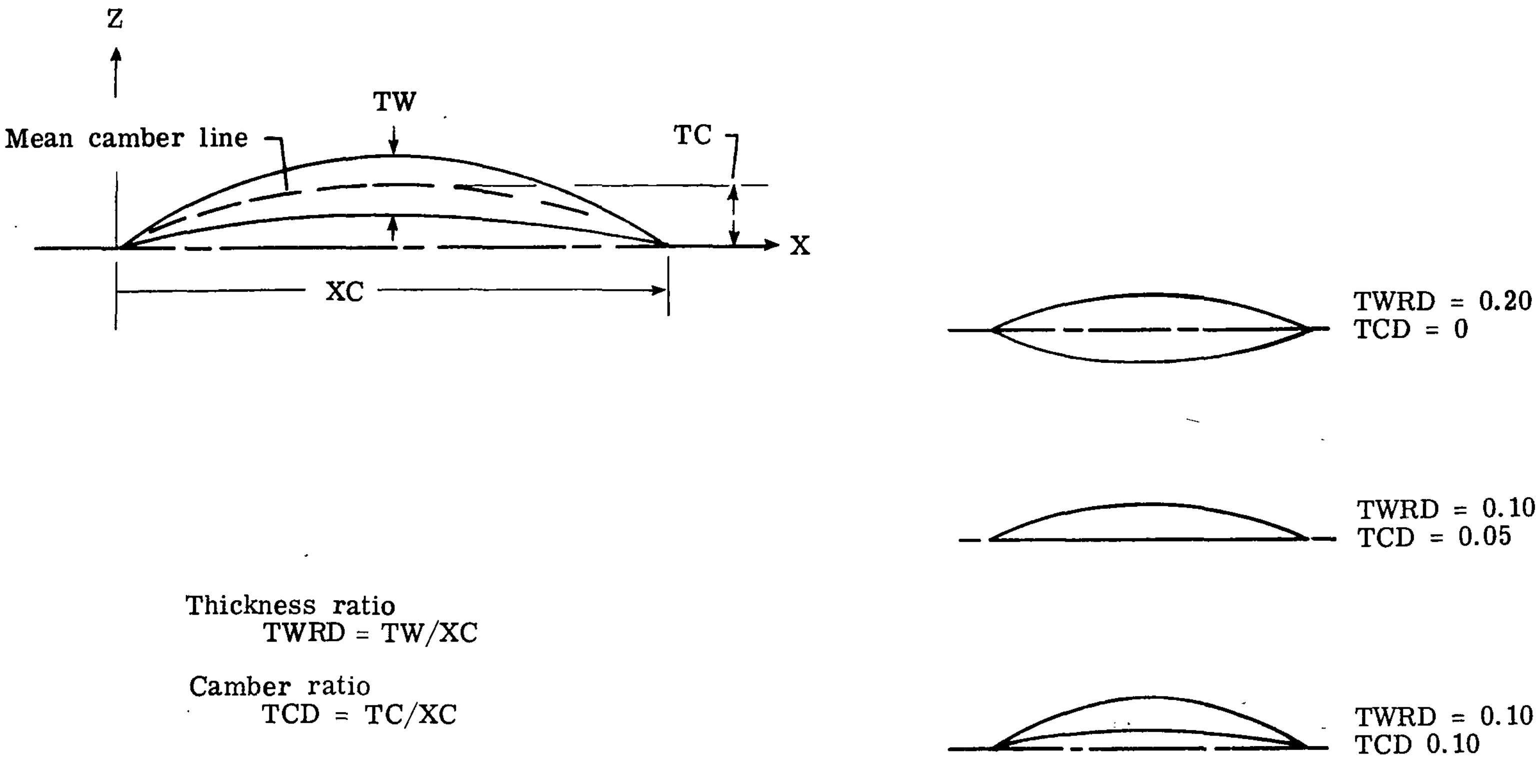
Figure 10.- Slab-sided airfoil section.



(a) Leading-edge construction.

(b) Large leading-edge condition.

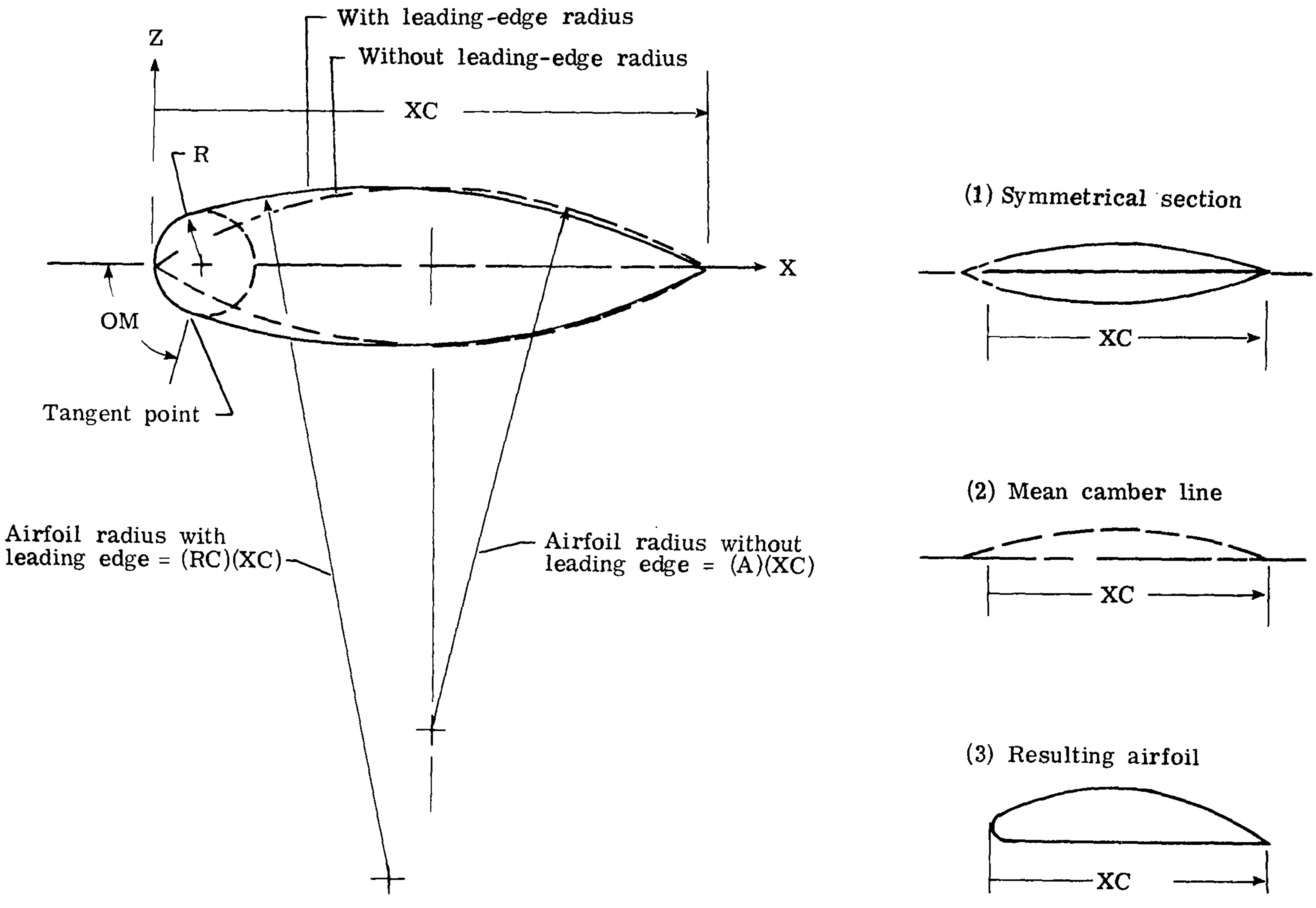
Figure 11.- Leading-edge slab-sided airfoil.



(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.

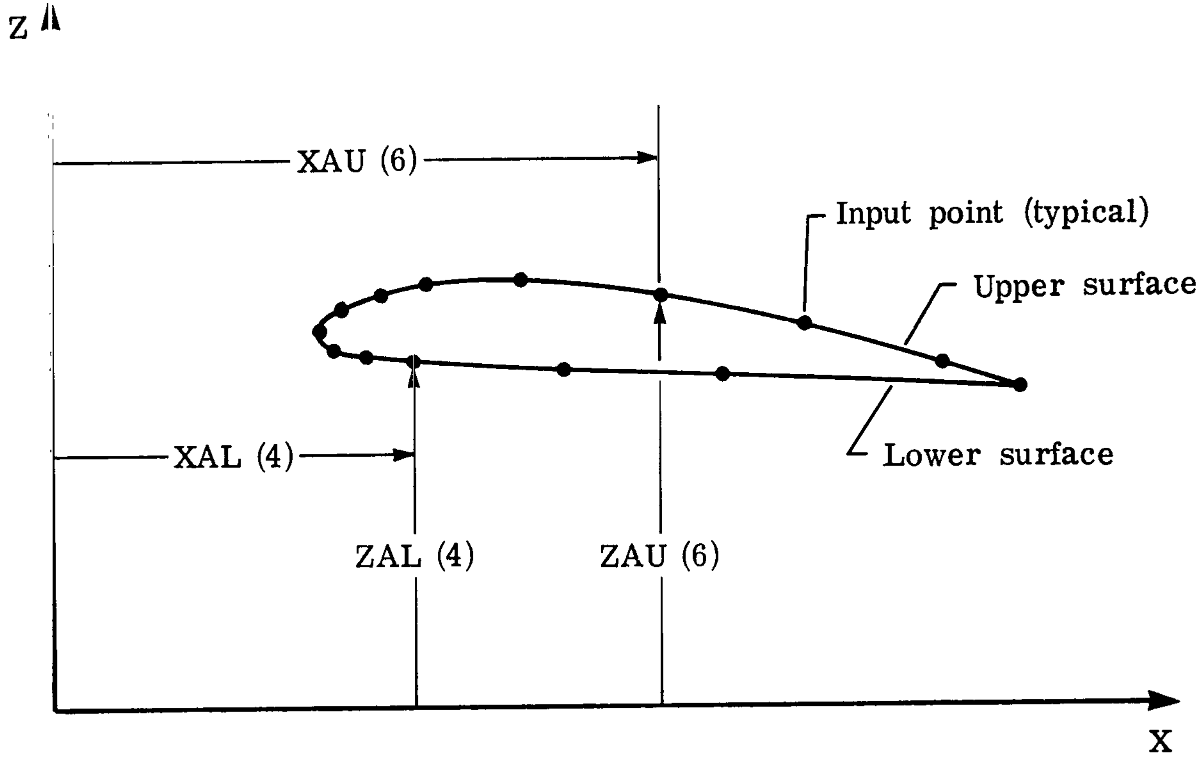


Figure 14.- Arbitrary airfoil section.

