JPL ENTRY VEHICLE DESIGN

COMPUTER PROGRAM USERS' MANUAL

Prepared by

SPACE SYSTEMS DIVISION AVCO CORPORATION Lowell, Massachusetts

> AVSSD-0001-66-RR Contract JPL 951070

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> > BOOK I

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APPROVED

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P. Levine Associate Manager. Special Projects

Prepared for

JET PROPULSION LABORATORY CALIFORNIA INSTITUTE OF TECHNOLOGY Pasadena, California

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FOREWORD

This Program Users Manual and the associated computer programs represent the final objectives of JPL Contract 951070. Several of the computer programs covered in the manual were largely developed under a prior contract (JPL-950626) and are partially described in the final report Avco/RAD Mars Venus Capsule Parameter Study, Vol. I, "Introduction and Analysis," TR-64-1, dated 21 March 1964.

The two JPL contracts leading to the development of the computer programs and the Users Manual were performed in the Advanced Space Systems Directorate at the Space Systems Division of Avco, Lowell, Massachusetts. Mr. P. Levine was the Project Engineer responsible for all technical work, and was assisted by other members of Avco's technical staff, including Messrs. P. Dicarlo, A. Robb, M. Russell, J. Cloutier, O. Zappa, M. Moge, J. Brown, P. Norton, G. Waldman, J. Serpico, R. Davis, and D. Flinn. The programming was done principally by Miss S. Sillers, Mr. D. Gillespie and Mr. J. Klugerman of Avco's Technical Programming Staff with assistance from Messrs. A. Ficado, M. Greenberg, E. Sova, C. Berndtson, and with overall guidance from Dr. J. Warga, Manager of the Mathematics Department.

Minor typographical corrections made by JPL 1 December 1966. The following pages are affected:

Program 1880; pg 16, 23, 48, 49, 67, 69 Program 1882; pg 31, 47, 48 Program 1883; pg 33, 50 Program 1885; pg 3, 12, 18, 92

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This manual has been divided into a number of sections, each treated as a separate document with its own table of contents and list of illustrations. The sections are listed below, and each section may be easily located by referring to its tabbed cover.

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INTRODUCTION

A. OBJECTIVE

The objective of this manual is to provide the program user with the necessary understanding of the approximations contained in the series of entry vehicle design programs developed under contracts JPL 950626 and 951070 (and of the input procedures, so that the programs can be utilized with ease and confidence. In view of the stated objective, the manual contains a description of each program and its specific purpose. The mathematical model used in each program and a list of basic limitations is provided, so that the user can establish the applicability of the program to the particular problem at hand,

Should the program user wish additional information about the calculations being performed in the program, the specific equations which are programmed are provided) Furthermore, should questions arise as to the manner in which the programming was done, (a section describing the IBM routines is also provided in the manual.)

The intent of the set of computer programs is to ascertain the effects of all important parameters known to influence significantly the choice of vehicle shape and the calculation of the heat shield, structural, descent, and landing system weights. To cover the complete design problem, one must consider the interrelated aspects of the vehicle aerodynamics, heat transfer, thermal protection, and structural design. Furthermore, the entry problem is often bounded by overall systems considerations as to vehicle diameter and weight limitations, range of entry conditions, descent and impact system requirements, and special heat shield and structure material and shape requirements.

Although it is indeed commendable to achieve a complete set of computer programs which utilize the very "best" calculation models, the use of such a set of programs would not be compatible with the overall objectives to provide a set of computer programs suitable for preliminary tradeoff and parametric studies. A compromise was sought in formulating the computer programs, whereby the necessary inputs are not unduly excessive and are readily avail-



able. Programming compromises were also needed to avoid excessive computational time and wasteful generation of information that is not directly usable for the problem at hand. The computer programs are not intended to be used for detailed design studies but rather to screen the range of design parameters, to narrow their scope, and to establish trends.

B. INFORMATION FLOW

The thermo-structural design problem of evolving the heat shield and structural weights centers about the heating and loads predictions arising from the entry trajectory calculations. The degree of sophistication in the whole design approach is therefore related to the nature of the approximations used in computing the trajectory. The simplest trajectory approximation considers the vehicle as a particle without lift and of constant drag coefficient. For the particle trajectory as the entry vehicle is completely characterized by its ballistic coefficient (M/C_DA).

The limitations of a particle trajectory are often prohibitive for the prediction of accurate heating and loads environment, except in the cases of spherical bodies or where the entry angle of attack and angular rates are very small. Hence, in the most general case, an aerodynamic configuration and the corresponding aerodynamic force and moment coefficients must be assessed prior to a trajectory calculation. Program 1881 provides a first estimate of the hypersonic aerodynamic coefficients based on Newtonian flow theory if wind tunnel data is not available. Frequently, limited test data is sufficient for preliminary design studies when combined with the results of Program 1881.

Specification of the entry vehicle geometry provides only part of the information necessary to calculate the angle-of-attack motions during entry. A major aspect of the entry motion centers about the vehicle's stability, which is highly dependent on the center-of-gravity location and the moments of inertia. The first estimate of the center of gravity and the corresponding moments of mertia can be obtained from Program 1881, based on prescribed stability criteria. As the preliminary design studies progress, the estimates of center of gravity and moments of inertia must be updated and certain changes could significantly alter the entry vehicle's stability and further change the heating and loads environments. The information flow diagram depicted in Figure 1, indicates the manner in which Program 1881 can provide aerodynamic coefficients and the first pass estimates of the center of gravity (XCG) and the moments of inertia about the roll and pitch axes given in terms of the respective radii of gyration (RGX) and (RGY). The trajectory computation performed by Program 1880 provides the angle of attack, velocity, and altitude history during entry. The variation of the drag and lift forces arising from the angle of attack motions is computed, and the effect of their variation on the trajectory kinematics is accounted for. As part of Program 1880, dynamic pressure



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Figure 1 INFORMATION FLOW WITHIN VEHICLE DESIGN PROGRAMS (XCG = DISTANCE OF CG FROM STAGNATION POINT, RGX, RGY = RADII OF GYRATION ABOUT X, AND Y AXES, RESPECTIVELY) and convective and radiative heat pulses are computed based on the instantaneous flight conditions; hence, the heating and loads environment is related to the vehicle dynamics which, in turn, depends on the estimates of the coefficients, center of gravity, and the moments of inertia.

The heat pulses calculated in Program 1880 are considered to be reference values, and the heating at a point of the body is expressible as a fraction (or multiple) of this value. Similarly, the pressures about the body are expressible as fractions (or multiples) of the dynamic pressure. The factors by which the reference pulses evolved from Program 1880 must be multiplied to provide the local pressure and heating may be found using Program 1885, if test data is unavailable. As shown in Figure 1, the output of Programs 1880 and 1885 are required simultaneously to compute the first pass on the structural weight. Program 1885 requires the vehicle geometry, atmosphere composition, and flight conditions as input, as well as the angles of attack for which the pressure and heating distributions are required. The output of Program 1885 is set forth as factors which can be applied directly to the heating and dynamic pressure pulses using the results of Program 1880. The distributions of Program 1880 are given for the windward and leeward meridians only. In actuality, a point on the vehicle is subject to a heating and ` loads environment which is affected by the roll attitude of the vehicle as well as its angle of attack. From the viewpoint of structural design, identification of the roll history of a particular point on a shell is unnecessary. provided thermal effects are not important. In order to perform an exact heat shield analysis, a streamline pattern around the complete vehicle would be required and a statistical treatment of the entry conditions would generally be required to establish the design requirements. With the view of obtaining preliminary design evaluations with assurance that the heat shield weights will be conservative, a simple approach can be taken (and is used in Programs 1887 and 1889) which considers the heating on the vehicle as if it were in a lunar motion utilizing the maximum angle-of-attack envelope generated by Program 1880.

An important structural consideration is that environments obtained from other trajectories on launch conditions may be more critical than the one for which the heating environment is most severe. By permitting optional inputs on peak dynamic pressure and deceleration (or acceleration) arbitrary combinations of heating and loads environments can be studied.

The information flow diagram of Figure 1, indicates that the appropriate outputs of Programs 1880 and 1885 are input to Program 1886. In addition, structural materials data and design criteria are input for Program 1886. Program 1886 provides for several options of construction: sandwich, stiffened, or monocoque. The failure criteria considers buckling and yield stress with further limitations due to minimum gage. As the structural weight may be dependent on its temperature rise due to loss of strength at elevated temperatures, an interaction exists between the heat shield and the structural analyses. Furthermore, the heat shield interacts with the structural calculation by creating inertial loads on the structure.

Following the initial sizing of the structure, from Program 1886, and the heat pulses via Programs 1880 and 1885, sufficient information is on hand to perform the heat shield analysis. Program 1884 calculates the heat shield requirements, if indeed one is needed. The heat shield material properties and design criteria are required input as well as the results of Programs 1880 and 1885. There are several interaction mechanisms between the heat shield and structure, two of which are noted above; hence, the flow diagram of Figure 1 indicates a thermo-structural loop.

The internal pavload is dependent on the total entry weight, the heat shield and structural weight, internal structural weight, and various system constraints placed on the descent and impact systems. Program 1882 integrates the system constraints and the results of Programs 1884 and 1886 to determine the net usable payload weight. In order to provide sufficient flexibility in a program of this sort, numerous options are possible, e.g. single chute, two parachutes, parachute and retro-rocket combinations, spherical payloads, cylindrical payloads, and conical payloads. System constraints (as impact deceleration limits) are inputs to Program 1882. Upon solving for the weight of the subsystem and determing the size and weight of each element, and of the payload, a packaging calculation is performed to ascertain whether the payload fits into the vehicle satisfactorily and provides a suitable center-of-gravity position. In addition, the overall moments of inertia are computed based on the detailed heat shield and structures and subsystems information evolved. As noted at the very outset, the initial estimates of center of gravity and moments of inertia may be sufficient for preliminary design purposes; however, the refined values arising from Program 1882 can now be tested by rerunning Program 1880 and observing the changes in the heating and loads environment. If the heating and loads change significantly due to the moment of inertia and center-of-gravity changes, then a complete iteration on the structure, heat shield, and subsystem weights is required.

The last step in the design study is the complete shell analysis by Program 1888, including the effects of payload attachment, bending, and shear. In order to perform this analysis, detailed pressure distribution information is required for which Program 1885 may be used. The inputs to Program 1888 include the preliminary structural sizing and the heat shield thicknesses, as well as the structural material properties and failure criteria. As a result of the refined structural analyses of Program 1888, any significant changes in structural weight can alter the complete internal structure and subsystem weight breakdown, requiring further iteration on these weights. The final overall loop, including Programs 1888 and 1887, is considered as Program 1889. The input of Program 1889 is clearly the input and output of all the other programs and/or experimental data when available. The results of Program 1889 are the complete vehicle weight breakdown of the heat shield, structure, internal structure, descent system, impact system, and usable payload. Program 1889 closes the aero-thermo-structures-systems loop, and as such arrives at a preliminary design suitable for a particular entry problem.

C. PROGRAM FORMAT

A primary objective sought throughout all the programs is the achievement of uniformity of format, such as notation, units, and input procedures. The problem of units arises due to the multidiscipline nature of the various programs. In dealing with each program a set of units was established which appeared both convenient in that they are in widespread use and logical. In dealing with gas dynamics and atmosphere calculations, temperature is commonly given in degrees Kelvin ($^{\circ}$ K), whereas in dealing with the heat shield and structure calculations, temperatures are commonly given in degrees Fahrenheit ($^{\circ}$ F).

The aerodynamicist deals with density in slugs/ft³, whereas the thermodynamicist and structural analyst prefers 1b (mass)/ft³ and these conventions are observed. The gas dynamicist deals with pressures in terms of atmospheres, the aerodynamicist in PSI or PSF, and similarly the thermo- and structural analysts. The units of length are restricted to either feet or inches throughout the programs.

D. PROGRAMMING METHOD

All programs are written in Fortran IV computer language. All data is read into the computer through use of the NAMELIST feature of Fortran IV. The use of machine language subroutines (other than the standard IBM library subroutines) are avoided whenever possible. All Fortran IV input and output statements refer to specific logical tape units.

The program linking for 1887 and 1889 employs the IBSYS overlay feature. As much independence as possible is retained among the links.

This users' manual provides input forms and the Fortran variable names of input and output quantities. This manual includes sample results, along with instructions for preparing data and running the programs.



TRAJECTORY PROGRAM (1880)

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I. INTRODUCTION

A. GENERAL DESCRIPTION

The purpose of this program is to determine the flight path, angle of attack envelope, heating, and loads as a function of time for an axisymmetric vehicle during its entry trajectory into planetary atmospheres. The general inputs required include:

- 1. Vehicle mass and moment of inertia data
- 2. Aerodynamic coefficients
- 3. Entry conditions
- 4. Planet and atmospheric data
- 5. Heating factors based on vehicle shape.

Convective heat pulses are computed at the stagnation point (laminar) and at the sonic point (laminar and turbulent). In addition, both equilibrium and nonequilibrium radiative heat pulses are computed.

B. CALCULATION MODEL

A detailed description at the calculation model is given in Reference 1. A brief summary description is provided herein for the program user.

1. Coordinate Systems

The treatment of the force equations during atmospheric entry is simplified by considering a coordinate system which uses only the elevation angle gamma to define its orientation relative to the local horizontal space plane. A heading angle is unnecessary because of the assumption of a spherical, nonrotating planet The velocity vector is specified by its scalar value and the elevation angle γ measured positive above the horizon.

Since planar trajectories are of primary interest, only two equations of motion are required to calculate the flight path of the vehicle in the plane of the velocity and gravity vectors.

The body axes are oriented with respect to a system of wind axes using a conventional system of Euler angles. The curvature of the flight path is reflected in a rotation of the wind axes with respect to a set of fixed (inertial) axes.

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The coordinate systems used in deriving the force and moment equations are depicted in Figure 1. The wind axes are X , Y , and Z , where X coincides with the velocity vector, and Z lies in the plane of the velocity and gravity vectors. The origin of the body axes X_B , Y_B , Z_B ,

and of the wind axes are taken at the c.g. of the vehicle. The total angle of attack α' is the angle between the body axis $X_{_{\mathbf{B}}}$ and the velocity vector (or X_).

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2. Aerodynamic Coefficients

The aerodynamic coefficients utilized in the program may be either experimental or theoretical values. The coefficients can be input as a double table of angle of attack and Mach number dependency, including C_{N} , C_{X} , C_{m} (or X_{cp}) $(C_{m_{d}} + C_{m})$. The coefficients can also be input to solve

the angle-of-attack motions using linear coefficients in which case the values are required only at zero angle of attack, but as functions of Mach number including C_D , $C_{L\alpha}$, C_m , and C_m , C_m . The sign and axes

conventions used in the aerodynamic coefficients are depicted in Figure 2.

The damping coefficient is nondimensionalized by $\frac{d}{2V}$, for example,

$$C_{m,\alpha} = \frac{\partial C_{m}}{\partial \left(\frac{\hat{\alpha} d}{2V}\right)}$$

The reference area corresponds to the reference length, which is the vehicle diameter.

Force Equations

The calculation model assumes a spherical nonrotating planet. The force equations are written in wind axes (X, Y, Z) aligned along the instan-

taneous velocity vector as shown in Figure 1. The side force equation was omitted, and the resulting drag and lift equations describe the motion of the vehicle's center of gravity in the instantaneous plane of the trajectory.

The component of the total lift that lies in the plane of the trajectory depends on the orientation of the vehicle. Using a set of Euler angles, ψ , θ , φ as shown in Figure 1, which determine the orientation of the body fixed axes (X_B, Y_B, Z_B) with respect to the wind axes, the force equations

have the form,

DRAG:
$$mV = -C_D Aq - mg \sin \gamma$$

LIFT: (In the plane of \overline{g} and \overline{V}),
 $m V \dot{\gamma} = \frac{mV^2}{R_Z} \cos \gamma - mg \cos \gamma + C_L Aq \frac{\sin \theta}{\sin \alpha'}$
. -2-







AXISYMMETRIC COEFFICIENT CONVENTIONS



ANGULAR RATE CONVENTIONS

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Figure 2 AERODYNAMIC COEFFICIENTS CONVENTIONS

-4-17< where α' is the total angle of attack and is related to the Euler angles by,

$$\sin^2 \alpha' = \sin^2 \psi + \cos^2 \psi \sin^2 \theta$$

The gravity vector is taken as radial, and pointed towards the center of the planet. The gravitational field assumes an inverse square relationship. The force coefficients required to solve the force equations can be specified as a function of angle of attack and Mach number.

4. Moment Equations

The moment equations are derived using the body axes indicated in Figure 1 and the total angular rates are taken with respect to a fixed set of axes. The angular rates are divided into two parts; those with respect to the wind axes, and those due to the motion of wind axes with respect to the fixed axes. The motion of the body axes with respect to the wind axes is given by the changes in Euler angles and also in a set of rate components P, O, R about each axis, where P, Q, R are related only to the changes in the Euler angles. The additional angular rate effects arise because of flight path curvature (changes in the direction of the velocity vector) due to lift and gravity.

The changes in flight path curvature due to lift is used in its entirety, i.e., the total lift force is used including the out of plane component. The analysis proceeds along the lines of Reference 1. An order of magnitude analysis is made and only those terms which could affect the results significantly are retained.

The total angular rate $\tilde{\Omega}$ with respect to a set of fixed axes has components P', Q', R' along the body axes such that,

 $\overline{\Omega} = \overline{i} P' + \overline{j} Q' + \overline{k} R'$

The calculation model is restricted to axisymmetric ballistic vehicles for which the products of inertia are zero, and $I_{\rm v}$ = $I_{\rm v}$, hence, the external

moment vector is related to the rate of change of angular momentum by

$$\overline{\mathbf{M}} = \overline{\mathbf{i}} \quad \mathbf{I}_{\mathbf{X}} \overset{\mathbf{P}'}{\mathbf{P}'} + \overline{\mathbf{j}} \left[\mathbf{I}_{\mathbf{Y}} \overset{\mathbf{Q}'}{\mathbf{Q}'} - \mathbf{P'} \mathbf{R'} \left(\mathbf{I}_{\mathbf{Y}} - \mathbf{I}_{\mathbf{X}} \right) \right]$$
$$+ \overline{\mathbf{k}} \left[\mathbf{I}_{\mathbf{Y}} \overset{\mathbf{R}'}{\mathbf{R}'} + \mathbf{P'} \mathbf{Q'} \left(\mathbf{I}_{\mathbf{Y}} - \mathbf{I}_{\mathbf{X}} \right) \right]$$

The external moment vector may be expressed as

$$\overline{M} = M^{*} \left(\frac{\overline{j} \sin \alpha}{\sin \alpha'} + \frac{\overline{k} \sin \beta}{\sin \alpha'} \right) + N^{*} \left(- \frac{\overline{j} \sin \beta}{\sin \alpha'} + \frac{\overline{k} \sin \alpha}{\sin \alpha'} \right)$$

The aerodynamic moments (M') and (N') are given approximately by

$$\mathbf{M}' = \mathbf{C}_{\mathbf{m}} \mathbf{q} \mathbf{A} \mathbf{d} + (\mathbf{C}_{\mathbf{m}} + \mathbf{C}_{\mathbf{m}}) \frac{\mathbf{q} \mathbf{A} \mathbf{d}^2}{2V} \dot{\alpha}'; \quad \mathbf{N}' = (\mathbf{C}_{\mathbf{m}} + \mathbf{C}_{\mathbf{m}}) \frac{\mathbf{q} \mathbf{A} \mathbf{d}^2}{2V} \quad \dot{\eta} \sin \alpha'.$$

where η is the rate of precession of the plane containing \overline{V} and \overline{i} . The wind axes pitch about the Y_o axis due to gravity at a rate,

$$\gamma_{\rm T}^{\prime} = -\frac{g \cos \gamma}{V}$$
 (Gravity term in above lift equation.)

Due to lift, the flight path curvature can be out of the plane of the trajectory and is given by

$$\gamma_{\rm L} = \frac{\rm L}{\rm mV}$$
 (Lift term in above lift equation is in-plane component only.)

As $\tilde{\gamma}_L$ lies along \widetilde{M}' , the expressions for P', Q', R' can be written as,

$$\begin{split} \mathbf{P}' &= \mathbf{P} + \dot{\boldsymbol{\gamma}}_{\mathrm{TX}} \\ \mathbf{Q}' &= \mathbf{Q} + \dot{\boldsymbol{\gamma}}_{\mathrm{L}} \quad \frac{\sin\alpha}{\sin\alpha'} + \dot{\boldsymbol{\gamma}}_{\mathrm{TY}} \\ \mathbf{R}' &= \mathbf{R} + \dot{\boldsymbol{\gamma}}_{\mathrm{L}} \quad \frac{\sin\beta}{\sin\alpha'} + \dot{\boldsymbol{\gamma}}_{\mathrm{TZ}} \end{split}$$

where $\dot{\gamma}_{TX}$, $\dot{\gamma}_{TY}$ and $\dot{\gamma}_{TZ}$ are the components of $\dot{\gamma}_{T}$ along the body axes $X_{B}^{}$, $Y_{B}^{}$, and $Z_{B}^{}$, respectively.

Introducing the further approximations,

then the resultant expression for the moment equations are,

$$\dot{\Omega} = \frac{qAd}{I_Y} \begin{bmatrix} C_m & \frac{\sin\alpha}{\sin\alpha'} + \frac{Qd}{V} \left(\frac{C_m + C_m}{2} - \frac{C_L I_Y}{md^2} \right) \end{bmatrix} + PR \ 1 - \frac{I_X}{I_Y}$$
$$- \frac{PI_X}{I_Y} \frac{C_LAq}{mV} \frac{\sin\beta}{\sin\alpha'} + \frac{PI_X}{I_Y} \frac{g\cos\gamma}{V} (\sin\psi\sin\theta\cos\omega - \cos\psi\sin\phi)$$
$$-6-$$

$$\dot{\mathbf{R}} = \frac{qAd}{\mathbf{I}_{Y}} \begin{bmatrix} \mathbf{C}_{m} \frac{\sin \theta}{\sin \alpha'} + \frac{Rd}{V} \left(\frac{\mathbf{C}_{mq} + \mathbf{C}_{m, \alpha}}{2} - \frac{\mathbf{C}_{L_{\alpha}} \mathbf{I}_{Y}}{md^{2}} \right) \end{bmatrix} - PQ \left(1 - \frac{\mathbf{I}_{X}}{\mathbf{I}_{Y}}\right)$$
$$+ \frac{PI_{X}}{\mathbf{I}_{Y}} \frac{\mathbf{C}_{L}Aq}{mV} \frac{\sin \alpha}{\sin \alpha'} - \frac{PI_{X}}{\mathbf{I}_{Y}} \frac{g \cos \gamma}{V} \left(\cos \psi \cos \phi + \sin \psi \sin \theta \sin \phi\right)$$
$$\dot{\mathbf{P}} = 0$$

The moment equations display the coupling of the plunge damping term ${}^{L}\alpha$ frequently found, e.g., References 3, 4, and 5. It should be noted that the ${}^{C}L_{\alpha}$ is now a function of angle of attack (and also of Mach number if desired).

The terms yielding the coupling effects of flight path curvature due to lift and gravity with spin have also been retained.

The occurrence of the ${}^{C}L_{\alpha}$ explicitly is of interest as the usual six-degree of freedom computation effectively computes ${}^{C}L_{\alpha}$ implicitly by interpolating ${}^{C}N$ and ${}^{C}N$ from input tables. Hence differences between the two formulations are likely at small values of ${}^{C}m_{q} + {}^{C}m_{\alpha}$ and especially at large negative values of ${}^{C}L_{\alpha}$ where the ${}^{C}L_{\alpha}$ controls the angle-of-attack envelope below peak dynamic pressure. The present program provides for accurate simulation of ${}^{C}L_{\alpha}$ by direct input tables or by curve fitting computed values of ${}^{C}L_{\alpha}$ obtained from ${}^{C}N$ and ${}^{C}N$ input data.

To permit elementary studies of lifting vehicles, the $(\dot{\vec{Q}})$ equation given above has the additional aerodynamic term,

By input of the quantity Z_{CG} , a trim condition at other than zero angle of attack can be achieved, resulting in a lifting trajectory. The use of the off-set center of gravity is restricted to planar motions, i.e. zero spin, and zero sideslip angle.

The dynamic solution is programmed for the two moment equations discussed above and also for the linearized solution discussed in Reference 1. The adequacy of the approximate dynamical treatment for most practical entry problems of ballistic vehicles has been studied and comparisons made with six-degree-of-freedom solutions in Reference 1 (Vol. II) and a typical result is shown in Figure 3, for a planar oscillation and for a spin case.



Figure 3g TRAJECTORY COMPARISONS WITH SIX DEGREE OF FREEDOM RESULTS

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Figure 3b TRAJECTORY COMPARISONS WITH SIX DEGREE OF FREEDOM RESULTS

5. Heat Pulses

Convective and radiative heat pulses are computed along the trajectory. The convective pulse at the stagnation point utilizes the stagnation point velocity gradient data for the particular shaped vehicle being studied. The stagnation heating is based on the correlations of Reference 1 for CO_2 , N_2 , O_2 mixtures. Turbulent heating at the sonic point is computed by testing against a specified local (not ambient) transition Reynolds number criterion. The turbulent heating correlation is for air as given by Detra. Comparison of the program calculations with data of Reference 3 is shown for the stagnation point in Figure 4. Limited data on turbulent heating in $N_2 - CO_2$ mixtures given in Reference 4, indicates a negligible difference in the heat rates due to composition when compared with air data.

The equilibrium radiation heating is calculated via Program 1883 which is connected directly to the trajectory computation. A description of the equilibrium radiation model is given in Program 1883. A comparison of the program calculations with data and other predictions is given in Figure 5.

The nonequilibrium model is discussed in Reference l and summarized in Figure 6. The relative features of the model can be controlled using experimental data to adjust the ratios of $I_{\rm NE}/I_{\rm E}$ by input of IRNE, and the extent of the nonequilibrium zone by input of KNE.

An alternate, nonequilibrium model is possible wherein the nonequilibrium radiation contribution is assumed to be independent of density (except for truncation effects) and only a function of velocity. A simplified model is utilized such that $I_{\rm NE} \Delta_{\rm NE}$ = f (V), with the nonequilibrium intensity specified as a function of velocity based on experimental data, e,g., References 5 and 6.

6. Summary of Calculation Model

The calculation model can be used to study any of the following problems.

a. Parachute Problem--The vehicle m/C_DA requirements for achieving a prescribed Mach number at/or prior to a specified altitude.

b. Vehicle Stability--The adequacy of the vehicle's stability as a function of entry pitch, yaw, roll rates, and angle of attack.

c. Vehicle Performance-- The change in the trajectory, heating, and loads caused by the effects of the angle-of-attack motions on the flight path (velocity-altitude history).



Figure 4 STAGNATION POINT HEATING COMPARISONS WITH DATA

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Figure 5 RADIATION HEATING COMPARISONS WITH DATA



Figure 6 NONEQUILIBRIUM RADIATION CALCULATION MODEL

d. Convective Heating-- The stagnation-point and sonic-point convective heating pulses as well as an indication of transition.

e. Radiative Heating--The stagnation-point equilibrium and non-equilibrium radiative heating pulses.

f. Loads -- The dynamic pressure, and axial and normal load pulses,

g. Atmosphere--The effects of atmosphere composition and vertical structure on all the trajectory variables.

h. Planet--The effects of planet parameters on all the trajectory variables.

i. Scaling -- The effects of changing vehicle diameter and/or mass.

C. PROGRAM LIMITATIONS

The calculation model imposes several basic limitations on the range of trajectory problems that can be simulated with the program. These limitations include:

1. The approximations utilized prevent the entry vehicle from developing an angle of attack due to flight path curvature alone; hence, vehicles entering with zero rates and $a_e = 0$ or $a_e = 180$ will remain at the same angle of attack throughout entry.

2. The vehicle motions which can be simulated are limited by the assumptions of an axisymmetric inertia ellipsoid (spin rate stays constant throughout entry).

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II. USAGE

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A. INPUT DEFINITIONS

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Name	Preset <u>Values</u>	Symbol	Parameter	Units
ALAM	0.5	^a L.	Density exponent in QS formula.	<u>.</u>
ALPCR	0.		Critical angle of attack; if angle of attack at peak dynamic pres- sure is < ALPCR, the dynamics computation switches to the lin- earized equations.	degrees
ALPHAE		a _e	Angle of attack at entry.	degrees
AR	89516.	R	Gas constant	ft ² /sec ² -mole- ^o K
ATMØS			Number used to identify atmos- phere used for the calculations.	
ATRB	0.8	^a T	Density exponent used in QSTAR formula after transition occurs.	
BLAM •	0.	^b L	(Velocity/10 ⁴)exponent used in QS formula. If = 0 (preset value), it is computed by the program to be 3.9090229M where M is the molecular weight of the atmosphere	5 re.
BTRB	3.18	Ϸ _ͳ	(Velocity/10 ⁴) exponent used in QSTAR formula after transition occurs.	- 1
CASE			Number used to identify the case being run.	<u>.</u>
CDFM		с _D	Table of zero angle of attack drag coefficient variation as a function of Mach number only. Maximum number of entries = 10. See MGNLY.	š

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Name	Preset Values	Symbol	Parameter	Units
CDRØP	2.		Number used to delete moment equations after peak dynamic pressure, Switches to MØNLY coefficients. When, $1/2 \rho V^2 < CDR \phi P\left(\frac{-m g_{sl}}{C_D A}\right)$.	
CLAFM	- -	C _{Lα}	Table of lift curve slope varia- tion as a function of Mach number only. Used with $M \phi NLY$ table; maximum number of entries = 10.	per radian
CMAFM		C _{ma}	Table of pitching moment de- rivative $\left(\frac{\partial C_m}{\partial a}\right)$, as a function of Mach num- ber only. Used with MØNLY ta- ble; maximum number of entries = 10.	per radian
СМСФД		X _{CM}	Nondimensional center-of-gravity location for CMFA data.	
CMFA		C _m	Table of pitching moment coeffi- cient as a function of angle of at- tack and Mach number. Used with CMCØD and CMIN = 1.0. Max- imum number of entries; 19 angles of attack (corresponding to TABAL) and 5 Mach numbers when used with MANDAL table.	
CMIN	0.		Number which if > 0 provides the pitching moment from CMFA and CMG \wp D, and if \leq 0 from XCPFA.	
CMQFA		^C m _q + ^C m _à	Table of damping coefficient, $\left(\frac{\partial C_{\rm m}}{\partial \frac{Q}{2V}}\right)$, as a function of an- gle of attack and Mach number. Maximum number of entries: 19 angles of attack (corresponding to TABAL) and 5 Mach numbers when used with MANDAL table.	per radian

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External Name	Preset Values	Symbol	Parameter	Units
CMQFM		$C_{mq} + C_{m\alpha}$	Table of damping coefficient variation as a function of Mach number only. Maximum num- ber of entries = 10. Used with $M\phi$ NLY table.	per radian
CNFA		C _N	Table of normal force coeffi- cient specified as a function of angle of attack and Mach num- ber. Maximum number of entries: 19 angles of attack (corresponding to TABAL) and 5 Mach numbers when used with MANDAL table.	
CXFA		c _x	Table of axial force coefficient, specified as a function of angle of attack and Mach number. Max- imum number of entries ¹⁹ an- gles of attack (corresponding to TABAL) and 5 Mach numbers, when used with MANDAL table.	
		đ	Vehicle diameter (reference length).	. feet
DATE			Number used to identify the problem being run.	
DELMAC	0.5		When the Mach number ≤ 5 , output will be provided whenever the difference in Mach number from the last output value is \geq DELMAC	
DELMT	0.00001		This is the lower limit in Δt to which the predictor-corrector in- tegration method is allowed to cut Δt to improve accuracy. See description of ADAMS4.	
DELØRC		Δ/R_{C}	Table of stagnation shock standoff	
			distance $\left(\frac{\Delta}{D/2}\right)$ corresponding to	
			TABDR. Maximum of 10 entries.	

Name	Preset Values	Symbol	Parameter	Units
DELTAT	0.01		Initial A: used by the predictor- corrector integration method. See description of ADAMS4.	sec
DIRNE			Total nonequilibrium radiation in-Be tensity. (Twice the body rate).	u/ft ² -sec
DNBND	0.001, 1.E 0.01, 0.00 0.0001, 1. 1.E-5, 1.E	-6, 01, E-5, 2-5	Array of lower limits used by the predictor-corrector subroutine ADAMS4, as accuracy bounds on V, γ , Z, Q, R, ψ , θ , φ .	
FALR		L ₁	Temperature gradient in tropos- phere expressed as a fraction of the adiabatic lapse rate.	
GAME		γ _e	Entry flight path angle (positive up).	degrees
GSL		g _{SL}	Gravitational acceleration at the planet surface.	ft/sec ²
GTST	2.		When the reference convective heat pulse is ≥ 1 , output will be provided if the difference in the current flight path angle from the last output value is \geq GTST.	degrees
IPHEAT	0.		When IPHEAT ≥ 1 , tables of time, QS, QSTAR, HM/RTØ, and QRNE are provided on punched cards from logical Tape 7.	
IPRINT (0.		When $IPRINT \geq 1$, output is pro- vided at each integration step. The angle of attack (not the en- velope) is printed. Use of this option more than doubles running time and increases output by 3 to 4 orders of magnitude.	
IPRQRD	0.		When IPRQRD is > 1, the com- plete output (chemical composi- tion, etc.) of each radiation heat- ing calculation is provided. -18-	

Name	Preset Values	Symbol	Parameter	Units
IRNE	10.	I_{NE}/I_{E}	Non equilibrium intensity ratio.	
KNE	2.3		Multiplicative constant used to compute the nonequilibrium thickness $\Delta_{\rm NE}$.	
LS	-5.		Sentinel used to control the pre- dictor-corrector integration meth- od, used for initialization and to follow the course of the integra- tion. See description of ADAMS4.	
LTH		L _{TH}	Temperature gradient in ther- mosphere.	°K/ft
MANDAL			(Preset = 0 for coefficients as a function of α only). Mach number table (maximum 5 values) for coeffi- cients as function of both Mach number and angle of attack. When this table is specified, tables CXFA, CNFA, CMQFA, and either XCPFA or CMFA must be speci- fied for each Mach number in MANDAL. At Mach numbers be- low (or above) those specified in— MANDAL table, program uses co- efficients corresponding to lowest (or highest) Mach number listed.	
MASS		m	Mass of vehicle.	slugs
мемф			Number, used to identify the pro- blem being run.	
MØNLY			Independent variable table of Mach numbers used to compute coefficients as a function of Mach number only. Maximum number of entries is 10. See CDFM, CMAFM, CLAFM, CMQFM.	

Name	Preset Values	Symbol	Parameter	Units
MVE	1.		If MVE = 1.0 (preset value), the atmosphere is computed from the input parameters. If MVE = 2.0, the atmosphere is computed from tables in which the altitude (ZTBL) is the independent variable.	
NPTST	51		Maximum number of lines of trà- Jectory output per page.	line/page
PE		Pe	Spin rate at entry.	rad/sec
PTH		₽ _{TH}	Atmospheric pressure at base of thermosphere.	1b/ft ²
PTMAC	-100.		If PTMAC >0, linearly inter- polated values of the trajectory output quantities will be printed at the Mach number = PTMAC Do not use simultaneously with QDYPT (see below).	
QDYPT	-100.		If QDYPT >0, linearly inter- polated values of the trajectory output quantities will be printed at the dynamic pressure = QDYPT. Do not use simultane- ously with PTMAC (see above)	lb/ft ²
QE		Q _e	Pitch rate at entry.	· rad/sec
QTST	200.		When the reference convective heat pulse is ≥ 1 , output will be provided if the difference of the integrated reference convective heat pulse from the last output value is $\geq QTST$.	Btu/ft ²
RE		R _e	Yaw rate at entry.	rad/sec
REYT	3.E5	R _e t	Transition Reynolds number for QSTAR based on SSØD.	

Name	Preset Values	Symbol	Parameter	Units
RGX		$\sigma_{\mathbf{x}}$	Nondimensional radius of gyra- tion for roll moment of inertia.	
RGY		о У	Nondimensional radius of gyra- tion for pitch moment of mertia.	
RHØSL		$^{ ho}{}_{ m SL}$	Density of the atmosphere at the planet surface.	slug/ft ³
RØTBL		ρ	Dependent variable table of den- sity used with ZTBL to compute atmospheric density when MVE = 2.0 (see above). Maximum num- ber of entries is 101.	slug/ft ³
RSL		R _{SL}	Radius of the planet.	feet
SSØD		S*/d	Ratio of distance from sonic point to the stagnation point at zero angle of attack to the vehicle diameter.	
TABAL		۵	Independent variable of angle of attack used to compute coeffi- cients as a function of Mach num- ber and angle of attack. Maxi- mum number of entries is 19.	degrees
TABDR		$ ho_{\rm s}/ ho_{\rm a}$	Independent variable table of stag- nation point density ratios (ρ_s / ρ_a) _s used with DELØRC (see above) and VGFDR (see below). Maxi- mum number of values is 10.	
TETBL		T	Dependent variable table of tem- perature used with ZTBL to com- pute atmospheric temperature when MVE = 2.0 (see above). Maximum number of entries is 101.	°ĸ
THF	1.		Turbulent heating factor used to compute QSTAR after transition has occurred.	

Name	Preset Values	Symbol	Parameter	Units
TSL		T _{SL}	Atmospheric temperature at the planet surface.	°к
TST		T _{ST}	Atmospheric temperature in the stratosphere.	°K
TSTØP	1000.		Maximum permitted value of the independent variable time for the integration of the trajectory equa- tions.	seconds
$ extsf{TZER} \phi$	0.		Initial value of the independent variable time for the integration of the trajectory equations.	seconds
UPBND	0.01, 1.E- 0.1, 0.001 0.0001, 0. 0.0001	.5, , 0.001, 0001,	Array of upper limits used by the predictor-corrector subroutine ADAMS4 as accuracy bounds on V, γ , Z, Q, R, ψ , θ , φ , respec- tively.	
UPDN	0.2		Factor by which the predictor- corrector method increases or decreases Δt (depending on ac- curacy) during the integration. See description of ADAMS4.	
VE		V _e	Entry velocity.	ft/sec
VEHICL			Identification number for vehicle.	
VIRNE			Velocity table used when DIRNE is specified maximum of 10 val- ues.	ft/sec
VGFDR		$\frac{d}{2V}\left(\frac{du}{ds}\right)_{s}$	Dependent table of velocity gra- dient, used with TABDR (see above). Maximum number of en- tries is 10.	
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Name	Preset Values	Symbol	Parameter	Units
VSTØPQ	12000.		The slowest velocity at which the radiation heating calculation will be done. It must be \geq 5000.	ft/sec
VTST	600.		When the reference convective heat pulse is ≥ 1 , output will be provided if the difference between the velocity and the last output velocity is \geq VTEST.	ft/sec
AX			Mole fraction of molecular Argon in the atmosphere.	in
xc			Mole fraction of CO_2 in the atmosphere.	
XCGØD			Center-of-gravity location of the vehicle as a fraction of vehicle diameter.	
XCPFA			Aerodynamic center-of-pressure location as a fraction of vehicle diameter. This table as a func- tion of angle of attack and Mach number is used to provide the pitching moment when CMIN = 0. Maximum number of entries: 19 angles of attack (corresponding to TABAL) and 5 Mach numbers when used with MANDAL.	
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XN			Mole fraction of N_2 in the atmosphere (must ≥ 0.001).	
XØ			Mole fraction of O ₂ in the atmosphere.	
XPRIN	1		If the value of LS (see above) is 1.0, output will be provided in even intervals of XPRIN, Using. this option will generally invali- date the angle-of-attack envelope values printed in the output.	sec .
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Name	Values	Symbol	Parameter	Units
ZCGØD			Center-of-gravity offset.	feet
ZE		Ze	Entry altitude.	feet
ZSTØP	0.		The integration of the trajectory equations is terminated when the value of the dependent variable Z is $< ZST \phi P$	
ZTBL			Independent variable table of alti- tude used with RØTBL and TETBL to compute atmospheric proper- ties when MVE = 2.0 (see above). Maximum number of entries is 101.	fĕet
ZTST	2.E4		Where the reference convective heat pulse is > 1, output will be provided if the change in altitude is > ZTEST.	feet

B. INPUT PROCEDURES

1. General

a. Decimal points can be used on all inputs. However, omitting decimal points on integers will not cause difficulty.

b. A preset variable need not be input unless a different value is desired.

c. After the first data case of a set of stacked cases, only changed inputs must be specified.

d. Inputs DATE, MEMØ, CASE, ATMØS, and VEHICL have no effect on the computation and may be omitted. They appear at the top of the trajectory printout as a convenience in identification.

All independent variable tables must be specified in monotonic e. ascending order.

The output is adjusted to allow for a maximum of 150 lines of f. printout; the amount of printout is adjusted by optional program controls.

g. A set of computer input forms are provided for the user. All the data shown on the form is keypunched when the variable is supplied.

2. Atmosphere

a. The atmosphere may be specified by either of two methods, parametric or tables. Optional input MVE, preset for parametric inputs, selects the input method.

b. The parametric input method is more convenient for theoretical atmospheres such as JPL Mars models G, H, I, J, and K^7 and NASA Mars models 1, 2, and 3^9 . The program inputs are readily obtainable from the definitions of these atmospheres (see Table I).

c. For precise atmosphere specification, e.g. Earth, complete tables of density and temperature versus altitude may be input.

d. Additional to the temperature and density properties of the atmosphere, the composition is input as mole fractions of oxygen, nitrogen, carbon dioxide, and argon. The sum of these fractions must equal 1. The nitrogen fraction must not be less than 0,001.

3. Calculation Time

The input $CDR \phi P$ was introduced to permit a reduction in computation time where a vehicle undergoing large oscillations has reached close to terminal velocity at high altitude. Calculation of the angle of attack motions until impact, using the moment equations, would consume a great deal of time for such a case. Hence, specifying $CDR \phi P$ places a restraint on the computational time.

Other controls on calculation time are possible by specifying TST ϕ P, the maximum permitted trajectory time, or by specifying ZST ϕ P as the altitude at which the trajectory calculation must be stopped.

Use of the linearized dynamics solution below peak dynamic pressure, when appropriate, also can save considerable time.

4. Amount of Output

The output is limited to 150 lines, which can be regulated by program controls on the interval of printout. The printout interval controls include successive output points in integrated stagnation point heating, altitude, and velocity.

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TABLE I

Inputs			····	JPL NASA					
Program Name	Tinata								
- togram Hame		<u> </u>	н	1	J	K	1	2	3
RSL	ft	11.E6	11.E6	11.E6	11.E6	11.E6	11.E6	11.E6	11. E6
GSL	ft/sec ²	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12
RHØSL	slug/ft ³	4.21E-5	4.21E-5	5.9E-5	1.042E-4	9.54E-5	8.97E-5	6.94E-5	4.19 E-5
TSL	•к	260	260	230	210	230	300	250	200
TST	°K	130	230	180	130	230	260	180	100
PTH	lb/ft ²	1.E-20	1.E-20	1.E-20	1.E-20	1.E-20	6.636E-2	1.454E-3	4.939-E9
FALR*	-	0.935	0.935	0.952	0,982	0	0.987	1.032	1.053
LTH	°K/ft	1.E-20	1.E-20	1.E-20	1.E-20	1.E-20	6.096E-4	6.096E-4	6.096E-4
XN	-	0.001	0.001	0.245	0.765	0.765	0.951	Q.892	0.512
ХØ	-	0	ó	0	0	0	0	0	0
xc	-	0.647	0.647	0,433	0.105	0.105	0.049	0.108	0.488
XA	-	0.352	0.352	0.322	0.13	0.13	0	0	0

MARS MODEL ATMOSPHERES

*Note Values of FALR have been adjusted to account for the difference between the C_p specified for the atmosphere model and the C_p computed in the program to provide the intended temperature variation (see Equations (3) and (6).

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5. Vehicle Data

a. Mass and diameter are the key inputs which affect the trajectory, coefficient calculation, heating, and scaling.

b. The radii of gyration and center of gravity, which affect the dymamics, are input as fractions of the diameter to simplify scaling. If these ratios can be assumed independent of size, only the mass and diameter need be respectified when the vehicle size is changed.

6. Aerodynamic Coefficients

a. Coefficients which are functions of angle of attack are specified only from 0 to 180 degrees, corresponding to the angles of attack listed in TABAL (up to 19 values). The program computes values of coefficients between 180 and 360 degrees.

b. When MANDAL table is specified, tables of all coefficients based on TABAL must be specified for each Mach number in MANDAL (maximum 5 values). At Mach numbers smaller (or larger) than those listed in MANDAL, the program uses coefficients corresponding to the smallest (or largest) Mach number specified.

c. An option is provided to input CMFA in place of XCPFA. To use this option, CMIN is set = 1.0 and specify CMC@D. With either CMFA or XCPFA input, the program computes the correct pitching moment for the input center-of-gravity location XCG@D.

d. For constant coefficients (invariant with Mach number) MANDAL is set = 0, in which case the program uses the first table of coefficients (lowest Mach number).

e. Computation of the dynamic motions can be switched to the linear solution at peak dynamic pressure by specifying ALPCR larger than the angle of attack envelope at that time.

f. Coefficients which are functions of Mach number only are specified for each Mach number listed in MØNLY (maximum 10 values). These are used by the program in the linear equations of motion, and to compute D/W, $M/C_{r}A$, and frequency.

g. CMAFM must be specified if printout is desired in the FREQ column.

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h. CDFM must always be specified (will switch to $CDR \phi P$ at peak dynamic pressure otherwise).

7. Entry Conditions

a. ZE; VE, and GAME must always be specified.

b. As the integration interval is determined by accuracy limits, large angular rates may lead to excessive computational time. To prevent usage of excessive computer time, a stop exists in the program, whereby a requirement for an integrating interval less than a prescribed value stops the calculations and a message is printed out DELTAT TOO SMALL. A possible source of this problem are inputs which create very large angular rates.

8. Particle Trajectories

Trajectories which do not allow for any effects of angle of attack can be computed by using the MANDAL coefficient table and specifying ALPHAE = 0.0 and ALPCR = 0.0.

The MANDAL table must have data at $\alpha = 0$ and for at least one other nonzero angle of attack. Tabular input for CDFM is required if M/CDA and D/W printout is desired.

9. Heating Data

a. Velocity gradient (VGFDR) and shock standoff distance (DEL/PRC) at the stagnation point are input (wind tunnel data or theory) as functions of the stagnation point density ratio (TABDR). Figures 7 and 8 obtained from Vinokur's' results show how these parameters vary theoretically with nose shape; comparison with the methods of References 10 and 11 are also shown. Correlation of Vinokur's' results with those of Traugott and Kaattari¹⁰ is shown in Figure 9, wherein all of Vinokur's' results are seen to compress into a single correlation curve at low density ratios (which agrees with Kaattari's¹⁰ recommended correlation).

b. The stagnation point quantities VGFDR and DELØRC are required to predict the convective and radiative heating. Sufficient information is provided to estimate these quantities using Figures 6 and 7. The suggested use of these curves for vehicles with various nose shapes is_depicted in Figure 10.

c. SSØD defines the approximate sonic point for turbulent heating calculation, and is determined by the nose shape of the vehicle.

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Figure 7 STAGNATION POINT VELOCITY GRADIENT WITH VARYING BLUNTNESS AND DENSITY RATIO

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Figure 10 METHODS FOR ESTIMATING VGFDR AND DEL/RC FOR VARIOUS NOSE SHAPES

d. REYT specifies the Reynolds number (based on S*) at which transition occurs at the sonic point. The Reynolds number computation is based on the viscosity-temperature dependency of Jos¹³ for nitrogen and is shown in Figure 11.

e. IRNE and KNE are nonequilibrium radiation heating parameters, preset at typical air values. 14 Additional data for N₂-CO₂ mixtures is given in Reference 5.

f. DIRNE specifies the nonequilibrium radiation intensity as a tabular function of the velocity (VIRNE). When DIRNE is used, IRNE must be specified as equal to zero.

10. Tabular Inputs of Coefficients

Since much of the input data for Program 1880 consists of one- and twodimensional tables, time and effort can be saved by understanding the following facts.

All independent variable tables must be specified in monotonic ascending order.

The total range of the variable of interest should be covered by the independent variable table. If the variable is smaller than the first entry of the array, then the table lookup is done by a linear extrapolation. If the independent variable is greater than or equal to the last entry in the array, then either an incorrect answer, a loop, or an unexpected stop is the result. The only exception to this in Program 1880 is in the calculation of coefficients of a function of angle of attack, since for angles between 180 and 360 degrees the coefficient is computed by a change of variable and a simple transformation of the coefficient in the range between 0 and 180. Hence the independent variable table TABAL need be specified only to the value 180.

Constant functions must be described for the table lookup by at least two different values of the independent variable.

The only (optional) exception to the above rule, applied to tables of coefficients as a function of angle of attack and Mach number, and in the special case where there is no Mach number dependence for the coefficient, ^{1S} described below.



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Figure 11 VISCOSITY-TEMPERATURE MODEL

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The tables of aerodynamic coefficients have as independent variable tables TABAL for angle-of-attack dependence and MANDAL for Mach-number dependence. The coefficient tables are matrices of maximum size 19 rows and 5 columns (or 19 angles of attack and 5 Mach numbers). The program has assumed that for Mach numbers less than the first (smallest) Mach number in the array MANDAL, the coefficient is equal to its value at the angle of attack and the smallest Mach number in MANDAL. Similarly, for Mach numbers greater than the largest entry in MANDAL, the coefficient is assumed to have the value of the angle of attack and the largest Mach number in the array MANDAL. Thus the Mach number dependence of the coefficient is treated as piece-meal constant off the ends of the table.

The coefficient matrices may be regarded as of the form a_{ij} , where i references the angle-of-attack value and j the Mach number. The coefficient is specified on a punched card as, for example,

CNFA (1, 1) = 1., 2., 3., 4., CNFA (1, 2) = 4., 3., 2., 1.

The double subscript specifies that the array is two-dimensional and that the left-most index varies the most rapidly. Hence, given a starting location such as CNFA (1, 1), the program loads information into successive storage locations (columnwise, in matrix notation), until a new starting location is specified. Since the maximum dimensions of the array are referenced for loading, here (19, 5), the above example could not be rewritten as

CNFA (1,1) = 1., 2., 3., 4., 4., 3., 2., 1.

All columns of the matrix do not have to be filled, but there must be a one-to-one correspondence between columns and entries in MANDAL.

It was stated above that for constant functions at least two different values of the independent variable must be specified with the corresponding (equal) values of the dependent variable. The single exception to this rule in Program 1880 is for aerodynamic coefficients which are dependent on angle of attack and independent of Mach number. For this case, two different values of Mach number may be specified, and the first two columns of the coefficient matrix made identical ($a_{I_1} = a_{I_1} , 2, I = 1, 2 ..., 19$). However, the same effect may be achieved by making all entries of MANDAL = 0 and specifying only the first column of the coefficient matrix. This latter may be done either by the CNFA (1, 1) a_{11} , a_{2} , 1, a_{31} , ...

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C. OUTPUT DEFINITIONS

.

External <u>Name</u>	Internal <u>Name</u>	<u>Symbol</u>	Parameter	Units
ALBAR	ALENV	ā	Total angle of attack envelope (max. envelope, interpolated linearly between peak ampli- tudes).	degrees (
ATM	ATMØS		Atmosphere identification.	
CASE	CAS		Case identification.	
D	D	đ	Diameter of vehicle (reference length).	feet
DATE	DATE		Date identification.	
D/W	XØW	D/₩	Zero angle-of-attack decelera- tion.	Earth g
DYN-PR	QDY	Q	Dynamic pressure.	lb/ft^2
FREQ	FRNAT	£	Natural undamped frequency of the vehicle based on CMAFM input.	cps
GAMMA	GAM	γ	Local flight path angle.	degrees
HD/HS	HDHS	${}^{\rm H}_{\rm D}/{}^{\rm H}_{\rm S}$	Ratio of dissociation enthalpy to total gas enthalpy.	
HMRT ϕ	HRT	HM/RT _O	Stagnation enthalpy.	
IX	ZIX	^I X	Moment of inertia about roll ax- is.	slug/ft ²
IY	ZIY	I _Y	Moment of inertia about pitch and yaw axes.	slub/ft ²
MACH	ХМСН	М	Flight Mach number.	
M/CDA	EMØCDA	m/C _D A	Ballistic coefficient.	slug/ft ²
мемø	мемф		Memo identification.	

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External <u>Name</u>	Internal <u>Name</u>	Symbol	Parameter	Units
N/W	ENØW	- N/W	Normal acceleration at angle- of-attack value.	Earth g
PE	PI	р e	Spin rate at entry.	rad/sec
QE	QI	Q _e	Pitch rate at entry.	rad/sec
QI	QI*	q_1*	Radiative heating contribution of each specie.	Btu/ft ² -sec
QR	QSUM	$q_{\mathbf{R}}$	Same as QRE (below).	
QRE	QR	ΦE	Zero angle-of-attack equilibri- um radiation heating rate at the stagnation point.	Btu/ft ² -sec
QRNE	QRNE	^q RAD	Corrected value of QRE account ing for nonequilibrium effects.	- Btu/ft ² -sec
QS	QS	qs	Zero angle-of-attack stagnation point convective heating rate.	Btu/ft ² -sec
QSTAR	QT	q*	Zero angle-of-attack convective heating rate at the sonic point (laminar before transition, tur- bulent after transition).	Btu/ft ² -sec
RE	RI	R _e	Yaw rate at entry.	rad/sec
REY	RTX		Free stream Reynold's number based on vehicle diameter.	
RHØA	RØ	ρ _a	Ambient density.	$slug/ft^3$
RHØS/RH	Ø RHØST	$ ho_{\rm s}/ ho_{\rm a}$	Normal shock density ratio at stagnation point.	
TIME	TIME	t	Flight time measured from en- try.	seconds
TS	т	Τ _S	Stagnation temperature,	۰ĸ
v	v		Flight velocity.	ft/sec

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External <u>Name</u>	Internal <u>Name</u>	Symbol	Parameter	Units
VEHICL	VEHICL		Case identification	
x	x	x	Specie Concentration	moles
XCG/D	XCGØD	X _{CG} /D	Center-of-gravity location as a fraction of vehicle diameter	
Z	Z	z	Altitude	feet -
ZS	Z		Compressibility factor; number moles per initial mole cold gas	
ZST	ZST	Z _{ST} .	Altitude of the base of the strate sphere	- feet
ZTH	ZTH	Z _{TH} ʻ	Altitude at the base of the ther- mosphere	feet

D. SAMPLE PROBLEM

1. <u>Statement of Problem</u> -- Determine the angle-of-attack envelope and heating history for a Mars entry of a blunt cone configuration. The vehicle parameters entry conditions, atmosphere, and planet data are to be prescribed as input. An orbital entry was chosen, for which the entry velocity is low.

Two trajectories were computed to provide both the heating and load data, for a typical entry to Mars following the orbit.

2. <u>Computer Input Forms</u> -- The computer input forms for the two sample cases containing all the necessary input data to be keypunched are shown on the following pages. All of the input on these forms are written with decimals, and everything shown on the forms are keypunched. Unused copies of the input forms are provided on pages in this report, from which the program user can make copies and use for further cases.

3. <u>Output</u> -- The output lists the cards read in and should be checked to ensure that the data have been keypunched correctly. The trajectory output format lists key data across the top of the page. The output of the two cases are given on pages following the input pages.

-38-

The trajectory of Case 1 indicates a peak deceleration of 25.8 g (Earth g), negligible radiation, an impact time of 301.28 seconds, and a subsonic impact. The time of transition was 189.97 seconds at which time the free stream Reynold's number was 2.1E+06, occurring at peak laminar heating. The data requested at Mach 1.2 are given at the end of the output as well as integrals of the heat pulses.

The trajectory for Case 2, which has the smaller entry angle and is the heat shield design trajectory, has a peak deceleration of 6.7 g and an impact time of 473 seconds. Transition did not occur on this trajectory. Additional messages are printed out for this case indicating (no valid solutions in zones) which refers to points along the trajectory where no solutions were obtained for the equilibrium gas composition. The reason for this occurrence is because of the nature of the approximate solution and requirements that the solution, in order to be valid, satisfy physical criteria.

E. DIAGNOSTICS

A number of messages are given in the printout reflecting the following program diagnostics.

1. NØ WØBBLES

The angle of attack did not oscillate, and the envelope value ALBAR is equal to the current angle of atack.

2. DELTAT TØØ SMALL

The integration interval required decreased to less than the input (preset) minimum allowable value.

3. <u>NØ VALID SØLUTIØN</u>

The equilibrium gas dynamics (1883) solution was not able to obtain a solution with positive concentrations for all the species satisfying the elemental and charge conservation relationships. In this case the data is linearly interpolated between the last and the next point for which a solution is found.

4. NØT CØNVERGED IN 30 ITERATIØNS

The equilibrium gas dynamics (1883) solution was unable to converge within 30 iterations to within 1 percent on the enthalpy; use the last value found.

AD 2 0963	DIGITAL COMPUTER INPUT		PROBLEM	PROBLEM NO 1880 PROGRAMMER D. Gillespie											
5.00	REG	UEST FOR	M	TITLE	TITLE Trajectory Dynamics P					Program					
	MEMO NO	SECTION NO	WORK O	RDER NO		(E240 USE	ONLY)	REQUESTED	98Y E	хт	EST TIME	٠Ţ	PAGE	105 /	PAGE
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RAD 2-0964	DIGITAL COMPUTER INPUT	PROBLEM NO. MEMO NO S		SECTION NO	CONTINUATION SHEET
5-63	REQUEST FORM	1880			PAGE 3 OF 6 PAGES
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AD 2-0964	DIGITAL COMPUTER INPUT	PROBLEM NO MEMO NO		SECTION NO	CONTINUATION SHEET		
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RAD 2-0964	DIGITAL COMPUTER INPUT	PROBLEM NO	MEMO NO.	SECTION NO	CONTINUATION SHEET
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RAD 2 0964	DIGITAL COMPUTER INPUT		PROBLEM NO MEMO NO		SEC	TION NO	Сонті	CONTINUATION SHEET		
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RAD 2-0963		COMPUTER	INPUT	PROBLEM	10 18	80		PR	OGRAMME	PD.	Gill	lespie	
	REG	UEST FOR	4	TITLE:	TR	AJECT	ORY	DYNAMIC	S PRC	GRAM			
İ	MEMO NO	SECTION NO	WORK OI	RDER NO		E240 USE 01	ILY) I	REQUESTED BY	EXT	EST TIME			
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	DATE =	5.11	_, мі	емØ= <u>16</u>	57. ,	CASE =	_1.	, atmøs	= <u>3.8</u>	, V:	EH)	ICL <u>= 60</u>	
	ALAM	=			IRN	E	=		_, TS	L	=,	200.0	
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	CLAFI	= A	-0.67	5 .	-0.6	75	-1.	231	1.227		1.	163 ,	
			-1.21	2	-1.2	212							
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RE-ORDER No. 66-417

RAD 2-0964	DIGITAL COMPLI	TEP INPILT	PROBLEM NO	MENO NO	SECTION NO	CONTINU	ATION SHEET
8-03	REQUEST	FORM	1880			PAGE 2	OF 6 PAGES
				J			`
	CMAEM			100	A 1 0	o	
	OMPT M	0, !	<u>185 0.</u>	183 ,	-0.12	-0.115	-0.138
		0	<u>.38</u> , <u>-0</u> ,	138_,	······································	······································	<u>` </u>
	CMQFM	=	92 ,0.	392 ,	-0.392 , -	0.392 ,	-0.392,
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	CM FA (1,	1)= 0.0	,0,	032 ,	0.062 , -	0.083 ,	-0.095 ,
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RE-ORDER IN. 66-417

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RAD 2 0964	DIGITAL COMPUTER	INPUT	PROBLEM	NO	NEMO NO	SECTION NO	CONTIN	UATION S	IEET	
5-05	REQUEST FOR	A	1880				PAGE	3 OF	6 PAGES	
	CMFA(1,2)=	0.0	;	0.0	<u>, 150</u>	-0.040	-0,053 ,	0.05	7;	
		-0,	-57 ,	0.0	<u>, 050</u>	-0,038 ,	-0.026 ,	-0.01	40_,	
	-	-0.1	006 ,	0,0	001_,	-0,0002,	-0.0002	-0,00	01_,	
	-	-0,0	, 1000	0_0	0001,	-0,0001				
	CMFA(1, 3)=	0.0		-0,0	<u>, 020</u>	,	-0.053	-0,05	7,	
	-	-0,0	<u>)57</u> ,	0.0	<u>, 050</u>	-0.038 ,	0.026,	-0.01	4,	}
	-		<u>, 206</u>	0.0	<u>.</u> ,	,	0.0002,	-0,00	01,	
		-0.0	<u>, 2001</u>		0001_,	-0,0001,	-0.0,			
	CMFA(1, 4)=	0.0		-0.0)24 ,	-0,058,	-0.077 ,	-0.08	9,	
	-	-0.0	<u>, 089</u>	-0.0	<u>)79</u> ,	-0.060 ,	-0.041 ,	-0,02	2,	
		-0.0	, _00	-0.0	<u>)02</u> ,	0.0003_,	-0.0003_,	-0,00	02_,	Í
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	CM FA (1, 5)=	0.0	,	-0.0)24,	-0.058,	-0.077 ,	-0.08	9,	
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	CMQ FA (1, 1)=	-0.	392 ,	-0, 3	386,	-0.369_,	-0.340 ,	-0,30	<u>1</u> ,	Í
		-0.	253_,	-0.1	<u>197</u> ,	-0,161 ,	-0.131 ,	-0,10	<u>z</u> ,	
		-0.	150_,	0.2	<u>200</u> ,	-0.254_,	-0.326	-0,38	7,	
	-	-0.	<u>437</u> ,	0.4	<u>474</u> ,	0.497_,	-0.505			
	CMQFA (1, 2)=	-0.	<u>392</u> ,	0, 3	386_,	0,369_,	0.340,	-0,30	<u>1 </u>	
	-	-0,	253_,	0.1	197,	0,161_,	-0.131	-0,10	<u>د</u>	ļ
		-0.	<u>150</u> ,	-0.2	200	,	-0.326	-0,38	7	
		<u>-0, -</u>	437_,	<u>-0,4</u>	<u>174</u> ,	<u>-0,497</u> ,	-0.505	- -		ļ
	CMQFA (1, 3) =	-0.	<u>392 </u> ,	<u>-0,3</u>	ب386	-0,369,	-0.340	-0,30	<u>1</u> ,	۰
		~0.3	<u>253</u> ,	-0.1	<u>197</u> ,	-0.161 ,	-0, 131	<u>0, 10</u>	2,	.
		-0,	<u>150</u> ,	-0,2	2 <u>00</u> ,	<u>-0.254</u> ,	-0.326 ,	-0.38	<u> </u>	
		-0.4	<u>437</u> ,	<u>-0.4</u>	<u>174</u> ,	-0.497	-0.505	•		

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RE-ORDER No. 66-4-17

RAD 2-0984	DIGITAL COMPUTER INP	UT PROBLEM	NO. MEMO NO	SECTION NO	CONTIN	UATION SHEET
8-03	REQUEST FORM	1880			PAGE	4 OF 6 PAGES
	CMQFA (1, 4)=	0.392 ,	-0.386 ,	-0.369 ,	-0.340 ,	-0.301,
		0.253 ,	-0,197 ,	<u>-0.161</u> ,	-0.131 ,	-0.102 ,
		0.150 ,	_0.200 ,	0,254 ,	-0.326 ,	-0.387,
		0.437	-0.474 ,	-0.497 ,	-0.505 · ,	
	CMQFA (1, 5)=	0.392	-0.386 ,	<u>-0.369</u> ,	-0.340,	0.301,
	•	0.253 _,	-0.197 ,	-0.161 ,	-0.131 ,	-0.1020
		0.150	-0,200	-0.254	-0.326_,	-0.387
		0.437	-0.474	-0,497	-0.505 ,	
	CNFA (1,1)=() <u>, 0 </u> ,	0,053	0.114	0,155 ,	0.177 ,
	(<u>), 181</u> ,	_0. <u>167</u> ,	0,139,	ر0.108	0,081
		0.062 ,	0.052	0.050	0.048 ,	0.043,
	(0 <u>036</u> ,	0.026 ,	0,014	0.0	
	CNFA (1, 2) = ().0,	<u>0,041</u> ,	0.080	<u>0.107</u> ,	0.122,
) <u>, 124</u> ,	0.115 ,	0.096	0.074 ,	0.051
	().0 <u>43</u> ,	0.036	_0.034_,	0.033 ,	0,030,
) <u>025</u> ,	0.018 ,	0.009	0.0 ,	-
	CNFA (1, 3)=).0,	0.040 ,	0.100 ,	0.133 ,	0.152 ,
) <u>, 155</u> ,	0.143 ,	0.119 ,	0.093 .	0.069,
) <u>053</u> ,	0.045 ,	0.043	0.041 ,	0.037
		0.031 ,	0.022 ,	0.012 ,	0.0 ,	
	CNFA (1,4)=	<u></u>	0.060 ,	0.130	0.174 ,	0.198
		0.204 ,	0,188,	0.156	0,121 ,	0.091
		0.070 ,	0.058 ,	0.056 ,	0,054 ,	0.048 ,
		0.041_,	0.029 ,	0.016 ,	0.0,	
	CNFA (1, 5)=	<u>, o</u> ,	0.060 ,	0,130 ,	0.174 ,	0.198 ,
		0,204	0.188,	,	0.121 ,	0.091
		0.070	0.058	0.056	0.054 ,	0.048
		0.041 ,	0.029	0.016	0,0 ,	

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HE-URDER No. 66-41/

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RAD 2-0964	DIGITAL COMPLETER INPUT	PROBLEM NO	MENO NO	SECTION NO	CONTINU	ATION SHEET
8-63	REQUEST FORM	1880			PAGE 5	OF 6 PAGES
		•				
	CXFA (1,1)= <u>1</u>	<u>o</u> ,	0.98 ,	0.93 ,	0,82 ,	_0, 67,
	_0.	53,	0.39 ,	0.27 ,	0.16 ,	0.07
	0	.04 , -	0.18 ,	-0.34 ,	-0.52	-0.69
	0	. 85 , -	-0.98 ,	-1.04 ,	-1.06 ,	
	CX FA . (1, 2)= 1.	52 ,	1. 47,	1.37,	<u> 1. 23 </u>	1.07,
	0.	78 , (0.56,	0.38 ,	0.22	0.11,
		02	-0.21	-0.44,	-0.72 ,	-1.0 ,
		. 24	-1.45,	-1.55 ,	<u>-1.57</u> ,	
	CXFA (1, 3) = 1.	55,	1.46,	1,33 ,	<u>1. 17</u> ,	1.00 ,
		76 , 0	0,54	0.36 ,	0.2,	0.09,
		.04,	-0.23,	-0.46	-0.74 ,	-1.02 ,
		.26 ,	-1.47 ,	-1.58 ,	-1.60 ,	
	CXFA $(1, 4) = 1$.	59	1.51 ,	1, 3,	<u>1, 12</u> ,	0.94 ,
	. <u>0.</u>	74,	0.52,	0.34 ,	<u>0.17</u> ,	0.06,
		.07,	-0.26 ,	-0.49 ,	<u>-0.78</u> _,	-1.06,
			-1.51 ,	-1.62 ,	<u>-1.64</u> ,	
	CXFA (1, 5)= <u>1</u> .	63,	1.56	<u>1.34</u> . ,	<u>1. 15 </u>	0.97,
		76, 0	0.57,	0.38,	<u>0.2</u> ,	0.08
		0.06	-0,25,	-0.47	<u>-0.77</u> ,	<u>-1.05</u> ,
		.3	-1.52 ,	-1.67	<u>-1.69</u> ,	
	XCPFA (1, 1)=		•		'	·
	l					
	·	•	······································		مستنسب	,
		·······				
	XCPFA (1, 2)=		·	,		
	·		'			*
		- •	······································	وسيسب	'	·
		······································				

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RAD 2-0964 5 63	DIGITAL COMPUTER INPUT	PROBLEM NO	MENO NO.	SECTION NO	CONTINU	JATION SHEET
	REQUEST FORM	1880	1		PAGE	6 OF 6 PAGES
	$\mathbf{X}\mathbf{C}\mathbf{PFA}(1,3) =$					
		'	· · · · · · · · · · · · · · · · · · ·		,	· ·
		/,	· ,		,,	,,
		,	,		,	3
	XCPFA (1,4)=		,		; <u> </u>	· ·
		,			,:	,
			······································		,	,,
					·	2
	XOPFA(1, 5) =	,	'		,	,,
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		/	······································		,	' <u></u> '
		·····				-
	TABAL = 0 .	, <u>10,</u>	, 2	<u>0. </u>	30,	,
	<u> </u>	<u> </u>	,	<u>. </u>	80,	_90,
	150	<u> </u>	<u>ا</u> ب	<u>20.</u> ,	130. ,	,
	150.	, <u>100</u>	·	<u></u>	,	, [,]
	\$					

PL_167	Letter no	WORK ORDER	NO	(E240 USE ONLY	REQUESTED B	YEXT	EST TIM	E	
I	K420	W305-05	0-0005		P. Levin	e 2996		PAGE] C	F 6P
\$INPUT									
DATE= _	5.11	мемф:	<u> 167. </u>	CASE= 2.	_, ATMØS	= 3.8	, VE	HICL =	60.
ALAM	=		IRNE	=		TSL	= .	275.0	. ر_
ALPCR	=	<u> </u>	KNE	=	,	TST	=	200.0	_,
ALPHA	C =	,	LS	=	,	TSTØ	P = .	·····	_
AR	=	,	LTH	=	,	TZER	Ø = _		,
ATRB	=		MASS	=	,	UPDN	=		_,
BLAM	=	,	MVE	=	,	VE	=	14000.0	_,
BTRB	=	,	NPTS	r = _	,	VSTØ:	PQ=		_,
CDROP	=	,	PE	=	,	VTST	=		_,
CMCOD	=	,	PTH	=	.525E-3,	XA	=		,
CMIN	=	,	PTMA	.C =	,	xc	=	0.2	_,
D	=	,	QDYP	т =	,	XCGØ	D = _		,
DELMA	C =	,	QE	=	,	XKT	=		,
DELMT	=	,	QSTST	: =	,	XN	= .	0.8	,
DELTAT	C =	, ,	RE	=	,	хø	=		_,
FALR	= 0.9	994 ,	REYT	=	·,	XPRIN	1 =]		_
GAME	= -13	. ,	RGX	=	,	ZCGØ.	D = _		,
GSL	=	,	RGY	=	,	ZE	=		_
GTST	=	,	RHØSI	. = 0.	132E-4 ,	zstø	P =		,
IPHEAT	=	,	RSL	=	· ,	ZTST	= .		,
IPRINT	=	,	SSØD	=	,		-		_
	-	_	THF	=	,				

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		IBLDR							12/01/0	54			
			* HEHORY	HAP *									
SYST	FM			00000	THRU	02717		-		• • • • • • • •			
F-11.6	-81.0CK-	03.IGIN		0272-0									
FILF	s	1. UNITO:	5										
		2 UNITO	6						~				
		 UNITO: 	7										
F-11.5	-6121-0	RIGIN		02764	·								
PRE-	EXECUTI	ON INITIALIZA	ATION	02772									
OBJE	CT PROG	RAM		0302-3	THRU	66025							
	DECK	JRIGIN	CONTROL	SECTIONS	(/NAME	E/=NON O	LENGTH	, (LO	C)=DELETE	0, *=NOT	REFERENC	ED)	
1.	1880	03030	111 1	(73566)	•••••	14650	*						
2	CCCTV	21676	- 1454	220550									
	SINTRE	22370	INTER	22220									
5.	SDEROG	23367	111 1	(73566)	DERON	25500							
6.	-SCETCL		GETCLA-	-26066	55.40	20000							
7.	SHEAT	26126	HEAT	26775									
	-\$10450		-NONEQU-	27402									-
9.	SCKTRE	27472	CKTRB	27612									
10+	-SCEIN-		GETN	31555									
11.	SGETQ	31620	GETQ	33674								-	-
-13-	-31-1401		-FINDT	-34247									
13.	SCOUL	34303	COUL	34725									
15	\$704E9	35504	70455	41242									***
-16.	-SADAHS	41405		44550									
17.	SARTLU	44710	ARTLU	45235									
-18.	LXCON	45415	LXS-TR-	45415-*	LXSTF			XOUT-	45467	LXRYN-	-45501	-T1X381-	
			-LXCAL	45504 *	-LXERF	45504	+ D	BCLS	45666 *	+LXARG	46035	-L0	46060 *
				46056	-LFBL	46067	* .	UN8-	-46070		-46071-		
19.	-100EF	46075	DEFIN	46075	. ATTAC	66101	* .C	LOSE	46103	OPEN	46105	.READ	46107
						- 46121	-	LAUR	46131		46133 *	-LAKEA	46144
			- COA	40102	- 60	40105	+ +A	CDD .	40177	ADDAT	40200	+ERIKT	40211
			.EX34	46311				chin	-10201		-10205-	*00HA1	10201-0
20	-1-XSI-		IXSEI	46316	1 XESEI	-46317		TP.TX	46322 *		46362-*		46373 *
			+LXIND	46442 *	.LXDIS	46445	* .2	FLG	46446 *	.L TCH	46447		
-21-	COLOD	46455		-46455-*	-FPOUT	-46614		PARG	46633	/.COUNT.	46635 *	OVELOW	46706 *
22.	+ERAS.	46715	E.1	46715	E+2	46716	E.:	3	46717	E.4	46720		-
-23-	-XCC-	46721		46721	-66-2-	-46722		.3	-46723		-46724		
24.	XIT	46725	EXIT	46725	•EXIT.	46725	* _						
	COUT	40120		46726	*FX001	47263		XARG-	47271	/.OPIN.,	-47345-		
20.	SCNV	47556	.F001.	47550	ECNV	47743		NOEC	47754	CHINEN	67760	EDV 1	47744
			-Fax2	47765	.DBC	47767	- 0	BCB	50110	- 0809	50713	DBCIO	50120
			-D8C-20-	-50146	-DOSH-		D	DFIX-	-50165	FIXSH	-50173-	DDBC-	-50250-
			.DDRS1	50522	.DDRS2	2 50524	• D	1	50527	*D2	50531	+FERR2	50616 *
			ANPT	-5065-2	-ONPT			NTP	50743		-51012	DFL-T	
			.FLT	51164	DEXPN	51254	• F:	KD	51255	.HOUT	51405	+ INTG	51455
				-51-573	-0001-	- 51612	-X	6F	-51643	TEST	52350	-KOUNT	\$2353
			+LIST	52356	+ DUNE	52367	-0	018F	52433	•B0P	52461	+9510	5246Z
		IBLOR							12/01/6	.			
-20	FLOC		-DDFLG	52521	• MQD	52522	• PI	x	52523	.FEXP	52524	.DIG	52525

-20 100-		-DUFLG	52521	• MQD	52522	•PEX	52523	•FEXP	52524	•DIG	52525
	- 22742	.FILL.	52730	FCLS	5273Z *	. FOP N	52736 *	REOF	52742 *	.TOUT.	52725 53105
29. FIOH	53201	.FIOH.	53201	.FFIL.	53114-*- 53770	•FRTN.	53115 54015 *	-FCKSZ-	53117-*		
31. FWRU	54226	FWRU.	54226	EDEST							
33. FROU -34. UN05	54657 	FRDU	54657 54720			_					
35. UNO6 -36. UNO7	54721 54725	-UN06-	54721 54725	- BUFSZ	54722						-
37. FIOU 38. JTNOR	54726 	.FIOU.	54726	•CTUIO	55401	.NMLST	55424	•NAHE•	56527	.INTAP	56530
39. JPLRT 40. JCDIV	57256 	POLROT CONDIV	60443 								
41. JPRT1 -42. FLOG-	60615 - 61077	POLRT1 	61000 61077 *	ALOG	-61101						
43. FXPF -44FSGN	61240 	EXP GOS	61240 		-61362						-
45. FSQR 46. FATN	- 61676	ATAN2	61571 -61676	ATAN	-61-700-*						
-481865-	-62231		62104 62231	-HONSW	62251	- +TEOR	62320		-62400	JOINX	62444 *
			-63021 *		63052 *	+SH1 	62710 *	• SH9	62752 *	+OPEN+	62773 -63140
		*FEE1T-	-63505 64725 *	-GTIOX-	63526 65337	-RH7	-63644 * 65464	-RETOP3	63354 * 64263-* 65472 *	-EUFEX ENDTR-	63435 * -64724 45521
49 10C SM	66026	.TGHEX-	-66-03-2	-BASIO	66025 *						-

-UNUSED CORE 73546-THRU- 73565

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181 7	-0.00000005-19,	-0-0000000E-19	0+0000000E-19+	-0.0000000E-19,	
	-0.0000000E-19,	-0.0000000E-19,	-0.000000000000000000000000000000000000	-0.00000000000000	-0.000000000-19,
	0.0000000E-19,				
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	-0.00000006-19,		-0,00000002-19,	-0.00000000-19	
	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.	-0.000000000000000	-0.000000002-19
	0,0000000E-19,		0.0000000E-19	-0-00000000e-19	
	-0.0000000E-19,	-0.0000000E-19,	-0.0000000000-19,	-0.000000000-19,	-0.000000002-19,
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		-0.0000000E-1-9,			
	 -0.0000000E-19. 	-0+00000000E-19+	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19,
			-0-0000000E=19;	-0.00000002-19,	0_0000000E=194
	-0.0000000E-19.	-0.00000000E-19.	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.
		-0.00000008-19,	0.0000000E-19,	-0.0000000E-19,	
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			A 444444	-0.00000005-10	-0.00000005-10
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	-0.0000000E-19,	-0.00000000-19,	-0.000000002-19,	-0.00000000000000	-0.000000000-19
	-0-0000000E-1-9+	_3_0000000E-19,		-0.00000000000000	-0.000000000-19.
	-0.0000000E-19,	-0.0000000E-14.	-0.00000000000000	-0.0000000000000	-0.000000000-19
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	-0.0000000E-19.	-D.00000000E-14	-0.0000000E-19,	-0.00000000000000	-0.000000002-197
	-0.0000000E-19,	-0.0000000E-19,			0.00000000000000
	-0.0000000E-19;	-0.0000000E-19;	-0.000000002-19,	-0.00000000000000	-0.000000002-194
		0.0000000E=19.	-0.0000000E-19,	-0-000000000-19,	-0.00000002-19,
	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.	-0.00000002-19;
	-0.00000008-19.	-0.00000006-19,	-0.000000000-19,	-0-000000000-19,	
	-0.0000000E-19,	-0.0000000E-19.	-0.0000000E-19,	-0.000000000-19,	-0.000000002-19:
			-0+000000005-19+	-0-00000006-19-	-0-0000000E-194
	-0.0000000E-19;	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19,	~0.0000000E-19.
	-0.00000008-19,	-0.0000000E-19.	-0.0000000E-19.		-0-00000000-19-
	-0.0000000E-L9,	-0.0000000E-19,	-0.0000000E-19.	-0.0000000000-19,	-0*0000005-14*
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	-0.0000000E-19,				-0-000000000-197
	-0.0000000E-19;	-0.0000000E-19.	-0.0000000E-19.	-0.000000000000000000000000000000000000	-0.000000000-19
			-0.0000000-10,	-0.000000000000000000000000000000000000	-0.000000000-17
	-0.0000000E-19+	-0-0000000E-19+	-0.000000000000000000000000000000000000	-0.00000000E-19;	-0.0000000000000
		-0.0000000E=19;		-0.000000000-19,	00000000E_10
	-0.0000000E-19.	-3.000000002-19,	-0.00000000E-19,	-0.0000000E-19,	-0.000000000-19
		0_0000000E=19,		-0.00000000000000-19,	
	-0.0000000E-19,	-3.0000000E-19;	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.
	=0.000000000=19,		-0.0000000E+19,	-0-0000000E-19	-0.0000000E-19,
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	-0.00000005-10	-0 00000005-10			

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		-0-0000000E-19,	-0:00000000E-19,	-0:00000008-197	-0.00000000E-19,	-0.00000000E-19.
		-0.00000000E-19;	-0.00000000E-19;	-0.00000000E-19,	-0.00000000E-19,	-0.000000000-19,
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MANDAL	-	0.500000000 00,	0.1500000E 01,	0.3000000E 01,	0.9000000E 01,	0.1900000E 02.
HONLY	-	0.0000000E-38,	0.50000000E 00,	0.15000000E 01,	0.3000000E 01,	0.90000000E 01,
		0+19000000E-02+	0~10000000E-03+	0+0000000E-19+		0-000000000-19-
GOFH			-0-10000000E-01,	0+15200000E-01+	0.15500000E 01.	0.159000000 01.
		0.16300000E 01,	0.16300000E 01,	-0.0000000E-19,	-0.00000000E-19,	-0.0000000E-19,
VE	*	0.15200000E 05,				
GAHE	=	-0.17500000E 02,				
ZE	2	0.8000000E 06,				
MASS	=	0,57600000E 02,				
TSTOP	я	0.1000000E 04,				
ZSTOP	œ	0.0000000E-38,				
FALR	=	0,11136700E 01,				
LTH	=	0.1000000E-19,				
RSL	=	0.11108900E 08,				
GSL	5	0.12300000E 02,				
XN	7	0.1000000E-02.				
×c	-	0.999000008 00.				-
TSL	=	0.2000000E 03,	_			
TST	=	0.1000000E 03,				
ртн	=	0.13843000E-10,				
RHOSL	P	0.25600000E-04.				
DELTAT	π	0.1000000E-01.				
UPBND	•	0.1000000F-01. 0.10000000E-03.	0.10000000E-04.	0.10000000E 00, 0.10000000E-03,	0.1000000E-02,	0.10000008-02.
DNBND	-	0.10000006-02. 0.10000000E-04.	0.1000000E-05,		0-10000000E03	
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			0.11400000E 00, 0.1300000E 00, 0.14000000E 01, 0.1400000E 01, 0.1400000E 01, 0.1400000E 01, 0.1400000E 01, 0.3000000E 01, 0.3000000E 01, 0.3000000E 01, 0.3000000E 01, 0.4000000E 01, 0.4100000E 01, 0.4100000E 01, 0.4100000E 01, 0.4100000E 01, 0.4100000E 01, 0.42000000E 01, 0.4200000E 01, 0.420000E 01, 0.4200000E 01, 0.420000E 01, 0.4200000E 01, 0.420000E 01, 0.42000E 01, 0.4200E 01, 0.4200E 01, 0.4200E 01, 0.4200E 01, 0.4200E 01, 0.4200E 01, 0.4200E 01, 0.4200E 01, 0.4200		
	-0.38000000E-01,	-0.26000000E-01,		-0.57000000E-01,	-0.20000000E-01, -0.50000000E-01, -0.10000000E-02,
	-0.20000005-03, -0.10000000E-03, -0.770000000E-01, -0.41000000E-01, -0.30000000E-03,			-0.10000000E-03, -0.24000000E-01, -0.70000000E-01, -0.20000000E-02, -0.20000000E-02,	-0.100000005-03, -0.58000000E-01, -0.6000000E-01, -0.3000000E-03, -0.10000005-03,
	0.00000000E-38, -0.89000000E-01, -0.22000000E-01, -0.20000000E-03,	0.0000000E-38, -0.89000000E-01, -0.90000000E-02, -0.20000000E-03,	-0.24000000E-01, -0.79000000E-01, -0.20000000E-02, -0.10000000E-03,	-0.58000000E-01, -0.60000000E-01, -0.30000000E-03, -0.10000000E-03,	-0.77000000E-01, -0.41000000E-01, -0.30000000E-03, -0.00000000E-33,
	-0.00000000 <u>5-19</u> -0.000000005-19,	-0.00000000E-19,	-0+00000000E-19,	-0.00000000E-19, -0.00000000E-19,	

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					and the second state of th
	-0.0000000E-19,	-0.00000002-19-	0.0000000000000000000000000000000000000	-0.000000000-19,	-0.00000000000000
	-0.0000000E-19,	-0.00000000000-19	-0*00000005-14*	-0.000000000000000000000000000000000000	-0.000000000-19;
	-0.0000000E-19.	-0+0000000E-19+	010000000E 191	-0+0000000L 19+	
	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19,	~0-0000000E-19,	-0.0000000E=14,
		-0.0000000E-19,		0=00000000E-19+	
	-0.0000000E-19,	-0.0000000000-19,	-0.0000000E-19.	-0.0000000E-19.	-0.0000000E-19,
	0.0000000E-19,			0-00000000E-19	0-0000000E-197
	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.
			-0.00000000E-19.		
	-0.0000000E-19,	-0.0000000E-19,	-0.00000000E-19,	-0.0000000E-19,	-0.00000000E-19,
	-0.0000000E-19,	-0-000000000-19		-0+0000000E-19-	
	-0,0000000E-19.	-0.0000000E-19.	-0.0000000E-19.	-0.000000000-19,	-0.0000000E-19,
			-0.00000000E-19	0+0000000E-19+	
	-0.000000005-19.	-3.0000000E-19.	-0.0000000E-19.	-0.0000000E-19.	-0.0000000E-19.
	-0-0000000E-10-	-0.00000006-19.		0.000000000-19	
	-0.0000000E-19.	~0.000000000000000000000000000000000000	-0-0000000E-19-	-0-0000000E-19	-0-0000000F-19-
	-0.00000005-10	-2 000000005-10	0.0000000000000	0-000000000-10-	0.00000000
	0100000000-199	5405000000 174	000000000000000	010000000000000000000000000000000000000	0.00000002 177
CHOT1 -	-0 20200005 00	-0.394000005-00	-0.348000005.00		
	-0.253000005 00	-2 19700005 00	-0 161000005 00	-0 131000000 000	-0 10200000 00
	-0.255000002 00.	-3.197000002 00;	-0.16100000E 00.	-0.131000002 00,	-0.102000002 000
	-0+190000000-00+		-0-2540000000-00-		
	-0.43700000E 00.	-0.47400000E 00+	-0.497000000 00,	-0.50500000E 00,	-0.3920000000 00,
	0-38600000E-00,		-0.34000000E-00.		-0.25300000E-00,
	-0.19700000E 00,	-0.16100000E 00,	-0.13100000E 00,	-0.10200000E 00;	-0.15000000E 00.
				-0-38700000E-00,	-0.43700000E-001
	-0.47400000E 00,	-0.49700000E 00,	-0.5050000E 00,	-0.39200000E 00,	-0.38600000E 00.
· · · · · · · · · · · · · · · · · · ·	0-36900000E 00-	-3.34000000E-00y		0.25300000E 00.	
	-0.16100000E 00.	-0.13100000E 00,	-0.1020000E 00,	-0.15000000E 00,	-0.20000000E 00.
	-0.25400000E-00.		-0-38700000E-00-		
	-0.49700000E 00.	-0.50500000E 00,	-0.39200000E 00.	-0.38600000E 00,	-0.36900000E 00,
	-0-3400000E-00-			-0-19700000E-00-	
	-0.13100000E 00.	-0.10200000E 00.	-0.15000000E 00.	-0.2000000E 00,	-0.25400000E 00,
		-3-38700000F 00-	-0.43700000E 00		
	-0.50500000E 00.	-3.39200000E 00.	-0-38600000E 00-	-0.36900000E 00.	-0.34000000E 00.
		-0. 263000005 00	-0-19700000E-00	-0-161000005-00	0-13100000F-00-
	-0.1020000E 00.	-0.1500000E 00.	-0.2000000E 00.	-0.25400000F 00.	-0.32600000E 00.
	-0.387000005-00	-0.437000005-00	-0-474000005-00-	-0-497000006-00-	-0-505000000 00
	01000002-007				
CYEA C	0.100000005 01	0 00000005-00	0.02000005.00	0 82000000 00-	
0111 1	0 530000005 00	0.30000005.00	0.220000005 00	0 160000005 00.	0.700000000-01.
	0.3300000000000000000000000000000000000	0.100000000 000		0.520000005 00	
	-0.450000000-01-	-0.0000000000000	-0.10(000005 01	-0.1050000000 001	015200000E_001
	-0.850000000 00,	-0.48000000E 004	-0.104000002 01;	-0.108000002 01;	0.192000000 017
			0.1230000000-01	0.101000002-01	
	0.5600000E 00,	0.380000000 00,	0.22000000E 00,	0.11000000E 00,	0.200000002-01,
	-0+21000008-00+	-3-44000000E-00+		-0-100000005-01-	-0.124000000-01.
	-0.14500000E 01,	-0.15500000E 01,	-0.15700000E 01.	0.15500000E 01,	0.14600000E 01.
			0-100000005-01-		0,54000000E-00,
	0.3600000E 00,	0.2000000E 00,	0.9000000E-01,	-0.4000000E-01,	-0.23000000E 00.
	-0-46000000E-00+	-0-74000000E-00-		-0+12600000E-01+	-0-14700000E-01
	-0.158000000 01,	-0.1600000E 01,	0.15900000E 01,	0.15100000E 01,	0.1300000E 01.
		0-940000006-00-	0.74000008-00,	0-52000000E 00-	
	0.17000000E 00.	D.6000000E-01,	-0.7000000E-01.	-0.26000000E 00,	-0.49000000E 00,
	-0.7800000E-00.	-0-106000005-01-	-0-1-3000000E-01		
	-0.16400000E 01.	0.16300000E 01.	0.15600000E 01.	0.13400000E 01.	0.11500000E 01.
	0.9700000E_00	0_76000000E_00.		0-38000000E-00-	0.200000000000
	0-8000000F-01	-0.6000000E-01.	-0.25000000E 00.	-0.4700000F 00.	-0.77000000E 00.
			0 153000005 01	-0.167000006 01	0 1600000E 01-

-		0.5000000E 0.1000000E 0.1500000F	02, 03, 03,	0.60000000E 0.11000000E 0.16000000E	02, 03, 03,	0.70000000E 02, 0.12000000E 03, 0.17000000E 03,	- 0.8000000E 02, 0.13000000E 03, 0.18000000E 03,	0.90000000E-02, 0.14000000E 03,
CLAFH	•	-0.67500000E	00, 01,	-0.67500000E -0.12120000E	00, 01,	-0.12310000E 01, -0.00000000E-19,	-0.12270000E 01,- -0.00000000E-19,	
CHOFH	•	-0.39200000E	00, 00, -	-0.39200000E	00, 00,	-0.39200000E 00. -0.00000000E-19. ~	-0.39200000E 00,	-0.39200000E 00,
- CHAFH -		-0.18300000E	00, 00,		00+ 00,	-0.12000000E-00,	-0+11500000E-00+ -0+00000000E-19+	-0.13600000E-00,- -0.0000000E-19,
XCGOD	= .	0.2500000E	00,					
D	=	0.150000008	oz,					-
VTST	z	0.6000000E	03,					
GTST	=	0.2000000E	01,					
ZTST	=	0.2000000E	05,					-
QTST	=	0.20000000	03,					•
XKT		-0.0000000E-	-19,					-
ATRB	=	0.8000000E	00,					
BTRB	=	0.31800000E	01,					
COROP	- '	0.0000000E	-38.					
ALPCR	=	0.00000008-	-38,					
DELHAC		0.5000000E	00,					
PTMAC	=	0+12000000E	01,					
QOYPT	2	-0.1000000F	03,					
CHIN	-	0.100000005	01,					•
CHC00	=	0.27000000F	00,			• • • • • • • • • • • • • • • • • • • •		
I PRORD		······						· · · ·
IPRINT	-					and an		
IPHEAT	-	a,						
VSTOPO	=	0.1200000E	05,					•
XA	=	0.0000000E-	-38,					
IRNE	-	0.1000000E	02,					
KNE	=	0.23000000E	01,					
VIRNE	-	-0.00000000-	-19,	-0.0000000E-	19,	-0.0000000E-19,	-0.0000000E-19+	-0.0000000E-19,
	-0.0000000E-19.	-0-0000000E-19;	-0:0000000E-19;	-0-0000000E=19;	=0-0000000E=19;			
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OIRNE -	0x0000000E-19y	-920000000E-197	0,00000000E-19,	0-0000000E-19-				
	-0.0000000E-19.	-9.0000000E-19.	-0.0000000E-19.	-0.000000005-19,	-0.00000000E-19.			
VGFOR =	0.3900000E 01,	0.27000000E 01,	0.18000000E 01,	-0.0000000E-19,	-0.00000000E-19,			
	0+00000000E 19,	0.00000000E-19,		0-00000008E-19	-0:0000000E-19;			
FABDR	0+62500000E-01+	0.125000006-02,			0100000000E-19-			
	-0+0000000E-19,	-0,0000000E-19,	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.			
LAN =	0.0000000E-38,							
ELORC =	0.19200000E-01;	0.10400000E-01,	0.54000000E-02,	-0.00000000E-19.	-0.0000000E-19.			
	0:0000000E-19;		0+0000000E-19+	0.00000000E 19,	-0.00000000E-19,			
• •••	0+300000005-00+							
RGY		· · · · · · · · · · · · · · · · · · ·	·		÷			
550h	0.57000000E-00,							
₹£¥1	-0.3000000E 06,					·····		
0				· · · ·				
LAN	0.5000000E 00.							
HF			- ·					
THOS -	0.38000000E-01			· · · · · · · · · · · · · · · · · · ·				
EHICL						.		
.6600	0+00000000-38-							
ATC -	0-51100000E 01.		·····					
A56	0.100000000-01,							
4EH0	0.167000000 03,							
	0545 IN 10							
UNDRELOW AT-6	0545 IN NO		····			ILL. CRG		
NORFLOW AT S	0535 IN MQ					ILL. CRG		
NORFLOW-AT 6	0540 IN NO					-ILL-CRO		
					<u>**</u> ********	ILL. CRG		
	0ATE -5.11	CASE-1+00-NEN0-1	57.00 ATN - 3.80 VE	HICLE-60-00				
n	PEOE		6/9 IX		ZST	ZTH		