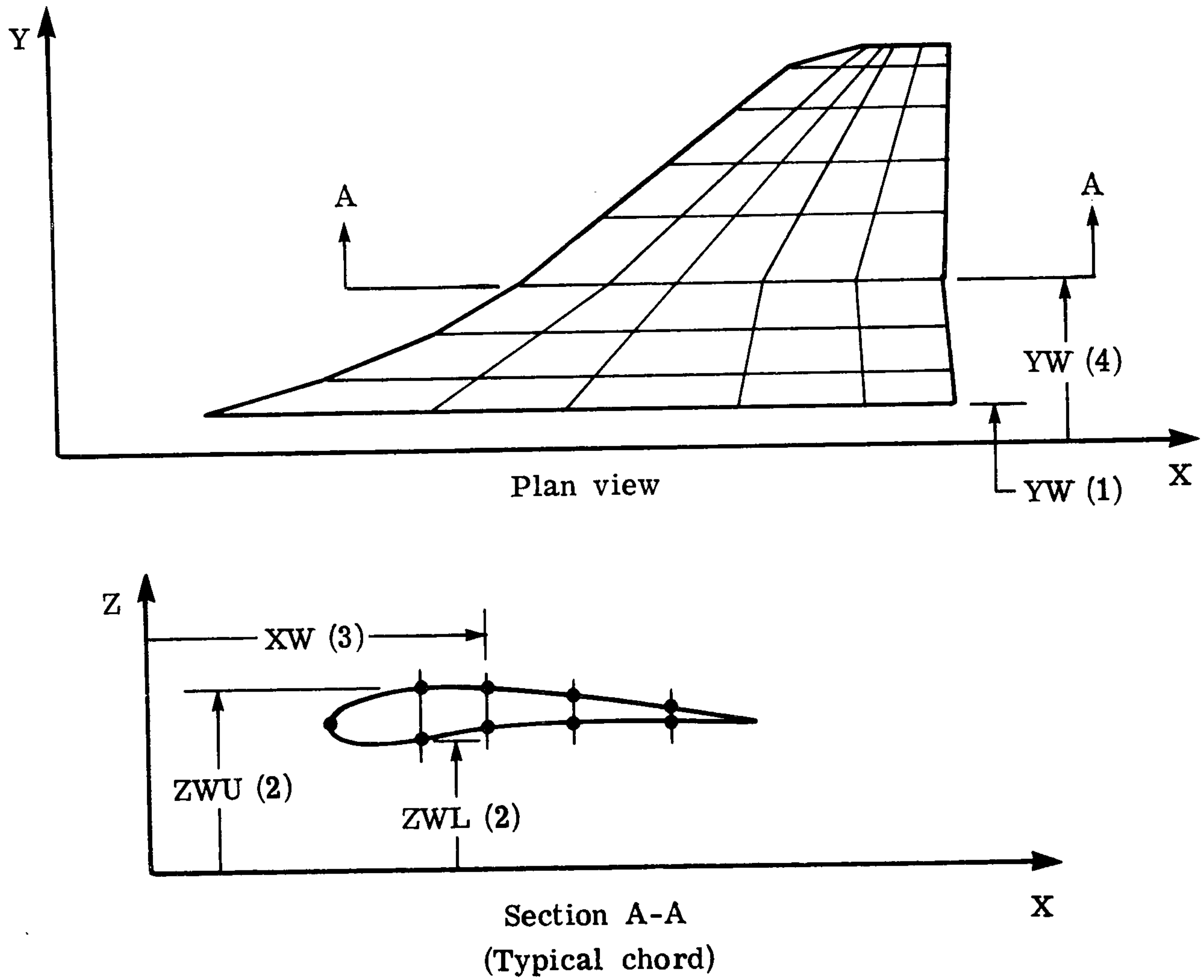
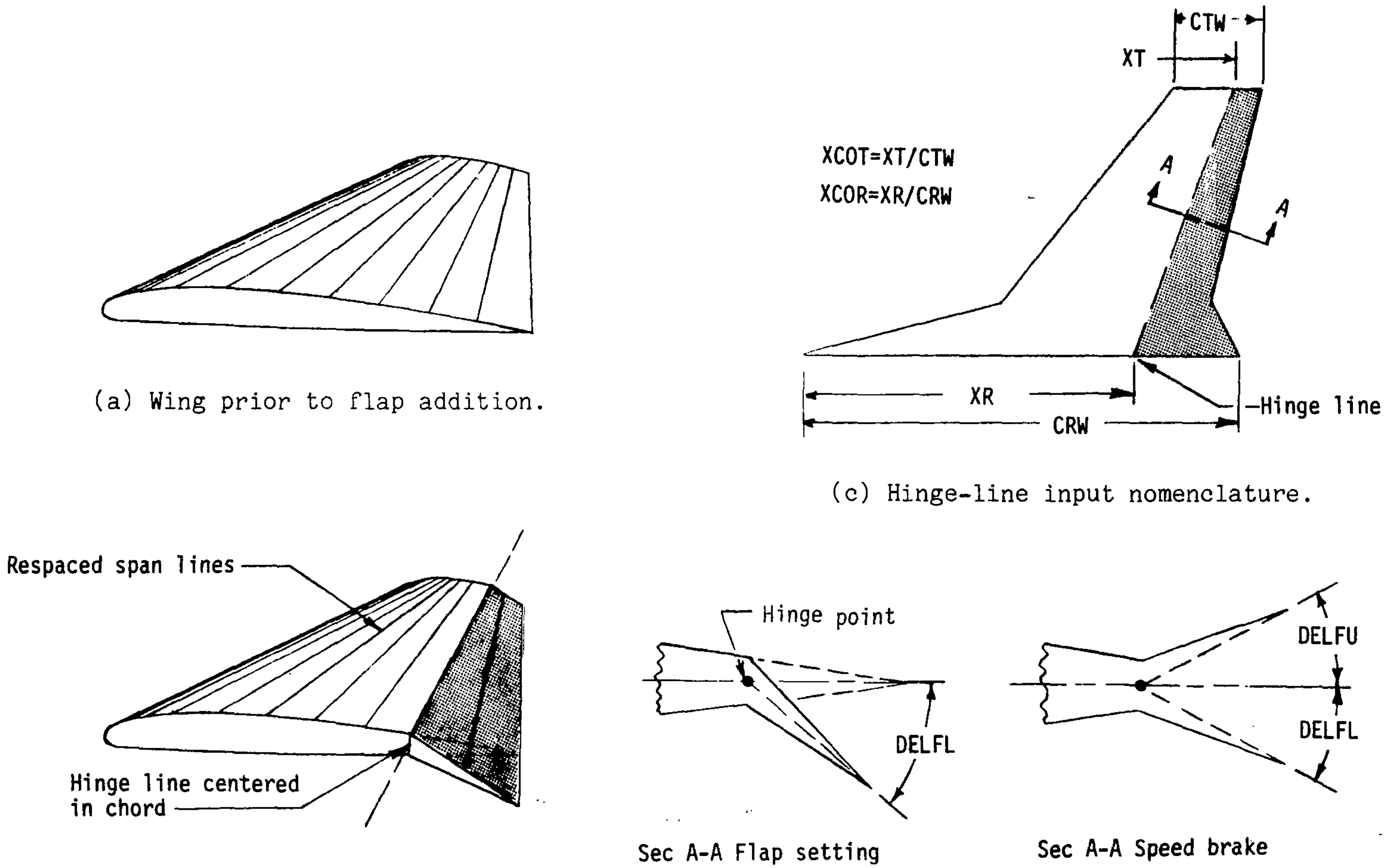


Figure 15.- Planar-surface manual input.

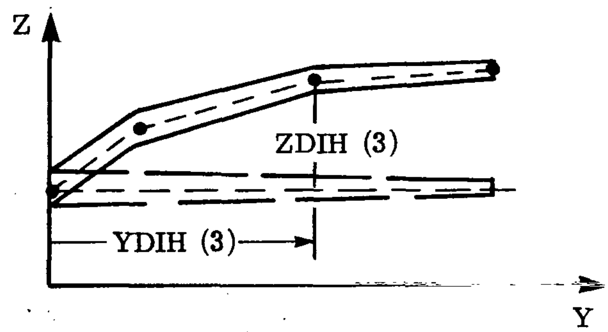


(a) Wing prior to flap addition.

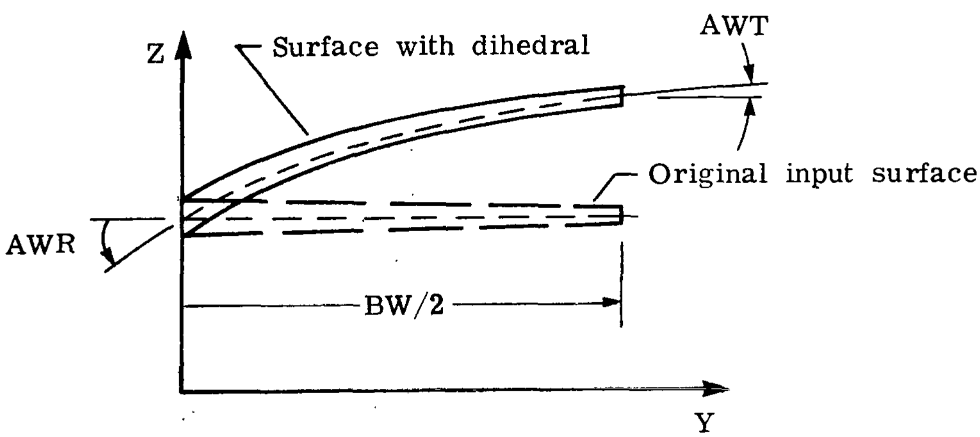
(c) Hinge-line input nomenclature.

(b) Wing with flap added.

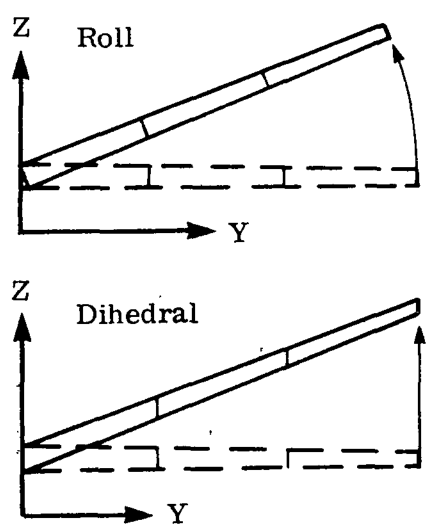
Figure 16.- Control-surface option.



(a) Dihedral hand input.



(b) Root and tip angle input.



(c) Roll and dihedral convention.

Figure 17.- Wing dihedral option.

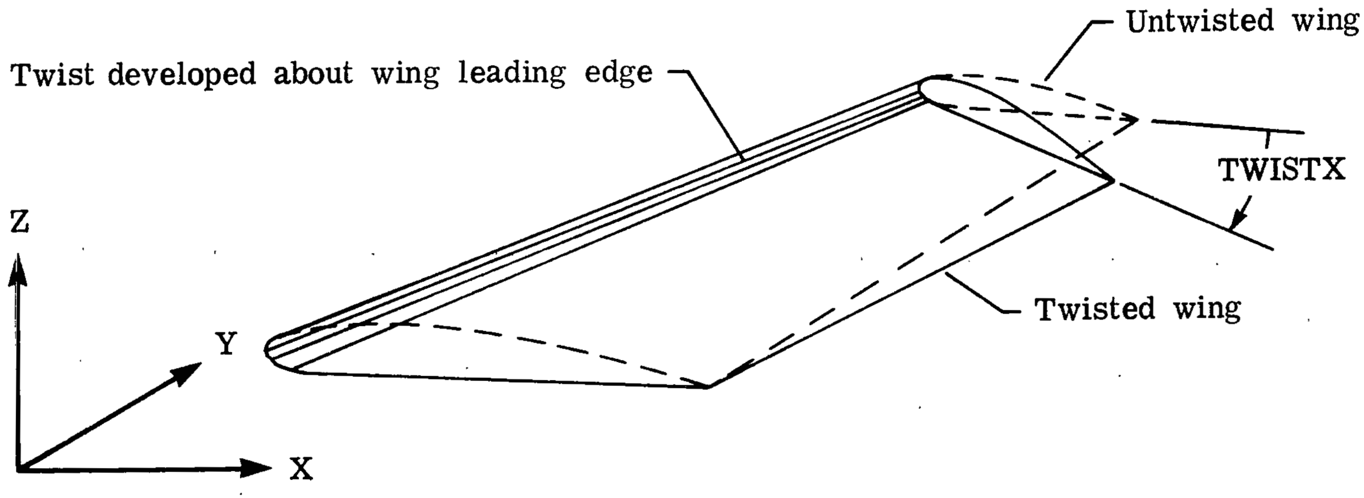
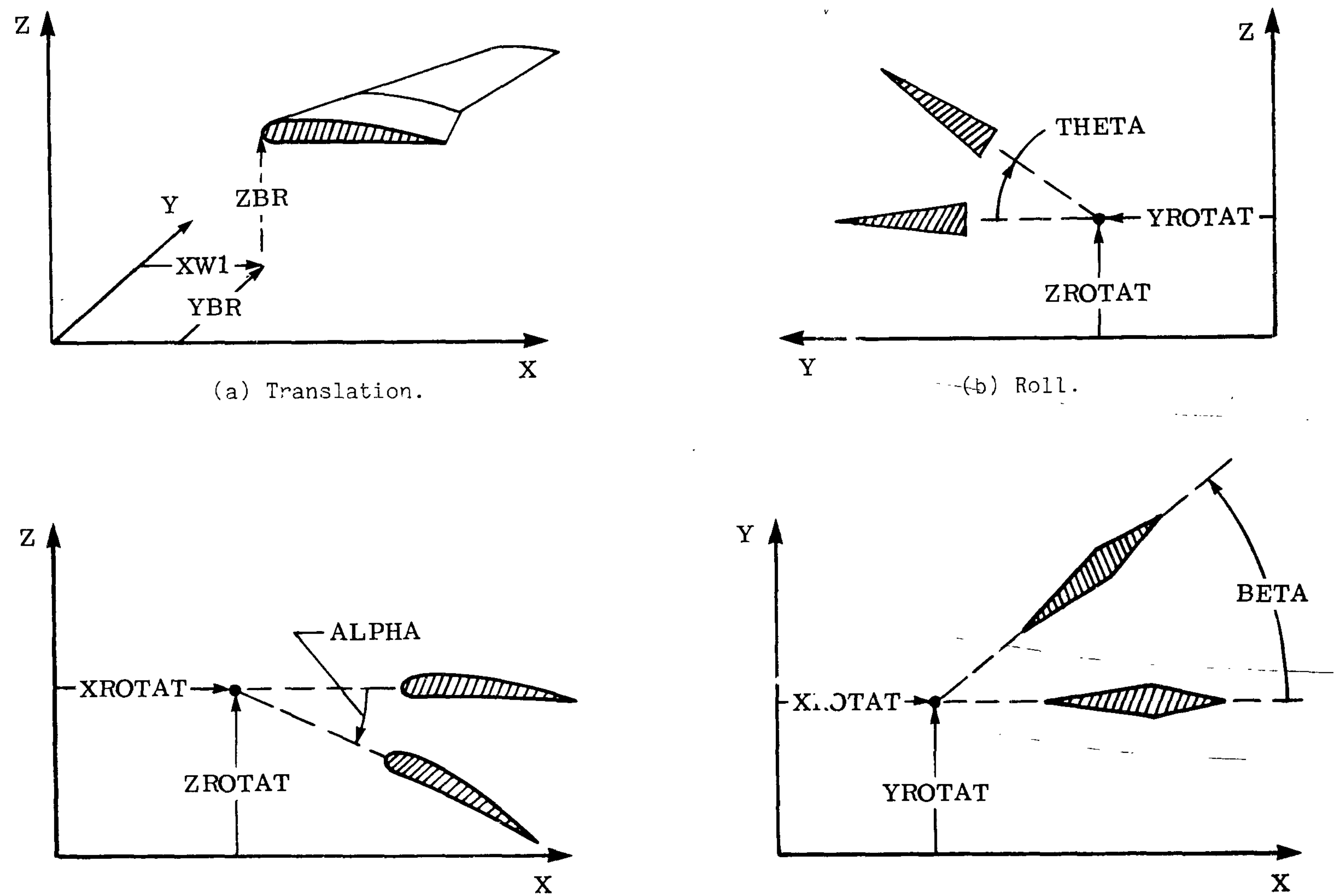


Figure 18.- Wing twist option.



(c) Pitch.

(d) Yaw.

Figure 19.- Planar-surface translation and rotation.

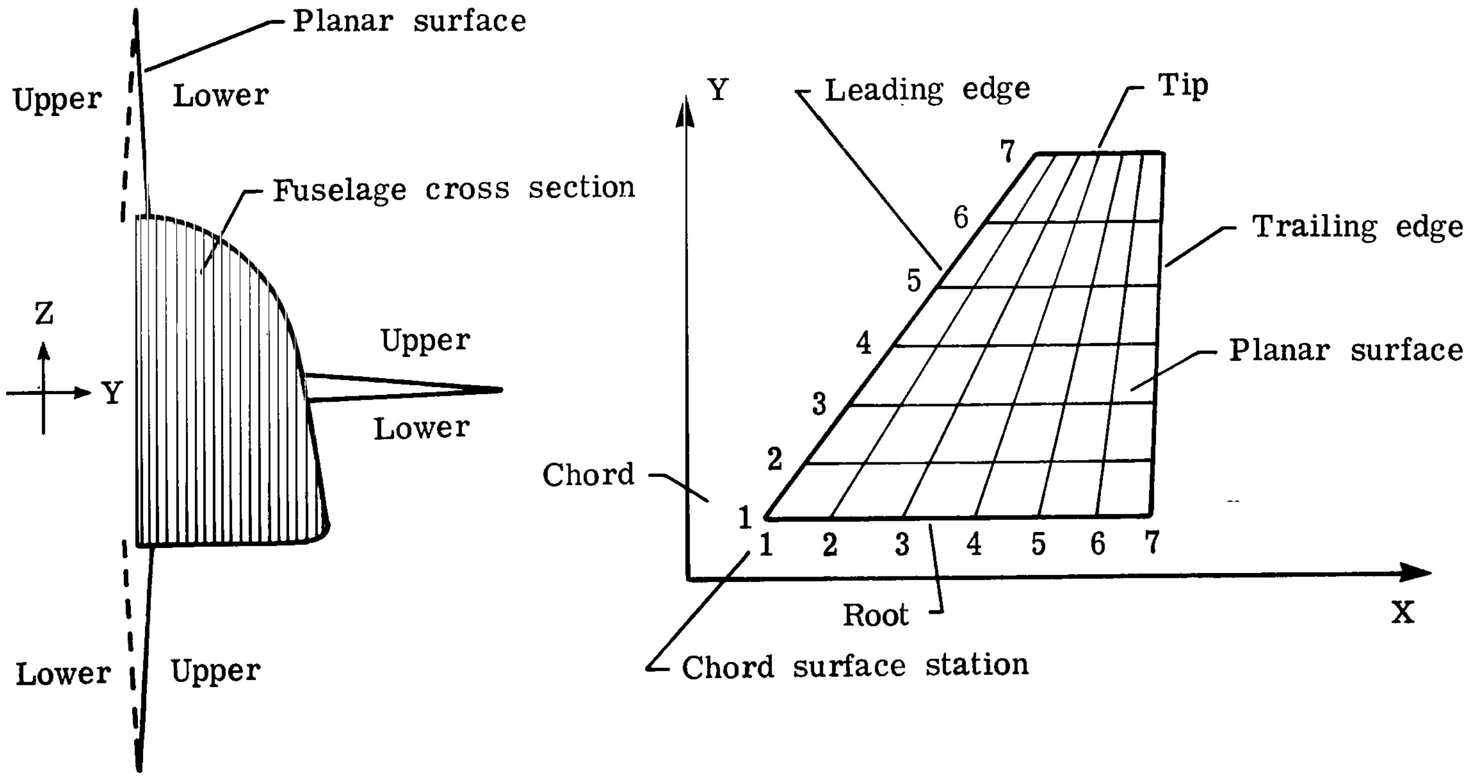


Figure 20.- Planar-surface geometry arrangement for MERGE.

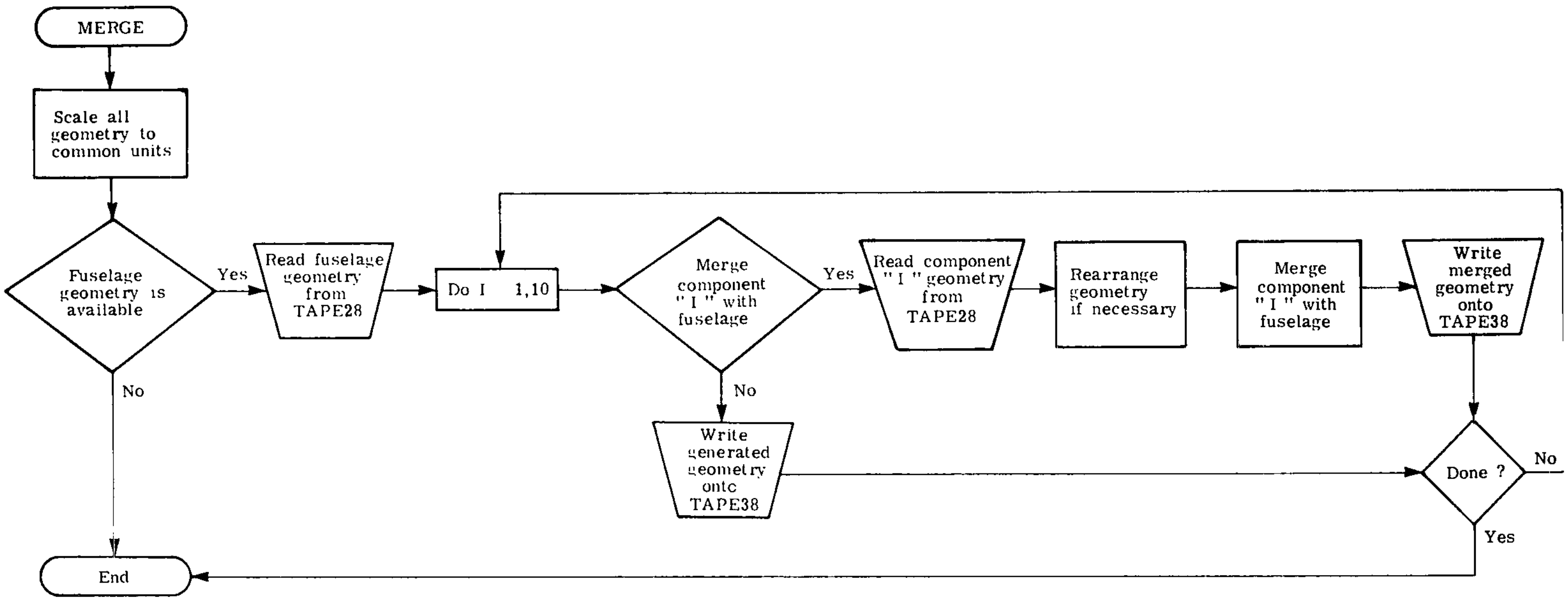


Figure 21.- Operations performed in MERGE.

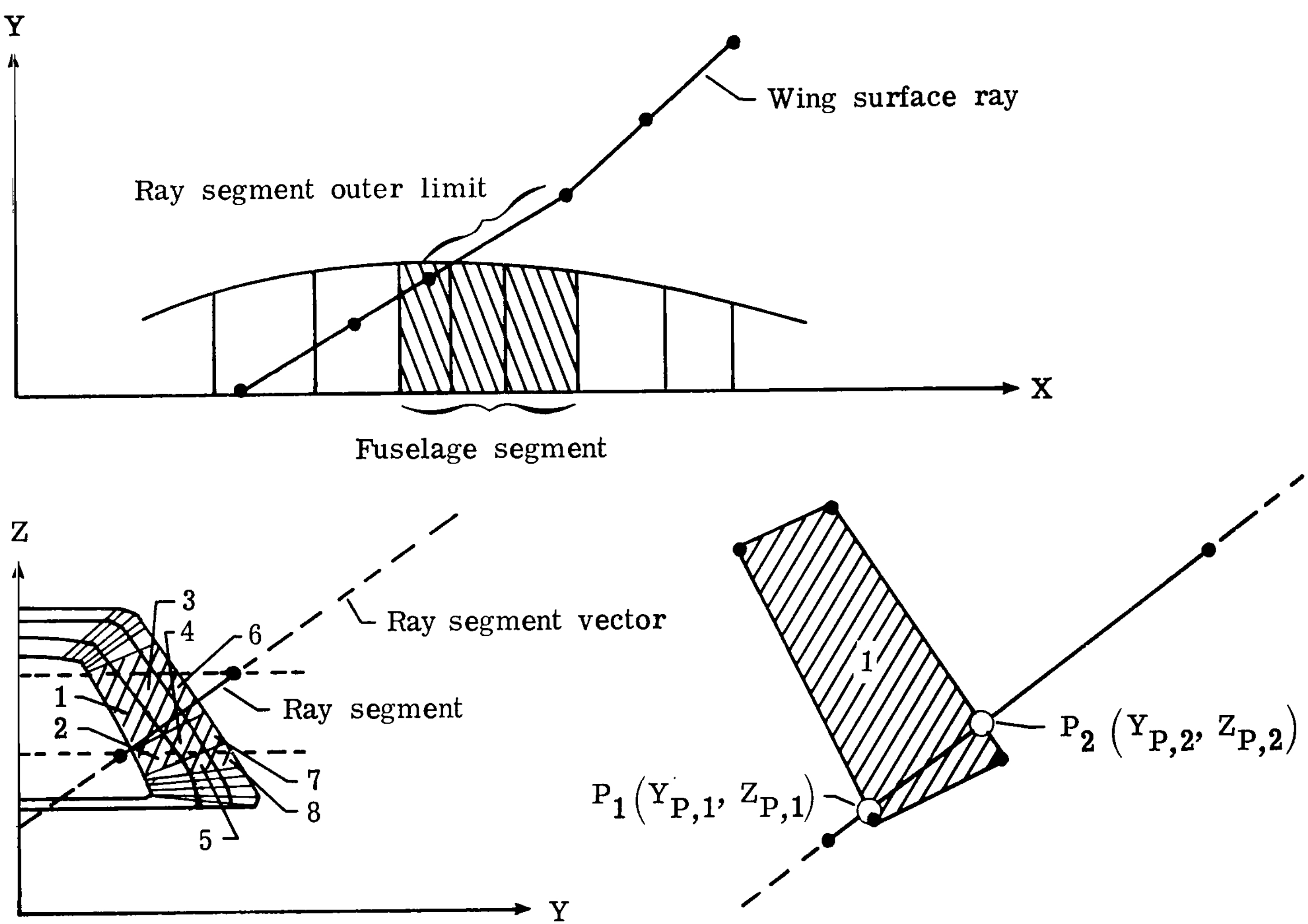
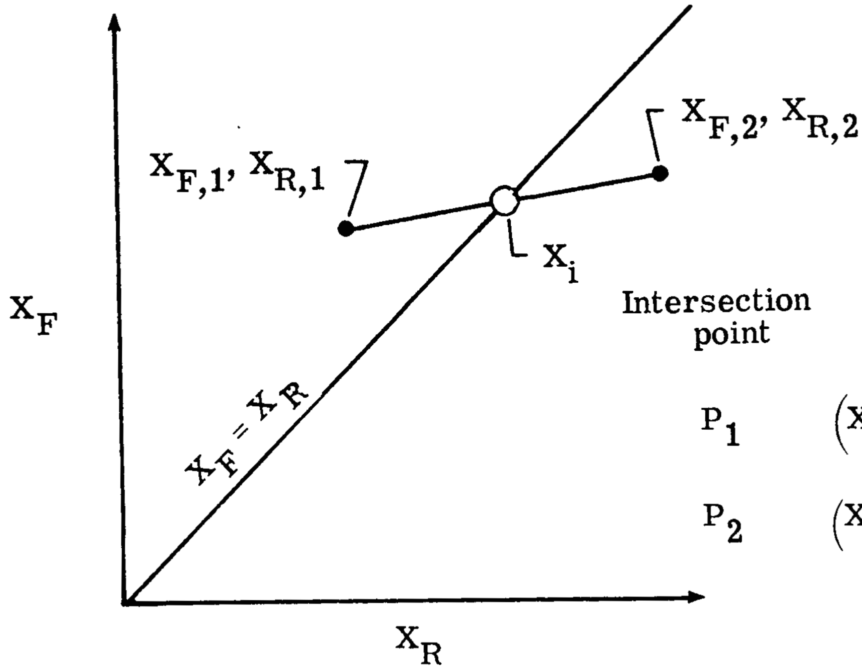


Figure 22.- Limits of search for intersection.



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.

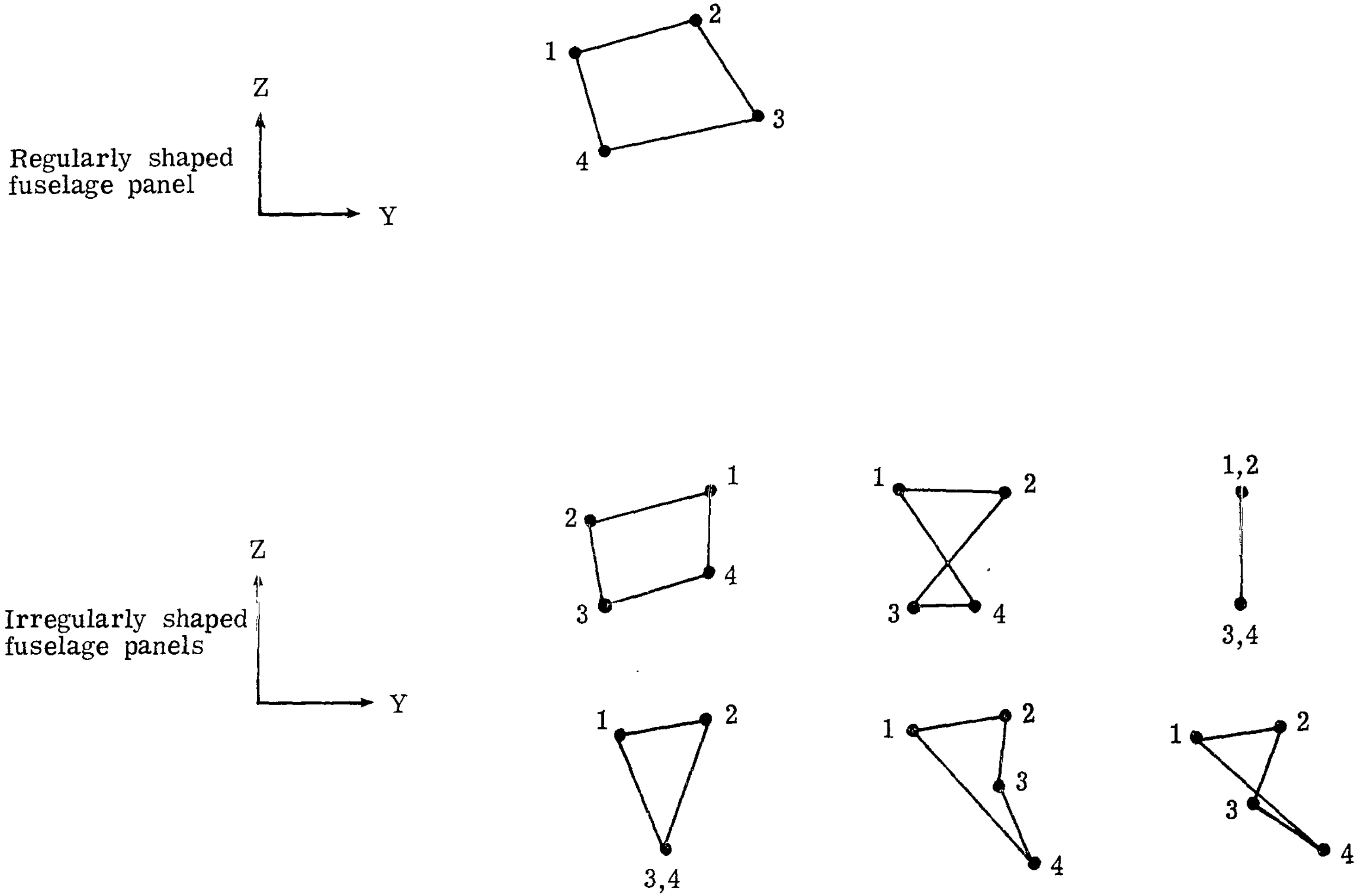
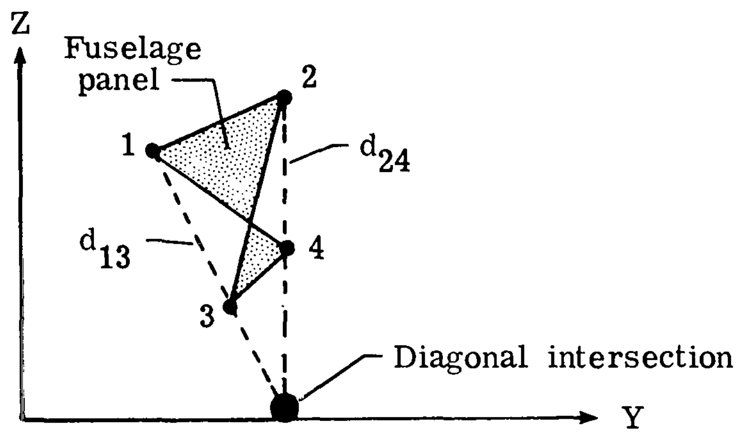
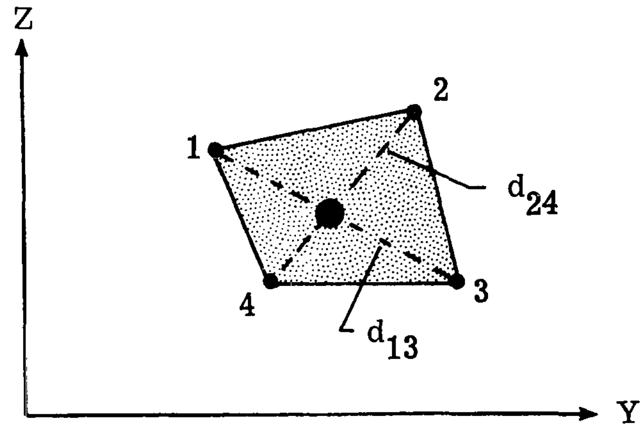