-TING	v		RHOA-	GANNA-	HAGH		-QSTAR-	-QRE	REY	HM/R TO-ALBAR	-OYN-PR	FREÓ-	QRNE-	-D/W	N/W
0.00	15230.	800000.	3.978-24	-17.50	29.18	0.0	0-0	0.0	6-28-12	208.9 142.3	0.0	0.0	0.0	0.0	. 0.0
144.50	15624-	218110-	3.73F-10	-12.72	29.99	1.5	1-5	0-0-	6.0E 02	220-6 144-1		- 0.0		0-0	0.0
-150.38	15639-	198051-	-1-206-09	-12-52	-30-02-	2.7		-0.0-	-1-96-03-	-221-0-142-1	0-1	0-0		-0-0-	-0+0-
156.36	15652.	177916.	3.895-09	-12-31	30.05	4.9	4.9	0.0	6.2E 03	221.4 143.3	0.5	Ó.1	0.0	0.1	0.0
-162.45	-15651-	157768-	1.276-08	-12-09-	-3006-	89	89	-0.0-	-2-08-04	221-7-144-1		0-2	-0-0-	-0-5-	-0-0-
168.61	15654.	137756.	4-12E-08	-11.85	30.05	16.1	16.1	~0.0	6.6E 04	221.5 143.1	5-0	0.3	-0.0	0.8	0.0
170.44	16460	102050	3 2 2 5 - 0 7	-11 44	20 69			- 0.0	-2-18 05	219-7 132-4		- 9-5			
193.07	15097	02550	5 985-07	-11.49	29.00	56.9	44.0		9 25 05	210.00 /0.4	20+2	,	0.0	-10-6	- 1.3
185.70	14496-	84907.	9-43E-07	-11.21	27.83	64-1	64.1	0.0	1-4E 06	190-1 46-6	99.0	1.2	0.0	15-4	1.9
-187.42	-13895	-80128-	1-255-06	-1-1-18	26 67-				1.85-06	-174-8-41-1	120-9	- 1-3		-18-8-	- 2.3
188.81	13293.	76438.	1.568-06	-11-13	25.52	65.7	65.7	0.0	2.18 06	160+1 37+1	137.9	1.4	0.0	21.4	2.5
180.00	12488	73437	<u>1-876-06</u>	-11-23	-24-36		-19-6	-0.0	-2-45-06-	- 146-0-34-1		- 1-5	00	-23-4	
191.06	12085.	70875.	2-18E-06	-11-31	23.20	60.2	18.9	0.0	2.7E 06	132.6 31.5	158.8	1.5	0.0	24+7	2.7
-192-03-	-11482-		2-492-06		-22-04-		-17-9	0-0-	-2-9E-06-	-119-8-29-3			-0+0-	-25-5-	2.7-
192+96	10881.	667(2	2.802-06	-11+29	20.89	50.4	16-0	0.0	3-1E 06	107.8 27.1	166+1	1.6	0.0	25.8	- 2.6
106 78	9477	62097	2 4 95-04	-11 20	10 50	40.0	12 4		3 45 06	96 6 33 0				25.2	
195 60	- 8072		-3-855-06	11-23	17.42	34.8	120_	0.0_	3.46 04	75 4 23-4	165+1		0.0	24-5	
196.61	8471.	59732	4-235-06	-11+30	16.26	29.9	10.4	0.0	3.7E 06	65.9 21.3	151.8	1.5	0-0	23.5	- 2.0
-197-58	7870		-4-54E-06	-11-38	14-95		8.7	-0.0-	3-66-06-	57.1-20.1				-21+7	1.0
198.62	7266.	56632.	4.856-06	-11.31	13.63	20.5	7.1	0.0	3.5E 06	48.9 19.1	128.0	1.4	0.0	19-6	1.5
-199-78-			-5-1-7E-06	-1-1-49	12-35-		5.7		3.36-06	-41.5-10.0		1-3	~0+0-	-17+6-	-1-3-
201.06	6051.	53416.	5.51E-06	-11-55	11.09	12.9	4-4	0.0	3.1E 06	34.6 16.9	101-3	1.2	0.0	15.4.	. 1.0
204 21	4055			-11-63	0 44	7 2		-0-0-	3 76 06	22 0 14 9		- 1-1		-13-3-	-0.7
-206-24	4253		-6-756-06	-12.22	7.48-				2.50 06	18.0 14.0			0.0		- 0.4
208.74	3652.	45921.	7.28E-06	-12.61	6.33	3.4	i.i	0.0	2.3F 06	13.8 13.1	48.5	0.8	0.0	. 7.3	- 0.3
-21-1-97	3050-	-43530	-7-906-06	-13-23	-5-20-	2.1	0-7	-0-0-	-2-06-06-	-10-2-12-3		0.7	-0.0-	-5-5-	-0.2
213.82	2775.	42295.	8.246-06	-13.67	4.69	1.6	0.5	0.0	1-9E 06	8.8 11.8	31.7	0.6	0.0	4.7	0.2
-215-97-	2500-		-8-6-28-06	-14-17	4-19-	-1-2-			-1-7E-06-	-7,5 11.5			0-0	-4-0-	0.1-
218.63	2218.	39387.	9+07E-06	-14.79	3.68	0.9	0.3	0.0	1.6E 06	6.4 10.9	22.3	0.5	0.0	3.3	0.1
-221-91-				-15-67	-3-18-		0-2-	-0.0-	-1-4E-06-	5-4-10-5		0+5	-0+0	-2-7-	
-721 01-	1763	32433-	1.036-05	-17.53	2+01	0.4	0.1	0.0	1. 26 06	*.5 10.1	14-0	0.4	0.0	2.1	- 0-1
240.56	1070.	28772	1.255-05	-74.45	1.67	0.1	0.0		0 5E 05	3 2 9.6	7.2	0.3		1.0	0.0
-256-80	777	-21573-	. 1.536-05	-35-45	_1.17			0-0-	7-85-05						- 0-0
301.38	556	-51.	2.56E-05	-65.55	0.75	0.0	0.0	0.0	7.8E 05	3.2 6.7	4.0	0.3	0.0	0.4	-0.0

255.68 79	7. 22071. 1.516-05 -	34.88 1.20 0.1	0.0 0.0 7.96 05	3.0 9.7 4	.8 0.3 0.0 0.6 0.
TIME AT TRANS	ITION = 189.99				
INPUT					
TO: -	-0.00000005-19-			-0.0000000E-19,	0-0000000E-19-
100	-0.0000000E-19	-9.0000000E-19.	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.
		-0-00000006-17,	-0.00000002-19,		-0.000000000000000000000000000000000000
	-0.0000000E-19,	-D.0000000E-19.	-0.000000000-19	-0.00000000000000	-0.00000000-19
	-0.00000000E=19,	-0-00000000E-19-	-0.00000000E-19	-0.0000000E-19.	-0.0000000E-19,
	-0-000000005-19	0.0000000E-19.	0+0000000E-19+ -	0.0000000E-19,	
	-0.0000000E-19,	-0.0000000E-19.	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19.
	0.00000000E-19,	-0.0000000000			-0.00000000E=19.
	-0.0000000E-19,	-0.00000000E=19;	=0.00000000000	-0-000000000	0_0000000E-197
	=0.0000000E=19-	-0.0000000E-19.	-0.00000000E-19,	-0.0000000E-19.	-0.0000000E-19.
	-0.00000005-19	-0.00000006-19,	0.0000000E-19		
	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19,	-0-0000000E-19+	-0.0000000E-19;
			-0.00000000E-19		-0.000000000000000000000000000000000000
	-0.00000000E-19.	-0.00000000E-19;	-0.00000000E=19;		
	-0.0000000E-19.	-0.0000000E-19	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.
	0.0000000E-19,	0.0000000E=19,			
	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19.	-0.0000000E-19.	-0.000000000-19,
	-0.0000000E-19;	·			
-	-0.00000005-19	-0 00000005-18		-0-00000000E-19-	
++0L	-0.00000000E-19,	-0.0000000E-19.	-0.0000000E-19.	-0.00000000E-19.	-0.0000000E-19,
	-0.000000000-19.	-0.0000000E-19,	-0.0000000E-19,		
	-0.0000000E-19;	-0.0000000E-19,	-0.0000000E-19.	-0.0000000E-19,	-0.00000000E-19,
	-0+0000000E-19+	-0-000000000-19-	-0-00000000E-19+	-0.00000000000000000000000000000000000	-0.00000005-19.
	~0.0000000E=19+	-0.000000000-19,	-0.000000000-19;	-0-00000000E-19	-0-0000000E-19-
	_0.0000000E=19;	=0.00000000E=19.	-0-00000000E-19	-0.00000000E-19.	-0.0000000E-19.
		-0.0000000E-19,	-0-00000000E-19,		
	-0.0000000E-19,	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19.	-0.0000000E-19,
	0.00000000E-19,	-0-0.0000000E-19,			-0.000000002=19;
	-0.0000000E-19,	-0.0000000000-19.	-0.00000000000000	-0.00000000-19	-0.0000000E-19
	-0.0000000E-19-	-0.00000000E-19+	-0-00000000E-19	-0.0000000E-19.	-0.0000000E-19,
	-0-00000000E=19	-0.00000000E-19.		-0-00000000E-19	0.0000000E-19.
	-0.0000000E-19,	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19.	-0.0000000E-19,
		-0-0000000E-19			-0.0000000E=19;
	-0.0000000E-19.	-3.00000000E-19,	-0.0000000000000	-0.000000000-19	-0.0000000E-19.
	-0.00000000E=19,	=D_00000000E-19-	-0-0000000E-19	-0.00000000E-19,	-0.0000000E-19,
	-0.0000000E-19				
					a anananar 10 -
0786	-0.0000000E-19.	-0-00000000E-19-		-0.000000000-19.	-0.000000000000000000000000000000000000
	-0.00000000E-19.	-0.0000000000-19-	-0.00000000E=19;	-0.00000000E-19	-0-00000008-19
-	-0-000000005-19-	-D.00000000E-19.	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19.
	-0.0000000E-19,	-0.000000005-19,			
	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.	-0,0000000E-19,
	0.0000000E=19,				-0.0000000000000
	-0.0000000E-19.	-0.000000002-19,	-0.000000000	-0-000000000-19-	
	-0.00000000000-19-	-0.0000000E-19-	-0.0000000E-19.	-0.00000000E-19,	-0.0000000E-19;
	-0-00000008-19.	-0.0000000E-17.	-0-00000000E-19,	-0.0000000E-19,	
	-0.0000000E-19,	-0+0000000E-19,	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19,
	-0.00000006-19,	-0+00000006-19+	0+00000000E-17+	-0.00000000 00-19,	
	-0.0000000E-19,	-0.00000008-19,	-0.0000000E-19;	-0*0000005-14*	-0.000000000000

	-0.00000000000000-19, -0.00000000000-19,	-0.00000000E-19,	-0.00000000E-19;	-0.00000000E-19,	-0:00000000E-19;
			-0.0000000E-19,		0+0000000E-19+-
	-0.0000000E-19,	-0.00000000E-19,	-0.00000000E-19,	-0.0000000E-19.	-0.00000000E-19,
	-0.0000000E-19.	-D.0000000E-19.	-0.00000000E-19.	-0.0000000E-19.	-0.00000000000000
• •	-0.000000005-19.				
MANDAL	0. \$000000E-00-		0.3000000E 01,		0+19000000E 02,
HONLY=	0+0000000E-38+				
	0.1900000E 02,	0.1000000E 03.	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19,
CDFH =	0.1000000E 01,	0.1000000E 01,	0.15200000E 01;	0.155000008 01,	"0.15900000E 01,
		0,16300000E-01,	-0.00000000E-19.		0;0000000E-19, ~
VE		· · · · · · · · · · · · · · · · · · ·			
GAHE	-0.1300000E 02,			·	
-26	0.8000000E 06,		·····		
MASS		· · · · · · · · · · · · · · · · · · ·			
-T\$TOP	-0.1000000E 04,			· · · · · · · · · · · · · · · · ·	
ZSTOP -			····		
FALR -			•		
LTH	0+10000005-19+				·
RSL	-0-111089005 08,		·		~
	0.12300000E-02				
XN	0.80000008-00,				
×c	0.200000000 00,				
T-SL	0.27500000E-03.				<u>.</u>
TST					
PTH	0.\$2500000E-03,		· · · · · · · · · · · · · · · · · · ·		
-RHOSL -	0-13200000E-04,				
DELTAT	0-1000000E-01,				
UP8Nn	9-10000000E-01,		0.10000000E-00,	0+1000000E-02+ -	0.1000000E-02.
	0.10000005-02-	0.1000000E-05-	0.10000006-01.	0.10000005-03.	0 10000005-03
	0_10000000E~04,	0-10000000E-04,	0-100000005-04		
UPDN	0+70000005-00			-	 .
-xprin	- 0,1000000E-01,				

•

DEFAL-	010000000E04,					
- AR	0.89516000F 05,					· -
-HVE	1,					
1-5						
-4PTST	51,					.
-PE	- 0.10450000E- 01, -			· · · · · · · · · · · · · · · · · · ·	<u> </u>	<u> </u>
-06	0.0000000E-38.					
- RE=	0.177000006-01, -				<u> </u>	-
CNFA	0.0000000E-38,	0_53000000E-01,	- 0.11400000E-00,		0+17700000E-00+	
	0.6200000E-01			0.10800000E 00.	0.81000000E-01,	
	0.360C0000E-01,	0.2500000E-01.	0.14000000E-01.	-0.0000000E-38,	0.0000000E-38,	-
	0.41000000E-01, -	0-8000000E-01	0.1070000E 00.	0-12200000E-00,	0-12400000E-00-	***
	0.115000000 00,	0.9600000E-01, ~	0.740000000-01,	0.5100000E-01.	0.4300000E-01,	_
	0.3600000E-01,	0+3400000E-01+			0-25000000E-01-	-
	0.18000008E-01,	0.9000000E-02,	0.0000000E-38,	0.0000000E-38,	0.4000000E-01;	
-	0.100000000 00,	0.13300000E-00,	0-15200000E-00,		0,14300000E00,	
	0.119000000 004	0.43000000000000	0.89000000000000	0.530000002-01,	0.450000002-01,	
~	0.130000002-01,	0.410000002-01,	- 0.310000000-01-			
	0 176000005 00	0.100000000-384	0.3060000005.00	0.10000000000001	0.1500000E 00;	-
-	0 121000005 00.	0.910000005-01	0.70000005-01	0 580000005-01	0 560000005-01	
	0-540000005-01			0.380000000000000	0.1600000000000	
	0.00000006-38.	0.000000005-38.	0.60000000000000	0.130000000 00.	0.174000005 00.	
	0.19800000E 00.	- 0.20400008-00- ·	- 0.18800000E-00-			
	0.9100000E-01.	0.7000000E-01.	0.580000008-01.	0.56000000E-01.	0.540000005-01.	
	0.4800000E-01,		0.29000000E-01-	0.16000000E-01	0-0000000E-38	·
CREA R	0.00000005-38.	0_3200000E=01		-0-83000005-01	-0.950000005-01	
	-0.95000000E-01.	-9.8400000E-01.	-0.64000000E-01.	-0-430000000-01-	-0.24000000E-01.	
	-0.1000000E-01					
	-0.2000000E-03,	-0.1000000E-03,	-0.1000000E-03.	0.0000000E-38,	0.0000000E-38,	-
	-0.21000000E-01, -	0+4000000E-01+		0-57000000E-01-	-0-57000000E-01+	
	-0.5000000E-01.	-0.38000000E-01,	-0.2600000E-01,	-0.140000005-01,	-0.6000000E-02;	
	-0.1000000F-02					-
	-0.1000000E-03,	-0.1000000E-03;	0.0000000E-38.	0.000000000-38,	-0.2000000E-01,	
	-0.40000000-01,	0+5300000E-01+				·
•	-0.38000000E-01,	-0.26000000E-01,	-0.1400000000-01,	-0.6000000E-02,	-0-100000008-02,	
	-0.100000000-03,					
	-0.77000000E=03;		-0.8900000000-38	-0.700000005-01	-0.5800000000-01,	
	-0.4100000E-01.	-0.22000000E=01-	-0.800000000000000000000000000000000000	-0.200000000-01	-0.300000000-01	
	-0.3000000E-03	0.2000000E-03			-0-10000000-03	•
	0.0000000E-38,	0.0000000E-38.	-0.24000000E-01.	-0.58000000E-01.	-0.77000000E-01.	
	-0.89000000E-01	0.89000000E-01	0.79000000E-01	0.6000000E-01-	-0-41000000E-01	
	-0.22000000E-01,	-0.9000000E-02,	-0.2000000E-02.	-0.3000000E-03,	-0.3000000E-03.	
				-0-1000000E-03	0-0000000E-38	
XCPFA =	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19-			
	-0.0000000E-19,	-3,0000000E-19,	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19,	
	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.		-0+0000000E-19+-	

				-0:0000000E-197	-0-0000000E-191-
	-0.00000002-19;	-3.000000000-19.	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19.
	-0.0000000E-19	-0.0000000E-19	-0.00000000E-19.	-0.0000000E-19	
	-0.0000000E-19.	-0.0000000E-19,	-0.0000000E-19,	-0.0000000E-19;	-0.0000000E-14.
	-0-0000000E-19-		0+0000000E 19+	-0-0000000E-19	
	-0.0000000E-19,	-0.0000000E-19.	-0.00000000E-19,	-0.00000000E-194	
	0.000000E-19	0.0000000E-19,	0+0000000E-1-9+	-0.0000000000000	-0.000000000000000000000000000000000000
	-0.0000000E-19.	-D.0000000E-19,	-0.00000000E-19,	-0.0000000000000	
	-0.0000000E-19	-0.00000008-19,	0_0000000E=197	-0.000000000-194	-0-00000000E-19
	-0.0000000E-19.	-0.0000000E-19.	-0.000000000-17;	-0.000000000000000000000000000000000000	0.0000000E-19-
	-0.0000000E-19.	-0.0000000E-19.	-0.000000000-19-	-0-0000000E-19-	-0.0000000E-19,
	-0.0000000E-19t	-0.000000000000000000000000000000000000	-0.000000000-19	0_00000000E_19	-0+0000000E-19+
		-0.000000000000	-0.0000000E-19	-0-0000000E-19-	-0.0000000E-19,
	-0.00000000000000	-0.00000000000000		-0-00000000E-19-	
	-0.0000000E-19,	-0.0000000E-19,	~0.00000000E-19.	-0.000000000-19.	-0.0000000E-19.
	-0.39200000F 00.	-0.38600000E 00.	-0.36900000E 00.	-0.34000000E 00,	-0.30100000E 00,
CHALM .	0_25300000F-00	-0.17700000E-00		-0-131000000-00-	-0-10200000-001-
	-0-15000000E 00+	-0.20000000E 00.	-0.25400000E 00.	-0.32600000E 00,	-0.387000000 00,
	-0-43708000E-00-		0.49700000E_00,	-0-505000000-00-	0139200000E_00
	-0.38600000E 00.	-0.36900000E 00,	-0.3400000E 00.	-0.30100000E 00.	-0.25300000E 00;
	-0,19700000E-00,				-4.437000005 00.
	-0.2000000E 00,	-0.25400000E 00,	-0.3260000E 00.	-0.38700000E 007	-0-38600000-00-
	-0.47400000E-00.	-0.49700000E 00.		-0.252000000 000	-0.1970000E 00.
	-0.36900000E 00.	-0.340000002 00.	-0.301000002 001	-0.1500000E 00v	-0-2000000E 00-
		-0.131000001- 00.	-0.387000005 00+	-0-43700000E 00-	-0.47400000E 00,
	-0.254000000 00.	-0.525000005-00		-0.3860000E-00.	
		-0 20100000E 00-	-0.25300000E 00.	-0.19700000E 00,	-0.16100000E 00,
	-0.131000005 001		0.15000000E_00	-0-20000000E-00y	-D+25400000E-00+
	-0.32600000E 00.	-0.38700000F 00.	-0.43700000E 00.	-0.47400000E 00,	-0.49700000E 00,
	50500000E_00			-0-369000006-00-	
	-0.30100000E 00.	-0.25300000E 00,	-0.19700000E 00.	-0.16100000E 00,	-0.13100000E 00,
	-0.1020000E 00.	-0.15000000E-00,			-0.50500005 00.
	-0.3870000DE 00,	-0+43700000E' 00+	-0.47400000E 00.	-0.497000002 007	-0.90900000 000
CXFA =	0.100000000 01,	0.98000000E 00,	0.93000000E 00,	0.82000000E 00;	0.670000000 00, -
				-0 530000005 00.	-0-6900000F 00.
	-0.4000000E-01,	-3.1800000000 00.	-0.34000000E 007	-010200000000000	-0-15200000E-01
	-0-8500000E-00-		0 17300000E 01	0.10700000E 01.	0.78000000E 00.
	0.14700000E 01,	0.200000000 00	0_72000000E_00+	-0-11000000E-00-	
		-0.440000000 00-	-0.72000000E 00.	-0.10000000E 01,	-0.12400000E 01.
	-0.145300005-03	-0.155000005-01	0,15700000E-01-	0-15500000E-01-	
	0 13300000F 01	0.11700000E 01.	0.1000000E 01.	0.76000000E 00,	0.5400000E 00.
	0.36000005-09-	0-20000000E-001	0-9000000E-01		-0.2300000E-00,
	-0.4600000E 00	-D. 74000000E 00.	-0.10200000E 01,	-0.12600000E 01,	-0.14700000E 01,
	-0.15800000E-01,		0.159000006_01.	0_15100000E-01	0.130000000-01
	0.11200000E 01.	0.94000000E 00,	0.7400000E 00.	0.5200000E 00;	0 490000000 00+
	0.170000005 00.	0-6000000E-01			-0 163000000 01.
	-0.78000000E 00+	-3.1060000E 01,	-0.13000000E 01.	-0.131000000 014	-0.11500000E 01.
	0.16400000E-01.		0.15600000E 01.	0.7800000E_00.	0.2000000F 00.
	0.9700000E 00.	0.76000000E 00,	0.5 (000000E 00+	-0-6700000E-004	
			-0.152000000- 01-	-0.1670000E-00	-0.16900000E 01,
	-0.10500000E 01.	-0.13000000E 01,	-0.152000002 01,		
ALPHAE =	0.14230000E 03,				
TABAL 3	0.0000000E-38.	0.100000008 02,	0.20000000E 0Z,	0.300000000 02,	0.4000000E 02,

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	·	0-50000006-02 0.10000000E 03- 0.15000000E93	0.60000000E-02; 0.11000000E 03.	0.120000000E 03, 0.12000000E 03,	0.8000000E 02, 0.13000000E 03, 0.18000000E-03,	0.14000000E 03;
CL-4FX-			-0-67500000E-00	-0-12310000E-01,	-0-12270000E-01-	
CHOFY	-	-0.39200000E 00,	-0.39200000E 00+	-0.39200000E 00.	-0.39200000E 00,	-0.39200000E 00,
GRAFH-		-0-18300000E-00-		-0+12000000E-00+		
	-	-0.138000000 00,	-0.138000002 000	-0.00000002-194	-0.000000002-19,	-0.00000000000000
ALGOD		0.150000002 00,			····	
μ 	-	0.130000002 02,				
V154	-	0.80000000 03,				
6757	=	0.2000000E 01.	·····			<u> </u>
2757		0.2000000E Q5,				
		0.2000000E 03,				
хкт		-0.0000000E-19.	······································			
ATRB		0.8000000E 00.				
BTRB	*	0.31800000E 01.				······
COROP	=	0.0000000E-38,				
ALPCR	=	0.0000000E-38,				·
DELMAC	-	0.5000000E 00.				
PTHAC	=	0.12000000E 01,				
ODYPT	*	-0.1000000E 03.				
CHIN	=	0.1000000E 01,				
CHCOD	-	0.2700000E 00,				
IPRORD	-	0,			•	
IPRINT	=	0,				
IPHEAT	-	0,				
STOPO	=	0.12000000E 05,				·····
CA .	=	0.0000000E-38,		· · · ·		····· · · ·
RNE	=	0.100000008 02.				
NE	22	0.23000000E 01,				
IRNE	=	-0.0000000E-19,	-0.0000000E-19,	-0-00000000E-19;	-0.00000000E-19;	-0.00000000E-19,
		-0.00000000000000	-0.0000000E=19;	-0.0000000E-19,	-0:0000000E=19;	-0-0000000-197
DIRNE		-0.00000000E-19, -0.00000000E-19,	-0.00000000E-19,	-0.00000000E-19, -0.00000000E-19,	-0.00000000E-19	-0.00000000E=19,
/GFDR	=	0.39000000E 01.	0.27000000E 01,	0.18000000E 01,	-0.00000000E-19,	-0.000000000-19
ABDR -						
		-0.62500000E 01, -0.00000000E-19,	-0.00000000000000000000000000000000000	0.25000000E 02. -0.00000000E-19.	-0.00000000E-19, -0.00000000E-19,	
BLAM	-	0.00000000E-38,	-0.00000000E-19,	-0.0000000E 02, -0.0000000E-19,	-0.00000000E-19,	
BLAM DELORC	-	0,62500000E 01, -0.00000000E-19, 0.00000000E-38, 0.19200000E-01, -0.00000000E-01,	0,10400000E-01, 0,00000000E-01, 0,10400000E-01,	0+25000000E 02 -0+0000000E 19 -0+54000000E 02 0+54000000E 02 0+54000000E 19	-0.00000000E-19, -0.00000000E-19, -0.00000000E-19,	0_00000000E_19, 0_00000000E_19, 0_00000000E_19,
BLAM DELORC	-	0,62500000E 01, -0.00000000E-19, 0.00000000E-38, 0.19200000E-01, -0.00000000E-19, -0.30000000E-00,	0.10400000E-01, -9.0000000E-01, 0.10400000E-01, -9.0000000E-01,	0.25000000E 02, -0.0000000E-19, 0.54000000E-02, 0.64000000E-02,	-0+00000000E-19; -0+00000000E-19; -0+00000000E-19; -0+00000000E-19;	0000000000000000000000000000000000
BLAM DELORC	-	-0.63500000E 01, -0.000000000E-19, 0.000000000E-38, 0.19200000E-01, 0.30000000E-00, 0.22000000E-00,	0.1040000E-01, 0.0000000E-01, 0.1040000E-01,	0.25000000E 02, -0.0000000E-19, 0.54000000E-02, 0.00000000E-19,	-0.0000000E-19, -0.0000000E-19, -0.0000000E-19, -0.00000000E-19,	
SOD	-	0.625600006 01, -0.00000000E-19, 0.00000000E-38, 0.1920000E-01, 0.00000000E-19, 0.30000000E-00, 0.22000000E-00, 0.57000000E-00,	0.1250000E 02, -0.00000000E-19, 0.1040000E-01, -0.0000000E-19,	0.25000000E 02, -0.0000000E-19, 0.54000000E-02, 0.6000000E-19,	-0.00000002 -19, -0.000000002 -19, -0.000000002 -19, -0.000000002 -19, -0.000000002 -19,	
SLAM DELORC RGX RGY SOD	-		9-12500000E 02- -9-00000000E-19- 0-10400000E-01- 9-0000000E-01- 9-0000000E-19-	0.25000000E 02, -0.0000000E-19, 0.55000000E-02, 0.56000000E-02,		
SOD	-	0.62500000E 01, 0.0000000E 19, 0.0000000E - 38, 0.1020000E - 01, 0.0000000E 00, 0.2200000E 00, 0.2200000E 00, 0.3000000E 00, 0.3000000E 06, 0.000000E - 38,	-12500000E 02, -3.000000005-19, 0.10400000E-01, -9.00000000E-01, -9.00000000E-19,	0.25000000E-02, -0.0000000E-19, 0.54000000E-02, 0.60000000E-02,	-0.00000000E 19, -0.0000000E-19, -0.00000000E-19, 0.0000000E-19,	
			9-12500000E 02- -9.00000000E-19. 0.10400000E-19. 9.0000000E-19.	0.25000006 02; -0.000000005-19; 0.540000006-02; 0.640000006-19;	-0.00000000E-19, -0.00000000E-19, -0.00000000E-19, 0.00000000E-19,	
EABDR BLAM DELORC RGX RGY SSOD REYT RO RAM REYT	-		9-12500000E 02, -0.00000000E-19, 0.10400000E-01, 9.0000000E-01,	0.25000000E 02; -0.0000000E-19; -0.0000000E-02; 0.54000000E-02;	-0-00000000E_19, -0.00000000E_19, -0.00000000E_19, -0.00000000E_19, -0.00000000E_19,	
ELAM DELORC DELORC CON CON CON CON CON CON CON CON CON CO				0.25000008 02, -0.00000000E-19, 	-0.00000000E 19, -0.00000000E-19, -0.00000000E-19, -0.00000000E-19, -0.00000000E-19,	
			9-12500000E 02- -9-00000000E-19- 0-10400000E-01- 9-0000000E-01- 9-0000000E-19-	0.2500000E 02, -0.0000000E-19, 		
ELAH DELORC CAX CAX CAX CAX CAX CAX CAX CAX CAX CA			9-12500000E 02- -9-00000000E-19- 0-10400000E-19- 0-0900000E-19-	0.25000006 02; -0.000000005-19; 0.540000006-02; 9;00000006-19;	-0.00000000E-19, -0.00000000E-19, -0.00000000E-19, 0.00000000E-19,	
ELAH DELORC RGX			9-12500000E 02- -9-00000000E-19- 0-10400000E-01- 9-0000000E-01- 9-0000000E-19-	0.2500000E 02; -0.0000000E-19; -0.0000000E-02; 0.54000000E-02; 0.6000000E-19;		
FAUDR BLAH DELORC RGX RGX RGX RGX RGX RGX RGX RGX RGX RGY RGY <td></td> <td></td> <td>9-13500000E 02, -9-00000000E-19, 0-10400000E-01, 9-0000000E-01, </td> <td>0.2500000E 02, -0.0000000E-19, 0.56000000E-02, 0.6000000E-19,</td> <td></td> <td></td>			9-13500000E 02, -9-00000000E-19, 0-10400000E-01, 9-0000000E-01, 	0.2500000E 02, -0.0000000E-19, 0.56000000E-02, 0.6000000E-19,		
BLAM BLAM DELORC QGX QXX QXX		0.62560000E 01, 0.0000000E 19, 0.0000000E 19, 0.0000000E 01, 0.200000E 00, 0.2200000E 00, 0.2200000E 00, 0.2200000E 00, 0.3000000E 00, 0.3000000E 00, 0.3000000E 01, 0.3000000E 01, 0.4000000E 01, 0.2000000E 00, 0.200000E 00, 0.200000E 00, 0.200000E 00, 0.200000E 00, 0.200000E 00, 0.200000E 00, 0.2000000E 00, 0.200000E 00, 0.200000E 00, 0.200000E 00, 0.200000E 00, 0.200000E 00, 0.20000E 00, 0.2000E 00, 0.20000E 00, 0.2000E 00, 0.2000		0.25000008 02, -0.00000000E-19, 		

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			e	CASE	-2-00	HEHO	167-00-	чтн-—-э	-80VEH	ICLE-6	0:00				· · · · · · · · · · · · · · · · · · ·
0		PE			RE	×	6670	ix -				-H/CDA	Z5	I	ZTH
	-011.	04506-00-		39 1.7	7-00E	00-2.5	000E-01		E036	-2726E	022	02926-01	-6.336	0E-04 · 4	.9202E-05
	v			-	AGH-		-05748	-085	REY			-OVN-PR-	Faco	-08 NE	0/WN/W
0+00	14000.	800000.	2.518-12 -	13.00 1	5.71	0.1	0+1	0.0	1.9E 00	127.5	142.3	0.0	0.0	0.0	0.0 0.0
	14189	-554528-	2.705-10	11.03 1	5.92				-2-15-02		-141-5-	0+0-	0.0-	~~0-0-	- 0.0
91.06	14205.	534457.	3.995-10 -	10.85 1	15.94	1-2	1.2	0.0	3.1E 02	131.1	141.2	0.0	0.0	0.0	0.0 0.0
206 36	14220-		P 755-10-	10 67 1	5 07	1+2	1.0	-0-0-	4.05 02	-131-4	-141.3		-0.0-		
114-20	14251	474110	1.305-09-	-10-78-1	5.99	23	2.3	0.0	1_05_07	132_0	142.5	0.1	0_0		- 0-0 - 0-0
122.15	14265.	454074.	1.936-09 -	10.08 1	6.00	2.8	2.8	0.0	1-5E 03	132.2	143.7	0.2	0.1	0.0	0.0 0.0
130,24	-14278.	434052.	2+885=09	-9.88 1	15-02	3.4.		00	-2-35-03		-142-7-			0-0	- 0-0-0-0-0-0-
138.51	14291.	414007.	4.28E-09	-9.67 1	6.03	4+1	4-1	0.0	3.4E 03	132-7	144.2	0.4	0.1	0.0	0.1 0.0
155 55	14302-	373040	- 0 395-09-	-0.24 1	6-04-			-0-0-	-5-0E-03	-132-5	144.2		-0-1-	0• <u>°</u> _	-0-1
- 166 37	14313	252953	1 425-08	-0.01_1	6.05	7.6	7.4	0.0	1.15-04		-143.5	1.0	-0.1	0.0	-0.2-0.0
173.44	14310.	333864.	2.14E-08	-8.79 1	6.05	9.3	9.3	0.0	1.76 04	133.0	143.3	2.2	0.2	0.0	0.3 0.0
-182.71-	14298	313856.	3.216-08	-8.57 1	16-04	11.4	11.4	0.0	2.58 04	132-8	142-2	3-3	0.2		-0.5-0.0-
192.25	14270.	293783.	4-82E-08	-8.35 1	6.01	13.9	13.9	0.0	3.8E 04	132+3	141-2	4-9	0.3	0-0	0.8 0.0
212-27	14137	253707	1 095-07	-7.94 1	5 96	20.4				-131-4	-139+0	10.0	-0-3-		-1-1-0-0-0-
221 55	14033	236076	1.576-07	-7.62	5.74	20.4	20.4		0.92 04	129.99	134+2	10.9	-0.5-		_2 6 0.1
229.58	13939.	221300.	2.136-07	-7.45 1	5.64	27.3	27.3	0.0	1.6E 05	126.4	94.8	20.7	0.6	0.0	3.2. 0.2
236.80	13723.	208437	2.775-07	-7,33 1	5.40	29.7	29.7	0.0	2.15 05	122-6	73-3	26-1	0.6		-4.0-0.4-
243.58	13367.	196824.	3.526-07	-7+1+ 1	5.00	30.0	30.0	-0.0	2.68 05	116.4	62.3	31.5	0.7	-0.0	4.8 0.5
250-28-	12261	-185890		-7.00 1	4.43			-0-0-	-3-15-05	-108-0	54-1		0.7	-0-0-	-5+60+7
261_33	11660	169223	6-255-07	-7-06-1	3-08	26.0	20.0		4-05-05		-42-6	40.5	0.8	0-0	- 6.5 - 0.8 -
265.91	11060.	162846.	7.13E-07	-7.05 1	2.41	23-8	23.8	0.0	4.3E 05	80.5	39.8	43-6	0.8	0.0	6-7 0-8
_ 270, 20_	10459-	_157185	-8-035-07-	-7-01-1	1.73	21.1	21-1	0.0	4-68-05	72-3	36-5	43.9	0.8		-6.7 0.8
274+35	9858.	151982.	8.95E-07	-7.07 1	1.06	18+4	18_4	0.0	4.8E 05	64.5	34-1	43.5	0_8	0.0	6.6. 0.8
278-44	-9255-	-147092	-9-915-07-	-7-21-1	0-38-	15-8		-0-0-	-5-06-05		-31.8	42.4-			-6.5-0.7
286 68	8049	137972	1-090-08	-7.51	9.11	13.4	13.4	0.0	5.28 05		29.3	40.9		0.0	6.2 - 0.1
290.97	7447.	133566.	1.31F-06	-7.72	8.35	9.1	9.1	0.0	5.45 05	38-0	25.7	36.5	0.7	0.0	5.5 0.5
295,47	- 5847-	129166	1-448-06-	-7.97-	7.68	7-3-	7.3	0.0	5.48 05	32.5	24.0		0.7		5.1 - 0.5
300.29	6246.	124689.	1.58E-06	-8.30	7.01	5.7	5.7	0.0	5.4E 05	27.5	22.8	30.9	0.7	0.0	4.6 0.4
	-5645-	-120061-	1.745-06-	-8.72	6-33-		4.3	0-0-	-5-4805			27.8-		0-0	-4-2
311.32	4454	110057	2 155-06	-10.04	5.00	3.2	3.2	- 0.0	5+3E 05	16.0	20.1	24-0	0.20	0.0	3. (0.3
323.28	4007.	105772.	2.36E-06	-10.95	4-50	1.7	1.7	0.0	5.2E 05	12.5	18.0	18.9	0.5	0.0	2.8 0.2
329.61	3558	101043	2.605-06-	-11.98-	3-99-	1.2	1.2		5.16 05		17.2	-16-5	š	0.0	2.4 - 0.1
336.98	3109.	95705.	2.91E-06 -	-13-21	3.49	0.8	0.8	0.0	5.0E 05	8.8	16.4	14.1	0.4	0.0	2.1 . 0.1
345.79	2660.	89474-	3-328-06-	-15-32-	2.98	-0.5-		0-0-	-4.8E-05					<u>0-0</u>	-1.7 0.1
356.68	2211-	81938+	3+84E-06 -	-18.19	2.48	0.3	0-3	0.0	4.7E 05	5.7	15.0	9.5	0.3	0.0	1.4 0.1
390.21	1335.	59151	6.15E-06	-30.66	1.48	0,2	0.1				16 1			0_0	-1-1
429.26			-8.965-06	49.30	0.98		0.0		4-05-05	3.7	12-6		-0.3		-0.6
473.07	791.	-16.	1.32E-05 -	67.55	0.76	0.0	0.0	0.0	4.3E 05	4.0	9.4	4-1	0.3	0.0	0.4*******
		التوسيع مرتب المالية	···· ,												

QS INTEGR	AL = 2	2.98912E	03 QSTAR	INTEGRAL	= 2.	98912E	03 QRE	INTEGRAL	= 7.94	109E-02	QRNE 1	NTEGRAL =	5.51	493E-02		
TINE 411.96	V 1120.	Z- 44036.	RH0A	-GAHHA	HACH 1.20	-95 0.1	-QSTAR- 0.1	QRE-0.0	REY 4.2E 05	HH/RTO 3.8	ALBAR- 13.3		FREQ 0.3	QRNE 0.0	- D/W- 0.6	-N/W
TRANSITIO	N DIO NO	OCCUR.													.	

III. COMPUTATIONS

A. BLOCK DIAGRAM

In the following pages are presented a block diagram (Figure 12) illustrating the operation of Program 1880, and a list of equations which are solved by the computer. The block diagram is arranged to indicate the sequence of operations as they are performed within the computer. Input data are located at the top of the diagram, computations are shown in the center, and outputs are grouped at the bottom. The list of equations which follow the diagram is divided into groups corresponding to the computation blocks in the diagram. Symbols used precede the equations.



Figure 12 BLOCK DIAGRAM ILLUSTRATING OPERATION OF PROGRAM 1880

B. SYMBOLS:

- a Speed of sound, ft/sec
- a (with subscript) density exponent in convective heating formula

A reference area
$$\left(\frac{\pi d^2}{4}\right)$$
, ft²

- b (with subscript) velocity exponent in convective heating formula
- cp specific heat at constant pressure, Btu/lb
- C_D drag coefficient
- C_L lift coefficient
- CLa lift coefficient derivative, per radian
- C_m pitching moment coefficient
- C_{ma} pitching moment derivative, per radian
- $C_{m_{\sigma}}$ pitch damping coefficient, per radian
- C_N normal force coefficient
- C_x axial force coefficient
- d reference length (diameter)~ feet
- D drag, pounds
- g local acceleration of gravity, ft/sec²
- g_{\oplus} Earth gravity at sea level, 32.17 ft/sec²
- H enthalpy, ft^2/sec^2
- I_x roll moment of inertia, slug-ft²
- I_{Y} moment of inertia in pitch and yaw, slug-ft².

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к	(with subscript) heating constant
L	temperature gradient, ^o K/ft
m	mass, slugs
М	molecular weight and Mach number
N	normal force, pounds
P	pressure, 1b/ft ²
P	vehicle roll rate, rad/sec
q	dynamic pressure $(\rho_a V^2/2)$, lb/ft^2
q	(with subscript) heating rate, Btu/ft ² -sec
Q	vehicle pitch rate, rad/sec
R	vehicle yaw rate, rad/sec
.R	universal gas constant, 89,516 ft ² /sec ² -mole- ⁰ K
^R z [·]	radius from center of planet, feet
Re	Reynolds number
S*	distance from stagnation point to sonic point, feet
ť	time, seconds
т	temperature, ^o K
v	velocity, ft/sec
W	Earth weight, pounds
x _{cg}	distance from nose to center of gravity, feet
x _{cm}	distance from nose to center of gravity for ${\rm C}_{\rm m}$ data, feet
x _{cp}	distance from nose to center of pressure, feet
x _A	mole fraction of argon in atmosphere
x _c	mole fraction of carbon dioxide in atmosphere
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- $\mathbf{X}_{\mathbf{N}}$ mole fraction of nitrogen in atmosphere
- X₀ mole fraction of oxygen in atmosphere
- Z altitude, feet
- α angle of attack, degrees
- a' total angle of attack (angle between vehicle axis of symmetry and velocity vector), degrees
- a total angle of attack envelope, degrees (max. value)
- β angle of sideslip, degrees
- β inverse scale height, feet⁻¹
- γ flight path angle (positive in climb), degrees
- y adiabatic exponent
- θ pitch angle, degrees
- μ viscosity, 1b-sec/ft²
- ρ density, slug/ft³
- σ non-dimensional radius of gyration $\left(\sqrt{\frac{I}{md^2}}\right)$
- ϕ roll angle, degrees
- ψ . yaw angle, degrees
- ω_n undamped natural frequency, rad/sec

Superscript:

sonic point

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Subscripts:
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- a ambient
- L laminar
- RE radiant equilibrium

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RNE	radıant nonequilibrium
S	stagnation point
SL	sea level
ST	stratosphere
т	turbulent
тн	thermosphere
TR	troposphere
Z	at altitude Z

- C. EQUATIONS
 - 1. Molecular Weight and Specific Heat

$$X_{\rm N} + X_{\rm O} + X_{\rm C} + X_{\rm A} = 1.0$$
 (1)

$$M = 28 X_{N} + 32 X_{O} + 44 X_{C} + 40 X_{A}$$
(2)

$$\frac{c_{p}}{R} = \frac{3.5 X_{N} + 3.5 X_{O} + 4.0 X_{C} + 2.5 X_{A}}{M}$$
(3)

- 2. Atmosphere Calculations
 - a. Troposphere

$$T = T_{SL} + L_{TR} Z \qquad (4)$$

$$\rho = \rho_{SL} \quad \frac{T_{SL}}{T_Z} \quad e^{- \left\{ \frac{M_{gSL}}{R(T_{SL} - L_{TR} R_{SL})} \right\}} \left[\frac{Z R_{SL}}{R_{SL} + Z} \right]$$

$$+ \frac{L_{\text{TR}} R_{\text{SL}}^2 \ln \left\{ \frac{R_{\text{SL}} (T_{\text{SL}} + L_{\text{TR}} Z)}{T_{\text{SL}} (R_{\text{SL}} + Z)} \right\}}{T_{\text{SL}} - L_{\text{TR}} R_{\text{SL}}} \right\}$$
(5)

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where,

$$L_{TR} = -L_{1} g_{SL}/c_{p}$$
(6)

 L_1 = temp gradient in troposphere expressed as a fraction of the adiabatic lapse rate b. Stratosphere

$$\rho = \rho_{ST} e^{\beta_{ST} Z_{ST}} e^{-\beta_{Z} Z}$$

$$\beta = \frac{M g_{SL} R_{SL}}{R T_{ST}(R_{SL} + Z)} \left\{ \frac{M g_{SL}}{R T_{ST}(R_{SL} + Z)} e^{-\beta_{Z} Z} \left\{ \frac{M g_{SL}}{R T_{SL} - L_{TR} R_{SL}} \left[\frac{Z_{ST} R_{SL}}{R_{SL} + Z_{ST}} \right] \right\}$$

$$+ \frac{L_{TR} R_{SL}^{2} ln \left\{ \frac{R_{SL} (T_{ST} + L_{TR} Z_{ST})}{T_{SL} (R_{SL} + Z_{ST})} \right\}}{T_{SL} - L_{TP} R_{SL}} \right\}$$
(9)

$$\beta_{\text{ST}} = \frac{M_{\text{BSL}} R_{\text{SL}}}{R_{\text{T}_{\text{ST}}} (R_{\text{SL}} + Z_{\text{ST}})}$$
(10)

$$Z_{\rm ST} = \frac{({\rm T}_{\rm ST} - {\rm T}_{\rm SL})}{{\rm L}_{\rm TR}}$$
(11)

c. Thermosphere:

$$T = T_{ST} + L_{TH} (Z - Z_{TH})$$
(12)
$$\rho = \rho_{TH} \frac{T_{ST}}{T_Z} e^{-\left(\sum_{R \in T_{ST} - L_{TH} (R_{SL} + Z_{TH})\right)} - \frac{R_{SL}^2 (Z - Z_{TH})}{(R_{SL} + Z) (R_{SL} + Z_{TH})}\right)}$$

$$+ \frac{L_{TH} R_{SL}^{2} ln \left\{ \frac{[T_{ST} + L_{TH} (Z - Z_{TH})] (R_{SL} + Z_{TH})}{T_{ST} (R_{SL} + Z)} \right\}}{T_{ST} - L_{TH} (R_{SL} + Z_{TH})} \right\}$$
(13)

(14) $\rho_{TH} = P_{TH} M/R T_{ST}$,

$$Z_{\text{TH}} = \frac{R T_{\text{SL}} \ln (\bar{\rho}/\rho_{\text{TH}})}{M R R}$$
(15)

$$\lim_{M \in SL} R_{SL} - R_{T} \ln (\bar{\rho} / \rho_{TH})$$

$$\rho = \rho_{ST} e^{(\beta_{ST} Z_{ST})}$$
(16)
Speed of Sound:

d. Speed of Sound:

$$\mathbf{a} = \begin{bmatrix} \frac{\left(\frac{c_p}{R}\right) RT}{\left(\frac{c_p}{R}\right) M - 1} \end{bmatrix}^{1/2}$$
(17)

3. Trajectory Calculations

a. Equations of Motion:

$$\dot{V} = \frac{-C_D q A}{m} - g \sin \gamma$$
(18)

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(2.5)

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$$V\dot{\gamma} = \frac{V^2 \cos \gamma}{R_Z} - g \cos \gamma + \frac{C_L Aq}{m} \frac{\sin \theta}{\sin \alpha'}$$
(19)

b. Supplementary Relationships

. (20) $\dot{Z} = V \sin \gamma$

$$q = \rho_a V^2/2$$
(22)

$$g \approx g_{\rm SL} \left(R_{\rm SL} / R_{\rm Z} \right)^2 \tag{25}$$

(24) $R_Z = R_{SL} + Z$

 ρ = f(Z) from atm calcs.

$$Re = \rho_a V d/\mu$$

 $\mu = f(T)$ from built in viscosity table

$$T = f(Z) \text{ from atm. calcs.}$$

$$D/W = (C_D)_{\alpha=0} q A/m g_{\phi}.$$

$$C_D = f(M, \alpha') \text{ from coefficient calculations}$$
(26)

- 4. Dynamics Calculations
 - a. Equations of Motion

The \dot{Q} equation is given in Section I. B.4 (Calculation Model) (27)

The R equation is given in Section I. B. 4 (Calculation Model) (28)

b. Supplementary Relationships:

$$\dot{\psi} = (R \cos \phi + Q \sin \phi) \sec \theta$$
 (29)

$$\dot{\theta} = (Q\cos\phi - R\sin\phi) \tag{30}$$

$$\dot{\phi} = (\mathbf{P} + \dot{\psi}\sin\phi) \tag{31}$$

(21)

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$$I_{\rm X} = m \sigma_{\rm X}^2 d^2$$
⁽³²⁾

$$I_{Y} = m \sigma_{y}^{2} d^{2}$$
⁽³³⁾

$$\sin a = (\sin \theta \cos \psi \cos \phi + \sin \psi \sin \phi)$$
(34)

$$\sin \beta = (\sin \psi \cos \phi - \sin \theta \cos \psi \sin \phi)$$
⁽³⁵⁾

$$\sin a' = (\sin^2 \psi + \cos^2 \psi \sin^2 \theta)^{1/2}$$
(36)

$$N/W \approx C_{N}(\bar{a}) q A/m g_{\oplus}$$
(57)

 $C_N, C_m, C_{m_q}, C_{L_a} = f(M, a')$ from coefficient calculations c. Linearized Equations of Motion c^t

$$\left(\frac{\bar{a}}{\bar{a}_{o}}\right)_{P=0} = \begin{bmatrix} -C_{m_{a},0} q_{o} \\ -C_{m_{a}} q \end{bmatrix}^{1/4} \begin{bmatrix} 1/2 & \int_{0}^{t} P_{1} V dt \\ e \end{bmatrix}$$
(38)

$$\omega_n^2 = - \frac{C_{m_\alpha} q \operatorname{Ad}}{I_Y}$$
(41)

$$\Delta \lambda = \frac{\frac{I_X}{I_Y}}{4 \left[\omega_n^2 + \left(\frac{I_X P}{2 I_Y} \right)^2 \right]^{1/2}}$$
(42)

$$Freq \approx \omega_{\rm B}/2\pi \tag{43}$$

5. Coefficients Calculations

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$$C_{\rm D} = C_{\rm X} \cos a + C_{\rm N} \sin a \tag{44}$$

$$C_{\rm m} = C_{\rm N} \left(\frac{X_{\rm cg}}{d} - \frac{X_{\rm cp}}{d} \right) , \qquad (45)$$

or

$$C_m = C_{m_{X_{cm}}} + C_N \left(\frac{X_{cg}}{d} - \frac{X_{cm}}{d} \right)$$
(46)

$$C_{L_{\alpha}} = \frac{\frac{(C_{L})_{\alpha + \Delta \alpha} - (C_{L})_{\alpha}}{\Delta \alpha}}{(47)}$$

where,

$$C_{L} = C_{N} \cos a - C_{X} \sin a \tag{48}$$

$$(C_{\rm N})_{a > 180} = -(C_{\rm N})_{180 - (a - 180)}$$
 (49)

$$(C_X)_{a>180} = (C_X)_{180 - (a - 180)}$$
(50)

$$(C_m)_{\alpha > 180} = -(C_m)_{180} - (\alpha - 180)$$
 (51)

$$(X_{cp})_{\alpha>180} = (X_{cp})_{180 - (\alpha - 180)}$$
(52)

$$(C_{L_{\alpha}})_{\alpha > 180} = (C_{L_{\alpha}})_{180 - (\alpha - 180)}$$
(53)

7. Convective Heating

a. Lamınar

$$q_{\rm S} = \frac{K_{\rm L}}{(d/2)^{1/2}} - \rho_{\rm a}^{1/2} \left(\frac{V}{10^4}\right)^{\rm b_{\rm L}}$$
(54)

where,

$$K_{L} = (1.1 + 0.075 M) \times 10^{4} \times \left[\frac{d}{2V} \left(\frac{du}{ds}\right)_{S}\right]^{\frac{1}{2}}$$
 (55)

$$b_{\rm L} = 3.909 - 0.0229 \,\rm M$$
 (56)

M = molecular weight

$$\frac{d}{2V} \left(\frac{du}{ds}\right)_{S}$$
 = velocity gradient at stagnation point

b. Turbulent

$$q_{\rm T} = K_{\rm T} \times \rho_{\rm a}^{0.8} \times \left(\frac{V}{10^4}\right)^{3.18}$$
 (57)

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where,

$$K_T = [540000/(S^*)^{0.2}] (THF)$$
 (58)

S* = distance from stagnation to sonic point at zero angle of attack

THF = turbulent heating factor

$$Re^* = \frac{\rho_a}{\mu^*} \left(\frac{\rho_S}{\rho_a}\right) \left(\frac{\rho^*}{\rho_S}\right) u^* S^*$$
(59)

where,

 $\rho_{\rm S}/\rho_{\rm a}$ = density ratio at stagnation point

 $\mu^* = f(T^*)$ from built-in viscosity table

$$\rho^*/\rho_{\rm S} = \left(\frac{2}{\gamma+1}\right)^{\gamma-1}$$
(60)

$$u^* = \left(\frac{2H}{\rho_S/\rho_a}\right)^{1/2} \tag{61}$$

 $H = (HM/RT_o) 24.4522 \times 10^6/M$ (62)

$$T^* = 2 T_S / (\gamma + 1)$$
 (63)

T_S = temperature at stagnation point

$$\gamma = \frac{(\rho_{\rm S}/\rho_{\rm a}) + 1}{(\rho_{\rm S}/\rho_{\rm a}) - 1}$$
(64)

$$HM/RT_{o} = \frac{V^{2}M}{2RT_{o}} + \frac{Mc_{p}Ta}{RT_{o}}$$
(65)

8. Nonequilibrium Radiation Heating

$$q_{\rm E} = \frac{-E^{-2}}{2}$$
 (71)

$$I_{E}(\epsilon_{1}, N_{1}, T) \rightarrow \text{see Program 1883}$$
 (72)

9. Alternate Nonequilibrium Model

$$\frac{I_{\rm NE}}{I_{\rm E}} = \frac{\Delta}{\Delta_{\rm NE}} \cdot \frac{\rm DIRNE}{QE}$$
(73)

DIRNE (VIRNE) (74)

IV. IBM ROUTINES

A. PROGRAM FLOW

The program flow 1s illustrated in Figure 13.



Figure 13 FLOW DIAGRAM OF PROGRAM 1880

B. CØMMØN STORAGE

Much data are transferred between the main program and the subroutine DERQO which computes the values at time (i) of the eight possible differential equations being integrated. Many other tables are placed in COMMON storage to prevent an overlap of the loading tables and the program when Program 1880 is placed in core. COMMON data are as follows:

DERQ0

Name	Quantity	Source	Input or Output	Description
ZST 、	z_{ST}	Main	Input	Stratosphere altitude.Used to compute atmospheric properties,
ZTH	z _{TH}	Main	Input	Thermosphere altitude. Used to compute atmospheric properties.
RHØ	ρ	DERQ0	Output	Ambient density at trajectory time t.
ZTBL		Program Input	Input	Altitude table for tabular atmosphere.
TETBL		Program Input	Input	Temperature table for tabular atmosphere.
RØTBL		Program Input	Input	Density table for tabular atmosphere.
CD	c_D	Program Input	Input	Drag coefficient as a function of Mach number XMACH.
XMACH		Program Input	Input ·	Mach number table used with CD above.
xĽı	Ll	Program Input	Input	Troposhere temperature grad ient. Used to compute at- mospheric properties.
GSL	G_{SL}	Program	Input	Sea level gravitational accel- eration. Used to compute atmospheric properties and

trajectory.

Name	Quantity	Source	Input or Output	Description
CPØR	CP/R	Main	Input -	Specific heat divided by gas constant. Used to compute atmospheric properties.
TST	TST	Program Input	Input	Stratospheric temperature. Used to compute atmos- pheric properties.
TSL	TSL	Program Input	Input	Sea level temperature. Used to compute atmospheric properties.
RH ØSL	$ ho_{\rm SL}$	Program Input	Input	Sea level density. Used to com- pute atmospheric properties.
RSL	R _{SL}	Program Input	Input	Planet radius. Used to com- pute atmospheric properties and trajectory.
XM	М	Maın	Input	Mean molecular weight of atmosphere. Used to compute atmospheric properties.
AR	R	Main	Input	Gas constant. Used to com- pute atmospheric properties.
XL2	L _{TH}	Program Input	Input	Thermosphere temperature gradient. Used to compute atmospheric properties.
MVE		Program Input	Input ,	If = 1, parametric atmos- phere if = 2, tabular.
ХLØ	LO	Main	Input	Troposphere temperature gradient. Used to compute atmospheric properties.
CSUBD	c _D	DERQ0	Output	Drag coefficient at trajectory time t.
C_{L}	c_{L}			No current use.

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Name	Quantity	Source	Input or Output	Description
XMAC	м	DER Q0	Output	Mach number at trajectory time t.
SMA	a	DER Q0	Output	Ambient speed of sound at trajectory time t.
A	A	Main	Input	Vehicle area. Used to compute trajectory.
SMM	m	Program Input	Input	Mass of vehicle. Used to com- pute trajectory.
TEMP	т	DERQ0	Output	Ambient temperature at tra- jectory time t.
RØBAR	P	Main	Input	Stratosphere density used to compute atmospheric prop- erties.
RНФТН	$\overline{ ho}_{\mathrm{TH}}$	Maın	Input	Thermosphere density Used to compute atmospheric properties.
TABAL		Program Input	Input	Angle-of-attack table. Used as independent variable table for coefficients as functions of a and M to compute tra- jectory.
CNFA	c_N	Program Input	Input	C_N table as function of a and M to compute trajectory.
XCPFA	x _{cp}	Program Input	Input	X_{CP} table as function of a and M to compute trajectory.
CMQFA	C _{mq}	Program Input	Input	C_{mq} tables as function of a and M to compute trajectory.
CLAFM	C_{L_a}	Program Input	Input	C_{L} table as function of M to compute trajectory.
CMQFM	C _{mq}	Program Input	Input	C _{mq} table as function of M to compute trajectory.

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Name	Quantity	Source	Input or Output	Description
CMAFM	C _{ma}	Program Input	Input	$C_{m_{\alpha}}$ table as function of M to compute trajectory.
XCGØD	xcg/ _D	Program Input	Input	XCG/D center of gravity. Used to compute trajectory.
ZIX	IX	Program Input	Input	I_X moment of inertia. Used to compute trajectory.
ZIY	IY	Program Input	Input	Iy moment of inertia. Used to compute trajectory.
D	d	Program Input	Input	Vehicle diameter. Used to compute trajectory.
NØEQD		Main	Input	Number of equations being integrated: 3 for particle trajectory; 8 for trajectory and dynamics.
ALDG	a*	DERQ0	Output	Angle of attack at trajectory time t.
Р	P	Program Input	Input	Constant spm rate used to compute trajectory.
RTX	REY			Used to prevent loading table, program overlap.
HRT	hm/rt _o			Used to prevent loading table, program overlap.
QS	qs			Used to prevent loading table, program overlap.
QT	q*			Used to prevent loading table, program overlap.
QR	^q _R			Used to prevent loading table, program overlap.
TIME	t			Used to prevent loading table, program overlap.

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Name	Quant1ty	Source	Input or Output	Description
ХМВСН	м	Program Input	Input	Independent variable. Mach number table used to com- pute coefficients as a function of α and M for trajectory.
CXFA	c _x	Program Input	Input	C_X table as a function of α and M used to compute trajectory.
CLAFA	$C_{L_{\alpha}}$	GETCLA	Input	$C_{L_{\alpha}}$ table as a function of α and M used to compute tra- jectory.
CMFA	Cm	Program Input	Input	C_{M} table as a function of a and M used to compute trajectory.
XØW	D/W			Drag force ratio.
enøw	N/W			Normal force ratio.
XMAX		Main	Input	Largest value of XMBCH.
XMIN		Main	Input	Smallest value of XMBCH,
IXMAX		Main	Input	Index of XMAX in XMBCH.
IXMIN		Maın	Input	Index of XMIN 1n XMBCH.
CMIN		Program Input	Input '	If CMIN >O, use CMFA and CMC ϕ D for C _M if CMIN \leq O, use XCP ϕ D for C _M .
СМСØD		Program Input	Input	Used to compute C_M for trajectory if CMIN > 0.

C. SUBROUTINES

	Variable	CNFA, C _N coefficient table	CXFA, C _X coefficient table	TABAL, d independ- ent variable table	CLAFA, CL coef- ficient table
GETCLA	Subroutine Input or output	Input	Input	Input	Output
	SOURCE	Program Input	Program Input	Program Input	GETCLA
	Variable	NXG, Atmos table number	XØ, Ø2 mole fraction	XN, N ₂ mole fraction	XC, CO ₂ mole fraction
	Input or Output	Input	Input Program	Input Program	Input Program
COOL	SOURCE	MAIN	Input	Input	Input
XA, A mole fraction	IPRG, print sentionol	RHØ, ambient density	VY, Vehicle velocity	QRIG, total equilibrium radiation	ZNAMI, table of 7 specie names
Input	Input	Input	Input	Output	Input
Program Input	Program Input	DEREQ	ADM4RK	GETN	MAIN
ZNAM2, table of radiation source names	ENTØT, stagnation enthalpy	RØRZ density ratio	DELØRC, table of Δ/RC	TSSZ Stagnation Temperature	TIM, Trajectory time
Input	Input	Output	Input	Output	Input
MAIN	MAIN	HEAT '	Program Input	HEAT	ADM4RK
TITBL, Zone 1 temperature table	T2TBL, Zone 2 temperature table	T3TBL, Zone 3 temperature table	HITBL, Zone 1 enthalpy table	H2TBL, Zone 2 enthalpy table	H3TBL, Zone 3 enthalpy table
Input	Input	Input	Input	Input	Input
HVST	HVST	HVST	HVST	HVST	HVST
DENR, table of density ratios	D, vehicle diameter	DELDG, A detachment distance			£
Input	Input	Output			
Program Input	Program Input	heat			

	,					
		Variable	V, Velocity	RHØ, ambient density	XN, N ₂ mole fraction	XØ, Ø2 mole fraction
	HEAT	Subroutine Input or Output	Input	Input	Input	Input
,		SOURCE	ADM4RK	DEREQ	Program Input	Program Input
	XC, CO ₂ mole fraction	XA, A mole fraction	NX atmosphere fäble numbers	P, Stagnation pressure	T, Stagnation temperature	Z, moles of gas mixture at T & P
	Input	Input	Input	Output	Output	Output
	Program Input	Program Input	MAIN	HEAT	HEAT	ZØNES
	RHØST, density ratio ps/pa	QSUM-total radiation heating	QI-component radiation heating	X-moles of species in mixture of T&P	HDHS dissociation energy-enthalpy	HRT, enthalpy
	Output	Output	Output	Output	Output	Output
	HEAT	GETN	GETN	ZØNES	FINDH	FINDH
-	DELGRC, table of A/RC	DUM-moles of O ⁺ , N ⁺ ; C ⁺ , e ⁻ in Zone 2	ENTØT-stagnation enthalpy (HRT)	HITBL, Zone 1 enthalpy table	H2TBL Zone 2 enthalpy table	H3TBL Zone 3 enthalpy table
	, Input	Output	Input	Input	Input	Input
1	Program Input	zønes	MAIN	HVST	HVST	HVST
	TITBL, Zone 1 temperature table	T2TBL, Zone 2 temperature table	T3TBL, Zone 3 temperature table	DENR, table of density ratio	D, vehicle diameter	DEL, ∆detachment distance
	Input i	Input	Input	Input	Input	Output
	HVST -	HVST	HVST	Program Input	Program Input	HEAT -

	CKTRB	Variable	RORZ = Density ratio PS/Pa	TSSZ stagnation temperature	TMPVS, temperature for viscosity	VISC, viscosity table
	Ň	Subroutine Input or Output	Input	Input	Input	Input
,						· · · · · · · ·
	ENTØT, stagnation enthalpy	DUMREY constant to compute Reynolds No	RØ (I), ambient density	SST, S* to compute Reynolds No	- REYS, local Reynolds No	Se
	Input	Input	Input	Output	Output	
	MAIN	MAIN	MAIN	MAIN	CKTRB	
ł						

Calling sequences for ADAMS4 and DERQ0 are described in the section of special routines

Calling sequences for HVST, GETN, ZONES, GETK, FINDT, FINDH, and GETQ are the same as for those routines in the 1883 program description.

	Variable	DELDG, detachment distance	DSP, distance to peak nonequilibrium intensity	· DNE nonequilibrium distance	XIRN, nonequilibrium intensity ratio		
NONEQU	Subrouting Input or Output	Input	Input	Input	Input		
	Source	HEAT	MAIN	MAIN	Program Input		
QR(I), Equilibrium radiation heating	QRNE (I) non- equilibrium radiation heating						
Input	Output						
GETN	NØNEQU						

1. Subroutine DER Q0

<u>Purpose:</u> DERQ0 computes the atmospheric properties for the altitude at each time step of the numerical integration of the trajectory and dynamics differential equations, and provides the values of the derivatives of the differential equations for the succeeding integration step.

<u>Method:</u> The values of the dependent variables of the integration are contained in the array X of the calling sequence, at time = TIM, and the derivatives are computed and stored in the array DERX. All other data are passed through COMMON. The quantities in each X are: Velocity (V), flight path angle (γ), altitude (Z), pitch rate (Q), yaw rate (R), and the Euler angles (ψ, θ, ϕ).

Knowing the altitude at time TIM, DERQ0 first computes the atmosphere temperature TEMP and density RH ϕ corresponding to that altitude. It does this with tables (MVE = 2, Statements 10 and 12) or from a parametric representation (MVE = 1, Statements 20 to 70). By the execution of Statement 93 the Mach number and speed of sound (XMAC and SMA) are calculated, as well as the value of dz/dt.

After Statement 92 the number of equations (NOEQD) is tested, and if this is 8 the remaining trajectory and dynamics derivatives must be evaluated using coefficients that are functions of angle of attack and Mach number. If NO(EQD = 3), only the two remaining particle trajectory derivatives (dv/dt, dy/dt) are evaluated using a drag coefficient as a function of MACH number (XMACH) only, and the RETURN before Statement 99 returns control to ADAMS4 so that the integration may be continued. If all eight derivatives must be evaluated, transfer is made to Statement 99 and by Statement 1000 the angle of attack at time TIM is computed from the Euler angles. Statements from 1000 to 1019 compute the aerodynamic coefficients by double interpolation in angle of attack (through ARTLU and ALPHA) and Mach number. Tests are first made (before 1000 or before 1001), and if the Mach number is lower (higher) than the lowest (highest) value in XMBCH. In addition, for values of ALPHA above 180 a transform is made to the value of the coefficient in the range between 0 and 180. The values of the derivatives are computed between Statements 1019 and 9999.

2. Subroutine COOL

<u>Purpose</u>: Subroutine COOL accepts data from the trajectory calculation in such form as is suitable for the radiation heating calculation, initiates the heating calculation, and returns radiation and gas dynamic data to the main program. If IPRQRD is ≥ 1.0 , COOL also causes data to be printed out each time it is called. <u>Method:</u> Subroutine $C\phi\phi L$ is analogous to the main program of Program 1883 (see 1883 description). The program flow for 1880 described above contains the logical position of the subroutine and, in fact, the "radiation heating Program 1883" division reflects the logical flow of Program 1883 (call HEAT, and so forth). If the sentinel IPRQRD is ≥ 1.0 , subroutine $C\phi\phi L$ will provide the normal 1883 output each time it is called, along with the trajectory time for identification.

3. Subroutine NØNEQU

<u>Purpose:</u> To compute the value of the nonequilibrium radiation heating for each time recorded on the output tables.

<u>Method</u>: Immediately before NØNEQU is called for some TIME entry, the equilibrium radiation heating calculation (subroutine CØØL, et al) has provided the equilibrium radiation and the detachment distance (QR (I) and DELDG). Given the distance to peak nonequilibrium intensity and the nonequilibrium density (computed in the main program as DSP and DNE, plus the input factor IRNE, the nonequilibrium radiation is computed from one of three relations (Reference 1, p. 104. Equation (78)) which relation is used to compute QRNE at time TIM, depending on the relative magnitude of DELDG, DNE, and DSP.

4. Subroutine CKTRB

<u>Purpose:</u> Subroutine CKTRB computes the local Reynolds number at the sonic point each time the equilibrium radiation calculation is successfully performed during the trajectory.

<u>Method:</u> Using output from the equilibrium radiation calculation, density ratio, stagnation temperature, and stagnation enthalpy, plus the ambient density, viscosity (known as a function of temperature), and S* from SS ϕ D in the program input, the Subroutine CKTRB evaluates the local Reynold's number at the sonic point from a straight-forward algebraic solution.

5. Subroutine HEAT

Purpose: See 1883 description

<u>Method:</u> The method used by HEAT in Program 1880 is the same as in 1883 with the following changes. HEAT no longer calls the subroutine HVST, but has the output from that subroutine given to it by subroutine $C\phi\phi L$, which receives it from the 1880 main program which calls HVST once for each trajectory. HEAT does not compute the stagnation enthalpy, but receives it via $C\phi\phi L$ from the trajectory

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calculation. Also the detachment distance is not supplied by direct input or the correlation in b/a and inverse density ratio, but from a direct correlation between detachment distance and density ratio supplied as program input (tables DEL ϕ RC and TABDR in the input).

6. Subroutine GETN

Purpose: See 1883 description

Method: Same as in 1883, but the effective emissivities and detachment distance are deleted from the program output.

Subroutines HVST, GETK, GETQ, FINDH, FINDT, and ZØNES are the same as in Program 1883.

7. Subroutine GETCLA

Purpose: GETCLA will compute a table of $C_{\rm L}$ from the input tables $\overline{C_{\rm N}}$ and $\overline{C}_{\rm X}.$

<u>Method</u>: Subroutine GETCLA computes the coefficient $C_{L_{\alpha}}$ by a linear approximation of the derivatives which depend upon tables of C_{N} and C_{X} . A value of $C_{L_{\alpha}}$ is computed for each of 5 Mach numbers and 19 angles of attack in the loop ending at Statement 1005.

8. Subroutine INTRP

Purpose: To interpolate trajectory data at a specified Mach number or dynamic pressure, and print the results.

Method: Linear interpolation.

D. MAIN PROGRAM

<u>Purpose:</u> The purpose of the main program is to acquire input, provide for the integration of the trajectory and vehicle dynamics equations (done by ADAMS4), exercise suitable options during the course of the trajectory calculations (depending on the value of certain input quantities), provide for the calculation and storage of all quantities which appear in the output tables, and provide output from the calculation.

Method: To easily follow the logical flow of the main program, one must remember two facts. First, the integration of the trajectory equations is arranged under normal operating procedure so that ADAMS4 returns control to the main program after each integration step. The size of this time interval depends only upon the behavior of the differential equations and the accuracy requirements. Second, since these time steps are usually rather small, to provide output for each step would be quite time consuming. Therefore, only some integration data appear on the output tables and the points selected depend upon the rates of change of physical quantities of interest to the user. For example, if the altitude is changing rapidly, finer resolution is shown on the output for the time span in which this occurs. All output points selected are stored on tables which are printed after the entire trajectory has been calculated.

The maximum number of lines of output is 150, and it is solely the responsibility of the problem submitter to assure (by judicious selection of values for VTST, GTST, ZTST, QTST, and DELMAC) that these tables are not exceeded. All statements before 500 either specify variables, or define preset input or tables. ZNAM1 and ZNAM2 are arrays of Hollerith names which define species and radiation contributors for the radiation heating block. The tables TMPVS and VISC define viscosity as a function of temperature. TBSUM is the sum of $O_2 + CO_2$ for each of the eleven atmospheric tables of enthalpy and temperature (see main description).

After Statement 500, sentinels are initialized for each case, and data is read in through the Namelist array INPUT. The values of the highest and lowest Mach numbers in the array XMBCH have been computed by Statement 3003, and subroutine GETCLA is called to provide a table of values for C_L for the tables of C_N and C_Y. Following the call GETCLA, the modes of certain input variables are changed, the moments of inertia computed from the radii of gyration, S* computed, and by Statement 3018 the appropriate tables for the atmosphere being run have been selected by the calculation of NXG (i.e. the tables whose sum of O, and CO, mole fractions is closest to the sum of the input XO and XC). Call HVST obtains these enthalpy and temperature tables for use by the radiation heating calculation. Diagnostic tests are performed before Statement 3048 to assure that the sum of the mole fractions is 1. - .001, and that $XN \ge .001$. By Statement 24, further initialization has been completed, constants computed for the theorized dynamic calculation, and the quantities which determine output points defined from the input. The statements immediately following 24 define atmospheric properties and constants for the computation of the convective heat pulses. The heat pulses which appear in the output tables are computed only at output points (not for every integration time step), since the pulses QS, QSTAR, and QRNE all depend upon the density ratio computed by the radiation heating calculation, and it is prohibitively expensive to compute the radiation for each integration step. However, the selection of an output point itself depends upon the rate of change of the stagnation point convective heating. For this reason an approximate

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heat pulse is computed and integrated by the program so that output points may be selected. The quantities XKL, QS1, QS2, and SMQS are used for this pulse. Then the initial values for the eight differential equations are defined, along with other parameters used by the predictor-corrector integration routine ADAMS4.

The statements between 220, CALL ADAMS4 and the computed GO $T\phi$ numbered 105 toward the end of the program form a logical loop completed for each time step of the trajectory calculation until the vehicles trajectory has been entirely computed (either until impact or $t = TST \phi P$). Immediately after the enthalpy (ENT ϕT), velocity (VY), and dynamic pressure (DYNPR) are computed, the sentinel NITWIT (preset to 0 after Statement 500) is checked. If NITWIT is > 0, this means that the linearized dynamic calculations were not done because the angle-of-attack envelope at peak dynamic pressure was > ALPCR, and the five dynamics equations are to be integrated until impact unless the dynamic pressure becomes larger than a quantity proportional to CDR ϕ P. When NITWIT >0, this quantity is computed and tested against the dynamic pressure for each time step (Statement 367). If larger than the dynamic pressure, only the first three (particle trajectory) differential equations are integrated; all remaining angle-of-attack envelope values (ALENV) are set equal to the last angle-of-attack envelope computed (DØ615) and no further angles of attack are computed (ILATE= 1, 12BIG = 1).

At Statement 368, the current value of the dynamic pressure is tested against the value computed for the previous time step. If its smaller, the last value of the dynamic pressure in the output tables (QD(I)) is taken as the peak dynamic pressure, and the values of all variables at TIME (I) are used to compute all quantities of interest at peak dynamic pressure, including initial values of the integrals and constants of interest in the linearized dynamic calculations (GM10, PHI10, PHI0GM, PSI10, TMIG1). ILATE, preset to 0, is set equal to 1 to delete any further testing for peak dynamic pressure,

Statements 601 to 605 complete the consideration of data for angle-of-attack calculation dependent upon the integration of the (last) five dynamics differential equations. Since only the value of the angle of attack at time (TIM) is known for each time step, additional calculations are necessary to compute the value of the angle-of-attack envelope at time t. The angle of attack at TIM is ALDG, and the previously computed value is AOLD. If the angle of attack has been increasing (IPK = 2), but the current ALDG < AØLD, then a peak is defined (PKNEW at TALNEW), and with a knowledge of the previously defined peak (PKØLD at TALØLD), an angle-of-attack

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envelope value for some output point such that TALØLD < TIME(JPAL)< TALNEW may be computed by linear interpolation (Statement 805). Here, JPAL is the number of envelope values already computed +1. The statements between 3055 and 807 serve only to compute, as a function of angle of attack and Mach number, the coefficients necessary in the calculation of N/W (ENØW). If ILATE > 1 (first computation for angle of attack after peak dynamic pressure), the statements following 606 are executed to compute quantities for the linearized dynamics which depend on the angle-of-attack envelope at peak dynamic pressure. If this envelope value is less than the input ALPCR, the dynamics differential equations are deleted, the integration reinitialized (Statement 1090), and ISKIP (preset to 0) is set to 1. The ISKIP value deletes all consideration of the angle of attack from the dynamics differential equations by skipping the statements between 700 and 605. If ALPCR is too small (no linearized dynamic option), the eight differential equations are retained, ISKIP is set to 0, ILATE is set to 0, and NITWIT (see discussion of CDR ØP above) is set to 1 (Statement 613). Statement 605 ends the angle-of-attack envelope portion, except for the linearized calculation.

If NPASS = 1, only the initial conditions of the integration have been computed, and the convective heat pulse used only for the determination of an output point is initialized (see the statements following 302). A transfer is made into the portion of the main program which generates the output tables (Statements 222 to 105), thus making the initial conditions the first line of the tabular program output. If NPASS = 2 for each time step, the integrals for the linearized dynamics and the output-determining heat pulse are integrated for each time step by the trapezoidal method (Statements 320 to 338). If I2BIG > 0, the linearized dynamic integrals are not computed since the sentinel indicates that the angle-of-attack envelope computed by the linearized method is unreasonably large. If ISKIP \leq 0, the angle-of-attack envelope is being computed from the 5 dynamics differential equations, and the linearized dynamics integrals are not evaluated. The statements between 7010 and 7011 provide output for each time step (IPRINT > 1).

After 7011 are ten tests used to select the time steps which appear in the output tables. The criteria for an output point are as follows: TIM = TZERØ (initial point), TIM>TSTØP (maximum) value of independent variable TIM), X (3) \leq ZSTØP (impact), Mach number \leq 5 and the difference from the last output line (XMØ) \geq DMK; only if the approximate heat pulse is greater than 1 Btu/ft²-sec, do the following tests determine an output point, velocity difference from last output velocity \geq VTEST, flight path angle (y) difference from last output point \geq GTEST, altitude difference from last output point \geq SITEST, statement 222 begins the calculation of the output tables.

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The statements to 358 compute a Mach number index for use at the end of the program in interpolating data at some input value of Mach number (PRTMAC). QDY (I) is computed, and the statements to 1076 compute the interpolation index if a specified dynamic pressure (QDYPRT) is to be used instead of the Mach number. Next the γ , $Z_{\rho} \rho$, t_{τ} and Mach tables are filled, plus the natural frequency (FRNAT). If the dynamics differential equations have been deleted at peak dynamic pressure (NITWIT = 0, ISKIP = 1), and the linearized integrals are not too large (TGMIG \leq 15, I2BIG \leq 0), the linearized dynamics integrals are evaluated and the angle-of-attack envelope and N/W based on that envelope value are computed by Statement 8005. I2BIG is set = 1 if the angle-of-attack envelope value from the linearized calculation is \geq 90 degrees.

Next the Reynolds number RTX(I) and enthalpy HRT(I) are calculated, along with the nonequilibrium distance (DNE) and distance to peak nonequilibrium intensity (DSP). If the velocity is greater than VSTØPQ(VSD), the dynamic pressure is ≥ 1 , and I = 1 (first output line) transfer is made to Statement 1999, for the equilibrium radiation heating calculation, the computation of the nonequilibrium radiation by subroutine NONEQU, the computation of the stagnation point convective heating (dependent upon the density ratio RØRZ computed with the radiation heating) and the call of CKTRB to see if the local Reynolds number REYS is > REYT. If REYS > REYT, transition has occurred, and the time for transition is stored as TIMTR. A transfer is made out of the radiation heating block to Statement 1997. If the velocity > VST ϕ PQ, dynamic pressure > 1, and I>1, transfer is made to Statement 2002. If IQRGO = 1, TIM ϕ D is calculated and IQRG ϕ = 2. The equilibrium and nonequilibrium radiation is computed by $C\phi\phi_L$ and NONEQU, the stagnation convective heating is calculated, and the same calculation done for REYS to check for transition. On occasion the radiation heating calculation fails to find a solution (N ϕ VALID S ϕ LN. in output). This is recognized by the fact that the equilibrium radiation from $C\phi\phi L$, QRIG, has the value 0. When this happens, the index MINUS is incremented for each such case and as soon as a valid solution is given linear interpolations are done to compute the appropriate values of laminar and turbulent convective heating and equilibrium radiation heating (Statements 2007 to 2009). The nonequilibrium radiation is then based on the interpolated value of the equilibrium radiation when NØNEQU is called (after Statement 3052). These interpolations are thought reasonable because of the fact that experience indicates NØ VALID SØLN. generally occurs away from peak heating and in areas where the radiation heating is quite small. The interpolation requires the continuous updating of TIM ϕ D for the interpolation (Statement 2009). If 149 lines of output have occurred, an attempt is made to eliminate all addition points from the output, except for impact (Statement 8001). This does not invariably work. Statement 105 ends the integration loop (see ADAMS4 description).

Except for the case DELTA-T $T \phi \phi / SMALL$ (Statement 130), the output tables from the entire trajectory are now printed with appropriate headings (Statements 1520 to 1660). First, however, all values of X/W (X ϕ W (I)), and the values of laminar and, if applicable, turbulent heating, which occur after the last time $C\phi\phi$ L was called, are computed in the loop ending 3043. The heating integrals are also computed in this loop by a trapezoidal approximation. The reason for the QSTAR and SQS calculation is that the restrictions V>VST ϕ PQ or dynamic pressure > 1 usually deletes the radiation heating before impact in order to save machine time calculating low radiation. The aerodynamic heating, however, depends upon the density ratio computed in the radiation block and hence the approximation is that this density ratio is constant between the last time radiation heating is computed and the impact time.

The values of the heating integrals are printed after Statement 400, and if interpolations are asked for at a specific Mach number (or dynamic pressure), the interpolations are completed and the answers written out in subroutine INTRP. The transition time is noted between 3060 and 3063, and indication of the deletion of the five dynamics differential equations is provided by Statement 3057 if such deletion occurred.

IF IPHEAT > 1.0 punched cards are provided on Tape 7 which includes tables of TIME, QS, QSTAR, HM/RT ϕ , and QRNE suitable for direct use in the heat shield calculation.

A transfer is then made to Statement 500, to begin the next case.

E. SIGNIFICANT EQUATIONS

- 1. <u>MAIN</u>
 - a. Molecular Weight

 $M = XM = 28 \cdot XN + 32 \cdot X\emptyset + 44 \cdot XC + 40 \cdot XA$ (24)

b. Specific Heat

 $CP/R = CP\emptyset R = 3.5 (XN + X\emptyset) + 4 \cdot XC + 25 \cdot XA)/XM$

c. Velocity Exponent for QS (I)

 $b_{LAM} = BLAM = 3.909 - 0.0299 \cdot XM$

d. Stagnation Enthalpy

$$HM/RT_{o} = ENT\phi T = V^{2}/(64.4.778. \cdot \frac{1.987 \cdot 454 \cdot 273.16}{252 \cdot XM}) + \frac{XM \cdot CP \phi R}{273.16} \cdot TEMP(298)$$

e. Dynamic Pressure

$$q_{\rm d} = \rm DYNPR = \frac{1}{2} \rho V^2 \tag{700}$$

f. Ballistic Coefficient

 $M/C_DA = EMØCDA = SMM/(C_{DD} \cdot A)$, $C_{DD} = drag coefficient at peak q_d$

- g. Normal Force, when Coefficients = F (α , M) N/W = ENØW (I) = C_N · Q_{DY} (I) · A/(32.16 · SMM), C_N from CNFA (3039) Q_{DY} (I) = i^{th} dynamic pressure in output table
- h. Normal Force when Coefficients = F (M)

 $N/W = ENØW(I) = (C_{LAD} + C_{DD}) \cdot ALENV(I) \cdot QDY(I) \cdot A/(57.3 \cdot 32.16 \cdot SMM)$ (8007)

 C_{LAD} and $C_{DD} = C_{L_{\alpha}}$ and C_{D} at same MACH number, (ALENV (I) = ith angle-of-attack

- envelope in output table).
- i. Natural Frequency

$$FREQ = FRNAT (I) = \frac{1}{2\pi} (-CMAD \cdot Q_{DY}(I) \cdot A \cdot D/ZIY)^{1/2}$$
(1076)

 $CMAD = C_{m_{\alpha}}$ at same Mach number, ZIY = moment of inertia.

j. Ambient Reynolds Number

'REY = RTX (I). RHØ · V (I) · D/VIS, VIS = viscosity at temperature TEMP (8005)

- k. Axial Force $X/W = X Ø W (I) = C_{DD} \cdot Q_{DY} (I) \cdot A/(32.16 SMM)$ where $C_{DD} = C_D$ at same Mach number
 - 1. Stagnation Point Convective Heating

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$$Q_{S} = Q_{S}(I) = \begin{cases} VLG \\ -\frac{1}{2}D \\ -\frac{1}{2}D \end{cases} \cdot (1.1 + 0.075 \text{ XM}) \quad 10^{4} \cdot \left(\frac{V}{10^{4}}\right) \stackrel{\text{BLAM}}{\cdot} (\text{RH}\emptyset) \stackrel{\text{ALAM}}{(3041)}$$

VLG = velocity gradient evaluated at same density ratio

m. Convective Sonic Point Heating

 $Q_{STAR} = Q_T (I) = Q_S (I)$ if laminar

$$Q_{\text{STAR}} = \frac{5.4 \times 10^5 \text{ THF}}{\left((\text{SSTAR/D}) \cdot \text{D}\right)^{0.2}} \cdot (\text{RHO}) \frac{\text{ATRB}}{\left(\frac{\text{V}}{10^4}\right)} \text{ if turbulent} \quad (3054)$$

Linearized dynamics - no spin

n. Angle-of-Attack Envelope - no spin

$$ALENV (I) = \frac{ENVPQ (-CMAPK \cdot PKDYN)^{1/4}}{((-CMAD \cdot Q_{DY} (I))^{1/4}} \cdot EXPF \frac{1}{2} \int_{t_0}^{t_1} \frac{\rho A}{2SMM} \left(- CLA + \frac{1}{2} \frac{CMQ}{SIGMA} \right) V \cdot dt$$

where ENVPQ, - CMAPK, and PKDYN are the angle-of-attack envelope, C_m , and $1/2 \rho v^2$ at peak dynamic pressure, CMAD and QDY (I) are the $C_m = f(M)$ and $1/2 \rho v^2$ at the ith time in the output table, and the exponential argument is integrated trapezodially with CMQ = $C_m = f(M)$

and SIGMA = ZIY/SMMD² t_0 is the trajectory time at the beginning of the linearized calculation, t_1 is the ith time in the output table, where $t_1 > t_0$.

o. Linearized Dynamics, Spin Correction

Angle-of-attack envelope, spin:

p. Angle of Attack, Spin

$$\overline{a}$$
 = ALENV (I) = $\frac{1}{2}$ (\overline{a})_{NO SPIN} [DUM · EXPF $-\frac{1}{2}$ TGMIG + DUM EXPF $\frac{1}{2}$ TGMI (8007)

$$TGMIG = \int_{t_0}^{t_1} -\pi \frac{RH \vec{\sigma} \cdot A \cdot V}{4SMM} \cdot \frac{ZIX}{ZIY} \cdot \left(CLA + \frac{CMQ}{2 \cdot SIGMA}\right) \frac{1}{\left\{\frac{RH \vec{\sigma} \cdot A \cdot V^2}{2 \cdot SMM \cdot D} \cdot \left(\frac{-CMA}{SIGMA}\right) + \frac{\pi^2}{4} \left(\frac{ZIX}{ZIY}\right)^2\right\}^{1/2}} dt$$

$$DUM = \left\{ \underbrace{\left[\frac{\text{RH} \& PK \cdot A \cdot \text{VYPK}^2}{2 \cdot \text{SMM} \ \text{D}} \cdot \left(\frac{-\text{CMA}}{\text{SIGMA}} \right) + \frac{\pi^2}{4} \left(\frac{\text{ZIX}}{\text{ZIY}} \right)^2}{\frac{1}{2 \cdot \text{SMM} \cdot \text{D}}} \right] \underbrace{\left[\frac{\text{RH} \& A \cdot \text{V}^2}{2 \cdot \text{SMM} \cdot \text{D}} \cdot \left(\frac{-\text{CMAD}}{\text{SIGMA}} \right) + \frac{\pi^2}{4} \left(\frac{\text{ZIX}}{\text{ZIY}} \right)^2}{\frac{1}{2 \cdot \text{SMM} \cdot \text{D}}} \right]}_{\text{H} \& \& A \cdot \text{V}^2}$$

For the integral TGMIG, RHØ, V, CLA, CMQ, CMA, are the density, velocity, $C_{L_{\alpha}}$, $C_{m_{q}}$, $C_{m_{\alpha}}$ (evaluated as f(M)) for each time SIGMA = $\frac{ZIY}{SMM \cdot D^2}$. For DUM, RHOPK, VYPK, CMA are the density

velocity, and $C_{m_{c}}$ evaluated at peak dynamic pressure. RHO, V, CMAD are these quantities evaluated at the ith time in the output table, $t_{i} > t_{o}$ where t_{o} is the trajectory time at the start of the linearized calculation.

q. Atmosphere Constants

 $L_{O} = XLO = -XLI \cdot GSL/CP$ $Z_{ST} = Z_{ST} = (TST - TSL) / XLO$ $\rho_{th} = RHØTH = PTH \cdot XM/(AR \cdot TST)$ (RHØL TSL)

$$\rho ST = RHØST = \frac{\left(\frac{11000}{TST}\right)}{e \left\{\frac{XM}{AR} \left(TSL - XLO RSL\right) \left(\frac{ZST}{RSL + ZST}\right) + XLO - RSL^{2} \ln\left(\left[\frac{RSL}{TSL} \left(TSL + XLO ZST\right)\right] - \frac{1}{TSL - XLO RSL}\right)\right\}} (24)$$

$$\overline{\rho} = ROBAR = RHØST \cdot e \left[\frac{XM \cdot GSL \cdot RSL \cdot ZST}{AR \cdot TST \cdot (RSL + ZST)}\right]$$

$$Z_{\text{TH}} = Z\text{TH} = \ln \frac{R\emptyset BAR}{RH\emptyset TH} \cdot \frac{AR \cdot T\text{ST} \cdot R\text{SL}}{\left[XM \cdot G\text{SL} \cdot R\text{SL} - \ln \left(\frac{R\emptyset BAR}{RH\emptyset TH} \right) \cdot AR \quad T\text{ST} \right]}$$

2. DERQO

Atmosphere

 $Z \leq ZST$

$$T = TEMP = TSL + XLO \cdot Z$$

$$\kappa \approx RH\emptyset = \frac{\frac{RH\emptyset SL TSL}{TEMP}}{\left\{ \frac{1}{e} \right\}^{AR} (TSL - XLO RSL)} \left(\frac{Z RSL}{RSL + Z} + XLO RSL^{2} \ln \left[\frac{RSL (TSL + XLO Z)}{TSL (RSL + Z)} \right] \frac{1}{TSL - XLO RSL} \right)$$
(32)

$$ZST < Z \leq ZTH$$

T = TEMP = TST

$$\rho = RH\emptyset = R\emptyset BAR / e^{-\frac{XM \cdot GSL \cdot RSL \cdot Z}{AR \cdot TST \cdot (RSL + Z)}}$$

Z>ZTH

T = TEMP = TSL + XL2 (Z-ZTH)



$$a = SMA = \left[\frac{AR}{R} \frac{\text{TEMP} \cdot CP \phi R}{R} - 1.\right]^{1/2}$$

$$M = XMAC V/SMA$$

$$V, \gamma, Z, Q, R, \psi, \theta, \phi = X (1 - 8) \text{ respectively}$$

$$\frac{dZ}{dt} = \text{DERX(3)} = V \cdot \text{sn}(\gamma)$$

$$\frac{dV}{dt} = \text{DERX(1)} = \frac{1}{SMM} \left[-CSUBD \frac{1}{2} RH \phi V^2 A - SMM \cdot GSL \left(\frac{RSL}{RSL + Z}\right)^2 \cdot sn(\gamma) \right] \phi$$

$$\frac{dV}{dt} = \text{DERX(2)} = \frac{1}{SMM} \left[\frac{SMM \cdot \cos(\gamma) V^2}{RSL + Z} - SMM GSL \left(\frac{RSL}{RSL + Z}\right)^2 \cdot \cos(\gamma) \right] \phi$$

$$particle trajectory, C_D = f(M) \text{ only}$$

$$sn (a) = SAL = sn (b) \cos(\phi) \cdot \cos(\phi) + sn (\phi) \cdot sn(\phi)$$

$$sn (a') = SALPHA = [sm^2(\psi) + (\cos(\psi) \sin(\theta))^2]^{1/2}$$

$$\cos(a') = CALPHA = cos(\theta) \cos(\psi)$$

$$a' = ALPHA = tan^{-1} \left(\frac{SALPHA}{CALPHA}\right)$$

$$\frac{dV}{dt} = DERX(1) = \frac{dV}{dt} \text{ above, but CSUBD = CX CALPHA + CN SALPHA,}$$

$$CX and CN = f(a', M)$$

$$\frac{dY}{dt} = DERX(3) = \frac{1}{SMM \cdot V} \left[\frac{SMM \cdot \cos(\gamma) V^2}{RSL + Z} + CL \frac{sn(\theta)}{sn(a')} \frac{A \cdot RH\phi V^2}{2} - SMM GSL \left(\frac{RSL}{RSL + Z}\right)^2 \cos(\gamma) \right]$$

$$respectively, C_D = t(a', M)$$

$$\frac{dV}{dt} = DERX(3) = \frac{1}{SMM \cdot V} \left[\frac{SMM \cdot \cos(\gamma) V^2}{RSL + Z} + CL \frac{sn(\theta)}{sn(a')} \frac{A \cdot RH\phi V^2}{2} - SMM GSL \left(\frac{RSL}{RSL + Z}\right)^2 \cos(\gamma) \right]$$

.

$$\begin{aligned} \frac{dQ}{dt} &= DERX(4) = \left\{ \frac{1}{2} \quad RH\phi \cdot V^2 \quad A \cdot D \quad \left[\frac{CM \cdot SAL}{SALPHA} + \frac{D \cdot CMQ \cdot Q}{2 \cdot V} - \frac{Q \quad ZIY \cdot CLA}{SMM \cdot V \cdot D} - CX \quad ZCG\phiD \right] \\ &+ (ZIY - ZIX) \quad P \cdot R + SPINER \quad SBE - P \cdot ZIX \quad GD\phiTT \ . \\ \left[\sin(\psi) \sin(\theta) \cos(\phi) - \cos(\psi) \cdot \sin(\phi) \right] \right\} \quad \cdot \left(\frac{1}{ZIY} \right) \\ \frac{dR}{dt} &= DERX(5) = \left\{ \frac{1}{2} \quad RH\phi \cdot V^2 \cdot A \cdot D \left[\frac{CM \cdot SBE}{SALPHA} + \frac{D \quad CMQ \quad R}{2 \cdot V} - \frac{R \cdot ZIY \cdot CLA}{SMM \cdot V \quad D} \right] \\ &+ (ZIX - ZIY) \cdot P \quad Q - SPINER \cdot SAL + P \cdot ZIX \cdot GD\phiTT \ . \\ \left[\cos(\psi) \quad \cos(\phi) + \sin(\psi) \sin(\theta) \sin(\phi) \right] \right\} \quad \frac{1}{ZIY} \end{aligned}$$

.