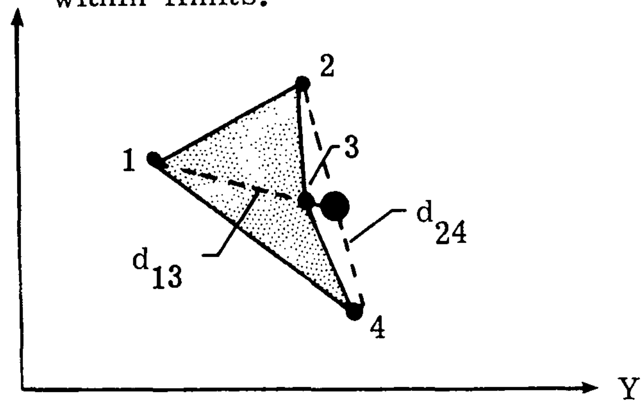
Figure 24.- MERGE: Examples of irregularly shaped fuselage panels.



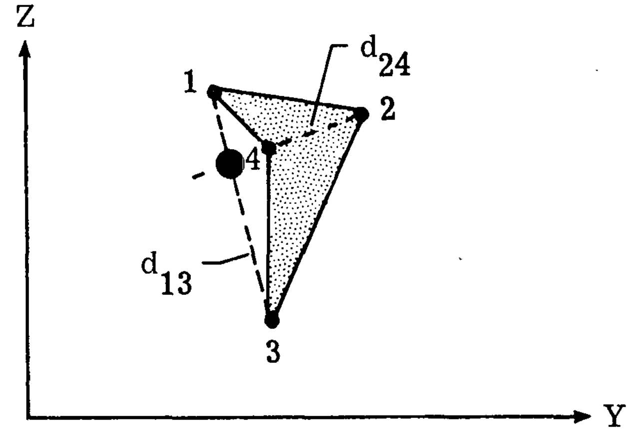
Fuselage panel diagonals, d_{13} and d_{24}, do not intersect within the end points of either diagonal. Program assumes that one pair of opposite panel sides intersect within limits.



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.

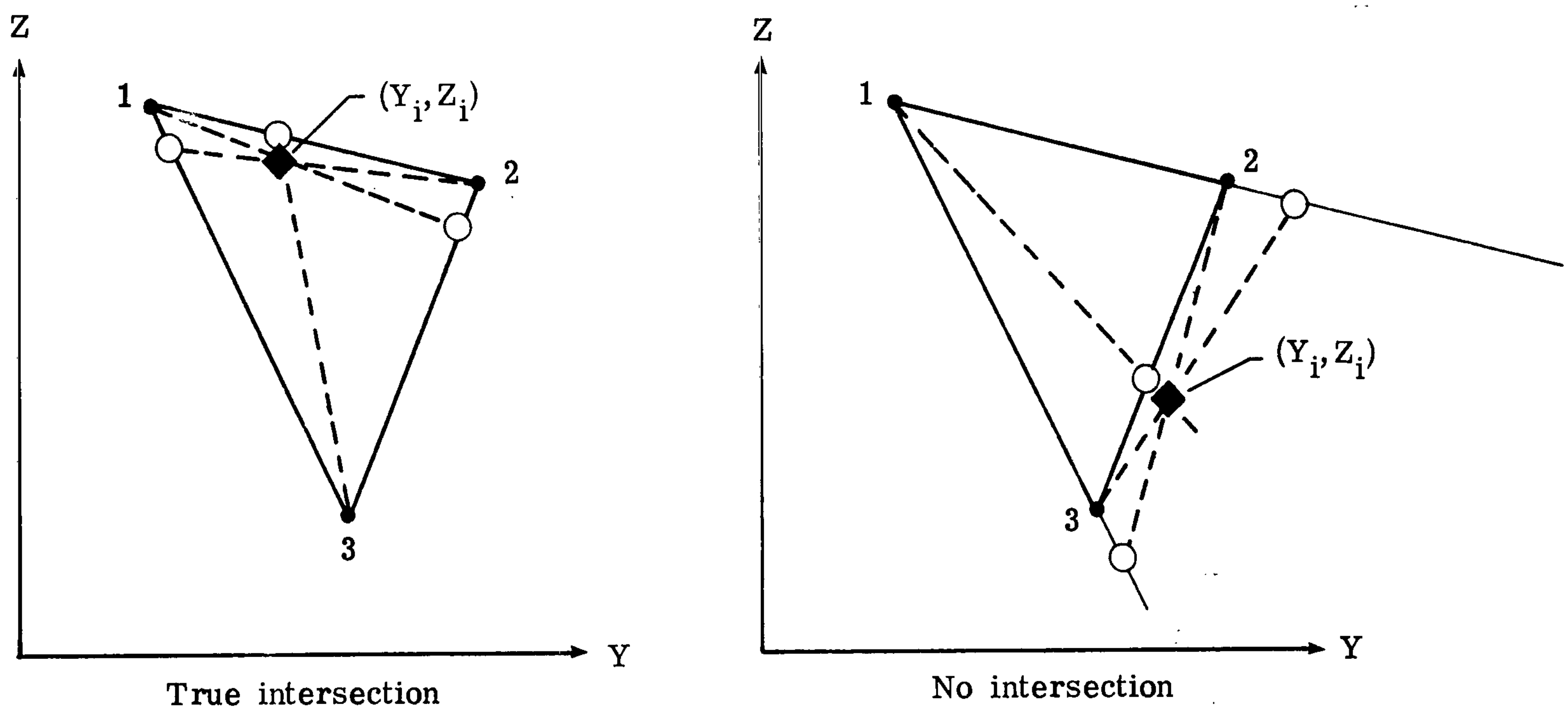


Figure 26.- Intersection "triangle check."

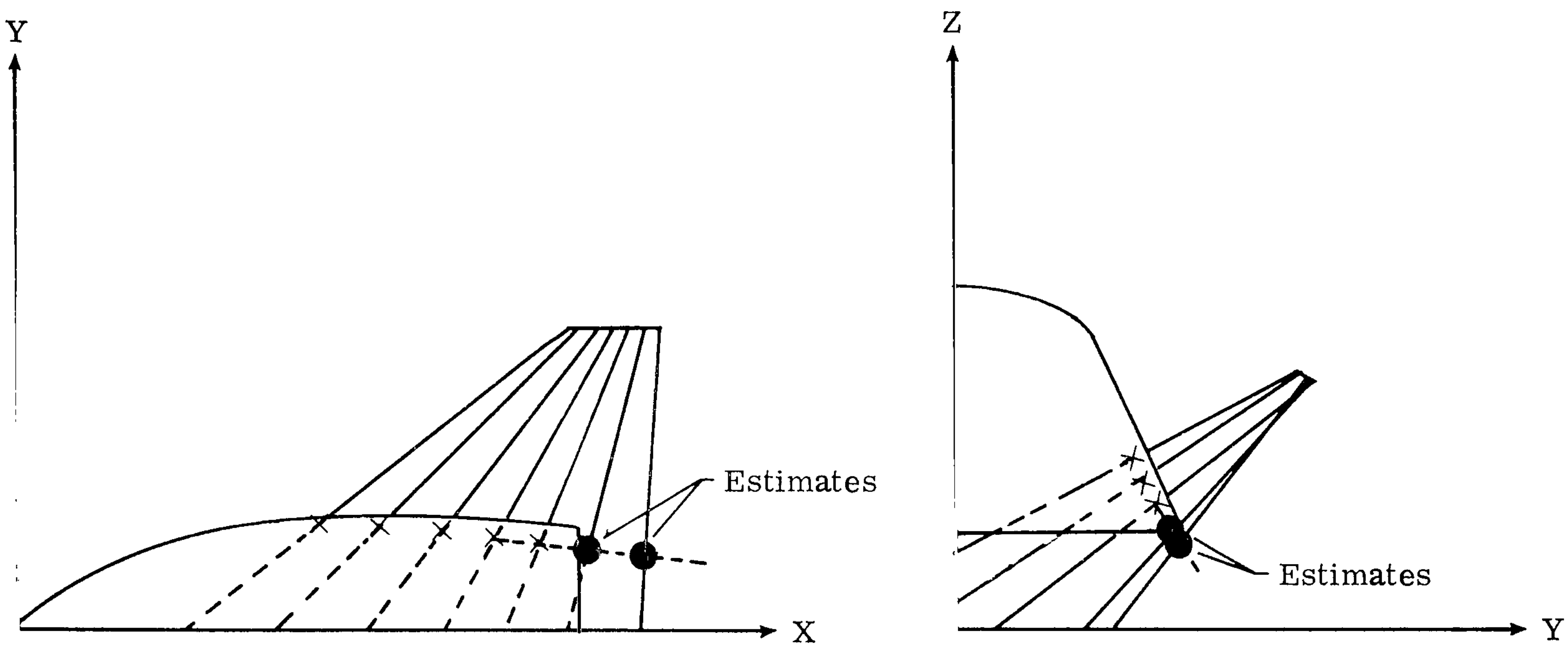


Figure 27.- Intersection extrapolation estimates.

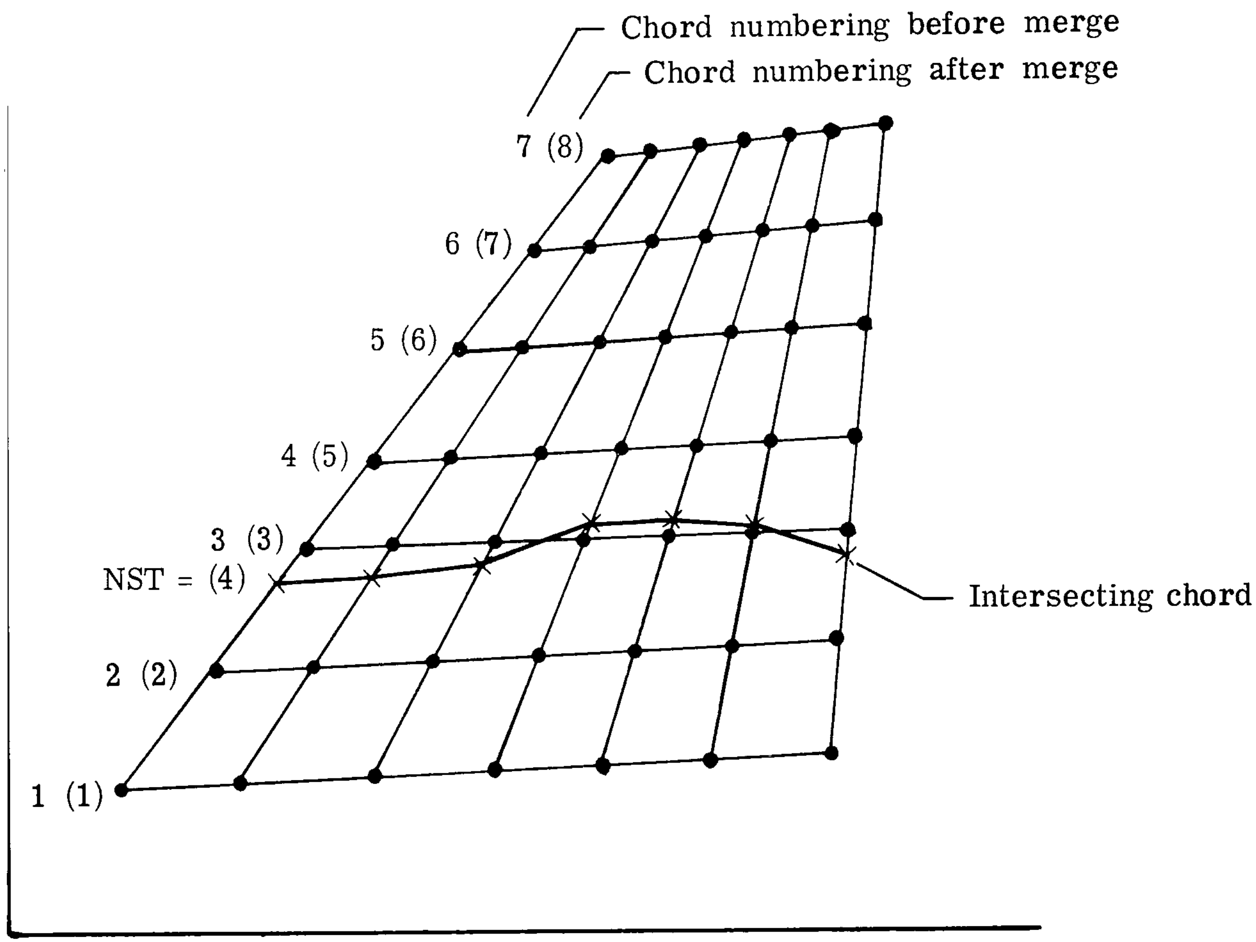


Figure 28.- Geometry redefinition for intersection.