.

where,

SPINER = -P·ZIX RHØ V A·[CN·CALPHA-CX·SALPHA] (8001) 2 · SMM · SALPHA

and,

$$GD \phi TT = -\frac{GSL}{V} \cdot \left(\frac{RSL}{RSL + Z}\right)^2 \cdot \cos(y)$$
$$-\frac{d\psi}{dt} = DERX(6) = \frac{R \cdot \cos(\phi) + Q \cdot \sin(\phi)}{\cos(\theta)}$$
$$\frac{d\theta}{dt} = DERX(7) \approx Q \cos(\phi) - R \cdot \sin(\phi)$$
$$\frac{d\phi}{dt} = DERX(8) \approx P + DERX(6) \cdot \sin(\theta)$$

3. <u>C $\phi\phi$ L</u> - (No Significant Equations)

4. NØNEQU

DELDG < DSP

$$QRNE = \frac{1}{2} \cdot QR \cdot XIRN \quad \left(\frac{DELDG}{DSP}\right) \cdot$$

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DSP < DELDG < DNE

$$QRNE = QR \left(1 - \frac{1}{2} \frac{DSP}{DELDG} - \frac{1}{2} \frac{DNE}{DELDG} + XIRN \frac{DNE}{2 DELDG} - \frac{1}{2} \frac{1}{DELDG} \left(\frac{(DNE - DELDG)^2}{(DNE - DSP)}\right)^2 (XIRN - 1.) (3)$$

DNE < DELDG

$$QRNE = QR \left(1 - \frac{1}{2} \frac{DSP}{DELDG} - \frac{1}{2} \frac{DNE}{DELDG} + XIRN \frac{DNE}{2 DELDG}\right)$$
(4)

5. CKTRB

$$\operatorname{REYS} = \frac{\operatorname{R}\emptyset}{\operatorname{Vis}} \cdot \operatorname{R}\emptyset\operatorname{R}\mathbb{Z} \cdot \operatorname{R}\emptyset\operatorname{S}\emptyset\operatorname{R}\emptyset \operatorname{SST} \cdot \left(\frac{2 \operatorname{ENT}\emptyset\operatorname{T} 24 \operatorname{4522} 10^6}{\operatorname{R}\operatorname{0}\operatorname{R}\mathbb{Z} \operatorname{XM}}\right)^{1/2}$$

 $R\phi$ = ambient density, $R\phi RZ$ from radiation calculation, SSTOS^{*} from input, ENT ϕT = stagnation enthalpy, XM = molecular weight.

$$y = GAMMA = (RORZ + 1)/(RORZ - 1)$$

$$\rho_{\rm S}/\rho = {\rm R} \dot{\sigma} {\rm S} \dot{\sigma} {\rm R} \dot{\sigma} = \left(\frac{2}{{\rm GAMMA} + 1}\right)^{1/{\rm GAMMA} - 1}$$

VIS = viscosity at temperature T^{*} = TSTR = $\left(\frac{2}{{\rm GAMMA} + 1}\right)$. TSSZ, TSSZ = stagnation temperature

GETCLA

$$C_{L_{\alpha}}(\alpha, M) = 573 \{2 \quad C_{L}(\alpha + 10, M) - \frac{3}{2} C_{L}(\alpha, M) - \frac{1}{2} C_{L}(\alpha + 20, M) \}$$
(1007)

$$C_{L} = CN \cdot \cos(a) - CX \sin(a)$$

6. HEAT

Same as 1883, but inverse density ratio, b/a correlation for detachment distance replaced by (input) detachment distancedensity ratio correlation in table look-up after Statement 502. GETH, HVST, GETK, GETQ, FINDH, FINDT, ZØNES - Same as 1883

V. REFERENCES

- RAD, Mars Venus Capsule Parameter Study, Vol. I, Avco/RAD TR-64-1 JPL Contract 950626 (21 March 1964).
- 2. Detra, R. W., and H. Hidalgo, Generalized Heat Transfer Formulae and Graphs, Avco Everett RR72 (March 1960).
- Collins, D. J., Convective Heat Transfer in Planetary Atmospheres, JPL TR No. 32-629 (1 July 1964).
- Sones, P., Laminar and Turbulent Convective Heating on Conical bodies in Planetary Atmospheres, Avco/RAD TM-64-68 (January 1965).
- Thomas, G., and G. W. Menard, Experimental Measurements of Nonequilibrium and Equilibrium Radiation from Planetary Atmospheres, AIAA Entry Technology Conference, American Institute of Aeronautics and Astronautics, pp. 170-185, New York (1964).
- Arnold, J. O., V. H. Reis, and H. T. Woodward, Theoretical and Experimental Studies of Equilibrium, and Nonequilibrium Radiation of Bodies Entering Postulated Martian and Venusian Atmospheres at High Speeds, AIAA paper No. 65-116, AIAA 2nd Aerospace Science Meeting, N. Y. (25 to 27 January 1965).
- Haurlan, P. N., private communication, Jet Propulsion Lab, JPL Contract 95086 (8 May 1964).
- Levin, G. M., E. D. Evans, and V. Stevens, NASA Engineering Models of the Mars atmosphere for Entry Vehicle Design, NASA TN D-2525 (November 1964).
- Vinokur, M., Hypersonic Flow around Bodies of Revolution whose Shock Waves are Generated by Comc Sections, IMSD, TR IMSD - 288139, General Research in Flight Sciences Vol. I, Part I, Fluid Mechanics, January 1959 to 1960).
- Kaattari, G. E., Shock Envelopes of Blunt Bodies at Large Angles of Attack NASA TND-1980 (December 1963).
- Hayes, W. D., and R. F. Probstein, <u>Hypersonic Flow Theory</u>, Academic Press, N. Y. (1959).
- Traugott, S. C., An Approximate Solution of the Direct Supersonic Blunt Body Problem for Arbitrary Axisymmetric Shapes, JAS, <u>27</u>, No. 5 pp. 361-370 (May 1960).

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- Jos, J. M., Transport Properties of Nitrogen, Hydrogen, Oxygen and Air to 30,000°K, Avco/RAD-TM-63-7 (March 1963).
- 14. Teare, J. D., S. Georgiev, and R. A. Allen, Radiation from Nonequilibrium Shock Fronts, Avco Everett RR112 (October 1961).

PROGRAM 1881



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AÉRODYNAMIC COEFFICIENTS PROGRAM (1881)

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I. INTRODUCTION

A. GENERAL DESCRIPTION

This program computes the aerodynamic coefficients of axisymmetric shapes as a function of angle of attack utilizing impact (Newtonian) theory. In addition, radii of gyration are computed based on uniform densities forward and rearward of the specified center-of-gravity location. The general inputs required include

- 1. Shape geometry,
- 2. Mass and center-of-gravity location, and
- 3. Desired angle of attack range.

Option is provided for determining the center-of-gravity location based on specified minimum values of the static margin and static moment coefficient derivative.

Configurations possible are bodies of revolution containing up to 10 sections of various geometries, including spherical segments, cones, tori, cylinders, and an optional section which may be a tension shape or a general shape input by coordinates. A typical shape containing 10 basic sections is illustrated in Figure 1. Figure 2 shows the alternate geometry for the tension shell and the general shape.

The program output includes the axial, drag, lift, and normal force coefficients, the static and pitch damping moment coefficients, the lift curve slope, and the center of pressure. The aerodynamic coefficient data generated are sufficient to facilitate the inputs to Program 1880. The lift curve slope is utilized in Program 1880, but it is not necessary as an input to that program as it is computed from the axial and normal force coefficients.

- B. CALCULATION MODEL
 - 1. Newtonian Coefficients

Using the coordinate system shown in Figure 3, consider an arbitrary surface in three dimensional space (g = g(x, y, z) = 0) which is continuous in the first derivative in the region of interest. The unit vector which is normal to the surface at any point, P, and which is positive into the surface is given by

$$\overline{\mathbf{n}} = - \overline{\nabla} g / |\overline{\nabla}g| \cdot$$





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Figure 1 VEHICLE SHAPE PARAMETERS



 β - TENSION SHELL INPUT PARAMETER R₃ - BASE RADIUS OF TENSION SHELL (NOT INPUT)



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Figure 2 TENSION SHELL AND GENERAL SHAPE GEOMETRIES

Denote the component of the relative wind vector, \overline{V} that lies along \tilde{n} as \overline{V}_n , the normal velocity vector. Hence,

 $\overline{V}_n = (\overline{V} \cdot \overline{n}) \overline{n}.$



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Figure 3 COORDINATE SYSTEM FOR CALCULATION MODEL

The Newtonian pressure approximation, used herein 1s then given by,

$$C_{p} = 2 \left(\frac{|\vec{v}_{n}|}{|\vec{v}_{o}|} \right)^{2} = 2 \left(\frac{\vec{v}}{\vec{v}} \cdot \vec{n} \right)^{2};$$

•

where,

$$V = |\overline{V}_{\infty}|$$
.

Defining $d\overline{C}_F$ as the element of the vector force coefficient acting normal to the surface at point P and \overline{C}_F as the sum of all such elements.

$$d \overline{C}_F = \frac{C_p d\overline{S}}{A}$$
, (A is the reference area.)

$$\overline{C}_{\mathbf{F}} = \frac{1}{A} \iint_{\mathbf{S}} C_{\mathbf{p}} \, d\overline{\mathbf{S}} = -\frac{2}{A} - \iint_{\mathbf{S}} \left(\frac{\overline{\mathbf{v}}}{\mathbf{v}} \cdot \overline{\mathbf{n}} \right)^2 \, d\overline{\mathbf{s}},$$

-4-122< and, inasmuch as

$$d\overline{S} = \overline{n}dS,$$

$$\overline{C}_{F} = \frac{2}{\overline{A}} \iint_{S} \left(\frac{\overline{V}}{V} - \overline{n}\right)^{2} \overline{n}dS.$$

It follows that the aerodynamic normal and axial force coefficients are found from:

$$C_X = \overline{i} \cdot \overline{C}_F$$
, and
 $C_N = \overline{k} \cdot \overline{C}_F$, respectively.

We define a position vector \overline{r} as the vector extending from the origin to the point P. The moment vector arm, \overline{l} is defined as that vector extending from the center of gravity of the vehicle to the point P. Thus,

$$\overline{l} = \overline{r} - \overline{d},$$

where \overline{d} is the vector position of the center of gravity.

The differential moment about the center of gravity is found from:

$$d\bar{C}_{M} = \frac{\bar{l} \times d\bar{C}_{F}}{D} = \frac{\bar{l} \times C_{p} d\bar{S}}{AD} = \frac{C_{p}}{AD} \bar{l} \times d\bar{S}.$$

Integrating,

$$\overline{C}_{M} = -\frac{2}{AD} \oint_{S} \left(\frac{\overline{V}}{V} - \overline{n} \right)^{2} \overline{l} \times d\overline{S},$$

.

which may be evaluated as

$$\vec{C}_{M} = -\frac{2}{\Delta D} \oint_{S} \left(\frac{\vec{v}}{\vec{v}} \cdot \vec{n} \right)^{2} (\vec{l} \times \vec{n}) dS.$$

The aerodynamic pitching moment coefficient is found from:

$$C_m = \overline{j} \cdot \overline{C}_M$$

The velocity at point P consists of two parts, one part from the velocity of the vehicle and one part from the rotation of the vehicle about its center of gravity. Hence,

 $\overline{\mathbf{V}} = \overline{\mathbf{V}}_{\infty} - \overline{\boldsymbol{\omega}} \times \overline{l}$.

where $\overline{\omega}$ is the total vector angular rate of the body about its center of gravity.

Developed expressions for the forces and moments on conic section are readily available, e.g., see References 1 through 3.

The computer program treats all sections, except the spherical nosecap section, as consisting of a series of conical frustra. The effects of shadowing of the incident flow are included to ensure that the local pressure coefficient is never less than zero (negative).

2. Radii of Gyration

A simplified method for estimating the radii of gyration is included in the program by considering the vehicle to be of uniform density fore and aft of the center of gravity as depicted in Figure 4. Specifying the desired center-of-gravity location and the total vehicle mass, then by elementary volume considerations, the relative densities fore and aft of the center of gravity can be determined and then the pitch and roll radii of gyration can be computed.







3. Center of Pressure

The integration of the pressure forces over the complete surface of the vehicle yields the component forces on the vehicle and the line of action of the resultant force. Location of the center of gravity on the line of action eliminates any moments on the body arising due to aerodynamic forces, in which case the body is neutrally stable. The intercept of the line of action and the body longitudinal axis is designated as the center of pressure. Restricting the forces and moments to the static values, i.e., $\overline{\omega} = 0$, and with the center of gravity on the axis, the center of pressure as given in the output (XCP) is then defined as

$$\frac{X_{CP}}{D} = \frac{-(C_m)_o}{C_N}$$

where $(C_m)_o$ is the pitching moment evaluated about the nose of the vehicle At zero angle of attack,

$$\frac{X_{CP}}{D} = \lim_{\alpha \to 0} \frac{(-C_m)_o}{C_N} = \frac{-C_m_\alpha}{C_{N_\alpha}}$$

The reference length (D) is taken as equal to (2 $R_{\rm C})$ throughout all the programs.

4 Moment Transfer

The center of pressure is independent of the center-of-gravity location but the moment coefficients must be modified if the center-of-gravity location is changed. Program 1880 provides for automatic static moment transfer, however, to transfer the damping moment coefficient, Program 1881 must be rerun for the new center-of-gravity position.

5. Pitch Damping Moment Coefficient

The pitch damping moment coefficient C_{m_q} is based on the normalized pitch rate qD/2V and is evaluated as $\left(\frac{qD}{2V}\right) \rightarrow 0$, i.e.,

$$\begin{array}{ccc} C_{m_{q}} & \cong & \lim & & \frac{1}{\sqrt{qD}} \\ & & \left(\frac{qD}{2V}\right) \rightarrow & 0 & \frac{1}{\sqrt{qD}} \end{array} ,$$

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C. PROGRAM LIMITATIONS

Program limitations are listed below:

1. Coefficients are based on the Newtonian pressure distribution, with the assumption that each section of the body has self-shadowing, but does not cast shadows on other sections.

2. Radii of gyration are based on uniform densities fore and aft of the center of gravity, the ratio of these densities being determined by the specified center-of-gravity location.

3. The effect of an off-axis center-of-gravity location can be accounted for in the coefficient calculation, but is not reflected in the radii of gyration.

4. Configurations are limited to axisymmetric shapes composed of spherical segments, cones, cylinders, tori, and an optional section which may be a tension shell or a general shape specified by up to 25 consecutive points in rectangular coordinates.

5. The Newtonian flow approximation assumes that the normal component of momentum is lost, while the tangential component is unchanged. All viscous forces and base pressures are neglected.

Comparisons have been made¹ between Newtonian predictions and hypersonic experimental aerodynamic characteristics for various sharp and blunt bodies of revolution.

In general, the theory was found to agree quite well with experimental results for sharp nose cones and for configurations having large blunted noses and steep surface slopes. However, agreement between theory and experiment generally is poor for the more slender ($\theta < 20$ degrees) slightly blunted conic bodies. Real flow phenomena, such as viscous effects, sharp corner effects, gas composition, gas kinetics, and heat transfer are all neglected by Newtonian theory and may, in some cases, have a sizable effect on the aerodynamic characteristics of the configuration and the adequacy of the theoretical predictions.

The agreement between theory and experiment can be improved by using the actual stagnation pressure coefficient behind the normal shock rather than the Newtonian value of two (2). The stagnation pressure coefficient can be

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estimated by the following relation:

$$C_{\mathbf{p}} = \frac{\gamma + 3}{\gamma + 1} \begin{bmatrix} 1 - \frac{2}{\gamma + 3} & \frac{1}{M_{a}^{2}} \end{bmatrix}$$

where γ is the ratio of specific heats (C $_{\rm p}/{\rm C}_{\rm V}).$

6. The tension shell equations contained in Program 1881 are derived in Reference 4, and correspond to the case of zero hoop stress and a Newtonian pressure distribution. A comparison of the numerical integration results for the shape coordinates with the results of Reference 4 are given in Table I below.

TABLE I

Sha	ıpe	Length/Base Radius						
A ²	β	Ref. 4	1881*					
0.5	62.50	0.343	0.343					
1.2	33.50	0,939	0,943					
1.6	22.835	1.413	1,417					

TENSION SHELL CHECK

*NDIV = 20.0

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II. USAGE

A. INPUT DEFINITIONS

	Preset		D	TT 4-
Name	Value	Symbol	Parameter	Units
A1, A1L A2, A2L A3, A3L	0.,		First and last values of angle of attack for each range of printout, these are all used only when the printout require- ments differ for each range of angle of attack.	degrees
BETA	0.	β	Initial angle for third section in case of tension shell.	degrees
CASE			Identification number for case.	
CMAG(1)	o.	C_mα0	Minimum pitching moment derivative at α = 0 degrees.	per radian
CMAG(2)	0.	C	Minimum pitching moment derivative at $\alpha = 180$ degrees.	per radias
DA 1 DA 2 DA 3	0. 0. 0.		Intervals of angle of attack for which printout is desired; three ranges can be requested if data are needed more finely over a specific angle of attack range. Hence, the interval of printout is specified jointly with the range of angle of attack for which the printout frequency is desired.	degrees
DATE	1	Ì	Date identification number.	
DERDEL	. 005		Interval of independent variable used to evaluate derivatives.	
G SØ	0.		This symbol is input 1.0 when the third section is a general shape; otherwise, need not be input.	
	1			

	ī			
LC	o.	L _C	Length of cylinder	feet
MASS	0.	m	Mass of vehicle	slugs
M2 M4 M7 M8 M10	10 10 10 10 10		Number of straight-line seg- ments into which the second, fourth, seventh, eighth, and tenth sections (curved sections) are to be divided for compu- tational purposes.	
MEMØ			Identification number for computer run.	
NDIV	20		Increments of radius for which points are determined on tension shell.	
NPGSØ	0.		Number of input points when third section is a general shape (includes last point but omits first point; max 25 points).	
RA	0.	R _A	Aft body radius.	feet
RB	0.	R B	Flare radius.	feet
RC	0.	Rc	Cylinder radıus.	feet
RINP		r	Ordinates of input points in case of general shape (third section).	
RN	0.	RN	Nose radius.	feet
RSB	0.	^R SB	Toroidal raduus (adjacent to flare cone).	feet
RSC	0.	R _{SC}	Toroidal radius (adjacent to cone).	feet

RSN	0.	R _{SN}	Toroidal radius (adjacent to nose).	feet
RT	0.	^R т	Aft cone base radius.	fect
SM	0.	SM	Minimum static margin at zero angle of attack.	feet
TH2G	0.		Initial angle when third section is a general shape.	degrees
TH 3G	0.		Final angle when third section is a general shape.	degrees
THA	0.	θ _A	Aft cone angle.	degrees
тнв	0.	θ _B	Flare section angle.	degrees
тнс	0.	θ _C	Cone angle.	degrees
THN	0.	θ_{N}	Complement of nose angle.	degrees
X CG	0.	x _{cg}	Center of gravity position measured from nose.	fset
XINP	0.	x	Abcissas of input points 1 case of general shape (third section).	
zcg	0.	z _{cg}	Center of gravity position for cases where center of gravity is not on the axis	feet

B. INPUT PROCEDURES

Input procedures are listed below

1. $R_{\rm C}$ must always be specified. Aerodynamic coefficients are based on the reference length, D = $2R_{\rm C}$

2. Contour angles (θ) are measured relative to free stream, progressing aft of the nose. Positive values indicate increasing body radius, negative values, decreasing radius (e.g., θ_A is negative).

3 Sections may be omitted provided the starting point of each section is compatible with the final point of the previous section. The first and last points on the body must be on the axis.

4. If several cases are run on a single memo, only changed inputs need be specified (inputs which are not repeated must be set = 0)

5. The tension shell option is specified by inputing RN, BETA, RC, and RSC the defining parameters of the tension shell as shown in Figure 2.

6. In the general shape option $(GS\emptyset = 1.0)$, up to 25 points may be specified along the desired contour. In addition, the initial slope, TH2G (which defines the final point on the preceding arc) and the final slope, TH3G, must be specified.

7. The center of mass may optionally be determined by specifying restraints on the stability at 0- and 180-degree angles of attack. The program checks the computed XCG to ensure a single, stable trim point from 0- to 180-degree angles of attack. This option is activated by specifying XCG = 0, and inputting the restraints on SM, CMAG (1), and CMAG (2)

8. The length and mass units of inputs called for in the definitions are feet and slugs. However, any consistent system of units may be employed with corresponding changes in the units of the outputs.

9. For shapes with flat bases, a value of R_{T} must be specified if θ_{Λ} = -90.

10. An input form is provided on page 17 for the user. All the information shown is keypunched, provided the variable is specified. All numerical values have decimal points.

11. A brief bibliography of experimental measurements of aerodynamic coefficients is provided at the end of the text. These data can be used to improve the theoretical values obtained from Program 1881 where applicable.

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C. OUTPUT DEFINITIONS

External Name	Internal Name	Symbol	Parameter	Units
ALPHA	ALPHA		Angle of attack.	degrees
CD	CD(1)	с _р	Drag coefficient as a function of angle of attack.	
CL	CL(1)	с _г	Lift coefficients as a function of angle of attack.	
CL/CD	CL(1)/CI	D(1) CL/CD	Lift/Drag ratio as a function of angle of attack.	
CLA	CLA	с _г	Derivative of lift coefficient	per radıan
СМ	CM I	с _т	Pitching moment coefficient as a function of angle of attack.	
CMQ	CMQ	C _m q	Damping coefficient.	per radian
CN	CN 1	с _N	Coefficient of normal force as a function of angle of attack	
сх	CX 1	с _х	Coefficient of axial force as a function of angle of atlack.	
R	R	r	Ordinates of all points computed along the body surface.	feet
RGX/D	RGXDD		Radius of gyration about roll axis as a fraction of diameter	2
RGY/D	RGYDD		Radius of gyration about pitch axis as a fraction of diameter.	
RHØA	RНØА	ρ _A	Density of vehicle aft of center- of-gravity position.	slug/ft ³

RHØN	RHØN	ρ _N	Density of vehicle forward of center-of-gravity position.	slug/ft ³
x	х	x	Abcissas of all points computed along the body surface.	feet
ХСG	GX		Center-of-gravity position measured from nose.	fe et
XCG/D	XCGDD	^X cg ^{/D}	Center-of-gravity distance as a fraction of capsule diameter.	
XCP/D	XCPDD	x _{CP} /D	Center-of-pressure distance as a fraction of capsule diameter.	

D. SAMPLE PROBLEM

1. Statement of Problem

Determine the Newtonian coefficients and estimated radii of gyration for a blunt cone configuration. The vehicle parameters, range of angle of attack, and XCG location are to be prescribed as input. The final plot of the configuration, as performed automatically, is shown in Figure 5.

2. Computer Input Form

The computer input form containing all the necessary input data to be keypunched is shown on page 18. All the input on this form is written with decimals.

3. Output

The output is given on page 19. The data keypunched is shown in the output and should be verified with the input form. An array of vehicle coordinates (X, R) are given which are useful for drawing the configuration; the first coordinates given correspond to the last point on the nose cap, which is spherical.

The coefficient data has two rows for each angle of attack; the first row corresponds to the XCG at the nose and the second row provides the moment data for the XCG specified. Following the coefficient data, are the densities fore and aft of the XCG necessary to yield the desired XCG location, and also the desired radii of gyration are given. A plot of the vehicle coordinates can be obtained, as shown on page 16 ; a Stromberg Carlson 4020 plotter was used for this purpose.



Figure 5 PLOT OF VEHICLE COORDINATES

RAD 2-0963 5 63	DIGITAL	COMPUTER	INPUT	PROBLEN	4 NO	18	881		PRO	GRAMME	* A. P	icado	_	
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	GSØ	=			RSB		=			THC	=			,
	LC	=		_,	RSC		=		,	THN	=			.
	MASS	=			RSN		=		,	ХCG	=			,
	NDIV	=		_,	RT		=		'	ZOG	=			,
	NPGSØ	=		_,	SM		=							
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42. XHODQ	35602	XHODV	35602	YHODV	35602		,				
43. SHXYV	35616	SHXYY	(35616)	MSXXV	35023						
45. GRIDIV	36417	GRIDIV	1364171						^		
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48. NONLNV	40400	NONENV	(40400)								
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20	0.09	0.1648	1.3442	-0.1229 -0.0817	-0.6043 -0.3047	-0.6729	-0.3048	1.3195	-0.2310	0.7458
10	0.00 3.00	0.2229	1,1801	-0.1658 -0.1101	-0.5577 -0.2810	-0.3663	-0.3970	1.1334	-0.3503	0.7441
40	0.00 3.00	0.2550	0.9785	-0.1890 -0.1253	-0.4947 -0.2489	-0.0494	-0.4337	0.9135	-0.4748	0.7413
50	0.00	0.2575	0.7637	-0.1897 -0.1254	-0.4172	0.2033	-0.4195	0.6882	-0.6095	0.7367
60	0.00 3.00	0.2306	0.5612	-0.1680 -0.1104	-0.3277 -0.1645	0.3373	-0.3707	0.4803	-0.7718	0.7286
70	0 00 3.00	0.1824	0.3863	-0.1301 -0.0845	-0.2689 -0.1352	0.4692	-0.3006	0.3035	-0.9904	0.7133
80	0.09 3.00	0.1295	0.2378	-0.0885 -0.0562	-0.2199 -0.1114	0.5334	-0.2117	0.1689	-1.2538	0.6836
90	0.00 3.00	0.0837	0.1105	-0.0479 -0.0270	-0.1908 -0.1160	0.6431	-0.1105	0.0837	-1.3202	0.5724
100	0.00 3.00	0.0540	-0,0369	-0.0085 0.0050	-0.2298 -0.1929	0.9426	0.0269	0.0596	0.4523	0.1583
110	0.00 3.00	0.0404	-0.2428	0.0203 0.0304	-0.2884 -0.2959	1.1671	0.2143	0.1210	1.7718	-0.5019
120	0.00 3.00	0.0393	-0.5058	0.0346 0.0444	-0.3563 -0.3993	1.1355	0.4184	0.2869	1.4584	-0.8806
130	0.00 3.00	0.0400	-0,8164	0.0406 0.0506	-0.4539 -0.5115	0.8760	0.5997	0.5554	1.0798	-1.0168
140	0.00 3.00	0.0374	-1.1462	0.0414 0.0507	-0.5385	0 . 3084	0.7081	0.9021	0.7850	-1.1066
150	0.0n 3.00	0.0315	-1.4558	0.0367 0.0446	-0.6072 -0.6878	-0.4296	0.7006	1.2765	0,5488	-1.1658
160	0.00 3.00	0.0228	-1,7080	0.0274 0.0331	-0.6580 -0.7461	-1.1520	0.5627	1.6128	0-3489	-1.2032
170	0.00 3.00	0.0120	-1.8775	0.0146 0.0176	-0.6891 -0.7819	-1.6736	0.3134	1.8462	0.1697	-1.2240
180	0.07 3.00	0.0000	-1.9297	0.0000 0.0000	-0.6996 -0.7940	-l.8599	0.0000	1.9297	0.0000	-1.2296
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3 341	60107		5 994126	74	
3, 36 3	73369		5.997377	69	
3. 366	3968		5.999342	62	
3.378	83.09		5 999999	96	
3 295	8383		5.998832	í i	
3 411	25054		5.995351		
3 437	01.69		5.989425	30	
2 44 2	7738		5 981765	60	
3.455	1758		5.971925	26	
3.467	6046		5.960295	56	
3.678	6759		5.947103	0.8	
3.686	3835		5.932604	42	
3 49 2	0086		5.917081	5	
3 4945	6000		5.900837	22	
4 00 93	5502		3 000000	00	
6 0093	6592		0.0000000	50	
4 4958 4 4958 4 698	35592		3.000000	00 00	

PRCGPAM 1881 VFVC= -0.00 C4SE= 1.00 DATE= -0.00

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III. COMPUTATIONS

A. BLOCK DIAGRAM

A block diagram illustrating the information flow within the Program 1881 is given in Figure 6.



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Figure 6 BLOCK DIAGRAM OF PROGRAM 1881

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B. SYMBOLS

A ₁ (x)	function defined by equation(10)	R _B	radius of flare		
B ₁ (x)	function defined by equation(11)	R _c	characteristic radius (cylinder radius, usually)		
с _D	drag coefficient	R.,	raduus of spherical nose cap		
c _L	lift coefficient	~N			
C _m	moment coefficient (based on characteristic radius R. and		toroidal radius between flare and aftcone		
	characteristic length d)	R _{SC}	toroidal radius following cone		
c _{mα}	$(\partial C_m/\partial \alpha)$	R _{SN}	toroidal radius following nose cap		
c _{mq}	$(\partial C_{m}/\partial Q)$	^R T	radius of truncated afterbody		
с _N	coefficient of force normal to	SM	static margin		
	body and a second second	v _A	volume rear of c.g. position		
с _х	axis	v _N	volume forward of c.g. position		
d	characteristic length, diameter (feet) = $2 R_c$	x	axial coordinate; nose is located at $x = 0$		
dQ	increment in Q used to compute derivatives (radians) dO =0,005	$\mathbf{x}_{\mathbf{f}}$	length of body		
dα	increment in α used to compute	x _{CG}	distance of center of gravity from nose		
G ₁ (x)	derivatives (radians) $da = 0.005$ function defined by equation 12	х _{ср}	distance of center of pressure from nose		
L _c	length of cylindrical section	z _{cg}	offset distance of center of gravity		
М	vehicle mass	Z _i (x)	function defined by equation (14)		
q	angular pitch speed (rad/sec)	a	angle of attack		
Q	pitching speed parameter Q = qd/2V (radians)	β	slope at start of tension shell		
$\rho_{\rm A}$	density aft of c g. position	θ_{2G}	slope at start of general shape		
------------------	----------------------------------	-----------------------	--------------------------------------		
$\rho_{\rm N}$	density forward of c.g. position	A	slone at end of general shape		
0	body contour slope	°3G	propo av ona or general entre		
θ _A .	slope of aftcone	$\theta_{\rm 3T}$	slope at end of tension shell		
$\theta_{\rm B}$	slope of flare	6)	Function defined by Equation (15)		
θ _C	slope of cone	<i>w</i> ₁	T uncertain defined by Equation (20)		
$\theta_{\rm N}$	slope at end of nose cap				

Subscr1pts

- 1 = 0 denotes moments taken about the nose
- i = g denotes moments taken about the center of gravity

C. EQUATIONS

1. Coefficient Calculation

a Newtonian Coefficients

$$C_{N_{1}} = -\frac{2}{\pi R_{c}^{2}} \int_{0}^{X_{f}} \left[-A_{1}(x) \cos \omega_{1}^{*} + B_{1}(x) \left(\frac{\omega_{1}^{*}}{2} - \frac{1}{4} \sin 2 \omega_{1}^{*} + \frac{\pi}{4} \right) (1) - \frac{2}{3} G_{1}(x) \cos \omega_{1}^{*} (\sin^{2} \omega_{1}^{*} + 2) \right] r(x) dx$$

$$C_{X_{1}} = \frac{2}{\pi R_{c}^{2}} \int_{0}^{X_{f}} \left[A_{1}(x) \left(\omega_{1}^{*} + \frac{\pi}{2} \right) - B_{1}(x) \cos \omega_{1}^{*} + 2G_{1}(x) \left(\frac{\omega_{1}^{*}}{2} - \frac{1}{4} \sin 2 \omega_{1}^{*} + \frac{\pi}{4} \right) \right] r(x) \tan \theta dx$$

$$(2)$$

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$$C_{m_{1}} = \frac{2}{\pi R_{c}^{2}} \int_{0}^{x_{1}^{c}} \left[-A_{1}(x) \frac{Z_{1}}{l} \sin \theta \left(\omega_{1}^{*} + \frac{\pi}{2} \right) - A_{1}(x) K_{1}(x) (3) \right]$$
$$- B_{1}(x) \frac{Z_{1}}{l} \sin \theta \cos \omega_{1}^{*} + \left(B_{1}(x) K_{1}(x) - 2 G_{1}(x) \frac{Z_{1}}{l} \sin \theta \right) \right]$$
$$\left(\frac{\omega_{1}^{*}}{2} - \frac{1}{4} \sin 2 \omega_{1}^{*} + \frac{\pi}{4} \right) - \frac{2}{3} G_{1}(x) K_{1}(x) \cos \omega_{1}^{*} \left(\sin^{2} \omega_{1}^{*} + 2 \right) \right] \frac{r(x)}{\cos \theta} dx$$

$$C_{L_1} = -C_{X_1} \sin \alpha + C_{N_1} \cos \alpha$$
(4)

$$C_{D_1} = C_{X_1} \cos \alpha + C_{N_1} \sin \alpha \tag{5}$$

$$X_{CP}/d = -C_{m_o}/C_{N_o}$$
(6)

$$C_{m_{\alpha_{1}}} = \frac{\partial C_{m_{1}}}{\partial \alpha} = \frac{C_{m_{1}}(\alpha + d\alpha, Q) - C_{m_{1}}(\alpha, Q)}{d\alpha}$$
(7)

$$C_{L_{a_{i}}} = \frac{\partial C_{L_{i}}}{\partial \alpha} = \frac{C_{L_{i}}(\alpha + d\alpha, Q) - C_{L_{i}}(\alpha, Q)}{d\alpha}$$
(8)

$$C_{\mathbf{m}_{q_1}} = \frac{\partial C_{\mathbf{m}_1}}{\partial Q} = \frac{C_{\mathbf{m}_1}(\alpha, Q + dQ) - C_{\mathbf{m}_1}(\alpha, Q)}{d Q}$$
(9)

b. Auxiliary Equations

$$A_{1}(x) = 2 \sin^{2} \theta \cos \alpha \left(\cos \alpha + 2 Q \frac{Z_{1}}{l} \right)$$
(10)

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$$B_{1}(x) = -2 \sin \theta \left[\cos \theta \sin 2\alpha + 2Q \left(K_{1}(x) \cos \alpha + \frac{Z_{1}}{l} \cos \theta \sin \alpha \right) \right]$$
(11)

$$G_{1}(x) = \cos \theta \sin \alpha (\cos \theta \sin \alpha + 2 Q K_{1}(x))$$
(12)

$$K_{1}(x) = \frac{r(x)}{l} \sin \theta + \frac{x - x_{1}}{l} \cos \theta$$
(13)

$$Z_{1} = 0 \quad \text{IF } 1 = 0 \tag{14}$$

$$Z_{g} \quad \text{IF } 1 = g \tag{14}$$

$$\omega_{1}^{*} = \begin{cases} ARC \sin\left(\frac{\sin\theta\cos\alpha}{\cos\theta\sin\alpha}\right) \text{ IF } \left|\frac{\sin\theta\cos\alpha}{\cos\theta\sin\alpha}\right| \leq 1 \\ \pi/2 \text{ If } \cos\theta\sin\alpha = 0 \text{ and } \sin\theta\cos\alpha \geq 0 \\ -\pi/2 \text{ If } \cos\theta\sin\alpha = 0 \text{ and } \sin\theta\cos\alpha < 0 \\ \pi/2 \text{ If } \frac{\sin\theta\cos\alpha}{\cos\theta\sin\alpha} > 1 \\ -\pi/2 \text{ If } \frac{\sin\theta\cos\alpha}{\cos\theta\sin\alpha} < -1 \end{cases}$$
(15)

c. Center of Gravity Determination

$$\left(\mathbf{x}_{\mathrm{CG}}\right)_{\alpha = 0} = \frac{\mathrm{d}}{C_{\mathrm{N}_{\alpha}}} \left[\left(\mathbf{C}_{\mathrm{m}_{\alpha}}\right)_{\mathrm{spec.}} - \left(\mathbf{C}_{\mathrm{m}_{\alpha}}\right)_{\mathrm{i} = 0} \right]_{\alpha = 0}$$
(16)

$$\left(X_{CG} \right)_{\alpha = 180} = \frac{d}{C_{N_{\alpha}}} \left[\left(C_{m_{\alpha}} \right)_{spec.} - \left(C_{m_{\alpha}} \right)_{1 = 0} \right]_{\alpha = 180}$$

$$(17)$$

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- 2) Static Margin Criteria
 - At $\alpha = 0$, $X_{CG} = X_{CP} SM$

At
$$0 < \alpha \le 180$$
, $X_{CG} \le X_{CP}$

- 2. Moments of Inertia
 - a. Density Distribution

$$X_{CG} = \begin{bmatrix} \int_{0}^{X_{CG}} xr^{2} dx + \frac{\rho_{A}}{\rho_{N}} & \int_{X_{CG}}^{X_{f}} xr^{2} dx \\ \frac{\rho_{A}}{\int_{0}^{X_{CG}} r^{2} dx + \frac{\rho_{A}}{\rho_{N}} & \int_{X_{CG}}^{X_{f}} r^{2} dx \end{bmatrix}$$
(18)

$$M = \rho_{N} \left(V_{N} + \frac{\rho_{A}}{\rho_{N}} - V_{A} \right)$$
(19)

where,

$$V_{\rm N} = \pi \int_{0}^{X_{\rm CG}} r^2 dx$$
 (20)

$$V_{A} = \pi \int_{X_{CG}}^{X_{f}} r^{2} dx$$
 (21)

b. Moments of Inertia

$$I_{y} = \pi \rho_{N} \qquad \left[\int_{0}^{X_{CG}} x^{2} t^{2} dx + \frac{\rho_{A}}{\rho_{N}} \int_{X_{CG}}^{X_{f}} x^{2} t^{2} dx + \frac{1}{4} \int_{0}^{X_{CG}} t^{4} dx \right]$$

$$+ \frac{\rho_{\rm A}}{4\rho_{\rm N}} \int_{\rm X_{CG}}^{\rm X_{\rm f}} {\rm e}^4 \, \rm{dx} \left[- M \, \rm X_{CG}^2 \right]$$
(22)

$$I_{x} = \frac{\pi \rho_{N}}{2} \left[\int_{0}^{X_{CG}} r^{4} dx + \frac{\rho_{A}}{\rho_{N}} \int_{X_{CG}}^{X_{f}} r^{4} dx \right]$$
(23)

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IV. IBM ROUTINES

A. PROGRAM FLOW

A flow diagram of Program 1881 is shown as Figure 7.



Figure 7 FLOW DIAGRAM OF PROGRAM 1881

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B. SUBROUTINES

CALINT	VARIABLE	THR '	DELR	R3	RK	SBETAR	CBETAR	RJ	Q000FL
	SUBROUTINE INPUT OR OUTPUT	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	OUTPUT	OUTPUT
	SOURCE	INPUT	MAIN	MAIN	MAIN	MAIN	MAIN		
	VARIABLE	x	R	L	т	RN	TH	ETAN	RAD
СРЬФТ	SUBROUTINE INPUT OR OUTPUT	INPUT	INPUT	INPUT	INPU	T INPUT	- IN	PUT	INPUT
	SOURCE	MAIN	MAIN	MAIN	INPU	T INPUT	г м	AIN	MAIN

1. Subroutine CALINT

a. Purpose

This subroutine is used in the case of the tension shell (third section) to compute the integrands Q000FL required to apply Simpson's Rule in subroutine ARSIMP.

b. Method

Starting with initial angle BETA at the first point of the section, other points along the section for each DELR increment in the radius are computed. The section is subdivided into NDIV portions. To compute the abcissa X of the righthand point of each of these portions, an integration is performed over each portion. Thirty-two (32) intervals are considered for each portion and, therefore, a loop is set up to compute the integrands Q000FL at 33 points. For each of these points the ordinate RJ is computed in the same loop. The last computed RJ for each portion is the ordinate of the point corresponding to that portion.

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2. Subroutine CPLØT

a. Purpose

To set up the array of points (X, R) to be plotted by library routine AICRT3.

b. Method

In MAIN, the first point computed is the end point of the first section. Therefore, for the purpose of plotting the whole body, compute 18 extra points in the first section of $CPL \varnothing T$. These extra points are then incorporated into the X and R arrays of points computed in MAIN. $CPL \vartheta T$ also computes the maximum values XU and YU for X and R from the respective arrays and chooses the greater of the two to establish the scale of the plot.

All the variables in the calling sequence of library routine AICRT3 are set to the proper values and the total array of points XPT (abcissas) and RPT (ordinates) are then plotted on the 4020.

- 3. Main Program
 - a. Purpose

The main program computes the array of coordinates (X, R) along the body, defines table of alphas to be considered, performs preliminary computations for the integration procedures, sets up the main logical flow of the problem and performs the final computations to obtain the aerodynamic coefficients.

b. Method

The program first sets the values of all preset input, then reads in the data through the Namelist array INPUT.

After converting all input angles to radians and finding the values of their sines and cosines, the program proceeds to compute the coordinates (X, R) of the points considered for each section. The first point to be computed is the intersection of the nose radius with the body surface, i. e., the end point of the first section (Statement No. 302). All curved sections (except the first) are subdivided into the prescribed input number, M2, M4, M7, M8, and M10. If these are not input, the program will use the preset values. The third section may have one of the three different shapes, i.e., general, tension, or conic shape.

In the general shape (Statement No. 9141), the points along the section are input (XINP, RINP) and are merely incorporated in the (X, R) arrays of coordinates for the whole body.

In the case of the tension shape (Statement No. 486), the initial angle BETA is input and the program computes the points determined by the input number of divisions NDIV. The angle θ along the section lies between BETA $\leq \theta \leq 90$ degrees and for the last point on the section $\theta = 90$ degrees. The number of divisions is preset to 20. For each subdivision a point (X, R) will be computed. The ordinate R is obtained by adding an increment ΔR to the R of the previous point. Each ΔX is obtained by integrating over the respective subdivision (Loop on Statement No. 5533). For integration purposes in each subdivision, 32 intervals (or 33 auxiliary points) are considered. The integrands Q000FL are computed in subroutine CALINT. Then library routine ARSIMP integrates using Simpson's Rule.

The ordinate R is, for each subdivision, the value RJ computed in CALINT. In the case of a conic shape (Statement No. 484), only the end point is computed. The remaining sections are handled by straightforward application of the given formulas. For RSB \neq 0 (internally RSCB), the program assumes that both toroidal sections 10 and 9 are given.

Symbol L represents the number of points whose coordinates were computed along the body. These L points plus 18 extra points on the nose computed by subroutine CPLØT will be plotted (R versus X) by library routine AICRT3, using the first available tape on channel A.

Arrays X(1-L) and R(1-L) are then printed out (Statement No. 4999) and the program proceeds by forming the angle of attack table for the 3 possible ranges using the input A1, A2, A3, A1L, A2L, A3L and the input increments DA1, DA2, DA3 (Statements between Statement Nos. 13 and 20).

A loop on ALPHAS (Statement number 1003) is set up comprising most of the rest of the program, i.e., for each ALPHA a set of force and moment coefficients ($C_{N_{i}} C_{X_{i}} C_{m_{i}} C_{L_{i}} C_{D_{i}} (L/D)_{i}$, Xcp and the corresponding derivatives $C_{N_{a_{i}}} C_{m_{a_{i}}} C_{N_{a_{i}}} C_{N_{a_{i}}} C_{N_{a_{i}}}$ and $C_{m_{a_{i}}}$ are computed.

The loop on ALPHAS is the outermost of a nest of loops which are completed as follows loop for subscript ϕ and XG (Statement number 345), loop to compute numerically the derivatives CNA, CMA, CNQ, and CMQ (DØ 91 MM - 1, 3), loop for the integration of body sections L(Statement number 2774) (the body is subdivided into a number of portions equal to the number of computed points), and loop for computation of integrands (D \emptyset 50 M = 1, J) (each of the L sections is further subdivided into a maximum of 9 intervals before Simpson's Rule (subroutine ARSIMP) is applied).

After exiting from this nest of loops, (after Statement No. 389) p. (internally RHØN), ρ_{Λ} (internally RHØA), XCG/D (internally XCGDD), RGX/D, RGY/D are computed.

Within the ALPHA loop, the program prints out for each ALPHA the coefficients CN, CM, CX, CMQ, CLA, CD, CL/CD, and XCP/D (immediately after Statement No. 370).

Outside this loop, at the very end of the program, the quantities RHØN. RHØA, XCG, XCG/D, RGX/D, and RGY/D are printed out.

C. SIGNIFICANT EQUATIONS

1.	Maın Program		Statement Number*
	Section 1 (NØSE):	$X(1) = RN \cdot [1 - \cos(THETAN)]$	
		$R(1) = \sqrt{X(1) \cdot [2RN - X(1)]}$	302

* The statement numbers are provided to assist in locating the equations in the program listing as the equations noted appear in the immediate vicinity of these statement numbers.

Section 2 (TØRØIDAL):

$$\begin{split} X(J) &= X(1) + RS \cdot \left\{ \cos \left(\text{THETAN} \right) - \sin \left\{ XJ \quad \frac{\left[90 - \left(\text{THETAN} + \text{THETAC} \right) \right]}{XM2} \right\} \right\} \\ \text{where, } XJ &= 1, \dots, XM2 \\ R(J) &= R(1) + RS \cdot \left\{ \cos \left\{ XJ \quad \left[\frac{90 - \left(\text{THETAN} + \text{THETAC} \right) \right]}{XM2} \right] \right\} - \sin \left(\text{THETAN} \right) \right\} \end{split}$$

Section 3 (CØNIC):

$$R(K) = RC - RSCA [1 - \cos (THETAC)]$$
$$X(K) = X(K - 1) + [R(K) - R(K - 1)] \frac{\cos (THETAC)}{\sin (THETAC)} , 306$$

303

Section 4 (TØRØIDAL).

$$X(J) = X(K) + RSCA [sin (THETAC) - sin (TJ)]$$

$$R(J) = R(K) + RSCA [cos(TJ) - cos (THETAC)]$$
where,
$$TJ = \frac{(XJ \cdot TM4)}{RAD}$$
and,
$$TM4 = THETAC/M4$$
325

Section 5 (CYLINDRICAL):

$$X(K) = X(K - 1) + DX1$$

R(K) = RC 312

Section 6 (C ϕ NIC):

$$R(K) = RB - RSCB [1 - \cos (FTHETA)]$$

$$X(K) = X(K - 1) + (R(K) - RC) \cdot \frac{\cos (FTHETA)}{\sin (FTHETA)}$$
314

Section 7 (T ϕ R ϕ IDAL):

$$X(J) = X(K) + RSCB [sin (FTHETA) - sin (TJ)]$$

$$R(J) = R(K) + RSCB \cdot [cos(TJ) - cos (FTHETA)]$$
where, TJ = XJ $\cdot \frac{FTHETA}{M7}$ /RAD 317
-35-

Section 8 (T ϕ R ϕ IDAL):

$$X(J) = X(K) + RSCB \cdot sin(TJ)$$

$$R(J) = RB - RSCB \cdot [1 - cos(TJ)]$$
where, $TJ = XJ \cdot \frac{THETAA}{M8} / RAD$
317

Section 9 (CØNIC).

$$R(K) = RA$$

$$X(K) = X(K - 1) + [R(K - 1) - R(K)] - \frac{\cos (THETAA)}{\sin (THETAA)}$$
321

Section 10 (SPHERICAL):

- $X(J) = X(K) + RSA \cdot [sin(TJ) sin(THETAA)]$ $R(J) = R(K) - RSA \cdot [\cos(THETAA) - \cos(TJ)]$
- where, TJ + [XJ · (90 THETAA)/M10 + THETAA]/RAD 326

$$B \emptyset X = -2 \sin (\text{THETA}) \begin{cases} \cos(\text{THETA}) \cdot \sin 2\text{ALPHA} + 2ZAQ \\ + \frac{ZZ(II)}{SL} \cdot \cos(\text{THETA}) & \sin (\text{ALPHA}) \end{bmatrix} \end{cases}$$

where, $ZK = RX(M) \cdot \frac{\sin (\text{THETA})}{SL} + (XZ(M) - ZX) \cdot \frac{\cos(\text{THETA})}{SL} = 48$

$$A \phi X = 2 \sin^2 (\text{THETA} \cdot \cos(\text{ALPHA}) \cdot \left[\cos(\text{ALPHA}) + 2ZAQ \cdot \frac{ZZ(II)}{SL} \right]$$
 48

48 $CN(M) = \left[-A \, \emptyset X \quad \cos(\emptyset \text{MEGA}) + B \, \emptyset X \quad \emptyset Z - 2G \, \emptyset X \cdot \cos(\emptyset \text{MEGA}) \cdot \frac{(\sin^2(\emptyset \text{MEGA}) + 2)}{3} \right]$

where, $ØZ = 5 \ ØMEGA - .25 \sin(2 \ ØMEGA) + .78539816$

$$RX(M) = \sqrt{2 RN XZ(M) - XZ(M)^2}$$

 $CX(M) = [A \mathscr{Q}X \cdot (OMEGA + 1 5707963) - B \mathscr{Q}X \cos(\mathscr{Q}MEGA) + 2 \cdot \mathscr{Q}Z \cdot G \mathscr{Q}X] \cdot RX(M) \frac{\sin(THETA)}{\cos(THETA)}$ 8

48

$$CM(M) = \begin{cases} -A \emptyset X \cdot ZZ(II) & \sin(THETA) \cdot (\emptyset MEGA + 1 5707963) - \\ -[A \emptyset X \cdot ZK \cdot SL - B \emptyset X \cdot ZZ(II) \cdot \sin(THETA)] \cdot \cos(\emptyset MEGA) + \\ + [B \emptyset X ZK SL - 2G \emptyset X ZZ(II) \cdot \sin(THETA)] \cdot \emptyset Z - \\ - 2 \frac{G \emptyset X}{3} \cdot ZK \cdot SL \cos(\emptyset MEGA)[\sin^2(\emptyset MEGA) + 2] \\ \end{cases} \frac{RX(M)}{\cos(THETA)}$$

$$48$$

$$CD(MM) = CX1 \cdot \cos(ALPHA) + CN1 \cdot \sin(ALPHA)$$
48

$$CL(MM) = CX1 sin(ALPHA) + CN1 \cdot cos(ALPHA)$$
 93

$$CNA = \frac{(CN3 - CN1)}{DDL}$$
352

$$CMA = \frac{(CM3 - CM1)}{DDL}$$

$$CNQ = \frac{(CN2 - CN1)}{DDL}$$

$$CMQ = 2 \quad \frac{(CM2 - CM1)}{DDL}$$

$$XCP = -SL \quad \cdot \quad \frac{CM1}{CN1}$$
920

2. Subroutine CALINT

THR = THR DELR * DERIN
RJ = RJ DELR
where,
$$C\phi TM = (C\phi TT C\phi TTM1)/2$$
.
 $AL\phi GBE = L\phi G \left[\frac{1 + \cos(BETAG)}{\sin(BETAR)}\right]$

DERVR1 =
$$\left\{ \frac{RK^2 - R3^2}{AL\phi GBE} \cdot \frac{\sin(THR)}{1 + \cos(THR)} \cdot \left[-1 - \frac{(1 + \cos(THR)) \cos(THR)}{\sin^2(THR)} \right] \right\}$$

DERIN = RJ/(0.5 * DERVR1)

.

3. <u>Subroutine CPLØT</u>

ANGL = (XK · DIVTHN)/RAD

where, DIVTHN = THETAN/18.

and, XK = 1,...18

 $XPT(I) = RN \cdot [1 - \cos(ANGL)]$

60

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RPT (I) = RN sin (ANGL)

V. REFERENCES

- Wells, W. R., and W. O. Armstrong, Tables of Aerodynamic Coefficients Obtained from Developed Newtonian Expressions for Complete and Partial Conic and Spheric Bodies at Combined Angles of Attack and Side Slip with Some Comparisons With Hypersonic Experimental Data, NASA TR R-127 (1962).
- Tobak, M., and W. R. Wehrend, Stability Derivatives of Cones at Supersonic Speeds, NACA TN 3788 (September 1956).
- Gray, J.D., Drag and Stability Derivatives of Missile Components According to the Modified Newtonian Theory, AEDC TN 60-191 (November 1960).
- 4. Anderson, M. S., H. G. Bush, and R. W. Frauch, A Tension Shell Structure for Application to Entry Vehicles, NASA TN D -2675 (March 1965).

VI. BIBLIOGRAPHY

A. FORCE AND MOMENT

Nichols, J. O., and E. A. Nierengarten, Aerodynamic Characteristics of Blunt Bodies, Jet Propulsion Laboratory, Pasadena, California, Technical Report No. 32-677, (19 November 1964).

Robinson, J.C., and A. W. Jordan, Exploratory Experimental Aerodynamic Investigation of Tension Shell Shapes at Mach 7, Washington, D.C., NASA TN D-2994 (September 1965).

Wehrend, W. R., Jr., Wind-Tunnel Investigation of the Static and Dynamic Stability Characteristics of a 10 Degree Semivertex Angle Blunted Cone, NASA TN D-1202 (January 1962).

Blaylock, R. B., Force Test of a Cold-Wall Blunt-Nose Cylinder-Flare Model in Air-Carbon Dioxide Mixtures in the JPL 21-inch Hypersonic Wind Tunnel, JPL N64-33218, Contract NAS 7-100 (15 March 1964).

Peterson, V. L., Motions of a Short 10-Degree Blunted Cone Entering a Martian Atmosphere at Arbitrary Angles of Attack and Arbitrary Putching Rates, Ames, Moffett, California, NASA TN D-1326 (May 1962).

Boylan, D. E., and W. H. Sims, Experimental Determination of Aerodynamic Drag on a Blunted 10-Degree Cone at Angle of Attack in Hypersonic Rarefied Flow, Arnold Engineering Development Center, Air Force Systems Command, United States Air Force, AEDC-TDR 64-60 (April 1964).

Keyes, J. W., Aerodynamic Characteristics of Lenticular and Elliptic Shapes Configurations at a Mach Number of 6, NASA Langley, N65-15613, NASA TN D-2606 (February 1965).

B. DYNAMIC STABILITY

Marte, J. E., and R. W. Weaver, Low Subsonic Dynamic-Stability Investigation of Several Planetary-Entry Configurations in a Vertical Wind Tunnel, Part I, Jet Propulsion Laboratory, Technical Report No. 32-743 (1 May 1965).

Fisher, L. R., A. L. Keith, Jr., and J. R. DiCamillo, Aerodynamic Characteristics of Some Families of Blunt Bodies at Transonic Speeds, NASA Memo 10-28-58L. Kilgore, R. A., Aero Damping and Stability of a Sphere at Mach Number from 0.20 to 4.63, Thesis, College of William and Mary.

Intrieri, P. F., Free Flight Measurements of the Static and Dynamic Stability and Drag of a 10-Degree Blunted Cone at Mach Numbers 3.5 and 8.5, NASA TN D-1299 (May 1962).

Wehrend, W. R., Jr., An Experimental Evaluation of Aerodynamic Damping Moments of Cones with Different Centers of Rotation, NASA TN D-1768 (March 1963).

Keyes, J. W., Longitudinal Aerodynamic Characteristics of Blunted Cones at Mach Nos. of 3.5, 4 2, and 6.0, Langley, NASA TN D-2201 (February 1964). PROGRAM 1882

SUBSYSTEM WEIGHTS PROGRAM (1882)

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I. INTRODUCTION

A. GENERAL DESCRIPTION

The purpose of this program is to determine the component system weights for an axisymmetric entry vehicle. The program has four distinct segments within which exists a number of options. The four segments are as follows

1. <u>Heat Shield and Structural Shell</u> -- The inboard profile coordinates of the vehicle are generated based on body input parameters. The moments of inertia, center of gravity, area and weight of each section of the vehicle are then computed. The weights are based upon specified unit weights for the heat shield and structure of each section.

2. <u>Descent System</u> -- The descent system weight computation is based on specified deployment and impact conditions. Three options exist (a) a two chute; (b) a single-chute, or (c) a drogue-chute retrorocket system.

3. <u>Impact Attenuation System</u> -- The amount of crushup weight is computed so as to assure a soft landing within impact velocity and acceleration limits. Three options exist as to the landed package configuration: (a) spherical; (b) lenticular; or (c) conical. The latter option utilizes a spherical segment of crushup and assumes preferred impact orientation. All of the options yield the geometric dimensions of the crushup and payload.

4. <u>Packaging Design</u> -- This portion of the program packages the landed package and descent system components within the inboard profile limits of the vehicle. A minimum overall specified center of gravity must be satisfied. With the overall vehicle center-of-gravity position established, the moments of inertia are then computed for the entire capsule. The internal structural weight of the lander is also computed in this portion of the program.

B. CALCULATION MODEL

The calculation model for each of the four segments of Program 1882 is as follows:

1. Heat Shield and Structural Shell

a. The evolved body coordinates of the vehicle reflect the bond line profile of the heat shield and structure shell. The heat shield and structural unit area weights are input for each vehicle section. The vehicle sections are identified parametically as shown in Figures 1 and 2.

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Figure 1 VEHICLE SHAPE PARAMETERS



 β - TENSION SHELL INPUT PARAMETER R_3 - BASE RADIUS OF TENSION SHELL (NOT INPUT)



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Figure 2 TENSION SHELL AND GENERAL SHAPE GEOMETRIES

b. The inertia, center of gravity, and area equations are based on a derivation assuming the heat shield and structure thickness to be small and uniform.

2. Descent System

a. The model atmosphere generated consists of a troposphere and stratosphere. Equations for the thermosphere are not utilized since it is reasonable to assume that chute deployment will always occur at an altitude well below the thermosphere region.

b. The equations of motion utilized in the trajectories are the two degree of freedom equations neglecting the centripetal acceleration and lift terms.

c. The drogue chute descent calculation assumes that the chute opens instantaneously, and hence does not account for the loss in altitude due to the filling time. This is a reasonable assumption since drogue chutes are usually fairly small in diameter with filling times in the order of 0.05 second. The drogue chute is sized by the requirement of achieving a prescribed Mach number at a prescribed altitude.

d. The main chute descent accounts for the loss in altitude due to chute opening and assumes constant velocity during filling. Subsonic chutes (Mach 0.8) in the order of 60 feet diameter would result in filling times of about 1.5 seconds, and hence incur an altitude loss of about 800 to 1000 feet.

e. Terminal descent velocity is assumed for the calculation of the main chute canopy size.

f. All trajectory calculations account for the correct vehicle and chute drag components where applicable.

g. Jettisoning of heat shield, structure, and drogue system weights are accounted for in the trajectory calculations where applicable.

h. A cluster of chutes is employed if the required diameter of a single main chute exceeds the maximum specified value DMCMAX.

i. The descent system options are depicted in Figure 3.

j. The parachute weight model (see below) accounts for materials, dynamic pressure and size.



Figure 3 DESCENT SYSTEM OPTIONS

Parachute Weight Model

Materials (K)

Dynamic Pressure (q)

$$W_{\rm T} = K \left[\frac{{\rm d}^3}{18.6} \quad \frac{{\rm q}}{65} \right]$$

Diameter (d)

3. Impact Attenuation System

a. The equations utilized are based on the analysis of Reference 1 which accounts for the variation of mass during the crush-up stroke and for materials with anisotropic properties.

b. Equations derived are for the particular case where the crushable material is in the shape of a spherical segment.

c. Crushing is assumed to start at the initial contact point and then the surface of crushing moves upward into the material during impact. Hence, at any time the mass below this surface has already been brought to rest such that the mass being decelerated is a variable with time.

d. The crushable material is assumed to be rigid and perfectly plastic, deforming at constant stress up to the total usable strain.

e. The conical and lentacular options which utilize a spherical segment of crushup assume preferred orientation upon impact, such that the resultant deceleration vector passes through the center of gravity of the landed package.

f. The impact surface is considered to be flat, smooth and infinitely rigid.

g. Landed package geometries are shown in Figure 4.



4a. CONE-CYLINDER SHAPE LANDER



4b. CYLINDER SHAPE LANDER



4c CONE SHAPE LANDER

Figure 4 LANDED PACKAGE GEOMETRIES



Figure 4 LANDED PACKAGE GEOMETRIES (Conci'd)

4 Lander Packaging Design

a. The thickness of the heat shield and structure is accounted for in the lander packaging by adding the thickness to the outer dimension of the landed package.

b. The internal payload is packaged with uniform density.

c. A symmetrical cylindrical ring, placed at the maximum radius of the landed package, is utilized for parachute packaging as shown in Figure 5.

d. The landed package is located as far forward in the vehicle as possible as shown in Figure 5.

C. LIMITATIONS

Limitations of Program 1882 are listed below:

1. The heat shield and structure must be of uniform unit weight and/or thickness for each section.

2. Parachute designs (drogue and/or main) do not account for reefing; however, the chute drag coefficients can be arranged so as to simulate reefing.

3. The parachute design does not include fabric heating effects which often result in Mach number deployment limitations for various fabrics.

4. The parachute design does not include stability considerations and/or losses in performance due to angle of attack or Reynolds number effects.

5. The retrorocket system design is based on a single-impulse system.

6. The impact crush-up design assumes homogeneous materials.

7. Only spherical segments of crushup can be utilized for the impact geometry.

8. The impact attenuation analysis assumes that crushing takes place only in the plane of the impact surface, that the payload is rigidly attached and that crushing cannot take place at an inner crushup surface and proceed outward.

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CONSTRAINTS.

I LANDER GEOMETRY $R_V(X) > R_P(X)$



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Figure 5 PACKAGING MODEL

II. PROGRAM USAGE

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Name	Preset Value	Symbol	Parameter	Units
ALPHA		a	Empirically determined con- stant relating crushing stress and density.	
AO		a _o	Empirically determined con- stant describing anisotropy of crushable material.	
Al		al	Empirically determined con- stant describing anisotropy of crushable material.	
A2		^a 2	Empirically determined con- stant describing anisotropy of crushable material.	
A.3		^a 3	Empirically determined con- stant describing anisotropy of crushable material.	
BETA	0.	β	Tangent angle at beginning of —— tension shell.	degrees
CDD		C _{DD}	Table of drogue chute drag co- efficients, Mach number de- pendent.	
CDMC		с _{рмс}	Table of main chute drag coef- ficients, Mach number depen- dent.	
CDV		с _{DV}	Table of entry vehicle drag coef- ficients, Mach number depen- dent,	
DELTA	0.01		Integration Δt .	seconds
DELMIT	1.E-5		Smallest allowable Δt .	seconds

	Preset			
Name	Value	Symbol	Parameter	Units
DESSYS			Input sentinel to designate type of descent system.	
DDMIN			Minimum drogue chute diam- eter.	feet
DLVFAC		ΔV	Velocity increment in rocket design.	ft/sec
DMCMAX	100.		Maximum main chute diameter.	feet
DMCMIN			Minimum main chute diameter.	feet
DNBND	1.E-3, 1 1.E-2	.E-6,	Lower bounds on trajectory integration (velocity, angle, altitude).	
DRV-EL	50.		Velocity interval for printout of drogue chute trajectory.	
EF		Е	Modulus of elasticity.	psi
EPSILN		¢	Total usable strain.	
EPSI	1.E-3		Convergence factor for y/R_2 .	
EPS3	1.E-3		Convergence factor for R _{CO} .	
FACTØR	0.2		Factor by which to change Δt .	
FALR		L ₁	Temperature gradient in tro- posphere expressed as a frac- tion of the adiabatic lapse rate.	
FREQ	0.5		Interval for exiting from inte- gration routine.	
FREQ2	2.		Time interval for exiting from ADAMS4 during main chute trajectory.	
FREQ3	2.		Time interval for exiting from ADAMS4 during drogue-retro- rocket trajectory.	

	Preset			
Name	Value	Symbol	Parameter	Units
GAMD		γ _D	Flight path angle at drogue chute deployment.	degrees
GAMMC		$\gamma_{\rm MC}$	Flight path angle at main chute deployment.	degrees
GIMP		γ_{imp}	Maximum allowable impact acceleration.	Earth g
GSL		g _{SL}	Gravitational acceleration at planet surface.	ft/sec ²
IMPSYS			Input sentinel to designate type of impact system.	
ISP		ISP	Required specific impulse of retrorocket.	lb-sec/lb
IYR2	0.4		Initial guess for Y/R2	
JET			Input sentinel to indicate when jettisoning of heat shield and structure occurs.	
LC	0.	^L C	Cylinder body section length.	feet
LCØRCØ	0.	^L co ^{/R} co	Ratio of cone length to cylinder radius (internal geometry).	
LCYRCØ	0.	^L CYL ^{/R} CC	Ratio of cylinder length to cyl- inder radius (internal geometry)	
LRDR		L _R /D _R	Ratio of retrorocket length to diameter.	
MACD		M _D	Drogue chute deployment Mach number.	
MACH			Table of Mach numbers.	
MACMC		M _{MC}	Main chute deployment Mach number.	
MCVEL	50.		Velocity interval for printout of main chute trajectory.	ft/sec

Name	Preset Value	Symbol	Parameter	Units
MR		MR	Mass-fuel ratio of retrorocket.	
NRINGS	0.		Number of rings.	
PSI		ψ	Empirically determined con- stant relating crushing stress and density.	
RA	0.	R _A	Radius of rear spherical cap.	feet
RB	0.	R _B	Flare radius.	feet
RC	0.	R _C	Reference vehicle radius.	feet
RCHUTE	l	ρ _{CHUTE}	Packaging density of the para- chute system.	lb/ft ³
RHØCM		ρ. _C MAX	Maximum allowable crushup density.	slug/ft3
RHØCMI		ρ _C MIN	Minimum allowable crushup density.	slug/ft3
RHØF		ρ_{fs}	Density of internal structural face sheet.	lb/ft ³
RHØI		ρ _i	Packaging density of the inter- nal payload.	slug/ft ³
RHØRØC		$\rho_{\rm R}$	Density of retrorocket,	1b/ft ³
RHØSL		$^{ m ho}_{ m SL}$	Density of the atmosphere at planet surface.	slug/ft ³
RN	0.	R _N	Nose cap radius.	feet
RR	0.	r	Ordinates for general shape.	feet
RSB	0.	^R SB	Toroidal radius from flare to afterbody sections.	feet
RSC	0.	R _{SC}	Toroidal radius following cone section.	feet

Name	Preset Value	Symbol	Parameter	Units
RSN	0.	R _{SN}	Toroidal radius following nose cap section.	feet
RT	0.	R T	Base radius of truncated after- body.	feet
SECTN	0.		Ordered array of vehicle sections Each element is a number be- tween 1 and 13.	
SIGCYF		σ _{cy}	Yield stress of the internal structural face sheet.	psi
STRFAC	1.		Structural weight factor.	
TFMIN		t_{fmin}	Minimum allowable face sheet thickness.	inches
THA	0.	θ _A	Aftcone section body angle (negative).	degrees
THB	0.	θ _B	Flare section body angle.	degrees
тнс	0.	θc	Cone section body angle.	degrees
тнсø	0.	^θ co	Cone angle of the internal payload.	degrees
тнм		θ _M	Angle subtended by the crush- able material segment.	degrees
THN	0.	θ _N	Tangent angle at end of nose radius.	degrees
THS		t _{H/S}	Thickness of heat shield and structure combined.	feet
TH2G	0.	θ _{2G}	Tangent angle at beginning of general shape.	degrees
TH3G	0.	θ _{3G}	Tangent angle at end of general shape.	degrees
TN		n	Empirically determined exponent describing anisotropy of crushable material.	

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Name	Preset Value	Symbol	Parameter	Units
TSL		T _{SL}	Atmospheric temperature at planet surface.	°ĸ
TST		Tst	Atmospheric temperature in the stratosphere.	°ĸ
TZERØ	ο.	т。	Initial time for trajectory.	seconds
UPBND	0.01, 1. 0.1	E-5	Upper bounds for trajectory integration (velocity, angle, altitude).	
VELW		v _w	Horizontal velocity component used in impact attenuation analysis.	ft/sec
VIMP		V _{IMP}	Design impact velocity for retrorocket system. (Vertical and horizontal components included).	ft/sec
vv		vv	Design vertical descent velo- city for chute system.	ft/sec
WE	1	We	Total capsule entry weight.	pounds
WHSD			Array of corresponding heat shield weights.	
WRING			Array of weights of rings.	
WSTR			Array of corresponding structure weights.	
XA		x _A	Mole fraction of Argon in the atmosphere.	
хс		xc	Mole fraction of CO ₂ in the atmosphere.	
XCGMIN		$\mathbf{x}_{\mathrm{CG}_{\mathrm{MIN}}}$	Minimum overall CG require- ment.	feet
XD		x _D	Dynamic opening shock load factor on drogue chute.	

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Name	Preset Value	Symbol	Parameter	Units
хмс		^х _{мс}	Dynamic opening shock load factor on main chute.	
XN		x _N	Mole fraction of N ₂ in the at- mosphere.	
хØ		x	Mole fraction of O ₂ in the at- mosphere.	
XRING		ş	Array of x-coordinates specifying location of rings.	
xx		x	Abcissas for general shape.	feet
ZD		z _d	Drogue chute deployment altitude.	feet
ZMC		^Z MC	Main chute deployment altitude.	feet

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B. INPUT PROCEDURES

1. Heat Shield and Structural Shell

a. The body sections are specified in the array SECTN in the order in which they appear on the vehicle. The specification for each section is an integer between 1. and 13., the correspondence being as follows:

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NUMBER	SECTION	INPUT REQUIRED
1.	NOSE SPHERE	RN, THN
2.	TORUS	RSN
3.	CONE	THC
4.	TENSION SHELL	BETA
5.	GENERAL SHAPE	TH2G, TH3G, X,R
6,	TORUS	RSC, RC
7.	CYLINDER	LC
8.	FLARE	THB
9.	TORUS	RSB
NUMBER	SECTION	INPUT REQUIRED
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10.	TORUS	RSB
11.	AFTCØNE	THA
12.	AFTSPHERE	RA
13.	BASE	RT

The nose sphere must always be the first section, i.e. SECTN (1) = 1. A vehicle consisting of a nose sphere, cone, aftcone, and base would be specified as SECTN = 1., 3., 11., 13. The individual sections are depicted in Figures 1 and 2.

b. Body Section 6 can be omitted or included only together with Sections 3, 4, and 5.

c. Body Section 9 can be omitted or included only together with Section 8.

d. The body radius R_c must always be specified

e. The body angle input θ_A (THA) describing the aftcone section must be input with a minus sign to be consistent with the coordinate system.

f. For the tension shell β (BETA) and R_{sc} (RSC) must be specified

g. For the general shape the initial and final body angles θ_{2G} (TH2G), and the approximate x and r coordinates of that section must be specified. A maximum of 25 and a minimum of 3 points can be specified.

h. If the Section 2 is deleted, then the initial angles β (BETA), θ (THC), and $\theta_{2,G}$ (TH2G) must be equal to the noise cap section body angle θ_{N}^{C} (THN).

1. For any of the body sections specified, all of the corresponding utilized body parameters must also be specified, i.e. as an example, if the aftcone section is specified, then θ_A (THA), R_A (RA), and R_{SB} (RSB) must also be specified. The body parameter R_B (RB) need not be specified unless a flare section is used.

j. For each body section specified, there must be a corresponding unit heat shield and structure weight. These are specified in the arrays WHSD and WSTR in the same order as the section appears in SECTN.

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k A total vehicle entry weight W (WE) must always be input

1. A set of computer input forms are provided for the user. All the data shown on the form is keypunched when the variable is supplied

2. Descent System

a. Each of the three options are individually specified by utilizing the sentinel DESSYS:

1)	Two-chute drogue-main option	DESSYS = 1.
2)	Single-chute main option	DESSYS = 2.
3)	Drogue-retrorocket option	DESSYS = 3.

b. When to jettison the heat shield and structure in the two chute drogue-main system and single chute system is specified by the sentinel JET:

1)	Jettisoning	at	main	chute	deployment	JET	=	1.

Jettisoning just prior to impact
 JET = 2.

c. Drag coefficients of the vehicle (CDV), drogue chute (CDD), and the main chute (CDMC) are input as a function of Mach number. As an example.

MACH = 0.0, 3.0, 5.0 CDV = 1.0, 1.5, 1.6 CDD = 0.7, 0.8, 0.9 CDMC = 0.6, 0.6, 0.6

d. The parameters used for calculating the atmosphere and/or trajectory are input for all options. These parameters list nine and are GSL, TSL, TSL, RH ϕ SL, FALR, XN, X ϕ , XC, and XA.

e. The main chute trajectory for DESSYS Options 1. and 2. is calculated based on a required vertical input descent velocity (VV). The horizontal wind velocity component, however, is not accounted for.

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f. The retrorocket system is designed on a specified input velocity (VIMP). Horizontal wind velocity can be accounted for by the input (VELW). The input (VV) is not an input for this option.

g. The minimum size drogue chute input DDMIN must be specified for the drogue-main option and the drogue-retro option. There is no requirement as to how small or how big this input should be. Note however, if a smaller drogue is actually required (in the drogue-main option), the minimum input value is utilized.

h. The minimum drogue diameter input DDMIN is the actual size of the drogue chute for the drogue-retrorocket option. There is no iteration involved in this option.

i. The minimum size main chute input DMCMIN must be specified for the drogue-main option and the single main chute option. There is no requirement as to how small this input should be. Note however, if a smaller main chute is actually required (for either option), the minimum input value is utilized.

j. The maximum size main chute input DMCMAX must be specified for the drogue-main option and the single main option. If the first pass design requires a chute which exceeds DMCMAX, then a cluster of chutes will automatically be employed. Note, DMCMAX must be greater than DMCMIN.

k. Additional specific inputs to be specified for the retrorocket are as follows. ISP, MR, RHØRØC, VIMP, VELW, LRDR, and DLVFAC.

1. Parachute data suitable for input are given in References 2 and 3.

3. Impact Attenuation System

a. Each of the two options are individually specified by utilizing the sentinel IMPSYS:

1) Lenticular option	IMPSYS =	1.
2) Cone-cylinder option	IMPSYS =	2.

b. A sphere can be utilized as the lander in the lenticular option by specifying θ_M (THM) as 90 degrees.

c. The cone portion of the internal payload can be deleted in the cone-cylinder option by specifying L_{CO}/R_{CO} (LCØRCØ) as zero.

d. The cylinder portion of the internal payload can be deleted in the cone-cylinder option by specifying L_{cvl}/R_{co} (LCYRCØ) as zero.

e. If it is desired to neglect the anistropy of the crushable material, merely set a_0 (A ϕ), a_2 (A2), and a_3 (A3) equal to zero.

f. The specified input value of θ_M (THM) cannot exceed 90 degrees.

g. The specified input value of $\rm L_{co}/R_{co}~(\rm LC\phi RC\phi)$ must be equal to or less than cot $\theta_{co}.$

h. The inputs for the crushing stress PSI and ALPHA, relate the stress to the density as

 $S_m = [(ALPHA) \rho_o]^{1/PSI}$

where (S_m) is the maximum crushing stress, (ρ_c) is the density in slugft³, and ALPHA and PSI are empirical constants. A summary of crushup data¹ is given in Figure 6, from which the following correlations for ALPHA and PSI occur:

MATERIAL	<u>ALPHA</u>	PSI
Al Honeycomb	2090	0.554
Plastic Foams	3980	0.662
Balsa Wood	$1.65 \ge 10^{10}$	1.81

4. Lander Packaging Design

a. Additional required inputs for the lander packaging design are as follows: THS, XCGMIN, RCHUTE, EF, RHØF, TFMIN, and SIGCYF.

C. OUTPUT	DEFINITIONS
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External Name	Internal Name	Symbol	Parameter	Units
AD	AD	A _D	Area of drogue chute,	ft ²
ALT	Z	Ż	Altitude	feet



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Figure 6 CRUSHING STRENGTH OF IMPACT MATERIALS

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External Name	Internal Name	Symbol	Parameter	Units
AMC	AMC	A _{MC}	Maın chute area.	ft ²
AREA	AREA	A	Area.	ft^2
DELXF		Δx _f	Distance between vehicle nose and payload nose.	feet
DD	DI	D _D	Diameter of drogue chute.	feet
DMC	DMC	D _{MC}	Diameter of main chute.	feet
DR	DR	D _R	Diameter of retrorocket.	feet
GAMMA	GAM	γ	Flight path angle.	degrees
GPEAK	PGCALC		Maximum value from PGCAL array.	g
GPEAKS	PGCAL		Array of impact acceleration values.	g
IX	RØLL	I _x	Moment of inertia about the x-axis.	slug-ft ²
IXTØTCG			Roll moment of inertia of the entire vehicle about the c.g.	slug-ft ²
IY	РІТСН	I y	Moment of inertia about the y-axis.	slug-ft ²
IYTØTCG			Pitch moment of inertia of the entire vehicle about the c.g.	slug-ft ²
LCØ		L _{co}	Length in the internal payload cone.	feet
LCYL		L cyl	Length in the internal payload cylinder.	feet
LR	XLR	LR	Length of retrorocket.	feet

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External Name	Internal Name	Symbol	Parameter	Units
MACH	XMAC	м	Mach number.	
MC		^m c	Mass of the crushable material.	slugs
MI		m ₁	Mass of the internal payload.	slugs
PD	PD	PD	Opening shock load on drogue chute.	pounds
PMC	PMC	Р _{МС}	Opening shock load on main chute.	pounds
R	R	r	Ordinates of all points computed along the body surface.	feet
R		R	Small radius of the internal payload cone.	feet
Rl		R ₁	Inner radius of the crushup segment.	feet
R2		R ₂	Outer radius of the crushup segment.	feet
RCØ			Internal payload cylinder radius	feet
RHØC		ρ _c	Density of the crushable material utilized.	slug/ft ³
s		s _m	Maximum crushing stress.	lb/ft ²
SECTIØN			Section specification number.	
Т	Т	t _o	Total time of descent system trajectory.	seconds
Т		t _c	Thickness of crushup material.	feet

External Name	Internal Name	Symbol	Parameter	Units
TD	Т	^t D	Total time on the drogue chute.	seconds
TF	TF		Maın chute filling time.	seconds
TIME	Т		Time,	seconds
T (INS)			Thickness of the internal structure face sheet.	inches
VEL	v	v	Velocity.	ft/sec
VFINAL	VFINAL	v _o	Final resultant descent velocity for the drogue retro system.	ft/sec
W(LBS)			Itemized section weights of the internal structure.	pounds
W INTERN STRUC	I VAL TURE		Total weight of the internal structure.	pounds
WD	WD	₩ _D	Drogue chute system weight.	pounds
WF	WF	₩ _F	Final weight for sizing retro system.	pounds
WHS	WHS		Unit weight heat shield factor times area.	pounds
WI	WI	W11	Initial weight for sizing retro system.	pounds
WL	WL	W _L	Landed weight.	pounds
WMC	WMC	[₩] MC	Main chute system weight.	pounds
WST	WST		Unit weight structure (includes weight factor)	pounds

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External Name	Internal Name	Symbol	Parameter	Units
WR	WR	W _{RR}	Entry weight less heat shield and structure weight.	pounds
WRØC	WRØC	W _R	Retrorocket system weight.	pounds
wнsтфт	WHSTØT		Total heat shield weight.	pounds
WSTTØT	WSTTØT		Total structural shell weight.	pounds
WSTRAPS	WSTRAP	[₩] STRAPS	$0.05(w_{D} + w_{MC})$.	pounds
x	x	х	Abscissas of all points computed along the body surface.	feet
XCGH/S	XCGH/S		C.g. position of the heat shield and structural shell.	feet
XCG	xcg	x _{nn}	Centroid of each section from the nose of the vehicle.	feet
XCGØ		х _{сс_о}	Total vehicle center of gravity measured from vehicle nose.	feet
YDD/G	PGCALC	y _{imp}	Peak impact acceleration.	g
Y/R2 VAL	UES YR2	y/R ₂	Nondimensional parameter.	

D. SAMPLE PROBLEM

1. Statement of Problem

Determine the residual weight for the blunt cone configuration used in the sample problems of Programs 1880, 1881, 1884, and 1886.

The descent system is to utilize a single main chute system. The chute is to be deployed at Mach 1.2 at an altitude of 21451. feet and a flight path angle of -35.19 degrees. The heat shield and structure is to be jettisoned at its deployment. Vertical impact velocity is to be 60 ft/sec. The lander geometry is to be a spherical shape utilizing balsa wood as the crushable material. The horizontal wind velocity is 30 ft/sec and the maximum impact acceleration is not to exceed $1000_{\rm g}$. The balsa density cannot exceed 0.4 slug/ft³ or be less than 0.1 slug/ft³.

The internal payload is to have a packaging density of 1.5 slug/ft^3 , and the parachute system packaging density is 35 lb/ft^3 . Internal structure is to be constructed of aluminum face sheet with a minimum thickness of 0.010 inch. Final design is to have a maximum center of gravity position of 3.75 feet.

2. Input Form

The input data required is shown on the following pages. Decimals are used for all input and all the variable names are keypunched wherever an input quantity is given. An additional unused input form 1s provided in the following page for the program user.

3. Output

The output is shown on the following pages. The keypunched data are listed and should be verified with the input form.

The vehicle coordinates (X,R) are provided for use in drawing the configuration. Detailed section data are given regarding the surface area, heat shield weight, structure weight, moments of inertia, and center of gravity. The coordinates refer to the exterior of the structural shell and are used to evaluate all the weights by considering that the thicknesses of the structure and heat shield are small with respect to the size of the vehicle.

The heat shield and structural weights for the individual sections are totaled and the remaining weight (WR) is given. The overall center of gravity of the heat shield and structure is also given.

The trajectories during descent on the drogue and main chutes are given, including velocity, Mach number, flight path angle, altitude, and density. The parachute designs are given in terms of their area, diameter, and weight. Other pertinent information is given, including the parachute filling time, opening shock load, and the dynamic pressure at chute deployment. The number of clustered chutes required for the main system is also given, as well as the estimated parachute harness weight and the landed weight (WL).

The impact attenuator design results indicate the density of the attenuator material, the peak deceleration, the crush up stroke and history of deceleration versus stroke. The size of the impact attenuator, the mass of crush-up, and the residual mass are determined. Details of the internal structure are also provided.

The overall vehicle center of gravity and moments of inertia are finally determined and given as output.

2 0963	DIGITAL	COMPUTER	INPUT	PROBLEM	NO	18	82		PROG	RAMME	R		
	REQUEST FORM		TITLE	Pacl	aging	and M	Moments of	of In	ertia				
	MEMO NO	SECTION NO	WORK O	RDER NO		(E240 USE	ONLY)	REQUESTED	BY E	XT	EST TIME	PAGE	1 OF 3 PAGES
			I										
								1					
	ŞINPUT												
	ALPHA	=		,	ISP		* .		'	STI	RFAC	= _	,
	A0	=		,	IYR	.2	≈		_,	TF	MIN	= _	
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	A2	=			\mathbf{LC}		≈.		_,	TH	в	=	
	A3	=			LC	ØRCØ	≈ .		_,	TH	С	=	,
	BETA	=		,	LC.	YRCØ	≈.		_,	\mathbf{TH}	CØ	=	
	DELTA	=		•	LR	DR	~ .		و	TH	м	-	,
	DELMII	' =			МА	CD	≈.		_,	TH	N	= _	
	DLVFAC] =		,	ΜА	СМС	≈.		••	TH	S	=	,
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	DDMIN	=		,	MR		2		,	TH	3G	=	··
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	DMCMA	X =		'	RA		~ _		_,	TS	Ľ.	=	,
	DRVEL	=			RB		~ .		•	TS'	Г	=	
	EF	=		_,	ŘС		=		,	ΤZ	ERØ	= _	,
	EPSILN	=			RC	HUTE	۳.			VE	LW	= _	••
	EPS1	=			RH	∮СМ	≈ _		_,	VIN	ΔP	=	,
	EPS3	=		,	RH	∮СМІ	۳.		_,	vv		=	,
	FACTØI	٤ =		,	RH	⊅F	~ _		_,	WE	:	-	
l	FALR	=		,	RH	ØI	۳.		_,	XA		=	. <u> </u>
	FREQ	=		,	RH	ØRØC	۳.		,	xc		=	
	FREQ2	=		_,	RH	⊅SL	= _		_,	xc	GMIN	=	,
	FREQ3	=		,	RN		= _		_,	XD		=	,
	GAMD	=			RSI	3	= _		_,	ХМ	C	=	,
	GAMMC	=		,	RSC	;	= .		_,	XN		=	,
	GIMP	=			RSN	ĩ	= _		_,	XØ		=	
	GSL	=			RT		۳.		<u>`</u> ,	ZD			,
	IMPSYS	=		,	SIG	CYF	Ξ.	*	_,	ZM	С	=	,
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RAD 2-0984	DIGITAL CON	DIGITAL COMPLITER INPUT		MEMO NO	SECTION NO	CONTINUATION SHEET
5 63	REQUE	ST FORM	1882			PAGE 2 OF 3 PAGES
			•			•
	NRINGS	=,				
	DNBND		····· •	,		
	UPBND	=,_	,	,		
	SECTN	=		,,		······ •······ • ······· • ······· •
	WHSD	=,		,,,,		و و و
	WRING	=,		·•	• •	و و و
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RAD 2 00F4			PROBLEM NO.	MENO NO	SECTION NO T			
5-63	DIGITAL CO	JEST FORM	1882			CONTIN	DATION SH	EET
			·	L	I	PAGE	5 013	PAGES
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RAD 2-0963 PROBLEM NO 1882 PROGRAMMER DIGITAL COMPUTER INPUT REQUEST FORM TITLE Packaging and Moments of Inertia SECTION NO WORK ORDER NO MEMO NO PAGE 1 OF 3 PAGES 2996 K420 W305-050-0005 P. Levine \$INPUT ISP STRFAC ALPHA = 1.65E10, = ____ 1.5 0.010 A0 Ŧ 1.0 , IYR2 = 0.4 TFMIN JET THA -80.-A1 = 1.0 A2 LC THB = 0, A3 LCØRCØ THC = 60.0 BETA 0. LCYRCØ THCØ = DELTA .01 LRDR THM 90.0 Ξ DELMIT 1.E-5 THN MACD 60.0 = THS DLVFAC MACMC 1.2 = 0.2 DESSYS MCVEL = 2.0 **≕** 50. TH2G 0. DDMIN MR = TH3G 0. = DMCMIN PSI TN 10.0 = 1.81 2.1 = DMCMAX RA TSL 80.0 0. 200.0 = = DRVEL 50.0 RВ TST 100.0 0. EF 1.0E7 RC 7.5 TZERØ EPSILN 0.75 RCHUTE = 35.0 VELW 30.0 = EPS1 RHØCM = 0.40 VIMP = .001 °.= .001 60.0 EPS3 = 0.1 vv RHØCMI . FACTØR .2 RHØF 172. WE 1850. = = FALR 1.11367 RHØI = 1.5 XA ο. = RHØRØC хċ FREQ .5 .= .999 = = 2.56E-5 FREQ2 2. RHØSL XCGMIN 3,75 = = FREO3 2. 1.25 RN XD = = = GAMD RSB 0.15 XMC 1.8 = GAMMC -35.19 0.15 RSC - XN .001 GIMP 1000.0 RSN Ο. XØ =, 0, = GSL = 12.3 RT ' = 3.75 ZD IMPSYS Ξ 1.0 SIGCYF = 6.0E4 ZMC 21451. = ť .

RE-CRIDER NO. 66-441

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RE-ORDER No. 66-417

RAD 2-0964	DIGITAL CO	MPUTER INPUT	PROBLEM NO	MEMO NO	SECTION NO	CONTIN	UATION SH	IEET
3 65	REQI	JEST FORM	1882	*		PAGE	2 OF	3 PAGES
	NRINGS	=,						
	DNBND	=			•			
	UPBND	=						
	SECTN	= <u>1.0, 3</u> ,	0, 6.0, 1	0.0, <u>11.0</u> ,	13.0,		<u>``</u>	
	WHSD	= 1.0 , .94	<u>. 94</u> , .	94_;,		,,	,	
	WRING	=,			,	,,		 [
	WSTR	= .507 , .52	<u>6,.526,.</u>	526 <u>,405</u> ,	.414 ,			
	XRING	=,						
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	RR	=;	•				_'	(
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RAD 2-0964	DIGITAL COMPUTER INPUT	PROBLEM NO	MEMO NO	SECTION NO	CONTINU	ATION SHE	ET	
	REQUEST FORM	1882			PAGE	5 OF 3	PAGES	
	CDV = 1.0,	1.0 , 1.	<u>2, _1.5</u> ,	<u>1.5</u> ,,		,		_,
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	MACH = <u>0.0</u> ,	0.7 , 1.0	<u>, 2.0</u> , 6	.0_,,	,	<i>,</i>	¢	, ,
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•IBLDR 2591 K •IBLDR 2591 K •IBLDR 26071 U •IBLDR 26071 U •IBLDR 26074 K •IBLDR 2674 K •IBLDR 56773 K •IBLDR 56773 K •IBLDR 56774 K					12/01/6 12/01/4 12/01/8 12/01/6 12/01/6 12/01/6 12/01/6 12/01/6 12/01/6	4 SZBLC 4 S3DLC 4 SARTC 4 SGENC 4 SGENC 4 SGENC 4 SDFRC 4 SDFRC 4 SDAC 4 SPLC 5 SBLC 5 SATAC 4 SADAC 4 SBLC 5 SATAC	000 000 000 000 000 000 000 000 000 00			
IBLOR		-				12/01/	64			
	* MENORY MA	P *								
- CVCTEN		00000	THRM C	12717						
FILE BLOCK DRIGIN		02720								
FILFS	105	-								
FILF LIST OPIGIN	105	02750								
PRF-EXECUTION INITIAL	L7ATION	02754								~
CALL ON OBJECT PROGPA	4	02777		10547						
BBJFCT FROMAP	•	05004								
DECK ORIGIN	CONTROL SE	стіям\$	{/NAME/	=NGN 0	LENGTH, (L	OC 1=DELFTE	0, ≄=NDT	REFERENCES	?	
1 1992 03004	/// //77	6361		12246	*					
- 2. SZBLK 12262	111 111	4341	BLOCK2	16265						
3. 538LK 16766	BLOCK3 25	624								
4. SAPTLU 26462	ARTLU 27	204								
6. SGENSH 30027	- GENSHP 30	437						-		
7. STENSH 30545	TENSHL 31	367								
8. SFINDR 31533	FINDRY 32	505								
9. SOEP07 32704		434) 450	OFXAS	33273						
11. SPEAK 36610	PEAK 37	055								
12. SR2R3 37140	R283 37	343								
13. SBL3IN 37402	BL3INT 40	031 722								
15. SATMOS 41112	ATMOS 41	374								
16. LXCON 41505	IXSTR 41	505 * "	"LXSTP"	41511	-LXOUT	41 55 7	-LXRTN	-41571	IBEXIT	41571 *
	.LXCAL 41	574 *	-LXFRR	41574	-D8CLS	41756 *	-LXARG	42125	•L0 -	42150 *
17. JODEE 42165	DEFIN 42	165	ATTAC	42157	* .CL3SE	42173	-OPEN	42175	+SE4D	42177
	WRITE 42	201	- B SR	42211	* .READS	42221	RELES	42723 *	.CAREA	47234
	LFBLK 42	252	LTSX	42755	* AREAL	42257	-LUNAL	42275	. ENTRY	42301
	-GDA 42	334 401	•60	42340	-DERR	42354	-NUPX1	4/354	+00481	42371
18. LXSL 42406	LXSFL 42	406 1	LXCSEL	42407	LXTST	42412 *	+LXOVL	42452 *	.LXRCT	42463 *
	LXIND 42	532 *	+LXDIS	42535	* LXFLG	42536 *	.LTCH	42537		
19. FPTRP 42545	FFPT. 42	545 * 766 i	.FPOUT	42674	- PPARG	42702	7.COUNT/	427(14 #	UVECOW	42/50 *
21		761	CC.2	42762	CC.3	42763	66.4	42765		
22. XIT 42765	FXIT 47	765	EXIT.	42765	*					
23. FXFM 47766	.FXF4. 42	766	FXOUT	43323	FXARG	43331	/.OPTH./	43405		
24. FOUT 43416	.FOUT. 43	416	ECNV	44007	ENDER	44014	rayer	44020 1	- FOX 7	64026 -
77. PUNY 45/60	FDY2 44	025	DBC	44027	+D8C8	44150	+D8C9	44153	DBC 10	44160
	D9C20 44	206	0.059	44216	00F1X	44225	FIXSW	44233	.DDBC	44310 -
	-DDRS1 44	552	DDRS2	44564	+D1	44557	.02	44571	.FFRP2	44656 *
	.ANPT 44	712	-UNPT	44727	LNTP	45093	ADUT	45057	*UPLT INTC	45070
	- LOUT 45	633 -	-00UT	45652	.FX0	45703	TEST	46410	KOUNT	46413
	-LIST 46	416	DUNE	46427	DUTRE	45473	-8JF	46521	-0STO	46522
· · ·		523	-GAIN	46524	-GAINL	46525	+F8D8F	46535	CONNEL	46560
	.DDFLG 46	561 -	YOD	46567	•PEX	46553	FEXP	46564	.016	46565
26. FIDS 46605	•F105• 46	770	• PSEL •	46745	+ FILR.	46751	*FK18*	40760 *	TOUT	40/05
	+**************************************			47142	- +ruPN	+3110 4	AGUE			

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	IBLOR					-	12/01/6	54	-		
			(1)(2)					50403			
27. FIOH	47241	.FIGH.	47241	. FFIL.	50030	-FRIN-	4/175 50055 #	+FUX52	4/15/ 4		
28. FWRD	5024?	.FHRD.	50242								
30. 6440	50266	.FWRO.	50246		50615 *						
31. FR00	50717	.FRDU.	50717								
32. UN05	50760	-UN05-	50760	BHES7	50762						
-34. FTOU	50765	.F 190.	50765	.CTUIO	51440	.NHLST	51453	.NAME.	52566	. INTAP	52567
35. JASIN	53212	ASINR	53272		53301	ASIND	53310 *				
37. JTNOR	53424	ATANOR	53502	ATANO	53511 *	ATANOD	53520 *				
38. JRSIM	53527	ARSIMP	53570								
40. FXPF	-53762	FXP	53762	ALUG	5 1623						
41. FSCN	54102	cos	54102	SIN	54104		_				
42. FSOR 43. FATN	54313 54420	SORT ATAN2	54313	ATAN	54422 *						
44. FXP3	54626	•XP3•	54626				-				
45IOCS	54753	-L(0)	54753	- MONSH	54773	TEOR	55042	-DEF1-	55122	- JOINX	55166 *
		+0P4	55543 ×	.027	55574 *	.OP9.2	55610 ¥	.RLSE.	55662	.RFR 2	55662
		.RFAD.	55663	- RERIT	55706	WRIT.	55710	WNT1A	56076	EDFFX	56157 *
		SEL 59	57450	-BSR-	60061	.60106	60206	*KE7	60214 *	SWITC	60243
		.TCHEX	60544	-BASIO	60547 *						
4610CS4	60550										
1/0 0055500											
TTU BOFFERS			605	SO THEO	(1113						
UNUSED CORF			77	34_THRU 7	7433	-					-
\$INPUT											
SECTN =	0.1	0000000F 01, 3000000E 02,		0.30000000	E-38,	- 0.600	00000E 01,	8	-10000000E	-38,	0.11000000F 02.
PN 10	0.1	25000000 01.									
		700000000-38-									
RSC =	0.1	500000000 001	·								
RSB =	0.1	5000000E 00,					-				
RA =	0.0	0000000E-38,									
THN =	0.6	000000000 021									
THC =	0.6	0000000E 02,									
THB =	0.0	01000008-38,									
THA =	-0.4	0000000F 02,									
XX =	0.0	000000007-38,		0.00000000)E-38,	0.000	0000E-18,	0	.0000000E	-38;	0.0000000E-38,
	0.0	0000000E-38,		0.00000000	DE-38,	0.000	0000E-18.	0	.00000000E	-38,	0.00000000E-38.
	0.0	0000000E-38,		0.0000000	0F-38.	0.000	00002-18,	ō	.0000000E	-38,	0.0000000E-38.
	. 0.0	0000000E-38,		0.00000000	DE-38,	0+000	00000E-18,	0	-0000000E	-38,	0.00000000F=38,
RR =	0.0	000000000-38	· · · · ·	0.0000000	DE-38,	0,000	00000E-38."	0	-0000000F	-38,	0:00000000000007387
	0.0	00000008-38		0.0000000	DF-38,	0.000	00000E-38,		-0000000E	-38,	0.0000000E-38+
	0.0	000000000000000000000000000000000000000		0.00000000	JE-38,	0.000	00000E-38,	ŏ	.00000000E	-38,	0.00000000E-38,
	0.0	000000F-38,		0.0000000	1E-38,	0,000	000002-38,	0	200000006	-38,	0.000000008-38-
-1C =	0.0	0000000E-38			•						
R8 =	0.0	1000000008-387									
-RC =	0.1	5000000E-01					· ·· ··				
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BETA =		1000000ar-38			•						•
THZG =	-0-0	0000000F=38									
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#r150 #	0.0	0000000E-38		-0.0000000	0F-19,	-0.000	00000E-19,	0	.00000000F	-19.	-0.00000000F-19,
WSTR =	0.5	597000005 00		0.5260000	0E 00.	0.576	000005 00,	- 0	-52600000E	00,	0.405000000 00,
	0.,	140000F-00		-0.0000000	ue-19,	-0.040	0000649,	-0	• 0000000E-	-19,	-u.00000000E-19;
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0.100000000 01;

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HACD		-0.00000000E-19,				
ZD	=	-0.0000000E-19,				
GAND	-	-0.00000000E-19,				
COD		-0.04046848E-26,	-0.04046847E-26,	0.205997108-24,	-0.00007680E-26.	0.20780487E-24,
		0.49963344E 00;	-0.00007880E-26,	0.00080777E-23,	-0.00000020E-26,	0.20780487E-24,
_		0+49938931E 00+	0.33135625E-23,	-0.70535401E-37,	0.10164460E-19,	0.00012614E-25,
		0.135854902-19.	0.00114795E-38,	-0.473197802-37.	0.00114797E-38;	-0.70529706E-37,
_		0.00028629E-38.	0.0000036E-26,	0.04144116E-23.	0.00000565E-38,	0.16181135E-25,
		0.00007878E-26,	0.31554578E-29,	0.10359927E-24.	-0.00000362E-36,	0.04417637E-27,
_		0.47111610E-37.	0.00028638E-38,	0.00080780E-24.	0.00028622E-38,	0.13579004E-19.
		-0.705354016-37.	0.135789986-19,	-0.33167972E-23,	0.18844881E-36,	0.00000235-38,
		0.16940659E-20.	0.00007877E-26+	0.103599416-24,	0.13578997E-19,	0.33167983E-23,
		0.000315158-26,	0.001/20325-14,	-0.331033/12-23;	-0.2058/5832-23	0.000005658-38.
XD	-	-0.0000000E-19,				
HACHC	F	0.12000000E 01,	- <u></u>		·······	
ZHC	=	9.21451000E 05,				
CORC	-	0.80000005 00-	0.80000005.00.	OT TODODODDE OT	0.1000000F 01.	
CONC	~	0.188440995-36.	0.16181135E=25.	0.00080781E=24-	0.12621977E-27.	0.414398105-24.
		0.000286305-38-		0.0000000000000000000000000000000000000	-0.000000005-37.	0-036736201-38-
		-0.715135705 24.	0.000000005-37	0.268663816-14	-0.001101145-19.	-0.06095738E 02.
		-0.060952395 02.	0.210797015-35	-0.17220459F=27-	-0.94603335E=26.	-0.892973715 06-
		0.00000008-38-	0-0000000E=38	0.000000005-38-	0.0000000E-38.	0-0000000E=38-
		0.000000000-38-	-0.000000305 19-	0.000104745 10.	-0.001219625-38	-0.012835105-19
		0.0000036E-19.	0.00000036E-19.	0.0000000E-38	0.0000000E-38.	0.00000000E-38.
		0.000000005-38.	0.0000000E-38.	0.0000000E-38.	0.000000000-38.	0.000000000000-38.
		0.0000000E-38.	0.0000000E-38,	0.0000000E-38,	0.0000000E-38,	0.0000000E-38.
XMC	-	0.18000000E 01.				
CDV	=	0.10000000E 01,	0.1000000E 01,	0,12000000E 01,	0.15000000E 01,	0.15000000E 01,
		-0.35764838E-37,	-0.0004/903E-31,	-0.040468165-26,	0.082/98/56-23.	0.00007851E-26,
		-0.47025514E-37.	0.00007853E-26.	0.10359898E-24,	0.00005131E-24,	-0.00008056E-23,
		0.49841258E 00;	0.13571695E-19,	0.13579000E-19;	0.000315156-26.	0.00028615E-38,
_		0.00015777E-26,	-0.00001985F-31,	0.08312195E-23,	0.33119475E-23,	0.331356316-23,
		0.12943596E-25.	0.13565698E-19.	0.20687552E-23+	0.338813186-20,	0.135591455-19,
		0.13571696E-19,	-0.00061630E-29,	0.041762928-23.	-0.00007860E-26.	0.00080777E-23,
		-0.00015777E-26+	-0.00048089E-31,	=0.000000016=20;	0.00028605E-38,	-0.00585335F 19,
		0.00007878E-26,	0.31554578E-29,	0.000183132-36+	0.041439/12-23,	-0.00317302E 00,
GSL	-	0.123000000 02,				
-99	*		·			
Therewe	-	0.20000000 01.				
	-					
-XN	÷	0.1000000E-02,				
xo		0.000000000-38,			······································	
xc	*	0.999000000 00,				
XA	×	0.000000000-38,			·······	

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TSL	=	0.2000000E 03,				
TST	ĸ	0+10000008 03+				
RHOSL	=	0.256000008-04,				
FALR	2	0.11136700E 01,				i
ISP	=	-0.0000000E-19,				
MR	=	-0.0000000F-19,		· ·		
RHOROC	=	-0.00000000E-19,				
VIMP	=	-0.00000000E-19,				
LRDR	-	-0.000000000-19,				
DIVFAC		-0.0000000F-19,				
TZERO	.=	0.000000005-38,				
DELTA	=	0.1000000E-01,				
UPBND	=	0.1000000F-01,	0.1000000E-04.	0.1000000E 00,		
ONBND	-	0+1000000E-02+	0.1000000E-05,	0.1000000E-01,		
FRED	=	0.5000000E 00,				
FACTOR	=	0.2000000E 00,			•	
DELMIT	=	0.10000000E-04,				
DHCMAX	=	0.8000000F 02.				
MACH	=	0.0000000F-38.	0.70000000E 00,	0.10000000E 01,	0.2000000E 01,	0.6000000E 01,
		0.000009862-36	0+33181914E-23+	0.351550000-257	-0.000916205 18	-0.000631105-26
		0.101044516-244	0.000002816-24,	0.101000152-224	-0.000910202 194	
		9-000289572-564	0.100440000-505	-0.000000252-581	0.000031101-200	0.000(0)300 00
		0.000078776-26,	0.103801482-24,	0.185448565-36,	=0.0000023F=38;	0.000631106-207
		0.000285416-38,	0.10339/816-24,	0.0000/8882-26;	0.103400395-24,	0.155849516-197
		0.13572358E-19,	0.339474936-20,	-0.00030652E-29,	0.03975120E-29,	0.04136187F-23,
		0.11858461F-19.	-0.0000001E-20,	0.01588642E-19,	0.266456776-14.	0.33167960E-23.
		-0.00007328E-35.	0.04417637E-27,	0.00032080E-26,	0.00028619E-38,	0.00031514F-26,
		0.00028579E-38,	0.12943596E-25,	0.000157778-26,	0.04143971F-23,	-0.35276303F-37;
GAMMC		-0.35190000E 02.				
DONIN	-	~0.0000000E-19,				
DRVEL	=	0.5000000E 02;				
MCVEL	-	0.5000000E 07,				
FREDZ	-	0.200000000 01.				
FRFQ3	=	0.2000000E 01,				
DHCHIN	a	0.100000000 02,	· · · ·			

RHOT =	0.150000000 01,				·····
RHOCH =	9.4000000F 00.				
RH0CH1 =	0.1000000E 00,				-
ALPHA =	0.16500000E 11.				
PSI =	0.18100000E 01.				
EPSTIN =	0.75000000E 00.				
THN =	0-9000000E 02+				
VELV =	0.3000000E 02.				
GINP =	0.10000000E 04.				
THPSYS =	0.1000000E 01.				
	0.0000000F-38.				
	0-0000000F-38+				
THCO =	0.000000000-38				
<u> </u>	0.10000005 01.				
A1 =	-0.0000000E-19.				
A7 =	-0.0000000E-19.				-
	-0.0000000F-19.				
EDS1 =	0.10000000E-02.				
EPS3 =	0.10000000E-02.				
TN =	0.21000000E 01.				
IYB2 =	0.400000000 00.				
FF =	0.1000000E 08.				
805 =	0.17200000E 03.				
TENTN =	0.1000000E-01.				
SIGCYE =	0.600000000 05,			3	•
THS =	0.2000000E 00,				
XCGHIN =	0.37500000E 01,				
RCHUTE =	0,35000000E 02,				
NRINGS =	0,			3	
XRING =	-0.0000000000-19,	-0.0000000E-19,	-0.00000000E-19.	-0.0000000E-19,	-0.0000000E-19.
	-0.00000000E-19.	-0.0000000E-19,	-0.00000000E-19,	-0.00000000-197	-0.000000000-19,
WRING =	-9.0000000E-19, -0.00000000E-19,	-0.00000000E-19, -0.00000000E-19,	-0.00000000E-19;	-0.00000000E-19, -0.00000000E-19,	-0.00000000E-19, -0.00000000E-19,
\$ ENO	· · · · · · · · · · · · · · · · · · ·				

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	X COORDINATES	R COORDINATES				
	0-0000E-39	0.0000E-39				
	1.0694E=02	1-6316E-01				
	4.2593F-02	3.23526-01				
	9.51510-02	4.7835E-01				
X1 =	1.6747E-01 R1 =	6+2500E-01				
X3 =	4.0934F 00 R3 =	7,42508 00				
	4.1173E 00	7.4561E 00				
	4.1484E 00	7.4799E 00				
	4.1845E 00	7.4949E 00				_
X4 ≅	4.2234E 00 R4 =	7.5000E 00				
	4.2747E 00	7.4910E 00				
	4.31081 00	7.4649E 00				
¥0 -	4,35335 00	7+4250E 00				
X0 -	4.3711E 00 K8 =	7.37602 00				
	5 01045 00 44 -	2 91255 00				
	5 01045 00	1 87505 00				
	5-01045-00	9.37505-01				· · · · · · · · · · · · · · · · · · ·
×10 =	5.0104F 00 R10 =	0.0000E-39			-	
SECTIO		NUS.	ист	TY	17	YCG
340110	ET2			re	10-6721	
	112	12037	(Char	(3)	200 1127	
<u> </u>	1.3153E 00	1.3153E 00	1.00035 00	1-4395E=02	7.8704E=03	8.3734E-02
	1.9857E 02	1.8666E 02	1.566BE 02	2.96288 02	2.4116E 02	2.6832E 00
6	7.3766E 00	6.9340E 00	5.8201E 00	2.21476 01	1.7904F 01	4.1518E 00
10	9.8114E 00	9.2227E 00	7.74126 00	2.9316E 01	2.4463E 01	4.3119E 00
11	1.2870E 02	0.0000E-39	7.8184E 01	8.3201E 01	9.6954E 01	4.6560E 00
13	4.4179F 01	0.0000E-39	2.74358 01	5.9963E 00	2.4408E 01	5.0104E 00
TOTAL	HEAT SHIELD - STRUCT	TURE RESULTS				
WHSTO WSTTO	01 = 2.0413F 07 217688€ 02 -	HR = 1.3690E XCGH/S = 3.2205E	03			
	,	VEL	MACH	GANHA	ALT	RH0
UNDRELO	IN AT 27146 IN 40					
UNDREID	W AT 27150 IN MO					
UNDRFLO	W AT 27151 IN 40					
UNDRELO	W AT 27154 IN MO					
UNDRELO	W AT 27156 IN MO					
CLUSTER	OF 5. CHUTES RE	EQUIRED.				
	3.7475F 00	1.8440E 02	2,740E-01			1.60256=05
	5.7475F 00	1.13336 02	1,6826-01	-4.6467E 01	1.94596E 04	1.6105E-05
	2.2175E 02 2.9596E 02	6-3248E 01 6-0096E 01	8,756E-02 8,158E-02	-9-000E 01	4.57416E 03	2:3124E-05 2-5660E-05
	4					

AMC = 3.5697574E 07 DMC = 6.7228651E 01 WML = 1.3603889E 02 VMC = 1.2505330E 05 WL = 1.2251706E 03 T = 2.9595168E 02 T TF = 1.7475145E 00 0MC = 4.8928737E 00 WSTRAPS = 6.8019444F 00

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RHDC=	4.0000E	-01 GPEAK=	6.0878E 02	Y/R7=	1+0284E-01		
GPEAKS		Y/R2 VALUES					
-0.0	000E-39	0.0000E-39		`			
7.4	598E 01	1.0284E-02					
1.4	601E 02	2.0568E-02					
2.1	430E 02	3.0852E-02			,		
2.7	950E 02	4.1136E-02				· · · · · · · · · · · · · · · · · · ·	
3.4	168E 02	5.1420E-02					
4.0	087 <u>E 02</u>	6.1704E-02					
4.5	714E 02	7.1988E-02	<u></u>		`		
5.10	051E 02	8.2271E-02					
5.6	105E 02	9.2555E-02				<u></u>	
6.08	878E 02	1.0284E-01					
SPHERE	OPTION						
R2 = 2 MC = 2 TF =	2.0177003 4.9207532 5.1174	E 00 T = 2.76 E 00 YDD/G = E-03LESS THAN	66522E-01 S 6.0877760E 0 1.0000E-	= 2.661719 2 RHOC = 2 02 MINIMUM	95E 05 MI = ••0000000E-0 GAUGE FACE	3.3159080E 01 DI SHEET.	
XCGO	= 2	4522E 00 DELX	-= 1.65	33E=01 XII		- 92996 05 - 4101CG	=
INTERN/	IE STRUCT	URE DESIGN					
		AREAL	FT23	TINS	·	#(LB5)	
SPHERE		3.809	1E 01	1.00005-	-02	5.4597E 00	
W INTER	NAL STRU	CTURE = 5.45	97E 00				

III. COMPUTATIONS

In the following pages are presented block diagrams illustrating the operation of each portion of Program 1882 and the engineering equations which are solved.

The block diagrams and engineering write-ups are broken down into the four portions of the program, namely; heat shield and structural shell, descent system, impact attenuation system, and the lander packaging design. Symbols used precede the equations.

A. BLOCK DIAGRAM

A block diagram of Program 1882 is shown below as Figure 7.



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Figure 7 BLOCK DIAGRAM OF PROGRAM 1882

B. SYMBOLS

^a o, ^a 1, ^a 2, ^a 3	Coefficients of the $S(\theta)$ equation in the anisotropic crush- up analysis
A	Area, ft ²
a	Speed of sound, ft/sec
CD	Drag coefficient
C _p	Specific heat at constant pressure, Btu/lb
d	Diameter, feet
D	Drag force, pounds
E	Modulus of elasticity, psi
g	Acceleration due to gravity, ft/sec ²
I sp	Required specific impulse of retrorocket system, lb-sec/lb
I _x	Roll moment of inertia, slug-ft ²
^I y	Pitch moment of inertia, slug-ft ²
L ₁	Temperature gradient in the troposphere expressed as a function of the adiabatic lapse rate
L _c	Length of cylindrical vehicle section, feet
L _{co}	Length of internal cone, feet
L _{cyl}	Length of internal cylinder, feet
L _o	Temperature gradient in the troposphere, $^{\mathrm{o}}\mathrm{K/ft}$
L _R	Length of a retrorocket, feet
m	Mass, slugs
М	Mach number
М	Molecular weight
MR	Mass-fuel ratio of retrorocket
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ζ N	Exponent of the $S(\theta)$ equation in the anisotropic crushup analysis
n	Number of chutes in a cluster
Р	Opening parachute shock load, pounds
q	Dynamic pressure, lb/ft ²
r	Vehicle ordinate dimension, feet
R	Universal gas constant, 89,516 ft 2 /sec 2 -mole - $^{\circ}$ K
R ₁	Inner radius of lander payload package, feet
R ₂	Outer radius of lander payload package, feet
R _A	Aft spherical body radius, feet
R _B	Flare body radius, feet
R _C	Vehicle cylinder body radius, feet
^R CO	Radius of internal cone and/or cylinder, feet
R _N	Spherical nose cap radius, feet
R _{SB}	Toroidal radius adjacent to the flare cone section, feet
R _{SC}	Toroidal radius adjacent to the cone section, feet
R _{SN}	Toroidal radius adjacent to the spherical nose cap section, feet
R _T	Aft cone base radius, feet
s	Crushing stress of impact material, $1b/ft^2$
tfs	Internal structure face sheet thickness, inches
tc	Thickness of the crushable material, feet
tcc	Thickness of the parachute packaging ring, feet
т	Temperature, ^O K

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V _{mp}	Design impact velocity for the retrorocket system (ver- tical and horizontal component included), ft/sec			
v _o	Total resultant impact velocity, ft/sec			
v _v	Design vertical descent velocity for chute systems, $ {\rm ft}/ {\rm sec}$			
v _w	Horizontal velocity component, ft/sec			
w	Unit weight, 1b/ft ²⁻			
w	Weight, pounds			
₩ _e	Total vehicle entry weight, pounds			
W _{RR}	Entry weight less the total heat shield and structure weight, pounds			
x	Vehicle abcissa dimension, feet			
x	Centroidal distance as measured from the vehicle nose, feet			
x _A	Mole fraction of argon in the atmosphere			
х _с	Mole fraction of CO_2 in the atmosphere			
x _D	Dynamic opening shock load factor on the drogue chute			
X _{MC}	Dynamic opening shock load factor on the main chute			
x _N	Mole fraction of $\ensuremath{\mathrm{N}_{2}}$ in the atmosphere			
х _о	Mole fraction of O_2 in the atmosphere			
ΔX	Distance between vehicle nose and lander nose, feet			
у	Crushup stroke coordinate, feet			
z	Altitude, feet			
a	Curve fit constant relating crushing stress and density			
β	Initial body angle in the tension shell section, degrees			
γ	Flight path angle (positive in climb), degrees			

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- ϵ Total usable strain
- $\theta_{\rm 2G}$ Initial body angle of the general shape section. degrees
- $\theta_{\rm 3G}$ Final body angle of the general shape section, degrees
- θ_A Aft cone section body angle, degrees
- $\theta_{\rm B}$ Flare section body angle, degrees
- $\theta_{\rm C}$ Cone section body angle, degrees
- $\theta_{\rm CO}$ Internal lander cone angle, degrees
- $\theta_{\rm M}$ Angle subtended by the crushable material segment, degrees
- θ_N Complement of nose cap angle, degrees
- ρ Density, slug/ft³
- σ Yield strength of face sheet, psi
- ψ Curve fit constant relating crushing stress and density

Subscripts:

1,2,3, etc.	Designated points on the vehicle surface
c	Crushup
cl	Parachute cluster
c.g.	Center of gravity
D	Drogue parachute conditions
f	Final utilized value
fs	Face sheet (internal structure)
HS	Heat shield
H/S	Heat shield and structure

1	Internal lander (payload and crushup)			
11	Initial weight just prior to retrorocket ignition			
ımp	Impact conditions			
m	Maximum			
MC	Main chute conditions			
R	Retrorocket conditions			
SL	Sea level conditions			
ST	Stratosphere conditions			
STR	External structure			
susp	Suspended weight on chute system			
v	Vehicle profile			
vert	Vertical component			
w	Wind component			
0	Earth conditions			

C. ENGINEERING EQUATIONS

1. Heat Shield and Structural Shell System

There are 13 possible body sections which exist for the overall general shape. The x and r coordinates can be evolved for any shape via equations which are provided. These coordinates are evolved from input body parameters.

For the tension shell option, the x and r coordinate equations are provided, and for the general shape option the x and r coordinates are specified as inputs.

With the body coordinates in hand for the desired vehicle shape, the area, centroid, moments of inertia, and weight of each section are then calculated.

The final calculation in this portion of the program is to establish the center of gravity of the heat shield and structural shell.

RE-ORDER No. 66-417

2. Shape Generation Equations

a. SECTIØN 1. Spherical Nose Cap					
	Coordinates	Formula	Independent Variable Limits		
	x _o	$\mathbf{x}_{\mathbf{o}} = 0$	$\theta_{0} = 90^{\circ}$		
	$\mathbf{x}_o \rightarrow \mathbf{x}_1$	$\mathbf{x} = \mathbf{R}_{\mathbf{N}} (1 - \sin \theta)$	$\theta_1 = \theta_N$		
	×1 .	$\mathbf{x}_{I} = \mathbf{R}_{N} (1 - \sin \theta_{N})$	$\theta_{\mathbf{o}} \leq \theta \leq \theta_{1}$		
·	r _o	r _o = 0			
	$r_o \rightarrow r_1$	$r = R_N \cos \theta$			
	r ₁	$r_1 = R_N \cos \theta_N$			
Ъ.	SECTIØN 2. Toru	15			
			0		
	$x_1 \rightarrow x_2$	$\mathbf{x} = \mathbf{x}_1 + \mathbf{R}_{SN} (\sin \theta_N)$	$-\sin\theta$		
	x 2	$x_2 = x_1 + R_{SN} (\sin \theta_N)$	$-\sin\theta_2$)		
	$r_1 \rightarrow r_2$	$\mathbf{r} = \mathbf{r}_1 + \mathbf{R}_{\mathrm{SN}} (\cos \theta - $	$\cos \theta_{\rm N}$)		
	θ_2 depends on whether θ_2 depends on whether θ_2 depends on whether the set of t	$r_2 = r_1 + R_{SN} (\cos \theta_2)$	- cos θ _N) ed•		
	SECTION 3.	$\theta_2 = \theta_2$			
	SECTIØN 4.	θ ₂ = β			
	SECTIØN 5.	$\theta_2 = \theta_{2G}$			
c.	SECTIØN 3.				
		•			
	$x_2 \rightarrow x_3$	$x = x_2 + (r - r_2) \cot \theta$	$r_2 \leq r \leq r_3$		
	· *3	$\mathbf{x}_3 = \mathbf{x}_2 + (\mathbf{r}_3 - \mathbf{r}_2) \cot$	θ_{c} .		
	$r_2 \rightarrow r_3$	r = r			
đ.	r3 SECTIØN 4.	$r_3 = R_C - R_{SC} (1 - c)$	$\cos \theta_{c}$)		

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$$\mathbf{r} = \begin{bmatrix} \mathbf{r}_{3}^{2} + (\mathbf{r}_{2}^{2} - \mathbf{r}_{3}^{2}) & \frac{\ln\left(\frac{1+\cos\theta}{\sin\theta}\right)}{\ln\left(\frac{1+\cos\beta}{\sin\beta}\right)} \end{bmatrix}^{1/2} \qquad (1)$$

$$\mathbf{x} = \mathbf{x}_{2} + \int_{\mathbf{r}_{2}}^{\mathbf{r}} \cot\theta \, d\mathbf{r} \qquad (2)$$

$$r_3 = R_C - R_{SC}$$
(3)

e. SECTIÓN 5.

Table of x and r coordinates (maximum of 25 points)

First pair of coordinates are x2, r2

Last pair of coordinates are x3, r3

Also specify θ_{2G} and θ_{3G}

$$\mathbf{x}_{2} = \mathbf{x}_{1} + \mathbf{R}_{SN} \left(\sin \theta_{N} - \sin \theta_{2G} \right)$$

$$\tag{4}$$

$$r_2 = r_1 + R_{SN} \left(\cos \theta_{2G} - \cos \theta_N \right)$$
(5)

$$\mathbf{x}_3 = \mathbf{x}_2 + (\mathbf{r}_3 - \mathbf{r}_2) \cos \theta_{2G}$$
 (6)

$$r_3 = R_C - R_{SC} (1 - \cos \theta_{2G})$$
 (7)

f. SECTIØN 6.

r4

$$\mathbf{x}_3 \rightarrow \mathbf{x}_4$$
 $\mathbf{x} = \mathbf{x}_3 + \mathbf{R}_{SC} (\sin \theta_3 - \sin \theta)$ (8)

$$\mathbf{x}_4 \qquad \mathbf{x}_4 = \mathbf{x}_3 + \mathbf{R}_{\mathrm{SC}} \sin \theta_3 \qquad \theta_3 \leq \theta \leq 0^\circ \qquad (9)$$

$$r_3 \rightarrow r_4$$
 $r = r_3 + R_{SC} (\cos \theta - \cos \theta_3)$ (10)

$$t_{\ell} = B_{\ell}$$
(11)

 θ_3 depends on which option section (2-3) utilizes, i.e:

SECTION 3. $\theta_3 = \theta_c$. SECTION 4. $\theta_3 = 90^\circ$ SECTION 5. $\theta_3 = \theta_{3G}$ g. SECTIØN 7.

$x_4 \rightarrow x_5$	x = x	$x_4 \leq x \leq (x_4 + L_c)$	(12)
x ₅	$x_5 = x_4 + L_c$		(13)

 $r_4 \rightarrow r_5$ $r = R_C$ (14)

$$r_5 r_5 = R_C$$
 (15)

h. SECTIÓN 8.

	$x_5 \rightarrow x_6$	$x = x_5 + (r - R_C) \cot \theta_B$	$r_5 \leq r \leq r_6$	(16)
•	×6	$x_6 = x_5 + (r_6 - R_C) \cot \theta_B$		(17)

$$r_5 \rightarrow r_6 \qquad r = r$$
 (18)

$$r_{6} = R_{B} - R_{SB} (1 - \cos \theta_{B})$$
 (19)

i. SECTIÓN 9.

^x 6 → ^x 7	$x = x_6 + R_{SB} (\sin \theta_B - \sin \theta)$	$\theta_{\rm B} \leq \theta \leq 0^\circ$	(20)
*7	$x_7 = x_6 + R_{SB} \sin \theta_B$		(21)
$r_{6} \rightarrow r_{7}$	$I = I6 + R_{OP} (\cos \theta - \cos \theta_{P})$		(22)

$$5^{-1}/1^{-1} = 16 + N_{SB} (\cos \theta - \cos \theta_B)$$
 (22)

$$r_7 r_7 = R_B$$
 (23)

J. SECTION 10.

$$x_7 \to x_8$$
 $x = x_7 - R_{SB} \sin \theta$ $0^\circ \le \theta \le \theta_A$ (24)

$$x_9 \qquad x_8 = x_7 - R_{SB} \sin \theta_A \tag{25}$$

$$r_7 \rightarrow r_8$$
 $r = R_B - R_{SB} (1 - \cos \theta)$ (26)

$$r_8 = R_B - R_{SB} (1 - \cos \theta_A)$$
 (27)

k. SECTIØN 11.

$$x_8 \rightarrow x_9$$
 $x = x_8 + (r - r_8) \cot \theta_A$ $r_9 \le r \le r_8$ (28)

$$x_9 = x_8 + (r_9 - r_8) \cot \theta_A$$
 (29)

$$r_8 \rightarrow r_9$$
 $r = r$ (30)

(31)

 $r_9 = R_A \cot \theta_A$

1. SECTIÓN 12.

$$x_9 \rightarrow x_{10}$$
 $x = x_9 + R_A (\sin \theta_A - \sin \theta)$ $\theta_A \le \theta \le -90^\circ$ (32)

$$x_{10}$$
 $x_{10} = x_9 + R_A (\sin \theta_A + 1)$ (33)

$$r_9 \rightarrow r_{10}$$
 $r = R_A \cos \theta$ (34)

$$r_{10} = 0$$
 (35)

m. SECTIÓN 13.

$$x_9 \rightarrow x_{10}$$
 $x = x_9$ $0 \le r \le R_T$ (36)

$$x_{10}$$
 $x_{10} = x_9$ (37)
 $r_9 \rightarrow r_{10}$ $r = R_T - r$ (38)

$$r_{10}$$
 $r_{10} = 0$ (39)

a. The nose cap, SECTIØN 1. cannot be omitted.

b. If the R_{SN}torus, SECTIØN 2. is omitted, then:

$$x_2 = x_4$$

 $r_2 = r_4$

d. If the cylinder, SECTIØN 7. is omitted, then:

 $x_5 = x_4$ $t_5 = t_4$ e. SECTIØN 8. and SECTIØN 9. can be omitted together only in which event: $x_7 = x_6 = x_5$ $t_7 = t_6 = t_5$. f. If SECTIØN 10. is omitted: $x_8 = x_7$ $t_8 = t_7$. g. If SECTIØN 11. is omitted, then: $x_8 = x_9$ $t_8 = t_9$. h. Either the aft sphere, SECTIØN 12. or the base, SECTIØN 13. has to be specified. Both can not be simultaneously present or deleted.

Listed below are the equations for the surface area, centroid, and moments of inertia of each section. The centroid and moments of inertia are measured about the nose of the vehicle.

- a. SECTIØN 1.
 - 1) Area

$$A = 2\pi R_{\rm N}^2 (1 - \sin \theta_{\rm N}) \, r \tag{40}$$

- 2) $\frac{\text{Centroid}}{\bar{X}} = \frac{\pi R_N^3}{A} [2(1 \sin \theta_N) \cos^2 \theta_N]$ (41)
- 3) <u>Roll moment of inertia</u>

$$I_{x} = \frac{2\pi w_{01} R_{N}^{4}}{3g_{\theta}} \qquad [2 - \sin \theta_{N}(\cos^{2} \theta_{N} + 2)]$$
(42)

4) Pitch moment of inertia

$$I_{y} = \frac{2\pi w_{01} R_{N}^{4}}{3g_{\oplus}} [1 - 3\sin\theta_{N} + 3\sin^{2}\theta_{N} - \sin^{3}\theta_{N}] + \frac{I_{x}}{2}$$
(43)

where $\,w_{01}$ is the sum of the unit heat shield and structure (the structure includes the weight factor STRFAC)

SECTIÓN 2. ь.

1) Area

$$A = 2\pi R_{SN} \left[\frac{R_{SN} \cos \theta_N}{57.3} \quad (\theta_N - \theta_2) + R_{SN} (\sin \theta_N - \sin \theta_2) + \frac{R_{SN} \cos \theta_N (\theta_2 - \theta_N)}{57.3} \right]$$
(44)

2) Centroid

$$\widetilde{X} = \frac{2\pi R_{SN}}{A} \left[\frac{A_{12} B_{12}}{57.3} (\theta_N - \theta_2) + B_{12} R_{SN} (\sin \theta_N - \sin \theta_2) + A_{12} R_{SN} (\cos \theta_N - \cos \theta_2) - \frac{R_{SN}^2}{2} (\sin^2 \theta_N - \sin^2 \theta_2) \right]$$
(45)

3) Roll moment of inertia

$$I_{x} = \frac{2\pi \ w_{12} \ R_{SN}}{g_{\oplus}} \left[\frac{A_{12}^{3} \ (\theta_{N} - \theta_{2})}{57.3} + 3 A_{12}^{2} \ R_{SN} (\sin \theta_{N} - \sin \theta_{2}) + \frac{3}{2} A_{12} \ R_{SN}^{2} \left(\frac{\theta_{N} - \theta_{2}}{57.3} + \frac{\sin 2 \theta_{N} - \sin 2 \theta_{2}}{2} \right) + \frac{R_{SN}^{3}}{3} \left\{ \sin \theta_{N} \ (\cos^{2} \theta_{N} + 2) - \sin \theta_{2} \ (\cos^{2} \theta_{2} + 2) \right\} \right]$$
(46)

-52-214<

4) Pitch moment of inertia

$$\begin{split} \mathbf{L}_{\mathbf{y}} &= \frac{2\pi \ \mathbf{w}_{12}}{B_{\phi}} \ \mathbf{R}_{\mathrm{SN}} \left[\frac{A_{12} \ \mathbf{B}_{12}^2 \ (\theta_{\mathrm{N}} - \theta_2)}{57 \ 3} + 2A_{12} \ \mathbf{B}_{12} \ \mathbf{R}_{\mathrm{SN}} \left(\cos \theta_{\mathrm{N}} - \cos \theta_2 \right) \right. \\ &+ \left. \frac{A_{12} \ \mathbf{R}_{\mathrm{SN}}^2}{2} \left(\frac{\theta_{\mathrm{N}} - \theta_2}{573} - \frac{\sin 2\theta_{\mathrm{N}} - \sin 2\theta_2}{2} \right) + \mathbf{B}_{12}^2 \ \mathbf{R}_{\mathrm{SN}} \left(\sin \theta_{\mathrm{N}} - \sin \theta_2 \right) \right. \\ &- \left. \mathbf{B}_{12} \ \mathbf{R}_{\mathrm{SN}}^2 \left(\sin^2 \theta_{\mathrm{N}} - \sin^2 \theta_2 \right) + \frac{\mathbf{R}_{\mathrm{SN}}^2}{3} \left(\sin^3 \theta_{\mathrm{N}} - \sin^3 \theta_2 \right) \right] + \frac{\mathbf{L}_{\mathrm{SN}}}{2} \end{split}$$

where,

 $A_{12} = r_1 - R_{SN} \cos \theta_N$ $B_{12} = x_1 + R_{SN} \sin \theta_N$

and θ_2 depends on which option is utilized:

SECTIØN 3.	•	θ2	=	$\theta_{\rm c}$
SECTIØN 4.		θ2	=	β
SECTIØN 5.		θ2	7	θ_{2G}

- c. SECTIØN 3.
 - 1) <u>Area</u> $A = \frac{\pi}{\sin \theta_c} (r_3^2 - r_2^2)$ (48)
 - 2) <u>Centroid</u>

$$\bar{X} = \frac{\pi}{A \sin \theta_{c}} \left[[A_{23} (r_{3}^{2} - r_{2}^{2})] + \frac{2 \cot \theta_{c}}{3} (r_{3}^{3} - r_{2}^{3}) \right]$$
(49)

3) Roll moment of mertia

$$I_{x} = \frac{\pi w_{23}}{2g_{0} \sin \theta_{c}} (r_{3}^{4} - r_{2}^{4})$$
(50)
4) Pitch moment of inertia

$$I_{y} = \frac{\pi v_{23}}{g_{0} \sin \theta_{c}} \left[A_{23}^{2} (r_{3}^{2} - r_{2}^{2}) + \frac{4 A_{23}}{3} \operatorname{cot} \theta_{c} (r_{3}^{3} - r_{2}^{2}) + \frac{\operatorname{cot}^{2} \theta_{c}}{2} (r_{3}^{4} - r_{2}^{4}) \right] + \frac{I_{x}}{2}$$
(51)

where,

.

$$A_{23} = x_2 - r_2 \cot \theta_c$$

- d. SECTION 4. and 5.
 - 1) <u>Area</u>

$$A = 2\pi \int \frac{t \, dx}{\cos \theta} \tag{52}$$

2) <u>Centroid</u>

$$\widetilde{X} = \frac{2\pi}{\Lambda} \int \frac{r x \, dx}{\cos \theta}$$
(53)

3) Roll moment of inertia

$$I_{x} = \frac{2\pi \cdot w_{23}}{g_{0}} \int \frac{r^{3} dx}{\cos \theta}$$
(54)

4) Pitch moment of inertia

$$I_{y} = \frac{2\pi w_{23}}{g_{\varphi}} \int \frac{r x^{2} dx}{\cos \theta} + \frac{I_{x}}{2}$$
(55)

SECTIØN 5.	$\theta_{2G} \leq \theta \leq \theta_{3G}$
SECTIÓN 4.	$\beta \leq \theta \leq 90^{\circ}$

-54-216< e. SECTIØN 6.

1) Area

$$A = 2\pi R_{SC} \left[\frac{r_3 \theta_3}{573} + R_{SC} \left(s_{III} \theta_3 - \frac{\theta_3 \cos \theta_3}{57.3} \right) \right]$$
(56)

2) <u>Centroid</u>

$$\vec{X} = \frac{2\pi R_{SC}}{A} \left[\frac{A_{34} B_{34} \theta_3}{57.3} + B_{34} R_{SC} \sin \theta_3 + A_{34} R_{SC} (\cos \theta_3 - 1) - \frac{R_{SC}^2}{2} (\sin^2 \theta_3) \right]$$
(57)

3) Roll moment of inertia

$$I_{x} = \frac{2\pi w_{34} R_{SC}}{g_{\phi}} \left[\frac{A_{34}^{3} \theta_{3}}{57.3} + 3 A_{34}^{2} R_{SC} \sin \theta_{3} + \frac{3}{2} A_{34} R_{SC}^{2} \sin \theta_{3} + \frac{3}{2} A_{34} R_{SC}^{2} \sin \theta_{3} + \frac{3}{2} A_{34} R_{SC}^{2} \sin \theta_{3} (\cos^{2} \theta_{3} + 2) \right]$$

4) Pitch moment of inertia

$$I_{y} = \frac{2\pi w_{34} R_{SC}}{g_{\oplus}} \left[\frac{A_{34} B_{34}^{2} \theta_{3}}{57.3} + 2A_{34} B_{34} R_{SC} (\cos \theta_{3} - 1) \right]$$
$$+ \frac{A_{34} R_{SC}^{2}}{2} \left(\frac{\theta_{3}}{57.3} - \frac{\sin 2\theta_{3}}{2} \right) + B_{34}^{2} R_{SC} \sin \theta_{3}$$
$$- B_{34} R_{SC}^{2} \sin^{2} \theta_{3} + \frac{R_{SC}^{3}}{3} \sin^{3} \theta_{3} + \frac{I_{x}}{2}$$
(59)

where,

,

$$A_{34} = r_3 - R_{SC} \cos \theta_3$$
$$B_{34} = x_3 + R_{SC} \sin \theta_3$$

and θ_3 depends on which option section 2-3 utilizes:

- SECTIØN 3. $\theta_3 = \theta_C$ SECTIØN 4. $\theta_3 = 90^\circ$ SECTIØN 5. $\theta_3 = \theta_{3G}$
- f. SECTIÓN 7.
 - 1) <u>Area</u> $A = 2\pi R_{C} L_{c}$ (60)
 - 2) Centroid

$$\bar{X} = x_4 + \frac{L_c}{2}$$
 (61)

- 3) Roll moment of inertia $I_{x} = \frac{2\pi w_{45} R_{C}^{3}}{g_{a}} (x_{5} - x_{4})$ (62)
- 4) Pitch moment of inertia

$$I_{y} = \frac{2\pi w_{45} R_{C}}{g_{\oplus}} (x_{5}^{3} - x_{4}^{2}) + \frac{I_{x}}{2}$$
(63)

- g. SECTIÓN 8.
 - 1) <u>Area</u> $A = \frac{\pi}{\sin \theta_{\rm R}} (t_0^2 - t_5^2)$ (64)
 - 2) <u>Centroid</u> $\bar{X} = \frac{\pi}{A \sin \theta_{\rm B}} \left[A_{56} \left(r_6^2 - r_5^2 \right) + \frac{2 \cot \theta_{\rm B}}{3} \left(r_6^3 - r_5^3 \right) \right]$ (65)
 - 3) Roll moment of inertia

$$I_{x} = \frac{\pi w_{56}}{2g_{\odot} \sin \theta_{B}} (r_{6}^{4} - r_{5}^{4})$$
(66)

-56->818 4) Pitch moment of inertia

$$I_{y} = \frac{\pi w_{56}}{g_{0} \sin \theta_{B}} \left[A_{56}^{2} (r_{6}^{2} - r_{5}^{2}) + \frac{4A_{56}}{3} \cot \theta_{B} (r_{6}^{3} - r_{5}^{3}) + \frac{1}{2} \cot^{2} \theta_{B} (r_{6}^{4} - r_{5}^{4}) \right] + \frac{I_{x}}{2}$$
(67)
re.

where,

 $A_{56} = x_5 - R_C \cot \theta_B$

h. SECTIØN 9.

The area, centroid and inertia equations for this section are identical to SECTIØN 6. with the following changes:

x₃ is replaced by x₆ R_{SC} is replaced by R_{SB} θ_3 is replaced by θ_B (for all options) r_3 is replaced by r_6 1. SECTIØN 10.

_

1) Area

$$A = 2\pi R_{SB} \left[R_{SB} \left(\frac{\theta_A}{573} - \sin \theta_A \right) - \frac{R_B \theta_A}{57.3} \right]$$
(68)

2) Centroid

$$\tilde{X} = \frac{2\pi R_{SB}}{A} \left[\frac{R_{SB}}{2} \sin^2 \theta_A - \frac{A_{78} B_{78} \theta_A}{573} - B_{78} R_{SB} \sin \theta_A - A_{78} R_{SB} (\cos \theta_A - 1) \right]$$
(69)

3) Roll moment of mertia

$$I_{x} = -\frac{2\pi w_{78} R_{SB}}{g_{\phi}} \left[\frac{A_{78}^{3} \theta_{A}}{(57.3)} + 3 A_{78}^{2} R_{SB} \sin \theta_{A} \right]$$
(70)

$$+ \frac{3}{2} A_{78} R_{SB}^2 \left(\frac{\theta_A}{57.3} + \frac{\sin 2\theta_A}{2} \right) + \frac{R_{SB}^3}{3} \sin \theta_A (\cos^2 \theta_A + 2)$$

4) Pitch moment of inertia

$$I_{y} = -\frac{2\pi w_{78} R_{SB}}{g_{\phi}} \left[\frac{A_{78} B_{78}^{2} \theta_{A}}{57.3} + 2 A_{78} B_{78} R_{SB} (\cos \theta_{A} - 1) \right]$$
$$+ \frac{A_{78} R_{SB}^{2}}{2} \left(\frac{\theta_{A}}{57.3} - \frac{\sin 2\theta_{A}}{2} \right) + B_{78}^{2} R_{SB} \sin \theta_{A}$$
$$- B_{78} R_{SB}^{2} (\sin^{2} \theta_{A}) + \frac{R_{SB}^{3}}{3} \sin^{3} \theta_{A} + \frac{I_{x}}{2}$$
(71)

where,

,

 $A_{78} = R_B - R_{SB}$ $B_{78} = x_7$

- j. SECTIØN 11.
 - 1) Area

$$A = \frac{\pi}{\sin \theta_A} (r_9^2 - r_8^2)$$
(72)

2) Centroid

$$\overline{X} = \frac{\pi}{A \sin \theta_A} \left[A_{89} \left(r_9^2 - r_8^2 \right) + \frac{2 \cot \theta_A}{3} \left(r_9^3 - r_8^3 \right) \right]$$
(73)

3) Roll moment of inertia $I_{x} = \frac{\pi w_{89}}{2g_{0} \sin \theta_{A}} (r_{9}^{4} - r_{8}^{4})$ (74)

.

4) Pitch Moment of inertia

$$I_{y} = \frac{\pi w_{89}}{g_{\phi} \sin \theta_{A}} \left[A_{89}^{2} (r_{9}^{2} - r_{8}^{2}) + \frac{4A_{89}}{3} \cot \theta_{A} (r_{9}^{3} - r_{8}^{3}) + \frac{\cot^{2} \theta_{A}}{2} (r_{9}^{4} - r_{8}^{4}) \right] + \frac{I_{x}}{2}$$
(75)

-58-220< where,

$$A_{89} = x_8 - r_8 \cot \theta_A$$

k. SECTIØN 12.

.

1) Area

$$A = 2\pi R_A^2 (\sin \theta_A + 1)$$
(76)

2)
$$\frac{\text{Centroid}}{\bar{X}} = \frac{2\pi R_A}{A} \left[A_{910} R_A (\sin \theta_A + 1) + \frac{R_A^2}{2} (1 - \sin^2 \theta_A) \right]$$
(77)

3) Roll moment of inertia
$$I_{x} = \frac{2\pi w_{910} R_{A}^{4}}{3g_{\odot}} [\sin \theta_{A} (\cos^{2} \theta_{A} + 2) + 2]$$
(78)

4) Pitch moment of inertia

$$I_{y} = \frac{2\pi w_{910} R_{A}^{2}}{g_{\phi}} \left[A_{910}^{2} (\sin \theta_{A} + 1) + A_{910} R_{A} (1 - \sin^{2} \theta_{A}) + \frac{R_{A}^{2}}{3} (\sin^{3} \theta_{A} + 1) \right] + \frac{I_{x}}{2}$$
(79)

where,

$$A_{910} = x_9 + R_A \sin \theta_A$$

1. SECTION 13.

1) Area

$$A = \pi R_{T}^{2}$$
(80)

$$\bar{X} = x_{10}$$
 (81)

3) Roll moment of inertia

$$I_{x} = \frac{\pi w_{910} R_{T}^{4}}{2g_{\varphi}}$$
(82)

4) Pitch moment of inertia

$$I_{y} = \frac{\pi w_{910} x_{10}^{2} R_{T}^{2}}{g_{\odot}} + \frac{I_{x}}{2}$$
(83)

The weight of each section of the vehicle is calculated in the following manner \cdot

Example

SECTIØN 1.

$$W_{HS} = W_{0I_{HS}} A$$
 pound

$$W_{STR} = (W_{01}_{STR} A) (STRFAC)$$
 pound

$$W_{RR} = W_e - \sum (W_{HS} + W_{STR})$$
 pound

The center of gravity of the heat shield and structural shell is calculated, with respect to the nose of the vehicle, by the following expression:

$$X_{CG_{H/S}} = \frac{\overline{w_{01} \ \overline{x}_{01} + w_{12} \ \overline{x}_{12} + \dots + w_{910} \ \overline{x}_{910}}}{w_{01} + w_{12} + \dots + w_{910}}$$
(84)

4. Descent System

The descent system portion of this program consists of three options, as shown in Figure 3; namely:

- a. Option One -- Two Chute System
 - 1) Drogue chute

Chute diameter > specified minimum diameter

2) Main chute

-60-

a) Single chute diameter > specified minimum diameter

b) Cluster of a chutes if the diameter of a single chute \geq maximum input diameter.

- b. Option Two -- Single Chute System
 - 1) Main chute
 - a) Single chute diameter > specified minimum diameter

b) Cluster of n chutes if the diameter of a single chute \geq maximum input diameter.

- c. Option Three -- Drogue Chute Retrorocket System
 - 1) Drogue chute

Specified chute diameter

2) Retrorocket

Sized on required ΔV

5. Atmosphere Equations

To solve the equations of motion utilized in each of the descent system options, a model atmosphere relating the atmospheric density and speed of sound as a function of altitude must be generated. The model atmosphere will consist of a troposphere and stratosphere. Equations are not generated for the thermosphere since it is assumed that chute deployment conditions will always be well below the thermosphere region. The inputs required to establish the atmosphere are sea-level temperature, stratosphere temperature, the temperature gradient in the troposphere expressed as a fraction of adiabatic lapse rate, the acceleration of gravity at sea level, the mole fraction of the concentrations of oxygen, nitrogen, carbon dioxide, and argon in the atmosphere, and the sea-level density. Nine quantities are used to specify the atmosphere. The atmosphere is assumed to be in hydrostatic equilibrium.

a. Troposphere

$$M = 28 X_{N} + 32 X_{O} + 44 X_{C} + 40 X_{A}$$
(85)

$$R = 89,516$$

$$C_{p} = \frac{R}{M} (3.5 X_{N} + 35 X_{O} + 4.0 X_{C} + 2.5 X_{A})$$
(86)

$$-61-$$

$$L_{o} = -L_{1} \left(\frac{B_{SL}}{C_{p}}\right)$$
(87)

$$Z_{\text{ST}} = \frac{T_{\text{ST}} - T_{\text{SL}}}{L_{0}}$$
(88)

$$\rho = \rho_{SL} \left(1 + \frac{L_o Z}{T_{SL}} \right)$$
(89)

$$T = T_{SL} + L_o Z$$
(90)

$$a = \sqrt{\frac{C_p T}{\frac{C_p M}{R} - 1}}$$
(91)

b. Stratosphere
$$Z > Z_{ST}$$

$$a = \sqrt{\frac{C_p T_{ST}}{\frac{C_p M}{R} - 1}}$$
(92)

$$\rho_{\text{ST}} = \rho_{\text{SL}} \left(\frac{T_{\text{ST}}}{T_{\text{SL}}} \right)$$
(93)

$$\rho = \rho_{ST} e^{-\frac{Mg_{SL}}{RT_{ST}}} (Z - Z_{ST})$$
(94)

6. Equations of Motion

. ~.

For purposes of short-range parachute trajectories, the two-degree-offreedom equations of motion are utilized neglecting the centripetal acceleration and lift component of the vehicle. The equations are as follows:

$$m\dot{V} = -D - mg_{SL} \sin \gamma$$
⁽⁹⁵⁾

$$V\dot{\gamma} = -g_{SL}\cos\gamma$$
⁽⁹⁶⁾

$$\dot{Z} = + V \sin \gamma$$
⁽⁹⁷⁾

a. Two Chute System - Option 1

1) Drogue chute

It is desired to deploy a drogue chute at some specified Mach number (M_D) and altitude (Z_D) so as to have the vehicle decelerate to a specified set of main chute deployment conditions of Mach number (M_{MC}) and altitude (Z_{MC}) . The intent is to determine the drogue chute canopy area which will satisfy these end conditions (see Figure 3b).

To start the drogue chute trajectory, a minimum specified diameter chute is used in the drag component:

$$D = \frac{1}{2} (C_{\rm D}A)_{\rm eff} \rho(Z) V^2(Z)$$
(98)

where,

$$(C_D A)_{eff} = (C_D A)_v + (C_D A)_D$$
 (99)

$$m = \frac{W_e}{g_{\phi}}$$
(100)

and,

$$A_V = \pi R_C^2$$
 (101)

If the minimum specified drogue chute diameter satisfies the main chute deployment conditions such that the main chute deployment Mach number ($M_{\rm MC}$) is reached at a higher altitude than the specified deployment altitude ($Z_{\rm MC}$), then the drogue is allowed to decelerate to the specified deployment altitude ($Z_{\rm MC}$) and some new somewhat lower Mach number. In this case the design drogue chute diameter is the minimum specified value and the main-chute descent commences at the specified deployment altitude ($Z_{\rm MC}$) with the newly established Mach number.

If the minimum specified drogue chute diameter does not satisfy the deployment conditions of the main chute, then increasing drogue chute areas (A_D) are used until the end conditions are satisfied within \pm 500 feet of the specified main chute deployment altitude ($Z_{\rm MC}$).

a) Drogue Diameter

$$d_{\rm D} = \sqrt{\frac{4\Lambda_{\rm D}}{\pi}}$$
(102)

b) Drogue Weight

$$W_{\rm D} = 0.11 \left[\frac{d_{\rm D}}{18.6} + \frac{q_{\rm D}}{65} \right] A_{\rm D} \qquad \qquad \begin{bmatrix} \text{Curve fit from} \\ \text{Reference 3} \end{bmatrix}$$

c) Opening Drogue Shock Load

$$P_{D} = X_{D} q_{D} (C_{D}A)_{D} \qquad [Reference 2] (103)$$

-

where,

$$q_{\rm D} = 1/2 \rho_{\rm D} v_{\rm D}^2$$
(104)

2) Main chute

The main chute canopy area is sized such that the suspended package decelerates to a specified vertical descent velocity (see Figure 3b). Terminal descent velocity is assumed such that

$$A_{MC} = \frac{2 g_{SL} m_{susp}}{\rho_{SL} C_{D_{MC}} V_{vert}^2}$$
(105)

The calculated main chute canopy diameter must be \geq a minimum specified diameter. If the calculated diameter is less than the minimum specified value, then the specified diameter is utilized. In the above equation m_{susp} is dependent upon when the heat shield and structure is jettisoned from the vehicle. There are two options; namely,

a) Jettison at main chute deployment

$$m_{susp} = \frac{\Psi_{RR} - \Psi_{D}}{g_{e}}$$
(106)

b) Jettison just prior to impact

$$m_{susp} = \frac{W_e - W_D}{8_e}$$
(107)

Main Chute Diameter

$$d_{\rm MC} = \sqrt{\frac{4A_{\rm MC}}{\pi}} \quad . \tag{108}$$

b. Main Chute Cluster Option

If the diameter of the main chute exceeds the maximum specified diameter, then a cluster of n chutes are employed so as to reduce the size of each chute to less than the maximum allowable value. The area of each chute in the cluster is defined as:

$$A_{\rm MC} \approx \frac{2 g_{\rm SL} m_{\rm susp}}{n \rho_{\rm SL} C_{\rm D_{cl}} V_{\rm vert}^2}$$
(109)

where n is the number of chutes in the cluster and ${\rm C}_{\rm D}{}_{\rm cl}$ the drag coefficient of each chute in the cluster.

$$C_{D_{cl}} = C_{D_{MC}} (0.95 - 0.03 n) \qquad \qquad \begin{bmatrix} Reference 2 \end{bmatrix} (110)$$

The diameter of each chute in the cluster is

$$d_{cl} = \sqrt{\frac{4A_{MC}}{\pi}} , \qquad (111)$$

hence a should be increased until this diameter \leq the maximum specified diameter.

The number of chutes n is increased in odd increments, i.e., n equal to 3, 5, 7, ...15.

The weight of the clustered main chute system is:

$$W_{\rm MC_{cl}} = \frac{0.013 \ q_{\rm MC} \ A_{\rm MC}}{10} \quad (0.98 + 0.045 \ {\rm n}) \ {\rm n} \tag{112}$$

c. Main Chute Descent Trajectory

With the area of the main chute canopy established via either a single chute or cluster, the actual man chute descent trajectory can be determined from the equations of motion. In general, because of the large size of the main chute, the filling time and/or loss in altitude has to be accounted for before the trajectory commences.

The main chute filling time is expressed as:

$$t_{f} = d_{MC} (0.05 - 3.0 \times 10^{-5} V_{MC})$$
 [Reference 2] (113)

Assuming no change in velocity during inflation, the loss in altitude is:

$$\Delta Z_{f} = V_{MC} t_{f};$$

hence the main chute trajectory commences at γ_{MC} , V_{MC} , and $(Z_{MC} - \Delta Z_{f})$. The mass(m) used in the equations of motion 1s m_{susp} and is dependent upon when the heat shield and structure are jettisoned.

1) Jettison at Main Chute Deployment

$$m_{susp} = \frac{W_{RR} - W_D}{g_{p}}$$
(114)

$$(C_DA)_{eff} = (C_DA)_{MC}$$
(115)

2) Jettison Just Prior to Impact

$$m_{susp} = \frac{W_{e} - W_{D}}{g_{e}}$$
(116)

$$(C_D A)_{eff} = (C_D A)_v + (C_D A)_{MC}$$
 (117)

Note that if the cluster option is utilized, then ${\rm C}_{{\rm D}_{\rm MC}}$ is replaced by (n) ${\rm C}_{{\rm D}_{\rm cl}}$.

3) Single Main Chute Weight

$$\overline{\Psi}_{MC} = \frac{0.013 \ q_{MC} \ A_{MC}}{10}$$
(118)

4) Opening Main Chute Shock Load (Single or Cluster)

$$P_{MC} = x_{MC} q_{MC} (C_D A)_{MC}$$
 (119)
-66-
228<

where,

$$q_{MC} = \frac{1}{2} \rho_{MC} V_{MC}^{2}$$
(120)

5) Landed Impact Weight (Crushup, Payload and Internal Structure)

$$W_{L} = W_{RR} - W_{D} - W_{MC} - W_{STRAPS}$$
(121)

where,

$$W_{\text{STRAPS}} = 0.05 (W_{\text{D}} + W_{\text{MC}})$$
.

d. Single Chute System-Option 2

It is desired to deploy a main chute at a specified Mach number (M_{MC}) and altitude (Z_{MC}) so as to decelerate the package to a specified impact velocity at zero altitude. This option is identical to the main chute portion of Option 1, including clusters.

e. Drogue Retrorocket System-Option 3

Option 3 consists of a specified drogue chute diameter and a retrorocket. The intent is to deploy the drogue chute at specified deployment Mach number (M_D) and altitude (Z_D) conditions. The drogue is allowed to decelerate down to impact and the drogue chute impact velocity (V_D) is obtained via the equations of motion and/or descent trajectory. The retrorocket is then sized on the ΔV which exists between the resultant of the drogue impact velocity (V_D) and horizontal wind velocity (V_W) , and the required specified impact velocity (v_{imp}) .

1) <u>Resultant Velocity at Retro Ignition</u>

$$V_{\rm R} = \sqrt{V_{\rm D}^2 + V_{\rm W}^2}$$
 (122)

<u>Required Rocket ΔV</u>

$$\Delta V = V_{\rm R} - V_{\rm Imp} \tag{123}$$

.....

3) Retrorocket Weight (Structure and Fuel)

$$W_{\rm R} = \frac{\Psi_{\rm i1} - \Psi_{\rm final}}{MR}$$
(124)

where,

$$\Psi_{\text{final}} = \Psi_{\text{ii}} \left(-\frac{\Delta v}{T_{\text{sp}} g_{\Theta}} \right)$$
(125)

4) Initial Weight Prior to Retro Ignition

$$W_{II} = W_E - W_D - W_{HS} - W_{STR} - W_{STRAPS}$$
(126)

(127)

(132)

 $\overline{5}) \underline{\text{Drogue Chute Weight}}$ $W_{\text{D}} = 0.11 \left[\frac{d_{\text{D}} q_{\text{D}}}{18.6 (65)} \right] A_{\text{D}}$

6) Strap Weight

$$W_{\text{STRAPS}} = 0.05 W_{\text{D}}$$
(128)

7) Rocket Volume

$$V_{OL_{R}} = \frac{\overline{w}_{R}}{\rho_{R}} = \pi d_{R}^{3} \left(\frac{L_{R}}{d_{R}}\right)$$
(129)

8). Rocket Diameter

$$d_{\rm R} = \left(\frac{\Psi_{\rm R} d_{\rm R}}{\pi \rho_{\rm R} L_{\rm R}}\right)^{1/3}$$
(130)

9) Landed Impact Weight (Crushup, Payload, and Internal Structure)

$$\mathbf{W}_{L} = \mathbf{W}_{II} - \mathbf{W}_{R} \tag{131}$$

10) Opening Drogue Shock Load

$$P_{D} = X_{D} q_{D} (C_{D} A)_{D}$$

where,

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$$q_{\rm D} = \frac{1}{2} \rho_{\rm D} V_{\rm D}^2$$
 (133)

Since the retrorocket system has some inherent ΔV error, it should be accounted for so as to ascertain a correct resultant impact velocity which is required in the impact attenuation system.

11) Final Resultant Impact Velocity

$$V_{o} = V_{imp} (1 + \Delta V_{error})$$
(134)

7. Impact Attenuation System

This portion of the program is the impact dynamics of the lander package using crushable material. The intent is to determine the weight and geometric dimensions of the crushable material and residual payload.

The equations presented herein are based on an analysis which accounts for the variation of mass during the crushup stroke and for materials with anisotropic properties.¹ The equations have been derived for the particular case where the crushable material is in the shape of a spherical segment.

There are two options for the type lander configuration and three special cases therein \cdot

- a. Option One Lenticular Shape
 - 1) Lenticular (see Figure 4d).
 - 2) Sphere -- The sphere is a special case of the lenticular with θ_{M} set equal to 90 degrees (see Figure 4e).
- b. Option Two Spherical Segment Cone-Cylinder Shape
 - 1) <u>Cone-Cylinder</u> -- A spherical segment of crushup ($\theta_M \leq 90$ degrees) with a cone and cylinder payload package (see Figure 4a).
 - <u>Cylinder --</u> A special case of the cone-cylinder with the exception that the cone portion of the payload is deleted (see Figure 4b).
 - 3) <u>Cone</u> -- A special case of the cone-cylinder with the exception that the cylinder portion is deleted (see Figure 4c).

a. Lenticular - Option One

This option is capable of handling either a lenticular or spherical shape lander. The sphere portion of the option is utilized by setting $\theta_{\rm M}$ equal to 90 degrees whereas the lenticular utilizes a $\theta_{\rm M}$ of anything between 0 and 90 degrees (see Figures 4d and 4e).

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1) Geometry Expression

$$R_{2} = \left[\frac{3 (m_{1} + m_{c})}{2\pi \left[\rho_{1} K_{1}^{2} K_{2} + \rho_{c} \left\{(1 - \cos \theta_{M})^{2}(2 + \cos \theta_{M}) - K_{1}^{2} K_{2}\right\}\right]}\right]^{1/3} (135)$$

where,

$$m_{1} + m_{c} = \frac{2}{g_{\phi}}$$

$$K_{1} = \left(1 - \frac{y_{m}}{\epsilon R_{2}} - \cos \theta_{M}\right)$$

$$K_{2} = \left(2 - \frac{2y_{m}}{\epsilon R_{2}} + \cos \theta_{M}\right)$$

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2) Internal Payload and Mass

$$m_1 = \frac{2\pi}{3} (\rho_1 R_2^3 K_1^2 K_2)$$
 (136)

3) Crushup Mass

$${}^{m}C \approx \frac{2\pi}{3} \rho_{c} R_{2}^{3} \left[(1 - \cos \theta_{M})^{2} (2 + \cos \theta_{M}) - K_{1}^{2} K_{2} \right]$$
 (137)

4) Maximum Crushing Stress

$$S_{\rm m} = (\alpha \ \rho_{\rm c})^{1/\psi} \tag{138}$$

5) Crushup Thickness

$$t_{\rm C} = \left(\frac{y_{\rm m}}{R_2}\right) - \frac{R_2}{\epsilon}$$
(139)

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6) Velocity Expression

$$\frac{V_o^2 (m_1 + m_c)}{4\pi S_m R_2^3} = \int_o^{y_m/R_2} \frac{\left(1 - \frac{y}{\epsilon R_2}\right)^2 \left[I\left(\frac{y}{R_2}\right)\right] d\left(\frac{y}{R_2}\right)}{\left[1 - \frac{\rho_c \pi R_2^3}{m_1 + m_c} \left\{\left(\frac{y}{\epsilon R_2}\right)^2 - \frac{1}{3} \left(\frac{y}{\epsilon R_2}\right)^3\right\}\right]}$$
(140)

where,

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$$V_{o} = (V_{v}^{2} + V_{w}^{2})^{1/2}$$

$$u = 1 - \frac{y}{\epsilon R_{2}}$$

$$I\left(\frac{y}{R_{2}}\right) = \frac{a_{o}}{(N-2)} \left[1 - u^{N-2}\right] + \frac{a_{1}}{2} - \frac{(1 - u^{2})}{(u^{2})}$$

$$+ \frac{a_{2}}{2u} \left[\frac{\cos^{-1} u}{u} - \sqrt{1 - u^{2}}\right]$$

$$+ \frac{a_{3}}{2} \left[\frac{(\cos^{-1} u)^{2}}{u^{2}} - 2\frac{(\cos^{-1} u)}{u} \sqrt{1 - u^{2}} - 2\ln u\right]$$

The constants a_0 , a_1 , a_2 , a_3 , and N are empirically determined and are used to describe the materials anistropy, i.e. the variation of crushing stress with the direction of loading (see Reference 1).

$$S(\theta) = a_0 \cos^N \theta + a_1 + a_2 \theta + a_3 \theta^2$$

7) Acceleration Expression

$$G_{imp} = \frac{2\pi S_m R_2^2}{(m_1 + m_c) g_{\oplus}} \left[\frac{\left(1 - \frac{y}{\epsilon R_2}\right)^2 \left[I\left(\frac{y}{R_2}\right)\right]}{1 - \frac{\rho_c \pi R_2^3}{m_1 + m_c} \left\{\left(\frac{y}{\epsilon R_2}\right)^2 - \frac{1}{3} \left(\frac{y}{\epsilon R_2}\right)^3\right\}} \right] (141)$$

b. Cone-Cylinder-Option Two

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This option is capable of utilizing a cone-cylinder, a cone, and a cylinder as the lander payload geometry (see Figures 4a, b, c). The special case of the cylinder is made possible by setting L_{co}/R_{co} equal to zero, whereas the special case of the cone is evolved by setting L_{cyl}/R_{co} equal to zero.

1) Geometry Expression

$$R_{2} = \left[\frac{(m_{1} + m_{c}) - \frac{\pi \rho_{1}}{3} \left(\frac{L_{CO}}{R_{CO}} \right) R_{CO}^{3} \left\{ 1 + K_{3} + K_{3}^{2} \right\} - \frac{\pi \rho_{1}}{3} \left(\frac{R_{CO}}{\sin \theta_{M}} - \frac{R_{CO}}{\tan \theta_{M}} \right)^{2} \left(\frac{2R_{CO}}{\sin \theta_{M}} + \frac{R_{CO}}{\tan \theta_{M}} \right)^{-} \frac{\pi \rho_{1} R_{CO}^{3} \left(\frac{L_{Cyl}}{R_{CO}} \right)}{\frac{2\pi}{3} \rho_{c} (1 - \cos \theta_{M})} + \frac{R_{CO}^{3}}{\sin^{3} \theta_{M}} \right]^{1/3}$$
(142)

where,

$$K_3 = 1 - \frac{L_{CO}}{R_{CO} \tan \theta_{CO}}$$

2) Internal Payload Mass

$$m_{1} = \frac{\pi \rho_{1} L_{CO}}{3} \left(R_{CO}^{2} + R_{CO} R + R^{2} \right) + \frac{\pi \rho_{1}}{3} \left(R_{1} - \frac{R_{CO}}{\tan \theta_{M}} \right)^{2} \left(2R_{1} + \frac{R_{CO}}{\tan \theta_{M}} \right) + \pi \rho_{1} R_{CO}^{2} L_{cyl}$$
(143)

where,

$$R_1 = \frac{R_{CO}}{\sin \theta_M}$$

 $R = R_{CO} K_3$ and,

$$\frac{\mathbf{y}_{m}}{\mathbf{R}_{2}} = \epsilon \left(1 - \frac{\mathbf{R}_{CO}}{\mathbf{R}_{2} \sin \theta_{M}} \right)$$

$$-72 - \frac{2}{2} \frac{2}{2} \frac{2}{4} \leq 2$$

3) Crushup Mass

$$m_{c} = \frac{2\pi \rho_{c}}{3} (1 - \cos \theta_{M}) (R_{2}^{3} - R_{1}^{3})$$
(144)

Note that the velocity and acceleration equations are identical as those utilized in the lenticular option.

$$L_{cy1} = \left(\frac{L_{cy1}}{R_{CO}}\right) R_{CO}$$
(145)

5) Cone Length

$$L_{CO} = \left(\frac{L_{CO}}{R_{CO}}\right) R_{CO}$$
(146)

8. Engineering Logic

In order to satisfy the geometry constraints of the lander, the impact velocity, and impact G simultaneously, iteration is required between specified values of the crushup density, i.e. $\rho_{c\mmax}$ and $\rho_{c\mmax}$. Both the lenticular option and the cone-cylinder option are started by using $\rho_{c\mmax}$ and then satisfying the geometry and velocity expressions. With these two expressions satisfied, the acceleration equation is checked to see that G_{peak} \leq $^{\rm G}_{\rm specified}$. If this requirement is not satisfied, then ρ_c is decreased by increments towards $\rho_{c\mmax}$ until G_{peak} \leq G_{specified}. If at $\rho_{c\mmax}$, G_{peak} is still greater than G_{specified}, then these are the values used, 1.e., $\rho_{\rm cmin}$ and the associated 6 and geometry. The method of solution is depicted by a flow diagram in Figure 8.

9. Lander Packaging Design

The intent in this portion of the program is to package the lander (payload and crushup) and descent system within the vehicle such that it both fits within the inboard profile of the vehicle and also satisfies a minimum center of gravity constraint. To include the thickness of the heat shield and structure in the packaging design it is necessary to redefine the lander outer radius as

$$R_2 = R_2 + t_{H/S}$$
 (147)

where t_{H/S} is the thickness in feet.

The design is started by placing the lander at the nose of the vehicle, i.e. $\Delta x = 0$; if the constraints are not met, then the lander is moved aft a given Δx until design is made possible. The geometry constraints are cited below

(DOUBLE ITERATION ON t_c AND P_c)



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Figure 8 METHOD OF SOLUTION OF IMPACT ATTENUATOR DESIGN

a. Lenticular Option

$$2 R_2 (1 - \cos \theta_M) < X_{V_{final}} - \Delta X$$
$$R_2 \sin \theta_M \le R_C$$

b. Cone-Cylinder Option

$$\begin{pmatrix} R_{2}' - \frac{R_{CO}}{\tan \theta_{M}} + L_{cyl} + L_{CO} \end{pmatrix} \leq X_{V_{final}} - \Delta X$$

$$R_{2}' \quad \sin \theta_{M} \leq R_{C}$$

If the above geometry constraints are not satisfied, then return to the impact attenuation system and increase $\rho_{\rm C}$ to $\rho_{\rm Cmax}$ and find new, smaller lander dimensions. With these new dimensions, check the geometry constraints again.

If ρC_{max} were already utilized in the impact attenuation system, then stop the problem realizing that packaging is impossible for the given design constraints.

Once the overall geometry constraints are satisfied, one can proceed to check the x and r coordinates of the lander(x_p and r_p) against the inboard profile coordinates x_v and r_v (see Figure 5). An overall logic diagram is shown in Figure 9, depicting the manner in which the packaging is done.

a. Lenticular (Sphere) Option

$$x_{p} = R_{2}'(1 - \cos \theta) + \Delta X , r_{p} = R_{2}' \sin \theta \quad 0 < \theta \le \theta_{M}$$
(148)

$$x_p = R_2 (1 - 2 \cos \theta_M + \cos \theta) + \Delta X$$
, $r_p = R_2 \sin \theta \quad \theta_M \le \theta < 0$ (149)

b. Cone-Cylinder Option

$$x_p = R_2 (1 - \cos \theta) + \Delta X$$
 $r_p = R_2 \sin \theta \quad 0 \le \theta \le \theta_M (150)$

$$\mathbf{x}_{\mathbf{p}} = \mathbf{R}_{2} \left(1 - \cos \theta_{\mathbf{M}}\right) + t \cos \theta_{\mathbf{M}} + \Delta \mathbf{X} + \mathbf{L} \quad \mathbf{r}_{\mathbf{p}} = \mathbf{R}_{\mathbf{CO}} \quad \mathbf{O} \leq \mathbf{L} \leq \mathbf{L}_{\mathbf{cyl}} \quad (151)$$

$$x_{p} = R_{2} (1 - \cos \theta_{M}) + t \cos \theta_{M} + L_{cyl} + \Delta X + L, r_{p} = R_{CO} - \frac{L}{R_{CO} - R}$$
$$O \le L \le L_{CO}$$



Figure 9 PACKAGING LOGIC DIAGRAM

<u>Vehicle Coordinate Logic</u> -- Solve for x_p from the given equations and then determine which body section x_p occurs. With this established, go to that section and find r_v noting that r_p must be equal to or smaller than r_v .

SECTIØN 1.0

$$r_v = R_N \cos \theta$$

(153)

where,

$$\theta = \arcsin\left(\frac{R_{N} - x_{p}}{R_{N}}\right)$$

2) SECTION 2.

$$\mathbf{r}_{\mathbf{v}} = \mathbf{r}_{1} + \mathbf{R}_{\mathrm{SN}} \, \left(\cos \theta \, - \, \cos \theta_{\mathrm{N}} \right) \tag{154}$$

where,

$$\theta = \arcsin\left(\frac{R_{SN} \sin \theta_N - x_p + x_1}{R_{SN}}\right)$$

3) SECTIØN 3.

$$r_{\rm v} = \frac{\mathbf{x}_{\rm p} + r_2 \quad \cot \theta_{\rm c} - \mathbf{x}_2}{\cot \theta_{\rm c}}$$
(155)

4) SECTION 4. and 5.

Linear extrapolation is used for both of these options.

5) SECTIØN 6.

$$r_{v} \approx r_{3} + R_{SC} (\cos \theta - \cos \theta_{3})$$
(156)

where,

$$\theta = \arcsin\left(\frac{x_3 + R_{SC} \sin \theta_3 - x_p}{R_{SC}}\right)$$
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and,

- a) SECTIØN 3. · $\theta_3 = \theta_C$ $r_3 = R_C - R_{SC} (1 - \cos \theta_C)$ $x_3 = x_2 + (r_3 - r_2) \cot \theta_c$
- b) SECTION 4.

 $\theta_3 = 90 \text{ degrees}$

 $r_3 = R_C - R_{SC}$ X_3 is the last point in this section.

- c) SECTIØN 5.
 - $\theta_3 = \theta_{3G}$

r3 and x3 are the last values of the input tables.

6) SECTION 7.

 $r_v = R_C$ for all x_p 's in this section.

7) SECTIØN 8.

$$r_{\rm v} = \frac{x_{\rm p} + R_{\rm C} \cot \theta_{\rm B} - x_{\rm 5}}{\cot \theta_{\rm B}}$$
(157)

8) SECTIØN 9.

$$r_{v} = r_{6} + R_{SB} (\cos \theta - \cos \theta_{B})$$
(158)

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(159)

where,

$$\theta = \arcsin\left(\frac{x_6 + R_{SB} \sin \theta_B - x_p}{R_{SB}}\right)$$

9) SECTIØN 10.

$$r_{v} = R_{B} - R_{SB} (1 - \cos \theta)$$

where,

$$\theta = \arcsin\left(\frac{x_7 - x_p}{R_{SB}}\right)$$

10) SECTIØN 11.

$$r_{\rm v} = \frac{x_{\rm p} + r_{\rm g} \cot \theta_{\rm A}}{\cot \theta_{\rm A}}$$
(160)

11) SECTIØN 12.

$$r_{v} = R_{A} \cos \theta$$
 (161)

where,

$$\theta = \arcsin \frac{x_9 + R_A \sin \theta_A - x_p}{R_A}$$
12) SECTION 13.
$$r_v = 0$$
(162)

If for a limiting value of ΔX , the lander still cannot fit within the inboard profile of the vehicle, then the design must return to the impact attenuation system and increase ρ_C to $\rho_{C\max}$ so as to assure a smaller dimensional lander which may or may not fit into the vehicle.

If the lander is finally positioned within the vehicle, the overall center of gravity position must be found such as to check the requirement that

$$c \cdot g \cdot overall \leq c \cdot g \cdot specified$$

Overall Vehicle Center of Gravity

a. Lenticular (sphere) Option

$$x_{CG_{0}} = \frac{[1 \text{ os } (\Psi_{D} + \Psi_{MC}) + \Psi_{c} + \Psi_{t}][\Delta x_{t} + R_{2} (1 - \cos \theta_{M})] + \Psi_{H/S} x_{CG_{H/S}} + \Psi_{R} \left(\Delta x_{t} + \frac{L_{R}}{2}\right)}{\Psi_{c}}$$
(163)

b. Cone Cylinder Option

$$x_{CG_{0}} = \frac{\Psi_{H/S} x_{CG_{H/S}} + \Psi_{R} \left(\Delta x_{f} + \frac{k_{R}}{2} \right) + \Psi_{e} \left(\Delta x_{f} + x_{CG_{C}} \right) + \Psi_{e} \left(\Delta x_{f} + t + x_{CG_{1}} \right) + 1.05 \left(\Psi_{D} + \Psi_{MC} \right) \left(\Delta x_{f} + t \cos \theta_{M} + \frac{k_{2}}{10} \right)}{\Psi_{e}}$$
where,
$$x_{CGC} = \frac{\left[R_{2} \left(R_{2}^{3} - R_{1}^{3} \right) \left(1 - \cos \theta_{M} \right) - \left(\frac{3 R_{2}^{4} - R_{1}^{4}}{8} \right) \sin^{2} \theta_{M} \right]}{\left(R_{2}^{3} - R_{1}^{3} \right) \left((1 - \cos \theta_{M}) \right)}$$
(164)

where,

$$X_{CGi} = \frac{\overline{\mathbb{W}_{CAP} \ X_{CAP} + \mathbb{W}_{cyl} \left(h + \frac{L_{cyl}}{2}\right) + \mathbb{W}_{cone} \ (h + L_{cyl} + X_{cone})}{(\mathbb{W}_{CAP} + \mathbb{W}_{cyl} + \mathbb{W}_{cone})}$$
$$\mathbb{W}_{CAP} = \frac{\pi h^2 \ \rho_1}{3} \ (3R_1 - h) \ g_{\Theta}$$
$$\mathbb{W}_{cyl} = \pi \rho_1 \ R_{CO}^2 \ L_{cyl} \ g_{\Theta}$$

•

$$\hat{\mathbb{W}}_{\text{cone}} = \frac{\pi \rho_1 L_{\text{CO}}}{3} (R_{\text{CO}}^2 + R_{\text{CO}} R + R^2) g_{\text{g}}$$

$$X_{CAP} = \frac{\pi}{V_{CAP}} \left(\frac{2 h^3 R_1}{3} - \frac{h^4}{4} \right)$$

$$V_{CAP} = \frac{\pi h^2}{3} (3R_1 - h)$$

$$X_{\text{cone}} = \frac{L_{\text{CO}} \left(R_{\text{CO}} - \frac{2 L_{\text{co}}}{3 \tan \theta_{\text{CO}}} \right)}{\frac{2 R_{\text{CO}} - \frac{L_{\text{co}}}{\tan \theta_{\text{CO}}}}{2 R_{\text{CO}} - \frac{L_{\text{co}}}{\tan \theta_{\text{CO}}}}$$

 $h = R_1 (1 - \cos \theta_M)$

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If $x_{cg_{overall}} > x_{cg_{specified}}$, then the design returns to the impact attenuation system and increases ρ_c to $\rho_{c_{max}}$. If $\rho_{c_{max}}$ was already utilized, then packaging is impossible for the given design constraints. If the center of gravity constraint is satisfied, i.e. $X_{CG_0} \in X_{CG_{specified}}$,

then the moments of inertia of the entire vehicle about the overall center of gravity can be established.

Total Moments of Intertia

1) Lenticular (sphere) option

$$I_{x_{TOT/X_{CG_{O}}}} = \sum I_{x_{H/S}} + \frac{1}{2} \frac{\overline{W_{R}} \left(\frac{D_{R}}{2}\right)^{2}}{g_{e}} + \frac{4\pi}{15} \rho_{c_{f}} \left(R_{2}^{5} - R_{1}^{5}\right) \left[2 - \cos\theta_{M} \left(\sin^{2}\theta_{M} + 2\right)\right] + \pi\rho_{i} \left(\frac{4}{3}R_{1}^{2}h^{3} - R_{1}h^{4} + \frac{h^{5}}{5}\right) + \frac{1.05\left(\overline{W_{D}} + \overline{W_{MC}}\right)}{2g_{e}} \left[\left(R_{2} + t_{cc}\right)^{2} - R_{2}^{2}\right]$$
(165)

where,

$$\begin{aligned} \mathbf{x}_{cc} &= \frac{0.80 \ (\mathbb{W}_{D} + \mathbb{W}_{MC})}{\mathbf{P}_{chute} \ \mathbb{R}_{2}^{2}} \\ \mathbf{I}_{YTOT/X_{CG_{O}}} &= \sum_{i} \mathbf{I}_{YH/S} + \frac{\mathbb{W}_{H/S}}{\mathcal{E}_{\Theta}} \left[\left(\mathbf{X}_{CG_{O}} - \mathbf{X}_{CG_{H/S}} \right)^{2} - \mathbf{X}_{CG_{H/S}}^{2} \right] \\ &+ \frac{\mathbb{W}_{R}}{\mathcal{E}_{\Theta}} \left(\frac{\mathbf{L}_{R}^{2}}{12} + \frac{\mathbf{D}_{R}^{2}}{16} \right) + \frac{\mathbb{W}_{R}}{\mathcal{E}_{\Theta}} \left(\mathbf{X}_{CG_{O}} - \Delta \mathbf{X}_{f} - \frac{\mathbf{L}_{R}}{2} \right)^{2} \end{aligned}$$
(166)
$$&+ \frac{4\pi}{3} \ \rho_{c_{f}} \ \mathbb{R}_{2}^{2} \ (\mathbb{R}_{2}^{3} - \mathbb{R}_{1}^{3}) \ (1 - \cos \theta_{M}) - \pi \ \mathbb{R}_{2} \ \rho_{c_{f}} \ (\mathbb{R}_{2}^{4} - \mathbb{R}_{1}^{4}) \ \sin^{2} \theta_{M} \\ &+ \frac{4\pi}{15} \ \rho_{c_{f}} \ (\mathbb{R}_{2}^{5} - \mathbb{R}_{1}^{5}) \ (1 - \cos^{3} \theta_{M}) + \frac{2\pi}{15} \ \rho_{c_{f}} \ (\mathbb{R}_{2}^{5} - \mathbb{R}_{1}^{5}) \ (2 - \cos \theta_{M} (\sin^{2} \theta_{M} + 2)] \\ &- 2\rho_{c_{f}} \ \mathbb{V}_{s} \ \overline{\mathbf{X}}_{s}^{2} + 2\rho_{c_{f}} \ \mathbb{V}_{s} \ (\mathbb{R}_{2} \ (1 - \cos \theta_{M}) - \overline{\mathbf{X}}_{s}]^{2} \end{aligned}$$

$$+ \frac{\Psi_{c} + \Psi_{1} + 1.05 (\Psi_{D} + \Psi_{MC})}{g_{\odot}} [X_{CG_{O}} - \Delta X_{f} - R_{2} (1 - \cos \theta_{M})]^{2}$$

$$+ \pi \rho_{1} \left(R_{1} + h^{4} - \frac{2h^{5}}{5} \right) + \frac{\pi \rho_{1}}{2} \left(\frac{4}{3} R_{1}^{2} + h^{3} - R_{1} + h^{4} + \frac{h^{5}}{5} \right) - 2\rho_{1} V_{CAP} X_{CAP}^{2}$$

$$+ 2\rho_{1} V_{CAP} (h - X_{CAP})^{2} + \frac{105 (\Psi_{D} + \Psi_{MC})}{g_{\odot}} \left[\frac{R_{2}^{2}}{300} + \frac{(R_{2} + t_{cc})^{2}}{4} \right]$$

where,

$$+ \frac{W_{R}}{s_{0}} \left[\frac{L_{R}^{2}}{12} + \frac{D_{R}^{2}}{16} \right] + \frac{W_{R}}{s_{0}} \left[X_{CG_{O}} - \Delta X_{f} - \frac{L_{R}}{2} \right]^{2}$$

$$+ \frac{2\pi}{3} \rho_{c_{f}} R_{2}^{2} (R_{2}^{3} - R_{1}^{3}) (1 - \cos \theta_{M}) - \frac{\pi R_{2} \rho_{c_{f}}}{2} (R_{2}^{4} - R_{1}^{4}) \sin^{2} \theta_{M}$$

$$+ \frac{2\pi}{15} \rho_{c_{f}} (R_{2}^{5} - R_{1}^{5}) (1 - \cos^{3} \theta_{M}) + \frac{\pi}{15} \rho_{c_{f}} (R_{2}^{5} - R_{1}^{5}) [2 - \cos \theta_{M} (\sin^{2} \theta_{M} + 2)$$

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$$\begin{aligned} &- \rho_{c_{f}} V_{S} \bar{X}_{S}^{2} + \frac{2\pi}{3} \rho_{c_{f}} (1 - \cos \theta_{M}) (R_{2}^{3} - R_{1}^{3}) (X_{CG_{O}} - \Delta X_{f} - \bar{X}_{S})^{2} \\ &+ \pi \rho_{t} \left[\frac{R_{1} h^{4}}{2} - \frac{h^{5}}{5} \right] + \frac{\pi}{4} \rho_{1} \left[\frac{4}{3} R_{1}^{2} h^{3} - R_{1} h^{4} + \frac{h^{5}}{5} \right] - \rho_{1} V_{CAP} \bar{X}_{CAP}^{2} \\ &+ \frac{W_{CAP}}{\mathcal{E}_{\Phi}} (X_{CG_{O}} - \Delta X_{f} - t_{c} - \bar{X}_{CAP})^{2} + \frac{W_{cyl}}{\mathcal{E}_{\Phi}} \left[\frac{L_{cyl}^{2}}{12} + \frac{R_{CO}^{2}}{4} \right] \\ &+ \frac{W_{cyl}}{\mathcal{E}_{\Phi}} \left(X_{CG_{O}} - \Delta X_{f} - t_{c} - h - \frac{L_{cyl}}{2} \right) + \\ &+ \frac{W_{cone}}{\mathcal{E}_{\Phi}} \left[\frac{L_{co}^{2}}{10} \left\{ \frac{R_{CO}^{2} + 3R_{CO} R + 6R^{2}}{R_{CO}^{2} + R_{CO} R + R^{2}} \right\} + \frac{3}{20} \left\{ \frac{R_{CO}^{5} - R^{5}}{R_{CO}^{3} - R^{3}} \right\} \right] \\ &- \frac{W_{cone}}{\mathcal{E}_{\Phi}} \left((X_{cone})^{2} + \frac{W_{cone}}{\mathcal{E}_{\Phi}} - (X_{CG_{O}} - \Delta X_{f} - t_{c} - h - L_{cyl} - \bar{X}_{cone})^{2} \\ &+ \frac{1.05 (W_{MC} + W_{D})}{\mathcal{E}_{\Phi}} \left[\frac{R_{2}^{2}}{300} + \frac{(R_{2} + t_{cc})^{2}}{4} \right] + \frac{1.05 (W_{MC} + W_{D})}{\mathcal{E}_{\Phi}} \left[X_{CG_{O}} - \Delta X_{f} - R_{2} (1 - \cos \theta_{M}) - \frac{R_{2}}{10} \right]^{2} \end{aligned}$$

10. Internal Structure

The internal structure consists of a cap or spherical segment, a cylinder, and a cone for all possible lander geometrics. The cap is designed for a buckling mode of failure assuming the maximum stress to be that applied to the crushup during impact. The cylinder is also designed for a buckling mode of failure and assumes the internal payload in the cylinder to be reacted at one end. The cone is designed by assuming it reacts the parachute opening shock load in tension.

- a. Lenticular (Sphere) Option
 - 1) Face sheet thickness

$$t_{fs} = 0.117 \left(\frac{S_m}{144 E_{fs}} \right)^{3/7} (1 - \cos \theta_M)^{1/7} R_1$$
 (169)

 t_{fs} must be \geq than a minimum gage face sheet $t_{f_{min}}$

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2) Area

$$A = 4\pi R_1^2 (1 - \cos \theta_M)$$
 (170)

- b. Cone-Cylinder Option
 - 1) <u>CAP</u>

$$A_{CAP} = 2\pi R_1^2 (1 - \cos \theta_M)$$
 (172)

$$r_{fs_{CAP}} = 0.117 \left(\frac{S_m}{144 E_{fs}}\right)^{3/7} (1 - \cos \theta_M)^{1/7} R_1$$
 (173)

$$\mathbb{W}_{CAP} = \frac{\rho_{fs} \ ^{A}CAP \ ^{t}f_{CAP}}{12}$$
(174)

2) Cylinder

$$A_{cyl} = 2\pi R_{CO} L_{cyl}$$
(175)

$$t_{fs_{cyl}} = \left(\frac{y_m |W_{i cyl} | L_{cyl}^2}{546 |R_{CO} |E_{fs}}\right)^{1/3}.$$
 (176)

$$\mathbb{W}_{\text{cyl}} = \frac{\rho_{\text{fs}} A_{\text{cyl}} t_{\text{fs}_{\text{cyl}}}}{12}$$
(177)

where,

$$W_{1 \text{ cyl}} = W_{1} \left[\frac{\pi R_{\text{CO}}^{2} L_{\text{cyl}}}{\frac{2\pi R_{1}^{3}}{3} (1 - \cos \theta_{\text{M}}) + \pi R_{\text{CO}}^{2} L_{\text{cyl}} + \frac{\pi L_{\text{co}}}{3} (R_{\text{CO}}^{2} + R_{\text{CO}}R + R^{2})} \right]$$

$$-84 - 246 \leq 100$$

3) Cone

$$A_{CO} = \pi (R_{CO} + R) [L_{co}^{2} + (R_{CO} - R)^{2}]^{1/2} + \pi R^{2}$$
(178)

$$t_{fs}_{CO} = \frac{P_{MC}}{2\pi R_{CO} \sigma_{cy}}$$
(179)

$$\mathbb{W}_{\text{CO}} = \frac{A_{\text{CO}} \rho_{\text{fs}} t_{\text{fs}_{\text{co}}}}{12}$$
(180)

If the drogue- retrorocket option is used in the descent system then

$$t_{fs_{CO}} = \frac{P_D}{2\pi R_{CO} \sigma_{cy}}$$
(181)

The total internal structural weight is the sum of the components; namely,

$$\mathbb{W} = \mathbb{W}_{CAP} + \mathbb{W}_{cyl} + \mathbb{W}_{CO}. \tag{182}$$

IV. IBM PROGRAM ROUTINES

A. PROGRAM FLOW

1. Descent System

The program flow for the descent system 15 shown in Figure 10.







2. Impact Attenuation System

The program flow for the impact attenuation is shown in Figure 11.



Figure 11 PROGRAM FLOW FOR IMPACT ATTENUATION SYSTEM

3. Lander Packaging Design

The program flow for the lander packaging system 1s shown in Figure 12.





Figure 12 PROGRAM FLOW FOR LANDER PACKAGING SYSTEM

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B. COMMON STORAGE

Name	Quantity	Source	Input or Output	Description
AD	A _D	Main	Output	Drogue chute area.
AMC	AMC	Main	Output	Main chute area.
AS	a	ATMØS	Output	Speed of sound.
AV	A	DERQZ		Area of vehicle.
CDD	c _{DD}	Input	Input	Table.
CDDD	C _{DD} value	ATMØS	Output	Interpolated value at XMAC.
CDM	C _{DMC} value	atmøs	Output	Interpolated value at XMAC.
CDMC	C _{DMC}	Input	Input	Table.
CDV	c _{DV}	Input	Input	Table.
CDVV	C_{DV} value	ATMØS	Output	Interpolated value at XMAC.
DV	D	Main		Diameter of vehicle.
FALR		Input		Temperature gradient in troposphere expressed as a fraction of adiabatic lapse rate.
G	G _{SL}	Input		Gravitational acceleration at planet surface.
IJET	JET	Input		Input sentinal.
IISYS	DESSYS	Input		Input sentinal.
MACH	м	Input		Table of Mach numbers.
Name	Quantity	Source	Input or Output	Description
-------	-----------------	--------	--------------------	---
PI	π	Main		
RHØ	Ø	ATMØS	Output	Density.
RHØSL	ρ _{SL}	Input		Density of atmosphere at planet surface.
TSL	TSL	Input		Atmospheric tempera- ture at planet surface.
TST	^T ST	Input		Atmospheric tempera- ture in stratosphere.
v	v	Main	Output	Velocity.
WD	W _D	BLØCK2	Output	Drogue chute weight.
WE	We	Input		Total entry weight.
WR	WR	Main	Output	WE - WHSTØT - WSTTØT.
XA	XA	Input		 Mole fraction of Argon in atmosphere.
хс	^х с	Input		Mole fraction of CO ₂ in atmosphere.
XMAC	м	ATMØS	Output	Mach number.
XN	x_{N}	Input		Mole fraction of N ₂ in atmosphere.
XZERØ	х _о	Input		Mole fraction of O ₂ in atmosphere.

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C. SUBROUTINES

		and the second				
		Variable	AS	CDD	CDDD	CDM
	ATMØS	Input or Output	Output ·	Input	Output	Output
		Source	atmøs	Main	ATMØS	ATMØS
	CDMC	CDV	CDVV	FALR	G	RHØ
l	Input	Input	Output	Input	Input	Output
	Main	Main	ATMØS	Main	Main	ATMØS
ŧ						
	RHØSL	TSL	TST	v	XA	XC
	RHØSL Input	TSL Input	TST Input	V Input	XA Input	XC Input
	RHØSL Input Main	TSL Input Main	TST Input Main	V Input Main	XA Input Main	XC Input Main
	RHØSL Input Main XMAC	TSL Input Main XN	TST Input Main XZERØ	V Input Main	XA Input Main	XC Input Main
	RHØSL Input Main XMAC Output	TSL Input Main XN Input	TST Input Main XZERØ Input	V Input Main · Z Input	XA Input Main	XC Input Main
	RHØSL Input Main XMAC Output ATMØS	TSL Input Main XN Input Main	TST Input Main XZERØ Input Main	V Input Main · Z Input Main	XA Input Main	XC Input Main

Calling Sequences and Definitions

ADAMS4

(See the writeup of ADAMS4 under the section SPECIAL SUBROUTINES.)

ARSIMP

(See the writeup of ARSIMP in the section SPECIAL SUBROUTINES.)