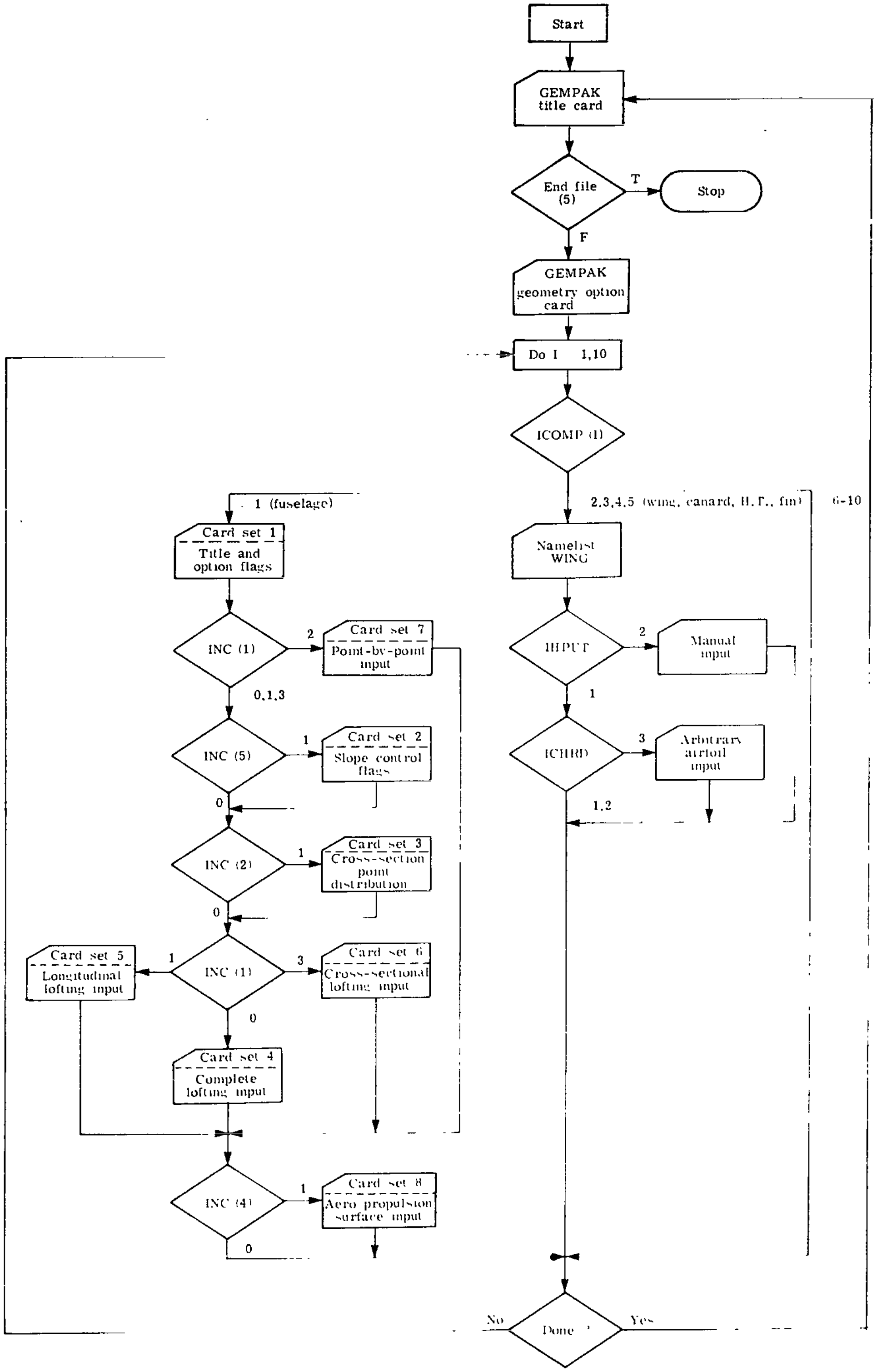


Figure 29.- GEMPAK input flow.

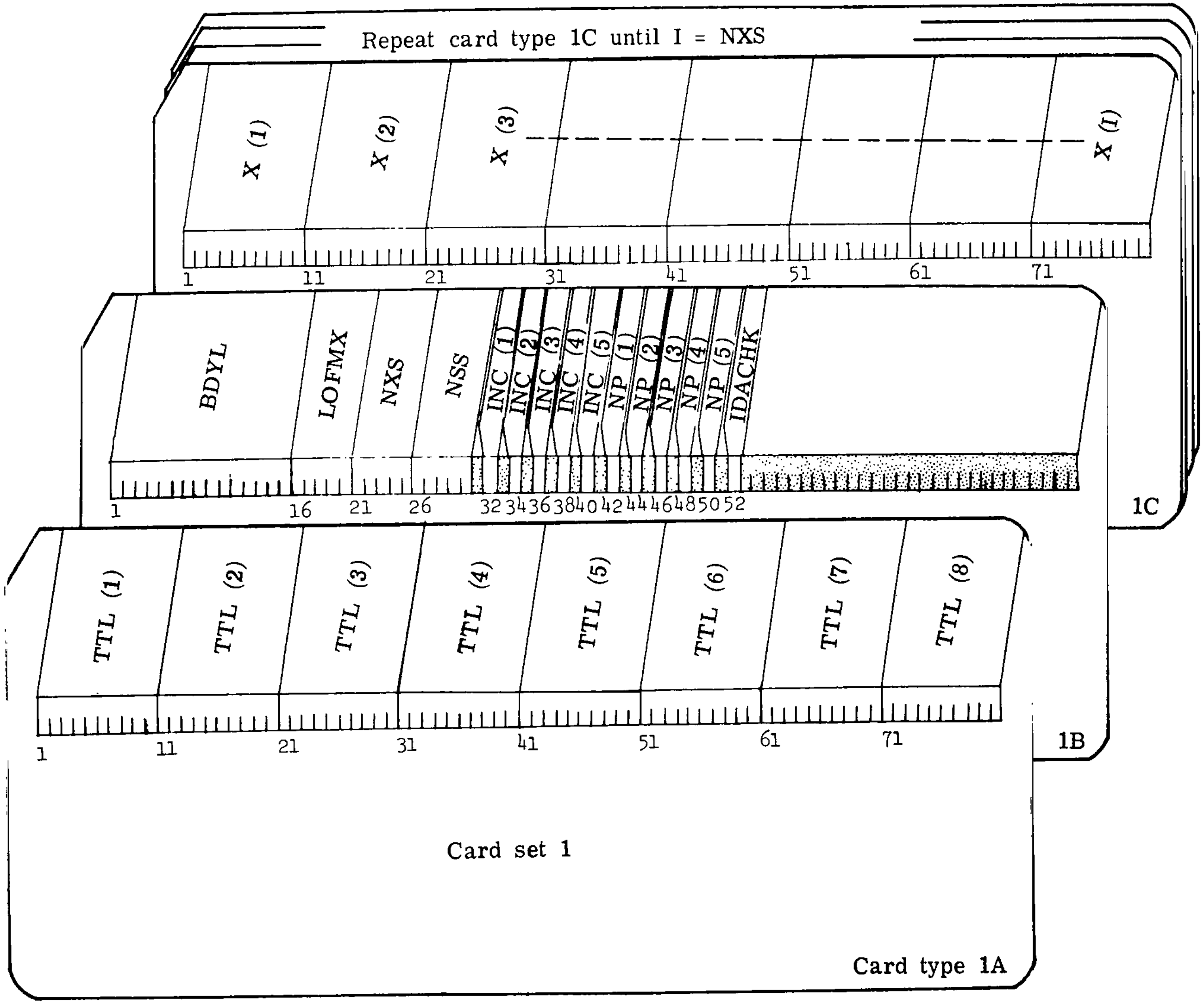


Figure 30.- Fuselage: card set 1 input.

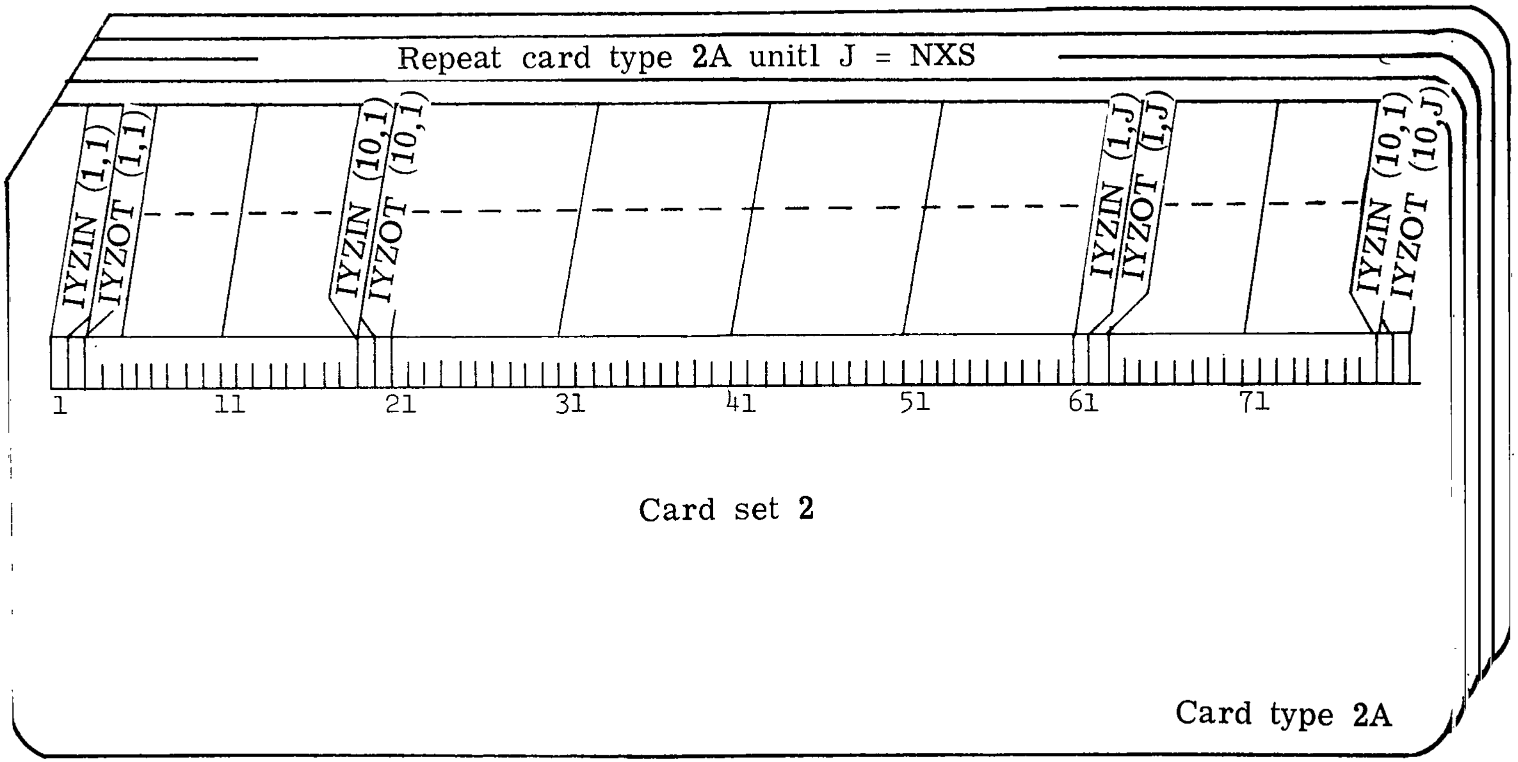


Figure 31.- Fuselage: card set 2 input.

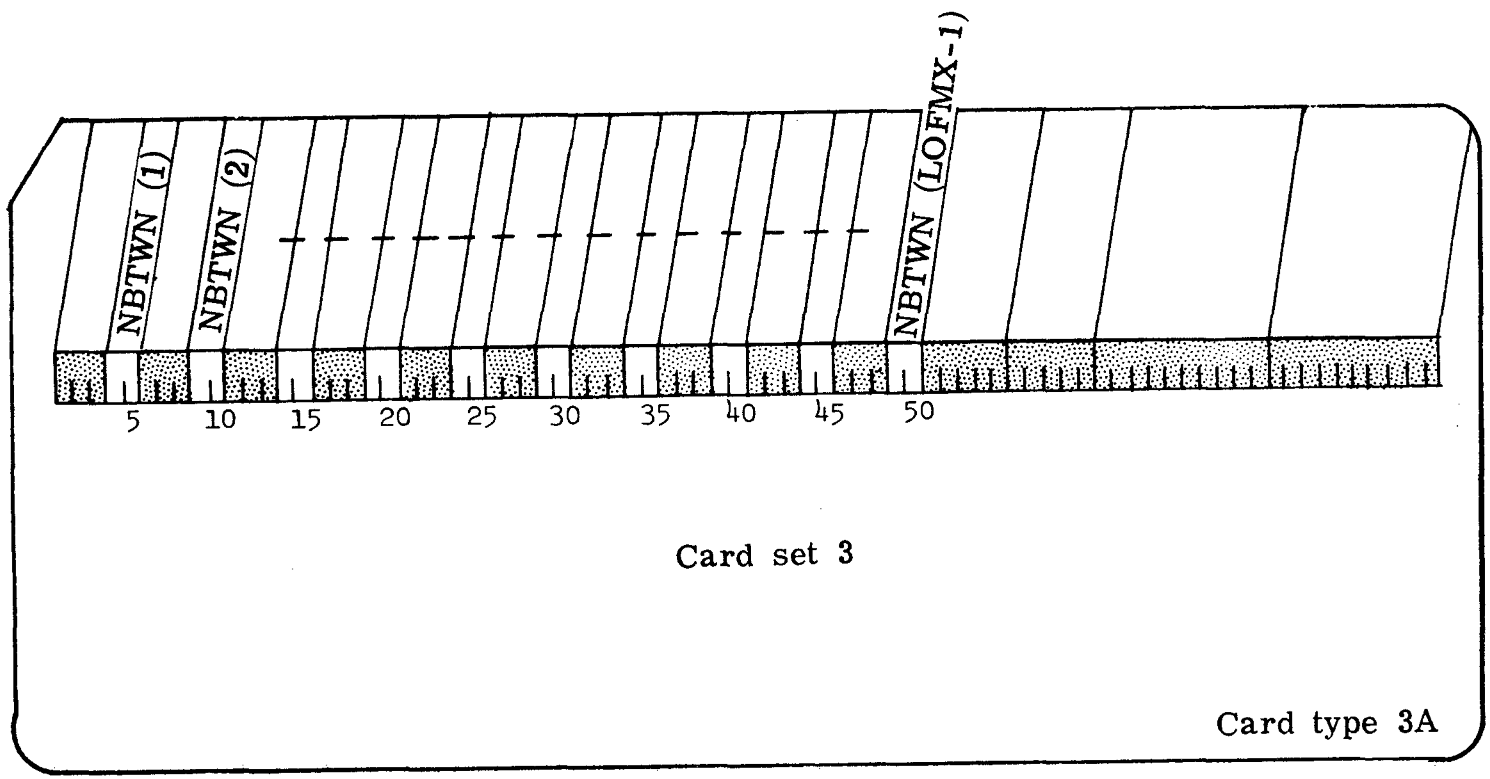


Figure 32.- Fuselage: card set 3 input.