	Variable	AMVEL	BEL	CDD	CDMC
BLOCK2	Input or Output	Input	Input	Input	Input
	Sõurce	Input	Input	Input	Input
CDV	DD	DELMIT	DLVFAC	DMCFAC	DMCMIN
Input	Output	Input	Input	Input	Input
Input	BLOCK2	Input	Input	Input	Input
DMIN	DNBND	DR	DRVEL	DV	FACTØR
Input	Input	Output	Input	Input	Input
Input	Input	BLØCK2	Input	Main	Input

	Variable	FALR	FREQ	FREQ2	FREQ3
BLØCK2	Input or Output	Input	Input	Input	Input
(Continued)	Source	Input	Input	Input	Input
G	GAMMAD	GAMMC	IGØØFX	IJET	IISYS
Input	Input	Input		Input	Input
Input	Input	Input	Output	Input	Input
PD	PMC	RHØR	RHØSL	TSL	TST
Output	Output	Input	Input	Input	Input
BLØCK2	BLØCK2	Input	Input	Input	Input
TZERØ	UPBND	VIMP	VFINAL	vw	w
Input	Input	Input	Output	Input	Input
Input	Input	Input	BLØCK2	Input	Main
wD	WE	wl	WMC	WR	WRØC
Output	Input	Output	Output	Input	Output
BLØCK2	Input	BLØCK2	BLØCK2	Main	BLØCK2
wwns	WWSTR	XA	хс	XD	XISP
Input	Input	Input	Input	Input	Input
Main	Main	Input	Input	Input	Input
XLRDR	XL	хм ас н	ХМС	XMD	ХММС
Input	Input	Input	Input	Input	Input
Input	Input	Input	Input	Input	Input
XMR	XN	XZERØ	ZD	ZMC	
Input	Input	Input	Input	Input	
Input	Input	Input	Input	Input	

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BLØCK3	Variable Input or Output Source	ALPHA Input	A0, A1, A2, A3 Input Input	BETA Input Maın	CTH1, CTH2, CTH3, CTH6, CTH9 Input Main
CTHM Output Main	DIAM Input	DR Input BLØCK2	EF Input Input	EPS1, EPS3 Input Input	ETA Input Input
GS Input Impact	IBLK3 Output	IGØØFX Output	IISYS Input Input	P Input Maın	PD Input BLØCK2
PMC Input BLØCK2	PS I Input Input	Q Input Main	R3, R12, R34, R67 Input Main	RA, RB, RC Input Main	RCHUTE Input Input
RHØF Input Input	RHØI Input Input	RHØMN Input Input	RHØMX Input Input	RØ Output BLØCK3	SIGCYF Input Input
STH1, STH2 STH3, STH6, STH9 Input Input	STHM Output Maın	SŸSIMC Input	TFMIN Input Input	THC Input Main	THETAM Input Input
THETCØ Input Input	THS Input	TTCØ Output Main	TTHM Output	VFINAL Input Maın	VV Input Main
VW Input Main	WC Output BLØCK3	WD Input BLØCK2	WE Input Input	WHSTØT Input Maın	WI Output BLØCK3
WMC Input BLØCK2	WRØC Input BLØCK2	WSTTØT Input Main	X3 Input	XCGHS Input Main	XCGMIN Input
XIRDR Input	XITØT Input	XLCRC Input Input	XLCYRC Input Input	XN Input Input	YIR2 Input
YITØT Input					

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		Variable	A0, A1, A2,	DYR2	ETA	FUNC
	BL3INT	Input or Output	Input	Input	Input	Output
		Source	Input	Main	Input	BL3INT
	GSTAR	GUNC	IISYS	PI	RHØC	RØFX
	Input	Output	Input	Input	Input	Input
ĺ	Main	BL3INT	Main	Main	Main	Main
	SM	SMIMC	VFINAL	vv	vw .	WW4
	Input	Input	Output	Input	Input	Output
	Main	Main	BL3INT	Main	Main	BL3INT
	WW5	XN	YR2I			
	Output	Input	Output			
	BL3INT	Input	BL3INT			

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	Variable	DERN	к	NPAR	NZ
DERQZ	Input or Output	Output	Input	Input	Input
	Source	DERQZ	ADAMS4		
PAR	Т	VALUE			
Input	Input	Input			
	Main	ADAMS4			

	Variable	BETA	CTH1, CTH2,	I	P
FINDRV	Input or Output	Input	Input CTH3, CTH6, CTH9		Input
	Source	Main	Input	FINDRV	Maın
			Main		
Q	R01, R3, R12	RA, RB,	RV	STH1, STH2,	тнс
Input	R34, R67 Input	RC Input	Output	STH3, STH6, STH9.	Input
Main	Main	Main	FINDRV	Input	Main
				Main	l
X3	XP				
Input	Input				
	Main	-94	-		

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	Variable	AREAG	NX	PG	RGEN
GENSHP	Input or Output	Output	Output	Output	Input
	Source	GENSHP	GENSHP	GENSHP	Input
RØLLG	THET2G	THET3G	WLB	XCGG	XGEN
Output	Input	Input	Input	Output	Input
GENSHP	Input	Input	Main	GENSHP	Input
	Variable	DYR2	ETA	GSTAR	PI
PEAK	Input or Output	Input	Input	Input	Input
	Source	Maın	Input	Main	Main
PGGAL	PGGALC	R3BLK3	RHØC	SM	SMIMC
Output	Output	Input	Input	Input	Input
PEAK	PEAK	Main	Main	Main	Main
YR2	YR2I	YR2P			
Input	Input	Output			
Input	Maın	PEAK			
	Variable	СТНИ	Έπα	 זכו	D2BI 173
R 2 B 3	Input or Output	Taput	Innut	Thout	Output
1425	Source	Main	Input	Mam	D2B3
	Source	1914111	upur	Wali	
RHØC	RHØI	SMIMC			
Input	Input	Input			
Main	Input	Main	•		

R2B34	Variable Input or Output Source	A0, A1, A2 A3, Input Input	CTHM Input Main	DR Y2 Output R3 B34	EPS3 Input
ETA	GSTAR	IISYS	PI	RCØ	RHØC
Input	Input	Input	Input	Input	Input
Input	Main	Maın	Main	Main	Maın
RHØI	RØFX	SM	SMIMC	STHM	TTCØ
Input	Output	Input	Input	Input	Input
Input	R2B34	Main	Main	Main	Main
VFINAL	vv	vw	XLCRC	XLCYRC	XN
Input	Input	Input	Input	Input	Input
Main	Main	Main			Input
YR2I Output					

RP3467	Varıable Input or Output Source	PIT3 Output RP3467	RØL3 Output RP3467	RR Input Maın	RRR Input Maın
THH	w	xx			
Input	Input	Input			
Main	Main	Main			

	Variable	AREAT	BETA	CTH2	PITT
TENSHL	Input or Output	Output	Input	Input	Output
	Source	TENSHL	Input	Main	TENSHL
RC	R3	R34	RØLLT	RT2	RTEN
Input	Output	Input	Output	Input	Output
Input	TENSHL	Input	TENSHL	Main	TENSHL
STH2	THETA3	WLB	XCGT	XT2	XTEN
Input	Input	Input	Output	Input	Output
Maın	TENSHL	Main	TENSHL	Maın	TENSHL

1. GENSHP

a. Purpose

This subroutine computes the surface area, centroid from the nose, and moments of inertia for the general shape.

b. Method

The trapezoidal rule is used, with as many as 25 input values for the coordinates XGEN and RGEN. The number of XGEN and RGEN values are counted.

2. TENSHL

a. Purpose

This subroutine computes the surface area, centroid from the nose and moments of inertia for the tension shell.

b. Method

A set of five ordinate values between R2 and R3 are computed corresponding to five abscissas and the trapezoidal rule is utilized.

- 3. <u>RP3467</u>
 - a. Purpose

This subroutine computes the moments of inertia of Sections 6 and 9.

b. Method

The given equations are utilized with the input variables for Sections 6 and 9.

- 4. <u>BLØCK2</u>
 - a. Purpose

This subroutine performs a trajectory calculation with three options, a drogue and main chute or cluster, a main chute or cluster, or a drogue chute with a retrorocket.

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b. Method

First the program checks which of these three options mentioned above are to be used, and presets initial conditions, including those for the derivative equations. In the drogue chute trajectory, the minimum diameter is used first and the Mach number is repeatedly checked unitl the time it becomes < MACD input. If the corresponding altitude is above ZMC, the program continues with this size drogue chute and prints the trajectory down to ZMC, where it switches to the main chute logic If this altitude is below ZMC, an equation is used to calculate the next drogue chute area. If the altitude is zero, AD is increased by 1.5 (Statement 250) and the program begins again This process of checking the Mach number MACMC against the altitude ZMC is repeated. When again the altutide is tested and it is not within 100 feet of ZMC, the present drogue area is multiplied by ZMC/S at Statement 249 Eventually an area will be found where MACMC occurs within 100 feet of ZMC. Then the trajectory is recalculated, and printed out at intervals specified by DRVEL, the change in velocity Output values for the drogue trajectory are also computed and printed before starting the main chute trajectory.

For the main chute portion, first the area is calculated. Then, if the diameter is less than DMCMIN, the minimum main chute size is used If the diameter is greater than DMCMAX, a cluster of three to fifteen chutes is used. (The number is increased from three to fifteen by intervals of two until a diameter less than DMCMAX is found (See DØ LØØP at Statement 351)). Then the program calculates the filling time for the main chute or cluster, and the initial conditions for the main chute trajectory. The trajectory printout proceeds at intervals of MCVEL changes in velocity until impact. Then final output quantities describing the main chute are calculated and printed

For the drogue-retrorocket option, a trajectory is computed utilizing a specified drogue chute size diameter DDMIN. The program prints out at intervals of DRVEL in velocity from ZD (drogue deployment altitude) to impact The impact velocity on the drogue VD is then taken with a specified horizontal wind velocity VW and the resultant velocity VR is evolved. The required retrorocket ΔV is the difference between the required specified impact velocity VIMP and the resultant velocity VR. With the ΔV established, the sizing of the rocket system commences, i.e diameter, length, and weight.

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5. <u>DERQZ</u>

a. Purpose

This subroutine computes the values of the derivatives of velocity, flight path angle, and altitude for the trajectory.

b. Method

Subroutine ATM ϕ S is called to obtain C_D values from which the drag is calculated. The value of the suspended weight Msusp is calculated depending on when the heat shield and structure is to be jettisoned

6. ATMØS

a. Purpose

This subroutine computes the density $\text{RH} \varnothing$ and speed of sound AS variations with altitude Z.

b. Method

Initially, Z_{ST} is calculated and compared with the altitude Z in the calling sequence. Then, depending on whether Z is greater or less than Z_{ST} , one or two sets of equations are used to compute the density RH \emptyset and the speed of sound AS.

7. BLØCK3

a. Purpose

This subroutine determines the crushup density (ρ_{C}) required to absorb the impact energy.

b. Method

First the program determines whether to use the lenticular (sphere) option or the cone-cylinder option. For the lenticular option, the program starts with $\rho_{\rm c}=\rho_{\rm cmax}$. Then Subroutine R2B3 is called to get ${\rm R_2}^3$. Next BL3INT is called, then ARSIMP. If the y/R2 value is good enough, the program calls PEAK, otherwise it uses a Newton-Raphson approximation

to converge on y/R2. The chosen PGCALC is compared with the input GIMP until PGCALC is less than GIMP. If it is not, $\rho_{\rm c}$ is reduced by ($\rho_{\rm cmax}~-\rho_{\rm cmin})/10$ and the loop starting at Statement 822 continues. If no satisfactory values are found before $\rho_{\rm cmin}$, is reached, the program continues with the values it has at that time to calculate output equations. Then it goes on to the lander packaging design.

If the cone-cylinder option is used, the iteration starts with $\rho_c = \rho_{cmax}$. Then Subroutine R2B34 is called with a starting value of R_{co} . Next PEAK is called to determine if PGCALC is less than GIMP. If it is, the program computes output equations and goes on to the packaging design. If PGCALC is still too large, ρ_c is reduced by $(\rho_{cmax} - \rho_{cmin})/10$ and the iteration continues from Statement 726. If ρ_{cmin} is reached without a satisfactory PGCALC, the program continues with the ρ_{cmin} value and calculates the output equations and continues on to the packaging design.

Geometry constraints are checked at 901 or 902 depending on which option was used in the impact system, the lenticular (sphere) or cone-cylinder. For the lenticular (sphere) option an array of $\theta_{\rm M}$ values is set up and each $x_{\rm p}$ and $r_{\rm p}$ is calculated. Subroutine FINDRV is then called to get $r_{\rm v}$. All $r_{\rm p}$ values must be less than the corresponding $r_{\rm v}$ values If not, the package must be moved back a distance of 0 025 $\rm R_2$ along the vehicle axis until a position is found where all the $r_{\rm p}$ values are acceptable. If no such position can be found, the program returns to the impact system with $\rho_{\rm c}$ equal to

ρ_{c max}

If all the geometry constraints are satisfied, then the overall X_{CGO} is calculated and tested against X_{CGmin} . If X_{CGO} is less than X_{CGmin} , the program continues; otherwise it goes back to the impact system with ρ_c equal to ρ_{cmax} . With X_{CGO} satisfied, the overall moments of inertia are calculated and finally, the internal structural weight.

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8. R2B3

a. Purpose

Subroutine R2B3 calculates the value of R2 for the lenticular and sphere option.

b. Method

The program evaluates the expressions for R2, using the values of $\rho_{\rm c}$ from BLØCK3.

9. BL3INT

a. Purpose

Subroutine BL3INT evaluates the integrand of Equation (140) in preparation for integration by Simpson's Rule.

b. Method

The expressions for the integrand of Equation 140 is evaluated at 11 points between 0 and y_m/R_2 .

10. PEAK

a. Purpose

This subroutine determines the maximum value of G during impact.

b. Method

Eleven (11) values of G corresponding to $0 \le y/R_2 \le y_m/R_2$ are computed and the maximum of these values is chosen as PGCALC, the output of the routine.

- 11. R2B34
 - a. Purpose

This subroutine computes the value of R_2 for the cone cylinder option.

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b. Method

Subroutine R2B34 computes the value of R_2 for the cone-cylinder option and calls it RØFX. Then it calls Subroutine BL3INT to evaluate the expression within the velocity integral using this R2. Next R_2 is

corrected by a Newton-Raphson approximation. This process is repeated until the R2 value gives a solution within EPS3.

12. FINDRV

a. Purpose

This subroutine determines whether the payload package fits within the vehicle envelope.

b. Method

This subroutine compares the X computed in the main program with the abscissas-computed in the heat shield and structural shell system until it finds the section in which X falls. Then it calculates the ordinate r_v which will correspond to X from the equations in that section.

D. MAIN PROGRAM

The program first sets the values of any preset input, then reads the data into storage as specified by the namelist array INPUT.

After converting angle to radians and computing their sines and cosines, the program begins at Statement 20, computes five (x) and (r) values for the nose cap section which is required to be the first segment. Area, moments of inertia, and centroid from the nose are also calculated after the (x) and (r) values are written on the output tape.

The program then tests to see if the toroidal section following the nose is included. If it is not, starting at Statement 31, theta 2 is set equal to theta 1, and x2 and r2 are set equal to x1 and r1 If the section is included, five (x) and (r) values are computed and written on the output tape. Then the moments of inertia and centroid from the nose are computed.

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Next, at Statements 21 and 28, the program determines which, if any, of the three options (3., 4, and 5.) for Section 23 is to be used. If none are included, theta 4 is set equal to theta 0, and r4 and x4 are set equal to r2 and x2 Section 34, a toroidal section, has to be included if Section 23 is used.

If the tension shell option is used, five (x) and (r) points are computed and written on the output tape The area, moments of inertia, and centroid from the nose are also calculated. All of these calculations use the trapezoidal rule and subroutine TENSHL, and occur between Statements 34 and 44.

For the general shape option, as many as 25 points may be used to describe the curve. The program proceeds in steps similar to those used for the tension shell, but with subroutine GENERL, between Statements 44 and 42

For the conic section, two (x) and (r) values are computed and written out, followed by area, moments of inertia, and centroid from the nose calculations, between Statements 42 and 52

Then, from Statements 52 to 22, Section 34, 1s handled a toroidal shape, with five (x) and (r) values which are written on the output tape. Next the area, moments of inertia, and centroid from the nose are calculated. The moments of inertia are calculated in Subroutine RP3467.

Section 45, if included, is a cylinder described by two points. If it is not used, x5 and r5 are set equal to x4 and r4 If used, the two (x) and (r) values are computed and written out. Then the area, moments of inertia, and centroid from the nose are calculated, (Statements 45 to 46).

Section 56, a flared section, is described by two points. If it is not used, x6 and x7 are set equal to x5, and r6 and r7 are set equal to r5. After the two (x) and (r) values are written on the output tape, the area, moments of inertia, and centroid from the nose are calculated. If section 56 is used, section 67 a toroidal segment must be included Five (x) and (r) values are written on the output tape, then the area and centroid from the nose are calculated. The moments of inertia are computed in subroutine RP3467. These computations occur between Statements 46 and 24

If section 78, a toroidal section, is not included, x8 is set equal to x7 and r8 is set equal to r7 If used, five (x) and (r) values are computed and written on the output tape. Then the area, moments of inertia and centroid from the nose are calculated, (Statements 24 to 25).

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Section 89, if used, is a cone described by two points If it is not included x9 is set equal to x8 and r9 is set equal to r8. When this section is used, two values of (x) and (r) are written on tape, and then the area, moments of inertia, and centroid from the nose are computed, (Statements 25 to 53).

There are two options, 12. and 13, for the final section, one of which must be used. The first is a cap described by five (x) and (r) values which are written on the output tape. Then the area, moments of inertia, and centroid from the nose are calculated. The other option is a two point base section. Two values of (x) and (r) are written on the output tape, and then the area, moments of inertia and centroid from the nose are calculated. (Statements 51 to 40).

Next, output values for the total heat shield and structure weights, WHS and WST, for each section are calculated. If one or more rings is to be added to the vehicle, the appropriate moments of inertia are computed and printed Then the total vehicle shield and structure weights called WHSTØT and WSTTØT, are calculated along with the vehicle center of gravity XCGHS and moments of inertia RØLLT and PITCHT. Depending on which sections have been included, a tabular printout of section number, area, WHS, WST, and moments of inertia is provided, followed by values of WHSTØT, WSTTØT, XCGHS, and WR, the entry weight less heat shield and structure weights. If WR is found to be less than or equal to zero, work on the present case is terminated, a transfer to Statement 1000 being made for consideration of the next case. If WR is greater than 0, subroutines BLØCK2 and BLØCK3 are called to carry out the rest of the computations for the case Then the transfer to 1000 is made.

E. SIGNIFICANT EQUATIONS

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1. MAIN

The programmed expressions for surface areas, center of gravity, moments of inertia, and weight, are very straightforward, and only the case of Section 2 is given here as an example.

Subroutines GENSHP and TENSHL perform similar calculations for the general and tension shell shapes.

A = AREA (2) = 2.• π · R12 · (R01 · CTH1 · (THETA1 - THETA2) + R12 · (STH1 - STH2) + R12 · CTH1 · (THETA2 - THETA1)) (Statement 1002)

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where,
```

where,

where,

$$\begin{split} & \text{WLBS(2) = WHS(2) + WST(2) \cdot STRFAC} \qquad (\text{Statement 54}) \\ & \text{WS2 = A121 \cdot (B12)}^2 \cdot (\text{THETA1 - THETA2}) + 2 \cdot \text{A121 \cdot B12 \cdot R12} \cdot \\ & \text{B12 \cdot R12 \cdot (CTH1 - CTH2}) \\ & \text{WS3 = A121 \cdot (R12)}^2 \cdot ((\text{THETA1 - THETA2})/2 \cdot - (\text{SINF}(2 \cdot \text{THETA1}) - \\ & \text{SINF}(2 \cdot \text{THETA2})/4) + (B12)^2 \cdot \text{R12 \cdot (STH1 - STH2}) \\ & \text{WS4 = B12 \cdot (R12)}^2 \cdot ((\text{STH1})^2 - (\text{STH2})^2) - (\frac{R12}{3})^3 ((\text{STH1})^3 - (\text{STH2})^3) \\ & \text{PITCH(2) = WS1 \cdot (WS2 + WS3 - WS4) + .5 \cdot R} \\ & \text{WST} \\ & \text{WST} \\ & \text{PT} \\ & \text{WST} \\ & \text{$$

,

2. BLØCK2

 $W_D \approx WD = .11 \cdot DIAD/18.6 \cdot QD/65. \cdot AD$ (Statement 4444) $P_D \approx PD = XD \cdot QD \cdot CDDGGI \cdot AD$

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```

where,

CDDGGI is value from CDD table versus Mach Amc = AMC = $(2. \cdot G \cdot SUSPM)/(RH\phi SL \cdot CDM \cdot (VV)^2)$ (Statement 501) C_{D} cluster = CDCL = CDM · (95 - .03 AN) A_{mc} = area of each chute in a cluster = AMC = (2. · G · SUSPM)/ mc (RHØSL · CDCL · (VV)² · AN) (Statement 321) W cluster = WMC = .0013 · QMC · AMC · AN·(98 + .045 · AN) (State-ment 215) $t_{s} = TF = DMC \cdot (05 - 3.E - 5 \cdot VMC)$ (Statement 214) $\dot{V}_{D} = VR = SQRTF((VD)^{2} + (VW)^{2})$ (Statement 406) $\Delta V = DELV = VR - VIMP$ W_c/W_i = WFWI = EXPF (-DELV/(XISP.GTHET)) (Statement 411) 3. DERQZ $\dot{V} = DERN(1) = (-D-SM \cdot G \cdot SGAM)/SM$ (Statement 2) $\dot{\gamma}$ = DERN(2) = (-G·CGAM)/V Z = DERN(3) = V·SGAM 4. ATMØS $M = AM = 28. \cdot XN + 32. \cdot XZER\phi + 44. \cdot XC + 40. \cdot XA$ $C_{p} = CP = R/AM \cdot (3.5 \cdot (XN + XZER\phi) + 4. \cdot XC + 2.5 \cdot XA)$ $Lo = AL = -FALR \cdot G/CP$ ZST = ZST = (TST - TSL)/AL $T = TSL + AL \cdot Z$ Troposphere FAC = -1. $-AM \cdot G/(R \cdot AL)$ $\rho = RH\phi = ((TSL + AL \cdot Z)/(TSL)^{FAC}) \cdot RH\phi SL$ $FAC1 = CP \cdot AM/R - 1.$ (Statement 4) $a = AS = SQRTF ((CP \cdot T)/FAC1)$

Stratosphere

.

> -106-268<

5. BLØCK3

```
SMIMC = WL/32.2
Sm = SM = SBLK3 = (ALPHA \cdot (RHOC)^{(1./PSI)})
t = TBLK3 = YR2:R213/ETA
R213 = (R2BLK3)(1./3.)
I(y/R_2)
                                                                    (Statement 832)
WS1 = 1. - YR2/ETA
WS2 = 2. \cdot \pi/3. \cdot R2BLK3
WS3 = (WSI - (CTHM)^2) \cdot (2 \cdot WS1 + CTHM)
FMI = RHOI \cdot WS2 \cdot WS3
WS4 = (1, - (CTHM)^2) \cdot (2, + CTHM) - WS3
FMC = RHOC \cdot WS2 \cdot WS4
WS1 = \pi \cdot \text{RH}\phi I \cdot C\phi P/3. \cdot ((\text{RC}\phi)^2 + \text{RC}\phi \cdot \text{RWS} + (\text{RWS})^2) (State-
ment 925)
WS6 = \pi \cdot \text{RH}\phi I/3, \cdot (\text{RP1} - \text{RC}\phi/(\text{TTHM})^2) \cdot (2, \text{RP1} + \text{RC}\phi/\text{TTHM})
       + \pi · RHØI · (RCØ)<sup>2</sup> · CYP
FMI = WS1 + WS6
FMC = 2. \cdot \pi \cdot (\text{RH} \phi \text{C}/3. \cdot (1. - \text{CTHM}) \cdot \text{R} \phi \text{FX} - \text{RC} \phi / (\text{STHM})^3)
WS3 = WHSSTT · XCGHS + WROC·(DEL4 + XLR · .5) (Statement 987)
WS1 = (1.05 (WD + WMC) + WC + WI) · DEL4+ R2BK3 · (1. - CTHM))(Statement
XCG\phi = (WS1 + WS3)/WE
                                                            (Statement 991)
                                                                                                988)
```

where,

WHSSTT = WHST
$$\phi$$
T + WST ϕ T
X_{CG} = XCGCR = 3. (R2BK3·WS1/3. (1. - CTHM) - ((R2BK3)⁴ (Statement
987)
- (R1BK3)⁴) / 8. (STHM)²)/((1 - CTHM) ·WS1)
WS1 = (R2BK3)³ - (R1BK3)³
h = H = R1BK3·(1. - CTHM)
X_{CG} = XCGI = (WCAP·XCAP + WCYL·(H + XLCY·.5)
i + WC ϕ N · (H + XLCY + XC ϕ N)) / WCAP + WCYL + WC ϕ N)
WCAP = WS2·(H)^{2/3}. (3. R1BK3 - H)
WCYL = WS2·(RC ϕ)² · XLCY
WC ϕ N = WS2·XLC/3. ((RC ϕ)² + RC ϕ ·RBK3 + (RBK3)²)
XC ϕ N = XLC (RC ϕ - (2. XLC)/(3. · TTC ϕ))/(2. · RC ϕ - XLC/TTC ϕ)
VCAP = $\pi \cdot$ (H)^{2/3}. (3. · R1BK3 - H)
XCAP = $\pi \cdot$ (H)^{2/3}. (3. · R1BK3 - H)
XCAP = $\pi \cdot$ (H)^{2/3}. (3. · R1BK3 - H)
XCAP = $\pi \cdot$ (H)^{2/3}. (3. · R1BK3 - H)
XCAP = $\pi \cdot$ (H)^{2/3}. (3. · R1BK3 - H)

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Lenticular

```
I_{x}T\phi T/XCG} (Statement 990)

WS1 = WR\phiC/(2. \cdot GSTAR) \cdot (.5 \cdot (DR)<sup>2</sup>) (Statement 990)

WS2 = 2. \cdot \pi /15. \cdot RH\phiC \cdot WS10 \cdot (2. - CTHM ((STHM)<sup>2</sup> + 2.))

WS10 = (R2BK3)<sup>5</sup> - (R1BK3)<sup>5</sup>

WS3 = \pi \cdot RH\phiI/2. \cdot (4. /3. \cdot (R1BK3)<sup>2</sup> \cdot (H)<sup>3</sup> - R1BK3 \cdot (H)<sup>4</sup> + (H)<sup>5/5.</sup>)

WS4 = 1. 05/2. \cdot (WD + WMC)/GSTAR \cdot ((R2BK3 + (TC)<sup>2</sup>) - (R2BK3)<sup>2</sup>)

XIT\phiT = \Sigma R\phiLL(I)

XT\phiTCG = XIT\phiT + WS1 + WS2 + WS2 + WS3 + WS3 + WS4

TC = (8 \cdot (WD + WMC)/(RCHUTE \cdot (R2BK3)<sup>2</sup>)
```

```
Cone - Cylinder
```

```
I_{x} T \phi T/SCG_{o}
WS16 = .5 WCYL/GSTAR · (RC\phi)<sup>2</sup> + .3 · RH\phiI · \pi · \dot{x}LC/3. · ((RC\phi)<sup>2</sup> (State-
ment '994)
+ RC\phi · RBK3 + (RBK3)<sup>2</sup> (((RC\phi)<sup>5</sup> - (RBK3)<sup>5</sup>)/((RC\phi)<sup>3</sup> - (RBK3)<sup>3</sup>))
XT\phiTCG = XIT\phiT + WS1 + WS2 + WS3 + WS16 + WS4
```

```
Lenticular
```

```
I_{y} T\phi T/XCG_{o} (Statement 990)

WS5 = WHSTT/GSTAR (Statement 990)

WS6 = (XCG$\overline{\mathcal{O}} - (XCGH$\mathcal{S}^2) - (XCGH$\mathcal{S}^2)

WS7 = WR$\phiC/GSTAR \cdot (((XLR)^2)/12. + (DR)^{2/16.}) + (XCG$\phi - DEL$\mathcal{A} - (XLR/2.)^2)

WS8 = 2. \cdot \pi 3. \cdot RH$\phiC \cdot (R2BK3)^2 \cdot WS11 \cdot (1. - CTH$\mathcal{M}) - \pi \cdot R2BK3 \cdot RH$\phiC/2. \cdot ((R2BK3)^4 - (R1BK3)^4) \cdot (STH$\mathcal{M})^2 + 2./15. \cdot RH$\phiC \cdot \pi - (XTH$\mathcal{M})^2 + 2./15. \cdot RH$\phiC \cdot \pi - (XTH$\mathcal{M})^2 + \pi - (R1BK3)^4 \cdot \pi - (R1BK3)^3 \cdot \pi - (R1BK3)^3 \cdot \pi - (R1BK3)^3 \cdot \pi - (R1BK3)^4 \cdot \pi - CTH$\mathcal{M}) \cdot WS11 \cdot \pi - CTH$\mathcal{M}) - ((R2BK3)^4 \cdot \pi - (R1BK3)^4)/8. (STH$\mathcal{M})^2 \cdot \pi - (R1BK3)^4 \cdot \pi - (R1BK3)^4)/8. (STH$\mathcal{M})^2 \cdot \pi - (R1BK3)^4 \cdot \pi - (R1BK3)^4 \cdot \pi - (R1BK3)^4 \cdot \pi - (R1BK3)^4)/8. (STH$\mathcal{M})^2 \cdot \pi - (R1BK3)^4 \cdot \pi - (R1BK3)^2 \cdot \pi - (R1BK3)^2 \cdot \pi - (R1BK3)^4 ```

-108-270<

```
\begin{split} & \text{WS12} = 1 \ 05^{\circ}(\text{WMC} + \text{WD})/\text{GSTAR} \cdot (\text{R2BK3})^{2/300^{\circ}} + ((\text{R2BK3} + \text{TC}))^{2/4^{\circ}}) \\ & \text{WS13} = 2^{\circ} \cdot \text{RH}\phi\text{C} \cdot \text{VS} \cdot ((\text{R2BK3} \cdot (1 - \text{CTHM}) - (\text{XBARS}))^2 \\ & \text{WS14} = (\text{WI} + \text{WC} + 1.05^{\circ}(\text{WD} + \text{WMC}))/\text{GSTAR} \cdot ((\text{XCG}\phi - \text{DEL4} - \text{R2BK3} \cdot (1 - \text{CTHM})))^2 \\ & \text{WS15} = 2^{\circ} \cdot (\pi \cdot \text{RH}\phi\text{I} \cdot (\text{R1BK3} (\text{H})^{4/2^{\circ}} - (\text{H})^{5/5^{\circ}}) + \pi \cdot \text{RH}\phi\text{I}/4. \\ & (4^{\circ} \cdot (\text{R1BK3})^2 \cdot (\text{H})^3 - \text{R1BK3} \cdot (\text{H})^4 (\text{H})^{5/5^{\circ}})) - 2^{\circ} \cdot \text{RH}\phi\text{I} \cdot \\ & \text{VCAP} \cdot (\text{XCAP})^2 + 2^{\circ} \cdot \text{RH}\phi\text{I} \cdot \text{VCAP} \cdot ((\text{H} - \text{XCAP}))^2 \\ & \text{VIT}\phi\text{T} = \sum \text{PITCH(I)} \\ & \text{YT}\phi\text{TCG} = \text{YIT}\phi\text{T} + \text{WS5} \cdot \text{WS6} + \text{WS7} + 2^{\circ} \cdot \text{WS8} - 2^{\circ} \cdot \text{WS9} + \text{WS13} \\ & + \text{WS14} + \text{WS15} + \text{WS12} \end{split}
```

```
Cone - Cylinder
```

$$I_{y^{T}\phi T/XCG}$$

$$WS17 = 2. \cdot \pi/3 \cdot RH\phi C. (1 CTHM) \cdot ((R2BK3)^{3} - (R1BK3)^{3}) \cdot ((XCG\phi)^{3} - DEL4 - XBARS))^{2}$$

$$WS19 = WCAP/GSTAR \cdot ((XCG0 - DEL4 - TBK3 - XCAP))^{2} + WCYL/GSTAR \cdot (((XLCY)^{2/12} + (RC\phi)^{2/4} \cdot (+(XCG\phi - DEL4 - TBK3 - H - XLCY/2.)))$$

$$WS18 = \pi \cdot RH\phi I \cdot (R1BK3 \cdot (H)^{4/2} - (H)^{5/5} \cdot (-RH\phi I \cdot VCAP \cdot (XCAP)^{2} + (R1BK3)^{2} \cdot (H)^{3} - R1BK3 \cdot (H)^{4} + (H)^{5/5} \cdot (-RH\phi I \cdot VCAP \cdot (XCAP)^{2} + ((RC\phi)^{2} + RC\phi \cdot RBK3 + (RBK3)^{2}) \cdot .15 \cdot (((RC\phi)^{5} - (RBK3)^{2})))$$

$$WS20 = WC\phi N/GSTAR \cdot ((XLC)^{2} \cdot .1 \cdot ((RC\phi)^{2} + 3. \cdot RC\phi \cdot (RBK3)^{2})/(((RC\phi)^{3} - (RBK3)^{3})))$$

$$W521 = WC\phi N/GSTAR \cdot (XC\phi N)^{2} - ((XCG\phi - DEL4 - TBK3 - H - XLCY - XC\phi N))^{2})$$

$$WS22 = 1.05 \cdot (WMC + WD)/GSTAR \cdot ((XCG\phi - DEL4 - R2BK3 \cdot (1. - CTHM) - .1 \cdot R2BK3))^{2}$$

$$YT\phi TCG = YIT\phi T + W55 \cdot WS6 \cdot WS7 + WS8 - WS9 + WS17 + WS18 + WS19 + WS20 - WS21 + WS12 + WS22$$

$$\begin{split} &\text{WS1} = \left((1. - \text{YR2}/\text{ETA} - \text{CTHM})\right)^2 \\ &\text{WS2} = 2. -2. \cdot \text{YR2}/\text{ETA} + \text{CTHM} \\ &\text{WS3} = \text{RH}\phi\text{I}\cdot\text{WS1}\cdot\text{WS2} \\ &\text{WS4} = \text{RH}\phi\text{C}\cdot\left(\left((1. - \text{CTHM})\right)^2 \cdot (2. + \text{CTHM}) - \text{WS1}\cdot\text{WS2}\right) \\ &\text{R2BLK3} = (3 \cdot \text{SMIMC})/(2. \cdot \pi \cdot (\text{WS3} + \text{WS4})) \end{split}$$

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7. BL3INT

where,

$$\int_{0} \text{ FUNC(I)} = \int_{0}^{Y_{m}/R_{2}} WW4 (I) / WW5(I)$$

8 PEAK

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-110-
272<
```

#### 9. R2B34

#### V. REFERENCES

- Cloutier, G. J., Dynamic Analysis of Crushable Material Impact Energy Absorbers, Avco/RAD Technical Report KHDR-15 (June 1965).
- Performance of and Design Criteria for Deployable Aerodynamic Decelerators, Wright-Patterson Air Force Base Technical Report No. ASD-TR-61-579 (December 1963).
- Turner, R. D., A Parachute Design Study for a Mars Entry Vehicle, Cook Electric Company, Report No. FR-3707B (September 1964).

PROGRAM 1883

PROGRAM 1883

## RADIATION HEATING PROGRAM (1883)

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| T GDTC | - | rabarar farach or | • | <br><u> </u> |

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#### I. INTRODUCTION

#### A. GENERAL DESCRIPTION

Program 1883 computes the equilibrium gas properties in the stagnation region behind a normal shock, and the associated radiative heating, given ambient conditions of density, temperature, and molecular composition of the atmosphere, the shock standoff distance and the flight velocity. The shock standoff distance can also be computed, provided sufficient body shape data are given, based on the correlation of standoff distance stored in the program.

#### B. CALCULATION MODEL

During hypervelocity entry, the state of the gas behind a bow wave can vary from a highly ionized state to a molecular and atomic state. Enumerating all the likely species to be encountered throughout entry to solve the thermodynamic state of the gas would require an equal number of equations to be solved simultaneously. The present approach is an approximate method which divides the thermodynamic states into 4 zones, wherein only a few major reactions govern the state of the gas result in simplified and more rapid solutions for the state conditions. For example, Figure 1 illustrates the variation in specie concentrations with temperature, and typical zone demarcation lines are indicated for initially pure CO<sub>2</sub> The zone division is performed automatically by testing enthalpy and pressure.

Assumptions include:

- 1. Rigid rotator molecules
- 2. Harmonic oscillators
- 3. Electronic energy states are not considered beyond 70,000°K
- 4. The enthalpy of all molecules is taken as 0 at 0°K
- 5. Equilibrium thermodynamics apply
- 6. Only several major reactions govern the thermodynamic state at any time.

The calculation model is described in detail in Reference 1, and a summary is presented herein for completeness.

-1-



Figure 1 TYPICAL ZONE MODEL FOR PROGRAM 1883

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#### 1. Stagnation Point Conditions

During hypervelocity entry, the state of the gas behind a bow shock can vary from highly ionized to atomic and molecular states. Enumerating all the likely species to be encountered throughout entry would require an equal number of equations to be solved simultaneously. In general, a sufficient number of chemical reaction equations,

$$\sum_{a_1} A_i \xrightarrow{} \sum_{b_1} B_i$$

(where  $A_i$  are the reactants,  $B_i$  the products, and  $a_i$ ,  $b_i$ , the stoichiometric coefficients) must be formulated, such that taken together with the element and charge conservation equations, we are able to solve for the specie concentrations. The present program considers 19 species, 4 elements and electrons and hence there are 14 reaction equations and 5 conservation equations.

The elements considered are carbon, oxygen, nitrogen, and argon; however, the conservation relationships are utilized in terms of the molecular concentrations of nitrogen, carbon dioxide, oxygen, and argon as they appear in the atmosphere. The complete reaction matrix is given in Table I-13, page 46, of Reference 1.

The 14 reactions could be solved at each point along the trajectory using the method of the minimization of free energy, e.g. Reference 2, page 207. Since the reactions cover the whole range of species to be encountered, at any one time only a few of them will be important, which leads to the alternate method of solving a small number of concentration equations simultaneously. The latter approach, demonstrated by Hansen<sup>3</sup> for air, is utilized in the present program.

For each reaction, an equation involving an equilibrium constant is formulated:  $^{\rm 2},\,^{\rm 3}$ 

 $K_{p} = \frac{\Pi [X(B_{I})]^{b_{I}}}{\Pi [X(A_{I})]^{a_{I}}} \left(\frac{P}{Z}\right)^{b_{I}-a_{I}}$ 

-3-

where Z is the compressibility factor and represents the number of moles of gaseous products per mole of reactants, and  $X(A_i)$  and  $X(B_i)$  are the moles of reactants and products, respectively.

The equilibrium constants are, in turn, calculated from kinetic theory using spectroscopic and structural aspects of the individual molecules, atoms and ions.  $^2,\,^3$ 

The equilibrium constants are expressible as

$$l_{n} K_{p} = -\frac{\Delta E_{o}}{RT} + \sum b_{i} l_{n} Q_{p}(B_{i}) - \sum a_{i} l_{n} Q_{p}(A_{i})$$

where  $Q_p(A_1)$  and  $Q_p(B_1)$  are the partition functions of the individual molecules, atoms, ions, and electrons, and  $\Delta E_0$  is the change in the zero point energy for the reaction. The expressions for the equilibrium constants and partition functions are given in Reference 1, Tables I-15 and I-18.

The partition functions and equilibrium constants are given in terms of pressure and temperature and hence the solution to the species concentrations is obtained for these two-state variables. During entry, sufficient trajectory data exist to compute the total enthalpy and to estimate the stagnation pressure closely, and hence an iterative solution of the specie concentrations is required to determine the temperature of the gas as well, such that the stagnation enthalpy is matched. The enthalpy of the gas given by:

$$\frac{HM}{RT_o} = \sum X_1 \left( \frac{H_1M}{RT_o} \right)$$

must equal the stagnation enthalpy during flight:

$$\frac{HM}{RT_{o}} = \frac{V^{2}}{2} \frac{M}{RT_{o}} + \frac{h_{a}M}{RT_{o}} .$$

.

The stagnation pressure is approximated as:

$$P \cong \frac{\rho V^2}{2116}$$

The velocity (V) is input in fps, the density as  $RH\phi A$  in slug/ft<sup>3</sup>, and the ambient temperature TAin degrees Kelvin(K).

For the approach selected, of solving a limited number of key concentration relationships simultaneously, a priori knowledge is required of the relative importance of the reactions for various flight conditions. Hence, tabular data were computed and stored in the program as Table I-19 in Reference 1, which specifies zones of  $HM/RT_o$  and P, where the number of simultaneous algebraic equations for the species concentrations can be optimized. The dominant reactions in each zone are discussed in Reference 1.

The general nature of the solution proceeds as follows

Trajectory Data



state variables for stagnation point behind normal shock.

The radiation heating is computed for a parallel slab of gas at uniform stagnation temperature and pressure of thickness ( $\Delta$ ) DELTA. The heating is given by.

 $QR = \overline{\epsilon}\sigma T^4$ 

where  $\sigma$  = the Stefan-Boltzmann constant. The calculated emissivity of the gas accounts for absorption, and is given as:

$$\overline{\epsilon} = 1 - 2 E_3(\Sigma \tau_1)$$

where  $\tau_{i}$  is the optical path length of each radiating specie,

$$\tau_1 = 1524 \frac{\epsilon_1}{L} \Delta$$

and  $E_3$  (r) is defined as:

$$E_3(r) = \int_0^1 s e^{-r/s} ds$$
.

Tabular values of  $1 - 2E_3(r)$  are shown in Table I and are used in the computer program.

$$\frac{\epsilon_{1}}{L} = C_{1} \frac{N_{1}}{54 \times 10^{19}} \cdot \frac{e^{-T_{1}/T}}{(T \times 10^{-4})^{n_{1}}}$$

where N: 1s the particle density of the radiating species.

The values of  $C_i$ ,  $T_i$ ,  $n_i$  for the corresponding species  $X_i$  are given in Table I-20 in Reference 1. A detailed discussion of the radiation heating model is given in Reference 1 also. The standoff distance ( $\Delta$ ) may be input, or the nose geometry can be input, in terms of RN, RSN, THN as shown in Figure 2 which utilizes the correlations of Reference 5 as shown in Figure 3.

#### 2. Limitations

The limitations of the calculation model are discussed in Reference 1, page 49, from the point of view of the kinetic theory approximations.

The flight speed range and atmosphere limits are governed by the range of species considered. Doubly ionized carbon, oxygen, and nitrogen ions



65-11701

Figure 2 CALCULATION MODEL FOR OPTION TO COMPUTE DELTA



Figure 3 SHOCK DETACHMENT DISTANCE FOR OBLATE ELLIPSOIDS

and singly ionized argon are considered in the extreme temperature range, hence, the calculable flight speed regime is higher for mixtures without argon. As the program was developed primarily for high-speed studies, its use for low-temperature work, corresponding to flight velocities below 8000 fps, is not recommended.

Because of the nature of the algebraic equations, several limitations arise in specifying concentrations; both the concentrations of argon and oxygen can be specified as zero, but the concentrations of  $CO_2$  and  $N_2$  should be greater than  $10^{-3}$ .

The radiation model uses the parallel slab approximation and assumes an isothermal gas layer of uniform composition; hence, the results will tend to be conservative, especially at large radiative heating rates when the radiation heat loss approaches the energy content of the gas. This limit has been treated by Wick\$ Yoshikawa and Chapman.<sup>7</sup>

The limitations of the model to predict the standoff distance are discussed under Program 1880.

Comparative results obtained from Program 1883 with those obtained from JPL and Ames Programs are given in Figure 4.

|                                                                                                                                                                 | AII/7-B1                                                                                                                            |                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                 |                                                                                                                                     | LFS                                                                                                                                                                                                                                            | 155(c)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| T<br>(1)<br>(3)<br>(4)<br>(6)<br>(6)<br>(7)<br>(6)<br>(7)<br>(6)<br>(7)<br>(10)<br>(12)<br>(13)<br>(14)<br>(13)<br>(14)<br>(15)<br>(16)<br>(16)<br>(17)<br>(18) | AUTBL<br>0<br>0.01<br>0.05<br>0 1<br>0 2<br>0 3<br>0 4<br>0 5<br>0 6<br>0 7<br>0 8<br>0 9<br>1 0<br>1 1<br>1 2<br>1 3<br>1 4<br>1.5 | EFS           (1)           (2)           (3)           (4)           (5)           (10)           (11)           (12)           (13)           (14)           (15)           (14)           (15)           (16)           (17)           (18) | TBL(f)<br>0 02<br>0 092<br>0 108<br>0 298<br>0 406<br>0 498<br>0 |
| (19)<br>(20)<br>(21)<br>(22)<br>(23)<br>(24)<br>(25)<br>(26)<br>(27)<br>(28)<br>(29)<br>(30)                                                                    | 1 6<br>1 7<br>1 8<br>1 9<br>2 0<br>2 5<br>3 0<br>3 5<br>4 0<br>6 0<br>10 0<br>1 0E + 10                                             | (19)<br>(20)<br>(21)<br>(22)<br>(23)<br>(24)<br>(25)<br>(25)<br>(25)<br>(27)<br>(28)<br>(29)<br>(30)                                                                                                                                           | 0 900<br>0 912<br>0 923<br>0 939<br>0 967<br>0 982<br>0 990<br>0 994<br>0 999<br>1 00<br>1 00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |