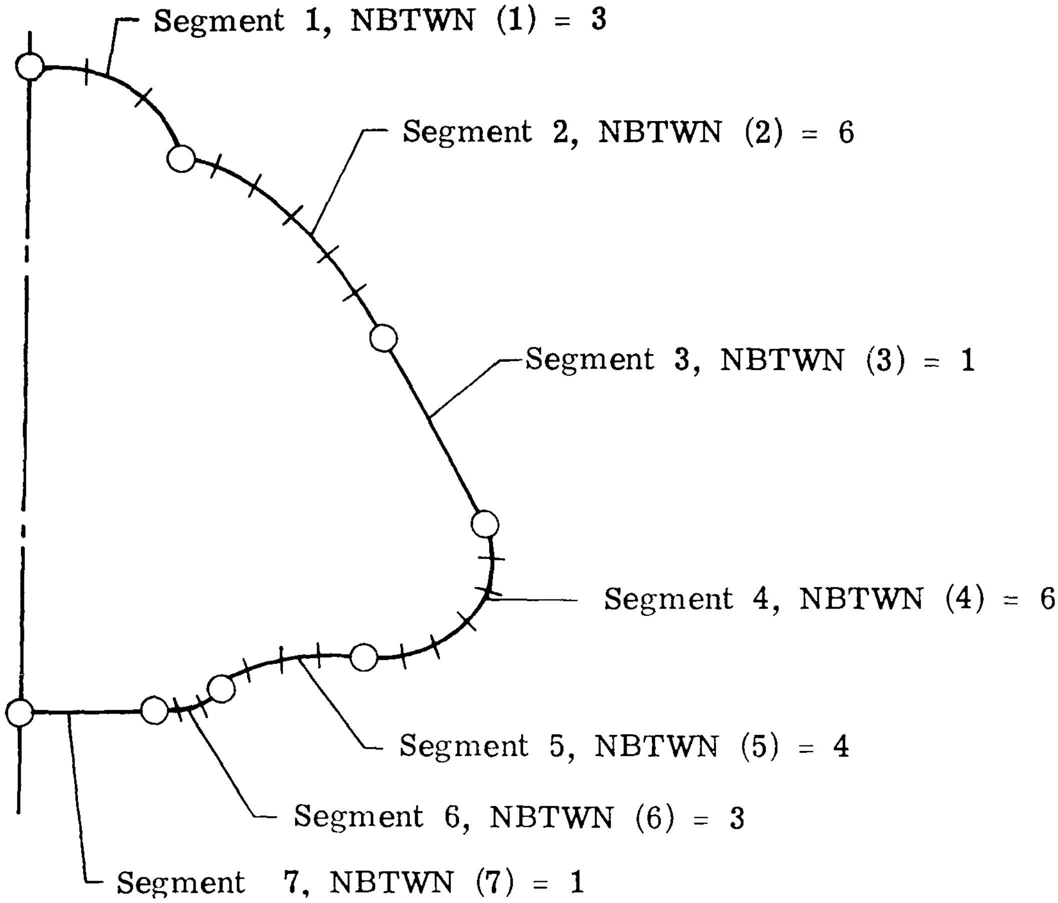


Figure 33.- Fuselage: prescribed uneven cross-section point distribution. Tick marks indicate segment subdivisions. NSS must equal 25; LOFMX must equal 8.

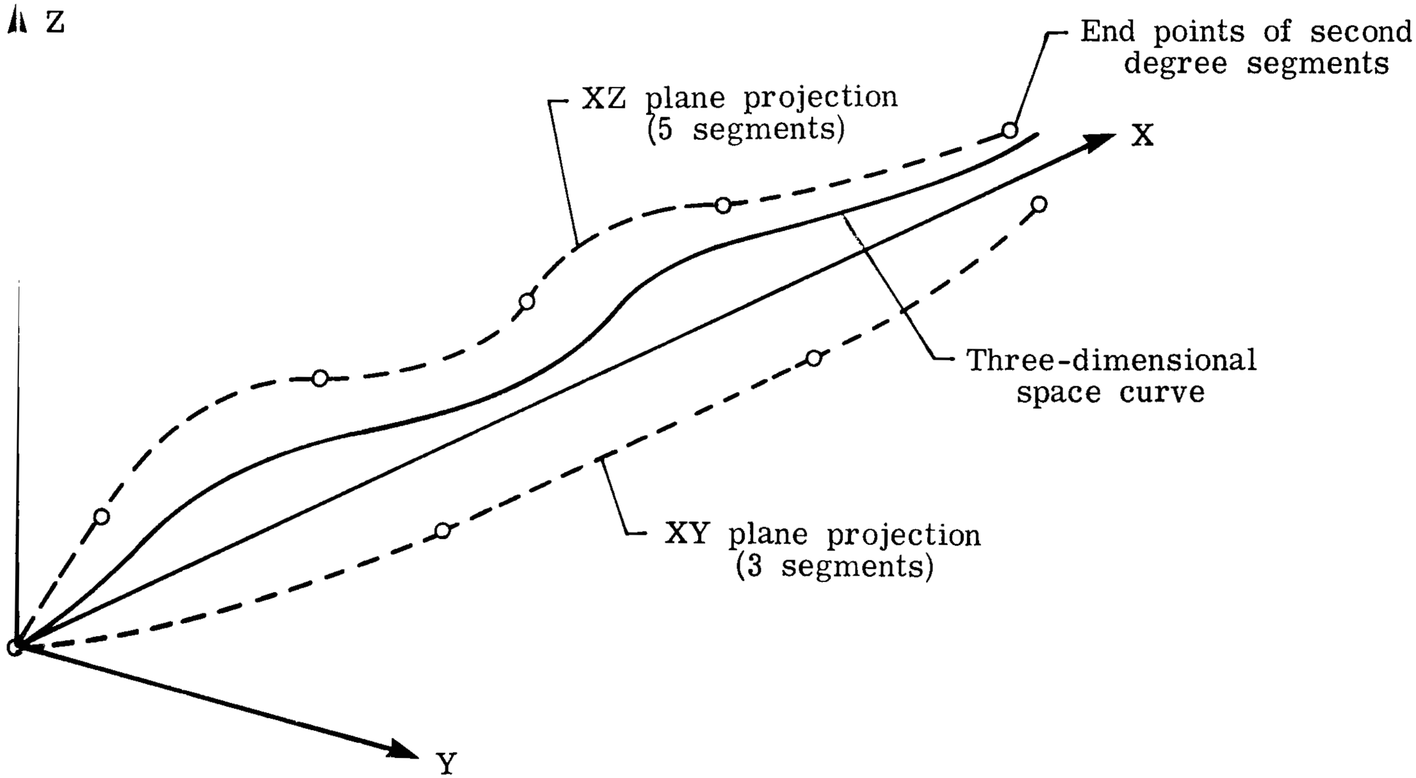


Figure 34.- Fuselage: coordinate plane projections of a three-dimensional space curve.

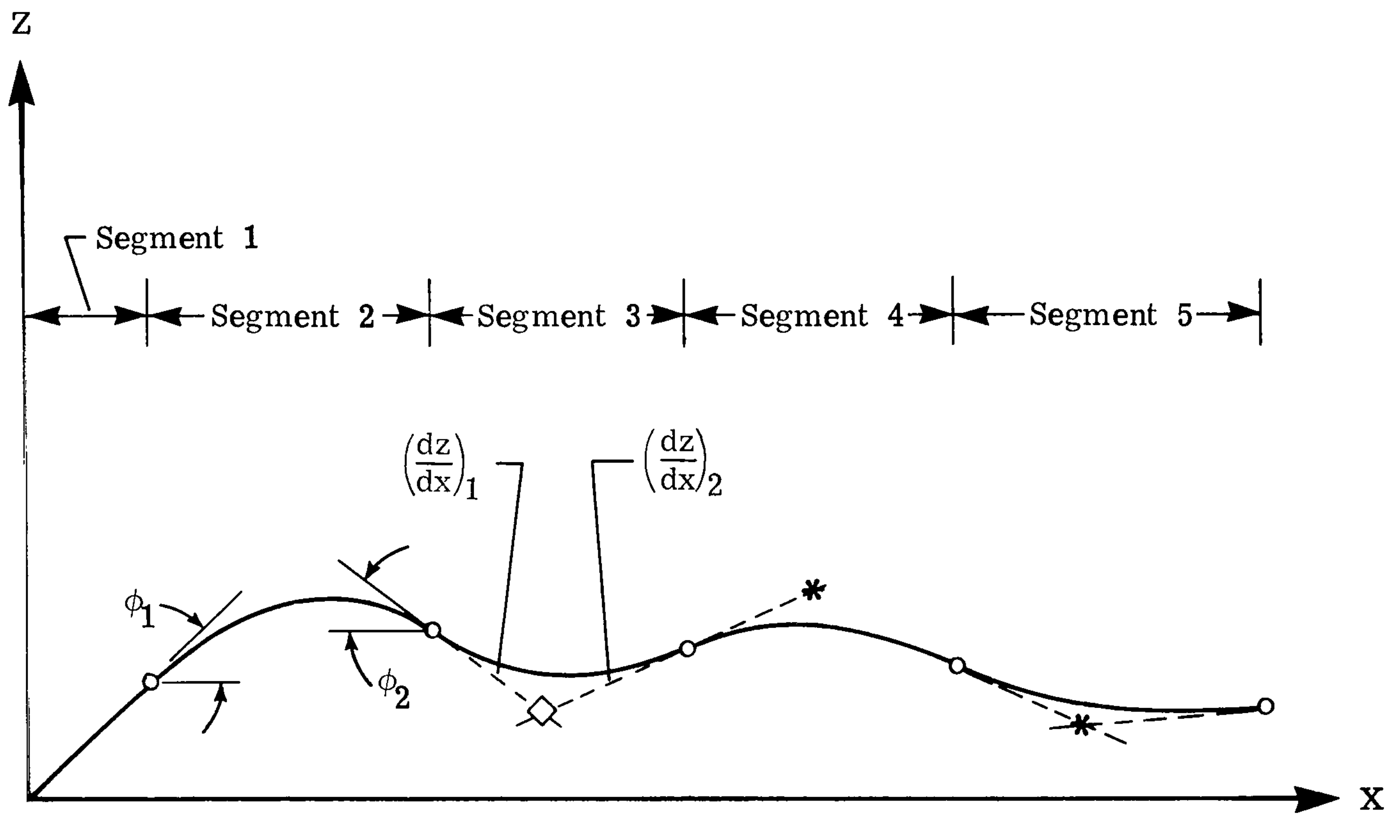


Figure 35.- Fuselage: slope control options for longitudinal segments. ◇ and * denote slope control points.

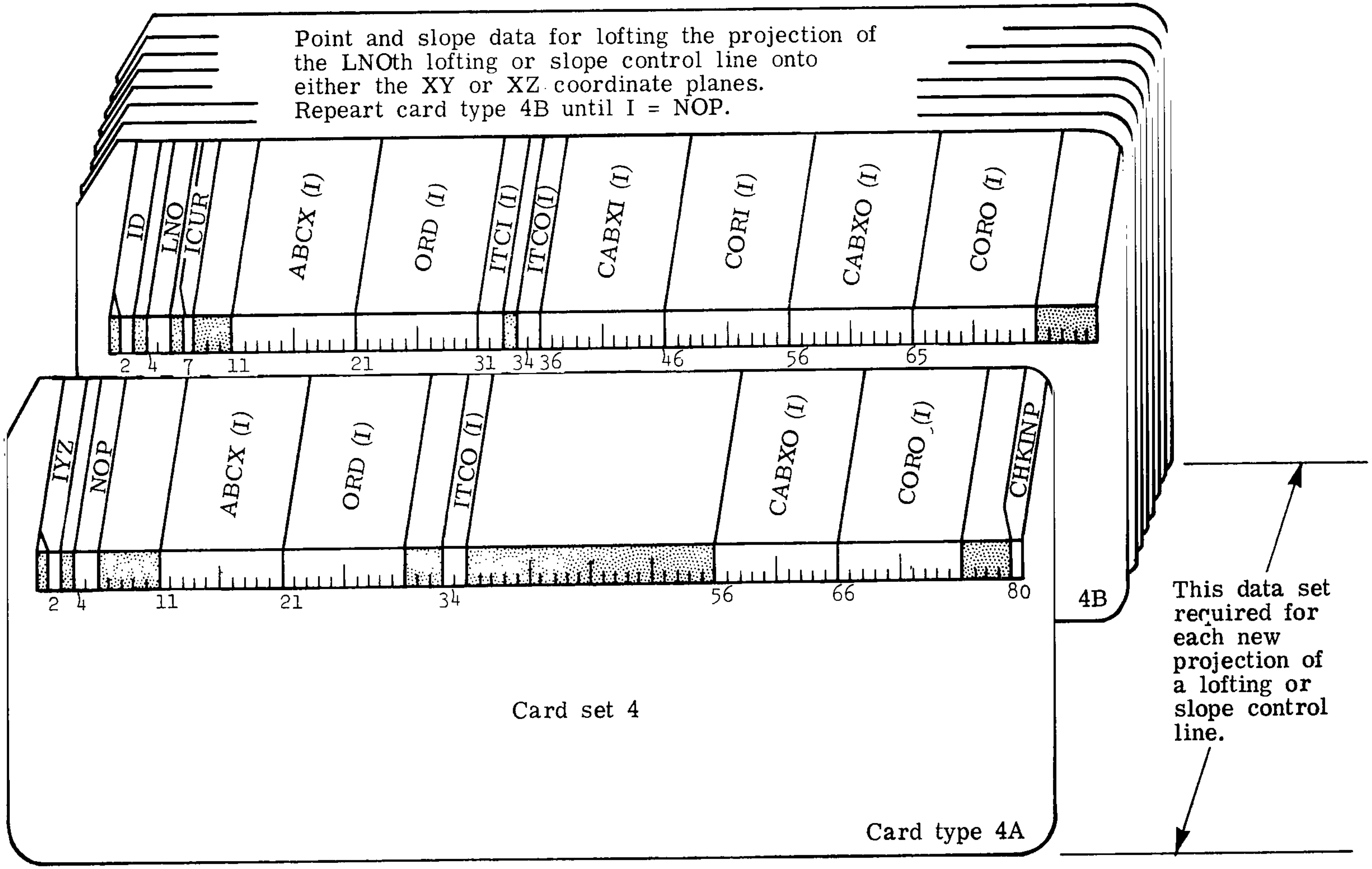


Figure 36.- Fuselage: card set 4 input.

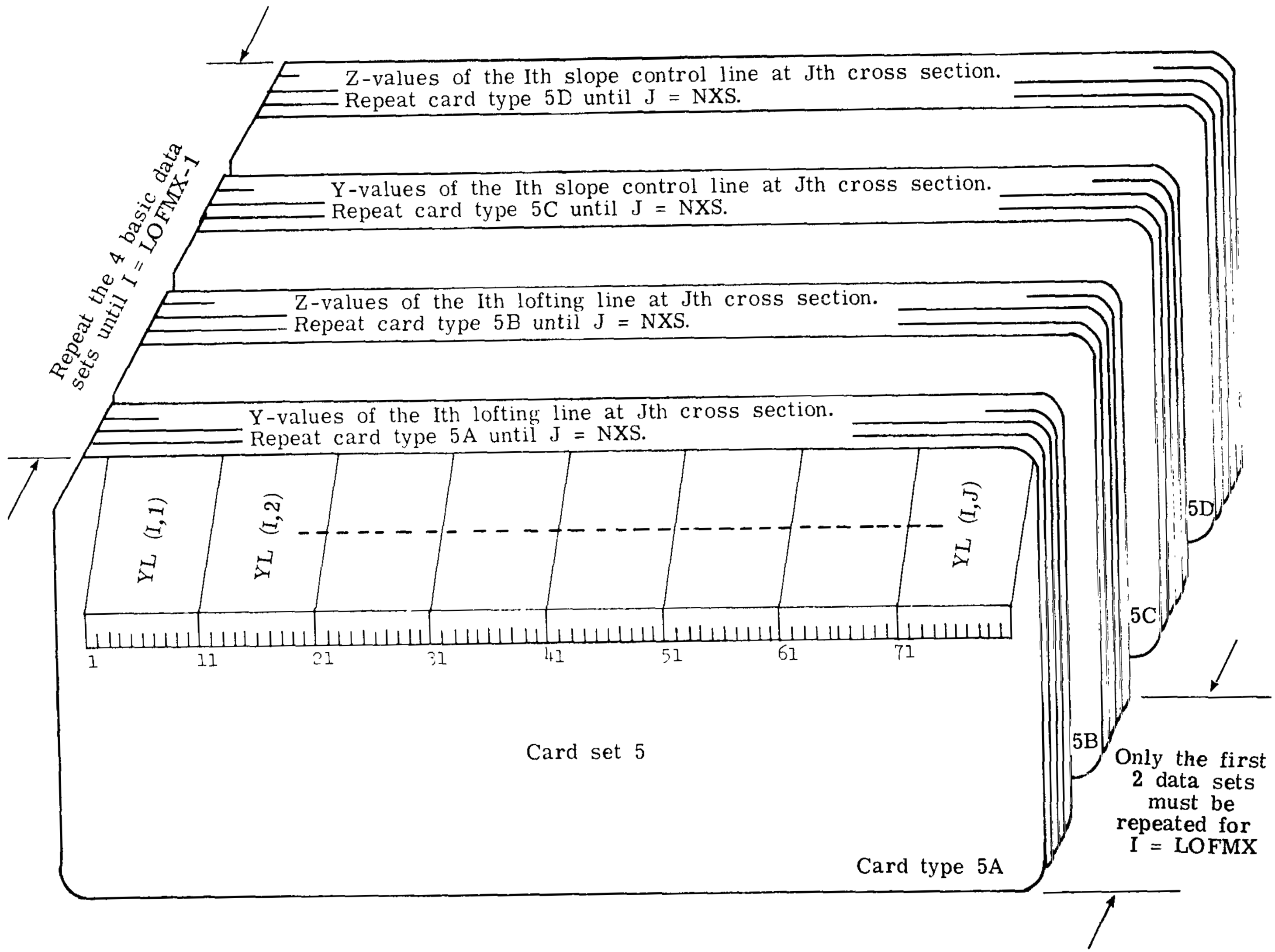


Figure 37.- Fuselage: card set 5 input.

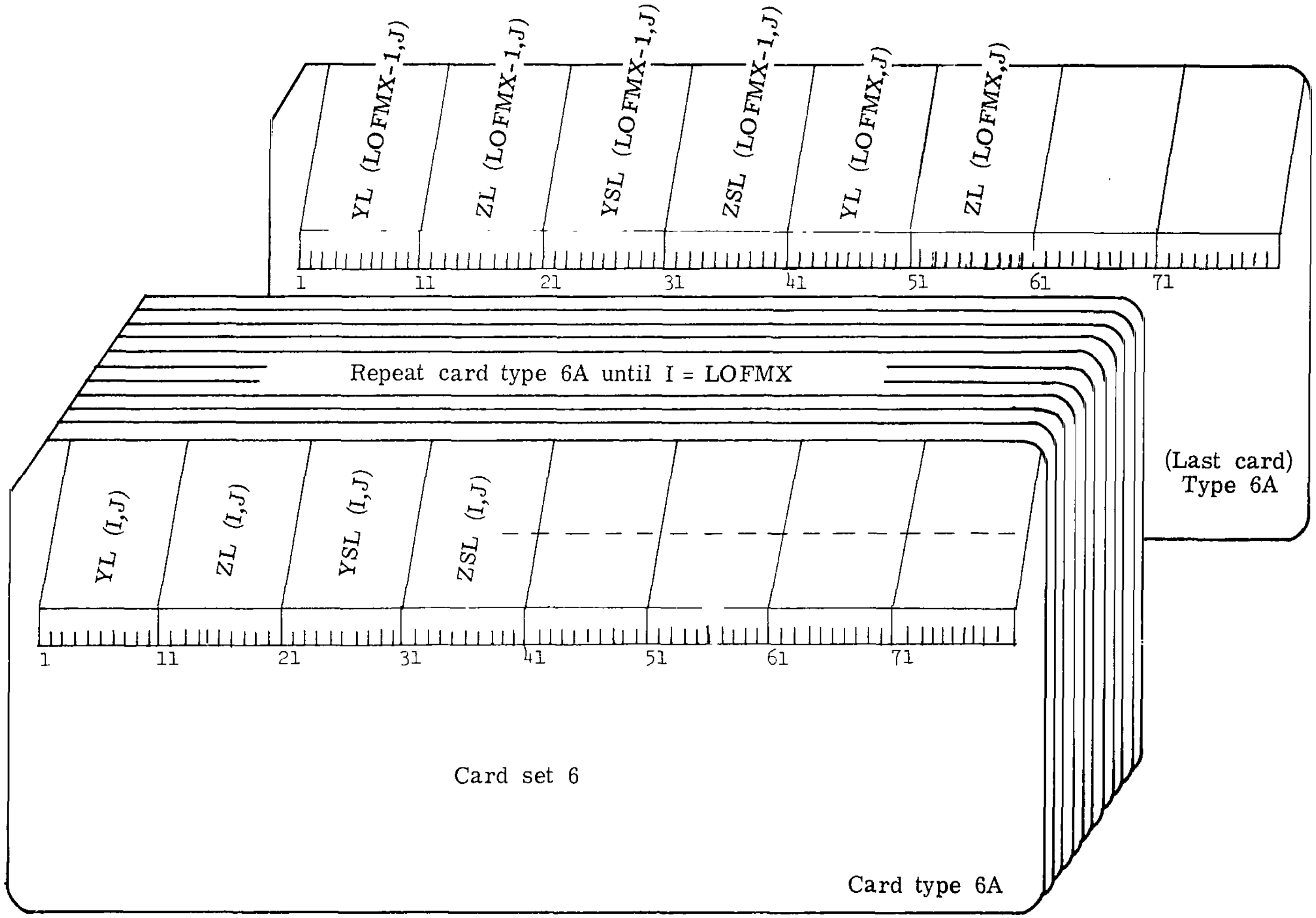


Figure 38.- Fuselage: card set 6 input.

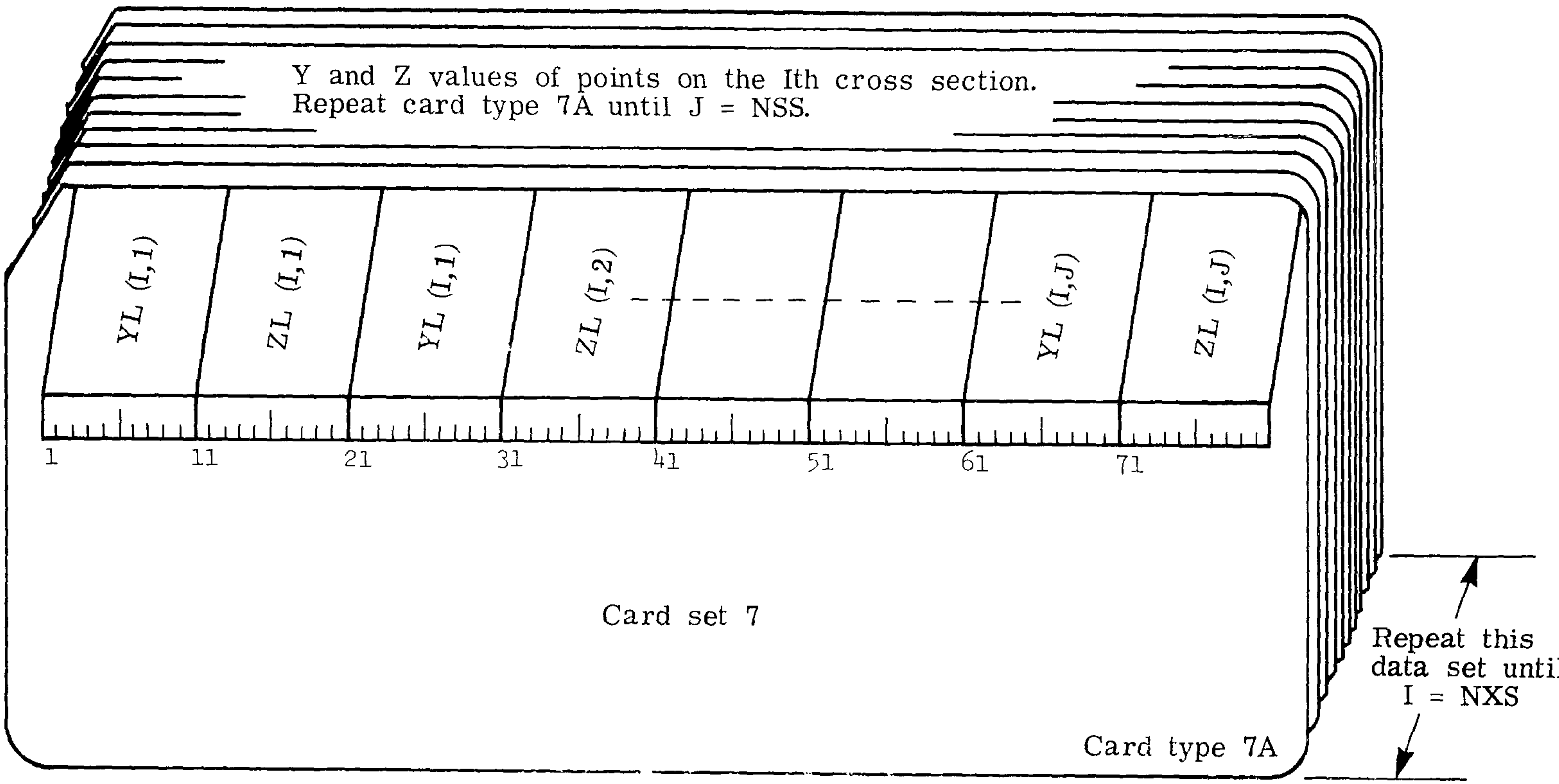


Figure 39.- Fuselage: card set 7 input.