```
TABULAR VALUES
```





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# II. USAGE

## A. INPUT DEFINITIONS

| External<br>Name | Preset<br>Values | Symbol           | Parameter                                                                               | Units                  |
|------------------|------------------|------------------|-----------------------------------------------------------------------------------------|------------------------|
| ATMØS            |                  |                  | A number of the form XX.XX for identification.                                          |                        |
| CASE             |                  |                  | A number of the form XX.XX for<br>identification.                                       |                        |
| DATE             |                  |                  | A number of the form XX.XX for identification.                                          |                        |
| DELTA            | 0.               | Δ.               | Shock detachment distance.<br>If = 0, $\Delta$ is computed from a geometry correlation. | feet                   |
| мемφ             |                  |                  | A number of the form XX.XX for identification.                                          |                        |
| RC               | 0.               |                  | Cylinder radius.                                                                        | feet                   |
| RHØA             | 0.               | ρ <sub>a</sub>   | Ambient density.                                                                        | slug/feet <sup>3</sup> |
| RN               | 0.               | r <sub>N</sub>   | Nose radius used for $\Delta$ correla-<br>tion (see DELTA).                             | feet                   |
| RSN              | 0.               | RSN              | Shoulder radius for $\Delta$ correlation (See DELTA).                                   | feet                   |
| TA               | 0 <b>.</b> ·     | Ta               | Ambient temperature.                                                                    | ٩ĸ                     |
| THN              | 0.               | $\theta_{\rm N}$ | Nose angle used for $\Delta$ correla-<br>tion (See DELTA).                              | degrees                |
| v                | 0.               | v                | Vehicle velocity.                                                                       | ft/sec                 |
| VEHICL           |                  |                  | A number of the form XX.XX for vehicle identification.                                  |                        |
| XA               | 0.               | XA               | Mole fraction of A in atmosphere.                                                       |                        |
| External<br>Name | Preset<br>Values | Symbol | Parameter                                       | Units |
|------------------|------------------|--------|-------------------------------------------------|-------|
| xc               | 0.               | хс     | Mole fraction of CO <sub>2</sub> in atmosphere. |       |
| XN               | 0.               | XN     | Mole fraction of N <sub>2</sub> atmosphere      |       |
| xø               | 0.               | xø     | Mole fraction of $\phi_2$ atmosphere            |       |

#### B. INPUT PROCEDURES

The following procedures are to be observed when formulating inputs for Program 1883:

1. All data are numerical and may be written with decimal points.

2. Since all variables have been preset to 0., before the first case, only those which are to be non-zero must be input.

3. The concentrations of oxygen and argon may be equal to zero; however, the concentrations of nitrogen and carbon dioxide should not be less than 0.001.

4. Argon is included only in Zones 1 and 2 and hence, if the flight conditions are outside of these limits, one must ensure that the concentrations of oxygen, carbon dioxide, and mitrogen total unity.

5. A set of computer input forms are provided for the user. All the data shown on the form 1s keypunched when the variable 1s supplied.

| External<br>Name | Preset<br>Values | Symbol | Parameter                                                                    | Units |
|------------------|------------------|--------|------------------------------------------------------------------------------|-------|
| atmøs            | ATMØS            |        | Number of the form XX. XX used<br>for identification of the atmos-<br>phere. |       |
| CASE             | CASE             |        | Number of the form XX.XX used for identification of the case.                |       |
| DATE             | DATE             |        | Number of the form XX. XX used<br>for identification of the problem<br>run.  |       |
| DELTA            | DEL              | Δ      | Detachment distance.                                                         | feet  |
| EPSILØN          | EPBAR            | ē      | Total effective emissivity.                                                  |       |

#### C. OUTPUT DEFINITIONS

| External    | Internal | Symbol                                    | Parameter                                                           | Units                     |
|-------------|----------|-------------------------------------------|---------------------------------------------------------------------|---------------------------|
| Ivanic      | Ivanic   | bymbor                                    |                                                                     | 01110                     |
| EPSILON (I) | EPS      | ε1                                        | Table of emissivities for each radiation source.                    |                           |
| HD/HS       | HDHS     | <sup>н</sup> <sub>D</sub> /н <sub>S</sub> | Ratio of dissociation enthalpy to stagnation enthalpy,              |                           |
| hm/rtø      | HRT      | HM/RT <sub>o</sub>                        | Stagnation enthalpy ratio.                                          |                           |
| MEMØ        | мемø     |                                           | Number of the form XX. XX used<br>for identification of the problem |                           |
|             |          |                                           | 1 411.                                                              |                           |
| QI          | QI       |                                           | Radiative heating contribution of each source.                      | Btu/ft <sup>2</sup> -sec. |
| QR          | QSUM     |                                           | Total radiation heating at stagna-<br>tion point.                   | Btu/ft <sup>2</sup> -sec. |
| RĦØS/RHØ    | RHØST    | ρ <sub>S</sub> /ρ <sub>a</sub>            | Ratio of stagnation density to ambient density.                     |                           |
| TS          | Т        | т <sub>s</sub>                            | Stagnation temperature .                                            | · °K                      |
| VEHICL      | VEHICL   |                                           | Number of the form XX.XX for vehicle identification.                |                           |
| х           | x        | x <sub>i</sub>                            | Specie concentration.                                               | moles                     |
| ZS          | z        | z                                         | Total moles of species.                                             | moles                     |

### 1. Chemical Terms

Although conventional chemical symbols are utilized in the text and especially in writing chemical reactions, the symbols used in the program and occurring on the program printout sheets must include only capital letters without subscripts. The following table summarizes the nomenclature for all the species considered in the program:

| Program Symbol | Chemical Symbol | Chemical Name    |
|----------------|-----------------|------------------|
| Ø              | 0               | Atomic oxygen    |
| Ø2             | 0 <sub>2</sub>  | Molecular oxygen |

| Program Symbol | Chemical Symbol | Chemical Name                     |
|----------------|-----------------|-----------------------------------|
| С              | С               | Atomic carbon                     |
| CØ2            | CO2             | Carbon dıoxide                    |
| СØ             | со              | Carbon monoxide                   |
| N              | N               | Atomic nitrogen                   |
| N2             | N <sub>2</sub>  | Molecular nıtrogen                |
| А              | А               | Argon (monatomic)                 |
| Ø+             | o*              | Singly ionized atomic oxygen      |
| Ø++            | 0++             | Doubly ionized atomic oxygen      |
| C+             | c+              | Singly ionized atomic carbon      |
| C++            | C++             | Doubly 10nized atomic carbon      |
| N+             | N <sup>+</sup>  | Singly 10nized atomic nitrogen    |
| N++            | N <sup>++</sup> | Doubly ionized atomic nitrogen    |
| N2+            | N2 <sup>+</sup> | Single ionized molecular nitrogen |
| A+             | A <sup>+</sup>  | Singly 10mzed argon               |
| CN             | CN              | Cyanogen                          |
| NØ             | NO              | Nitric oxide                      |
| E-             | e~              | Electrons                         |

#### D. SAMPLE PROBELM

1. Statement of Problem

Determine the radiation heating for a specified flight condition for a gas mixture of 51.2 percent nitrogen and 48.8 percent carbon dioxide.

#### 2. Input Form

The input form containing the necessary data is shown on a following page. Case 1 typifies the input when the vehicle geometry is specified, and Case 2 is the optional input of specifying the shock stand off distance. All the variable names for which data are given should be keypunched.

#### 3. Output Form

The output is shown on the following pages. The keypunched data are shown and should be compared with the input form. The emissivities of each specie contributing to the radiation are given as well as the total emissivity including self absorption (grey gas approximation).

The stagnation temperature, compressibility factor, shock density ratio, radiation heating, enthalpy, and dissociation energy are given. The concentrations of the individual constituents are given as well as the radiation contributions of the species considered.

#### E. DIAGNOSTICS

The number of messages are given in the printout reflecting the following program diagnostics.

#### 1. NØ VALID SØLUTIØN

The equilibrium gas dynamics (1883) solution was not able to obtain a solution with positive concentrations for all the species satisfying the elemental and charge conservation relationships. In this case, the data is linearly interpolated between the last and the next point for which a solution is found.

#### NØT CØNVERGED IN 30 ITERATIØNS

The equilibrium gas dynamics (1883) solution was unable to converge within 30 iterations to within 1 percent on the enthalpy; use the last value found.

| RAD 2+0963<br>5 63 | DIGITAL COMPUTER INPUT |              |        | PROBLEM NO 1 | 883             |             | PROGRAMMER D. Gillespie |          |                   |  |  |
|--------------------|------------------------|--------------|--------|--------------|-----------------|-------------|-------------------------|----------|-------------------|--|--|
|                    | REC                    | REQUEST FORM |        | TITLE Radia  | tion Heating    | Program     | m                       |          |                   |  |  |
|                    | MEMO NO                | SECTION NO   | WORK O | RDER NO      | (E240 USE ONLY) | REQUESTED E | Y EXT                   | EST TIME |                   |  |  |
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|                    | DELTA                  | =            |        | _,           | RSN =           | •           | , ,                     | =        |                   |  |  |
|                    | RC                     | =            |        | <u></u>      | TA =            |             | , xc                    | =        |                   |  |  |
|                    | RHØA                   | =            |        |              | THN =           |             | , XN                    | =        | ,                 |  |  |
|                    | RN                     | =            |        | _            | v =             |             | . xø                    | =        |                   |  |  |
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| RAD 2-0963<br>5 63 | DIGITAL | DIGITAL COMPUTER INPUT |                 | PROBLEM NO | 1883            |             | PROGRAMMER D. Gillespie |          |           |         |
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|                    | REG     | UEST FOR               | M               | TITLE Radi | ation Heatin    | g Program   | n                       |          |           |         |
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|                    | RC      | =6.                    | 7681            |            | TA =            | 100.        | _, xc                   | =        | 488       | _ ر     |
|                    | RHØA    | = 1.                   | 21E-6           |            | THN =           | 66.92       | , XN                    | =        | 512       | ,       |
|                    | RN      | = 16                   | .2434           | -          | V =             | 19705.      | , xø                    | =        |           | .       |
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| PRE-EXECUTIO | N INITIALIZ | ATION     | 02754       |         |           |            |           |          |           |                                              |         |     |
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| 1. SAR2TL    | 03004       | AR2TLU    | 03306       |         |           |            |           |          |           |                                              |         |     |
| 2+ 1883      | 03357       |           | -04146 -*   |         |           |            |           |          |           |                                              |         |     |
| 3. SGETN1    | 04162       | GETN1     | 06152       | *       |           |            |           |          |           |                                              |         |     |
| 5. SARTLU    | 13223       | ARTLU     | 13435       |         |           |            |           |          |           |                                              |         |     |
| 6. SHFATI    | 13606       |           | -15754      |         |           |            |           |          |           |                                              |         |     |
| 7. SFNDH1    | 16157       | FINDHL    | 16516       |         |           |            |           |          |           |                                              |         |     |
| 9. SGETK1    | 21031       | GETK 1    | 21363       |         |           |            |           |          |           |                                              |         |     |
| -10-SFNDT1-  | 21523       | -FINDTI-  | -71754      |         |           |            |           | -        |           |                                              |         |     |
| 11. SZONS1   | 22070       | ZONESI    | 25624       |         |           |            |           |          |           |                                              |         |     |
| 12. LXCON    | -25767      | LXSTR     | -25767-*    | LXSTP   | 25773-    | LXOUT      | 26041     | +LXRTN   | 26053     | IBEXIT                                       | -26053  | * ~ |
| ·····        |             | -CLSF-    | -26440      | TEFBL   | -26441-+  | LUNB       | 26442     | DFOUT    | 26443     | 10                                           | 20492   | -   |
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|              |             | -WRITE    | -26463      | -85R    | 26473-+   | -READR-    | ~26503 -  | RELES    | 26505 *   | -LAREA                                       | 26516   |     |
|              |             | -LFBLK    | 26539       | + 15X   | 26537 *   | AREAL      | 26551     | - NOPY I | 26557     | CONT                                         | 26563   |     |
|              |             | •EX34     | 26663       |         | LUGLE     |            | 20050     | •        | 20051     |                                              |         |     |
| -14          | -26670      |           | 26670       | LXCSEL  | 26671     |            | 26674-*   | +LX8VL   |           | LXRCT                                        | 26745   | *   |
| 15           | -270.27-    | LXIND     | 27014 #     | +LXDIS  | 27017 *   | -LXFLG     | 27020 *   | +LTCH    | 27021     | -OVEL ON-                                    | 27222-  | *   |
| 16ERAS.      | 27237       | E+1       | 27237       | E+2     | 27240     | E.3        | 27241     | E.4      | 27242     | OFFLOR                                       | 61232   |     |
| -17XCC.      | 27243       |           | -27243      | -CC-2-  | -27244-   |            | - 27245   |          | 27246     |                                              | ·       |     |
| 18. XIT      | 27247       | EXIT      | 27247       | .EXIT.  | 27247 *   |            | 27/12     |          |           |                                              |         |     |
| 20. FOUT     | 27700       | -FOUT.    | 27700       | 11 X001 | 21005-    |            | -27619    | -7.02142 | -21001    |                                              |         |     |
| -21FCNV      | 30242       | .FCON.    | 30242       | FCNV-   |           | +ENDF-S    |           | -CHVSH   |           |                                              | -30306  |     |
|              |             | +F0X2     | 30307       | - DBC   | 30311     | -DBC8      | 30432     | •DBC9    | 30435     | DBC 10                                       | 30442   |     |
|              |             | -00851    | 31044       | - 005H- | 31046     | - +001-1-2 | 31051     | -02      | 31053     |                                              | 31140   | *   |
|              |             | ANPT      | 31174       | ONPT-   | -31211-   | -LNTP-     | -31265    | -AGUT-   |           |                                              | -31352- |     |
|              |             | -FLT      | 31506       | DEXPN   | 31576     | •FXD       | 31577     | -HOUT    | 31727     | .INTG                                        | 31777   |     |
|              |             | -1001-    | 32115       |         |           | -XCF       | -32165    | -TEST-   | 32672     |                                              | -32675  |     |
| -1           |             |           | -33005      | -GAIN-  |           |            | -33007    |          |           |                                              | -33042- |     |
|              |             | .DOFLG    | 33043       | - HQD   | 33044     | -PEX       | 33045     | -FEXP    | 33046     | DIG                                          | 33047   |     |
| -22 105      | 33067       | -F105-    | 33067       | FSEL-   |           |            | -33233-   | FRTB-    | 33242 *   |                                              | 33247   |     |
|              |             | -REED     | -33435 *    | -BIN-   |           | +FOFM      | -33437    | -FCKS2   |           | +1001+                                       | 33461   |     |
| 23. FINH     | 33523       | .F13H.    | 33523       | .FFIL.  | 34312     | .FRTN.     | 34337 *   |          |           |                                              |         |     |
| -24- FMR0    | 34524       | FWRD      | -34524      | -       | · · · · · |            |           |          |           |                                              |         |     |
| 25. FWRU     | 24550       | * P NRU*  | 34350 .     |         |           | -          |           |          |           |                                              |         | _   |

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|         | WR3     |            |            | -34574-                                       |         |         |         |         |            |          |                  |
| 27. F   | RDU     | 35201      | .FROU.     | 35201                                         |         |         |         |         |            | -        |                  |
|         | NUS     | 35242      | -0405      | 35242                                         | 011657  | 36344   |         |         |            | -        |                  |
| 24. 0   | NUG     | 35245      | -0106.     | 35245                                         |         | 35277   |         |         |            |          | - INTA 0         |
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|         | COTU    | -40724     | CONDIN-    | -40335-                                       |         |         |         |         |            |          |                  |
|         | DDT 1   | 41033      | PRIPTI     | 41 21 6                                       |         |         |         |         |            |          |                  |
|         | 1.06-   | -41316-    | -41-04-10- | -41.21 5-+                                    |         | 41317   |         |         | -          |          |                  |
| 35. 6   | YPF     | 41456      | EXP        | 41456                                         |         |         |         |         |            |          |                  |
|         | SC-4    | -41576     | -005       | -41576                                        |         | 41600 - | • •     | -       |            |          |                  |
| 37. F   | SOR     | 42007      | SORT       | 42007                                         |         |         |         |         |            |          |                  |
|         | xp3     | -42114     |            | -42114                                        |         |         |         |         |            |          |                  |
| 39.     | TOCS    | 42241      | .L(0)      | 42241                                         | + HONSH | 42261   | • TEOR  | 42330   | .DEFI.     | 42410    | .JOINX 42454 *   |
|         |         |            | -+6L35-    | -42473                                        | ATTC+   | 42506   | +SH1    | 42720 * | • SH9      | ·42762 * | .OPEN 43003-     |
|         |         |            | •OP4       | 43031 *                                       | .OP7    | 43062 * | +0P9.2  | 43076 * | -RLSE-     | 43150    | "RERZ. 43150     |
|         |         |            | .READ.     | 43151                                         | RER1.   | 43174   | •WRIT•  | 43176   | -HNT LA-   | 43364 *  | .EOFEX -43445-*- |
|         |         |            | FEEIT      | 43515                                         | .GTIOX  | 43536   | +RW7    | 43654 * | •RE7       | 44273 *  | •ENDTR 44734     |
|         |         | -          | -•SEL59-   | ~44736 *                                      | BSR.    | 45347   | .E010F  | 45474   | •ET0F3     | ·45502 * | •SHITC45531      |
|         | 10654   | 46036      | .TCHEX     | 46032                                         | .RASIO  | 46035 ¥ |         |         |            |          |                  |
|         | IFFERS  | -          |            | - 460                                         | 6 THRU- | 77741   |         |         |            |          |                  |
|         |         |            |            | 777                                           | 57 THRI | 7777    |         |         |            |          |                  |
| 040321  | , ci)k- |            |            |                                               |         |         |         |         |            |          |                  |
| \$INPUT | r       |            |            |                                               |         |         |         |         |            |          |                  |
| v       |         | 0.197      | 05000E 05  | •                                             |         |         |         |         |            |          |                  |
| XN      | -       | 0.512      | 000000 00  | ,                                             |         |         |         |         |            |          |                  |
| xo      | =       | <br>0.000  | 00000E-38  | ÷                                             |         |         |         |         |            |          |                  |
| XA      | -       | 0.000      | 000005-38  |                                               |         |         |         |         |            |          |                  |
| ¥C.     |         | <br>D. 488 | 00000E 00  |                                               |         |         |         |         |            |          |                  |
|         | ·       | 0 //0      | 200005 02  |                                               |         |         |         |         |            |          |                  |
|         | ***     | 0.669      | 20000F 02  | ·                                             |         |         |         |         |            |          |                  |
| RN      |         | 0.162      | 43400E 02  | ·                                             |         |         |         |         |            |          |                  |
| RC      | =       | 0.676      | 91000E 01  | <b>!</b>                                      |         |         |         |         |            |          |                  |
| RHOA    | =       | 0.121      | 000005-05  | <u>,                                     </u> |         |         |         |         |            |          |                  |
| TA      | *       | 0.100      | 00000E 03  | •                                             |         |         |         |         |            |          |                  |
| DELTA   | =       | 0.000      | 00000E-38  | •                                             |         |         |         |         |            |          |                  |

ATMOS =

VEHICL =

DATE = -NFNO CASE \$ FND

RSN -

0.30000000E 01. 0.99900000E 01,

0.67680000E 00,

0.40100000F 01, 0.10000000E 01, 0.10000000E 01,

| DATE 4.01 CASE 1.00 NEHO 1.00 ATHOS 3.00 VEHICLE 9.99                                                  |    |
|--------------------------------------------------------------------------------------------------------|----|
| UNDPFLOW_AT_40753_IN_HQ                                                                                |    |
| UN9RFLD#~47~497 <del>63_TN~AC~AND_HQ</del>                                                             |    |
| UNDRFLOW_AT=40763_IN_H3                                                                                |    |
|                                                                                                        |    |
| UN0RFE40#-4076311H9-mm-m-m-m-m-m-m-m-m-m-m-m-m-m-m-m-m-                                                |    |
| FDS:[I:0]/(-1)                                                                                         |    |
|                                                                                                        |    |
| 1 8.79953E-06 2 7.16842E-05 3 3.60825E-09 4 0.00000E-39 5 6.99787E-04 6 0.000006E-39<br>7 0.00075-30 8 |    |
| 13 1.20001E-06 14 1.15892E-06 15 2.31807E-07 16 5.56989E-30 17 3.82328E-26 18 6.93851E-22<br>          |    |
|                                                                                                        |    |
|                                                                                                        |    |
|                                                                                                        | 33 |
| X1 MOLAR-CONC.                                                                                         |    |
| N2 0.39343028E 00 N2 1 0.45589459E-01 0.00000000E-38N2-2 0.37035265E 00                                |    |
| C0 0.47152183E 00 N2 0.1859374E-04<br>                                                                 |    |
| 0 0,49955057E 00 C0 0.3262598E 01                                                                      |    |
| CN 0.85895380E-03 02 0.000000E-38                                                                      |    |
| C 0.15619319E-01 N 0 0.7930976E-04                                                                     |    |
| N+ 0.57380483E-05 C VID 0.2388492E 02                                                                  |    |
|                                                                                                        |    |
|                                                                                                        |    |
| 0++ 0.00000005-38 C 0.12009494-00<br>                                                                  |    |
| N2+ 0.11474966E-05 N+ 0.19808027E-21                                                                   |    |
| A+ 0,00000000E-38 N2+ 0,6008/11E 00<br>→ → → → → → → → → → → → → → → → → → →                           |    |
| ,A+ 0.0000000E-38                                                                                      |    |
| \$ TNPUT                                                                                               |    |
| y ∞ 0.19705000F 05,                                                                                    |    |
| XN = 0.51209000E 00,                                                                                   |    |
| XO = 0.0000000E-38,                                                                                    |    |
| XA = 0.00000000-38,                                                                                    |    |
| xc = 0.48800000E 00,                                                                                   |    |
| THN = 0.66920000E 02,                                                                                  |    |
| RN = 0.16243400E 02.                                                                                   | -  |
| RC = 0.6761000E 01,                                                                                    |    |
| RH0A = 0.121000006-05,                                                                                 |    |
| T4 = 0.10000000E 03,                                                                                   |    |
| DELTA = 0.10107000E 01,                                                                                |    |
| ATHOS = 0.30000000E 01,                                                                                |    |
| VFHICL = 0.99900000E 01,                                                                               |    |
| RSM = 0.67680000E 00,                                                                                  | •  |
| DATE = 0.40100000E 01,                                                                                 | •  |
| MEND = 0.10000000F 01,                                                                                 | -  |
| CASE = 0.70000000E 01,                                                                                 | -  |
| \$ END                                                                                                 | •  |
|                                                                                                        |    |

| -EPSILO  | <del>N(1),-1</del> - | 1-f0-21         |                      |                  |                 |                      |                   |                         |                       |               |                            |            |
|----------|----------------------|-----------------|----------------------|------------------|-----------------|----------------------|-------------------|-------------------------|-----------------------|---------------|----------------------------|------------|
| 1 8      | .95931F-             | 06 2            | 7.278                | 22E-05           | 3               | 3.67377E             | -09 4             | 0.000001                | -39 5                 | 7.12494E-04 6 | 0.00000E-39                |            |
| 13 1     | -22272E-             | -34 8<br>-06 14 | 4.514                | 150-08<br>966-06 | 15              | 1-558610<br>2.36016E | -08-10-<br>-07 16 | 3.01504<br>5.67103      | -03-11<br>-30 17      |               | 8-84382E-05<br>7-06450E-22 |            |
| 19       | -140145-             | 04-20-          |                      | 005-34-          | ~1              | 0100000              | -39               |                         |                       |               |                            |            |
|          |                      |                 | 902-09-              |                  | 110             |                      | 05/880            |                         |                       |               | ç                          |            |
|          |                      |                 |                      | 23               |                 | All                  | 0071110           |                         |                       | 1.0711        | •                          | 1457 (10   |
|          | 56528459             | E-04            | 0.16                 | 1226146          | -01             | 0-170                | 423586-0          | 20.+                    | <del>1523944</del> 0E | -02-0-589071  | 265-00                     | 82404568-0 |
|          |                      | HOLAR           | EONG-)               |                  |                 |                      |                   | 01                      |                       |               |                            |            |
| NZ       | c                    | . 398430        | 28E 00               |                  | NZ 1            |                      | 0+4641            | 7324E-01                |                       |               |                            |            |
| 205      |                      | .000000         | 00 <del>5 38</del>   |                  |                 |                      | -0.3770           | 7764E-00-               |                       |               |                            |            |
| ço       | 9                    | +471521         | B3E 00               |                  | N2              |                      | 0.1903            | 3426E-04                |                       |               |                            |            |
|          |                      | 400550          | 576 00               |                  |                 |                      | -020000           | 34365 01                |                       |               |                            |            |
| <u> </u> |                      |                 | 37 <u>6 00</u>       |                  |                 | -P                   | 0.0000            | 00005-30-               |                       |               |                            |            |
| CN       | č                    | .858853         | ROF-03               |                  | 02              | N.                   | 0.0000            | 0000E-38                |                       |               |                            |            |
| NO       | 0                    | +492760         | 156-02-              |                  | -0              |                      | -0+2338           | 7349E-03                |                       |               |                            |            |
| С        | 0                    | .156193         | 196-01               |                  | N               |                      | 0.8074            | 99008-04                |                       |               |                            |            |
| 0+       | ······               | -169341         | 54 <del>0</del> -04- |                  | -CN-R           | 0                    | -0-1562           | 0621 <del>5-02-</del> • |                       |               |                            |            |
| N+       | C                    | .533804         | 836~05               |                  | CN VI           | .0                   | 0+2442            | 0011E 02                |                       |               |                            |            |
| 5        |                      | . 976161        | 35t-04-              |                  |                 | -G                   | -0-4581           | 09995E-00-              |                       |               |                            |            |
|          |                      |                 | 04E-03               |                  | - 10 10         | ,                    | 0.6334            | 25915-02                |                       |               |                            |            |
| )++      | ő                    | - 0000000       | 10F-38               |                  | C               |                      | 0.1222            | 7770E-02                |                       |               |                            |            |
|          | G                    | -0000000        | 90E-38-              |                  |                 |                      | -0-2938           | 10536-25-               |                       |               |                            |            |
| N2+      | d                    | .114749         | 56E-05               |                  | Ň+              |                      | 0.2016            | 7708E-21                |                       |               |                            |            |
| ۸        |                      | +0000000        | <del>)0E-38-</del>   |                  | - <del>C+</del> |                      | -0-3660           | 0477 <del>E-17</del> -  |                       |               |                            |            |
| A+       | c                    | .000000         | 00E-38               |                  | N2+             |                      | 0.6117            | 5749E 00                |                       |               |                            |            |
|          |                      |                 |                      |                  |                 |                      | -0.0000           | 0000E~38-               |                       |               |                            |            |
|          |                      |                 |                      |                  | A+              |                      | 0.0000            | 0000E-38                |                       |               |                            |            |
|          |                      |                 |                      |                  |                 |                      |                   |                         |                       |               |                            |            |
|          |                      |                 |                      |                  |                 |                      |                   |                         |                       |               |                            |            |

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#### III. COMPUTATIONS

#### A. BLOCK DIAGRAM

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The block diagram for Program 1883 is given in Figure 5.



number density of 1th specie, particles/cm<sup>3</sup>

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|   | Р                          | pressure, atmospheres                                                             |
|---|----------------------------|-----------------------------------------------------------------------------------|
|   | R                          | universal gas constant                                                            |
|   | QR                         | equilibrium radiative heating rate, Btu/ft <sup>2</sup> -sec                      |
|   | T <sub>a</sub>             | atmospheric temperature, °K                                                       |
|   | Т                          | temperature, °K                                                                   |
|   | To                         | reference temperature, 273.16 °K                                                  |
|   | v                          | flight velocity, fps                                                              |
|   | X()                        | molar concentration                                                               |
|   | XA, XC, XN, XO             | molar concentrations of argon, carbon dioxide, nitrogen, and oxygen in atmosphere |
|   | Z                          | compressibility factor; number of moles of products per<br>mole reactants         |
| - | <sup><i>e</i></sup> i<br>L | emissivity per unit thickness, cm <sup>-1</sup>                                   |
|   | 7.<br>1                    | optical path length, feet                                                         |
|   | ē                          | emissivity, accounting for absorptivity (smeared out model)                       |
|   | Pa                         | atmospheric density, slug/ft <sup>3</sup>                                         |
|   | C. EQUATIONS               |                                                                                   |

## 1. Basic Equations

a. Enthalpy

$$\frac{H_{I}M}{RT_{o}} = \frac{E_{oI}}{RT_{o}} + \frac{T^{2}}{T_{o}} \left(\frac{\partial \ln Q_{I}}{\partial T}\right)_{P}$$
(1)

$$\frac{HM}{RT_{o}} = \Sigma X_{i} \left( \frac{H_{i}M}{RT_{o}} \right)$$
(2)

b. Energy of Dissociation

$$\frac{H_{D}M}{RT_{o}} = \sum_{i} X_{i} \frac{E_{oi}}{RT_{o}}$$
(3)

c. Equilibrium Constants

The equilibrium constants for all the reactions used in the program are given as a function of (T, P) in Reference 1, Table I-15.

d. Partition Functions

The partition functions for all the species considered in the program are given as a function of (T, P) in Reference 1, Table I-18.

e. Zero Point Energies

The zero point energies used are given in Reference 1, Table I-14. It is important to note that the values for all molecules are zero.

- 2. Zone 1
  - a. Major Species
    - 1) Six major species considered:

Six major species considered X(N2),  $X(CO_2)$ ,  $X(O_2)$ , X(A), X(CO), X(O)

b. Major Specie Reactions

$$CO_2 \rightarrow CO + 1/2O_2$$

 $O_2 \rightarrow 20$ 

c. Major Specie Conservation Equations

$$X(N_2) = XN \tag{4}$$

$$X(CO_2) = XC - X(CO)$$
<sup>(5)</sup>

$$X(O_2) = XO + (1/2) X(CO) - (1/2) X(CO)$$
 (6)

$$X(A) = XA \tag{7}$$

d. Equilibrium Constants for Major Species Reactions

$$K_{P1} = \frac{[X(CO)]\sqrt{[X(O_2)]}\sqrt{P}}{[X(CO_2)]\sqrt{Z}}$$
(8)

$$K_{P2} = \frac{[X(0)]^2 P}{[X(0_2)] Z}$$
(9)

Total moles: (10)  $Z = \Sigma X_1 = 1 + (1/2) X(CO) + (1/2) X(O)$ 

e. General Solution

There can be as many as six major species governing the thermodynamic state of the gas. Hence, six equations are required to be solved (identified as Equations (4) through (9)). The auxiliary equation for the compressibility factor Z is given by Equation (10). Making use of Equations (5) and (6), and combining Equations (8) and (9), an explicit solution for the CO concentration can be found, namely,

X(CO) Polynomial

$$\sum_{i=1}^{4} C_i X(CO)^{4-i} = 0$$
(11)

$$C_{1} = K_{P1}\sqrt{K_{P2}} \left(\frac{K_{P1}}{\sqrt{K_{P2}}} - 1\right) - P$$

$$C_{2} = K_{P1}\sqrt{K_{P2}} \left\{\frac{2K_{P1}}{\sqrt{K_{P2}}} (1 - XC) + XC - 1 - XO\right\} - 2PXO$$

$$C_{3} = K_{P1}\sqrt{K_{P2}} XC \left\{XO + 1 + \frac{K_{P1}}{\sqrt{K_{P2}}} (XC - 4)\right\}$$

$$C_{4} = 2(XC)^{2} K_{P1}^{2}$$

- 3. Zone 2
  - a. Major Species

Six major species are considered in Zone 2:

 $X(N_2)$ , X(N), X(A), X(O), X(C), and X(CO).

b. Major Specie Reactions

 $N_2 \rightarrow 2N$ 

 $CO \rightarrow C + O$ 

c. Major Species Conservation Equations

,

$$X(N_2) = XN - (1/2)X(N)$$
 (12)

$$X(CO) = XC - X(C)$$
<sup>(13)</sup>

$$X(0) = 2XO + XC + X(C)$$
 (14)

$$X(A) = XA$$
(15)

d. Equilibrium Constants for Major Species Reactions

$$K_{P3} = \frac{[X(N)]^2 P}{X(N_2) Z}$$
(16)

$$K_{P4} = \frac{[X(C)] [X(O)] P}{X(CO) Z}$$
(17)

$$Z = 1 + XO + XC + \frac{X(N)}{2} + X(C)$$
(18)

e. Minor Species

A large number of minor concentrations are considered in Zone 2 because of their importance in the radiative heating calculations. Eight minor species are considered:

$$X(CN), X(NO), X(N^{+}), X(C^{+}), X(O^{+}), X(A^{+}), X(N_{2}^{+}), and X(e^{-}).$$

30Z<

f. Minor Species Reactions

$$\begin{split} \mathbf{N} &\rightarrow \mathbf{N}^{+} + \mathbf{e}^{-} \\ \mathbf{O} &\rightarrow \mathbf{O}^{+} + \mathbf{e}^{-} \\ \mathbf{C} &\rightarrow \mathbf{C}^{+} + \mathbf{e}^{-} \\ \mathbf{A} &\rightarrow \mathbf{A}^{+} + \mathbf{e}^{-} \\ \mathbf{N}_{2}^{+} &\rightarrow \mathbf{N}^{+} + \mathbf{N} \\ \mathbf{C} &+ \mathbf{N} \rightarrow \mathbf{CN} \\ \mathbf{N} &+ \mathbf{O} \rightarrow \mathbf{NO} \,. \end{split}$$

.

g. Minor Species Concentrations

$$X(0^{+}) = K_{P7} - \frac{Z}{P} - \frac{X(0)}{X(e^{-})}$$
 (19)

$$X(N^{+}) = K_{P8} \frac{Z}{P} \frac{X(N)}{X(e^{-})}$$
 (20)

$$X(C^{+}) = K_{p,9} \frac{Z}{P} \frac{X(C)}{X(e^{-})}$$
 (21)

$$X(N_2^+) = \frac{K_{P8}}{K_{P13}} \frac{[X(N)]}{X(e^-)}^2$$
(22)

$$X(CN) = X(C)X(N) K_{P5} \frac{P}{Z}$$
 (23)

$$X(NO) = X(N) X(O) K_{P6} \frac{P}{Z}$$
 (24)

.

$$\left[X(e^{-})\right]^{2} = \frac{Z}{P} \quad X(0) \ K_{P7} + X(N)K_{P8} + X(C)K_{P9} + X(A)K_{P14} + \frac{K_{P8}}{K_{P13}} \left[X(N)\right]^{2}$$
(25)

-26-303< h. General Solution

$$\begin{aligned} & \text{X(N) Polynomial} \end{aligned}$$
(26)  

$$\begin{aligned} & \sum_{i=1}^{5} c_{i} x_{i} x_{i} x_{j} \\ & = 0 \end{aligned} \\ & c_{1} = - \left( K_{P4} \right) \left( 4P + K_{P3} \right) - 2P \left[ 2P - K_{P3} \right] - \frac{K_{P3}^{2}}{8} \\ & c_{2} = \frac{(K_{P3})(K_{P4})}{2} \left[ xN - (1 + xC + x0 + xC) \right] + \frac{K_{P3}}{8} \left[ 4P (2XN - 2 - xC) \right] \\ & - \frac{K_{P3}^{2}}{8} \left( 2 - 2XN + xC \right) \\ & c_{3} = (K_{P3})(K_{P4}) \frac{xN}{2} (1 + XO + 2XC) + \frac{P}{2} (K_{P3}) XN (2 + XC) \\ & - \frac{K_{P3}^{2}}{8} \left[ xN^{2} - 2XN (2 + xC) + (1 + XC - XOXC - XO^{2}) \right] \\ & c_{4} = - \frac{K_{P3}^{2}}{8} \left[ xN^{2} (2 + xC) - 2XN (1 + xC - XOXC - XO^{2}) \right] \\ & c_{5} = - \frac{K_{P3}^{2}}{8} xN^{2} (1 + XC - XOXC - XO^{2}) \\ & x (CN) Polynomial \\ & \sum_{i=1}^{4} c_{i} [X(CN)]^{4-i} \\ & c_{4} = - \left[ x_{i}(C_{i}) \right]^{2} \frac{K_{P3}^{2}}{K_{P3}^{2}} X(N) P [X(C) + xC + 2XO] K_{P6} \\ & c_{3} = (K_{P3}) X(C) [X(C) K_{P5} H + D + 2W_{S6}] \\ & H = PK_{P6} [X(C) + XC + 2XO] \end{aligned}$$

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$$D = P (K_{P6}^{2}) [X(C) + XC + 2XO] [X(C) + XC + 2XO + X(N)]$$
  
+ [1 + XC + XO + X(C) +  $\frac{1}{2} X(N)$ ] [X(C) + XC + 2XO) K<sub>P6</sub>]

$$WSG = -(K_{P6} - K_{P5}) X(N) P K_{P6} [X(C) + XC + 2XO]$$

,

-

$$\begin{aligned} C_2 &= X(C) K_{P5} (F + 2WSH) + F(WS2) + (K_{P6} - K_{P5}) (D + WSG) \\ F &= -K_{P6} [X(C) + XC + 2XO] - K_{P6}^2 P[X(C) + XC + 2XO] \\ WSH &= (K_{P6} - K_{P5}) PK_{P6} [X(C) + XC + 2XO] \\ WS2 &= K_{P6} [X(C) + XC + 2XO] \\ C_1 &= (K_{P6} - K_{P5}) (F + WSH) \end{aligned}$$

- 4. Zone 3
  - a. Major Species

Seven major species are considered in zone 3:

X(N), X(C), X(O), and X(e-).

- b. Major Species Reactions
  - $N \rightarrow N^{+} + e^{-}$  $C \rightarrow C^{+} + e^{-}$  $O \rightarrow O^{+} + e^{-}$
- c. Major Specie Conservation Equations
  - $X(N) = 2XN X(N^{\dagger})$  (28)
  - $X(C) = XC X(C^{\dagger})$  (29)

$$X(0) = 2XO + 2XC - X(O^{+})$$
 (30)

$$X(e^{-}) = X(N^{+}) + X(C^{+}) + X(O^{+})$$
 (31)

d. Equilibrium Constants for Major Species Reactions

$$K_{P7} = \frac{X(O^{+}) X(e^{-}) P}{X(O)Z}$$
(32)

$$K_{P8} = \frac{X(N^{+}) X(e^{-}) P}{X(N) Z}$$
(33)

$$K_{P9} = \frac{X(C^{+}) X(e^{-}) P}{X(C) Z}$$
(34)

Total moles

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$$Z = 1 + XN + XO + 2XC + X(e^{-})$$
 (35)  
e. Minor Species

A number of minor concentrations heavily influence the radiative heating and the following additional specie concentrations are required.

 $X(CN), X(NO), X(N_2^+)$ 

f. Minor Species Reactions

$$C + N \rightarrow CN$$
  
  $N + O \rightarrow NO$ 

$$N^+ + N \rightarrow N_2^+$$

g. Minor Species Concentration

$$X(CN) = X(C) X(N) K_{P5} \frac{P}{Z}$$
 (36)

$$X(NO) = X(N) X(O) K_{P6} \frac{P}{Z}$$
 (37)

•

$$X(N_{2}^{+}) = \frac{X(N^{+}) X(N)}{K_{p13}} \frac{P}{Z}$$
(38)

#### h. General Solution

X(C<sup>+</sup>) polynomial

$$\sum_{i=1}^{5} c_{i} [X(C^{i})]^{5-i} = 0$$

$$C_{1} = (K_{P8} - K_{P9}) (K_{P7} - K_{P9}) (K_{P9} + P)$$

$$C_{2} = (K_{P9} + P) \{ 2XN K_{P8} (K_{P7} - K_{P9}) + 2 (XC + XO) K_{P7} (K_{P8} - K_{P9}) + XCK_{P9} (K_{P8} + K_{P7} - 2K_{P9}) \} + \{ (K_{P8} - K_{P9}) (K_{P7} - K_{P9}) + XCK_{P9} (K_{P9} + K_{P7} - 2K_{P9}) \} + \{ (K_{P8} - K_{P9}) (K_{P7} - K_{P9}) + ((1 + 2XC + XO + XN) K_{P9} - XCK_{P9}] \}$$

$$C_{3} = XCK_{P9} \{ (K_{P9} + P) [ 2XN K_{P8} + 2K_{P7} (XC + XO) + K_{P9} XC] + (K_{P8} + K_{P7} - 2K_{P9}) + ((1 + 2XC + XO + XN) K_{P9} - XCK_{P9}] \}$$

$$- [ 2XN K_{P8} (K_{P7} - K_{P9}) + 2 (XC + XO) (K_{P7}) (K_{P8} - K_{P9})]$$

$$- (1 + 2XC + XO + XN) (K_{P8} - K_{P9}) (K_{P7} - K_{P9}) \}$$

$$C_{4} = xc^{2} \kappa_{P9}^{2} \{ (1 + 2XC + XO + XN) K_{P9} - XC K_{P9}$$

$$- 2 (XC + XO) K_{P7} - 2XN K_{P8}$$

$$- (1 + 2XC + XO + XN) (K_{P8} + K_{P7} - 2K_{P9}) \}$$

$$C_{5} = -K_{P9}^{3} XC^{3} (1 + 2XC + XO + XN)$$

5. Zone 4

Seven major species are considered in Zone 4:  $X(N^+)$ ,  $X(C^+)$ ,  $X(O^+)$ ,  $X(N^{++})$ ,  $X(Q^{++})$ ,  $X(O^{++})$ , and  $X(e^-)$ .

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a. Major Species Reaction

$$N^+ \rightarrow N^{++} e^-$$

$$C^+ \rightarrow C^{++} e^-$$

$$O^- \rightarrow O^{++} e^-$$

b. Major Species Conservation Equations

$$X(N^{+}) = 2XN - X(N^{++})$$
 (40)

$$X(C^{+}) = XC - X(C^{++})$$
 (41)

$$X(O^{+}) = 2XO + 2XC - X(O^{++})$$
 (42)

$$X(e^{-}) = 1 + XN + XO + 2XC + X(C^{++})$$
 (43)

$$+ X(O^{++}) + X(N^{++})$$

c. Equilibrium Constants for Major Species

$$K_{P10} = \frac{X(C^{+}) X(e^{-}) P}{X(C^{+}) Z}$$
(44)

$$K_{P11} = \frac{X(N^{++}) X(e^{-}) P}{X(N^{+}) Z}$$
(45)

$$K_{P12} = \frac{X(0^{++}) X(e^{-}) P}{X(0^{+}) Z}$$
(46)

Total moles:

$$Z = 1 + XN + 2XC + XO + X(e^{-})$$
(47)

d. General Solution

X(O<sup>++</sup>) polynomial

$$\sum_{i=1}^{5} C_{i} [X (0^{+})]^{5-i} = 0$$
(48)

-

$$C_{1} = (K_{P12} + P)(K_{P10} - K_{P12})(K_{P11} - K_{P12})$$

$$C_{2} = (K_{P12} + P)\{K_{P12} 2(XC + X\phi) [K_{P10} + K_{P11} - 2K_{P12}]$$

$$+ XC K_{P10} (K_{P11} - K_{P12}) + 2XN K_{P11} (K_{P10} - K_{P12})\}$$

$$+ (K_{P10} - K_{P12})(K_{P11} - K_{P12}) \{1 + 5XC + 3(XO + XN) K_{P12}$$

$$+ [2(XN + XO) + 3XC] P - K_{P12} 2(XC + XO)\}$$

$$C_{3} = K_{P12} 2(XC + XO) \{\{(K_{P12} + P) [K_{P12} 2(XC + XO) + XCK_{P10} + 2XN K_{P11}]\}$$

$$+ (K_{P10} K_{P11} - 2K_{P12}) \{[1 + 5XC + 3(XO + XN)] K_{P12}$$

$$+ [2(XN + XO) + 3XC] P - 2K_{P12} (XC + XO)\}$$

$$- [1 + 5XC + 3(XO + XN)] (K_{P10} - K_{P12})(K_{P11} - K_{P12})$$

$$- [XC K_{P10} (K_{P11} - K_{P12}) + 2XN K_{P11} (K_{P10} - K_{P12})]\}$$

$$C_{4} = [2K_{P12} (XC + XO)]^{2} \{[1 + 5XC + 3(XO + XN)] K_{P12}$$

$$+ [2(XN + XO) + 3XC] P - K_{P12} 2(XC + XO)$$

$$- XCK_{P10} - 2XN K_{P11} - [1 + 5XC + 3(XO + XN)] .$$

$$[K_{P10} + K_{P11} - 2K_{P12}]\}$$

$$C_{5} = -[1 + 5XC + 3(XO + XN)] [K_{P12} 2(XC + XO)]^{3}$$

6. Equations Defining the Radiation Heating

a. Basic Equations

$$QR = \bar{\epsilon}\sigma T^4$$
(49)

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. . .

where,

.

 $\sigma$  = Stefan-Boltzmann constant

$$\tilde{\epsilon} = 1 - 2 E_3(\Sigma_{r_1}) \tag{50}$$

$$r_1 = 15.24 \frac{\epsilon_1}{L} \quad (DELTA) \tag{51}$$

$$E_{3}(r) = \int_{0}^{1} se^{-r} \cdot i \, ds \,. \tag{52}$$

The tabular values of  $\overline{c}$  (r) given in Table I are used in the computer program.

#### b. Emissivities

The emissivities are taken to have the form:

$$\frac{\epsilon_{i}}{L} = C_{i} \frac{N_{i}}{5.4 \times 10^{19}} \frac{e^{-T_{i}/T}}{(T \times 10^{-4})^{n_{i}}}$$
(53)

where,

$$N_{i} = 2.7 \frac{\frac{(\text{RHO}) (M)}{2116}}{(89516)(273.16)} 10^{19} X_{i} .$$
(54)

The values of  $C_i\,,\,T_i\,$  , and  $n_i\,$  for the corresponding species  $X_i$  are given in Reference 1, Table I-20.

$$P = \frac{\rho_a V^2}{2116}$$
 (55)

$$\frac{HM}{RT_o} = \frac{V^2M}{2RT_o} + \left(\frac{MC_p}{R}\right) \frac{T_a}{T_o}$$
(56)

$$\frac{MC_p}{R} = 3.5 \text{ XN} + 3.5 \text{ XO} + 4.0 \text{ XC} + 2.5 \text{ XA}$$
(57)

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#### IV. IBM ROUTINES

#### A. PROGRAM FLOW

A diagram depicting the flow of information within the program is shown in Figure 6.



Figure 6 FLOW DIAGRAM FOR PROGRAM 1883

#### B. MAIN PROGRAM

The purpose of the main program is to define tables used with output from the calculation, to acquire program input and provide output. The main program defines tables of Hollerith words (ZNAM1 and ZNAM2) which appear in the output of Program 1883. ZNAM1 contains the array of specie names in the same order as their concentrations are stored in the array X, and the table ZNAM2 contains the names of the radiation heating sources as they are arrayed in the table QI. The arrays ZNAM1 and ZNAM2 should be referred to for any changes on the computation of an individual specie or radiation component.

There are eleven tables of temperature and enthalpy which, with a pressure table, are used to define the zone<sup>1</sup> in which a solution is computed. The selection of the proper set of tables from the 11 possibilities is determined by the value of the quantity NX. Each of the 11 tables'is based on a specific composition of O<sub>2</sub>, N<sub>2</sub>, A, and CO<sub>2</sub> in the undissociated mixture, and the main program selects NX by choosing the table whose sum of mole fractions of O<sub>2</sub>

-34-311< and  $CO_2$  is closest to the input sum XO and XC. The array TBSUM contains the sum  $O_2 + CO_2$  for each of the 11 tables.

All input variables are read in through the namelist array INPUT.

Subroutine HEAT1, called after Statement 2001, begins all of the significant calculations done by the program. When control is passed back to the main program, the only remaining task is to provide the program output, all of which is contained in the calling sequence of HEAT1, save for the effective emissivities written out by Subroutine GETN1.

#### C. SUBROUTINES

- 1. HEAT 1
  - a. Purpose

HEAT1 defines the heats of formation of each specie in the equilibrium mixture, provides data for the computation of the detachment distance if this quantity is not specified as input and defines the zone on which the equilibrium solution will be found. Moreover, it controls the temperature iteration which computes an equilibrium mixture of some known pressure and enthalpy at the stagnation point, and obtains total radiation heating and individual radiation components.

b. Method

The major function of subroutine HEAT1 is to control the iteration in  $T_{s}$ , this stagnation temperature being such that the equilibrium mixture has pressure (P) and an enthalpy (HRT) whose relative error to the known stagnation enthalpy (HRTZ) is less than some number (PCNT).

HEAT1 first defines PCNT, then the heats of formation of each specie (the array E) and the quantities necessary for the detachment distance DELTA. DELTA is computed by a two-dimensional table lookup, unless it is specified in the program input as some number > 0. The lookup has, as independent variables, the inverse density ratio which appears in the output (RH $\phi$ S/RH $\phi$ ), and the geometry parameter b/a (see Reference 1): The corresponding tables are called RKTBL and BATBL. The two-dimensional dependent variable table of detachment distance is called DELTBL.

HEAT1 then calls subroutine HVST1 which provides a set of tables --T1TBL, T2TBL, T3TBL, H1TBL, H2TBL, and H3TBL. This set is selected from 11 possible sets, and depends on the value of NX and thus on the 02 and CO<sub>2</sub> concentrations of the ambient mixture. These temperature and enthalpy tables are used with a pressure table (PTBL) to define the upper boundaries of the zone, in which a solution will be found, T1TBL being Zone 1, T2TBL being Zone 2, and so forth

After calling HVST1, subroutine HEAT1 defines the pressure (P) and enthalpy (HRTZ) at the stagnation point. If the pressure is lower (higher) than the lowest (highest) value in the array PTBL, it is set equal to the lowest (highest) value (Statements 11 to 14).

Subroutine FINDT1 provides a first guess for temperature, the number of the zone for the solution (NUM), and upper and lower bounds in temperature and enthalpy from the proper zone tables (TITBL), and Statements 1007 to 1009 test to be certain that no argon 'so forth will be calculated in Zones 3 or 4, where argon species are not computed. If argon is present in Zones 3 or 4, no solution is provided (GO TO 999). Between Statements 1010 and 106 successive values of the temperature are computed by redefining the bounds in temperature and enthalpy (TUP, TLOW, HUP, and HLOW) and interpolating linearly to the value T which, with P, would give (for a linear variation) an enthalpy HRT=HRTZ. For each iteration subroutine FINDH1 is called; this routine solves the equation of state of the equilibrium mixture at the pressure P and approximate temperature T. In addition to specie concentration, the enthalpy HRT is computed and compared to HRTZ. If it is close enough, the iterative procedure 1s terminated (Statement 106); if not, TUP and HUP or TLØW and HLØW are recalculated, and a new temperature is interpolated. If no adequate solution is found within 30 iterations, this fact is noted in the output and the last value of temperature is used to provide the solution. Experience indicates that a failure to converge occurs close to the boundary of a zone, and generally where the total radiation heating is small.

Statement 106 deletes the computation of the radiation for velocities lower than 8000 ft/sec. Statements 116 and 107 define the "trace" specie N in Zone 4. If a positive detachment distance has not been provided as program input, Statements 503 to not including, 504 compute the density ratio  $\rho_a/\rho_s$ , and a/b and compute the detachment distance from a two-dimensional table lookup performed by AR2 TLU (see description of AR2TLU).

If the species  $O^+$ ,  $N^+$ ,  $C^+$ , and  $E^-$  are present in Zone 2, in which zone they are treated as trace species, their concentrations are entered in the regular array X of specie concentrations from the trace specie table DUM (Statements 504 to 502).

The normalized stagnation density is computed, and this with the list of concentrations, temperature, and detachment distance is used to compute effective emissivities, radiation components, and total radiation in Subroutine GETN1.

#### 2. HVST-1

a. Purpose

Subroutine HVSTl provides subroutine HEATl with a set of six tables--TITBL, T2TBL, T3TBL, H1TBL, H2TBL, and H3TBL--which are used to determine zone boundaries and to obtain a first guess for the stagnation temperature.

b. Method

The quantity NX, computed by the main program as the index of that set of tables which most closely approximates the concentrations of  $O_2$  and  $CO_2$ , is used in a computed "go to" statement at the beginning of HVST1 to select the appropriate set of T1TBL, T2TBL, T3TBL, H1TBL, H2TBL, and H3TBL.

These tables are the same as in Reference 1 (pp. 59 to 69), except that for the first nume sets of tables each value in the enthalpy tables is modified from Reference 1 by the subtraction of a constant times the concentration of argon. The indices 1 through 7 correspond to values of PTBL in HEAT1 with indices 1 through 7.

#### 3. FINDT1

#### a. Purpose

Subroutine FINDT1 provides a first guess for the stagnation temperature iteration, upper and lower bounds for the stagnation temperature and enthalpy, and the number of the zone in which the solution will be found.

b. Method

The quantities Hl and Tl are first found by table lookups using the pressure P and the independent variable table PTBL. If the Hl is within a specified percent of HRTZ, then the zone number is 1 and the first guess T is Tl. If the Hl is < HRTZ, but not sufficiently close, the

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zone number is 1, enthalpy bounds are H1 and 0, temperature bounds are T1 and 0, and the transfer to Statement 100 provides a first guess T by linear interpolation. If H1>HRTZ, but not sufficiently close, then the next higher zone is considered and an H2 and T2 obtained by table lookup from P and the array PTBL. Then H2 is compared to HRTZ as was H1, and the process is carried on until the zone containing HRTZ, the first guess temperature, is obtained from the interpolation at Statement 100.

#### 4. FINDH1

#### a. Purpose

Subroutine FINDH1 provides the HRT for each of the temperature iterations controlled by subroutine HEAT1. In doing so, the equation of state for the equilibrium mixture must be computed at the pressure and approximate temperature T. Hence, the concentrations of each specie and total values of mixture are also computed.

#### b. Method

Subroutine FINDH1 first obtains the logs of pertinent partition functions (QP) and their partial derivatives (QPAR) from subroutine GETQ1. Which partition functions are computed depends upon the species in which zone the solution lies. The symbol QP is really the log of the partition function times pressure, and hence the - In P term in the equations of Reference 1, page 54 is not included in the computations of subroutine GETQ1. With these partition functions, the relevant equilibrium constants for the zone are computed by subroutine GETK1, and are stored in the array PK.

The arrays of specie concentrations are then cleared to zero (X and DUM) and subroutine ZONESI called. If a solution is found in ZONESI, the X array will contain some nonzero elements. The doloop ending at Statement 104 uses the heats of formation, molar concentration, and partial derivative of the partition function of each of the first 16 species to compute the dissociation enthalpy and total enthalpy (SUMD and SUMH, respectively). If species A and A+ exist (XC18, XC19), their contributions to the enthalpy are included (the partial derivatives of their partitions having first been computed), since these have not been previously computed in GETQ1 (Statements 107 to 110). N<sub>2</sub>+ does not contribute in this model to the enthalpy; hence, its heat of formation is not stored in the array E, and for this reason the 17th heat of formation is for the 18th specie (A), and the 18th heat of formation is for the 19th specie (A+). Having computed the HRT and HDHS, the subroutine returns control to subroutine HEAT1.

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#### 5. <u>GETQ1</u>

#### a. Purpose

Subroutine GETQ1 provides the log of the partition functions times pressure and their partial derivatives with respect to temperature for those species which are included in the relevant zone.

#### b. Method

The evaluation of the logs of the partition functions times pressure (QP) and their partial derivatives (QPAR) are merely algebraic evaluations of the equations of Reference 1, page 54. Since the equations of reference are  $\ln Q$ , but our evaluation is for  $\ln QP$ , the -ln P term of the reference is not included in the GETQl calculations.

If the solution lies in Zone 1, the functions evaluated are for N<sub>2</sub>, CO<sub>2</sub>, CO, O<sub>2</sub>, and O (QP and QPAR 1 to 5, respectively). For Zone 2, the functions are evaluated only for N<sub>2</sub>, CO, O, N, CN, NO, and C (QP and QPAR 1, 3, 5, 6, 7, 8, and 9, respectively). For Zone 3, the functions are evaluated for O, N, C, O<sup>+</sup>, N<sup>+</sup>, C<sup>+</sup>, and e<sup>-</sup> (QP and QPAR 5, 6, 9, 10, 11, 12, and 13 respectively). For Zone 4, the functions are evaluated for N, O<sup>+</sup>, N<sup>+</sup>, C<sup>+</sup>, e<sup>-</sup>, N<sup>++</sup>, O<sup>++</sup>, and C<sup>++</sup> (QP and QPAR 6, 10, 11, 12, 13, 14, 15, and 16, respectively).

6. GETK1

#### a. Purpose

Subroutine GETK1 evaluates appropriate equilibrium constants given  $\ln PQ$  for the relevant species.

b. Method

The equations for the equilibrium constants are given in Reference 1, page 48. In Zone 1, the constants computed are for the reactions  $CO_2 \rightarrow CO + 1/2 \ O2 \ and O2 \rightarrow ZO \ (PK 1 \ and 2, respectively).$  For Zone 2, the reactions are  $N_2 \rightarrow ZN$ ,  $CO \rightarrow C+O$ ,  $C+N \rightarrow CN$ , and  $N+O \rightarrow NO$ (PK 3, 4, 5, and 6, respectively). In Zone 3, the reactions are  $O \rightarrow O^++e^-$ , and  $C \rightarrow C^++e$  (PK 7, 8, and 9 respectively). In Zone 4, the reactions are  $N \rightarrow N^++e^-$ ,  $C^+ \rightarrow C^{++}+e^-$ ,  $N^+ \rightarrow N^{++}+e^-$ , and  $O^+ \rightarrow O^{++}+e^-$ (PK 8, 10, 11, and 12, respectively).

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#### 7. <u>ZØNES1</u>

#### a. Purpose

Subroutine ZONES1 computes the concentrations of each specie of the equilibrium mixture at the given pressure and temperature of the iteration controlled by subroutine HEAT1.

#### b. Method

Given temperature, pressure, mole fractions of  $O_2$ ,  $N_2$ ,  $CO_2$ , and A in the undissociated atmosphere, along with the zone number and pertinent equilibrium constants, subroutine ZQNES1 will compute the moles of each specie in the equilibrium mixture at the stagnation point, and the total moles of gas.

The method of solution depends on finding the roots of a polynominal whose argument is equal (or proportional) to one of the important species in the equilibrium mixture. The root which is used may be determined by physical constraints (e.g. it must be real and positive). If no such root is found, "NO VALID SØLU" is printed and the case deleted. Which specie is solved for depends upon the zone in which the solution is found. The coefficients of the polynominal are functions of the mole fractions of N<sub>2</sub>, O<sub>2</sub>, CO<sub>2</sub>, and A in the atmosphere, and the equilibrium constants of the reactions assumed to be important in the zone. The important reactions thus considered for equilibrium constants are those (and only those) computed by the subroutine GETK1. Where trace species are considered (Zones2 and 3), their concentrations are purely ancillary to the principal reactions to these trace species are computed in subroutine GETK1.

In Zone 1, no trace species are present and the species considered from principal reactions are N<sub>2</sub>, CO<sub>2</sub>, CO<sub>2</sub>, O<sub>2</sub>, and O the reactions being  $CO_2 \rightarrow CO + 1/2 O_2$ , and  $O_2 \rightarrow 2O$ . In Zone 2, the species considered from principal reactions are N<sub>2</sub>, CO<sub>2</sub> O, N, CN, NO, and C, the reactions being N<sub>2</sub> $\rightarrow$ 2N, CO $\rightarrow$ C+O, C+N $\rightarrow$ CN, and N+O $\rightarrow$ NO. Trace species considered are O<sup>+</sup><sub>4</sub> N<sup>+</sup><sub>4</sub>, C<sup>+</sup><sub>4</sub>, e<sup>-</sup><sub>4</sub>, and A<sup>+</sup><sub>4</sub>, which come from reactions  $O\rightarrow O^+$  +e<sup>-</sup>, N $\rightarrow$ N<sup>+</sup> +e<sup>-</sup>, C $\rightarrow$ C<sup>+</sup> +e<sup>-</sup>, N<sub>2</sub> $\rightarrow$ N<sup>+</sup>+N, and A $\rightarrow$ A<sup>+</sup> +e<sup>-</sup>. The equilibrium constants and necessary partition functions for these last five reactions are computed at the beginning of the subroutine before Statement 100 (DLPQ5, DLPQ6, DLPQ9, DLPQ10, and DLPQ11 are the logs of the partition functions times pressure for O, N, C, N<sup>+</sup><sub>4</sub>, and N<sub>2</sub><sup>+</sup>; DGK13 is the equilibrium constant for the reaction N<sub>2</sub><sup>+</sup> $\rightarrow$ N<sup>+</sup>N), and in the Zone 2 calculations between Statements 55 and 8512 (DLPQ12, DLPQ13, DLPQ14, DLPQ15, DLPQ16 are the logs of the partition functions of the partition function times pressure O<sup>+</sup>, e<sup>-</sup>, C<sup>+</sup>, A, and A<sup>+</sup>; DGK7, DGK8, DGK9, DGK14 are equilibrium constants for the reactions are O, N, C, A<sup>+</sup> +e<sup>-</sup>, In Zone 3, the species considered from principal reactions are O, N, C,

O<sup>+</sup>, N<sup>+</sup>, C<sup>+</sup>, and e<sup>-</sup>, the reactions being O  $\rightarrow$  O<sup>+</sup>+e<sup>-</sup>, N  $\rightarrow$  N<sup>+</sup>+e<sup>-</sup>, and C  $\rightarrow$  C<sup>+</sup>+e<sup>-</sup>. Trace species are CN, NO, and N<sup>+</sup> which come from the reactions C+N  $\rightarrow$  CN, N+O  $\rightarrow$  NO, N<sub>2</sub><sup>+</sup>  $\rightarrow$  N<sup>+</sup>+N. The equilibrium constants and logs of the necessary partition functions times pressure are computed at the beginning of the subroutine before Statement 100 (DGK13 is the equilibrium constant for the reaction N<sub>2</sub><sup>+</sup>  $\rightarrow$  N<sup>+</sup>+N, DLPQ5, DLPQ6, DLPQ9, DLPQ10, and DLPQ11 are the logs of the partition function times pressure for O, N, C, N<sup>+</sup>, and N<sub>2</sub><sup>+</sup>). In the Zone 3 calculation between Statements 28 and 8112, (DLPQ7 and DLPQ8 are the logs of the partition function times pressure for the species CN and NO. DGK5 and DGK6 are equilibrium constants for the reactions C+N  $\rightarrow$  CN and N+O  $\rightarrow$  NO.

In Zone 4 no trace species are present and the species considered from principal reactions are O<sup>+</sup>, N<sup>+</sup>, C<sup>+</sup>, e<sup>-</sup>, N<sup>++</sup>, O<sup>++</sup>, and C<sup>++</sup> from the reactions N  $\rightarrow$  N<sup>+</sup>te<sup>-</sup>, C<sup>+</sup>  $\rightarrow$  C<sup>++</sup>te<sup>-</sup>, N<sup>+</sup>  $\rightarrow$  N<sup>++</sup> + e<sup>-</sup>, and O<sup>+</sup>  $\rightarrow$  O<sup>++</sup>te<sup>-</sup>.

- 8. <u>GETN1</u>
  - a. Purpose

Subroutine GETN1 computes the effective emissivities of each component of the total radiation heating and from them computes the total radiation heating and the radiation component of each contributor.

b. Method

Subroutine GETN1 first defines the tables TAUTBL and EPSTBL, a tabulation of 1-2E  $_2$  (7) (EPSTBL) as a function of the independent variable 7 (TAUTBL). Next the table of emissivities EL is cleared to zero, and then the concentration of each specie in the equilibrium mixture is converted to particles per cm (ZNI). The DO LOOP ending on Statement 199 then computes the emissivities of each component to the total radiation which may come from a positive concentration of any of the first 12 species contained in the array X. These emissivities (EL, i = 1 to 21 correspond to the radiation contributors in the same order as the Hollerith names in the table ZNAM2 of the main program. No radiation contribution is made from the species X(13-16) (e<sup>-</sup>, N<sup>++</sup>, O<sup>++</sup>, C<sup>++</sup>), but contributions are made by X (17-19), and the emissivities for these species are computed from Statement 213 to 218. The emissivity formula and constants used to obtain the average emissivity of the gas (EP BAR) may be found in Reference 1, page 102. The total radiation and contribution of each component is then computed based on the  $\overline{\epsilon}$  and  $\epsilon_1$  (DO LOOP ending on 301). Output is provided, which includes the  $\bar{\epsilon}$ ,  $\epsilon_1$ , and  $\Delta$ .

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|                                | Variable<br>Name                 | V, Velocity                                                                                  | RHØ, density                              | XN, N <sub>2</sub> mole<br>fraction | XO, O <sub>2</sub> mole<br>fraction     | XC, CO <sub>2</sub> mole<br>fraction    |
|--------------------------------|----------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------|-------------------------------------|-----------------------------------------|-----------------------------------------|
| HEAT1                          | Input Or Output<br>of subroutine | Input                                                                                        | Input                                     | Input                               | Input                                   | Input                                   |
|                                | Source                           | Program<br>Input                                                                             | Program<br>Input                          | Program<br>Input                    | Program<br>Input                        | Program<br>Input                        |
| XA, A mole<br>fraction         | NX, enthalpy<br>table no.        | P, pressure                                                                                  | THN, O <sub>N</sub> nose<br>angle         | RN, R <sub>N</sub> , nose<br>radius | RS, R <sub>S</sub> , shoulder<br>radius | RC, R <sub>C</sub> , cone<br>radius     |
| Input                          | Input                            | Output                                                                                       | Input                                     | Input                               | Input                                   | Input                                   |
| Program<br>Input               | Maın<br>Program                  | HEAT1                                                                                        | Program<br>Input                          | Program<br>Input                    | Program<br>Input                        | Program<br>Input                        |
| T, temperature                 | Z, moles of<br>mixture           | RHØST, $\rho_s / \rho_a$<br>density ratio                                                    | QSUM, Q <sub>R</sub><br>radiation heating | QI, radiation<br>by specie          | X, specie<br>concentration              | HDHS, dissociation<br>energy + enthalpy |
| Output                         | Output                           | Output                                                                                       | Output                                    | Output                              | Output                                  | Output                                  |
| HEAT1                          | ZØNES1                           | HEATI                                                                                        | GETN1                                     | GETN1                               | ZØNES1                                  | FINDHI                                  |
| HRT, HM/RTo,<br>total enthalpy | DEL, detach-<br>ment distance    | DUM, concentra-<br>tion of O <sup>+</sup> , N <sup>+</sup> , C <sup>+</sup> , e <sup>-</sup> | TINF, ambient<br>temperature              |                                     |                                         |                                         |
| Output                         | Input                            | Output                                                                                       | Input                                     |                                     |                                         |                                         |
| FINDH1                         | Program<br>Input                 | 20NES1                                                                                       | Program<br>Input                          |                                     |                                         |                                         |

| CALLING | SEQUENCE |
|---------|----------|
|         | 02202002 |

|                                | Varıable                         | NX, atmos. table<br>number | TITBL Zone 1<br>temp table | T2TBL Zone 2<br>temp. table | T3TBL Zone 3<br>temp. table | HITBL Zone 1<br>enthalpy table |
|--------------------------------|----------------------------------|----------------------------|----------------------------|-----------------------------|-----------------------------|--------------------------------|
| HVST1                          | Input Or Output<br>of subroutine | Input                      | Output                     | Output                      | Output                      | Output                         |
|                                | Source                           | Main                       | HVST1                      | HVST1                       | HVSTI                       | HVST1                          |
| H2TBL Zone 2<br>enthalpy table | H3TBL Zone 3<br>enthalpy table   | XA, mole fraction<br>of A  |                            | ····                        |                             |                                |
| Output                         | Output                           | Input                      |                            |                             |                             |                                |
| HVST1                          | HVST1                            | Program<br>Input           |                            |                             |                             |                                |

|   |                                                               | Variable                                                  | P, pressure                                                | HRTZ, stagnation<br>enthalpy                                   | PTBL, pressure table<br>(used with T&H tables)                 |
|---|---------------------------------------------------------------|-----------------------------------------------------------|------------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------------------|
|   | FINDT1                                                        | Input or Output<br>for subroutine                         | Input                                                      | Input                                                          | Input                                                          |
|   |                                                               | Source                                                    | HEATI                                                      | HEAT1                                                          | HEATI                                                          |
|   | TITBL-Zone 1<br>temp table<br>(used with PTBL &<br>HITBL)     | T2TBL-Zone 2<br>temp table<br>(used with PTBL &<br>H2TBL) | T3TBL-Zone 3<br>temp. table<br>(used with PTBL &<br>H3TBL) | HITBL, Zone 1<br>enthalpy table<br>(used with PTBL &<br>TITBL) | H2TBL-Zone 2<br>enthalpy table<br>(used with PTBL &<br>•T2TBL) |
| l | Input                                                         | Input                                                     | Input                                                      | Input                                                          | Input                                                          |
|   | HVST1                                                         | HVST1                                                     | HVST1                                                      | HVST1                                                          | HVST1                                                          |
|   | H3TBL Zone 3<br>enthalpy table<br>(used with PTBL &<br>T3TBL) | TUP-Highest temp. for<br>lst enthalpy iteration           | TLØW-Lowest temp.for<br>lst enthalpy iteration             | HUP-Highest enthalpy<br>for 1st enthalpy iteration             | HLØW-Lowest enthalpy<br>for 1st enthalpy iteration             |
|   | Input                                                         | Output                                                    | Output                                                     | Output                                                         | Output                                                         |
|   | HVST1                                                         | FINDTI                                                    | FINDTI                                                     | FINDTI                                                         | FINDT1                                                         |
|   | T-first guess for<br>in enthalpy iteration                    | NUM-Zone number for<br>enthalpy iteration                 | PCNT-percent error<br>acceptable in enthalpy               |                                                                | ·                                                              |
|   | Output                                                        | Output                                                    | Input                                                      |                                                                |                                                                |
|   | FINDT1                                                        | FINDT1                                                    | HEAT1                                                      |                                                                |                                                                |

|                                         | Variable                                 | NUM, Zone Number                                     | P, pressure                                            | T, temperature for<br>current enthalpy<br>iteration  |
|-----------------------------------------|------------------------------------------|------------------------------------------------------|--------------------------------------------------------|------------------------------------------------------|
| FINDH1                                  | Input or Output<br>for Subroutine        | Input                                                | Input                                                  | Input                                                |
| · · · · · · · · · · · · · · · · · · ·   | Source                                   | HVST1                                                | HEAT1                                                  | HEATI                                                |
| E, Heats of formation<br>at 0°K         | PK, equilibrium<br>constants             | XO, mole fraction<br>of O <sub>2</sub> in atmosphere | XC, mole fraction<br>of CO <sub>2</sub> in atmosphere  | XN, mole fraction<br>of N <sub>2</sub> in atmosphere |
| Input                                   | Output                                   | Input                                                | Input                                                  | Input                                                |
| HEATI                                   | GETK1                                    | Program<br>Input                                     | Program<br>Input                                       | Program<br>Input                                     |
| XA, mole fraction<br>of A in atmosphere | Z, total moles of<br>equilibrium mixture | X, specie moles in<br>equilibrium mixture            | HRT, enthalpy at T and P<br>( HRTZ for last iteration) | HDHS, dissociation<br>energy - enthalpy              |
| Input                                   | Output                                   | Output                                               | Output                                                 | Output                                               |
| Program Input                           | ZØNES1                                   | ZØNES1                                               | FINDH1                                                 | FINDH1                                               |
| DUM-moles of Ot Nt Ct                   |                                          |                                                      |                                                        |                                                      |

DUM-moles of O+, N+, C+ and e= in Zone 2

Output

ZØNES1

|                                                       | Variable                                | NZZ, Zone<br>number | TZ temp. at current<br>enthalpy iteration | ZLPQ, log of<br>partition functions                  | QPAR-derivatives<br>of QP at constant P               |
|-------------------------------------------------------|-----------------------------------------|---------------------|-------------------------------------------|------------------------------------------------------|-------------------------------------------------------|
| GETQ1                                                 | Input or Output<br>for Subroutine       | Input               | Input                                     | Output                                               | Output                                                |
|                                                       | Source                                  | Main                | HEATI                                     | GETQ1                                                | GETQ1                                                 |
|                                                       |                                         |                     |                                           |                                                      |                                                       |
|                                                       | Varıable                                | NZ, Zone<br>number  | TZ-temp at current<br>enthalpy iteration  | ZLPQ, log of<br>partition functions                  | PK; Equilibrium<br>constants                          |
| GETK1                                                 | Input or Output<br>for Subroutine       | Input               | Input                                     | Input                                                | Output                                                |
|                                                       | Source                                  | Main                | HEAT1                                     | GETQ1                                                | GETK1                                                 |
|                                                       |                                         |                     |                                           |                                                      |                                                       |
|                                                       | Variable                                | NUM, Zone<br>number | ZT-temp at current<br>enthalpy iteration  | XØZ mole fraction<br>of O <sub>2</sub> in atmosphere | XCZ mole fraction<br>of CO <sub>2</sub> in atmosphere |
| 2ØNES1                                                | Input or Output<br>for Subroutine       | Input               | Input                                     | Input                                                | Input ,                                               |
|                                                       | Source                                  | Main                | HEAT1                                     | Program<br>Input                                     | Program<br>Input                                      |
| XNZ mole fraction<br>of N <sub>Z</sub> in atmosphere  | XAZ mole fraction<br>of A in atmosphere | PZ, pressure        | PK, equilibrium<br>constants              | ZZtotal moles of<br>equilibrium-mixture              | XX specie moles in<br>equilibrium mixture             |
| Input                                                 | Input                                   | Input               | Input                                     | Output                                               | Output                                                |
| Program<br>Input                                      | Program<br>Input                        | HEAT1               | GETK1                                     | ZØNES1                                               | 3ØNES1                                                |
| DUM, moles of $O^+$ , $N^+$ , $C^+$ , & e^- in Zone 2 |                                         |                     |                                           |                                                      |                                                       |
| Output                                                |                                         |                     |                                           |                                                      |                                                       |
| ZØNES1                                                |                                         |                     |                                           |                                                      |                                                       |

|                         | Variable                          | TZ temp, at current<br>enthalpy iteration | X, specie moles in<br>equilibrium mixture | RHØS, normalized<br>stagnation density | DEL, shock<br>detachment distance                |
|-------------------------|-----------------------------------|-------------------------------------------|-------------------------------------------|----------------------------------------|--------------------------------------------------|
| GETN 1                  | Input or Output<br>for Subroutine | Input                                     | Input                                     | Input                                  | Input                                            |
|                         | Source                            | HEAT1                                     | 2ØNES1                                    | HEAT1                                  | Program Input or<br>from correlation in<br>HEAT1 |
| QI, specie<br>radiation | QSUM total<br>radiation           |                                           |                                           |                                        | ·                                                |
| Output                  | Output                            | •                                         |                                           |                                        |                                                  |
| GETN1                   | GETN1                             |                                           |                                           |                                        |                                                  |

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#### D. SIGNIFICANT EQUATIONS

#### Main Program None

1. HEATI

M = ZM = 28 XN + 32 X0 + 44 XC + 40 XA

$$C_p/R = CP\phi_R \approx (3.5 (XN + XO) + 4 XC + 2.5 XA)/ZM$$
 Specific heat of cold gas/R

$$H/RT_{o} = HRTZ = \frac{V^{2}}{\left(64.4 \cdot 778 \cdot \frac{1987 \cdot 4535 \cdot 273.16}{252 \quad ZM}\right)} + ZM \cdot \left(\frac{CP\phi_{R}}{273.16}\right) \cdot TINF \text{ stagnation point enchalpy}$$

Molecular weight of cold gas

 $P = P = (RH\phi V^2)/2116.$  stagnation point pressure

The above are computed prior to the execution of the IF test before Statement 11.

If  $\Delta$  is not specified as program input, the following quantities are computed (Statements 503 to 604)

$$b/a = BA = \left[\frac{RN}{RC} (1 - \cos(THN)) + \frac{RS}{RC} \cos(THN)\right] \left/ \left[\frac{RN}{RC} \sin(THN) + \frac{RS}{RC} (1 - \sin(THN))\right] \right]$$

$$\rho_{s} \rho_{a} = V^{2} \left/ \left[Z \frac{89516}{ZM} T\right] \text{ Density ratio} \right]$$

 $\Delta = DELA [RN sin (THN) + RS (1 - sin (THN))] Detachment distance$ 

The radiation depends upon the normalized stagnation density

$$\rho = RH\phi S = \frac{P}{Z} \frac{273.16}{T}$$

HVST1 - Trivial modifications of Reference 1, pp. 59-69.

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2. FINDT1

Linear interpolations to find a first guess for the stagnation temperature, the zone number, and the ranges of enthalpy and temperature for the stagnation temperature iteration.

3. 
$$\frac{\text{FIND} \text{H1}}{\frac{\text{H}_{1}\text{M}}{\text{RT}_{0}}} = \text{HI}_{(1)} = \text{E}_{(1)} + \frac{\text{T}^{2}}{273.16} \text{ QPAR}_{(1)} - \text{ Enthalpy of 1th specie (reference 1, p. 58)}$$
$$\frac{\text{HM}}{\text{RT}_{0}} = \text{SUMH} = \sum_{i}^{1} X(i) \cdot \text{HI}(i) - \text{ Enthalpy at P and approximate stag. temperature T}$$
$$\text{H}_{D} = \text{SUMD} = \sum_{i}^{1} X(i) \text{ E}(i) - \text{Dissociation enthalpy}$$
4. 
$$\frac{\text{GETQ1}}{\text{GETQ1}}$$

This subroutine evaluates  $\ln$  PQ  $(X_{1})\,$ , pressure times the log of the partition and the partial derivative of the partition function with respect to temperature for some set of species dependent on the zone numbers.

The correspondence between QPAR(1)= 
$$\left(\frac{\partial \ln Q_1}{\partial T}\right)_p$$
 and ZLPQ(1)= in (PQ\_1)

is explained on the description of GETQ, the ZLPQ(i) are contained in the set of functions documented in Reference 1, p. 54, and the derivatives are obtainable by inspection.

#### 5. GETK1

The subroutine evaluates equilibrium constants for the principal reactions assumed to exist in the appropriate zone. The equations are in Reference 1. p. 48.

#### 6. ZØNESI

The partition functions, their derivatives, and equilibrium constants computed in ZQNES are explained in the subroutine description and documented in Reference 1 (p. 48 and 54).

The Zone 1 equations are solved between Statements 100 and 200. The specie concentrations are computed by finding on the appropriate root of a polynomial.

$$f(\Sigma_1) = \sum_{i=1}^{4} (C \phi ED(i) \Sigma_1^{(4-i)})$$

Real and imaginary roots are computed by the library subroutine POLROT (see subroutine description  $\tilde{J}$ . The "appropriate" root must be real. positive, and such that no negative specie concentrations result. If no such root is found, the message "NØ VALID SØLN" is written in the output and the case deleted. The equations for the specie concentrations are as follows:
$$\begin{split} \Sigma_{2} &= \Sigma_{1} \quad xo + \frac{\Sigma_{1}}{2} / \left[ 2 \frac{PK_{1}}{\sqrt{PK_{2}}} (xc - \Sigma_{1}) + \Sigma_{1} \right] \\ X(N_{2}) &= X(1) = XN \\ X(CO_{2}) &= X(2) \approx Xc - \Sigma_{1} \\ X(CO) &= X(3) \approx \Sigma_{1} \\ X(O_{2}) &= X(4) = XO + \frac{\Sigma_{1}}{2} - \Sigma_{2} \\ X(O) &= X(5) \approx 2\Sigma_{2} \\ Z &= 1 + \frac{\Sigma_{1}}{2} + \Sigma_{2} \end{split}$$

In Zone 2, the computations are done between Statements 200 and 300. First POLROT is used to find the roots of the polynomial

$$f(\Sigma_6) = \sum_{i=1}^{5} COED(i) \Sigma_6^{(5-i)}$$

•

Then the roots are computed for the polynomial

$$f(\Sigma_7) = \sum_{6=1}^{4} COED(1) \Sigma_7^{(4-1)}$$

As in Zone 1, the root used must be real, positive, and such that no negative concentrations are permitted. The principal species are as follows:

$$\begin{split} \Sigma_4 &= (4 \quad \Sigma_6^2 \quad P/(PK_3 (XN - \Sigma_6)) - 1 - XC - XO - \Sigma_6 \\ \Sigma_8 &= \frac{\Sigma_7 (\Sigma_4 + XC + 2XO) PK_6}{(\Sigma_4 - \Sigma_7) PK_5 + \Sigma_7 PK_6} \\ X (N_2) &= X (1) = XN - \Sigma_6 \\ X (CO) &= X (3) = XC - \Sigma_4 \\ X (O) &= X (5) = \Sigma_4 + 2 (XO + XC - \Sigma_8) \end{split}$$

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$$x (N) = x (6) = 2\Sigma_6 - \Sigma_8 - \Sigma_7$$

$$x (CN) = x (7) = \Sigma_7$$

$$V (NO) = V (8) = \Sigma_8$$

$$x (C) = x(9) = \Sigma_4 - \Sigma_7$$

$$Z = 1 + XC + XO + \Sigma_4 + \Sigma_6 - \Sigma_7 - \Sigma_8$$

For trace species,

$$X(e^{-}) = X (13) = DUM (2) = \left\{ \frac{Z}{P} (X(0) - PK_7 + X(N) \cdot PK_8 + X(C) - PK_{14}) + \frac{X(N)^2 KP_8}{KP_{13}} \right\}$$
$$X(N^+) = X (11) = DUM(1) = KP_8 \left\{ \frac{Z}{P} \frac{X(N)}{X(e^{-})} \right\}$$

$$X (0^{+}) = X(10) = DUM(3) = K P_7 \begin{cases} \frac{Z}{P} & \frac{X(0)}{X(e^{-})} \end{cases}$$
  
 $X (C^{+}) = X(12) = DUM(4) = K P_9 \begin{cases} \frac{Z}{P} & \frac{X(C)}{X(e^{-})} \end{cases}$ 

$$X(N_2^+) = X(17) = DOM(4) = KP_9 \left\{ \frac{F_8 X(N)^2}{F_9} \right\}$$
  
 $X(N_2^+) = X(17) = \frac{KP_8 X(N)^2}{KP_{13} X(e^-)}$ 

$$X(A) = X(18) = XA$$
  
 $X(A^+) = X(19) = K P_{14} \left\{ \frac{Z}{P} \frac{XA}{X(e^-)} \right\}$ 

In Zone 3, the calculations are done between Statements 300 and 400. POLROT is used to fine the roots of a polynomial

$$F(\Sigma_{11}) = \sum_{i=1}^{5} COED(\omega) \Sigma_{11}^{(5-1)}$$

The root used must be real, positive, and such that there are no negative concentrations. The specie equations are as follows:

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$$\Sigma_{10} = \frac{2 \Sigma_{11} (XC + X 0) PK_7}{[X C + PK_9 + \Sigma_{11} (PK_7 - PK_9)]}$$

$$\Sigma_9 = \frac{2 \cdot \Sigma_{11} \cdot XN \cdot PK_8}{[XC - PK_9 + \Sigma_{11} (PK_8 - PK_9)]}$$

$$X(0) = X(5) = 2 (XC + X\phi) - \Sigma_{10}$$

$$X(0) = X(6) = 2 XN - \Sigma_9$$

$$X(C) = X(9) = XC - \Sigma_{11}$$

$$X(0) = X(10) = \Sigma_{10}$$

$$X(N^+) = X(11) = \Sigma_9$$

$$X(C^+) = X(12) = \Sigma_{11}$$

$$X(e^-) = X(13) = \Sigma_9 + \Sigma_{10} + \Sigma_{11}$$

$$Z = 1 + 2 XC + XO + XN + \Sigma_9 + \Sigma_{11}$$
For trace species,  

$$X(CN) = X(7) = \frac{P \cdot PK_5}{Z} (2 XN - \Sigma_9) (XC - \Sigma_{11})$$

$$X(N0) = X(8) = \frac{P \cdot PK_6}{Z} (2 XN - \Sigma_9) (2 XO + 2 XC - \Sigma_{10})$$

$$X(N_2^+) = X(17) = \frac{\Sigma_9 (2 XN - \Sigma_9) P}{Z \cdot PK_{13}}$$

In Zone 4, the calculations are done between Statements 400 and 900. POLROT is used to find the roots of a polynomial

$$f(Z_{12}) = \sum_{i=1}^{5} COED(i) \Sigma_{12}^{(E-i)}$$

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The root used must be real, positive, and such that there are no negative concentrations. The equations for the concentrations are:

$$\begin{split} \Sigma_{13} &= \frac{\Sigma_{12} \cdot XC \cdot PK_{10}}{\left[2 \cdot PK_{12} (XC + XO) + \Sigma_{12}(PK_{10} - PK_{12})\right]} \\ \Sigma_{14} &= \frac{2 \cdot \Sigma_{12} \cdot XN \cdot PK_{11}}{\left[2 \cdot XO_{12} (XC + XO) + \Sigma_{12}(PK_{11} - PK_{12})\right]} \\ X(0^{+}) &= X(10) = 2 (XC + XO) - \Sigma_{12} \\ X(N^{+}) &= X(11) = 2 XN - \Sigma_{14} \\ X(C^{+}) &= X(12) = XC - \Sigma_{13} \\ X(e^{-}) &= X(13) = 2 (XN + XO) + 3 \cdot XC + \Sigma_{12} + \Sigma_{13} + \Sigma_{14} \\ X(N^{++}) &= X(14) = \Sigma_{14} \\ X(O^{++}) &= X(15) = \Sigma_{12} \\ X (C^{++}) &= X(16) = \Sigma_{13} \end{split}$$

One trace specie is considered,

.

$$X(N) = X(6) = \frac{X(N^+) \cdot X(e^-) \cdot P}{Z \cdot PK_8}$$

This specie 1s unique in that it is computed in subroutine HEAT.

7. GETN1  

$$ZNI_{i} = X_{i} \cdot RHOS \cdot 2.69 \times 10^{19} \quad i = 1, 19 \qquad \text{Specie concentration to particles} \\ \frac{\epsilon_{i}}{L} = EL_{i} = C_{i} \left(\frac{ZNI_{i}}{5.4 \times 10^{19}}\right) \frac{1}{(T \times 10^{-4})^{T_{i}}} e^{-T_{i}/T} \quad i = 1, 21 \\ \text{Emissivities without self-absorption} \\ correction. C_{i}, n_{i}, and T_{i} from \\ Reference 1, p 102 \\ \text{Argument of } E_{3}(r_{i}) \text{ for effective} \\ emissivities} \end{cases}$$

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$$r = TSUM = \sum_{i=1}^{21} r_i$$

$$\epsilon_i = EPS(i) \quad i=1, 21$$

$$\epsilon = EPBAR$$

$$r_i = QI(i) = \frac{0.174 \times 10^{-8}}{3600} (1.8 \times T)^4 EPS(i), i=1, 21$$

$$Component radiation heating$$

$$Q = QSUM = EPBAR \frac{0.174 \times 10^{-8} (1.8 \times T)^4}{3600}$$
 Total radiation heating

#### V. REFERENCES

- RAD, Mars-Venus Capsule Parameter Study, 1, Introduction and Analysis JPL Contract 950626, Avco/RAD -TR-64-1 (21 March 1964).
- Mayer, J. E., and M. G. Mayer, <u>Statistical Mechanics</u>, John Wiley and Sons, New York (1961).
- 3. Hansen, C. F., Approximations for the Thermodynamic and Transport Properties of High Temperature Air, NASA TR R-50 (1959).
- Kivel, B., and K. Bailey, Tables of Radiation from High-Temperature Air, Avco-Everett Research Lab, Research Report 21 (October 1959).
- Vinokur, M., Hypersonic Flow around Bodies of Revolution Whose Shock Waves are Generated by Comc Sections, LMSD-288139 General Research In Flight Sciences, I, Part I, Fluid Mechanics (January 1959 to 1960).
- Wick, B. H., Radiative Heating of Vehicles Entering the Earths Atmosphere, NASA N6212453 (April 1962).
- Toshikawa, K.K., and D. R. Chapman, Radiative Heat Transfer and Absorption Behind a Hypersonic Normal Shock Wave, NASA TN D-1424.
- Wolf, F. and J. Speigel, Analysis of Equilibrium Shock-Layer Radiation for Atmospheric Entry to Mars, JPL Space Programs Summary No. 37-33, <u>IV</u>.
- Williams, M. J. and C. E. Treanor, A Method for Calculating Diatomic Spectra Using a Digital Computer, CAL Report No. QM-1626-A-5, Cornell Aeronautical Laboratory, Inc., Buffalo, New York (May 1962).

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PROGRAM 1884



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# HEAT SHIELD PROGRAM (1884)

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# I. INTRODUCTION

#### A. GENERAL DESCRIPTION

The purpose of this program is to determine the heat shield thickness and weight requirements to protect the heat shield substructure from exceeding a specified temperature limit at any time during the entry trajectory. The general inputs include:

1. Convective heat rates as a function of time in tabular form and an indication if, and when, turbulent flow occurs

2. Radiation heat rates as a function of time in tabular form

3. Supporting heat transfer data as the stagnation enthalpy variation with time, atmospheric composition, and heat pulse scaling factors

4. Heat shield material properties, including the density, conductivity, specific heat, emissivity, ablation temperature, heat of vaporization, and convective blocking factor

5. Design constraints as the maximum allowable substructure temperature, the total entry time during which the substructure must be protected, the substructure thermal capacitance, and bond thickness and thermal propertues.

The calculation model simulates a one-dimensional, heat-conduction problem into a slab of finite thickness, subject to various thermal boundary conditions as depicted in Figure 1.



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Figure 1 HEAT SHIELD CALCULATION MODEL

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The primary output 1s the heat shield unit area weight  $(lb/ft^2)$  required to satisfy the design constraints. If ablation occurs, the relative proportions of ablative and insulative weights are indicated also.

#### B. CALCULATION MODEL

The calculation model is described in detail in References 1 and 2; hence only a brief summary is given here. The approach utilized considers that aerodynamic heating data are available based on a cold wall consideration (i.e.the heating calculations are developed without a knowledge of the wall temperature history

with time, and the assumption is made that  $\frac{H_w}{H_s} <<1$ ). Hence, the convective heating inputs must be corrected for the hot wall reduction,  $(1 - \frac{H_w}{H_s})$ , as the wall temperature history is computed.

To arrive at a rapid method suitable for parametric studies, an approximate calculation model which permits a direct solution for the unit area heat shield weight is utilized. The approximate model replaces the actual heating history with an equivalent one having the same total integrated heating, but also having a constant surface temperature. The solution for the time wise variation of the temperature distribution in a finite slab with constant surface temperature, and hence the solution to the equivalent simulation model, is well known and the solution is given in Reference 3

As shown in Figure 1, the calculation model allows for the inclusion of a bond and substructure and a composite heat shield material and considers the effects of laminar or turbulent heating, radiative heating, reradiation, the hot wall reduction, and convective heating blockage due to ablation.

In order to apply the approximate method, a number of detailed assumptions regarding the nature of the heat pulse were made. Key features of the calculation model are summarized below.

1. Initial Time (TI)

The heating data input to the program'is usually based on the flight time history during the entry flight. For the simulated calculation model, an effective initial time is defined such that the portion of the heat pulse up to the combined peak heating rate (1. e. add the convective and radiative pulse and determine the time for their peak) is triangular, and the integrated cold wall heating is identical with the actual data. The location of the initial time (TI) is shown in Figures 2 and 3 for nonablating and ablating cases, respectively.







TI INITIAL TIME OF CONSTANT TEMPERATURE PROBLEM TADJ START TIME OF INSULATION PROBLEM AFTER END OF ABLATION HADJ AVERAGE STAGNATION ENTHALPY Too: TIME WHEN QTBL=001 QTBLMAX

TSTOP TIME AT END OF THERMAL PROBLEM

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Figure 3 ABLATING HEAT SHIELD CALCULATION MODEL



# 2. Final Time (Actual TSTØP)

The final time of the simulation model is dependent on a number of program test criteria. The input value of TSTPP reflects the trajectory flight time and also the post-flight time during which the substructure must be thermally protected by the heat shield. The input TSTPP is therefore a test criterion for the actual TSTPP. The linearization of the calculation model by utilizing an average stagnation enthalpy for the nonablating cases, and when obtaining the insulative requirements of the heat shield during the post-ablation period, depends on the actual TSTPP. Experience has shown<sup>1</sup> that the actual TSTPPshould be limited to less than twice the length of the heat pulse (the length of the heat pulse being defined as the time from TSTART to the point where the convective heating is 1 percent of the maximum value). The above two criteria are compared and the smaller value used for the actual TSTPP.

In addition to the criteria above, program tests are performed in the case of nonablating slabs that reduce TSTOP if the slab equilibrates at a time smaller than the TSTOP, in which case the actual TSTOP is taken as the time to equilibrate (i.e. for this case, the slab temperature reaches a peak, which is equal to TREAR at the actual TSTOP).

#### 3. Ablation Model

The steady-state ablation model is used to estimate the mass loss and heat stored in the heat shield during ablation. A discussion of this approach is given in Reference 1. The calculation model provides for blockage of the convective heating only, during ablation as a result of either radiative or convective heating.

# 4. Wall Enthalpy

The wall enthalpy is required to correct the cold wall convective heating. Tables are built into the program, which automatically evaluate the wall enthalpy as a function of temperature based on the atmosphere composition which is input.

# 5. Material Properties

The material properties input are taken as average values commensurate with the range of heating and enthalpy levels expected in the problem. A special consideration has been given to the calculations where radiation heating predominates by permitting an effective radiative heat of vaporization to be input as well as an effective convective heat of vaporization. The heat shields considered can be homogeneous or composed of two separate materials, as a plastic resin with glass fibers, in which case the material properties for each and the relative proportions of each are specified.

An allowance is made for incomplete vaporization of the melted surface by specifying the vaporizing fraction.

Under ablating conditions, the material properties can be dependent on whether the flow is laminar or turbulent and provision is included for handling both sets of inputs and specifying the transition time; in this case, the convective heat pulse input must contain the laminar and turbulent heating rates.

### 6. Heat Shield Bond

The calculation model can handle the effects of a bond by specifying the average bond thickness and the bond thermal properties The heat shield weight is reduced by the thermally equivalent (insulative) weight of the bond. The total weight of bond and heat shield is an output.

#### 7. Structural Thermal Capacitance

The calculation model provides for the effects of substructure thermal capacitance on reducing the heat shield weight requirements. Program tests are performed to determine whether a heat shield is needed by comparing the structural thermal capacitance with the total heating and with the peak heat rate to ascertain whether an excessive temperature rise occurs. The possible combinations of tests could yield the result that (a) no heat shield or bond is required, (b) no heat shield is required as the bond and structure are adequate; or (c) a heat shield and bond are required.

#### C LIMITATIONS

The limitations of the program arise because of the assumptions made in the calculation model, namely:

1. The ablation model does not simulate the detailed phenomena of charring.

2. The choice and performance of heat shield materials could be limited by mechanical forces encountered in flight or while on the ground. These forces are not considered in the program.

3. Minimum thickness limits on the heat shield are not considered.

The simplicity of the calculation model results in the need for spot-checking results with the results of more sophisticated programs, and either modifying the inputs to adjust the agreement or to adjust the outputs with a scale factor. The program is aimed at determining trends parametrically.

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# II USAGE

# A INPUT DEFINITIONS

| 1  | Name  | Preset<br>Values | Symbol                          | Parameter                                                                                                | Units                  |
|----|-------|------------------|---------------------------------|----------------------------------------------------------------------------------------------------------|------------------------|
| Ał | łR    | 1                | H/H <sub>s</sub>                | Recovery factor.                                                                                         |                        |
| CA | ASE   | 0                |                                 | A number of the form XX XX<br>used for identification                                                    |                        |
| CI | ?В    | 0                | CPB                             | Specific heat of bond.                                                                                   | Btu/lb- <sup>0</sup> F |
| CI | PHS   | 0                | C <sub>P</sub> HS               | Specific heat of heat shield.                                                                            | Btu/lb- <sup>o</sup> F |
| CI | PSTR  | 0                | CP STR                          | Specific heat of structure.                                                                              | Btu/lb-°F              |
| DA | ATE   | 4 01             |                                 | A number of the form XX. XX used for identification.                                                     |                        |
| ים | TI    | 01               | Δτ                              | Time step for graphical integration of $q_c$ and $Hg/_{RT_o}$ and computation of $\dot{W}_A$ .           | seconds                |
| EI | MIS   | - 0              | e                               | Emissivity                                                                                               |                        |
| EI | PSIL  | 0.005            |                                 | Maximum relative error<br>allowed in iterations for<br>structural capacitance<br>correction.             |                        |
| F  | actør | 0.1              |                                 | Initial relative change in heat<br>shield weight for structural<br>capacitance correction itera-<br>tion |                        |
| H  | TBL   |                  | H <sub>s</sub> /RT <sub>o</sub> | Free stream gas enthalpy table,<br>maximum number of entries =<br>150.                                   |                        |
| H  | VIR   | 0                | H <sub>VIR</sub>                | Heat of vaporization of solid<br>when convective heating is<br>blocked.                                  | Btu/lb                 |

| Name   | Preset<br>Values | Symbol           | Parameter                                                                   | Units                     |
|--------|------------------|------------------|-----------------------------------------------------------------------------|---------------------------|
| HV2R   | 0.               | H <sub>V2R</sub> | Heat of vaporization of resin<br>when convective heating is<br>blocked.     | Btu/lb                    |
| кв     | 0.               | к <sub>в</sub>   | Thermal conductivity of bond.                                               | Btu/hr-ft- <sup>0</sup> F |
| KHS    | -                | к <sub>нs</sub>  | Thermal conductivity of heat shield.                                        | Btu/hr-ft- <sup>0</sup> F |
| KSTR   | 0,               | K <sub>STR</sub> | Thermal conductivity of structure.                                          | Btu/hr-ft- <sup>o</sup> F |
| LAM    | 0.               |                  | Array of material proper-<br>ties for laminar flow,<br>arranged as follows: |                           |
|        |                  | f <sub>1</sub>   | Vaporızatıon fractıon of solid                                              |                           |
|        |                  | <sup>H</sup> v1  | Heat of vaporization of solid                                               | Btu/lb                    |
|        |                  | $\eta_1$         | Transpiration fraction of solid                                             |                           |
|        |                  | x                | Solid fraction                                                              |                           |
|        | 1                | f2               | Vaporization fraction of resin                                              |                           |
|        |                  | н <sub>v2</sub>  | Heat of vaporization of resin                                               | Btu/lb                    |
|        |                  | $\eta_2$         | Transpiration fraction of resin.                                            |                           |
| memø   | 0.               |                  | A number of the form XX XX used for identification.                         |                           |
| MXIT   | 50.              |                  | Maximum number of iterations<br>in structural capacitance cor-<br>rection.  |                           |
| QCMULT | 1.               |                  | Convective heat pulse multiplier,                                           |                           |
| QRMULT | ` 1.             |                  | Radiative heat pulse multiplier.                                            |                           |
| QTBL   |                  | <sup>q</sup> c   | Convective heat pulse table,<br>maximum number of entries =<br>150.         | Btu/ft <sup>2</sup> -sec  |

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| Name     | Preset<br>Values                                                                    | Symbol                        | Parameter                                                                                                                                                                                                    | Units              |
|----------|-------------------------------------------------------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| RHØB     | 0.                                                                                  | ρ <sub>B</sub>                | Density of bond.                                                                                                                                                                                             | lb/ft <sup>3</sup> |
| RHØHS    | 0.                                                                                  | $\rho_{\rm HS}$               | Density of heat shield.                                                                                                                                                                                      | lb/ft <sup>3</sup> |
| RHØSTR   | 0.                                                                                  | $\rho_{\rm STR}$              | Density of structure.                                                                                                                                                                                        | lb/ft <sup>3</sup> |
| RTBL     | q <sub>r</sub> Radiative heat pulse table, B<br>maximum number of<br>entries = 150. |                               | Btu/ft <sup>2</sup> -sec                                                                                                                                                                                     |                    |
| TABL     | 0.                                                                                  | TA                            | Ablation temperature                                                                                                                                                                                         | oF                 |
| TBL1     | See<br>program                                                                      |                               | Table of $(\Delta T_R/\Delta T_S, \alpha t/L^2)$ ,<br>arranged with first a value of<br>$\Delta T_R/\Delta T_S$ then $\alpha t/L^2$ , then<br>the next pair, etc. Maximum<br>number of entries = 25 pairs.   |                    |
| <br>TBL2 | See<br>program                                                                      |                               | Table of $(\alpha t/L^2, \Delta T_M/\Delta T_S)$ ,<br>arranged with first a value<br>of $\alpha t/L^2$ , then $\Delta T_M/\Delta T_S$ , then<br>the rext pair, etc. Maximum<br>number of entries = 25 pairs. |                    |
| TEMPI    | 0.                                                                                  | т <sub>і</sub>                | Initial Temperature.                                                                                                                                                                                         | oF                 |
| TIME     | 0.                                                                                  | t                             | Table of independent variable<br>time for use with HTBL, RTBL,<br>and QTBL dependent variable<br>arrays. Maximum number of<br>entries = 150.                                                                 | seconds            |
| TMSTR    | 0                                                                                   | T <sub>MST</sub>              | Melting temperature of structure                                                                                                                                                                             | oF                 |
| TREAR    | 0.                                                                                  | T <sub>R</sub>                | Maxımum allowable desıgn<br>rear temperature.                                                                                                                                                                | ٥F                 |
| TSTART   | o                                                                                   | to                            | Start of reentry heating.                                                                                                                                                                                    | seconds            |
| tstøp    | 0,                                                                                  | <sup>t</sup> f                | End of reentry heating                                                                                                                                                                                       | seconds            |
| TTRANS   | 1000.                                                                               | <sup>t</sup> f <sub>con</sub> | Time transition occurs in heating                                                                                                                                                                            | second             |

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| Name  | Preset<br>Values | Sýmbol           | Parameter                                                                          | Units              |
|-------|------------------|------------------|------------------------------------------------------------------------------------|--------------------|
| TURB  | 0.               |                  | Array of material properties<br>for turbulent flow, arranged as<br>LAM (see above) |                    |
| WTB   | 0.               | ₩ <sub>B</sub>   | Weight of bond.                                                                    | lb/ft <sup>2</sup> |
| WISTR | 0.               | ₩ <sub>STR</sub> | Weight of structure.                                                               | 1b/ft <sup>2</sup> |
| XA    | 0.               | x <sub>A</sub>   | Mole fraction of argon in undissociated mixture.                                   |                    |
| хс    | 0.               | х <sub>с</sub>   | Mole fraction of CO <sub>2</sub> in<br>undissociated mixture.                      |                    |
| XN    | 0.               | x <sub>N</sub>   | Mole fraction of N <sub>2</sub> in<br>undissociated mixture                        |                    |
| xø    | 0.               | x <sub>o</sub>   | Mole fraction of O <sub>2</sub> in undissociated mixture.                          |                    |

# B INPUT PROCEDURES

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Input procedures include the following:

1. Input heat shield, structure, and bond properties.

2. Input QTBL, HTBL, and RTBL as a function of TIME (NOTE: for each TIME input, there must be a QTBL, HTBL, and RTBL input; maximum 150 values for each table).

In stacking cases it is necessary to add at least one 0. value at the end of the TIME table after the first case if the number of entries in the table is decreased. This 0. is used internally as an indication of the end of the table.

3. If transition does not occur during the convective heat pulse, input only the LAM array of material properties.

4. If transition occurs during convective heat pulse, input both LAM and TURB arrays and TTRANS, the time at which pulse switches from laminar to turbulent flow.

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5. Input atmospheric constituents, initial temperature, and stop time of problem.

6. Input design rear temperature of problem.

7. For succeeding cases, input only the changes desired. However, note (2) above if TIME, HTBL, QTBL, and RTBL are to be changed.

8. A set of computer input forms are provided for the user. All the data shown on the form is keypunched when the variable is supplied.

| External Name     | Internal Name | Parameter                                                                          | Units                    |
|-------------------|---------------|------------------------------------------------------------------------------------|--------------------------|
| ACTUAL TSTØP      | TSTØP         | t <sub>f</sub> used for problem.                                                   | seconds                  |
| CASE              | CASE          | Identification number                                                              |                          |
| CØRRECTED<br>WINS | WEIGHT        | Insulation weight corrected<br>for structural capacitance<br>and bond capacitance. | lbs/ft <sup>2</sup>      |
| CRMAX             | RQCMAX        | Maximum combined heating rate.                                                     | Btu/ft <sup>2</sup> -sec |
| DATE              | DATE          | Identification number.                                                             |                          |
| DTM               | DTM           | Average temperature rise.                                                          | °F                       |
| HADJ              | ндтфт         | Average stagnation enthalpy                                                        |                          |
| MEMØ              | мемф          | Identification number.                                                             | '                        |
| MINCRABL          | QR            | Minimum combined heat rate necessary for ablation.                                 | Btu/ft <sup>2</sup> -sec |
| QCTØT             | QTØT          | Integrated convective heating including multiplier.                                | Btu/ft <sup>2</sup>      |
| QRTØT             | QRRA          | Integrated radiative heating including multiplier.                                 | Btu/ft <sup>2</sup>      |
| QTØTREQ           | QTREQT        | Combined integrated heating<br>necessary to require heat<br>shield.                | Btu/ft <sup>2</sup>      |

#### C OUTPUT DEFINITIONS

| External Name | Internal Name | Parameter                                                                                                       | Units              |
|---------------|---------------|-----------------------------------------------------------------------------------------------------------------|--------------------|
| TADJ          | TADJ          | Start time of insulation problem after end of ablation.                                                         | seconds            |
| TCRMAX        | RTQMAX        | Time of maximum combined heating rate.                                                                          | seconds            |
| TI            | TI            | Initial time of constant temperature problem.                                                                   | seconds            |
| TR            | TR            | Time of maximum rear temperature.                                                                               | seconds            |
| TSMAX         | TS2           | Maximum surface tempera-<br>ture of insulation material.                                                        | ٥F                 |
| TTESTI        | TTEST1        | Structural surface tempera-<br>ture attained without heat<br>shield, must be $\leq$ TMLTSTR<br>to stop problem. | ٥F                 |
| TTEST2        | TTEST2        | Structural rear tempera-<br>ture attained without heat<br>shield, must be $\leq$ TREAR to<br>stop problem.      | ٥F                 |
| TURB          | FCØN (1,1-7)  | Array of material proper-<br>ties for turbulent flow.                                                           |                    |
| TIA           | TIA           | Start time of ablation.                                                                                         | seconds            |
| T2A           | T2A           | Time ablation ends.                                                                                             | seconds            |
| WA            | WA            | Ablated weight.                                                                                                 | lb/ft <sup>2</sup> |
| WINS          | WT, W9        | Insulation weight before capacitance corrections.                                                               | lb/ft <sup>2</sup> |
| ₩ТØТ          | WTØTAL        | Total heat shield weight including bond.                                                                        | lb/ft <sup>2</sup> |

When ablation occurs, there are printed out 8 columns arranged time, ablation rate, time, ablation rate, etc., from left to right. Time is in seconds, ablation rate is in lb/sec-ft<sup>2</sup>. Internally, these are called A27A(J), WDQT(J).

#### D. SAMPLE PROBLEM

#### 1. Statement of Problem

Determine the heat shield weight for the configuration and trajectory used in the sample problems of Programs 1880, 1885. The heat shield material properties are to be specified as well as the necessary data on the bond and substructure.

# 2. Input Form

The input form containing all the necessary input is shown on the following pages. A number of cases are shown, representing the heating at several stations on the vehicle. The keypunched input shown should be checked with the input form.

The results indicate the integrated radiation and convective heating, and the heat load for which a heat shield is required. The maximum combined heating rate, and the time at which it occurs is shown. The minimum combined rate necessary for ablation is shown, and can be seen to be larger than the maximum rate occurring. The initial time and adjusted enthalpy are given.

The solution indicates that no ablation occurs and that the heat shield has not fully equilibrated at the time TSTOP; this is further shown by the time required to achieve the maximum rear face temperature. The surface temperature and maximum mean temperature of the heat shield are given. The insulation weight (nonablating) required with and without the effects of thermal capacitance of the structure and bond are shown. Finally, the total weight, including the bond weight is given.

Case 4 indicates that the required convergence was not achieved and the results must be interpreted with caution. Case 5 indicates that the heating level has been reduced to the point where no heat shield is required.

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|              | AL CO      | OMPUTER   | RINPUT  | PROBLEM NO | 1884        |      |                                        | PROGRAM  | MER   |          |           |    |      |
|--------------|------------|-----------|---------|------------|-------------|------|----------------------------------------|----------|-------|----------|-----------|----|------|
| _            | REQU       | JEST FOR  | RM      | TITLE      |             |      |                                        |          |       |          |           |    |      |
| MEMO NO      | ) si       | ECTION NO | WORK O  | RDER NO    | E240 USE ON | LYIF | EQUESTED B                             | YEXT     | EST.  | TIME     |           | 1  |      |
| ļ            |            |           |         |            |             |      |                                        |          |       |          | FAGE      |    | FAGE |
| ¢T           | NOT        | т         |         |            |             |      |                                        |          |       |          |           |    |      |
| φ <b>ι</b> . | NI U       | *         |         |            |             |      |                                        |          |       |          |           |    |      |
| D            | ለጥም        | _         |         |            | NEN/0       | _    |                                        |          | CACT  | -        | •         |    |      |
|              | 18         | -         |         | ,          | KHS<br>MDMA | 2 .  |                                        | ,        | TPE   |          |           |    | ,    |
|              | DB         | -         |         | ,          | KSTR        |      |                                        | '        | TST   |          |           |    | ·,   |
|              | - E<br>-HS | -         |         | ,          | MXTT        |      |                                        | _,       | TSTO  | 5D -     |           |    | _,   |
| CT           | STR        | 2 -       | <u></u> | 3          | OCMULT      |      |                                        | _,       | TTP   |          |           |    | ,    |
| יח           |            |           |         | ,          | ORMULT      |      |                                        | _,       | WTB   |          |           |    | ·•   |
| EN           | ATS        | _         |         | ,          | внав        |      |                                        |          | WTS   | <br>- 07 | ·         |    | ,    |
| EF           | PSTT.      | -         |         | ·'         | RHOHS       |      |                                        | _,       | YA XA |          |           |    |      |
| F.A          | ACTO       | 7a =      |         | ······     | RHØSTR      |      |                                        | _,       | xc    | -        |           |    | '    |
| HV           | /1R        | =         |         | ,          | TABL        |      |                                        | '        | XN    | _        |           |    | ,    |
| HV           | 72R        | =         |         | ,          | TEMPI       |      |                                        | <b>,</b> | xø    | _        |           | •  | _,   |
| KF           | 3          | =         |         | ,          | TMSTR       | = -  |                                        | '        |       | _        |           |    | ,    |
|              |            |           |         | ,          |             | -    |                                        | _,       |       |          |           |    |      |
| LA           | M          | =         |         |            |             |      | ,                                      |          |       | ,        |           | ,  |      |
|              |            |           |         |            | ,           |      | ,                                      |          |       | ,        |           | _, |      |
| тU           | RB         | =         |         | ,          | ,           |      | ,                                      |          |       | ,        |           | ,  |      |
|              |            |           |         | ,          | ,           |      | ······· ,                              |          |       | ,        |           | _, |      |
|              |            |           |         |            |             |      |                                        |          |       |          |           |    |      |
| ТB           | SL1        | =         |         | ,          |             |      | ,                                      |          |       | ,        |           | ,  |      |
|              |            |           |         | ,          | ,           |      | ,                                      |          |       | ,        |           | ,  |      |
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|              |            |           |         | ······ ·   |             |      | <b>'</b> .                             |          | ••    |          |           | _' |      |
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|              |            |           |         |            |             |      |                                        |          |       |          |           |    |      |

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| RAD 2-0984 | DIGITAL COMPLETED IND | PROBLEM NO                             | MENO NO.                               | SECTION NO.                            | CONTINUATION SHEET                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------|-----------------------|----------------------------------------|----------------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5-63       | REQUEST FORM          | 1884                                   |                                        |                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       |                                        |                                        |                                        | PAGE 2 OF 6 PAGES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|            | <b>mp</b> 7.0         |                                        |                                        |                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            | TBL2 = -              |                                        |                                        | ······································ |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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|                    | REQUEST FORM       |         | 1884        |                                         |                                        | PAGE 3 OF 6 PAGES                      |
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| REQUEST FORM      | 4        | 1884     |                                        |                                        | PAGE 4                                 | OF 6 PAGE                              |
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| 5 45       | REQUEST FORM         | 1884 | ŧ               |                                        |                                        | PAGE 5                                 | OF 6 PAGES                             |
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|                    | CPS1                   | rr. =,     |                 | ,               |     | QCMULT                                 | =   | 1                                      | ,      | т              | TRANS =  |                                        |          | _          |
|                    | DTI                    | z          |                 |                 |     | QRMULT                                 | =   |                                        | ,      | w              | тв =     | 1                                      | 6        | _,         |
|                    | EMIS                   | =          | .76             | ,               |     | RНØВ                                   | =   | <u>    30.    </u>                     |        | w              | TSTR =   | . 0.                                   | 5075     | <u>;</u> , |
|                    | EPSI                   | L =        | <u> </u>        |                 |     | RHØHS                                  | =   | 39.4                                   | _,     | X              | A =      | •••••••••••••••••••••••••••••••••••••• |          | _,         |
|                    | FAC                    | rør =      |                 | ,               |     | RHØSTR                                 | =   | 172,0                                  | ,      | x              | C =      | 20                                     |          |            |
|                    | HV1F                   | t =        | 10000           | ر:              |     | TABL                                   | =   | 3700.                                  | _,     | x              | N =      | 80                                     | _        | ,          |
|                    | HV2F                   | ٤ =        |                 |                 |     | TEMPI                                  | =   | 100.                                   | _,     | X              | Ø =      |                                        |          | <b>,</b>   |
| [                  | KB                     | =          | .1              |                 |     | TMSTR                                  | =   | 1000.                                  | _,     |                |          |                                        | '        |            |
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|                    | LAM                    | =          | 1.              | ,               | -23 | 90. ,                                  |     | 1.53 <u></u> ,                         |        | 1.             |          |                                        | ,        |            |
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| 1   | TBL2                   | =     | ,                                      |                               | ,           |                                        | ,                                      | ,,            |  |
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|     | HTBL                   | = 127 | .5 ,                                   | <u>13</u> 0                   | .9 ,        | 131.1                                  | 131.4                                  | , 131.7 ,     |  |
|     |                        | 132   | .0                                     | 132                           | .2 ,        | 132.5                                  | 132.7                                  | , 132.9 ,     |  |
|     |                        | _133  | .0                                     | 133                           | <u>.1</u> , | 133.0                                  | 132.8                                  | , _132.3,     |  |
|     |                        | 131   | .4,                                    | 129                           | .9,         | 128.0                                  | 126.4                                  | 122.8         |  |
|     |                        | _116  | .7,                                    | 108                           | .2_,        | 98.6                                   | 89.4                                   | 80.7          |  |
|     |                        | 72    | .5                                     | 64                            | .7          | 57.4                                   | 50.5                                   | , 44.1        |  |
|     |                        | 38    | 32,                                    | 32                            | 7,          | 27.6                                   | 23 1                                   | 19 0          |  |
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| QTBL =           | 0.1  | , <u>1.</u>  | <u>o                                    </u> | , 1.2      | 1.5,                                    | <u> </u>   |
|                  | 2.3  | , 2.         | 8                                            | 3.4        | 4.1 ,                                   | 5.1 ,      |
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|                    | RTBL =           |                        | ,                                      |      |              |             | ,                                      |        | ,                                      |  |  |  |
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|                    | TIME =           | 0.0                    | ,                                      | 83.  | <u>59</u> ,  | 91.01       | ,                                      | 98.59  | , 106.29 ,                             |  |  |  |
|                    |                  | 114.                   | <u>11</u> ,                            | 122  | .04 ,        | 130.1       | <u>5</u> ,                             | 138.41 | , 146.83 ,                             |  |  |  |
|                    |                  | 155                    | .43 ,                                  | 164  | .26 ,        | 173.3       | 2_,                                    | 182.60 | , 192.13 ,                             |  |  |  |
|                    |                  | 201                    | .94 ,                                  | 212  | <u>.11</u> , | 221.4       | 2,                                     | 229.50 | , _236.71 ,                            |  |  |  |
|                    |                  | 243                    | .49_,                                  | 250  | .18,         | 256.2       | 4,                                     | 261.31 | 265.89                                 |  |  |  |
|                    |                  | 270                    | . 19 ,                                 | 274  | .35 ,        | 278.4       | 1,                                     | 282.47 | 286.62                                 |  |  |  |
|                    |                  | 290.                   | .91_,                                  | 295  | . 42 ,       | 300.2       | 4,                                     | 305.47 | , 311.25 ,                             |  |  |  |
|                    |                  | 317                    | . 80 ,                                 | 323  | .33_,        | 329.6       | <u>2</u> ,                             | 336.92 | 345.61 ,                               |  |  |  |
|                    |                  | 356                    | 33 ,                                   | 370  | .26 ,        | 389.4       | 1,                                     | 426.40 | 473.0                                  |  |  |  |
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| WTSTR = 0.5266            |            |         |            |                   |      |
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| OCMULT = 0.354            |            |         |            |                   |      |
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| CASE = 40                 |            |         |            |                   |      |
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| CASE = 5.0                |            |         |            |                   |      |
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| QCMULT = 0.00332          |            |         |            |                   |      |

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| 4. SCURVE            | 20007            | CURVE<br>CORFIT- | 20075                     |           |             |           |                          |                      |           |        |         |
| 6. STLUO             | 22340            | TLUQ             | 22443                     |           |             |           |                          |                      |           |        |         |
| 8LXCON               | 23070            | +LXSTR           | 23070 *                   | .LXSTF    | 23074       | .LXOUT    | 23142                    | LXRTN                | 23154     | [BFXIT | 23154   |
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|                      |                  | -WRITE           | 23564                     | • B SR    | 23574 *     | +RFADR    | 23604                    | .RELES               | 23606 *   | +LAREA | 23617   |
|                      |                  | -GOA             | 23717                     | .60       | 23723       | -DERR     | 23737                    | -NOPX I              | 23740     | CONXI  | 23742   |
| 10LXSL               | 23771            | -LXSEL           | 23771                     | LXCSEL    | 23772       | +LXTST    | 23775 *                  | LXOVL                | 24035 *   | .LXRCT | 24046   |
| 11 EPTRP             | 24130            | - +LXIND-        | 24115 *                   | - EPOUT   | 24267       |           | - 24121-*<br>24306       | /+CDUNT/             | 24310 *   | OVELOW | 74361   |
| 12                   | 24370-           |                  | 24370                     | 6-2       | 24371       | - [.3     | -24372                   |                      | 24373     |        |         |
| 15XLU.<br>14. XIT    | - 24400          |                  | 24400                     | -EXIT.    | 24375       | 6643      | 24310                    | ····                 | 24377     |        |         |
| 15. FXFM             | 24401            | .FXEM.           | 24401                     | .FXOUT    | 24736       | +FXARG    | 24744                    | /.OPTH./             | 25020     |        |         |
| 17. FCNV             | 25373            | .FCON.           | 25373                     | .FCNV.    | 25416       | .ENDFS    | 25431                    | .CNVSW               | 25433     | .FOX1  | 25437   |
|                      |                  | +F0X2            | -25440<br>25621           | +08C      | 25631       |           | 25553                    | -0869-               | 25646     |        | 25723   |
|                      |                  | +00R31           | 26175                     | +DDRS2    | 26177 -     | - 01      | -25202                   | -02                  | 26204     | FERR2  | -26271  |
|                      |                  |                  | 26325                     | -ONPT     | 26342       | -LNTP     | 26415<br>~26730          | -1001<br>-1001       | 20465     | -0+LT  | 26503   |
|                      |                  | -LOUT            | 27246                     | LOOUT     | 27265       | .XCF      | 27316                    | .TEST                | 30023     | -KOUNT | 30026   |
|                      |                  | WIDTH            | 30136                     | .GAIN     | 30137       | -GAIN1    | 30140                    | +F8DBF               | 30150     | +000FL | 30173   |
| 0 5105               | 30220            |                  | 30174                     | HOD       |             | .9EX      |                          | FEXP                 | 30177     |        | -30200  |
|                      | 50220            | *Fitte           | 30403                     | -FGLS-    |             | FOPN      | -30411 *                 |                      | -30415 *  |        | -30540  |
| 9- FTOH-             |                  | -REED            | 30566 *                   | .BIN      | 30567 *     | .FCT      | 30570                    | +FCKSZ               | 30572 *   |        |         |
| 20. FWRD             | 31655            | -FWRD.           | 31655                     |           |             |           |                          |                      |           |        |         |
| 22. FWRO             | 31725            | .FWRD.           | 31725                     | .FREST    | 32230 *     |           |                          |                      |           |        |         |
| 23. FROU             | 32332            | -FROU-           | 32332                     |           |             |           |                          | ···                  |           |        |         |
| 25. UN06             | 32374-           | -UN06-           | 32374                     | .8UPSZ    | 32375       |           | ·                        |                      |           |        |         |
|                      |                  |                  |                           |           |             |           | -12/01/                  | 64                   |           |        | -       |
| 26+ ETUU             | 32400            | .E 1011.         | 32400                     |           | 33053       | NHI ST    | 33.076                   | NAME.                | 34201     | INTAP  | 34202   |
| 7. FLOG              | 34625-           | -AL-06-10-       | 34625 *                   | ALOG      |             |           | ~                        | •••••                |           |        |         |
| 28. FXPF<br>9FSOR    | 34766<br>        | EXP<br>SORT      | 34766<br><del>35186</del> |           |             |           |                          |                      |           |        |         |
| 0. FXP3              | 35213            | • XP 3 •         | 35213                     |           |             |           |                          |                      |           |        |         |
| ·r** #1065           |                  | L107             | 35572                     | .ATTC.    | 35605       | • SH1     | 35017 *                  | • SH9                | 36061 *   | .OPEN. | 36102   |
|                      |                  |                  | <del>36130-*</del>        |           | 36161 *     | -+0P9+2   | 36175 +-                 | -RLSE-               | 36247     | -95b2- | 36247   |
|                      |                  | FFEIT            | 36614                     | -6110X    | -36635      | -RW7      | -36753 *                 | -RE7                 | 17372-*   | ENDIA  | 40033   |
|                      |                  | + SEL 59         | 40035 *                   | .BSR.     | 40446       | EOTOF     | 40573                    | .ETOF3               | 40601 *   | .SHITC | 40630   |
| 2 10754              | 41135            | •••••            |                           |           |             |           |                          |                      |           |        |         |

 32..10054
 41135

 1/0 BUFFFRS
 41135 THRU

 1/0 BUFFFRS
 41135 THRU

 UNUSED CORF
 77701 THRU

| \$1NPUT      |                                                       |                                                       |                                                       |                                                       |                                                       |
|--------------|-------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------|
| -DATE        |                                                       |                                                       |                                                       |                                                       |                                                       |
| HEN0         | 0.184000000 03,                                       |                                                       |                                                       |                                                       |                                                       |
| CASE -       | 0;1000000E-01;                                        | a                                                     |                                                       |                                                       |                                                       |
| AHP .        |                                                       |                                                       |                                                       |                                                       |                                                       |
| TABL         |                                                       |                                                       |                                                       | ······································                | ·                                                     |
| TREAR -      | 0.4000000E-03,                                        |                                                       |                                                       |                                                       |                                                       |
| TEHP1        | 0.1000000E-031                                        |                                                       |                                                       |                                                       |                                                       |
| -EH15        | 0:7600000E-00;                                        |                                                       |                                                       |                                                       |                                                       |
| -TSTART-C    |                                                       |                                                       |                                                       |                                                       |                                                       |
| -DTI         | 0.10000000E 00y                                       |                                                       | · · · · · · · · · · · · · · · · · · ·                 |                                                       |                                                       |
| -78t1 -      | 0+6000000E-38;                                        | 0.15000000F-01,                                       | 0.50000000E-32,<br>0.70000000E-31,                    | 0.5000000E-01,<br>0.26000000E-01,                     | 0,300000000000000000000000000000000000                |
|              | 0.12500000E 00.                                       | 0.18200000E 00.                                       | 0.17500000E 00.<br>0.46500000E 00.                    | 0.27400000E 00,<br>                                   | 0.22500000E 00.                                       |
| <del>.</del> | 0.4000000E 00.<br>0.67400000E 00.<br>0.65000000E 00.  | 0.58400000E 00,<br>0.55000000E 00,<br>0.77400000E 00, | 0.45000000E 00,<br>                                   | 0.83000000E-00,<br>0.80100000E-00,                    | 0.720000000 00.<br>0.720000000 00.<br>0.750000000 00. |
|              | 0.9000000E 00,                                        | 0.1000000F 01.                                        | 0.10000000E 01.                                       | 0.5000000E 03,                                        | 0.1000000E 01.                                        |
| TBL2 =       | 0.0000000E-38,<br>0.11400000E-00,                     | 0.00000000E-38,                                       | 0.25000000E-02.                                       | 0.5000000E-01.                                        | 0.1000000E-01.                                        |
|              | 0.69000000E-01.<br>0.42000000E-00.                    | 0.30000000E 00,<br>0.17500000E 00,<br>0.56200000E 00, | 0.10000000E 00.<br>0.47500000E-00.<br>0.30000000E 00. | 0.35000000E 00,<br>0.2000000E 00,<br>0.61400000E 00,  | 0.13500000E 00,<br>0.35000000E 00,                    |
|              | 0.5000000E 00,<br>0.5000000E 00,<br>0.81600000E 00,   | 0.4000000E 00.<br>0.76400000E 00.<br>                 | 0.55000000E 00,<br>0.55000000E 00,<br>0.89600000E-00, | 0.45000000E 00,<br>0.79100000E 00,<br>0.70000000E 00, | 0.73300000E 00,<br>0.60000000E 00,<br>0.65700000E 00, |
|              | 0.7500000E 00;<br>                                    | 0.87400000E 00,<br>                                   | 0.80000000E 00,<br>0.10000000E-01,                    | 0.88800000E 00;                                       |                                                       |
| CPSTR -      | C.30000000E-00.                                       |                                                       | ······                                                |                                                       |                                                       |
| -WTSTR       | 0+5¢750000E-00+                                       |                                                       |                                                       |                                                       |                                                       |
| -HX17 =      | 0.50000008-02.                                        |                                                       |                                                       |                                                       |                                                       |
| -EPSIL       | 0.500000000-02,                                       |                                                       |                                                       |                                                       |                                                       |
| FACTOR       | 0.10000002 00,                                        |                                                       |                                                       |                                                       |                                                       |
| -TIME =      | 0.11411000E-38,<br>0.115543000E-03,                   | 0.12204000E 03,<br>                                   | 0.13015000E 03,<br>0.13015000E 03,<br>0.17332000E-03, | 0.98590000E 02,<br>0.13841000E 03,<br>0.16260000E 03, | 0.14683000F 03+<br>0.14683000F 03+<br>0.19213000F 03- |
|              | 0.20194000E 03.<br>0.24349000E 03.<br>0.27019000E 03. | 0.21211000E 03,<br>0.25018000E 03,<br>0.27435000E 03, | 0.22142000E 03.<br>0.25624000E 03.<br>0.27841000E 03. | 0.22950000E 03.<br>0.26131000E 03.<br>0.28247000E 03. | 0.28662000E 03.                                       |

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|                                         | 0:29542000F 03-                         | 0.30024000 03                           |                                         | 0.311250000 03.                         |
|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
| 0.21700000 03                           | 0.32333000E 03.                         | 0.329620008 03                          | 0.33692000E 03,                         | 0.34561000E 03.                         |
| 0.317800002 034                         | 0.270260005-03-                         |                                         | 0.42640000E-03.                         | 0_47390000E 03+-                        |
| -0.35633000E-03-                        |                                         | 0.0000006-38                            | 0.000000005-38.                         | 0.0000000E-38.                          |
| 0.0000000E-38,                          | 0.00000000000000                        | 0.000000000000                          | 0.00000000-38                           | 0_0000000E=38+                          |
| -0.0000000E 38v                         |                                         | 0100000000000000                        | 2 00000000 - 20                         | 0.000000005-38-                         |
| 0.00000008-38.                          | 0.0000000E-38.                          | 0.000000000-38,                         | 0.0000000000000000000000000000000000000 | 0.0000000000000                         |
| - 0-0000000E-38*                        |                                         |                                         | 0+000000000000                          |                                         |
| 0.0000000F-38.                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38,                          |
|                                         | 0.0000000C 30.                          |                                         |                                         | 0.00000006=38+                          |
| - 000000000 30                          | 0.0000000E-38.                          | 0.00000000000-38.                       | 0.0000000E-38,                          | 0.0000000E-38,                          |
| 0.0000000000000000000000000000000000000 | 0.000000000000                          |                                         |                                         | 0.0000008-38+                           |
| -0-00000000-201 -                       | 0.0000000000000000000000000000000000000 | 0.00000005-38                           | 0.000000E-38.                           | 0.0000000E-36.                          |
| 0.0000000E-38,                          | 0.000000000-58,                         | 0.00000000000000                        |                                         | 0_00000000-38-                          |
| -0:0000000E-38;                         | -0.000000L-301                          |                                         | 0.000000005-38                          | 0.0000000F-38-                          |
| 0,0000000000000-38,                     | 0.0000000E-38,                          | 0.0000000000000                         | 0.00000000000000                        | 0.00000005-38                           |
| -0.0000000E-39,                         |                                         | 0.000000000-30                          |                                         | 0.000000000-38                          |
| 0.00000000-38.                          | 0.0000000000-38,                        | 0.0000000E-38,                          | 0.000000000-38,                         | 0.0000000000000000000000000000000000000 |
|                                         | 0-00000000-30                           |                                         |                                         | 0.0000000E~38-                          |
| 0.0000000000000                         | 0.0000000E-38.                          | 0.00000000000-38,                       | 0.0000000E-38,                          | 0.0000000E-38,                          |
| 0.0000000000000                         | 0.00000005-30                           | -0-00000000F-391                        | 0.000000E-30                            |                                         |
| -0.0000000-38                           | 0.000000005-39                          | 0.00000000000000                        | 0.000000E-38.                           | 0.0000000E-38,                          |
| 0.000000000-38.                         | 0.000000000-384                         | 0.000000000 30                          | 0.00000007 38                           | 0.000000E-38                            |
| -0.0000000E-30r                         | 0-0000000-381                           | 0.000000001 301                         | 0.00000000=38                           | 0.000000005-38.                         |
| 0.0000000E-38.                          | 0.0000000E-38.                          | 0.00000000-38,                          | 0.00000000 30                           | 0.00000000 38-                          |
| -0.000000000-36,                        | -0.00000000-38,                         | 0.00000000-38;                          | 0.0000000000000                         | 0.000000000-38                          |
| 0.0000000E-38.                          | 0.0000000E-38.                          | 0.0000000E-38,                          | 0.00000000-38,                          | 0.00000002-38;                          |
|                                         |                                         |                                         |                                         |                                         |
| 0 1000000E 00.                          | 0.1000000E 01.                          | 0.12000000E 01,                         | 0.15000000E 01,                         | 0.1900000E 01.                          |
| 0.230000000 00                          | 0.20000005-01                           | 0.34303000E 01.                         |                                         |                                         |
| 0 ( 00000000 01                         | 0 7600000E 01.                          | 0.94000000E 01.                         | 0.11400000E 02,                         | 0.14100000E 02,                         |
| 0.62000000E 01.                         | 0.703000000 014                         | 0 23000000 02.                          | 0.772000005 02                          |                                         |
| -0.168000002 024                        | 00203000000 024                         | 0.397000005 02.                         | 0.26400000F 02.                         | 0.23800000E 02,                         |
| 0.29400000E 02.                         | 0.304000000 021                         | 0.201000000 021                         |                                         | 0-1-1-2000005 02-                       |
| -0.2110000CE 02.                        |                                         |                                         | 0. ((0000005 01                         | 0.220000006 01.                         |
| 0.92000000E 01.                         | 0.74000000E 01.                         | 0.580000002 01,                         | 0.440000002 011                         |                                         |
| -0.23000000E 01,                        | 0.17000000E-01;                         | 0.120000000-01.                         |                                         | 000000000000000000000000000000000000000 |
| 0.3000000E 00.                          | 0.2000000E 00.                          | 0.1000000E 00,                          | 0.0000000E-38,                          | 0.000000000-38,                         |
| -0-0000000F=19                          | -0-0000000E-19-                         | -0.00000000E-19,                        |                                         | -0.00000000-191                         |
| -0.00000000E-19.                        | -0.0000000E=19.                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         |
| -0100000000 177                         |                                         |                                         |                                         |                                         |
|                                         | -0.000000000000000000000000000000000000 | -0.0000000F-19.                         | -0.0000000E-19.                         | -0.0000000F-19,                         |
| -0.00000000E-194                        | -0.00000000-190                         |                                         | 0.0000000E-19                           |                                         |
| -0106000006-101                         | -0.0000000000000                        | 0.000000000000000                       | -0.0000000E=19-                         | -0-00000000E-19-                        |
| -0.0000000E-19.                         | -0.00000005-19,                         | -0.000000000000000000000000000000000000 |                                         |                                         |
| -0.0000000E-19-                         |                                         | -0.000000000-19;                        | -010000000000000                        | 0.00000000000000                        |
| -0.00000000E-19,                        | -0.00000000F-19,                        | -0.0000000E-19;                         | -0.0000000-194                          |                                         |
| -0.0000000E=19.                         |                                         | -0.000000000-19,                        | -0:00000001-19:                         |                                         |
| -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         |
|                                         | -0.000000F-19-                          | -0.0000000E-19.                         | -0.0000000E~19.                         |                                         |
| 0.00000000000000                        | -0.00000000E-19-                        | -0.0000000E-19.                         | -0.0000000F-19.                         | -0.0000000E-19,                         |
| -0.000000000000                         |                                         |                                         |                                         |                                         |
|                                         | -0.000000000000000000000000000000000000 | -0.0000000E-19                          | -0.000000005-19.                        | -0.0000000E-19.                         |
| -0.0000000E-19,                         | -0.000000000-19,                        | -0.0000000000000                        | -0-000000000-19                         | -0-0000000E-19.                         |
| -0:00000000-19-                         | -01000000001-19,                        | -0.00000002-13;                         | -01000000000000000000000000000000000000 | -0.00000006-19-                         |
| -0.00000000E-19,                        | -0.0000000E-19+                         | -0.00000000-19.                         | -0.0000000000000                        | 0-0000000E-10-                          |
| -0.0000000E-19.                         |                                         |                                         |                                         | 0.0000000000000000000000000000000000000 |
| -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E=19,                         |
| 0-0000000F-19-                          | -0-090000005-19.                        | -0-00000000E-19,                        | -0:0000000E-19;                         |                                         |
| -0.0000000E-19.                         | -0.00000000E-19.                        | -0.0000000E-19,                         | -0.0000000E-19.                         | -0.0000000E-19,                         |
| 0.0000000000000000000000000000000000000 |                                         | -0.000000005-19                         | -0.00000000E-19,                        | -9-000000000-19+                        |
| -0.0000000E-131                         | -0.0000000000000                        |                                         |                                         |                                         |
|                                         |                                         | A 121-100005 03                         |                                         |                                         |
| 0.127500008 037                         | 0.130300002 03,                         | 0.131500005 03                          | 0 12270000E 03-                         | 0.13290000F 03.                         |
| 0.13200000E 03,                         | 0.13220000E 03.                         | 0.1325000000 03,                        | 0.1327000E 031                          |                                         |
| -0-13300000E-03.                        | 0.133100008 03.                         | 0.133000002 03.                         | 0-13200000-031                          | 0 122900005 03                          |
| 0.13140000E 03.                         | 0.12990000E 03.                         | 0.12800000E 03.                         | U.12540000E 03+                         | 0.122400002 05,                         |

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| -0.11670000E 03.                        | 0.108200008 03.                         | 0.98500000E 02.                         | 0.894000000 027                         | 0;807009000 02+                         |
|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
| 0.72500000E 02.                         | 0.64700000E 02.                         | 0.57400000E 02.                         | 0.50500000E 02,                         | 0.44100000E 02,                         |
| -0-36200000E-02-                        |                                         | 0.276090000 02.                         | 0.231000005 02.                         | 0-1-9000000E 02-                        |
| 0.15300000E 0Z.                         | 0.12900000E 02.                         | 0.108000000 02.                         | 0.8900000F 01.                          | 0.7200000E 01.                          |
| -0-506000005-01                         | 0-470000000-01-                         | 0.39000005 01                           | 0.37000000 01.                          | 0.4000000E 01-                          |
| -0.000000000-19.                        | -0.0000000E-19.                         | -0.0000000E-19.                         | -D.0000000E-19.                         | -0.00000000E-19.                        |
| -01000000000000000000000000000000000000 |                                         |                                         |                                         |                                         |
| -0.000000000000                         | -0.0000000000000                        | -0.000000000000000000000000000000000000 | -0.000000000000000                      | -0.0000000E-19.                         |
| -0.000000000000000000000000000000000000 | -0.000000000-17                         | -0.000000000-10                         | 010000000000000000000000000000000000000 | -0.0000000000000                        |
|                                         | -01000000000                            | -0100000000000000                       | 0.0000000000000000000000000000000000000 | -0.00000006-10                          |
| -0.000000000-14                         | -0.000000000000000000000000000000000000 | -0.000000000000000000000000000000000000 | -0.00000000000000                       | -0.000000000-14                         |
| -0100000000-19                          | -01000000000-170                        | -01000000000-199                        | 0.0000000000000000000000000000000000000 | 0.0000000000-10                         |
| -0.0000000E-19,                         | -0.00000008-19,                         | -0.000000002-19,                        | -0.000000000-14                         | 0.0000000000000000000000000000000000000 |
| -010000000E-191                         |                                         | 0200000000 177                          |                                         | 0.00000000000000                        |
| -0-0000000E-14*                         | -0.0000000E-19,                         | -0.00000002-19,                         | -0.000000000-19,                        | -0.000000002-17;                        |
| -0:000000E-19,                          | 0-00000000E_19+                         | 0,000000000 19,                         | -0+00000001 19                          | -9-00000000014-                         |
| -0.00000000E-19,                        | -0 0000000E-19,                         | -0.0000000E-19,                         | -0.00000000E-19,                        | -0.00000006-14                          |
| ~0-000000000000-19y                     |                                         |                                         | 0+00000000E-19+                         | -0+000000005-19+                        |
| -0.0000000E-19,                         | -0.0000000F-19,                         | -0.00000000E-19,                        | -0.0000000E-19,                         | -0.0000000E-19.                         |
| -0-000000E-191                          |                                         |                                         |                                         |                                         |
| -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19.                         |
| -0.000000E-19,                          |                                         | -0.00000000E-19                         | 0.0000000000.19,                        |                                         |
| -0.0000000E-19.                         | -0.0000000E-19.                         | -0.00000000E-19.                        | -0.00000000E-19,                        | -0.0000000E-19;                         |
| -3-0-0000000E-19-                       | -0-00000000E-19                         | -0-00000000E-19                         | 0.000000000 19.                         |                                         |
| -0.0000000E-19.                         | -0.0000000F-19.                         | -0.00000000E-19.                        | -0.0000000E-19,                         | -0.0000000E-19.                         |
| ~0-0000000F-19                          | -0-00000000F-19                         |                                         | -0-00000000E 17-                        | -0.0000000E-19-                         |
| -0.000000000-19.                        | -0.000000005-19.                        | -0.0000000F-19.                         | -0.0000000E-19.                         | -0.0000000E-19.                         |
|                                         |                                         |                                         |                                         |                                         |
| 0.000000005=38-                         | 0.000000005-38.                         | 0.00000006-38.                          | 0.00000000-38.                          | 0.0000000E-38.                          |
| -0-00000000-30                          |                                         |                                         |                                         | -0.0000000E-38-                         |
| 0.00000000000000                        | 0.000000000000                          | 0.0000000000000                         | 0.0000000000000-38-                     | 0.0000000E-38.                          |
| -0-00000000-20-                         | 0.00000000000000                        | 0.00000000000000                        | 0.00000005_38                           | 0.00000005-38-                          |
| 0.000000005-38                          | 0.00000000000000                        | 0.00000000000000                        | 0.000000005-38-                         | 0.000000005-38.                         |
|                                         | 0.000000000000000                       | 0.0000000000000                         | 0.00000005 38                           | 0.00000005-38-                          |
| 0,0000000000000000000000000000000000000 |                                         | 0.0000000000000                         | 0.00000000.30                           | 0.00000005-38                           |
| 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 | 0.00000002-38,                          | 0.00000000000000                        | 0.0000000000000000000000000000000000000 |
| -010000000P=387                         | -0200000002-387                         | 0100000000000000                        |                                         | 0.00000000538                           |
| 0.0000000E-38,                          | 0.0000000000000000000000000000000000000 | 0.000000002-38,                         | 0.0000000000000000000000000000000000000 |                                         |
| ~0.0000000E-14,                         | -0-0000000E-19,                         | 0.00000005-17                           |                                         | 0.00000000000000                        |
| -0.0000000E-19,                         | -0.0000000E-19,                         | -0.00000002-19,                         | -0.000000000-19,                        | -0.000000000000                         |
| -0.00000090E-19                         | 0:0000000E_19                           |                                         |                                         |                                         |
| -0.0000000E-19,                         | -0.00000000E-19,                        | -0.0000000E-19,                         | -0.0000000E-19+                         | -0.00000000000000                       |
| ~0:000000000-19                         | ~0.0000000E~19,                         | -0-000000000-19,                        | -0.000000000E-191                       | -0-0000000E-193                         |
| -9.00000000E-19,                        | -0.00000000E-19,                        | -0.0000000000000.                       | -0.0000000E-19,                         | -0.0000000E-19.                         |
| -0.0000000E-19.                         |                                         | -0+000000006-19+                        |                                         | 0:000000E-19+                           |
| -0.0000000E-19,                         | -0.0000000E-19,                         | -0.00000000E-19,                        | -0 0000000E-19,                         | -0.00000000E-19,                        |
| -3-00000000E-19;                        |                                         | -0-00000000E 19,                        |                                         | C+00000000C-14+                         |
| -0.0000000E-19,                         | -0.0000000F-19,                         | -0.00000000E-19,                        | -0.0000000E-19,                         | -0.0000000E-19,                         |
| -0.0000000E-19,                         | 0-00000000E-1-9.                        |                                         |                                         | 0.00000000F19,-                         |
| -0.00000000E-19.                        | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19;                         | -0,0000000E-19,                         |
| -0-00000000E-19-                        | -0-00000000E-19                         |                                         | 0.0000000000000                         | -0.0000000F-19v-                        |
| -0.000000000-19.                        | -0.0000000E-19.                         | -0.00000000E-19.                        | -0.000000000-19,                        | -0.0000000F-19,                         |
| -0-0000000F-19                          |                                         | -0.0000000E-19                          |                                         |                                         |
| -0.000000008-19.                        | -0.0000000E-19.                         | -0.00000000E-19.                        | -0.0000000000-19,                       | -0.00000000E-19,                        |
| -0-0000000F-19-                         |                                         |                                         |                                         | 0.0000000E 19-                          |
| -0.0000000E-19-                         | -0.0000000F-19                          | -0.0000000E-19-                         | -0.0000000E-19.                         | -0.0000000E-19.                         |
|                                         |                                         | -0.0000000000000                        | 0.0000000000000                         |                                         |
| -0.00000005-19                          | -0.00000006-19.                         | -0.000000005-19.                        | -0.00000000-19                          | -0.0000000E-19.                         |
|                                         | -0-00000000-197                         |                                         | 0.000000000 10/                         | 0.000000005-17-                         |
| -0.000000000000000000000000000000000000 | -0.00000000-19.                         | 0.0000000000000000000000000000000000000 | 0.00000000000000                        |                                         |
|                                         |                                         |                                         |                                         |                                         |
| 0.00000000000000                        | -0.237000000-047-0-                     | 0.13300000E-014                         | 0+1000000C 314                          |                                         |
| 0.0000000000000000000000000000000000000 | 0.000000000-381                         |                                         |                                         |                                         |