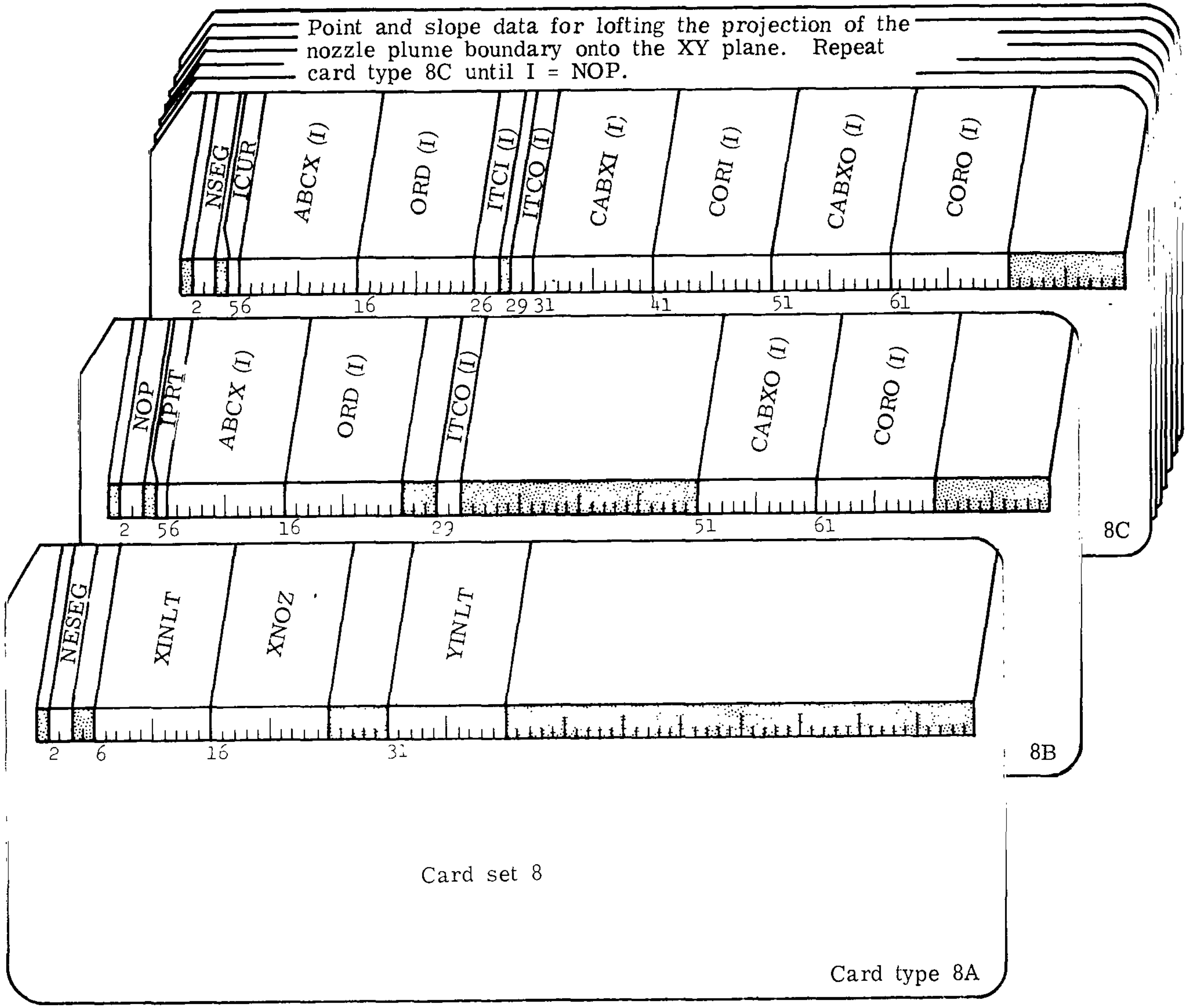


Figure 40.- Fuselage: card set 8 input.

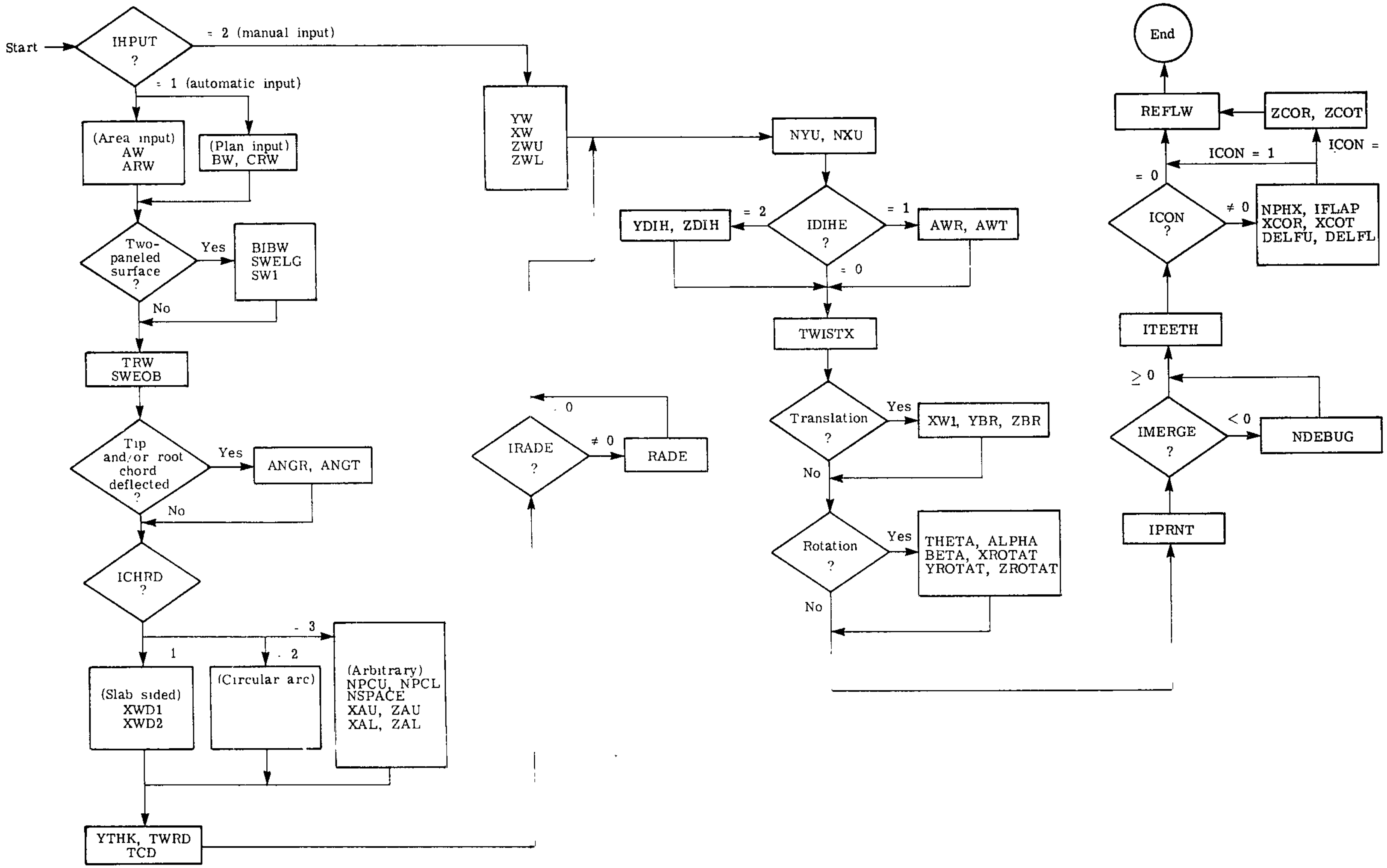


Figure 41.- Planar-surface input flow.

- Overlay (GEM,0,0) GEMPAK
  - SCALE
  - TØLER
  - IUNI
  - SECBI
  - ZBRENT
  - ERRØR
  - Overlay (GEM,1,0) FUS2
    - SLPDET
    - SECDEG
    - Overlay (GEM,1,1) GØØDY
    - Overlay (GEM,1,2) ENGØUT
      - FØRD
      - CRØSXD
  - Overlay (GEM,2,0) WINGEX
    - Overlay (GEM,2,1) INITL
      - DFALT
      - PRNTIN
    - Overlay (GEM,2,2) WINGF
      - FØFX
      - ATAK
  - Overlay (GEM,3,0) MERGE
    - Overlay (GEM,3,1) RTAP28
    - Overlay (GEM,3,2) RENUM
    - Overlay (GEM,3,3) REVERS
    - Overlay (GEM,3,4) PTINT
      - CRØSS
      - RAYØRD
      - TRICHK
      - NØRMAL
    - Overlay (GEM,3,5) NØINT
    - Overlay (GEM,3,6) ADCHRD

Figure 42.- GEMPAK program structure.

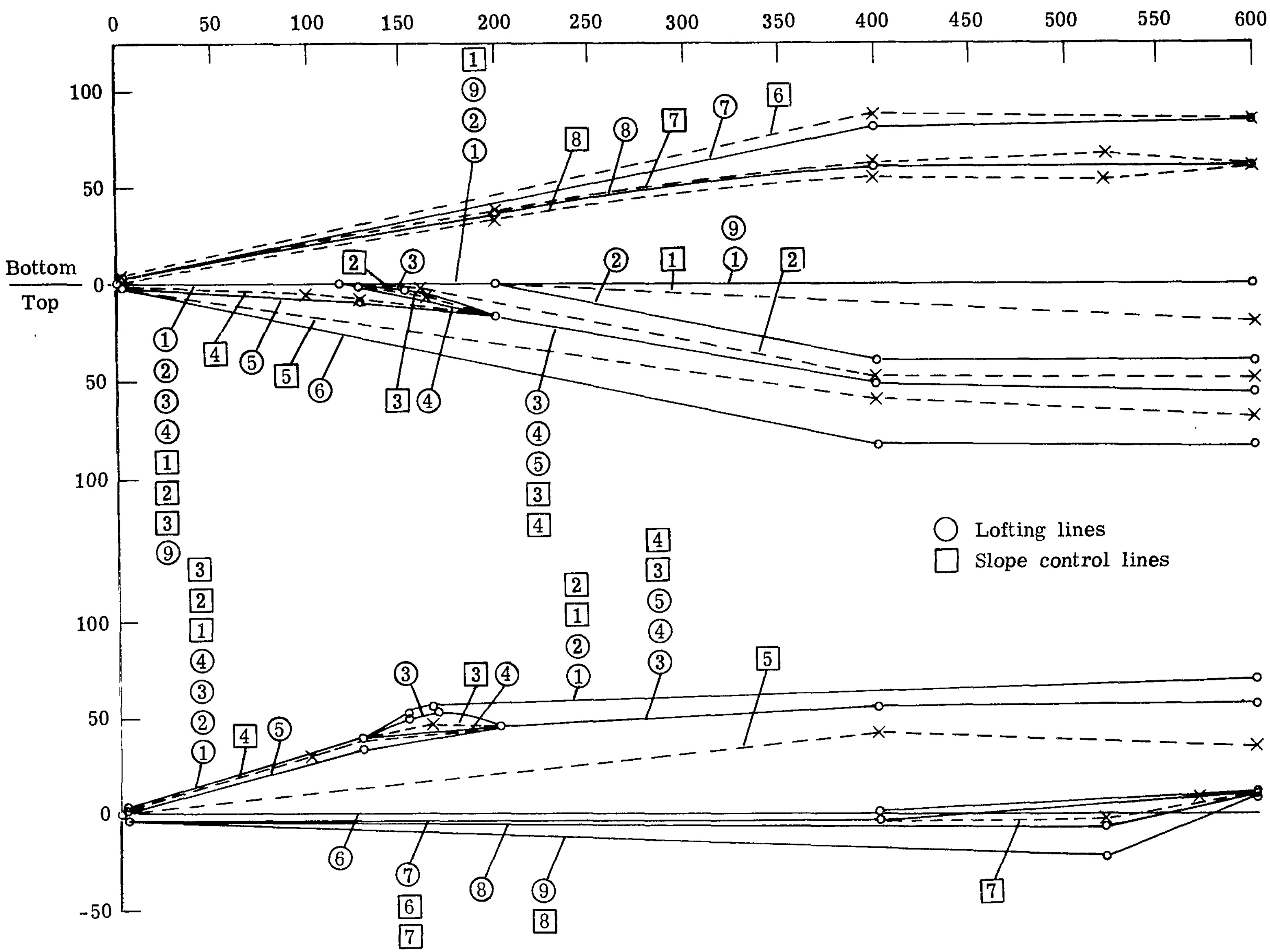


Figure 43.- Sample 1: fuselage input layout. Numbers indicate order of lofting and slope control lines. Solid lines are lofting lines and dashed lines are slope control lines.

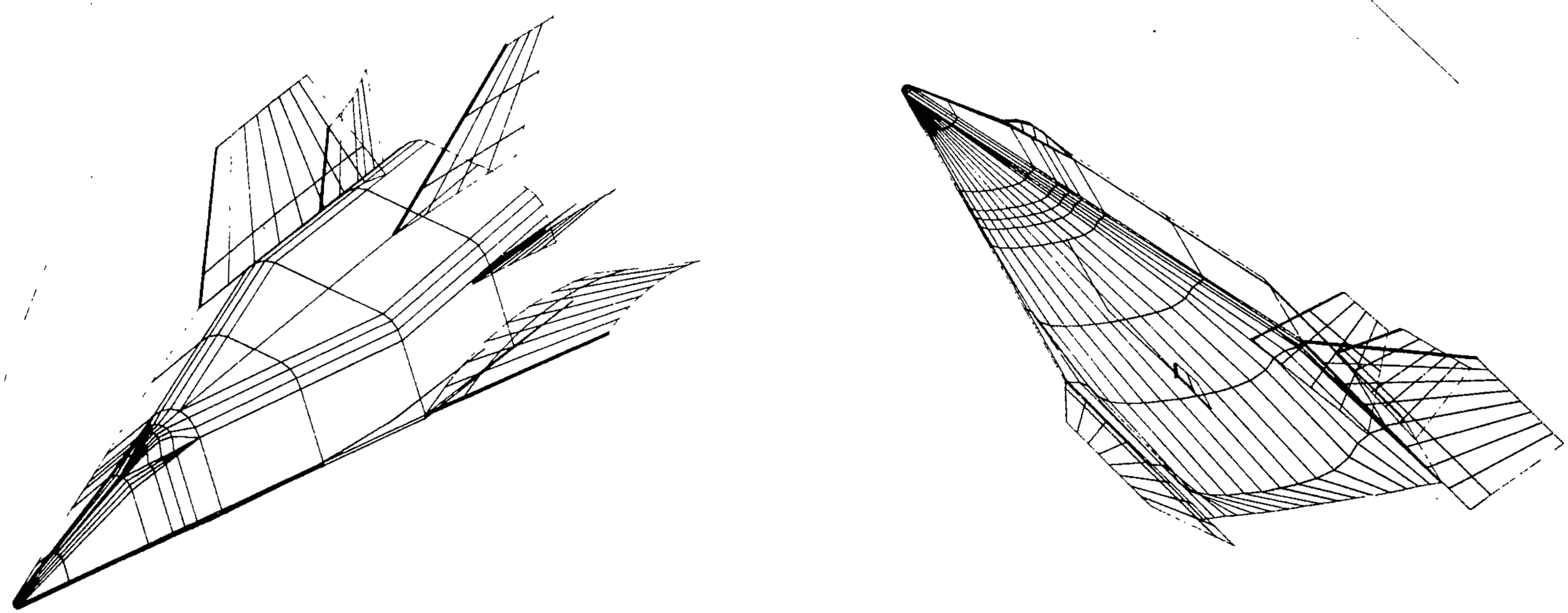


Figure 44.- Computer drawing of final generated geometry for sample case 1.

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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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