| TURB          | - | 0 0000000E-38;    |  |
|---------------|---|-------------------|--|
| <b>OCPULT</b> | - | 0.1000600CE 01,   |  |
| QRHUL T       |   | 0.100000008 01,   |  |
| KHS           |   | 0.5800000E-01,    |  |
| TTRANS        | = | 0.1000B000E 04,   |  |
| RHOHS         | - | 0,39400000E 02,   |  |
| CPHS          | * | 0.44000000E 00, ' |  |
| XN            | 2 | 0.800000000 00.   |  |
| XO            | = | 0.0000000E-38,    |  |
| XA            | - | 0.0000000F-38.    |  |
| xc            | - | 0.20000000E 00, 1 |  |
| KSTR          | 4 | 0.12500000E 03,   |  |
| WTB           | = | 0.16000006E 00.   |  |
| CPB           | = | 0.2500000CE 00,   |  |
| TSTOP         | - | 0.41160000E 03.   |  |
| КВ            | = | 0.1000000CE 00,   |  |
| RHOSTR        | * | 0.17200000E 03,   |  |
| THSTR         | = | 0.1000000E 04.    |  |
| RHOB          | 2 | 0.3000000E 02, ,  |  |
| HVIR          | = | 0.10000000E 05,   |  |
| HV2R          | - | 0.0000000E-38,    |  |
| S END         |   |                   |  |
|               |   |                   |  |

| -ogt01        | 00E-38 0CTOT=0-2.       | 0504E-04-010TRF0-                             | 0:45675E 02 CR44X=                    |                            | 4AX=-0.25018E-03 |
|---------------|-------------------------|-----------------------------------------------|---------------------------------------|----------------------------|------------------|
|               |                         | -<br>17746E-03                                |                                       |                            |                  |
|               |                         |                                               |                                       |                            |                  |
|               |                         |                                               |                                       |                            |                  |
| NUN-ABL       | TING CASE               |                                               |                                       |                            |                  |
| HABJ- 72-1    | 61                      |                                               |                                       |                            |                  |
| SLAB NOT FOU  | LIBRATED AT END OF PROI | )LEH                                          |                                       |                            |                  |
| TTRNAX 0.11   | 034E-05TSMAX0+1         | 5792E 04- DTH0+1                              | 12376E 03 ABTJAL TS                   | <del>T3P=0.41160E-03</del> |                  |
| #INS= -0-1404 |                         | IS=0-11399E 01H                               | 10T0,12999E-01                        |                            |                  |
|               |                         |                                               |                                       |                            |                  |
| DATE= 5-16-   |                         | SE= 2.00                                      |                                       |                            |                  |
|               |                         |                                               |                                       |                            |                  |
|               |                         |                                               |                                       |                            | · · ·            |
| STNPHT        |                         |                                               |                                       |                            |                  |
|               | 0 5160000F 01           |                                               |                                       |                            | -                |
|               | 3131000000-011          |                                               |                                       |                            |                  |
| nre0 =        |                         |                                               |                                       |                            |                  |
| CASE          | 0-20000008 01-          | · · · <u>· · · · · · · · · · · · · · · · </u> |                                       |                            |                  |
| 4HR = -       |                         |                                               |                                       |                            |                  |
| TABL -        |                         |                                               | · · · · · · · · · · · · · · · · · · · |                            | ,                |
| TREAR -       |                         |                                               |                                       |                            |                  |
| FENPT         |                         |                                               |                                       |                            |                  |
| -N15          |                         |                                               |                                       |                            |                  |
|               | 0.00000005 30           |                                               |                                       |                            |                  |
|               | 01000000C-301           |                                               |                                       |                            |                  |
| 97 <b>1</b>   |                         |                                               |                                       |                            |                  |
| T8L1          |                         | 0.150000005-01                                | 0.500000000-02,                       |                            |                  |
|               | 0-3900000E-01,          |                                               |                                       | 0.26000000000000           | -0.92090000E-01. |
|               | 0.12500000E 00.         | 0.18200000E 00,                               | 0.17500000E 00,                       | 0.27400000E 00,            | 0.22500000E 00,  |
|               | 0-35700000E-00-         |                                               |                                       |                            |                  |
|               |                         |                                               |                                       |                            |                  |
|               | 0.650000008 00,         | 0.77400000E 00,                               | 0.7000000E 00,                        | 0.80100000E 00.            | 0.75000000E 00+  |
|               | 0.92400000E 00.         | 0.10000000E-00.                               | 0.84500000E-00,                       |                            |                  |
|               | 0.00000005-39           | 0.00000005-30                                 | 0.25000005-02                         | 0.5000000C 031             | 0.10000002 01    |
|               | 0.11400000E 00.         |                                               |                                       |                            | 0-25400000E-00-  |
|               | 0.690000008-01,         | 0.30000000E 00,                               | 0.1000000E 00,                        | 0.35000000E 00,            | 0.13500000E 00,  |
|               |                         | 0-17500000E-00-                               | 0.47500000E-00,                       | -0.2000000E DO.            | 0.5060000E00,    |
|               | 0.250000002 00,         | 0.982000002 00.                               |                                       | 0.814000002 00.            | 0.350000000 00,  |
|               | 0.5000000E 00.          | 0.76400000E 00.                               | 0.55000000E DD.                       | 0.79100000F 00.            | 0.60000000E 00.  |
|               | 0.816000000 00.         | -0-65000000F-00-                              | 0.838000005-001                       | -0.7000000t 00.            |                  |
|               | 0.75000000E 00,         | 0.87400000E 00.                               | 0.8000000E 00,                        | 0.888000000 00,            | 0.90000000E 00,  |
| 04TR          |                         |                                               |                                       |                            | -                |
|               | 0.50000000 000          |                                               |                                       |                            |                  |
| 1318          | 0+5266000L 00,          |                                               |                                       |                            |                  |
| ×17 -         | 0-50000006E-02,         |                                               |                                       |                            |                  |
| PSIL -        | 0-5000000E-02,          |                                               |                                       |                            |                  |
| ACTOR -       | 0-1-000000E-00,         |                                               |                                       |                            | <u>.</u>         |
| 1ME           | 0-0000000E-38           | 0-03590000E-021                               |                                       |                            |                  |
|               | U-11411000E 03,         | 0.12204000E 03,                               | 0.13015000E 03.                       | 0.138410008 03.            | 0.14683000E 03,  |
|               | 0.201940005 03.         | 0.212110005 03                                | u, 17332000E-03, -                    |                            |                  |
| ··· ·         | 0.24349000E 03-         |                                               |                                       | 0.261310000-03-            |                  |
|               | 0.27019000E 03,         | 0.27435000E 03,                               | 0.27841000E 03.                       | 0.282470000 03.            | 0.28662000E 03.  |
|               |                         |                                               |                                       |                            |                  |

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|                                       | 0.2909100CE 03.                         | 0.29542000E 03,                         | 0.30024000E-03                          | 0-30547090E03                           | 0+31125000E-03+-                        |
|---------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
|                                       | 0.31780000E D3,                         | 0.323330008 03,                         | 0.32962000E 03,                         | 0.336920008 03,                         | 0.34561000E 03,                         |
|                                       |                                         | 0.37026000E-03,                         | 0+38941000E-03,                         |                                         | 0.47300000E 03,                         |
|                                       | 0.000000E-38,                           | 0.00000000000000.38,                    | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          |
|                                       | 0,0000000-38,                           | 0.0000000E-38,                          |                                         | 0.00000008-38,                          | 0.0000000E=38+                          |
|                                       | 0,00000008-38,                          | 0.0000000E-38.                          | 0.00000000000.38,                       | 0.0000000E-38.                          | 0.0000000E-38,                          |
| <u> </u>                              | -0:000000E-38, ····                     | 0-00000000E-30-                         | 0.0000000E-36                           | 0.0000000E-38,                          |                                         |
|                                       | 0.00000000000-38,                       | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000F-38.                          | 0.0000000E-38,                          |
|                                       |                                         |                                         | 0.0000000E-38,                          | 0,0000000E-38,                          | 0.0000000E-38-                          |
|                                       | 0.0000000E-38,                          | 0.0000000F-38.                          | 0.0000000E-38.                          | 0.0000000000-38.                        | 0.0000000E-38,                          |
|                                       | 0.00000000 38,                          |                                         |                                         | 0+0000000E-38-                          | 0.00000005-38,                          |
|                                       | 0.0000000E-38,                          | 0.000000008-38,                         | 0.0000000E-38.                          | 0.0000000E-38,                          | 0.0000000E-38,                          |
|                                       |                                         |                                         | 0.0000000E-38.                          | -0x0000000E-38-                         |                                         |
|                                       | 0.0000000E-38.                          | 0.00000000000-38.                       | 0.00000000E-38,                         | 0.000000008-38.                         | 0.0000000E-38,                          |
|                                       | 0.0000000E-38,                          | 0.0000000C 30.                          |                                         | 0.0000000E-38                           |                                         |
|                                       | 0.0000000E-38,                          | 0.0000000F-38.                          | 0.0000000E-38.                          | 0.0000000000-38,                        | 0.0000000E-38,                          |
|                                       |                                         | 0.0000000E-30,                          | 0.00000005 38,                          |                                         | 0-00000000E=38,                         |
|                                       | 0.0000000E-38,                          | 0,00000000000-38,                       | 0.000000000-38,                         | 0.0000000000-38,                        | 0.0000000E-38,                          |
|                                       | 0.0000000E-38,                          | 0:0000000E-30                           | 0.0000000E-38,                          | 0.000000000-38,                         | 0.0000000E-38,                          |
|                                       | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.000000000-38,                         | 0.00000005-38.                          | 0.0000000E-38,                          |
|                                       | 0.000000000-30                          | 0.000000005-30.                         | 0.00000000 38.                          | 0-0000000E-38-                          | 0.0000000E-38,                          |
|                                       | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.00000000E-38,                         | 0.0000000E-38.                          | 0.0000000E-38,                          |
| ·······                               | 0.0000000000000000000000000000000000000 |                                         | 0-0000000E-30                           | 0.00000000 38.                          | 0.0000000E-38                           |
|                                       | 0.0000000000-38,                        | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          |
| OTBL =                                | 0.10000000E 00,                         | 0.10000000E 01.                         | 0.12000000E 01.                         | 0.15000000E 01,                         | 0.1900000E 01,                          |
|                                       |                                         |                                         | 0.3400000E-01                           | 0.41000000E 01,                         | 9-5100000E-01                           |
|                                       | 0.6200000E 01,                          | 0.7600000E 01.                          | 0.94000000E 01,                         | 0.11400000E 02,                         | 0.14100000F 02,                         |
| · · · · · · · · · · · · · · · · · · · | 0.16909000F02,                          |                                         | 0.23800000E 02,                         | 0+27200000E-02+                         | 0+28300000E-02+                         |
|                                       | 0.29400000E 02.                         | 0.30400000E 02.                         | 0.28700000E 02,                         | 0.26400000E 02;                         | 0.23800000E 02,                         |
|                                       | 0.211000000 -02                         |                                         | 0.15900000E 02,                         | 0.135000000 02.                         |                                         |
|                                       | 0.9200000E 01,                          | 0.74000000E 01,                         | 0.58000000E 01.                         | 0.44000000E 01,                         | 0.32000000E 01.                         |
|                                       | 0.23000000E 01,                         | 0.1700000E 01,                          | 0+1-2000000E-01                         |                                         | 0.600000000-00,                         |
|                                       | 0.3000000E 00,                          | 0.2000000E 00,                          | 0.1000000E 00,                          | 0.0000000000000000000000000000000000000 | 0.0000000E-38,                          |
|                                       | 0.0000000000000000000000000000000000000 | -0.000000000-19,                        | 0:00000000L_19,                         | 0+00000000L 19+                         | 0.0000000E-19,                          |
|                                       | -9.0000000E-19,                         | -0.00000000E-19,                        | -0.0000000000-19,                       | -0,0000000E-19,                         | -0.0000000E-19,                         |
|                                       | -0.000000000-19,                        | -0.00000000-19,                         |                                         |                                         | 0.00000000 19.                          |
|                                       | -0.00000000-14,                         | -0.00000000E-19,                        | -0-0000000E-19.                         | -0.000000000-19,                        | -0.000000000-19,                        |
|                                       | -0.00000000 19,                         | -0.00000000L-191                        |                                         |                                         |                                         |
|                                       | -0.0000000E-194                         | -0.0000000000000000                     | -0.00000000E-19,                        | -0.00000000-19.                         | -0.0000000E-19.                         |
|                                       | -0.0000000000-10,                       | -0.00000000E-14,                        | 0.0000000000000                         | 0.0000000000000000000000000000000000000 | -0.000000000000000000000000000000000000 |
|                                       | -0.00000000000000                       | -0.000000000000000                      | -0.00000000 19,                         | -0.000000000000000000000000000000000000 | -0.000000000-19                         |
|                                       | -0.000000005-19                         | -0.000000000E-10                        | -0.000000000000000000000000000000000000 | -0.0000000000000000                     | -0.000000000000000000000000000000000000 |
|                                       | -0.000000000-19                         | -0.000000000000000000000000000000000000 | -0.00000000-197                         | -0.000000000000000000000000000000000000 | -0.000000000-194                        |
|                                       | -0.000000000-19-                        | -0.0000000E-19-                         | -0.0000000E-19-                         | -0.00000000E-19-                        | -0.0000000E-19-                         |
|                                       | -0-000000000-19-                        |                                         |                                         | 0.0000000000000000000000000000000000000 | 0-00000000 -10-                         |
|                                       | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.00000000F-19.                        | -0.00000000E-19.                        | -0.0000000F-19.                         |
|                                       | -0.0000000F-19.                         | -0-0000000F-19x                         | -0-00000000-19                          | -0-00000007-13                          |                                         |
|                                       | -0.0000000E-19.                         | -0.0000000F-19.                         | -0.0000000E-19.                         | -0.0000000F-19.                         | -0.00000000E-19.                        |
|                                       | -0.0000000E-19                          | 0.0000000C-19.                          | -0.00000000E-19.                        |                                         | 0.0000000000000                         |
|                                       | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.00000000E-19,                        | -0.0000000E-19,                         | -0.0000000E-19.                         |
|                                       | -0.0000000E-19;                         | -0.0000000E-19,                         | ~0.0000000E-19                          |                                         | 0.0000000E 19,                          |
|                                       | -0.0000000E-19,                         | -0.0000000E-19,                         | -0-00000000E-19,                        | -0.0000000E-19,                         | -0.0000000E-19,                         |
|                                       | -0-000000002-17;                        | -0:0000000E-19,                         | -0-00000000E-19,                        | -0:00000000E-19;                        |                                         |
| - HTRI                                | -0-127500005-03-                        | 0-10000005-03                           |                                         | 0.131(00005 03-                         | 8.131700005 03-                         |
|                                       | 0-13200000F 03-                         | 0-13220000E 03-                         | 0-13250000E 03-                         | 0-13270000E 03-                         | 0.13290000E 03.                         |
|                                       | 0.133000005 03                          |                                         | 0-13300000F 03-                         | 0-13280000F 03                          |                                         |
|                                       | 0.131400005 03.                         | 0.12990000E 03.                         | 0-128000005 03.                         | 0+12640000F 03+                         | 0.12280000E 03.                         |
|                                       |                                         |                                         |                                         |                                         |                                         |

|          |                                         |                                         | 0-985000008-02+                         | 0-89460090E 02.   |                                         |
|----------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-------------------|-----------------------------------------|
|          | 0.72500000E 02.                         | 0.64700000E 02.                         | 0.57400000E 02,                         | 0.50500000E 02.   | 0.4410000E 02.                          |
|          |                                         | 0.327000000-02.                         | 0.276090000-02-                         | 0.23100000F-02,   | - 0.19000006 02, -                      |
|          | 0.15300000E 02.                         | 0.12900000E 02,                         | 0.10800000E 02,                         | 0.89000000E 01,   | 0.72000000E 01.                         |
|          |                                         | 0.470000005 01.                         |                                         |                   |                                         |
|          | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.00000000E-19,  | -0.0000000E-19,                         |
|          |                                         | -0.0000000E-197-                        | -0.000000000-19                         |                   |                                         |
|          | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.00000000E-19,                        | -0.0000000E-19,   | -0.00000005-19,                         |
|          |                                         |                                         |                                         | -0.00000000E-19,  |                                         |
|          | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.000000002-19,                        | -0.00000000E-19,  | -0.0000000E-19,                         |
|          | -0.0000000E-19-                         | 0.0000000E 191                          |                                         |                   | 0,n00n000nE_19,                         |
|          | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.00000000E-19;                        | -0.00000000E-19,  | -0.0000000E-19,                         |
|          |                                         |                                         | 0+000000000-19-                         | -0.0000000E 17,   |                                         |
|          | -0.00000008-19.                         | -0.0000000F-19.                         | -0.00000000E-19,                        | -0.0000000E-19;   | -0.0000000E-19,                         |
|          |                                         |                                         | -0+00000000E-19                         | -0.00000000E-19,  |                                         |
|          | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.00000000E-19,  | -0.00000000E-19.                        |
| <u> </u> |                                         |                                         | 0.0000000E-17,                          | -0-000000000-1-9- | -9-00000000E-19-                        |
|          | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.00000000E-19,  | -0.00000000E-19+                        |
|          | -0.0000000E-17                          | 0.000000000-19,                         | 0+00000000E-19                          |                   |                                         |
|          | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.00000000E-19,                        | -0.000000002-19,  | -0.00000000E-19.                        |
|          |                                         |                                         |                                         | 0.0000000E-19,    |                                         |
|          | -0.0000000E-19.                         | -0.00000008-19.                         | -0.00000000E-19,                        | -0.00000000E-19,  | -0.0000000E-19,                         |
|          | -0-00000000-19                          |                                         |                                         |                   |                                         |
|          | -0.0000000E-19.                         | -0.0000000E-19.                         | -0,0000000E-19,                         | -0.0000000E-19,   | -0.00000000E-19,                        |
|          |                                         |                                         | -0.00000000 17.                         |                   | -0.00100008-11.                         |
|          | -0.0000000E-19.                         | -0.0000000E-19;                         | -0.0000000E-19,                         | -0.00000000E-19,  | -0.0000000E-19.                         |
| RTBL =   | 0.0000000000-38,                        | 0.000000000000.38,                      | 0.0000000E-38,                          | 0.0000000E-38,    | 0.00000000E-38,                         |
|          |                                         |                                         |                                         |                   | 0-0000000F-38                           |
|          | 0.000000000-38.                         | 0.0000000E-38.                          | 0.0000000000000                         | 0.000000008-38,   | 0.0000000E-38.                          |
|          |                                         |                                         | 0+0000000E-38+                          | 0.000000E 38.     |                                         |
|          | 0.00000008-38-                          | 0.0000000E-38+                          | 0.0000000E-38,                          | 0.0000000E-38,    | 0.000000002-38.                         |
|          |                                         | 0+000000000-38+                         | 0,0000000E-38,                          |                   |                                         |
|          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.00000002-38.                          | 0.0000000000000   | 0.00000000-38,                          |
|          |                                         |                                         | 0-0000000E-39                           | 0.0000000038,     |                                         |
|          | 0.00000000000000,                       | 0.0000000E-38.                          | 0.0000000E-38,                          | 0.000000000-38,   | 0.0000000E-38,                          |
|          |                                         | -0.000000000-19,                        |                                         |                   |                                         |
|          | -0.0000000E-19,                         | -0.000000000-19,                        | -0.00000000E-19,                        | -0.0000000E-19,   | -0.000000000000000000000000000000000000 |
|          |                                         | -0.0000000E-19,                         |                                         | 0,000000000000000 |                                         |
|          | -0.0000000E-19.                         | -0.000000000-19.                        | -0.00000000E-19,                        | -0.000000000-19,  | -0.00000000000000                       |
|          | -0-00000000E-19,                        | -0-00000000-194                         | -0.0000000E-17;                         | -0.00000000000000 | 0,0000000000000000000000000000000000000 |
|          | -0.0000000E-19.                         | -0.0000000000-19,                       | -0.00000000E-14,                        | -0.000000002=19,  | -0.000000000000000000000000000000000000 |
|          | -0.00000000 <u>0</u> -19,               | -0.00000000E-19,                        | 010000000E-197                          |                   | 0.00000000000000                        |
|          | -0.0000000E-19,                         | -0.000000000000000000000000000000000000 | -0.0000000E-14                          | -0.00000000E-19;  | -0.00000000000000                       |
|          | -0.000000E-191                          | -0.00000000-199                         | 0.0000000000000000000000000000000000000 | 0.00000000E-10    | -0.000000000000                         |
|          | -0.000000000000                         | -0.000000000000000000000000000000000000 | -0.000000000-17                         | -010000000E-19    | -0.00000000E-19                         |
|          | -0.0000000000000                        | -0.00000000000000                       | -0.000000000000000000000000000000000000 | -0.0000000E-19-   | -0.0000000E-19.                         |
|          | -0.000000000000000                      | -0.00000000000000                       | 0-000000000-10-                         | -0-0000000E-19    |                                         |
|          | -0.00000000000000                       | -0.000000000000000000000000000000000000 | ~0.00000000000000                       | -0.0000000E-19-   | -0.0000000E-19.                         |
|          | -0.000000000000000000000000000000000000 | -0.000000000000000000000000000000000000 |                                         |                   | -0-00000000E-1.9                        |
|          | -0.0000000F-19.                         | -0.0000000E-19.                         | -0.00000000E-19.                        | -0.0000000E-19,   | -0.0000000F-19,                         |
|          | -0.00000000-19-                         |                                         | -0-00000000E-19-                        | 0.0000000E-19,    | -0-0000000E-19-                         |
|          | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.   | -0.0000000E-19,                         |
|          | -0:0000000E-19-                         | -0.0000000E-19                          | 0+00000000E-19,                         | -0.0000000E 19.   |                                         |
|          | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E=19,   | -0.0000000F-19,                         |
|          | -0.0000000E-19;                         | -0.00000000E-19.                        | -0+000000000 19+                        |                   | -0.0000000E-19.                         |
|          |                                         |                                         | 0.15300000 01-                          | 0.10000005-01-    | 0.00000000 38.                          |
| Lan -    | 0-000000000-38.                         | 0.000000005-38.                         | 5                                       | 5110000000 011    |                                         |
|          |                                         |                                         |                                         |                   |                                         |

-0-00000000E-38--

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0+0000000E-38+ 0+0000000E-38+

| TUKD    | - | 0.00000000E-38.  |
|---------|---|------------------|
| OCHULT  |   | 0.76000000E 00,  |
| ORMUL T | - | 0.10000000E 01,  |
| KHS     |   | 0.580000002-01.  |
| TTRANS  | - | 0.100000CCE 04,  |
| RHOHS   | - | 0.39400000F 02.  |
| CPHS    | - | 0.440000G0E 00,  |
| XN      | - | 0.800000CE 00,   |
| xo      | - | 0.0000000000-38. |
| XA      | * | 0.0000000E-38,   |
| xc      | Ξ | 0,20000000E 00,  |
| KSTR    | = | 0+12500000E 03,  |
| WTB     | = | 0.16000000E 00,  |
| СРВ     | = | 0.25000000E 00.  |
| TSTOP   | * | 0.41160000E 03,  |
| КВ      | π | 0.101000000 00.  |
| RHOSTR  | - | 0.172000005 03,  |
| THSTR   | - | 0.10000000E 04,  |
| RHOB    | = | 0.3000000CE 02,  |
| HV18    | - | 0.10090000E 05,  |
| HV2R    | - | 0.0000000E-38,   |
| S END   |   |                  |

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364<

0.00000000E-38,

|                    | 00E-38                  | 651E 04 QTOTREO: - | 0 <del>=473946 02 CRMAX-</del> |                 | 4 <del>X= 0.25018E 03</del> |
|--------------------|-------------------------|--------------------|--------------------------------|-----------------|-----------------------------|
|                    | 10E CO NINERABL=O       | -17746E-03         |                                |                 |                             |
|                    |                         |                    |                                |                 |                             |
| NON-ABLA           | TING-CASE               |                    |                                |                 |                             |
| HADJ               | 61                      |                    | •                              |                 |                             |
| SLAD-NOT-EQUI      | LIBRATED AT END OF-PROB | :EH                |                                |                 |                             |
| TTRMAX= 0.81       | 248E-04 TSHAX- 0.1-     | +348E-04           | 7240E 03 ACTUAL-TS             | FOP0.41160E-03  |                             |
| WINS= 01459        | 7e-01 CORRECTED WIN     | 5                  | 0T= 0,12458E 01                |                 |                             |
|                    |                         |                    |                                |                 |                             |
| DATE               |                         |                    |                                |                 |                             |
| 5810- 5810         |                         |                    |                                |                 |                             |
|                    |                         |                    |                                |                 |                             |
|                    |                         |                    |                                |                 |                             |
| 3INPUI             |                         |                    |                                |                 |                             |
| UATE               | 0*514000005 01.         |                    | · · · · ·                      |                 |                             |
| *E*0               | 0.18400000E-03,         |                    |                                |                 |                             |
| CASE =             | 0.30000COE 01,          |                    | -                              |                 |                             |
| AHR -              | 0.100000000-01,         |                    |                                |                 |                             |
| TABL               | 0-3700008E 04+          |                    |                                |                 |                             |
| TREAR -            | 0.4000000E-03.          |                    |                                |                 |                             |
| <del>TEMP1 -</del> |                         |                    |                                |                 | ·                           |
| EHIS               | 0.7600000E-00.          |                    |                                |                 |                             |
| TSTART -           |                         |                    |                                |                 |                             |
| BTI                |                         |                    |                                |                 |                             |
| T9:1               |                         |                    | 0.50000005-02-                 | 0               |                             |
| 18L1 ÷             | 0.6000000E-01.          | 0.15000000E-01.    | 0.70000000E-01,                | 0.26000000E-01; | 0.8000000E-01;              |
|                    | 0.12500000E 00.         | 0.18200000E 00.    | 0.17500000E-01                 | 0.27400000E 00. | 0.22500000E-01.             |
|                    | 0.357000005 00.         | 0.275000000 00.    | - 0.46500000E 00,              | 0.35000000E 00. |                             |
|                    | 0.400000000 00,         | 0.58400000E 00,    | 0.45000000E 00,                | 0+6300000DE 00+ | 0.50000000E 00,             |
|                    | 0.65000000E 00,         | 0.77400000E 00,    | 0.7000000E 00,                 | 0.80100000E 00, | 0.75000000E 00,             |
|                    | 0.82400000E-00,         |                    |                                | 0+85000008E 00+ |                             |
| ,                  | 0.90000008 00,          | 0.1000000E 01.     | 0.1000000E 01.                 | 0.50000002 03.  | 0.1000000E 01,              |
| TBL2 =             | 0.0000000E-38,          | 0.0000000E-38.     | 0.2500000E-02.                 | 0.5000000F-01,  | 0.1000000E-01.              |
|                    | 0.11400000E-00,         | 0.250000000-01-    |                                |                 |                             |
|                    | 0-420000000-00-         | -0+1-7500000F 00-  | 0.100000000 00;                |                 | 0+1350000000 00+            |
|                    | 0.25000000E 00.         | 0.56200000E 00,    | 0.30000000E 00.                | 0.61400000E 00. | 0.35000000E 00.             |
|                    | 0.6500000E 00.          |                    | 0+699000002-00+                |                 |                             |
|                    | 0.50000005 00.          | 0.76400000E 00.    | 0.55000000E 00,                | 0.79100000E 00, | 0.6000000E 00,              |
|                    | 0.75000005 00.          | 0.87400005 004     | 0.800000000 00.                | 0.888000005 00. | 0.90000000 000              |
|                    | -0:912000002-00,        | 0+10000000E 01,    |                                | 0.000000000-38  |                             |
| CPSTR =            | 0.3000000E-00,          |                    |                                | t               |                             |
| WTSTR =            | 0.52660000E-00;         |                    |                                |                 | · · · · · ·                 |
| #X11               | 0.50000008 02.          |                    | ·                              |                 |                             |
| EPSIL              | 0-5000000E-02           |                    |                                |                 |                             |
| FACTOR             | 0.1000000E 00.          |                    |                                |                 |                             |
| 7145               |                         |                    |                                |                 | 0                           |
|                    | 0.11411000E 03-         | 0.12204000E 03-    | 0.13015000E 03-                | 0.13841000E 03- | 0.146830000 03.             |
|                    |                         | 0.164260008 03,    |                                | 0.102600000 03. |                             |
|                    | 0.201940D0E 03,         | 0.21211000E 03,    | 0.22142000E 03.                | 0.22950000E 03, | 0.23671000E 03,             |
|                    | 0.24349000E-03,         | 0.250180005-03,    | 0.256240000-03,                | 0.261310000-03. |                             |
|                    | 0.27019000E 03,         | 0.27435000E 03+    | 0.27841000E 03,                | 0.28247000E 03. | 0.289950005 03*             |

|       |                                         | 0.29542000E 03:                         | 0-300240008-03,- | 0+30547000E-03+                     |                                         |
|-------|-----------------------------------------|-----------------------------------------|------------------|-------------------------------------|-----------------------------------------|
|       | 0.31780000E 03,                         | 0.323330000 03.                         | 0.32962000E 03,  | 0.33692000E 03,                     | 0.34561000E 03,                         |
|       | 0,35633000E-03,                         |                                         |                  | 0-42640000F 03,                     | 0.473000000 03.                         |
|       | 0.000000CE-38,                          | 0.000000008-38,                         | 0.0000000E-38,   | 0.000000000-38,                     | 0.00000000000000                        |
|       |                                         |                                         |                  | 0.0000000000000                     | 0.0000000000000                         |
| •     | 0.0000000E-38,                          | 0.0000000000-38+                        | 0.00000000-38    | 0.00000000000000                    | 0-000000005-38-                         |
|       | -0.0000000E-30,                         | 0.00000000000000                        | 0.000000000-38-  | 0.0000000000000                     | 0-0000000F-38-                          |
|       | 0.00000000-38,                          | 0.0000000000000                         | 0.0000000000000  | 0_00000000E=38                      | .0.000000005-38-                        |
|       |                                         | 0.000000000000000                       | 0-00000000-38+   | 0.0000000F-38.                      | 0.0000000F-38.                          |
|       | 0.000000000000                          |                                         | 0-0000000E-30    | 0,0000000E-38,                      |                                         |
|       | 0.0000000000000000000000000000000000000 | 0.00000008-38.                          | 0.00000000E-38.  | 0.0000000E-38.                      | 0.00000000000-38,                       |
|       |                                         |                                         |                  | 0,00000000C-39,                     |                                         |
|       | 0.00000008-38-                          | 0.0000000E-38,                          | 0.000000000-38,  | 0.000000000-38,                     | 0.0000000F-38,                          |
|       |                                         | 0+0000000E-38+                          | 0+00000000 38,   | 0.0000000E-38                       | 0-0000000E=38.                          |
|       | 0.0000000E-38.                          | 0.000000E-38.                           | 0.0000000E-38,   | 0.0000000E-38.                      | 0.000000002-38,                         |
|       |                                         |                                         |                  |                                     | 0.000000000-38                          |
|       | 0.00000008-38.                          | 0.0000000E-38,                          | 0.0000000E-38,   | 0.00000000000000                    | 0.0000000000000                         |
|       | 0.00000000-38.                          |                                         | 0.00000000000000 | 0.00000000000000                    | 0.000000005-38-                         |
|       | 0.000000E-38,                           | 0.00000000000000                        | 0.00000000000000 | 0.00000000000000                    | 0.000000005-38                          |
|       |                                         | 0.00000000000000                        | 0.000000000-38-  | 0.0000000F-38.                      | 0.0000000E-38.                          |
|       | 0.0000000E-38,                          | -0-000000000000000000000000000000000000 | 0.00000000-30    |                                     | 0.00000006-39.                          |
|       | 0.00000009E-38,                         | 0.00000000E-3A,                         | 0.0000000E-38.   | 0.0000000E-38,                      | 0.000000008-38,                         |
| (BL = | 0.100000000 00,                         | 0.10000000E 01,                         | 0.12000000E 01,  | 0.15000000E 01,                     | 0.1909000DE 01,                         |
|       |                                         | 0.28000000 01.                          |                  | 0,41000000E_01,                     | 0_s100000F_01,                          |
|       | 0.6200000E 01,                          | 0.7600000E 01,                          | 0.94000000E 01,  | 0.11400000E 02,                     | 0.14100000E 02.                         |
|       | 0.1680000E 02.                          | 0.203000005 02,                         |                  |                                     |                                         |
|       | 0.29400000E 02,                         | 0.30400000E 02,                         | 0.28700000E 02,  | 0.264000000 02.                     | 0.112000002 021                         |
|       |                                         |                                         | 0.580000005-024  | 0.44000000E 01-                     | 0.32000000E 01.                         |
|       | 0.9200000E 01,                          | 0.740000000 011                         | 0.130000000 011  | 0.000000E_00                        | 0.600000005-00                          |
|       | 0.23000000000000                        | 0 20000000E 00.                         | 0.10000000 01    | 0-0000000F-38-                      | 0.000000008-38.                         |
|       | 0.300000000000000                       |                                         | -0.00000000-19   |                                     | -0.0000000E 19                          |
|       | -0.000000000000                         | -0.000000000-19.                        | -0.0000000E-19.  | -0.0000000F-19.                     | -0.0000000E-19,                         |
|       |                                         | -0-00000000019-                         |                  |                                     |                                         |
|       | -0.0000000E-19.                         | -0.00000000E-19,                        | -0.0000000E-19.  | -0.00000000E-19+                    | -0.0000000E-19,                         |
|       | -0.0000000CE-19.                        |                                         |                  | - 910000000E-191                    |                                         |
|       | -0.00000008-19,                         | -0.0000000E-19.                         | -0.0000000E-19.  | -0.0000000E-19.                     | -0.00000008-19,                         |
|       | -3:0000000E-19;                         |                                         |                  | -0-00000000E-19+                    | -0.00000000-14                          |
|       | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.  | -0.00000000E-19,                    | -0.000000000000000000000000000000000000 |
|       | -0+00000000000-19+                      |                                         | -0.00000000E-195 | -020000000000000                    | -0.000000000000000000000000000000000000 |
|       | -0.0000000F-19.                         | -0,00000000000-19,                      | -0.000000000-19. |                                     | -0-000000000 19-                        |
|       | -0-000000000000-194                     | -0.00000000E-19                         | -0.00000000000   | -0.0000000E=19.                     | -0.0000000E-19.                         |
|       | -0.00000000-19;                         | -0.00000000-197                         | -0.00000000000   |                                     |                                         |
|       | -0.00000000=19,                         | =0.00000000E=19;                        | -0.0000000E-19   | -0.0000000E-19.                     | -0.00000000E-19.                        |
|       | -0.000000000000000000000000000000000000 |                                         |                  | -0-0000000E 19                      | 0,000000F-19,                           |
|       | -0.0000000F-19.                         | -0.0000000E-19                          | -0.0000000E-19.  | -0.0000000E-19.                     | -D.00000000E-19,                        |
|       | -0.00000000E-17                         | 0.00000000E-19                          | -0.0000000E-19,  | -0-00000000E-19-                    |                                         |
|       | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.  | -0.0000000E-19,                     | -0.0000000E-19,                         |
|       | -3-0000000F-19-                         | -0.00000000 -19                         | -0+00000000E-19+ | 0:00000000E-19.                     |                                         |
|       | -0.00000000E-19.                        | -0.0000000E-19.                         | -0.00000000E-19, | -0.00000000E-19,<br>-0.0000000F-19, | -0.00000000F=19;<br>0.00000000E=19;     |
|       |                                         |                                         | 0.131100005 03.  | 0-1-1140000F 01-                    |                                         |
| 182   | 011275000012 031                        | 0 132200005 03                          | 0.132500006 03   | 0.13270000E 03-                     | 0.13290000F 03.                         |
|       | 0.132000000-03,                         | 0+13220000E 03;                         | 0.13200000 03;   | -13280000E 034                      |                                         |
|       | 0 121600005 03                          | 0.12000000 03.                          | 0.12800000E 03.  | 0.12640000E 03.                     | 0.12280000E 03,                         |
|       | U.13140000C U34                         | V#16770000C 031                         | 0+12000000 dD1   |                                     |                                         |

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| 00006-02  |                                        | <u>0_0000000000000000000000000000000</u>                                               |                                                                                                                                                                                      |
|-----------|----------------------------------------|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DODDE 02. | 0.574000000 02.                        | 0.505000000 02.                                                                        | 0.4410000DE 02.                                                                                                                                                                      |
| 00005 02  | 0.276000005-02                         | 0-231000005-02-                                                                        | 0.1900000E 02.                                                                                                                                                                       |
| 00006 02, | 0.10800000E 02.                        | 0.8900000F 01.                                                                         | 0.72000000E 01.                                                                                                                                                                      |
| 00005 01  | 0-3900000E 01-                         | -0.37000000F 01                                                                        | 0.40090000E-01.                                                                                                                                                                      |
| 00006-19  | -0.000000005-19.                       | =0.0000000E-19.                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| 0000C 190 | 0.0000000000000                        | -0.00000000 19                                                                         |                                                                                                                                                                                      |
| 00005-19. | -0.00000000E-19.                       | -0.0000000F-19.                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| 00000.10  | 0.000000000 10                         | -0-000000E-10-                                                                         | -0.00000006-19.                                                                                                                                                                      |
| 00000-19  | =0.00000000E=19.                       | =0.0000000E=19.                                                                        | -0.00000000E-19.                                                                                                                                                                     |
| 00005-10  | 0.00000000 19                          |                                                                                        | -0-0000000E-19.                                                                                                                                                                      |
| 00005-19. | ~0.00000000F~19.                       | -0.00000000F-19.                                                                       | -0.0000000E-19.                                                                                                                                                                      |
| 00005-19  |                                        | -0-00000000E-1-9-                                                                      | -0.00000006-19,                                                                                                                                                                      |
| 00005-19. | -0.0000000E-19.                        | -0.0000000F-19.                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| 0000E-10  | 0-00000005-10                          | -0-0000000F-19-                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| 00005-19- | -0-00000000E-19.                       | -0.0000000F-19.                                                                        | -0.00000000E-19.                                                                                                                                                                     |
| 00005-19- | 0.00000005-19                          |                                                                                        |                                                                                                                                                                                      |
| 00005-10. | -0.0000000E=19-                        | -0-0000000E-19.                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| 00005-10  | 0-00000005-19-                         | 0.00000005-19                                                                          | -0-0000000F-19-                                                                                                                                                                      |
| 0000E-19  | -0.00000000E=19-                       | -0.0000000E-19-                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| DODDE-10  |                                        | 0.00000000-19                                                                          | -0-000000005-19                                                                                                                                                                      |
| 0000E=19. | -0-00000000E-19-                       | -0.0000000F-19.                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| 00000 10  |                                        | -0-00000000-19                                                                         | -0-0000000F-19                                                                                                                                                                       |
| 00006-19  | -0.00000000E-19.                       | -0.0000000E-19.                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| 00000 10  |                                        | 0.000000E-19                                                                           | -0.000000000-19                                                                                                                                                                      |
| 0000E-19- | -0-0000000F-19-                        | -0.0000000E-19.                                                                        | -0.0000000E-19.                                                                                                                                                                      |
|           |                                        |                                                                                        |                                                                                                                                                                                      |
| 0000E-38. | 0.0000000E-38+                         | 0.0000000E-38.                                                                         | 0.0000000E-38.                                                                                                                                                                       |
| 0000E 38  |                                        | -0+0000000E-38+                                                                        | 0-00000000E-38-                                                                                                                                                                      |
| 0000E-38. | 0.000000000000-38,                     | 0.0000000E-38,                                                                         | 0.000000000-38,                                                                                                                                                                      |
| 00005 38  |                                        |                                                                                        |                                                                                                                                                                                      |
| 0000E-38. | 0.0000000E-38,                         | 0+00000008-38+                                                                         | 0.0000000E-38,                                                                                                                                                                       |
| 0000E-38  |                                        |                                                                                        | 0.000000F=38,                                                                                                                                                                        |
| 0000E-38, | 0.0000000E-38,                         | 0.0000000E-38.                                                                         | 0.0000000E-38.                                                                                                                                                                       |
| 0000E 38  |                                        |                                                                                        |                                                                                                                                                                                      |
| 0000E-38, | 0.0000000E-38,                         | 0.0000000E-38,                                                                         | 0.0000000E-38.                                                                                                                                                                       |
| 0000E 17  |                                        | -0.0000000E-19.                                                                        |                                                                                                                                                                                      |
| 0000E-19, | -0.00000000E-19,                       | -0.0000000E-19,                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| 0000C 17  | -0.0000000E-19,                        | -0.00000000E-1-9                                                                       | -0.00000000E-1-9.                                                                                                                                                                    |
| 0000E-19- | -0.00000000E-19.                       | -0.00000000E-19.                                                                       | -0.0000000F-19,                                                                                                                                                                      |
| 0000E-19  | 0.00000000E-19,                        |                                                                                        |                                                                                                                                                                                      |
| 0000E-19. | -0.00000000E-19.                       | -0.0000000E-19,                                                                        | -0.0000000F-19.                                                                                                                                                                      |
| 0000E-19  |                                        | -0+0000000E 19-                                                                        | 0.0000000E-19.                                                                                                                                                                       |
| 0000E-19. | -0.00000000E-19.                       | -0.0000000E-19.                                                                        | -0.00000000E-19,                                                                                                                                                                     |
| 0000E 19  |                                        | -0.0000000E 19,                                                                        | 0.0000000E-19,                                                                                                                                                                       |
| 0000E-19. | -0.00000000E-19.                       | ~0,0000000E-19,                                                                        | -0.0000000000-19,                                                                                                                                                                    |
| 0000E-19  |                                        | -0-00000000F-19,                                                                       |                                                                                                                                                                                      |
| 0000E-19. | -0.0000000E-19.                        | -0.0000000E-19.                                                                        | -0,0000000E-19,                                                                                                                                                                      |
| 0000E-19  |                                        |                                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| 0000E-19. | -0.00000000E-19.                       | -0.0000000E-19.                                                                        | -0.0000000E-19,                                                                                                                                                                      |
| 0000E-19- | -0-00000000E-19-                       | -0-0000000E-197                                                                        | -0.0000000E-19,-                                                                                                                                                                     |
| 0000E-19- | -0.00000000E-19-                       | -0.0000000E-19.                                                                        | -0.0000000E-19.                                                                                                                                                                      |
| 0000E-19- |                                        | -0.0000000E-19-                                                                        | -0.00000000-19                                                                                                                                                                       |
| 0000E-19. | -0.00000000E-19.                       | -0.00000000E-19,                                                                       | -0.0000000E-19,                                                                                                                                                                      |
| 00006 19  | 0.0000000E-19.                         |                                                                                        |                                                                                                                                                                                      |
| 0000E-19. | -0.000000008-19.                       | -0.0000000E-19.                                                                        | -0.0000000E-19.                                                                                                                                                                      |
|           |                                        |                                                                                        | -0.0000000E-17.                                                                                                                                                                      |
| 0         | 00000E-19,<br>00000E-19,<br>00000E-19, | 00000E-19, -0.00000000E-19,<br>00000E-19, -0.0000000E-19,<br>00000E-19, 0.0000000E-19, | 00000E-19, -0.0000000E-19, -0.0000000E-19,<br>00000E-19, -0.0000000E-19, -0.0000000E-19,<br>00000E-19, -0.0000000E-19, -0.0000000E-19,<br>00000E-19, -0.0000000E-19, -0.0000000E-19, |

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| <br>0.10000000E 01 | -0.23900000E 04, | -0.153000000-01. | -0+10000000C 01+0+00000000C 38+ |
|--------------------|------------------|------------------|---------------------------------|
| <br>               |                  |                  |                                 |

| TURB     | 0.00000000E-38, | 0.0000000E-38, | 0=00000000000000-38,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0+000000000-38+ | 0+0000000F~38+ |
|----------|-----------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------|
| OCHULT = | 0.35400000E 00; |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| QRMULT = | 0.1000000E 01,  |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| КН\$ =   | 0.5800000E-01.  |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| TTRANS = | 0.10000000E 04, |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| RHOHS =  | 0.39400000E 02+ |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| CPHS =   | 0.44000000E 00. |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| XN =     | 0.8000000E 00,  |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| x0 =     | 0.0000000E-38,  |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| ×A =     | 0.00000008-38,  |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| xc =     | 0.200000CCE 00, |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| KSTR =   | 0.12500000E 03. |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| WT8 =    | 0.16000000E 00+ |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| CPB =    | 0.25000000E 00, |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| TSTOP =  | 0.41160000E 03, |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| КВ ==    | 0.1000000E 00,  |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| RHDSTR = | 0.17200000E 03, |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| THSTR =  | 0.10000000E 04, |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| ,RH08 =  | 0.300000078 02. |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| HVIR =   | 0.1C000000E 05. |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
| HV2R =   | 0.000000000-38. |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                |
|          |                 |                | and a second sec |                 |                |

\$ END

| NON-ABEA       | TING CASE                |                     |                   |                                       |                 |
|----------------|--------------------------|---------------------|-------------------|---------------------------------------|-----------------|
| HADJ 72+1      | <u>41</u>                |                     | ···.              |                                       |                 |
| CLAR NOT-FOUL  | 1.1.00 AT-FNO-OF-000     | u.FM                |                   |                                       |                 |
| JEAN AD1-1 VOI | erekareo an eno en -proc |                     |                   |                                       |                 |
| -T-TRMAX=0x-33 | 761F-04T5HAX=0;1         | 0658E-04            | 39596-03AGTUAL TS | +3P=-0+41150E 03                      |                 |
|                | 2C-01 CORRECTED-WIN      | 15= 0,92142E-00- WT | OT= 0-10814E-01   |                                       |                 |
| -DATE=         |                          |                     | •                 |                                       |                 |
|                |                          |                     |                   |                                       |                 |
| SINPUT         |                          |                     |                   |                                       |                 |
| -BATE -        |                          |                     |                   |                                       |                 |
| - <u></u>      | -0-18400000E 03,         |                     | ·                 | • • • • •                             | _               |
|                | 0.4000000E-01;           |                     |                   |                                       |                 |
| - AllR         | 0:100000000 01,          |                     | =.                |                                       |                 |
|                |                          |                     |                   |                                       |                 |
| TREAR          | 0:40000000 03,           | ·                   |                   |                                       |                 |
| TCHPI          | 0.1000000C 03,           |                     |                   | a                                     |                 |
| -6415          |                          |                     |                   | · · · · · · · · · · · · · · · · · · · |                 |
| -TSTART        |                          |                     |                   |                                       |                 |
| -DT-I          |                          |                     |                   |                                       | ····            |
|                |                          |                     | 0.50000000-02.    | 0+5000000000-01+                      |                 |
|                | 0.600C0000E-01,          | 0.15000000E-01,     | 0.7000000E-01.    | 0.26000000E-01,                       | 0.8000000E-01.  |
|                | 0.3900000E-01.           | 0.900000066-01.     | 0.5100000E-01,    | 0.100000000-00,                       |                 |
|                | 0.125000002 00.          |                     | 0.17500000E 00.   |                                       |                 |
|                | 0.400000005 00.          | 0.58400000E 00.     | 0.45000000E 00.   | 0.63000000E 00.                       | 0.500000B0E 00. |
|                | 0-67400000E-00           | 0.55000000 00.      | 0.7130000E 00,    | 0.6000000E 00                         |                 |
|                | 0.65000000E 00,          | 0.77400000E 00.     | 0.7000000E 00.    | 0.80100000E 00,                       | 0.75000000E 00. |
|                | 0.9000000E 00.           | 0.10000000E 01,     | 0.10000000E 01,   | 0.5000000E 03,                        | 0.10000000E 01. |
| TBL2 =         | 0.00000005-38,           | 0.0000000F-38,      | 0.25000000E-02,   | 0.5000000E-01,                        | 0.1000000E-01,  |
|                |                          |                     | 0.100000000000    | 0*5000000E-01,                        |                 |
|                |                          | 0-175000000 001     |                   | 0+3500000000 001                      | -0-5060000E 00- |
|                | 0.250000000 00,          | 0.56200000E CO,     | 0.3000000E 00,    | 0.61400000E 00;                       | 0.35000000E 00, |
|                | -0.6500000E 00,          | 0.40000000 00.      |                   |                                       | 0.73300000E 00, |
|                | 0.500000000 00,          | 0.16400000E 00.     | 0.5500000E 00.    | 0.7910000E 00.                        | 0.6000000E 00.  |
|                | 0.75000000E 00.          | 0.874000005 00.     | 0.8000000E 00.    | 0.88800000F 00.                       | 0.9000000E 00.  |
|                | 0.91200000E-00.          | 0-1000000E 01-      |                   |                                       |                 |
| CPSTR          | 0.9000000E-00.           | ·                   |                   |                                       |                 |
| WTSTR -        |                          |                     |                   | · · · · · · · · · · · · · · · · · · · |                 |
| -HX11          | 0:5000000E-02+           |                     |                   |                                       |                 |
| -EPSIL         | 0.50000000-02,           |                     |                   |                                       |                 |
| - FACTOR       |                          |                     |                   |                                       |                 |
| -T1HE          | 0.000000E-39.            | 0.835900905 02.     | 0-91010000E 02+   | 0+99590000E 02+                       |                 |
|                | 0.11411000E 03,          | 0.12204000F 03,     | 0.130150008 03,   | 0.13841000E 03.                       | 0.14683000E-03. |
|                | 7:1-5543000E 03,         | 0:16426000E-037     |                   |                                       |                 |
|                | 0.20194000E 03,          | 0.21211000E 03.     | 0.22142000E 03.   | 0.22950000E 03;                       |                 |
|                | 0.27019000E 03,          | 0.27435000E 03.     | 0-27841000E 03.   | 0.28247000E 03.                       | 0.28662000E 03. |

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|             | -0.29091000E 03.                        |                                         | 0-300240008-03-                         |                                         |                                                                                                                 |
|-------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------|
|             | 0.31780000E 03,                         | 0.32333000E 03.                         | 0.32962000E 03,                         | 0.33692000E 03,                         | 0.34561000E 03,                                                                                                 |
| <del></del> | 0.35633086E 03                          | - 0.37026000E 03.                       | -0.38941000E-03,                        | 0+42640000E-03+                         | 0_47300000E_03,                                                                                                 |
|             | 0.00000006-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0:00000008-38,                                                                                                  |
|             | 0.0000000E 38,                          | 0.0000000E-38v                          | 0.0000000E-38.                          |                                         |                                                                                                                 |
|             | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.000000000-38,                         | 0.0000000E-38.                          | 0.0000000E-38.                                                                                                  |
|             |                                         |                                         | 0.00000000-30                           |                                         | 0+00000000-38,                                                                                                  |
|             | 0.000000E-38,                           | 0.00000002-38,                          | 0.0000000E-38+                          | 0.0000000E-38,                          | 0.0000000000000000000000000000000000000                                                                         |
|             |                                         | 0,0000000L-30,                          | 0.00000000 30,                          | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000                                                                         |
|             | 0.0000000E-38,                          | 0.000000002-38,                         | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000                                                                         |
|             |                                         | 0.0000000L-381                          | 0.00000000-30,                          | 0100000000-30                           | 0.0000000000000000000000000000000000000                                                                         |
|             | 0.0000008-38.                           | 0.0000000E-38,                          | 0.0000000E=38,                          | 0.00000000000000                        | 0.000000000-38                                                                                                  |
|             | 0.00000000-38,                          | 0.00000000-98,                          | 0,0000000000000000000000000000000000000 | 0.0000000000000                         | 0.000000005-38                                                                                                  |
|             | 0.00000002-38,                          | 0.0000000000000                         | 0.0000000000000000000000000000000000000 | 0.000000002-384                         | 0.00000005-38                                                                                                   |
|             | -0+00000000-30+                         |                                         | 0.0000000000000                         | 0.00000000000000                        | 0.000000005-38                                                                                                  |
|             | 0.0000000000000000000000000000000000000 | 0.00000000000000                        | 0.0000000000000000000000000000000000000 | 0.000000000000000                       | 0.000000000000                                                                                                  |
|             | 0.00000000000000                        | 0.0000000000000000000000000000000000000 | 0.000000005-38                          | 0.000000000000                          | 0.0000000E=38.                                                                                                  |
|             | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 | 0.00000000000000                        | 0.000000000000                          | 0.000000000-38                                                                                                  |
|             | 0.00000000.38,                          | 0.000000000000000                       | 0.0000000000000                         | 0.000000000000                          | 0.0000000000000                                                                                                 |
|             | 0.0000000000000000                      | 0.00000002-38,                          | 0.00000002-38                           | 0-000000000-30                          | 0-000000005-38                                                                                                  |
|             | 0.000000005-38                          | 0.000000005-38                          | 0-0000000E=38-                          | 0.0000000E-38.                          | 0.0000000E-38.                                                                                                  |
|             | 0.00000000000                           |                                         |                                         | 0-00000005 30-                          | 0.0000000E-38                                                                                                   |
|             | 0.0000000E=38.                          | 0.00000000E=38-                         | 0.00000000-38.                          | 0.000000005-38.                         | 0.0000000E-38.                                                                                                  |
|             | 010000002-507                           | 0.0000000000000000000000000000000000000 |                                         |                                         |                                                                                                                 |
| 0791 -      | 1 0.1000000E 00.                        | 0.1000000E 01.                          | 0.1200000F 01.                          | 0.15000000E 01.                         | 0.1900000E 01.                                                                                                  |
| QIDE -      |                                         | 0.28000000F_01                          | 0.3400000E-01                           |                                         | 0.510000000 01,                                                                                                 |
|             | 0.62000000E 01.                         | 0.7600000E 01.                          | 0.94000000E 01.                         | 0.11400000E 02,                         | 0.14100000E 02.                                                                                                 |
|             |                                         |                                         |                                         | 0+27200000E 02+                         | 0.2830000E 02,                                                                                                  |
|             | 0.29400000E 02.                         | 0.30400000E 02.                         | 0.28700000E 02.                         | 0.26400000E 02,                         | 0.23800000€ 02.                                                                                                 |
|             |                                         | 0.18500000E 02                          | 0-15900000E-02.                         | 0.135000000 02,                         |                                                                                                                 |
|             | 0.9200000E 01.                          | 0.74000000E 01.                         | 0.58000000E 01,                         | 0.44000000E 01,                         | 0.32000000E 01,                                                                                                 |
|             |                                         |                                         | 0.120000000-01,                         | 0+0000000E 00+                          |                                                                                                                 |
|             | 0.3000000E 00,                          | 0.2000000E 00,                          | 0.1000000E 00.                          | 0.0000000E-38,                          | 0.0000000E-38.                                                                                                  |
|             | -0.0000000E-19;                         |                                         | -8.0000000E-19.                         |                                         |                                                                                                                 |
|             | -0.0000000E-19,                         | -0.0000000E-19;                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                                                                                                 |
|             | -0.00000002-19;                         |                                         | -0.00000000E-19;                        | -0.0000000E-19,                         | -0:0000000E-19;                                                                                                 |
|             | -0.0000000000-19,                       | -0.000000000-19.                        | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                                                                                                 |
|             | -0:0000000E-19;                         |                                         |                                         |                                         |                                                                                                                 |
| ,           | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.00000000E-19,                        | -0.0000000E-19;                         | -0.000000000-19,                                                                                                |
|             | -0:0000000E-19;                         |                                         | -0.000000000-19,                        |                                         |                                                                                                                 |
|             | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19.                         | -0.000000000-19,                        | -0.000000000000000000000000000000000000                                                                         |
|             | -0-0000000E-19,                         |                                         | -0.00000008-19,                         |                                         | -0.000000000000000000000000000000000000                                                                         |
|             | -0.0000000E=19,                         | -0.00000000E-19.                        | -0.000000002-19.                        | -0.000000000000000000000000000000000000 | -0.0000000000-19                                                                                                |
|             | -0.000000000-19                         | -0.000000000-19                         | -0.0000000000-19                        | -0.00000000000000                       | -0.000000005-19-                                                                                                |
|             | -0.0000000E=19,                         | -0.00000000-19.                         | -0.000000000-19,                        | -0.00000000E-191                        |                                                                                                                 |
|             | -0.00000002-19.                         | 0.0000000000000000000000000000000000000 | -0.0000000000-19,                       | -0.0000000000000                        | -0.0000000E=19.                                                                                                 |
| •           | -0.000000000-19,                        | -0.000000000-19;                        | -0.00000000000                          | -0:0000000E=197                         |                                                                                                                 |
|             | -0.000000000000000                      | -0.000000000-19                         | =0.0000000E=19.                         | -0-00000000F-19-                        | -0.0000000E-19.                                                                                                 |
|             | -0.00000002-19                          | - 00000000C 10                          | -0.000000000000000000000000000000000000 |                                         | -0-00000000E 19-                                                                                                |
|             | -0.000000005-19.                        | -0.0000000E-19.                         | -0.00000000E-19.                        | -0.0000000E-19.                         | -0.0000000000-19.                                                                                               |
|             | -0+0000000E-19                          |                                         | -0.0000000E-19                          |                                         |                                                                                                                 |
|             | -0-0000000E-19-                         | -0.00000000000000                       | -0.0000000E-19.                         | -0.00000000E-19.                        | -0.0000000E-19,                                                                                                 |
|             | -0.0000000E-19                          | -0-00000005-19-                         | -0-0000000E-19                          | -0-0000000E-19                          | -0.00000000 17,                                                                                                 |
|             |                                         |                                         |                                         |                                         |                                                                                                                 |
|             | 0.12750000E 03                          | 9.1309000E 03.                          | - 0.13110000£ 03,                       | -0-13140000E 03,                        | 0.131700000-03,                                                                                                 |
|             | 0.13200000E 03.                         | 0.132200000 03.                         | 0.13250000E 03.                         | 0.13270000E 03,                         | 0.13290000E 03.                                                                                                 |
| ·           | 0-133000002 03-                         | 0.133100008 03.                         | 0.133000000 03.                         | 0.132800000-03,                         | 0.132300008 03                                                                                                  |
|             | 0.131400005 03,                         | 0.12990000E 03,                         | 0.12800000E D3,                         | 0.12640000E 03,                         | 0.122800006 03.                                                                                                 |
|             |                                         |                                         |                                         |                                         | the second se |

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|        |                                         |                                         | 0-985000006-02                          | 0-89400000E-02-                         | 0.8070000E-02-                          |
|--------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
|        | 0.72500000F 02.                         | 0.64700000F 02.                         | 0.57400000F 02.                         | 0.5050000E 02.                          | 0.44100000E 02.                         |
|        |                                         | 0.327090005-02                          |                                         | 0.23100000E-02                          |                                         |
|        | 0.15300000E 02.                         | 0.12900000F 02.                         | 0.10800000E 02.                         | 0.8900000E 01.                          | 0.720000008 01.                         |
|        |                                         | 0.47000000E 01.                         | 0.3900000E 01, -                        | 0.37000000E-01,                         |                                         |
|        | -0.0000000E-19,                         | -0.00000000E-19.                        | -0.00000000E-19,                        | -0.0000000E-19.                         | -0.0000000E-19;                         |
|        | -0:0000000E-19;                         | -0.00000000E-19r                        |                                         |                                         | -0.0000000E-19,                         |
|        | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         |
|        |                                         |                                         |                                         | 0.0000000E-19,                          |                                         |
|        | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.00000000E~19,                        | -0.0000000E-19,                         |
|        | -0.00000000E-19,-                       | -0-00000000F-19                         | -0.0000000 <u>0</u> -19,                | 0:0000000E-19,                          | 0.0000000E-19.                          |
|        | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0:0000000E-19,                         |
|        | -0:0000000E-19;                         |                                         | 0.00000000E-19,                         | 0+0000000E-19+                          | -0-00000000E-19-                        |
|        | -0.0000000CE-19,                        | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19;                         |
|        |                                         |                                         |                                         | -0.00000000-19-                         | -0.0000000E-19-                         |
|        | -0.0C000000E-19,                        | -0.0000000E-19,                         | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19;                         |
|        |                                         |                                         | -0.0000000000000                        |                                         |                                         |
|        | -0.0000000F-19.                         | -0.00000000E-19,                        | -0.00000006-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         |
|        |                                         | -0.00000000001-19.                      | 0.000000000-19,                         | -0.0000000L 17,                         |                                         |
|        | -0.0000000E-19,                         | -0.000000000000000000000000000000000000 | -0.00000002-19,                         | -0.00000000E-19.                        | -0.000000000000000000000000000000000000 |
|        | -0.00000000000000                       |                                         | 0.00000000000000                        |                                         |                                         |
|        | -0.000000000000000000000000000000000000 | -0.000000000-10                         | -0.00000002-19,                         | -0.000000000-19,                        | -0.000000000000000000000000000000000000 |
|        |                                         | -0.00000000-19                          | 0.00000000000000                        | 0.00000000000000                        | 0.00000000000000                        |
|        | -0.0000000000000                        | =0.0000000F=19.                         | -0.000000000000000000000000000000000000 | -0.00000000000000                       | -0.0000000E-19;                         |
|        | -0.000000000000000000000000000000000000 | -0.000000005-10                         | -0.0000000000-10                        | -0.00000000000000                       | -0.000000000                            |
|        | -0.0000000E=14;                         | -010000000-191                          |                                         | 01000000000000                          |                                         |
| PTRt - | 0-000000E=38-                           | 0-00000006-38-                          | 0-000000005-38-                         | 0-00000005-38-                          | 0.000000000000                          |
|        |                                         |                                         | -0.00000000-30                          |                                         | 0-00000005-38-                          |
|        | 0.00000006-38.                          | 0.00000000000-38.                       | 0.000000002-38.                         | 0.0000000E-38.                          | 0.0000000CE-38.                         |
|        |                                         |                                         | 0.0000000E 30                           | 0.0000000E-38.                          | -0.0000000E-38                          |
|        | 0.0000000E-38.                          | 0.0000000E-38.                          | 0.0000000E-38.                          | 0.0000000E-38,                          | 0.0000000E-38.                          |
|        | 0.00000000-38.                          |                                         | 0.00000000E-38                          |                                         |                                         |
|        | 0.0000000E-38.                          | 0.0000000E-38.                          | 0,000000008-38,                         | 0.0000000E-38,                          | 0.0000000E-38,                          |
|        | 0.0000000E-38                           |                                         | 0.00000000:38,                          |                                         | 0.0000000E-38                           |
|        | 0.0000000E-38.                          | 0.0000000E-38,                          | 0.000000005-38.                         | 0.0000000E-38,                          | 0.00000000000000.38,                    |
|        | -0-0000000E-19-                         | -0:00000000E-19,                        | 0:0000000E-19                           | -0.0000000E-19,                         |                                         |
|        | -0.0000000E-19;                         | -0.0000000E-19,                         | -0.00000000E-19,                        | -0.0000000E-19.                         | -0.0000000E-19,                         |
|        | -0:00000000E-19                         |                                         |                                         | 0.0000000E-19y                          |                                         |
|        | -0.0000000E-19,                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.                         |
|        | -0.0000000E-19.                         |                                         | 0-000000000-19,                         | -0.000000002-19.                        | -0.0000000t 19-                         |
|        | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.00000002-19.                         |
|        | ~0.0000000E=19,                         |                                         | 0.0000000E-19.                          | 0.000000E-19.                           |                                         |
| _      | -0.000000000-19,                        | -0.0000000E-19.                         | -0.0000000E-14,                         | -0+000000000000000                      | -0.000000000000000000000000000000000000 |
|        | -0.00000000-197                         | 0.0000000000000000000000000000000000000 | -0.00000000 19,                         | 0.00000000000000                        | 0.000000000000                          |
|        | -0.0000000E-19,                         | -0.00000000E-19,                        | -0.000000002-194                        | -0.000000000-19                         | -0.000000000-19,                        |
|        | -0.0000000000000                        | -0.000000000-19                         | -0.000000000000000000000000000000000000 | -0.000000000000000000000000000000000000 | -0.0000000000000                        |
|        | -0.0000000000000                        | -0.00000000000000                       | -0.000000000000000000000000000000000000 | -0.000000002-14                         | -0.00000000000000                       |
|        | -0.00000005-19.                         | -0.000000005-19-                        | -0.000000006-19                         | -0.0000000E-19.                         | -0.0000000E-19-                         |
|        |                                         | 0.0000000000000000000000000000000000000 | -0.000000000000000000000000000000000000 | 000000000E_10                           | 00000000E-10                            |
|        | -0.0000000E-19-                         | -0.0000000F-19-                         | -0.0000000F-19-                         | -0.0000000E-19                          | -0-0000000E-19-                         |
|        | -0-00000000-19                          |                                         | 0.00000006-19                           |                                         |                                         |
|        | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.                         |
|        | -0.0000000E-19                          | 0-00000000E-19                          |                                         |                                         | -0.0000000C-12-                         |
|        | -0.0000000F-19.                         | -0.0000000E-19.                         | -0.00000000E-19.                        | -0.0000000E-19.                         | -0.0000000E-19.                         |
|        | -0-00000000E-19, - ·                    | -0-00000000E-19.                        | -0.00000000E 19,                        |                                         |                                         |
|        |                                         |                                         |                                         |                                         | -                                       |
| LAN =  | 0.100000000-01,                         |                                         | 0.15300000E 01;                         |                                         |                                         |
|        | 0.0000000E-38,                          | 0.0000000E-38.                          |                                         |                                         |                                         |

٠

| <del></del> | 2  | 0.0000000E-38,   |  |
|-------------|----|------------------|--|
| OCHUL T     | r  | 0.810000008-01,  |  |
| ORMULT      | -  | 0.100000C0E 01,  |  |
| кня         | -  | 0.580000000-01.  |  |
| TTRANS      | -  | 0.1000C000E 04,  |  |
| RHDHS       | ×  | 0.3940000CE 02.  |  |
| CPHS        |    | 0.440D000CF 00.  |  |
| XN          | -  | 0.800000CGF 00,  |  |
| xo          | -  | 0.0000C000E-38.  |  |
| XA          | -  | 0.000000005-38.  |  |
| xc          | =  | 0.2000000CE 00.  |  |
| KSTR        | =  | 0.1250000CE 03.  |  |
| WTB         | =  | n,1600000E 00,   |  |
| CPB         | =  | 0.25000COCE 00,  |  |
| TSTOP       | =  | 0.41160000E 03,  |  |
| К8          | -  | 0.1000000F 00,   |  |
| RHOSTR      | 11 | 0.17200000E 03.  |  |
| THSTR       | -  | 0.100°COOCE 04.  |  |
| RHPB        | ~  | 0.30000CC0E 02.  |  |
| HV1R        | -  | 0.100000000 05,  |  |
| HV2R        | =  | C+CPG000000E-38+ |  |
|             |    |                  |  |

HV2R = S END

.

|          | 0=00000E-98QC+0T=0=2<br>9=12110E-03HINGRABL= | 41418-03 ¥TOTREQ=<br>0+17746E 03-      | 0.47394E 02                            | 0+24624E 01                        | Aχ= 0+25018C 03                       |
|----------|----------------------------------------------|----------------------------------------|----------------------------------------|------------------------------------|---------------------------------------|
|          | ·····                                        | ······································ |                                        |                                    |                                       |
| NON      | -ABLATING-CASE                               |                                        |                                        |                                    |                                       |
| HADJ     | 72+161                                       |                                        | ·····                                  |                                    |                                       |
| THIS     | DID NOT CONVERGE IN 20 ITE                   | RATIONS , THE LAST VALU                | SARE AS FOLLOWS                        |                                    |                                       |
| TTRMAX=  | 0.52747E 03 TSMAX= 0.                        | 46960E 03 DTH= 0.3                     | S627E 03 ACTUAL TS                     | TOP= 0.41160E 03                   |                                       |
| WINS= 0  | 88799E 00 CORRECTED WI                       | NS= 0.33522E 00 H1                     | 0T= 0.49522E 00                        |                                    |                                       |
| DATE=    | 5 <del>,16 N</del> E <b>₩0+ 184_00</b> 6     | ≪SE~ 5+00 ····                         |                                        |                                    |                                       |
| \$TNPUT  |                                              |                                        |                                        |                                    |                                       |
|          | 0-516000005-01                               | · · · · · · · · · · · · · · · · · · ·  |                                        |                                    |                                       |
| - NFHO   | 0-184000000-02                               |                                        | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ |                                    |                                       |
|          |                                              |                                        |                                        |                                    | · · · · · · · · · · · · · · · · · · · |
| AND -    | 8-100000002-01                               |                                        |                                        |                                    |                                       |
|          | 0.220000005-01                               |                                        |                                        |                                    |                                       |
| TAUL -   | 0.91000002-04.                               |                                        |                                        |                                    |                                       |
|          | 0-4000000L 031                               |                                        |                                        |                                    | ·····                                 |
| (EU)     |                                              |                                        | · · · · · · · · · · · · · · · · · · ·  |                                    |                                       |
| -tais    | - 6,76000000E-00,                            |                                        |                                        |                                    |                                       |
| TSTART = | 0.0000000E-30,                               |                                        |                                        |                                    |                                       |
| DTI =    | 0+1000000C-00y                               |                                        |                                        |                                    |                                       |
| -T8L-1   | 0.6000000E-38.                               | 0-15000000E-38-                        | 0.7000000E-02.                         | 0.5000000E-01,                     |                                       |
|          | 0.39000006-01,                               |                                        |                                        | 0.10000000E-00,                    |                                       |
|          |                                              | 0.18200000E-00.                        | 0.17500000E 00,                        | 0.27400000E-00.                    | 0.22500000E 00;<br>0.52700000E-00;    |
|          | 0,400000000 00,                              | 0.58400000E 00.                        | 0.45000000E 00,                        | 0.6300000E 00,                     | 0.5000000E 00.                        |
|          | 0.65000000E 00,                              | 0.77400000E 00,                        | 0.70000000E 00.                        | 0.80100000E 00,                    | 0.75000000E 00.                       |
|          | 0-02400000E-00+                              | 0.8000000E-00y                         | 0.84500006E-00,                        | 0-8500000E-00-                     | 0.86300000E-00,                       |
|          | 0.90000002 00,                               | 0.1000000E 01,                         | 0.1000000E 01,                         | 0.5000000E 03.                     | 0.1000000E 01,                        |
| T8L2 ≈   | 0.00000008-38.                               | Q.0000000E-38.                         | 0.250000008-02,                        | 0.5000000E-01.                     | 0.100000008-01.                       |
|          | 0-6900000E-01-                               | 0.3000000E 00.                         | 0.1000000E 00.                         | 0.35000000E 00.                    |                                       |
|          | 0.420000005-00                               |                                        |                                        |                                    |                                       |
|          | 0.25000000E 00.                              | 0.5620000E 00.                         | 0.3000000E 00.                         | 0.61400000E 00,                    | 0.35000000E 00,                       |
|          | 9-5000000E 00-                               | 0.7640000000 00.                       | 0.55000000E 00.                        | 0.79100000E.00-                    | 9,73300000E-00,                       |
|          | 0.8160000E 00,                               | 0.6500000E 00.                         |                                        |                                    |                                       |
|          | 0.75000000E 00.                              | 0.87400000E 00,                        | 0.8000000E 00,                         | 0.88800000E 00,                    | 0.90000000E 00,                       |
| CPSTR +  |                                              |                                        |                                        |                                    |                                       |
| -urere   |                                              |                                        |                                        |                                    |                                       |
|          | 0.52000002-909-                              |                                        |                                        |                                    |                                       |
|          | 0.500000000 02                               |                                        |                                        |                                    |                                       |
| C-0100   | 0.10000000E-02,                              |                                        |                                        |                                    | ·····                                 |
| FACTUR - | 0.10000000-00.                               |                                        |                                        |                                    |                                       |
| -TTHE    | 0:000000000-38,                              | 0-83590000E-02                         |                                        | 0.98590000F-02,                    | 0.106290005-03-                       |
|          | 0+114110002 03,<br>0+15543000E~03;           | 0-16426000E-03-                        | 0.13015000E 03.                        | 0.13841000P 03,<br>0.18260000E 03. | u.14683000F 03,                       |
|          | 0.20194000E 03.                              | 0.21211000E 03,                        | 0.22142000E 03,                        | 0.22950000E 03,                    | 0.23671000E 03,                       |
|          | 0.249490008 03                               | 0.25018000E-03,                        |                                        |                                    | 0.265890008-03.                       |
|          | 0.210170002 03,                              | V+214550000 03,                        | V+21841000E 03+                        | 0.28247000E 03,                    | 0.28652000E 0                         |

|        | 0.29091000E 03.                         | 0.29542000E 03,                         | 0.30024000E 03, -                       | 0+30547000E-03+                         | 0.311250008-03.  |
|--------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|------------------|
|        | 0.31780000E 03,                         | 0.32333000E 03,                         | 0.32962000E 03.                         | 0.33692000E 03.                         | 0.34561000E 03.  |
|        | 0+35633060E-03+                         |                                         | 0+38941000E03+                          |                                         | 0.473000000E03,  |
|        | 0.00000005-38.                          | 0-0000000F-38-                          |                                         | 0.00000000000000                        | 0.000000005-38,  |
|        | 0-0000000F-38-                          | 0.0000000E-38.                          | 0.0000000E-38.                          | 0.0000000E-38.                          | 0-0000000F-38-   |
|        |                                         |                                         | 0+000000005-38                          | 0.00000000-38                           |                  |
|        | 0.0000000000-38,                        | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.   |
|        |                                         | 0,0000000E-30,                          |                                         | 0,0000000E-38,                          | 0.0000000E-38,   |
|        | 0.0000000F-38,                          | 0.0000000E-38,                          | 0.000000000-38,                         | 0.0000000E-38,                          | 0.0000000E-38.   |
|        |                                         |                                         | 0.000000001. 38                         |                                         | 0,0000000E=3B,   |
|        | 0.0000000000000000000000000000000000000 | 0-00000000-38+                          | 0-00000002-38,                          | 0.0000000000000                         | 0.00000000000000 |
|        | 0.0000000000000                         | 0.00000000E-38.                         | 0.00000000E-38.                         | 0.00000000E-38.                         | 0.00000000E-38-  |
|        |                                         | -0-00000000E 38-                        |                                         | 0.0000000E-38.                          |                  |
|        | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38,                          | 0.000000000-38,                         | 0.0000000E-38.   |
|        |                                         | 0,0000000E-38,                          | 0.06000000 38,                          |                                         | 0.00000006-38,   |
|        | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000F-38,                          | 0.0000000E-38.   |
| ,      |                                         |                                         |                                         | 0+000000000-38+                         | 0.00000006-38,   |
|        | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38,   |
|        | 0.0000000000000                         | 0.00000000000000                        | 0.000000005-38                          | 0.000000000-38                          | 0.0000000000000  |
|        | 0.00000000000000                        |                                         | 0.00000000000000                        | 0.0000000000000000000000000000000000000 | 0.00000000000000 |
|        | 0.00000000E-38,                         | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,   |
| QTBL = | 9.10000000E 00.                         | 0.10000000E 01,                         | 0.12000000E 01,                         | 0.15000000E 01.                         | 0.19000000E 01.  |
|        |                                         |                                         |                                         | 0+41000000E-01+                         | 0.51000000E-01.  |
|        | 0.6700000E 01,                          | 0.7600000E 01,                          | 0,9400000E 01,                          | 0.11400000E 02.                         | 0.14100000E 02.  |
|        | 0.168000902-02                          | 0.203000001 02                          | 0.233000000 02,                         | 0.2/2000000-02                          | 0-28300000E-02,  |
|        | 0.29400000E 02;                         | 0.304000000 02.                         | 0.287000002 02,                         | 0.1254000002 02;                        | 0.238000000 02,  |
|        | 0.92000000F 01.                         | 0.74000000F 01.                         | 0.58000000F 01.                         | 0-44000000F 01-                         | 0-32000000E 01-  |
|        |                                         | 0.170000005 01.                         |                                         | 0.8000000E 00                           |                  |
|        | 0.3000000E 00.                          | 0.200000000 00,                         | 0.1000000E 00,                          | 0.0000000E-38,                          | 0.0000000E-38,   |
|        |                                         | -0.0000000E-19,                         |                                         | - 0.0000000E-19                         | 0.0000000E-19,   |
|        | -0.00000008-19,                         | -0.00000000E-19,                        | -0.000000000-19,                        | -0.000000000000000000000000000000000000 | -0.00000000E-19, |
|        | =0.0000000E=19                          | -0.00000000000000                       | =0.00000000E=19                         | -0.00000000E-19                         | -0.000000000-19- |
|        | -0.00000000F-19                         | -0.00000000000000000000000000000000000  | -0.00000002-19;                         | -0.00000000E-19.                        | -0.000000000-19  |
|        | -0.00000000E-19.                        | -0.0000000E-19.                         | -0.0000000E-17.                         | -0.0000000E-19.                         | -0.0000000E-19.  |
|        | -0.0000000E-19.                         | -0.000000000-19,                        | -0.00000000E-19                         | -0:00000000 <u>0</u> -19,               | 0.0000000E 19.   |
|        | -0.0000000F-19,                         | -0.0000000E-19,                         | -0.00000000E-19;                        | -0.0000000E-19,                         | ~0.0000000E-19,  |
|        | -0-0000000E-19                          | -0.0000000E-19,                         | -0.000000000-19,                        |                                         | 0.0000000E 17.   |
|        | -0.0000000E-19,                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19,  |
|        | -0.000000005-10                         | -0.00000000000000                       | -0.000000000000000000000000000000000000 | -0.000000000000000000000000000000000000 | -0.00000000E-19. |
|        | -0.00000000E=19+                        | -0.000000000000000000000000000000000000 | -0.00000002-19;                         | -0.00000000-19,                         | -0.000000000-19. |
|        | -0.0000000E-19;                         | -0.00000000E-19.                        | =0.00000000000000000000000000000000000  | =0.0000000E=19.                         | -0.00000000E=19. |
|        | -0.0000000E-19-                         | -0.00000006-19                          | -0.000000000-19.                        |                                         |                  |
|        | -0.0000000E-19,                         | -0.00000000E-19.                        | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.  |
|        |                                         | 0.0000000E-19.                          |                                         | -0.0000000E-19.                         | -0.00000008-1-9, |
|        | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19,  |
|        | -0.0000000E-19                          | -0.000000000 19,                        | -0.0000000E-19y                         |                                         | -0.0000000E-17,  |
|        |                                         | -0:0000000000-19;                       | -0.000000000000000000000000000000000000 | -0.0000000000-19,<br>                   | -0.00000000E-19, |
| HTOL - | -0.12750000E-03                         |                                         |                                         | 0.131400005-03.                         |                  |
|        | 0.13200000E 03,                         | 0.13220000E 03.                         | 0.13250000E 03.                         | 0.13270000E 03.                         | 0.13290000E 03.  |
|        | 0;133000000 03,                         | 0.13310000E-03-                         | 0.13300000E 03.                         | 0.132800000 031                         |                  |
|        | 0.13140000E 03,                         | 0,12990000E 03,                         | 0.12800000E 03,                         | 0.12640000E 03.                         | 0.12280000E 03,  |
|        |                                         |                                         |                                         |                                         |                  |

| TURD    |           |                      | 0.00000000E-38, | 0+00000000E-30, | <br> |
|---------|-----------|----------------------|-----------------|-----------------|------|
| QCPULT  | =         | 0.33200000E-02,      |                 |                 |      |
| QRHUL T | =         | 0.1000000E 01,       |                 |                 |      |
| KHS     | =         | 0.5800000E-01,       |                 |                 |      |
| TTRANS  | -         | 0.1000000E 04,       |                 |                 |      |
| RHOHS   | 2         | 0.39400000E 02.      |                 |                 |      |
| CPHS    | a         | 0.44000000E 00.      |                 |                 |      |
| XN      | c .       | 0.8000000F 00,       |                 |                 |      |
| xo      | 5         | 0.0000000E-38.       |                 |                 |      |
| XA      | =         | 0.0000000E-38,       |                 |                 |      |
| xc      | -         | 0.2000000E 00,       |                 |                 |      |
| KSTR    | =         | 0.12500000E 03,      |                 |                 |      |
| WTB     | -         | 0.16000000E 00,      |                 |                 |      |
| CPB     | -         | 0.2500000CE 00,      |                 |                 |      |
| TSTOP   | a         | 0.41160000F 03,      |                 |                 |      |
| КВ      |           | 0.10000000E 00,      |                 |                 |      |
| RHOSTR  | -         | 0.17200000F 03,      |                 |                 |      |
| THSTR   | -         | 0.1000000CE 04,      |                 |                 |      |
| RHOR    | 2         | 0.30000000E 02,      |                 |                 |      |
| HV1R    | =         | 0.100000002 05,      |                 |                 |      |
| HV2R    | 2         | 0.0000000E-38,       |                 |                 |      |
| \$ END  |           |                      |                 | -41-            |      |
| TTESTI  | 1.0078 02 | 2 TTEST2 1.626E 02 % | 101 0.0000      |                 |      |

ı.

| <br>-01000000000000000000000000000000000000 | -0.0000000000000000                     | 0.153000000.03                          | 0.0000000000000000000000000000000000000 | 0.00000000 39                           |
|---------------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
| -3-00000005-13                              | -0-00000000-19                          |                                         |                                         |                                         |
|                                             |                                         | 0.00000005-19                           | -0.0000000E-1.9                         | -0.00000005-1.9-                        |
| -0.0000000E-19-                             | ~0.0000000E-19                          | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.00000000E-19.                        |
|                                             |                                         |                                         |                                         | 0-00000000-19-                          |
| -0.00000000E=19.                            | ~0.0000000E=19.                         | -0.000000000000                         | -0-00000000E-19+                        | -0-000000000-19-                        |
| -0.00000000000000000000000000000000000      | ~0.0000000E=19,                         | -0.00000000E-19,                        | -0.0000000E-14,                         | -0.0000000000000                        |
|                                             |                                         |                                         | -0.00000000-10                          | -0.000000005-10                         |
| -0.00000000E-19,                            | ~0.0000000E-19,                         | -0.00000000E-19,                        | -U.0000000E-19.                         | -0.000000000000000000000000000000000000 |
|                                             | -0.0000000E 19                          | -0.00000000 -19.                        | -0.0000000E-19.                         |                                         |
| -0.0000000E-19,                             | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000E-19,                         |
|                                             | -0+0000000E-19+                         |                                         | -0-0000000E-19,                         | -0-00000000-1-                          |
| -0.0000000E-19,                             | ~0.0000000E-19,                         | -0.0000000E-19.                         | -0.0000000E-19.                         | -0.0000000000-19,                       |
| 0-00000000E-19                              | -0.000000000-19,                        | 0.00000000E-19,                         | -0.00000000E-19                         | -0.00000000-19-                         |
| -0.0000000E-19.                             | -0.0000000E-19.                         | -0.00000000E-19.                        | -0.0000000E-19.                         | -0.0000000000-19.                       |
| -0-00000000E-19-                            | -0-0000000E-19                          |                                         |                                         | 0.00000000 19.                          |
| -0.000000000-19.                            | -0.00000000E=19.                        | -0.0000000E=19.                         | -0-00000000F-19-                        | -0-00000000F-19-                        |
| -0.00000008-19,                             | -0.00000000000000                       | -0.000000000000000000000000000000000000 | -0.000000000000000000000000000000000000 | -0.000000000000000000000000000000000000 |
| -0-000000000-19-                            | -0.0000000E=19                          | =0.00000000E=19;                        | -0-00000000E-19-                        | -0.00000006-19                          |
| -0-00000000E-19,                            | ~0.0000000E-19,                         | -0.00000000E-19.                        | -0.00000000E-19,                        | -0.000000000000000000000000000000000000 |
|                                             | -0.00000000E-19,                        |                                         | -0.000000001-19,                        | -0.000000000000000000000000000000000000 |
| 0.0000000E-38,                              | 0.0000000E-38.                          | 0.0000000E-38.                          | 0.0000000E-38,                          | 0.000000006-38.                         |
| -0.000000005-38,                            | 0.000000C 38.                           |                                         | 0+00000000E-38+                         | 0-00000008-38-                          |
| 0.0000000E-38,                              | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000F-38,                          | 0.0000000E-38,                          |
| -0.00000000 38,                             | 0v0000000E-38v                          | 0.0000000000-38,                        | 0.0000000E-39,                          |                                         |
| 0.00000000000-38,                           | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38,                          |
| -0.0000000E-30.                             |                                         | 0+000000005-38                          |                                         | 0.00000006-38-                          |
| 0.0000000E-38.                              | 0.0000000E=38.                          | 0.0000000F-38.                          | 0.0000000E-38.                          | 0.0000000E-38.                          |
|                                             | 0.0000000000000000000000000000000000000 |                                         |                                         | 0.0000000000000000000000000000000000000 |
| 0.00000005-38                               | 0.00000000-38                           | 0.00000005.39                           | 0.00000005-38                           | 0.00000005-39                           |
| -0.00000000E-19,                            | ~0.0000000E-19,                         | -0.0000000E-19,                         | -0.0000000E-19.                         | -0.0000000F-19.                         |
| -0.000000000-19.                            | 0.0000000E 19-                          | -0.000000000-19.                        | -0.0000000E-19                          | -0-00000008-19-                         |
| -0.00000000E-19,                            | -0.0000000E-19.                         | -0.00000000E-19,                        | -0.0000000E-19.                         | -0.0000000E-19.                         |
| -0-00000000-19                              |                                         |                                         |                                         | 0.0000000E-19                           |
| -0.0000000E-19.                             | =0.0000000E-19;                         | -0.0000000000000                        | -0.000000005-19-                        | -0.0000000E-19.                         |
| -0.00000000E-19,                            | -0.0000000E-19,                         | -0.00000000F-19,                        | -0.00000000E-19,                        | -0.00000000000000-19,                   |
| -0.00000000E-19,                            |                                         |                                         | -0.0000000E 19.                         | -0.000000005-10                         |
| -0.0000000E-19,                             | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.00000000E-19,                        |
| -0+06900090E 19,                            | -0.000000005-19.                        |                                         |                                         |                                         |
| -0.00000000E-19,                            | -0.0000000E-19,                         | -0.0000000E-19.                         | -0.0000000E-19,                         | -0.0000000E-19,                         |
| -0.06900000F 19,                            | -0-00000000E 19                         |                                         |                                         | -0.00000008-19,                         |
| -0.0000000E-19.                             | -0.0000000E-19.                         | -0.00000000E-19.                        | -0.0000000E-19,                         | -0.00000000E-19,                        |
| -0-00000000-19                              |                                         |                                         |                                         | 0.00000005-19-                          |
| -0.0000000E-19.                             | -0-00000000E-19+                        | -0.00000000E-19.                        | -0.0000000F-19.                         | -0.0000000E-19.                         |
| -0.0000000-19;                              | -0.00000000-14                          | -0.000000000000000000000000000000000000 | -0.00000000000000                       | -0.00000000E-19                         |
| -0.000000000-19                             | -0.000000000000000000000000000000000000 | -0.000000000000000000000000000000000000 | -0.000000005-10                         | -0.000000000000                         |
| -0.000000002-19,                            | -0.00000000E-19,                        | -0.00000000E-19,                        | -0.000000000-19,                        | -0.000000000-19,                        |
| -0.000000000-19;                            | -0.0000000CE-19-                        | -0.00000000E 19                         | -0-0000000F 19-                         | 0-00000005-19-                          |
| -0.0000000F-19,                             | -0.0000000E-19,                         | -0.00000000E-19,                        | -0.0000000E-19.                         | -0.0000000E-19,                         |
| -0=56909000E 01                             |                                         | 0,3900000E 01,                          | 0-370000005-01-                         | 0++0000000E_01+                         |
| 0.15300000E 02.                             | 0.1290000CE 02.                         | 0.10800000E 02,                         | 0.89000000E 01,                         | 0.72000000F 01,                         |
| -9-38260030F-02                             |                                         | 0.276900000-02                          |                                         |                                         |
| 0.725000005 02.                             | 0.44700000E 02.                         | 0 576000305 02                          | 0.505000000 02.                         | 0.44100000F 02.                         |
|                                             |                                         | 0.006000000.00                          | 0.00400005 07                           | 00.200000F02                            |

#### III. COMPUTATIONS

### A. BLOCK DIAGRAM

The block diagram for Program 1884 1s given in Figure 4.



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Figure 4 BLOCK DIAGRAM FOR PROGRAM 1884

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B. SYMBOLS

| Symbol                                             | Definition                                             | Units                       |
|----------------------------------------------------|--------------------------------------------------------|-----------------------------|
| C <sub>B</sub> , C <sub>HS</sub> , C <sub>ST</sub> | Specific heat of bond, heat shield, and structure.     | Btu/lb- <sup>o</sup> F      |
| κ <sub>B</sub> , κ <sub>HS</sub> , κ <sub>ST</sub> | Conductivity of bond, heat shield, and structure.      | Btu/ft-hr-°F                |
| $\rho_{\rm B},\rho_{\rm HS},\rho_{\rm ST}$         | Density of bond, heat shield, and structure.           | lb/ft <sup>3</sup>          |
| E                                                  | Emissivity.                                            |                             |
| σ                                                  | Stefan-Bolzmann constant.                              | Btu/ft <sup>2</sup> -sec-°R |
| t <sub>1</sub>                                     | Initial time.                                          | seconds                     |
| t<br>m                                             | Time at peak combined heating.                         | seconds                     |
| t <sub>f</sub>                                     | Final time of problem.                                 | seconds                     |
| t <sub>1a</sub> , t <sub>ta</sub>                  | $T_1mes$ when ablation starts and stops.               | seconds                     |
| <sup>t</sup> R                                     | Time when rear temperature equals specified. value.    | seconds                     |
| tadj                                               | Start time for post-ablation insulation problem.       | seconds                     |
| T <sub>1</sub>                                     | Initial temperature.                                   | ٥R                          |
| T1, T2                                             | Temperature defined by Equations (6) and (7).          | °R                          |
| TA                                                 | Ablation temperature.                                  | °R                          |
| ΔT <sub>m</sub>                                    | Mean temperature rise.                                 | °R                          |
| ď                                                  | Maximum combined heat rate.                            | Btu/ft <sup>2</sup> -sec    |
| q <sub>c</sub> , q <sub>R</sub>                    | Convective and radiative heat rates.                   | Btu/ft <sup>2</sup> -sec    |
| <sup>H</sup> s, <sup>h</sup> w                     | Stagnation and wall enthalpy.                          | Btu/lb                      |
| Q <sub>c</sub> , Q <sub>R</sub>                    | Integrated convective and radiative heating $\cdot$    | Btu/ft <sup>2</sup>         |
| Q <sub>PA</sub>                                    | Total heat load for post-ablation insulation analysis. | Btu/ft <sup>2</sup>         |

| Symbols_                                      | Definition                                                             | Units                   |
|-----------------------------------------------|------------------------------------------------------------------------|-------------------------|
| $\dot{\mathbb{W}}_{a}, \dot{\mathbb{W}}_{aR}$ | Ablation rates for convection and radiation<br>and for radiation only. | lb/ft <sup>2</sup> -sec |
| WA                                            | Total ablated weight.                                                  | $lb/ft^2$               |

- C. EQUATIONS
  - 1. Initial Time

$$t_{i} = t_{m} - 2 \int_{0}^{t_{m}} q_{c} dt + 2 \int_{0}^{t_{m}} q_{R} dt$$
 (1)

2. Integrated Heating

$$Q_{c} = \int_{t_{1}}^{t_{f}} q_{c} dt$$
(2)

$$Q_{R} = \int_{t_{i}}^{t_{f}} q_{R} dt \qquad (3)$$

- 3. Average Total Enthalpy
  - a. Nonablating Case

$$H_{SA} = \frac{1}{(t_f - t_i)} \int_{t_i}^{t_f} H_s dt$$
(4)

b. Ablating Case

$$H_{SA} = \frac{1}{(t_f - t_{adj})} \int_{t_{adj}}^{t_f} H_s dt$$
(5)

-44-3'76< 4. Heat Shield Requirement Tests

$$TI = T_{i} + \frac{33 q_{m} \sqrt{2(t_{m} - t_{i})}}{\sqrt{K_{ST} \rho_{ST} C_{ST}}}$$
(6)

$$T_{2} = T_{1} + \frac{(Q_{C} + Q_{R})}{W_{ST}C_{ST}}$$
(7)

5. Thermal Capacitance of Bond

$$\Delta \Psi_{\rm HS} = \Psi_{\rm B} - \sqrt{\frac{\kappa_{\rm HS} \,\rho_{\rm HS} \,C_{\rm B}}{\kappa_{\rm B} \,\rho_{\rm B} \,C_{\rm HS}}}$$
(8)

### 6. Insulation Weight -- Nonablating Case

a. Test Time for Equilibration (t<sub>R</sub>)

$$t_{\rm R} = t_{\rm 1} + \left\{ \frac{\sqrt{\rho_{\rm HS} \kappa_{\rm HS} c_{\rm HS} \Delta T_{\rm R}^2 + 4\epsilon\sigma T_{\rm R}^4 \left[ Q_{\rm c} \left( 1 - \frac{h_{\rm w}}{H_{\rm SA}} \right) + Q_{\rm R} \right]}{2\,\epsilon\sigma \, T_{\rm R}^4} - \frac{\Delta \, T_{\rm R} \sqrt{\rho_{\rm HS} \kappa_{\rm HS} c_{\rm HS}}}{2\epsilon\sigma \, T_{\rm R}^4} \right\}$$

b. Weight for 
$$t_R \leq t_f$$

$$\overline{W}_{\rm HS} = \sqrt{\frac{\rho_{\rm HS} \, K_{\rm HS}}{C_{\rm HS}}} \sqrt{t_{\rm R} - t_{\rm i}}$$
(10)

c. Weight for  $t_R > t_f$ 

$$Q_{C}\left[1-\frac{h_{w}}{H_{SA}}\right] + Q_{R} - \epsilon \sigma T_{w}^{4} (t_{f} - t_{i}) \approx \Psi_{HS} C_{HS} \Delta T_{M}$$
(11)

Where  $\Delta T_M / \Delta T_W$  and  $\Delta T_R / \Delta T_W$  are assumed to be a function of

 $\left(\frac{\rho_{HS}\,\kappa_{HS}\,(t_f-t_i)}{C_{HS}\,\overline{w}_{HS}^{\,2}}\right) \quad \text{in accordance with the constant surface temperature}$ 

model and the solution given in Reference 3. The solution is found via iteration on  $(T_W)$  using the relationships for  $\Delta T_m / \Delta T_W$  and  $\Delta T_R / \Delta T_W$  developed in Reference 3.

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## 7. Ablation Weight

a. Test for Occurrence of Ablation

$$q_{c} \left(1 - \frac{h_{w}}{H_{S}}\right) + q_{R} > 1.82 \sqrt{\frac{\rho_{HS} K_{HS} C_{HS}}{2 (t_{m} - t_{i})}} + \epsilon \sigma T_{A}^{4}$$
(12)

b. Ablation Rate  $(\dot{w}_a)$ 

1) Convective and Radiation Heating

$$\dot{W}_{a} = \frac{q_{c} \left[1 - \frac{h_{w}}{H_{s}}\right] + q_{R} - \sigma \epsilon T_{A}^{4}}{C_{HS} \Delta T_{A} + X f_{1} [H_{V1} + \eta_{1} (H_{S} - h_{w})] + (1 - X) f_{2} [H_{V2} + \eta_{2} (H_{S} - h_{w})]}$$
(13)

,

c. Test for Blockage of all Convective Heating

$$\begin{split} \dot{\bar{w}}_{aR} \left\{ \eta_{1} \left( H_{s} - h_{w} \right) X f_{1} + \eta_{2} \left( H_{s} - h_{w} \right) \right\} > & (14) \\ q_{c} \left[ 1 - \frac{h_{w}}{H_{s}} \right] \\ \dot{\bar{w}}_{aR} = \frac{q_{R} - \epsilon \sigma T_{A}^{4}}{C_{HS} \Delta T_{A} + X f_{1} H_{VIR} + (1 - X) f_{2} H_{V2R}} & (15) \end{split}$$

If Equation (14) is satisfied, then ablation rate calculation switches from Equations (13) to (15).

d. Start and Stop of Ablation

Ablation starts and stops when:

$$q_{c} \left(1 - \frac{h_{w}}{H_{s}}\right) + q_{R} = \epsilon \sigma T_{A}^{4}$$
(16)

e. Insulation Weight for Ablation Period

$$\Psi_{\text{INA}} = \frac{4 \left( t_{\text{fa}} - t_{\text{ia}} \right)}{\Psi_{\text{a}}} \left( \frac{\rho_{\text{HS}} \, K_{\text{HS}}}{C_{\text{HS}}} \right)$$
(17)

f. Adjusted Time EANITING 1 11 .VI

g. Post-Ablation Heat Stored

$$Q_{PA} = \int_{t_{adj}}^{t_{f}} \left[ q_{c} \left( 1 - \frac{h_{w}}{H_{S}} \right) + q_{R} \right] dt - Q_{A}$$
(19)



The coefficients A and B are computed automatically by specifying the atmospheric composition, and; utilizing: tabular, whermochemical data stored in the program. All modules are assumed to have zero enthalpy at 0°K.

# IV. IBM ROUTINES

## A. PROGRAM FLOW

The program flow 1s shown in Figure 5.

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Figure 5 FLOW DIAGRAM FOR PROGRAM 1884

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### B. MAIN PROGRAM

# 1. Purpose

The purpose of the main program is to acquire the necessary input data, and to transmit this data to subroutine PR1884 within which the computations are completed.

### 2. Method

The input variables are defined by their inclusion in the namelist array INPUT, and their types and dimensions specified. The data statements and the arithmetic statements setting the elements of TBL1 and TBL2 preset values are of the solution for a finite slab with one end insulated and the other at constant temperature (Reference 1, p. 244, Equation (9)). These tables are arranged so that for TBL1 add indices are monotonic increasing values of the parameter  $\Delta T_R / \Delta T_W$  and even indices are monotonic tonic increasing values of  $\alpha t/L^2$  and even indices are values of  $\Delta T_m / \Delta T_W$ .

The program input is read through namelist at Statement 100. The identification numbers DATE, MEM $\phi$ , and CASE are written on the output tape followed by the namelist data. The call to Subroutine PR1884 initiates all of the calculations and output of results for the case. After this call control is transferred immediately back to Statement 1000 for consideration of the next case.

# C. SUBROUTINES

# CALLING SEQUENCES

|               | Variable        | AHR           | TABL          | TREAR         | TEMPI         |
|---------------|-----------------|---------------|---------------|---------------|---------------|
| PR1884        | Input or Output | Input         | Input         | Input         | Input         |
|               | Source          | Program Input | Program Input | Program Input | Program Input |
| EMIS          | TSTART          | DTI           | TBL1          | TBL2          | CP2DG(CPSTR)  |
| Input         | Input           | Input         | Input         | Input         | Input         |
| Program Input | Program Input   | Program Input | Program Input | Program Input | Program Input |
| W2DG(WTSTR)   | XITDG(MXIT)     | EPSDG(EPSIL)  | FCTDG(FACTØR) | DDG1(TIME)    | DDG2(QTBL)    |
| Input         | Input           | Input         | Input         | Input         | Input         |
| Program Input | Program Input   | Program Input | Program Input | Program Input | Program Input |
| DDG3(HTBL)    | DDG4(RTBL)      | XLAM(LAM)     | XTURB(TURB)   | QMULT(QCMULT) | ERT(QRMULT)   |
| Input         | Input           | Input         | Input         | Input         | Input         |
| Program Input | Program Input   | Program Input | Program Input | Program Input | Program Input |
| ZK1 (KHS)     | TFCØN(TTRANS)   | RHØ(RHØHS)    | CP(CPHS)      | XN            | xø            |
| Input         | Input           | Input         | Input         | Input         | Input         |
| Program Input | Program Input   | Program Input | Program Input | Program Input | Program Input |
| XA            | хс              | ZKSTR(KSTR)   | WTB           | СРВ           | TSTPØ(TSTØP)  |
| Input         | Input           | Input         | Input         | Input         | Input         |
| Program Input | Program Input   | Program Input | Program Input | Program Input | Program Input |
| ZKB(KB)       | RØST(RHØSTR)    | TMST(TMSTR)   | RØB(RHØB)     | HVIR          | HV2R          |
| Input         | Input           | Input         | Input         | Input         | Input         |
| Program Input | Program Input   | Program Input | Program Input | Program Input | Program Input |
| 1             | 1               |               | 1             |               | 1 1           |

|      |                 |                                  |                                                     | · · · · · · · · · · · · · · · · · · · |
|------|-----------------|----------------------------------|-----------------------------------------------------|---------------------------------------|
| TLUQ | Variable        | ARG, value of<br>indep. variable | TBL, table of<br>alternate indep.<br>and dep. vars. | ANS, result of<br>table look-up       |
|      | Input or Output | Input                            | Input                                               | Output                                |
|      | Source          | Calling program                  | Main                                                | TLUQ                                  |
|      |                 |                                  |                                                     |                                       |

| CURVE  | Variable<br>Input or Output | ZK, K <sub>HS</sub><br>Input | RHO, P <sub>HS</sub><br>Input | CP, C <sub>PHS</sub><br>Input | TR, t <sub>R</sub><br>Input |
|--------|-----------------------------|------------------------------|-------------------------------|-------------------------------|-----------------------------|
|        | Source                      | Program Input                | Program Input                 | Program Input                 | MAIN                        |
| TSS, T | TEMPI, T                    | WW, WINS                     | TSTØP, t <sub>r</sub>         | TI, t                         | ANS                         |
| Input  | Input                       | Input                        | Input                         | Input                         | Input                       |
| MAIN   | Program Input               | CURVE                        | Program Input<br>or MAIN      | MAIN                          | TLUQ                        |
| ANS2   | TBL1                        | TBL2                         | DTM, A                        | TREAR                         |                             |
| Output | Input                       | Input                        | Output                        | Input                         |                             |
| CURVE  | Program Input               | Program Input                | CURVE                         | Program Input                 |                             |
| 1 1    | 1                           |                              |                               | ,                             |                             |

|                                                           | VARIABLE                                              | MITDG, max<br>iterations for<br>corrected WINS      | EPSDG,<br>convergence tol-<br>erance for<br>corrected WINS | FCTDG, relative<br>change<br>iteration for<br>corrected WINS | CPIDG, C <sub>PHS</sub> ,<br>Specific heat of<br>heat shield |
|-----------------------------------------------------------|-------------------------------------------------------|-----------------------------------------------------|------------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------|
| CØRFIT                                                    | Subroutine<br>Input or Output<br>Source               | Input<br>Program<br>Input                           | Input<br>Program<br>Input                                  | Input<br>Program<br>Input                                    | Input<br>Program<br>Input                                    |
| CP2DG, C <sub>PSTR</sub><br>Specific heat of<br>structure | W2DG, WSTR,<br>weight of structur                     | RHØ1DG, p,<br>e heat shield<br>density              | ZK1DG, K <sub>HS</sub> ,<br>heat shield<br>thermal cond    | TIMIDG, t <sub>1</sub> ,<br>effective initial<br>tume        | WW, WINS,<br>uncorrected heat<br>shield weight               |
| Input<br>Program Input                                    | Input<br>Program<br>Input                             | Input<br>Program<br>Input                           | Input<br>Program<br>Input                                  | Input<br>Main                                                | Input<br>Main                                                |
| TSTPDG,t <sub>f</sub> , actual<br>TSTØP                   | TSRDG, T <sub>R</sub> ,<br>max allowable<br>rear temp | TSBID, T <sub>1</sub> ,<br>initial tempera-<br>ture | TSSDG, T <sub>S</sub> ,<br>average surface<br>temperature  | QTDURZ, duration<br>of heat pulse                            | TSTTDG, t <sub>1</sub> ,<br>initial time of<br>problem       |
| Input<br>Main                                             | Input<br>Program<br>Input                             | Input<br>Program<br>Input                           | Input<br>Main                                              | Input<br>Maın                                                | Input<br>Program<br>Input                                    |
| DTMZ, AT <sub>m</sub> ,<br>mean temperatur                | WEIGHZ,<br>c corrected heat-<br>shield weight         |                                                     |                                                            |                                                              |                                                              |
| Input<br>Main                                             | Output<br>CØRFIT                                      |                                                     |                                                            |                                                              |                                                              |

|                               | VARIABLE                                         | R, 1/¢, thermal-<br>capacitance ratio | TAU, r ,<br>dimensionless<br>time | DV, V <sub>2</sub> ,<br>dimensionless<br>temperature | RT, indep.<br>var table of R |
|-------------------------------|--------------------------------------------------|---------------------------------------|-----------------------------------|------------------------------------------------------|------------------------------|
| FINWI                         | Subroutine<br>Input or Output<br>Source          | Input<br>CØRFIT                       | Input<br>CØRFIT                   | Output<br>FINW 1                                     | Input<br>CÓRFIT              |
| TAUT, indep<br>var.table of r | DVT, dep var.<br>table of dimension<br>less temp | n-                                    |                                   | • • • • • • • • • • • • • • • • • • • •              |                              |

Input CØRFIT Input CØRFIT

#### SUBROUTINE DESCRIPTIONS

## 1. PR 1884

#### a. Purpose

The purpose of Subroutine PR 1884 is to compute the heat shield weight necessary to limit the backface temperature to some (input) design limit given a knowledge of the heating environment, and provide the necessary output from the calculation.

## b. Method

Immediately following the subroutine and dimension statements is the definition of the wall enthalpy function HWALL(T), where T is some temperature in degrees F and the coefficients A27N and B27N are computed as functions of the input atmosphere.

The first executable statements initialize WT $\phi$ TAL, WA, and NM, the D $\phi$  50 loop counts the number of values entered in the TIME table (DDG1), by checking for the first zero entry beyond the first table element.

By Statement 8003, the sum of the atmosphere constituent mole fractions has been checked to see if it is =  $1\pm 0.001$ , and by the Statement DØ 8000, the wall enthalpy coefficients A27N and B27N have been computed. The DØ 10 loop arranges the tables QTB, HTBL, and RTBL so that odd indices contain values of the TIME table, and even indices contain the corresponding values of the input convective heating, enthalpy, and radiation heating, respectively.

The tests and calculations preceding Statement 8005 redefine the value of TST $\phi$ P if necessary. The duration of the heat pulse (QTDUR) is defined as the time after maximum convective heating that the convective heating is  $\leq 1$  percent of the maximum heating, minus the input TSTART. If the input TST $\phi$ P minus the input TSTART is > 2.QTDUR, TST $\phi$ P is changed to = 2(QTDUR-TSTART).

Between Statements 8005 and 7331, constants are stored for use by subroutine CØRFIT, QTBL is defined (loop ending on 102) to be the convective heating time QCMULT, RADR, RADA, DELTA, and DELTR are defined, the heat shield thermal conductivity is changed for agreements in units, and the maximum combined radiative and convective heating is computed along with the time it occurred (RQGMAX and RTQMAX, respectively).

The DØ loop ending on 7332 computes three integrals by the trapezoidal method, the integrals from the first entry on the TIME table to TSTØP of the combined radiative and convective heating (QRTØT) and of the radiative heating (QRRA), and the integral from the first entry in TIME to RTQMAX (see above) of the combined radiative and convective heating (RQINT).

The DØ loop 203 computes the maximum convective heating (QCMAX) and the time when it occurred (TQMAX). DØ loop 207 computes by the trapezoidal method two integrals, the integral from the first entry of the TIME table to TSTØP of the convective heating (QTØT), and the integral from the first entry on the TIME table to TQMAX of the convective heating (QINT).

Statement 208 defines an effective initial time TI, and by Statement 6048 the enthalpy at TABL and TREAR (HWABL and HWABR), along with the output quantity MINCRABL (internally, QR) and the quantity QPIMER are computed. By Statement 8008 the quantities TTEST 1 and TTEST 2 are computed. If TTEST 1 < TMST (input as TMSTR) and TTEST 2 < TREAR, no protective shield is required and the next case is considered (RETURN). Between Statements 8011 and 7248, the quantity QTREQT is computed and selected heating integrals, and time are provided as output. After Statement 7248 TIA is defined to be TSTART, and a test is made so that if QR < RQMAX, (Reference 1, p 250, Equation(23)) the ablation case is solved (Statements 300 to, but not including, 400). Otherwise the nonablating case is computed (Statements 400 to, but not including, 500).

Statements 301 to 308 compute the times T1A and T2A which define the time interval during which ablation is occurring. This logical loop provides for successive evaluations of the quantity DIF as the independent variable. TIME is incremented by the input DTI, and T1A is defined as that time before RTQMAX that DIF passes through zero, and T2A is the time after RTQMAX that DIF passes through zero. Test 302 indicates a change of sign in the residual and hence the existence of a near root. Test 1778 assures that the value of DIF is within  $\pm 0.01$  of zero. It should be noticed that if DIF > 0.01 at TSTART + DTI, then T1A is arbitrarily set equal to TSTART, and/or if DIF >

0.01 at TST $\phi$ P, T2A is arbitrarily set equal to TST $\phi$ P. For problems of this nature, the potential errors inherent are obvious.

The block of statements between 928 and 926 are executed twice, first with the control variable KKK = 1, then with KKK = 2. For KKK = 1, the DØ loop entry at 311 computes the ablation rate (WDØT(J)) as a function of time (A32A(J)) between T1A and T2A. The test before Statement 826 determines if laminar or turbulent material properties will be used to compute WDØT(J). The first row of the array FCØN when the input TTRANS (internally TFCØN) is  $\leq$  TIME, the second row when TTRANS > TIME. The IF test before 3085 will modify the computation of WDØT(J) when the convective heating is "blocked". The DØ loop ending on 312 integrates WDØT(J) by the trapezoidal rule to compute the total ablation rate (WA).

The statements between 313 and 6003 initialize  $T_{11}$  and KKK for the second pass through Statements 928 and 926. This pass provides for the calculations of WD $\phi$ T(J) between the times RTQMAX and T2A, which are used to compute the "adjusted" time TADJ. Again suitable properties are selected depending on whether the heating is laminar or turbulent, or the convective heating is blocked: The D $\phi$  loop ending on Statement 6004 computes the cumulative sum WA7C, which is used after Statement 6005 to compute TADJ (Reference 1, p. 253, Equation (34)). For the purposes of the structural capacitance correction, T1 is taken to be TADJ for ablating cases (after Statement 326, TIMDG).

Between 6005 and 500, three integrals are computed for use in the insulation weight calculation. These are the enthalpy and convective heating integrals HGADJ and QINS between TADJ and TST $\phi$ P (loop ending on 326), and the radiation heating integral QRT $\phi$ T1 between T2A and TST $\phi$ P. The first two integrals are computed by the trapezoidal rule, and the third by a firts-order Euler method. After 326 the average enthalpy is computed and stored in HGT $\phi$ T. Output is provided as HGT $\phi$ T, TI, TIA, T2A, and WA before 3026. This ends the calculations made for ablation, and the G $\phi$ T $\phi$  500 before Statement 700 transfers to the final insulation weight calculations.

The nonablation calculation is done between Statements 400 and 500. Three entegrals are computed, the first of which, QC, is simply equal to QT $\phi$ T (see above), the integral of the convective heating from the first entry of the TIME table to TST $\phi$ P. In the D $\phi$  loop ending on 3325 the radiation heating integral QRT $\phi$ T1 between TSTART (equal to T1A for nonablating cases) and TST $\phi$ P is computed by a first-order Euler method. The D $\phi$  loop ending on 404 computes the enthalpy integral HGT $\phi$ T between the effective initial time TI and TST $\phi$ P. After Statement 404, this enthalpy is averaged over the time range and stored in GHT $\phi$ T. The nonablating calculation ends at Statement 500, where the insulation weight calculation starts for both ablating and nonablating cases.

The Statements from 500 to 132 check the validity of the average enthalpy calculation. The first restriction is that the average enthalpy times AHR  $\geq$  the enthalpy at temperature TREAR. If it is not, TST $\phi$ P is arbitrarily shortened by 5 seconds, N $\phi$ G $\phi$  set = 1, and the G $\phi$ T $\phi$ 499 provides for reaveraging the enthalpy. More specifically, the variable N $\phi$ G $\phi$  is 1 if TST $\phi$ PP is decreased, 2 if TST $\phi$ PP is increased, and 0 if no corrections were necessary.

If the average enthalpy is sufficiently large, then the quantity TR, the time at which the backface reaches the design limit temperatures is computed. If TST $\phi$ P has not been adjusted to recompute the average enthalpy (N $\phi$ G $\phi$  = 0), and TR  $\geq$  TST $\phi$ P-TI, then the slab has not equilibrated and the transfer to Statement 502 begins the insulation weight computation. If TR<TST $\phi$ P-TI, N $\phi$ G $\phi$  is set to 1 and TST $\phi$ P is decreased by 5 seconds and the average enthalpy is recomputed (G $\phi$ T $\phi$ 499) and the tests start again.

If the average enthalpy is sufficiently large but TST $\phi$ P has been decreased immediately before (N $\phi$ G $\phi$  = 1), then TR is again compared to TST $\phi$ P-TI; if <, N $\phi$ G $\phi$  is set to 1, TST $\phi$ P is decreased, and a new average enthalpy computed; if =, then the slab is in equilibrium and the transfer to 501 starts the insulation weight calculation; if >, N $\phi$ G $\phi$  is set to 2, TST $\phi$ P is increased by 1 second, and a new average enthalpy is computed. Resetting the counter NM assures that TST $\phi$ P cannot be thus increased more than 40 times.

If the average enthalpy is sufficiently large but TST $\phi$ P has been increased immediately before (N $\phi$ G $\phi$  = 2), then TR is compared to TST $\phi$ P-TI. If the slab is in equilibrium, the transfer to 501 starts the insulation weight calculation. If >, N $\phi$ G $\phi$  is set to 2, TSTART is increased by 1 second and if NM < 40, a new average enthalpy is computed.

The calculation of the insulation weight is done in two ways, depending on whether the slab has equilibrated by the end of the problem. If so, then this fact is indicated and the statements from 501 to (not including) 502 compute the insulation weight (WT), corrected insulation weight (WEIGHT) and total weight (WT0TAL) from algebraic evaluations involving only input and TR. Output is provided (after Statement 8015) and the next case is considered (RETURN before Statement 502).

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When the slab has not equilibrated at the end of the problem, the insulation weight is computed between Statement 502 and the end of the program. There are two iterations necessary to compute the insulation weight. The outer iteration is for the weight (W9). Statements 600 to, but not including, 6605, and inner iteration is for the average surface temperature TSS from Statements 601 to, but not including 603. The statements from 502 to 600 define the first iteration coefficients for the function of TSS whose root 1s computed by an accelerated Newton-Raphson procedure in the temperature iteration loop. The first guess for weight is 0, and the first guess for the temperature 1s a maximum value (TSR) from Reference 1, p. 245, Equation (13). The temperature iteration starts at 601. If the temperature converges to within 1 degree R in less than 41 iterations (counted by INØT), and 1s > 460, subroutine CURVE 1s called at Statement 6606. CURVE uses the converged temperature to compute an insulation weight WW from the tables of the solution to the constant surface temperature problem, TBL1 and TBL2. If this weight WW converges with a relative error less than 0.0001 to the weight computed in the previous iteration (W9), then the iteration stops. If not, then a successive approximation is done if the number of iterations (counted by III) is < 20. If more than 20, the iterative procedure is terminated and the last values of TSS and W9 are used.

Statement 703 follows the iteration for insulation weight. The call CØRFIT statement provides Subroutine CØRFIT with the necessary information to compute the insulation weight (WEIGHT), corrected for structural capacitance. After the return from CØRFIT, the insulation weight (WEIGHT) is further corrected for the effective thermal resistance of the bond, and the total weight is computed. Before 8007, output is provided including the insulation weight (W9), the corrected insulation weight (WEIGHT,  $\geq 0$ ), and the total weight (WTØTAL). The RETURN provides for the consideration of the next case.

- 2. TLUQ
  - a. Purpose

TLUQ performs a linear interpolation on the tables in 1884 TBL1, TBL2, QTBL, HTBL, and RTBL.

b. Method

The value of the independent variable is ARG, and both dependent and independent variable tables are contained in TBL, the odd indexes referring to independent variable values and the even indexes to the corresponding values of the dependent variable. The result of the linear interpolation is placed in ANS. TLUQ is used instead of ARTLU, only because of the arrangement of the Tables TBL1, TBL2, QTBL, HTBL, and RTBL.

## 3. CURVE

### a. Purpose

CURVE uses input data and tables plus a value of the average surface temperature to compute the insulation weight.

b. Method

Given input constants and the tables TBL1 and TBL2, CURVE first defines DTRTS, and performs a table look-up in TBL1 to obtain a value of  $\alpha r/L^2$ , which is stored in ANS. This value is then used to compute the insulation weight WW and is used as the value of the independent variable in the table look-up in TBL2 to define a value of  $\Delta T_m/\Delta T_S$ . This quantity is stored in ANS 2, and is used to compute the average temperature rise DTM.

### 4. CØRFIT

a. Purpose

For the case in which the slab has not equilibrated by the end of the problem. CØRFIT is used to compute the insulation weight corrected for structural capacitance (see Reference 1, p.p. 254, 255, and the first two lines of p. 256).

b. Method

GØRFIT first defines DVT as a two-dimensional dependent variable table, the function of Reference 1, p. 255. The independent variable tables are TAUT ( $\tau$  of Reference 1), and RT ( $1/\phi$  of References 1). By statement 30 these tables have been defined, along with the necessary input to CØRFIT for the calculation. By Statement 2, a value of  $\tau_f$  (TLL) is defined for computing  $\tau$ . TLLL is first defined as the actual TSTØP used by the main program minus the effective initial time for the calculation (the output TI for nonablating cases, TADJ for ablating cases). If the actual TSTØP minus the input TSTART is greater than twice the duration of the heat pulse (see MAIN program description). TLLL is redefined (Statement 1) to be twice the duration of the heat pulse minus the effective initial time.

The solution for W1 must be an iterative procedure since  $\tau$  and  $1/\phi$  depend on W1. The procedure used here is a method of false position, with WI for the first guess corresponding to the largest value of  $\tau$  in the tables (10), as defined by Statement 3. Immediately before Statement 3, the reference temperature difference ratio is defined as DTREF.

Having selected a W1,  $\tau$  and  $1/\phi$  are computed (TAU and R), their values checked to see if they are inside the range of TAUT and RT, and the subroutine FINW1 provides the temperature difference ratio (DV) corresponding to TAU and R. This value of DV is compared to DT REF (before Statement 9), and if the relative error is less than the input EPSIL, the iteration procedure is terminated. If greater than EPSIL, W1 is decreased by the input quantity FCT (FACTØR externally) and a new DV computed by going to Statement 4, etc. This continues until a change of sign in the residual indicates a near root (Statement 12), at which time W1 is reset, but FCT is reduced by multiplying by 0.3 (Statement 13). This process continues until convergence is reached, or until the number of iterations exceeds the input MIT (MXIT externally).

Errors are checked for by the program by four successive IF tests ending at Statement 7. If W1 is negative, a message is printed in the output and the corrected weight (WEIGHT) is not computed. If W1 is too large (TAU lower than first entry of TAUT, the upper limit for W1 is tried. If the sign of the residual has not changed, the quantity WEIGHT is not computed, and a message is written. If W1 is too small (TAU larger than the last entry of TAUT), the lower bound for W1 is tried to see if the sign of the residual has changed. If there is a root, the iteration continues. If not, the corrected insulation weight is computed at Statement 14 (Reference 1, p. 257, Equation (41)). An additional error noted occurs when no convergence has occurred before MIT iterations (counted by IT), in which case this fact is noted and no WEIGHT is computed. The weight corrected for structural capacitance must be  $\geq 0$ .

- 5. FINW1
  - a. Purpose

Given in tabular form the function of Reference 1, p. 255, FINW1 computes the temperature difference ratio (DV) given values of TAU and R as independent variables.

b. Method

FINW1 performs a two-dimensional table look-up using the independent variable table DVT whose rows correspond to the independent variable array TAUT and whose columns correspond to the independent variable arrat RT. Using the value of TAU, two table look-ups are done, the first for the entry in RT $\leq$  R, the second for the first entry in RT> R. The results are interpolated linearly in R to compute DV. If R=RT(1), only one table look-up is performed.

## D. SIGNIFICANT EQUATIONS

# 1. MAIN Program

h (T) = HWALLF(T) = A27N (T+460.) + B27N (T+460)<sup>2</sup>

RADR = EMIS. 
$$\left(\frac{\text{TREAR} + 460}{1203.9}\right)^4$$
  
RADA = EMIS.  $\left(\frac{\text{TABL} + 460}{1203.9}\right)^4$ 

K = ZK1/3600.

 $QR & QC \text{ from RTBL & QTBL} \\ q_{max} = RQCMAX = Max (ERT \cdot QR_t + QC_t \cdot QCMULT) (Statement 7330)$ 

$$QRTOT = \int_{\substack{(QR_t + QC_t \cdot QCMULT)dt \\ TIME(1)}}^{TSTOP} QRt + QC_t \cdot QCMULT)dt , QR from RTBL input (Statement 7335) QC from QTBL input$$

$$QRTOT = QRRA = \int_{TIME(1)}^{TSTOP} (QR_t ERT) dt QR from RTBL input (Statement 7335)$$

 $RQINT = \int_{TIME (1)}^{RTQMAX} QR \text{ from } RTBL \\ QR_t \cdot ERT + QC_t \cdot QCMULT dt QC \text{ from } QTBL \\ (Statement 7335)$ 

 $QCMAX = MAX (QC_t \cdot QCMULT)$ 

TQMAX = time QCMAX occurs.

 $QT\phiT = \int_{TIME (1)}^{TST\phiP} (QC_t \cdot QCMULT)dt \quad QC \text{ from } QTBL \text{ (Statement 207)}$ 

QINT = 
$$\int_{\text{TQMAX}}^{\text{TQMAX}} (\text{QC} \cdot \text{QCMULT}) dt, \text{ QC from QTBL input (Statement 205)}$$
  
TIME (1)

 $t_i = TI = RTQMAX - \frac{2 \cdot RQINT}{RQCMAX}$  (Statement 208)

HWABL = HWALLF (TABL) - enthalpy

HWABR = HWALLF (TREAR) - enthalpy

$$QR = \frac{1.82}{(2(TQMAX-TI))} \begin{cases} \frac{2K \cdot RH\phi \cdot CP}{2(TQMAX-TI)} \end{cases} (TABL-TEMPI) + RADA \\ (AHR - \frac{HWABL}{HGMAX}) \end{cases}$$

HGMAX = enthalpy from HTBL at time TQMAX (Statement 6048)

 $TTEST1 = TEMPI+33 \cdot RQCMAX \left\{ \frac{2 (RTQMAX - TI)}{2KSTR \cdot R\phi ST \cdot CP2DG} \right\}^{1/2}$ 

 $TTEST2 = TEMPI + \frac{(\Omega T \phi T + QRRA)}{(W2DG \cdot CP2DG)}$  (Statement 8003)

QTREQT = W2DG ·CP2DG (TREAR - TEMPI)

If QR (above) <RQCMAX, ablation;  $\stackrel{>}{\rightarrow}$ , nonablation Ablation equations

TIA = Time before RTQMAX that

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where  $QC_t$ ,  $HG_t$ ,  $RC_t$  are from the tables QTBL, HTBL, RTBL If such a time is not found, T1A = TSTART

 $t_{\rm fa}$  = T2A = time after RTQMAX that the relation for T1A holds, If such a time is not found, T2A = TSTOP

 $\dot{W}_{a} = WD\phiT_{t} = (\underbrace{QCMULT \cdot QC_{t}(AHR - \frac{HWABL}{HG_{t}}) + ERT \cdot RC_{t} - RADA}_{CP (TABL - TEMPI) + FCRD}$ 

when 
$$WD\phiT_t$$
:  $WSA \leq QC_t$ : QCMULT (AHR  $-\frac{HWABL}{HG_t}$ )

 $\dot{W}_a = WDOT_t = \frac{(ERT \cdot RC_t - RADA}{CP \cdot (TABL - TEMPI)} + DENOM$  when the above is not true.

QC<sub>t</sub>, HG<sub>t</sub>, and RC<sub>t</sub> are from tables QTBL, HTBL, and RTBL at time t. When TFCON  $\leq$  TIME, FCRD in above equation is TURB(4) · TURB(1) [TURB(2)+TURB(3) · (HG<sub>t</sub> - HWABL) · 33.86] +[1 - TURB (4)] TURB(5) [TURB(6)+TURB(7)(HG<sub>t</sub>-HWABL) · 33.86] when TFCON >TIME, FCØN is the same but TURB (1-7) is replaced by LAM (1-7). TURB and LAM are input tables, which are stored as the first and second rows of the matrix FCØN (i, j) When TFCØN  $\leq$  TIME, DENØM = TURB (4) · TURB(1) · HV1R + [1-TURB(4)] TURB (5) · HV2R When TFCON > TIME, TURB(i), alone are replaced by LAM(1) When TFCON  $\leq$  TIME WSA = {TURB(4) · TURB(1) · TURB(3) + [1-TURB(4)] · TURB(5) · TURB(7)} x (HG<sub>t</sub> - HWABL) · 33.86

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when TFCØN>TIME, TURB (i) above are replaced by LAM(i)

$$W_{a} = WA = \int_{T1A}^{T2A} UD\phi T (t) dt \qquad (Statement 312)$$

 $t_{ad_i}$  = TADJ requires the computation of the above WDØT(j) over the time interval from RTQMAX to T2A, DØ loop ending at 6003, Each increment to the WA integral over this time is computed (WA7), and if its squared inverse is individually larger than the quantity

 $C_{P}$  (T2A-TI) /(.8 RH $\phi$ ·ZK·DT<sup>2</sup>), DT being the true time increment

the sum WA7C is incremented by the inverse of the above expression. If the integral increment's squared inverse is  $\leq$  the above expression, WA7C, is not incremented, (loop ending 6004)

$$t_{adj}$$
 = TADJ = T2A-  $\frac{0.8 \cdot Z K \cdot R H O \cdot D T^2 \cdot W A7C}{C P \cdot Z N}$  , where  $Z N$  = the number

of points (separated by DT time increments) between T2A and RTQMAX.

$$QC = \int_{\text{TIME (1)}}^{\text{TSTØP}} dt \qquad (\text{Statement 326})$$

where  $QDII = QCMULT \cdot QC_t - QQQ$ ,  $QC_t$  from input table QTBL.

$$QQQ = \begin{cases} 0, & t \leq T1A, t \leq T2A \\ QCMULT \cdot QC_t \left[AHR - \frac{HWABL}{HG}\right] - RADA, T1A < t < T2A \end{cases}$$

 $HG_t$  and  $QC_t$  from input HTBL and QTBL at time t. (Statement 325)

$$HGT\phi T = \frac{\int_{HG_t dt}^{HG_t dt} HG_t dt}{(TST\phi P - TADJ)} HG_t \text{ from HTBL at time t}$$

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$$QRT\phiT1 = \int_{T2A}^{TST\phiP} RC_t dt, RC_t from input RTBL (Statement 6373)$$

This ends the ablation calculation. The nonablation equations are as follow:

QRT
$$\phi$$
T1 =  $\int_{TST \phi P}^{TST \phi P} RC_t dt$ ,  $RC_t$  from input RTBL (Statement 3329)

 $QC = QT\phi T$  (see above)

$$HGT \phi T = \frac{\int_{HG_t dt}^{.TST \phi P - TI}}{(TST \phi P - TI)}, HG_t \text{ from HTBL at time t (Statement 404)}$$

This ends the nonablation section. For the calculation of TR between  $S_{\mathrm{tatements}}$  500 and 594, see main program write-up.

$$t_{R} = TR = \left\{ \left[ ZK \cdot RH\phi \cdot CP \right]^{1/2} (TREAR - TEMPI) - \left[ Zk \cdot RH\phi \cdot CP \cdot (TREAR - TEMPI)^{2} + 4 \cdot RADR \left( QC(AHR - \frac{HREAR}{HGT\phi T} \right) \right]^{1/2} \right\} / (2 \cdot RADR) \quad (Statement 599)$$
If the slab is equilibrated at the end of the problem,

q  $\mathbf{p}$ 

WINS = WT = 
$$\begin{bmatrix} \frac{RH\phi \cdot Zk \cdot TR}{CP} \end{bmatrix}^{1/2}$$
 (Statement 501)

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$WT\phi T = WT\phi TAL = WEIGHT + WA + WTB$ 

If the slab is not equilibrated at the end of the problem, the weight 1s found as follows TSMAX = T S R, computed from an accelerated Newton-Raphson iteration for the polynomial  $f(t) = A \cdot TSR + B \cdot TSR^2 + C \cdot TSR + D$ , where the coefficients are a function of the current (iterated) insulation weight. (Statements 601 to 603)

WINS = WW-computed by subroutine CURVE based on value of TSS during current iteration for insulation weight (Statements 600 to 6604).

Corrected WINS = WEIGHT (computed from CØRFIT subroutine)-WTB $\begin{bmatrix} ZK1 \cdot RH\Phi/CP \\ ZKB \cdot R\Theta B/CPB \end{bmatrix}$  1/2

 $WT\phi T = WT\phi TAL = WEIGHT + WA + WTB.$ 

#### 2. Subroutine CURVE

 $\frac{\Delta T_R}{\Delta T_S} = \frac{(TREAR-TEMPI)}{(TSS-460-TEMPI)}$  , TSS from main program iteration

A table look up (TLUQ) produces a value of  $at/L^2$  from TBL1, and

the weight is

$$WW = \begin{bmatrix} \frac{Zk \cdot RH\phi \cdot (TST\phiP-TI)}{Cp} & 1/2 \\ \frac{Zk \cdot RH\phi \cdot (TST\phiP-TI)}{Cp} & , -\frac{at}{L^2} \end{bmatrix} from table look-up.$$

$$DTM = DTM = \begin{pmatrix} \frac{\Delta T_m}{\Delta T_S} \end{pmatrix}_{at/L^2} (TSS - 460 - TEMPI) ,$$

$$\begin{pmatrix} \frac{\Delta T_m}{\Delta T_S} \end{pmatrix}_{at/L^2} from TLUQ look-up at current at/L^2$$

3. Subroutine TLUQ -

No significant equations (linear interpolation table look-up).

4. Subroutine CØRFIT

DTREF = (TSR - TSI) / (TSS-TSI)

TSR = input TREAR, TSI = input TEMPI,

TSS = output TSMAX

TLIL = TSTØP - TL, TSTØP - TSTART ≤ 2.QTDUR

= 2.QTDUR - TI, TSTØP-TSTART > 2.QTDUR

QTDUR is computed in the main program as the time after peak convective heating that  $QC_t \leq .01 \cdot QC_{max}$ , minus TSTART.

 $CONTAU = (RH\phi \cdot ZK1 \cdot TLIL) / (CP \cdot 3600).$ 

 $CONR = (W2 \cdot CP2)/CP1$ 

 $TAU = CONTAU / (W1)^2$ 

R = CONR / W1

A method of false position is used with W1 changing TAU and R computed, and a table look-up done in FINW1 to obtain a temperature difference ratio, W1 changing until this ratio is sufficiently close to DTREF. At that time the corrected insulation weight is set equal to W1.

If TAU > 10., WEIGHT is computed as Weight = WW  $\left(1 - \frac{W2 \cdot CP2 \cdot (TSR - TSI)}{WW \cdot CP1 \cdot DTM}\right)$ , W2, CP2 being the structure

weight and specific heat; TSR, TSI as above, DTM the average temperature rise, WW and CP1 the heat shield uncorrected weight and specific heat.

```
5. Subroutine FINW1
```

No equations, two dimensional table look-up.

#### V. REFERENCES

- RAD, Mars-Venus Capsule Parameter Study, V. <u>I</u>, Introduction and Analysis, JPL Contract No. 950626, Avco/RAD, TR-64-1 (1964).
- Brown, J.E., and F.A. Shukis, An Approximate Method for Design of Thermal Protection System, Contract AF 33(616)-7483, Avco/RAD TM-62-3 (25 January 1962).
- Carslaw, H.S., and J.S. Jaeger, <u>Conduction of Heat In Solids</u>, 2nd edition, p. 282, Oxford Press, London (1959).

PROGRAM 1885



## PRESSURE AND HEATING DISTRIBUTIONS (1885)

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#### I. INTRODUCTION

#### A. GENERAL DESCRIPTION

The object of this program is to compute the pressure distribution, laminar heating distribution, turbulent heating distribution, and radiative heating distribution at arbitrary angle of attack for axisymmetric bodies. The resultant distributions can be applied as multiplicative factors on the trajectory data of Program 1880, yielding the local pressure and heating histories at a point on the body. A general functional diagram of the program is given in Figure 1.



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Figure 1 FUNCTIONAL DIAGRAM OF PROGRAM 1885

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The general inputs include:

1. The pertinent shape parameters describing the vehicle geometry. The shape parameters are depicted in Figures 2 and 3 and a partial listing of parametric combinations is given in Table I.

2. The flight conditions, namely, the velocity, ambient temperature, density, and atmospheric composition

3. The angles of attack at which pressure and heating distributions desired

4. The option to consider the windward and leeward meridians as symmetric or two-dimensional bodies

5. A control on the boundary layer edge conditions by specifying the shock angle to which the total conditions correspond (temperature, pressure, etc.) adiabatic exponent  $\gamma_s$  is computed.

6. A control on the shock shape calculation by specifying the degree of the polynomial used to approximate the mass flow distribution across the shock layer

7. A control on the radiation heating calculation by specifying the degree of the polynomial used to approximate the radiation heating distribution across the shock layer.

The general outputs include.

1. The coordinates, surface distance, slope, and curvature of points on the windward and leeward meridians for each angle of attack (in body axes aligned with the relative wind vector, and having their origin at the stagnation point)

2. The location of the stagnation and sonic points

3. The pressure distribution as a fraction of the normal shock stagnation pressure

4. The stagnation point convective heating

5. The sonic point turbulent heating

6. The laminar and turbulent heating distributions

7. The local Reynolds number

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Figure 3 TENSION SHELL AND GENERAL SHAPE PARAMETERS

# TABLE I

## PARTIAL TABLE OF POSSIBLE SHAPES

|    | Shape                      | RN | THN      | RSN | THC | RC | тнв | RSB | RB | THA | RA  | RT      | BETA | TH2G<br>TH3G | RSC | LC         |
|----|----------------------------|----|----------|-----|-----|----|-----|-----|----|-----|-----|---------|------|--------------|-----|------------|
| 1. | Sphere                     | ж  | x        | x   |     | x  |     | x   |    | ж   | x   |         |      |              |     |            |
| 2. | Blunt Cones,               | ×  | x        |     | x   | x  |     | х   |    |     | x   |         |      |              | x   |            |
|    | a. Mod. nose               | x  | x        | x   | x   | x  |     | x   |    |     | x   |         |      |              | x   |            |
|    | <li>b. Mod. aft. body</li> | x  | x        | x   | x   | x  |     | x   |    | x   | ж   |         |      |              |     |            |
|    | c. Mod. aft. body          | x  | x        | x   | ×   | x  |     | x   |    | x   |     | x       |      |              |     |            |
|    |                            |    |          |     |     |    |     |     |    |     |     |         |      |              |     |            |
| з. | Cone Cyl., Flare           | x  | x        |     | x   | х  | x   | x   | x  | ×   | x   |         |      |              |     |            |
|    | a. Mod. nose               | x  | x        | ×   | ×   | x  | x   | x   | x  | x   | x   |         |      |              |     | <u></u>    |
|    | b. Mod. aft. body          | x  | x        | x   | x   | x  | x   | x   | x  | x   |     | x       |      |              |     | x          |
|    | c. Mod. aft. body          | x  | x        | x   | x   | x  | x   | ж   | x  |     | x   |         |      |              |     | x          |
|    |                            |    |          |     | .   |    |     |     |    |     |     |         |      |              |     |            |
| 4. | Capsule Type               | ×  | x        | x   |     | x  |     | x   |    | x   | ×   |         |      |              |     |            |
|    | a. Mod. aft. body          | ×  | x        | x   | x   | x  |     | ×   |    | x   | 1.5 | x<br>() |      |              |     |            |
|    | b. Add. Cyl.               | ×  | x        | x   |     | x  |     | ×   |    | x   | (x) | (x)     |      |              |     |            |
| _  |                            |    |          |     |     |    |     |     |    | ~   |     |         | v    |              | x   |            |
| 5. | Tension Shell              | x  | ×        |     |     |    |     | ^   |    | ^   |     | v       | v    |              | ×   |            |
|    | a. Mod. nose               | x  | x        | ×   |     |    |     |     |    |     |     | ^       | ~    |              |     |            |
| ,  | General Share              |    |          |     |     |    |     |     |    |     |     | x       |      | x            | x   |            |
| •  | General Shape              | ×  | <u></u>  |     |     |    |     |     |    |     |     |         |      | x            |     |            |
|    | a. Mod. nose               | x  | ^        | l î |     |    |     |     |    |     |     |         |      |              |     |            |
| 7  | Sphere Cyl. Flare          | ×  |          |     |     | x  | x   | x   | x  | ×   | х   |         |      |              |     | ×          |
| •• | a Mod nose                 | x  | ×        | x   |     | x  | x   | x   | x  | x   |     |         |      |              |     | 1          |
|    | h Mod aft hody             | *  | <b>1</b> |     |     | x  | x   | x   | x  | x   | ×   |         |      |              |     | 1 1        |
|    | D. Mou. alt. Douy          |    |          | I   |     |    |     |     |    |     |     | i       |      |              |     |            |
| 8. | Sphere, Cone, Cone         | x  | x        |     | x   | x  | x   | x   | x  | х   | x   |         |      |              |     |            |
| 21 |                            |    | 1        |     |     |    |     |     |    |     |     |         |      |              | I   | <u>i j</u> |

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- 8. The local shock standoff distance and corresponding wave angle
- 9. The radiation heating distribution.

#### B. CALCULATION MODEL

#### 1. Vehicle Shapes

Axisymmetric vehicle shapes are considered by prescribing a number of separate conic sections which, when mated together, form the desired shape. The sections allowed are spherical, contal, toroidal, continuous flare(or tension shell), as shown in Figures 2 and 3 A general form for the continuous flare is permitted as an option. A maximum of nine separate sections can be specified at one time. A minimum of two (a sphere) sections can be specified. Further discussion on the omission of various sections is given in the section on usage. Table I lists some of the shapes which can be studied.

#### 2. Angle-of-Attack Geometry and Axes

The angle of attack is measured from the body axis of symmetry, and is the angle between this body axis and the relative wind vector. A new set of body axes are created at each angle of attack, lying along the wind vector and orthogonal to it; these axes are designated wind axes. Essentially, wind axes are utilized at all times, but only at a = 0, 180, does this result in an axisymmetric geometry about the relative wind vector (except for a sphere). The origin of these wind axes is taken at the stagnation point, which is assumed to be located at the most forward point on the body, measured in wind axes as shown in Figure 4. At angle of attack, therefore, there are two sets of body coordinates; one for the windward and one for the leeward meridian. The flow-field calculations are in general taken as dependent on the local body coordinates, slope, surface distance, and curvature, all measured in wind axes.

A special problem area arises when the angle of attack is such that the stagnation point occurs on a straight section (e.g. cone or cylinder), in which case the stagnation point is taken at the midpoint of the straight section. Another problem area is that of a sharp convex corner. In general, sufficient tori sections exist to preclude the occurrence of a sharp convex corner; however, when the flat base section (BASE) is specified, then a sharp convex corner can exist between the aft cone (AFTC $\phi$ N) and the base (BASE).

The calculation model for the translation and rotation of the axes is shown in Figure 5. The stagnation point is located by maximizing  $\bar{x}_a$  where

 $\bar{x}_a = y_{os} \sin a - x_{os} \cos a$ .



Figure 4 TYPICAL WIND AXES LOCATIONS FOR SEVERAL ANGLES OF ATTACK

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COORDINATE TRANSFORMATION EQUATIONS:  $Y_b(\alpha) = (Y_0 - Y_{0S}) \cos \alpha + (X_0 - X_{0S}) \sin \alpha$ 

 $X_b(\alpha) = (X_0 - X_{OS}) COS\alpha - (Y_0 - Y_{OS}) SIN\alpha$ 

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Figure 5 TRANSLATION AND ROTATION OF AXES

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Interpolation formulas are provided for each section to determine the location of the stagnation point precisely. Each section is uniformly divided into a number of N divisions of surface distance, where N is an input number for each section. The coordinates of the N divisions are transformed for each angle of attack as shown in Figure 5. In addition, the local slope is transformed to be the slope with respect to the wind axis and the surface distance of each point is adjusted for the newly found stagnation point.

#### 3. Sonic Point Location

The sonic point location is necessary to aid in determining the pressure distribution in the subsonic region and the stagnation point velocity gradient and shock standoff distance. The calculation model assumes that the sonic point location occurs at the smallest value of  $(x_b)$  where

$$\sin^2 \theta_{\rm b} = \left(\frac{2}{\gamma_{\rm s}+1}\right)^{\frac{\gamma_{\rm s}}{(\gamma_{\rm s}-1)}}$$

The sonic-point relationship given above assumes that the local slope where the flow first becomes sonic is given by Newtonian theory. The adiabatic exponent  $(\gamma_s)$  may either be an input value or is calculated within the program, as discussed in the following section. The precise  $(x_b, \gamma_b)$  coordinates corresponding to the sonic point angle are interpolated.

#### Adiabatic Exponent(y<sub>s</sub>)

An adiabatic exponent  $(y_s)$  is utilized based on the density rațio across a normal shock at the specified flight conditions using the strong shock approximation:

$$\gamma_{\rm s} = \frac{\rho_{\rm w}/\rho_{\rm a} + 1}{\rho_{\rm w}/\rho_{\rm a} - 1}$$

The derivation of the above result from the normal shock equations is premised on the thermodynamic relationship that

$$h = \frac{\gamma_s}{(\gamma_s - 1)} \frac{P}{\rho}$$

Since for isentropic flow,

$$dh = -\frac{1}{\rho} dp$$
 .

it can be seen that if  $(y_s)$  is assumed constant along a streamline, then

$$\frac{h}{H} = \left(\frac{P}{P_s}\right) \frac{\frac{\gamma_s - 1}{\gamma_s}}{s}$$

The adiabatic exponent noted above is only an approximation for determining the speed of sound, and hence the Mach number as,

$$a^2 = \left(\frac{\partial P}{\partial \rho}\right)_{S/R} \stackrel{\sim}{=} \frac{\gamma_s P}{\rho}$$

and further

$$\frac{P}{P_s} = \left(\frac{\rho}{\rho_s}\right)^{\gamma_s}$$

Comparisons of the adiabatic exponents for the enthalpy-pressure and for density-pressure are given in Reference 1. A single adiabatic exponent is used freely to compute all conditions along a streamline, including the Prandtl-Meyer variable in supersonic flow.

#### 5. Oblique Shock Calculations

The oblique shock calculation employs Program 1883 as a subroutine. The conditions behind an oblique shock are needed to perform the shock shape and radiative heating calculations. An iteration is performed using the enthalpy and pressure equation, where

$$\frac{h_{w}M}{RT_{o}} = \frac{HM}{RT_{o}} \left\{ 1 - \frac{V^{2}}{2H} \left[ \left( \frac{\rho_{a}}{\rho_{w}} \right)^{2} \sin^{2}\theta_{w} + \cos^{2}\theta_{w} \right] \right\}$$

$$\frac{P_{w}}{P_{o}} = \frac{\rho_{a}V^{2}}{P_{o}} \sin^{2}\theta_{w} \left( 1 - \frac{\rho_{a}}{\rho_{w}} \right) + \frac{P_{a}}{P_{o}} \quad .$$

The calculation model is depicted in Figure 6. The flight conditions are specified; hence the molecular weight of the atmosphere (M) and the velocity (V), the ambient pressure (P<sub>a</sub>) and density ( $\rho_a$ ), and the total enthalpy (H) are all known. An initial estimate on ( $\rho_a / \rho_w$ ) is made and the enthalpy and pressure computed by the equations, Program 1883 computes the density ratio ( $\rho_a / \rho_w$ ) for these conditions and the enthalpy and pressure are recomputed, tested for accuracy, and further iterated if necessary.

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#### 6. Stagnation Point Velocity Gradient

The calculation of the velocity gradient on the windward and leeward meridians is performed as follows:

a. If no straight section  $\left(\frac{d\theta}{dS} < 0\right)$  exists between  $0 \le S_b < S_b^*$ , evaluate

(du/ds)via Table II (from Reference 2), letting  $x_{\rm T}$  y\_T correspond to the sonic point values.

b. If a straight section occurs between  $0 < S_{\rm b} < S_{\rm b}^{*}$  , and if

$$\frac{d\theta}{dS} = 0, \text{ at } S_{b} = 0$$

$$\mathbf{x}_{b}^{*} \leq \Delta_{so}$$

then,

$$\frac{dU}{dS} = \frac{V}{R_{wo}} \qquad \sqrt{\frac{8}{3}} \frac{\rho_a}{\rho_s}$$

(Reference 4, Page 161)

Otherwise (dU/dS) is evaluated from Table II with  $x_T$ ,  $y_T$  corresponding to the coordinates of meridian at the start of the straight section.

7. Subsonic Pressure Distribution ( $S \leq S_b^*$ )

Two pressure calculation methods are possible within the program, Newtonian or a polynomial distribution. The choice of either depends on the following tests:

a. 
$$\begin{cases} \frac{d\theta}{dS} < 0 & \text{at all points } 0 \le S_b < S_b^* \\ \text{and,} \\ x_b^*/y_b^* \ge \frac{1 - \sin \theta_b^*}{\cos \theta_b^*} \\ \text{b. } \frac{d\theta}{dS} = 0 & \text{at one point or more } 0 < S_b^* < S_b^*, \text{ and} \\ \frac{d\theta}{dS_b} < 0 & \text{at } S_b^* = 0 \end{cases}$$

If either of the tests is satisfied, the Newtonian method is used; if not, the polynomial distribution is used. The polynomial distribution is of the form:

$$\frac{P_{e}}{P_{s}} = 1 + C_{1} S_{b}^{2} + C_{2} S_{b}^{4}$$

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#### TABLE II

#### VELOCITY GRADIENT CORRELATION

| -                       |       | 1      |       | ×T/yT | x <sub>T</sub> /y <sub>T</sub> |       |       |  |  |
|-------------------------|-------|--------|-------|-------|--------------------------------|-------|-------|--|--|
| $\frac{\rho_a}{\rho_s}$ |       | 0      | 0.10  | 0,20  | 0.30                           | 0.35  | . 40  |  |  |
|                         | 0     | 0      | 0     | 0     | 0                              | 0     | 0     |  |  |
|                         | 0.005 | 0.004  | 0.007 | 0 014 | 0 035                          | 0.050 | 0 110 |  |  |
|                         | 0.01  | 0 008  | 0.015 | 0.025 | 0.060                          | 0.090 | 0.150 |  |  |
|                         | 0.02  | 0.016  | 0,022 | 0.050 | 0.100                          | 0.140 | 0.195 |  |  |
|                         | 0.04  | 0. 032 | 0.052 | 0.087 | 0.150                          | 0.195 | 0.255 |  |  |
|                         | 0,08  | 0.070  | 0 098 | 0.145 | 0.225                          | 0 278 | 0.324 |  |  |
|                         | 0.16  | 0. 143 | 0.183 | 0.238 | 0.325                          | 0.380 | 0.455 |  |  |

 $\frac{y_{\mathrm{T}}}{v} \frac{\mathrm{d}u}{\mathrm{d}S} \left( \frac{\rho_{\mathrm{a}}}{\rho_{\mathrm{s}}} , \frac{x^{*}}{y^{*}} \right)$ 

\*Obtained using the method of Reference 2

at some point where 
$$\theta_{\rm b}^{*} = \sin^{-1} \left(\frac{2}{\gamma_{\rm s}+1}\right)^{\frac{\gamma_{\rm s}}{2(\gamma_{\rm s}-1)}}$$
.

#### TABLE III

SHOCK PARAMETERS FOR BLUNT CYLINDER

| Δ <sub>so</sub> /y <sub>b</sub> | R <sub>wo</sub> /y <sup>*</sup> <sub>b</sub> | Ps/Pa |
|---------------------------------|----------------------------------------------|-------|
| 1.20                            | 2.40                                         | 1     |
| 0.72                            | 3.40                                         | 3     |
| 0.60                            | 3.75                                         | 4     |
| 0.53                            | 4.05                                         | 5     |
| 0.47                            | 4 30                                         | 6     |
| 0.40                            | 4.90                                         | 8     |
| 0.36                            | 5, 25                                        | 10    |
| 0.33                            | 5.55                                         | 12    |
| 0 28                            | 6 20                                         | 16    |
| 0.13                            | 9 30                                         | • 50  |

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where the coefficients  $C_1$  and  $C_2$  are found by the conditions

a. 
$$S_b = S_b^*$$
,  $\frac{P_e}{P_s} = \frac{P_e^*}{P_s}$ 

b. 
$$S_b = 0$$
,  $\frac{d^2 P_e}{dS^2} = -\rho_s \left(\frac{dU}{dS}\right)^2$ 

8. Pressure Distributions for  $S_b > S_b^*$ 

The pressure distribution downstream of the sonic point  $(S_b > S_b^*)$  is found by selecting one of several possible methods. The possible methods included in the program are:

- a. Newtonian theory
- b. Constant pressure
- c. Entropy Layer Theory
- d. Prandtl-Meyer

The choice of the method to be used at each succeeding division (or section), along the meridian is dependent on tests of curvature, slope, and pressure at the last point calculated. The test criteria are summarized in Table IV. The MP data are given in Table V.

The entropy layer theory is described in References 5 and 6 and provision is included for considering the meridian as that of an axisymmetric or twodimensional body by input of the sentinel XJ = 1. or XJ = 0, respectively.

A limit is placed on the pressure distribution computation in that when the pressure first reaches the ambient value, then the pressure is kept constant at this value over the remainder of the body.

The Prandtl-Meyer calculation is performed via table lookup using the data in Table VI, obtained from Reference 7.

A comparison of the pressure distributions obtained via Program 1885 with experimental data for a hemisphere cylinder is shown in Figure 7.

#### 9. Total Pressure Option

For bodies of small bluntness, an option is provided to compute the boundary layer edge conditions corresponding to flow through a specified oblique shock as discussed in Reference 9. The static pressure distribution is assumed to be unchanged. A shock wave angle other than 90 degrees is specified as input, for which the new total conditions are computed



Figure 7 PRESSURE DISTRIBUTION ON A HEMISPHERE CYLINDER

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# TABLE IV

# TEST CRITERIA FOR PRESSURE METHOD SELECTION

| $ \left[ \begin{pmatrix} \frac{d\theta}{dS} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\$ | $\frac{P_e}{P_s}$                                   | $\theta_{\rm b}$ | Method |
|-------------------------------------------------------------------------------------------------------|-----------------------------------------------------|------------------|--------|
| +                                                                                                     | _ <mp< td=""><td>All</td><td>NEWT</td></mp<>        | All              | NEWT   |
| +                                                                                                     | >MP                                                 | A11              | NEWT   |
| 0                                                                                                     | >MP                                                 | <u>&gt;</u> 0    | PC     |
| o                                                                                                     | _ <mp< td=""><td><u>&gt;</u>0</td><td>EL</td></mp<> | <u>&gt;</u> 0    | EL     |
| 0                                                                                                     | ALL                                                 | <u>&lt;</u> 0    | PC     |
| -                                                                                                     | >MP                                                 | A11              | NEWT   |
| -                                                                                                     | <u>&lt;</u> MP                                      | A11              | PM     |

# TABLE V

# NEWTONIAN-PRANDTL MEYER MATCH POINTS

| γ <sub>s</sub> | MP     |
|----------------|--------|
| 1.15           | 0.4086 |
| 1.18           | 0.3985 |
| 1.20           | 0.3918 |
| 1.22           | 0.3854 |
| 1.24           | 0.3790 |
| 1.26           | 0.3728 |
| 1.28           | 0.3667 |
| 1.30           | 0.3607 |
| 1.40           | 0.3318 |
| 1.67           | 0.2678 |

#### TABLE VI

|   |                      |         | 1       |         |          |
|---|----------------------|---------|---------|---------|----------|
|   | $\nu \gamma = 1, 15$ |         | 1.2     | 1.3     | 1.4      |
| - | 0                    | 0.5744  | 0.5645  | 0.5457  | 0.5283   |
| 1 | 4                    | 0.4567  | 0.4451  | 0.4230  | 0 4029   |
|   | 8                    | 0.3867  | 0.3743  | 0.3511  | 0.3298   |
|   | 12                   | 0.3292  | 0 3165  | 0.2927  | 0.2712   |
|   | 16                   | 0,2801  | 0.2673  | 0.2436  | 0 2222   |
| 1 | 20                   | 0.2375  | 0.2249  | 0,2016  | 0 1808   |
|   | 24                   | 0.2006  | 0 1882  | 0 1656  | 0 1459   |
|   | 28                   | 0,1685  | 0 1564  | 0 1352  | 0.1165 - |
|   | 32                   | 0.1406  | 0.1294  | 0 1093  | 0.09202  |
|   | 36                   | 0.1174  | 0.1061  | 0.08747 | 0.07176  |
| 1 | 40                   | 0.09606 | 0.08635 | 0.06934 | 0.05519  |
|   | 44                   | 0.07860 | 0 07069 | 0.05433 | 0.04181  |
|   | 48                   | 0.06381 | 0.05577 | 0.04206 | 0.03116  |
|   | 52                   | 0.05144 | 0.04421 | 0.03214 | 0.02280  |
| ļ | 56                   | 0.04114 | 0.03471 | 0.02424 | 0.01635  |
| - | 60                   | 0 03296 | 0.02698 | 0.01800 | 0.01148  |
| 1 | 64                   | 0.02565 | 0.02078 | 0 01317 | 0.00786  |
|   | 68                   | 0.01998 | 0,01580 | 0.00946 | 0.00524  |
|   | 72                   | 0.01543 | 0.01189 | 0.00668 | 0.00339  |
| į | 76                   | 0.01181 | 0.00883 | 0.00462 | 0.00212  |
| ł | 80                   | 0.00894 | 0.00649 | 0.00313 | 0.00127  |
| 1 | 84                   | 0.00670 | 0.00470 | 0.00207 | 0.00073  |
|   | 88                   | 0 00497 | 0.00335 | 0.00133 | 0.00040  |
| ł | 92                   | 0.00364 | 0 00237 | 0 00083 | 0.00020  |
| į | 96                   | 0 00264 | 0 00163 | 0 00050 | 0.00010  |
|   | 100                  | 0.00189 | 0.00111 | 0 00029 | 0 00004  |
|   | 104                  | 0 00134 | 0.00074 | 0.00016 | 0.00002  |
|   | 108                  | 0.00093 | 0.00049 | 0.00009 | 0.0      |
|   | 112                  | 0.00064 | 0.00031 | 0 00004 | 00 -     |
|   | 116                  | 0.00044 | 0.00020 | 0.00002 | 0.0      |
|   | 120                  | 0.00029 | 0.00012 | 0.00001 | 0.0      |

PRANDTL - MEYER - TABULAR DATA FOR  $P/P_T$ 

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# TABLE VII

shock stand off distance (  $\Delta_{s}/y_{\rm T}$  ) for convex bodies

.

|                |      | 0     | 0.1   | 0.2   | 0.3    | 04      | È  |
|----------------|------|-------|-------|-------|--------|---------|----|
| ρ <sub>a</sub> | 0.02 | 0.21  | 0.135 | 0.070 | 0 032  | 0.020   | l  |
| ρ <sub>s</sub> | 0 04 | 0.275 | 0.190 | 0.115 | 0.065  | 0.040   | Ŀ  |
| T.             | 0.05 | 0.30  | 0 210 | 0 135 | 0.080  | 0.050   |    |
| ļ              | 0.06 | 0.32  | 0.235 | 0 155 | 0 095  | 0.060   | l  |
| 4              | 0 08 | 0 357 | 0.272 | 0.192 | 0 125  | 0 080   | İ. |
|                | 0.10 | 0.387 | 0 305 | 0 225 | 0.150  | 0.100 ' | l  |
|                | 0.12 | 0.415 | 0.335 | 0 255 | 0 177  | 0.118   | l  |
|                | 0.16 | 0.462 | 0 390 | 0.310 | 0. 232 | 0.157   | ŀ  |

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( $P_T$ ,  $\rho_T$ ,  $T_T$ ) and for which a new adiabatic exponent ( $\gamma$ ) is found, these quantities are then used to calculate the necessary flow variables needed to compute the convective heating.

#### 10. Stagnation Point Convective Heating

The stagnation point heating is computed using the correlations of Reference 10 for air The stagnation point velocity gradient on which the heating is based depends on what section of the body the stagnation point occurs If the stagnation point occurs on a spherical cap, then the velocity gradient, for the purposes of computing heat transfer, is taken as the average of the windward and leeward value. If the stagnation point occurs on a torus, cone, or cylinder, the velocity gradient, for the purposes of computing the heating, is taken as the average of the value found above and the value corresponding to a cylinder of radius  $y_{ns}$  /sin a.

The stagnation point heating expression from Reference 10 is:

$$q_{LS} = \frac{0.76}{\sigma^{0.6}} \left( \frac{\rho_{b} \mu_{b}}{\rho_{s} \mu_{s}} \right)^{0.1} \sqrt{\rho_{s} \mu_{s}} \frac{H}{778} \sqrt{\left(\frac{dU}{ds}\right)} \left[ 1 + (L^{a} - 1) \frac{h_{D}}{H} \right]$$

The Lewis and Prandtl numbers are input as well as the exponent (a). The dissociation enthalpy  $(h_D)$  is computed in the oblique shock subroutine.

The stagnation point heating to a three dimensional stagnation point has been derived by Reshotko<sup>11</sup>. The result indicates that the heating can be found in a similar way as in the case of the axisymmetric stagnation point, except that the velocity gradient is given by

$$\frac{dU}{dS} = \left(\frac{dV}{dy} + \frac{dW}{dz}\right) \frac{1}{2}$$

where (dV/dy) and (dW/dz) are the gradients along the two principal radii of curvature. In axisymmetric flow the two velocity gradients are equal, whereas, in two dimensional flow, one is zero, hence, the heating to a cylinder is  $\sqrt{1/2}$  of that to a sphere of the same radius.

The velocity gradient dU/dS must be singly valued for both the leeward and windward meridian When the stagnation point is on a spherical cap, the velocity gradient is approximated as.

$$\frac{dU}{dS} = \frac{1}{2} \left(\frac{dU}{dS}\right)_{leeward} + \frac{1}{2} \left(\frac{dU}{dS}\right)_{windward}$$

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When the stagnation point is on a torus or straight section, the velocity gradient is approximated as

$$\frac{dU}{dS} = \frac{1}{2} \left[ \frac{1}{2} \left( \frac{dU}{dS} \right)_{\text{leeward}} + \frac{1}{2} \left( \frac{dU}{dS} \right)_{\text{windward}} \right] + \frac{V}{2} \frac{\sin \alpha}{y_{\text{os}}} \sqrt{\frac{3 \rho_{\text{a}}}{\rho_{\text{s}}}}$$

where the last term on the right is the velocity gradient for a cylinder (Reference 4) of radius ( $y_{os} / \sin \alpha$ ).

#### 11. Laminar Heating Distribution

The laminar heating equations are based on Reference 9 for air The distribution is obtained by normalizing the results with the zero angle of attack stagnation point value. An option is provided to calculate the heating along the windward and leeward meridians assuming either a two-dimensional or axisymmetric body. The calculation includes the affect of local pressure gradient using the approach of local similarity, however, unfavorable pressure gradients (e g., along a tension shell) are not accounted for, in which case the pressure gradient term is placed equal to zero.

The laminar distribution, generalized for either two-dimensional or axial symmetric flows, is given by

$$\frac{q_{\rm L}}{q_{\rm LS}} = \frac{y_{\rm b}^{\rm J} \rho_{\rm b} \mu_{\rm b} U_{\rm e} (1 + 0.096 \sqrt{\beta})}{(1.068) \sqrt{2 \xi} \sqrt{2 \rho_{\rm bs}} \mu_{\rm b} \left(\frac{\rm dU}{\rm dS}\right) \psi_{\rm r,L}} \sqrt{\frac{2}{j+1}}$$

where,

$$\xi = \int_{0}^{S} \rho_{b} \mu_{b} U_{e} y_{b}^{2j} dS , \beta = 2 \frac{d \ln U_{e}}{d \ln \xi}$$

$$\begin{pmatrix} du \\ dS \end{pmatrix}$$
 is velocity gradient for either windward or leeward meridian.

The tabulated output references the heating to the zero angle-of-attack stagnation point values and so,

$$\frac{q_{\rm L}}{(q_{\rm LS})}_{\alpha = 0} = \frac{q_{\rm L}}{q_{\rm LS}} \times \frac{q_{\rm LS}}{(q_{\rm LS})}_{\alpha = 0}$$

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#### 12. Turbulent Heating

The turbulent heating calculation utilizes the flat plate reference enthalpy method of Reference 12. The inputs include the Prandtl number and a correction term for axial symmetry if J=1. (XJ = 1.). The output is normalized with respect to the zero angle-of-attack sonic point value.

#### 13 Radiation Heating

The radiation heating model is based on the following equation:

$$q_{R} = \frac{\xi_{w}}{2} \left[ \frac{m}{m+1} I_{b} + \frac{1}{m+1} I_{w} \right]$$

where (m) defines the radiation profile across the shock layer as

$$I = I_b + (I_w - I_b) \left(\frac{\xi}{\xi_w}\right)^n$$

and where  $I_b$  and  $I_w$  are the radiation intensities at the body and at the shock along a line normal to the body at the coordinates  $x_b$ ,  $y_b$ . The exponent (m) is an input quantity The intensities are computed by the subroutine containing Program 1883. The quantities ( $\xi_w$ ,  $\theta_w$ ) are computed from the shock shape as described in the following section. The laminar, turbulent and radiative heating distributions on a hemisphere cylinder are shown in Figure 8, as computed by Program 1885.

#### 14. Shock Standoff Distance

The shock shape calculation uses the approach of Reference 3 to compute the shock standoff distance and the shock curvature at the stagnation point. The value of the shock standoff distance at the stagnation point depends on whether,

a. 
$$j = 0, 1$$
  
b.  $\frac{d\theta}{dS} < 0$ ,  $0 \le S_b < S_b^*$   
c.  $x_b^* > \Delta_{so}$ .

dS

For j = l, and if  $\frac{d\theta}{ds} < 0$  for  $0 \le S_b < S_b^*$ , then Table VII is utilized with  $x_T = x_b^*$ ,  $y_T = y_b^*$  If a straight section  $\left(\frac{d\theta}{ds} = 0\right)$  occurs at any point,  $0 \le S_b < S_b^*$ ,

and if  $x_b^* \ge \Delta_{so}$ , then utilize Table VII, and  $x_T = x_{bb}$ ,  $y_T = y_{bb}$  where  $x_{bb}$ and  $y_{bb}$  are the coordinates at the start of the straight section However, if  $x_b^* < \Delta_{so}$ , then utilize Table VII with  $x_T = x_b^*$ ,  $y_T = y_b^*$  and  $\Delta_s = \Delta_{so} - x_b^*$ . For j = 0, and if  $d\theta < 0$  between  $0 \le S_b \le S_b^*$  then,

$$\Delta_{\rm s} = \rho_{\rm a} / \rho_{\rm s} \, {\rm F}$$

where,

$$\begin{split} F &= \frac{1}{\sqrt{1 - \frac{\beta_{a}}{\rho_{s}}}} \begin{bmatrix} \cosh^{-1} \frac{1}{\sqrt{\frac{3 \rho_{a}}{\rho_{s}}}} \end{bmatrix} \begin{pmatrix} -\frac{dS}{d\theta} \\ S_{b} &= 0 \end{split}$$
  
If  $\frac{d\theta}{dS} = 0$  at any point  $0 \leq S_{b} < S_{b}^{*}$ , and if  $x_{b}^{*} \geq \Delta_{so}$  where,  
 $\Delta_{so} &= \frac{3}{2} y_{b}^{*} \begin{pmatrix} \rho_{a} \\ \rho_{s} \end{pmatrix}^{0.25}$  (Reference 4)

evaluate  $\Delta_s$  as noted above. However, if  $x_b^* < \Delta_{so},$  evaluate  $\Delta_s$  as noted above but with

$$\left(\frac{\mathrm{dS}}{\mathrm{d}\theta}\right)_{\substack{\mathbf{S}_{\mathbf{b}} = 0}} = \frac{y_{\mathrm{os}}}{\sin a}$$

#### 15 Shock Curvature at Stagnation Point

Following an approach similar to that of Reference 3, the shock is assumed to be of constant curvature between the stagnation and sonic points. By geometry the radius of curvature is a function of the shock standoff distance at the stagnation and at the sonic points By continuity of mass flow, the standoff distance is further related to the radius of curvature and hence the shock wave is determined. The continuity is invoked by estimating the unit mass flow distribution along a normal ( $\xi$ ) to the body as

$$\rho \mathbf{U} \cos \left(\theta_{\mathrm{WL}} - \theta_{\mathrm{b}}\right) = \left(\rho \mathbf{U}\right)_{\mathrm{e}} + \left[\rho \mathbf{U}_{\mathrm{w}} \cos \left(\theta_{\mathrm{WL}} - \theta_{\mathrm{b}}\right) - \left(\rho \mathbf{U}\right)_{\mathrm{e}}\right] \left(\frac{\xi}{\xi_{\mathrm{w}}}\right)^{\mathrm{n}}$$

as depicted in Figure 9.

The exponent n is an input quantity. The conditions at the shock wave (sub w) are found via the oblique shock computations.

#### 16. Shock Shape

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The shock shape is assumed to have the form

$$Y_w^2 = 2 R_w (X_w + \Delta s) + B (X_w + \Delta s)^2$$

The value of  $R_w$  (the shock wave curvative at the stagnation point) is found as described in Section 15. above. The coefficient (B) is found by satisfying continuity at the first point where  $\theta_b \leq 0$ . The continuity check involves the input of the exponent (n) described above and the choice of the flow index j = 0, l

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UNIT MASS FLOW DISTRIBUTION:  

$$PU - (PU)_{e} + \left[ P_{W}U_{W}COS(\theta_{WL} - \theta_{b}) - (PU)_{e} \right] \left( \frac{\xi}{\xi_{W}} \right)^{n}$$

85-0258

Figure 9 MASS FLOW CONTINUITY MODEL

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As options, the quantities  $\Delta_s$ ,  $R_w,$  B can be input for the windward and leeward meridians and varied for each angle of attack

#### C. LIMITATIONS

Program 1885 was developed primarily for determining the pressure and heating distribution for preliminary design purposes To handle the wide range of configurations and the whole range of angle of attack, within a reasonably sized and quick program, the approach selected was to utilize simple but powerful analytical techniques. The techniques in general are based on the nature of the physics of the problem and should, in general, yield useful initial predictions The limitations which can be clearly identified include:

#### 1. Separated flow effects are not considered

Experimental results of Larson<sup>13</sup> for laminar and turbulent flows have shown that the average heat transfer for the separated laminar boundary layer was found to be 56 percent of that for the equivalent attached laminar boundary layer, independent of Mach number and Reynolds number in agreement with Chapman's<sup>14</sup> theoretical results. Average turbulent heating for the separated case was found to be about 60 percent of that for the equivalent attached boundary layer, but a trend was observed where the reduction in heat transfer increases with increasing Reynolds number.

2 Three-dimensional flow effects are not considered, except in a minor way for the stagnation point heating as the calculation models presume, in general, that the flow field is either axisymmetric or two-dimensional.

3 The convective heating distributions are based on relationships developed for air

4. The viscosity table is for nitrogen.

5. The shock shape and radiation predictions depend on a priori knowledge of (m) and (n) which are important in determining the distributions of mass flow and radiation intensity across the shock layer. These inputs can be adjusted so as to calibrate the program with more detailed numerical calculations or with experiment.

 $\boldsymbol{6}.$  The effects of shock interactions on the tension, general, and flare-shaped bodies are not considered

7. Perfectly sharp nosed shapes cannot be considered.

8. Angle-of-attack conditions leading to attached shocks cannot be considered.

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#### II. USAGE

#### A. 1885A INPUT DEFINITIONS

Due to the size of the program, it was necessary to divide the program into two parts, 1885A and 1885B. Program 1885A computes all the oblique shock data necessary for the heating and pressure distribution calculation. Program 1885B may be run separately provided tabular oblique shock data is input, to replace what would otherwise be computed by the 1885A Program.

| Name   | Preset<br>Values | Symbol         | Parameter                                                                 | Units                 |
|--------|------------------|----------------|---------------------------------------------------------------------------|-----------------------|
| CASE   | 0.               |                | Identification number of the form XX.XX.                                  |                       |
| DATE   | 4.01             |                | Identification number of the form XX.XX.                                  |                       |
| DELAL  | 2.               |                | Calculation interval of oblique shock data.                               | degrees               |
| мем∅   | 0.               |                | Identification number of the form XX.XX.                                  |                       |
| RHØA   | 0.               | Pa             | Atmospheric density.                                                      | slugs/ft <sup>3</sup> |
| TA     | 0.               |                | Atmospheric temperature.                                                  | Kelvin                |
| v      | 0.               | v              | Flight velocity.                                                          | ft/sec                |
| XA     | 0.               | x <sub>A</sub> | Mole fraction argon.                                                      |                       |
| xc     | 0.               | x <sub>c</sub> | Mole fraction carbon dioxide.                                             |                       |
| XN     | 0.               | x <sub>N</sub> | Mole fraction mtrogen.                                                    |                       |
| xø     | 0.               | xo             | Mole fraction oxygen.                                                     |                       |
| XPLAST | 0.               |                | Print out sentinel for all<br>thermochemical data at each<br>shock angle. |                       |

The inputs for the 1885A Program are given initially.

| Name   | Preset<br>Values | Symbol | Parameter                                                                                                                    | Units               |
|--------|------------------|--------|------------------------------------------------------------------------------------------------------------------------------|---------------------|
| ILAST  | 0.               |        | If > 0., tape 8 is rewound at<br>the end of the case. ILAST<br>should normally be set >0<br>only for the last case of a run. |                     |
| INSTØP | 1.               |        | Radiation intensity below which<br>the equilibrium problem<br>is not solved.                                                 | Btu/ft <sup>3</sup> |
| PRTAB  | 1.               |        | If >0., will print tables of shock data.                                                                                     |                     |
| PRTAPE | 1.               |        | If >0., the array TABLE and<br>selected 1885A input are written<br>on Tape 8 for linkage with an<br>1885B run.               |                     |
| XPEVER | 0                |        | If >0., will print all thermo-<br>chemical data for every itera-<br>tion for each shock angle.                               |                     |

# B. 1885B INPUT DEFINITIONS

| Name   | Preset<br>Values | Symbol | Parameter                                                                                                                                                                                                                                                                   | Units   |
|--------|------------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| ALPHA  | 0.               | α      | Array of angles of attack. Max<br>number is 10, of which the<br>first must be 0.                                                                                                                                                                                            | degrees |
| BETA   | 0.               | β      | Tension shell angle.                                                                                                                                                                                                                                                        | degrees |
| BSHØCT |                  | BS     | 10 by 2 matrix of values of<br>the shock parameter $\beta$ if the<br>shock shape 1s 1nput. The<br>first column (1-10) corre-<br>sponds to each $\alpha$ on the wind-<br>ward side, the second column<br>(11-20) to each $\alpha$ on the lee-<br>ward side. See DELS and RW. |         |
| CASE   | 0.               |        | CASE number for identifica-<br>tion, of form XXXX.0.                                                                                                                                                                                                                        |         |

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| Name   | Preset<br>Values | Symbol               | Parameter                                                                                                                                                                                  | Units                             |
|--------|------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| CØMQRD | 0.               |                      | Shock shape sentinel; if 0.,<br>no shock shape and radia-<br>tion is to be computed, > 0<br>otherwise.                                                                                     |                                   |
| DATE   | 4.01             |                      | DATE number for identifi-<br>cation of form X.XX                                                                                                                                           |                                   |
| DELT   |                  | ∆.s                  | An array of at most 10 values<br>of the shock detachment dis-<br>tance $\Delta s$ , one for each $\alpha$ . It<br>is to be specified if the shock<br>shape is input. See BSHØCT<br>and RW. | feet                              |
| DN2    | 0.0001           |                      | Lower limit for accuracy in integrating d(Pe/Ps)/dx by the entropy-layer formulation.                                                                                                      |                                   |
| DTDSTB |                  | (dθ∕dS) <sub>b</sub> | Array of at most 25 values of $(d\theta/dS)_{b}$ for the general shape option.                                                                                                             | rad/ft                            |
| ENTH   | 0.               | hA                   | Ambient enthalpy when shock<br>gas dynamics data are input,<br>rather than from 1885A. See<br>TABLE, RH $\phi$ A, XA, XC, XN,<br>X $\phi$ , TA, V, PRES, XM, MACH,<br>HDHS90, and TAPE.    | ft <sup>2</sup> /sec <sup>2</sup> |
| GAMSØ  | 0.               | γ <sub>s</sub>       | Value of adiabatic exponent at<br>the stagnation point if it is<br>different from the 1885A data,<br>or if 1885A is not used. If =<br>0, 1885A or TABLE (1, 5)<br>value is used.           |                                   |
| HDHS90 | 0.               | HD/HS                | Ratio of dissociation enthalpy<br>to stagnation enthalpy, specify<br>when 1885A is not used.                                                                                               |                                   |

| Name  | Preset<br>Values | Symbol | Parameter                                                                                                                                                                                                                                                                                                                                                                                                                     | Units |
|-------|------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| ILAST | 0.               |        | If > 0., the tape prepared by<br>1885A will be rewound. It<br>must be > 0 for the last case<br>if 1885A data are used, and if<br>> 0 for an intermediate 1885B<br>case the gas dynamics data of<br>the first 1885A case will be<br>used, and the sequence of<br>1885A-1885B cases regener-<br>ated.                                                                                                                           |       |
| XØTBL | 0.               |        | If $\neq$ 1., the $\alpha = 0$ body geo-<br>metry data will be printed in<br>the output.                                                                                                                                                                                                                                                                                                                                      |       |
| LC    | 0.               | LC     | Cylinder length.                                                                                                                                                                                                                                                                                                                                                                                                              | feet  |
| LE    | 0.               | L      | Lewis number.                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| LX    | 0.               |        | Lewis number exponent.                                                                                                                                                                                                                                                                                                                                                                                                        |       |
| MACH  | 0.               | М      | Mach number, specify 1f<br>1885A 1s not used.                                                                                                                                                                                                                                                                                                                                                                                 |       |
| мемф  | 0.               |        | MEMØ number for identifi-<br>cation of form X.X.                                                                                                                                                                                                                                                                                                                                                                              |       |
| ММ    | 0.               | m      | A 10 by 2 matrix of exponents<br>on the radiation polynomial,<br>specified like BSHØCT above.                                                                                                                                                                                                                                                                                                                                 |       |
| Ν     | 0.               |        | An array of at most 10 numbers,<br>each of which is the number of<br>increments to be used on the i <sup>th</sup><br>body section. For Section 3, i.e.<br>N(3), XX. 1, XX. 2 and XX. 3 are<br>the number of increments for<br>cone, tension shell, or general<br>shape, respectively. For Sec-<br>tion 10, i.e. N(10), XX. 1, and<br>XX. 2 are the number of incre-<br>ments for spherical cap or flat<br>base, respectively. |       |

|        |                  |                 |                                                                                                                                                                                                                                                                                                                                                                    | and the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second s |
|--------|------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Name   | Preset<br>Values | Symbol          | Parameter                                                                                                                                                                                                                                                                                                                                                          | Units                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| NALPHA | 0.               |                 | Number of $\alpha$ 's in the ALPHA array.                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| NN     | 0.               | п               | A 10 by 2 matrix of exponents<br>on the mass flow polynomial.<br>Specified like BSHØCT above.                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| PN     | 0.               | σ               | Prandtl number.                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| PRES   | 0.               | PA              | Ambient pressure, specified when 1885A is not used.                                                                                                                                                                                                                                                                                                                | 1b/ft <sup>2</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| RA     | 0.               | RA              | Aft cap radius.                                                                                                                                                                                                                                                                                                                                                    | feet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| RB     | 0.               | R <sub>B</sub>  | Flare and aft cone base radius.                                                                                                                                                                                                                                                                                                                                    | feet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| RC     | 0.               | <sup>R</sup> C  | Cylinder and cone base radius.                                                                                                                                                                                                                                                                                                                                     | feet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| RHØA   | 0.               | Pa              | Atmospheric density. Speci-<br>fy when 1885A is not used.                                                                                                                                                                                                                                                                                                          | slugs/ft <sup>3</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| RN     | 0.               | R <sub>N</sub>  | Nose radius.                                                                                                                                                                                                                                                                                                                                                       | feet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| RSB    | 0.               | R <sub>SB</sub> | Toroidal radius at aft cone.                                                                                                                                                                                                                                                                                                                                       | feet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| RSC    | 0.               | R <sub>SC</sub> | Toroidal radius at base of cone.                                                                                                                                                                                                                                                                                                                                   | feet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| RSN    | 0.               | R <sub>SN</sub> | Toroidal radius aft of nose.                                                                                                                                                                                                                                                                                                                                       | feet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| RT     | 0.               | <sup>R</sup> T  | Base truncation radius.                                                                                                                                                                                                                                                                                                                                            | feet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| RTBL   | 0.               | Y <sub>i</sub>  | Array of ordinates for general shapes, maximum 25 points.                                                                                                                                                                                                                                                                                                          | feet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| R₩Ø    |                  | R               | A matrix of at most 10 by 2<br>numbers which are bow wave<br>radii, specified like BSH $\phi$ CT<br>above. If any RW(i, j) for an<br><i>a</i> and windward or leeward<br>meridian is specified $\leq 0$ , it<br>is assumed that DELT,<br>BSH $\phi$ CT, and RW are to be<br>computed by the program for<br>use on the shock shape and radia-<br>tion computations. | feet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

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| Name   | Preset<br>Values | Symbol                 | Parameter                                                                                                                                                                       | Units   |
|--------|------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| TA     | 0.               | T <sub>a</sub>         | Ambient temperature, specify if 1885A 1s not used.                                                                                                                              | Kelvin  |
| TABLE  |                  |                        | A matrix of at most 46 by 13<br>numbers, each of whose<br>columns is a corresponding<br>column from 1885A. For<br>example, TABLE (1-46) =<br>THW <sub>i</sub> , TABLE (47-92) = |         |
|        |                  |                        | $RW/RA_1$ , TABLE<br>(553-598) = $IB_1$ . See 1885A<br>output. Specify in the same<br>order as 1885A, and only<br>when 1885A is not used.                                       |         |
| TAPE   | 1.               |                        | If > 0, 1885A input is read<br>in from A2. If $\leq 0$ , shock<br>gas dynamics data is assum-<br>ed to be program input.                                                        |         |
| тв     | 0.               |                        | Body temperature.                                                                                                                                                               | Kelvin  |
| THA    | 0.               | $\theta_{\rm A}$       | Aft cone angle.                                                                                                                                                                 | degrees |
| THB    | 0.               | $\theta_{\rm B}$       | Flare angle.                                                                                                                                                                    | degrees |
| THC    | 0.               | θC                     | Fore cone angle.                                                                                                                                                                | degrees |
| THETAT | 0.               | $\theta_{\mathrm{TT}}$ | Shock angle for stagnation conditions. Used only if $TT \leq 0$ .                                                                                                               | degrees |
| THIN   | 0.               | $\theta_{N}$           | Nose cap angle                                                                                                                                                                  | degrees |
| TH2G   | 0.               | θ2                     | Angle at first point of general shape.                                                                                                                                          | degrees |
| TH3G   | 0.               | θ3                     | Angle at last point of general shape.                                                                                                                                           | degrees |
| Name | Preset<br>Values | Symbol         | Parameter                                                                                                                                                                                       | Units  |
|------|------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| тт¢  | 0.               |                | Total pressure sentinal. If $\leq$ 0 uses normal shock, if >0,<br>P <sub>T</sub> , T <sub>T</sub> , $\rho_{T}$ and $\gamma_{s}$ come<br>from shock gas dynamic data<br>at THW = THETAT (above). |        |
| U:₽2 | 0.001            |                | Upper limit for accuracy in integrating $\frac{d(P_e/P_g)}{d_x}$ by the entropy-layer formulation.                                                                                              |        |
| v    | 0.               | v              | Flight velocity, specify 1f<br>1885A 1s not used.                                                                                                                                               | ft/sec |
| XA   | 0.               | x <sub>A</sub> | Mole fraction of argon in<br>atmosphere. Specify if<br>1885A not used.                                                                                                                          |        |
| xc   | 0.               | х <sub>с</sub> | Mole fraction of $C\phi/_2$ in atmosphere. Specify if 1885A not used.                                                                                                                           |        |
| хј   | 0.               | j              | A 10 by 2 matrix of flow<br>field indixes, 1 = axisym-<br>metric, 0 = two dimensional.<br>Specify like BSHØCT above.                                                                            |        |
| ХМ   | 0.               | M              | Mean molecular weight of<br>atmosphere, specify if<br>1885A is not used.                                                                                                                        |        |
| XN   | 0.               | x <sub>N</sub> | Mole fraction of N <sub>2</sub> in<br>atmosphere. Specify if<br>1885A not used.                                                                                                                 |        |
| хø   | 0.               | х <sub>о</sub> | Mole fraction of $\phi_2$ in atmosphere. Specify if 1885A not used.                                                                                                                             |        |
| XTBL | 0.               | X,             | An array of at most 25 points which are the $X_i$ for the general shape.                                                                                                                        | feet   |

### C. INPUT PROCEDURES

## 1. Vehicles Section Specification (refer to Figures 2 and 3).

The vehicle sections are identified as follows:

Section 1 -- Nose sphere - Specify N (1) followed by number of points desired, i.e., if 8 points are desired, specify N (1) = 8. Specify as input RN, THN, Section 1 cannot be omitted.

Section 2 -- Toroidal section following nose cap. If present, specify N (2) followed by number of points desired. Specify also RSN.

Section 3 -- Three options existing for Section 3, the cone, tension shell, or general shell. If, for example, 25 points are desired for any one of these, then for the cone the input would be N (3) = 25.1, and for the tension shell N (3) = 25.2, and for the general shell N (3) = 25.3. Specify THC for cone, BETA for the tension shell, and TH2G, TH3G for the general shape.

Section 4 -- Toroidal section aft of Section 3, specified as N (4) and also specify RSC, RC. For example, if 12 points are desired, specify N (4) = 12.

Section 5 -- Cylinder section, specified as N (5) and also specify LC, RC. For example, if five points are desired, specify N (5) = 5.

Section 6 -- Flare cone specified as N (6) and with RB, RSB, THB, and with number of points desired as above.

Section 7 -- Toroidal radius aft of flare cone as N (7) and with RSB and with number of points desired as above.

Section 8 -- Toroidal radius at base of aft cone as N (8) and with RSB number of points desired as above.

Section 9 -- Aft cone as N (9) and with THA, and either RA or RT and number of points desired.

Section 10 -- Base section is specified either as a spherical cap or as a flat base. A spherical cap is specified, for example, as N (10) = 8.1, where 8 is the number of points desired and RA is input. A flat base is specified similarly as N(10) = 8.2 and RT is given.

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## 2. Stagnation Conditions Option.

An option is provided for considering stagnation conditions, other than those for a normal shock, at the edge of the boundary layer, to compute the convective heat transfer. The option is used by specifying  $TT\phi$  as the desired shock angle.

## 3. Adiabatic Exponent Option.

An option is provided to input a value of  $(\gamma)$  rather than utilizing the value computed in the oblique and normal shock subroutine.

## 4. Straight Sections

On straight sections, an odd number (N) of points is recommended because roundoff may confuse the point count.

# 5. Shock Shape Parameters

Values of the coefficients ( $R_w$ ) and (B) have been correlated from numerical flow solutions in Reference 15 for spherical bodies. The value of  $R_w$  was found to be given by

$$R_w = R_N (2.09) \left(\frac{\rho_a}{\rho_s}\right) 0.1958$$

The value of B was found to be a function of ( $x_w$ ) and the normal shock density ratio, however, an approximate form was found to provide good agreement when (B) was taken as a constant and equal to (-0.646).

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Studies of the shock shapes about elipsoids and blunt cones are reported in References 16 and 17, but these are directed principally at the region downstream of the nose.

Additional shock shape studies are presented in References 18 and 19. The shock shape form utilized in Reference 18 is of a slightly different form, but the numerical results presented can be used to deduce the parameter ( $R_w$ ) and (B) for elipsoidal and parabolic bodies as well as spheres.

The values of ( $R_w)$ , ( $B_s$ ), and  $(\Delta_s)$  can be input for both the windward and leeward meridians, as a function of angle of attack. The first ten values specified correspond to the windward meridian and values (11-20) correspond to the leeward meridian.

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# 6. Value of (NN)

The value of (NN) to be used 15 found via comparison of shock calculations with results of "exact" calculations and/or experiment.

Values of (NN) can be found from the results given in Reference 18 for a point slightly downstream of the some point for a sphere. A typical correlation of the theoretical distribution of mass flow rate across the shock layer is shown in Figure 10.

Values of NN can be input for both the windward and leeward meridians, as a function of the angle of attack. The first ten values specified correspond to the windward meridian and values (11-20) correspond to the leeward meridian.

## 7. Value of (MM)

The value of (MM) to be used 1s found via comparison of radiation predictions with more "exact" calculations and/or experimental data where available.

Values of MM can be input for both the windward and leeward meridians as a function of the angle of attack. The first ten values specified correspond to the windward meridian and values (11-20) correspond to the leeward meridian.

## 8. Flow Field Option

By specifying XJ as 0. or 1, the calculations consider the body as either two dimensional or axisymmetric. The values of XJ can be specified for both the windward and leeward meridians as a function of angle of attack. The first ten values specified correspond to the windward meridian and values (11-20) correspond to the leeward meridian.

## 9. Two-Part Program

The program consists of two parts, 1885A and 1885B as the latter portion fills the core of the IBM 7094. An option is provided to read in the data of 1885A as tables or via tape. A typical output of 1885A is shown in the following IBM listing. The tabular inputs must include the 13 listed tables as given by a typical 1885A calculation. In addition, several aerodynamic and thermodynamic variables must be input if 1885A is not used, including HDHS90, PRES, MACH, ENTH, XA, XN, XC, XØ, RHØA, V, MACH, TA.

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### 10. Angle-of-Attack Choices

Avoid angles-of-attack choices which place stagnation point close to discontinuities in body curvature because the simplified flow model is inadequate to cope with strong 3-dimensional effects.

## 11. Number of Output Points (N)

Specify (N) large enough for each section such that first (5) points on each side of stagnation point occur on the same section, the choice of (N) is therefore related to the angle-of-attack choices. Discontinuities in curvature near the stagnation point may affect the accuracy of the laminar heating distribution.



Figure 10 MASS FLOW DISTRIBUTION ACROSS THE SHOCK LAYER

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# 12. Input Forms

An input form is provided for the user. All the information shown is keypunched for those variables specified. All numerical values have decimal points.

# D. OUTPUT DEFINITIONS

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| External Name | Parameter                                                             | Units               |
|---------------|-----------------------------------------------------------------------|---------------------|
| GAMMA W       | Adiabatic exponent behind shock.                                      |                     |
| HW/H          | Ratio of local to total enthalpy behind shock.                        |                     |
| ІВ            | Radiation intensity at body.                                          | Btu/ft <sup>3</sup> |
| IW            | Radiation intensity behind shock.                                     | Btu/ft <sup>3</sup> |
| PW/PØ         | Pressure behind shock.                                                | atmosphere          |
| PWS/PØ        | Stagnation pressure behind shock.                                     | atmosphere          |
| RW/RA         | Ratio of density behind shock to ambient density.                     |                     |
| RWS/RA        | Ratio of stagnation density behind shock to ambient value.            |                     |
| RWUW/RAV      | Ratio of specific mass flow rate<br>behind shock to freestream value. |                     |
| TH WL         | Flow angle behind shock.                                              | degrees             |
| THW           | Shock wave angle.                                                     | degrees             |
| TW            | Temperature behind shock.                                             | ۰ĸ                  |
| TWS           | Stagnation temperature behind shock.                                  | °K                  |

## 1885A OUTPUT

| External Name  | Parameter                                                                                                                    | Units                     |
|----------------|------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| ALPHA          | Angle of attack.                                                                                                             | degrees                   |
| DP/DSL, DP/DSW | Leeward and windward pressure gradients.                                                                                     | lb/ft <sup>3</sup>        |
| DT/DSTBL       | Body curvature.                                                                                                              | rad/ft                    |
| DTDS ST        | Body curvature at the stagnation point.                                                                                      | rad/ft                    |
| IST            | Coordinate location number for stagnation point.                                                                             |                           |
| IWSN, ILSN     | Coordinate location for sonic point<br>in windward and leeward meridians.                                                    |                           |
| MØTBL          | Body section number.                                                                                                         |                           |
| PE/PSL, PE/PSW | Leeward and windward pressure distribution.                                                                                  |                           |
| QLL, QLW       | Leeward and windward laminar<br>heating distribution; ratio of local<br>to zero angle-of-attack stagnation<br>point value.   |                           |
| QLS ALØ        | Laminar heating rate at stagnation<br>point at zero angle of attack; used<br>to normalize all laminar heating<br>rates.      | Btu/ft <sup>2</sup> -sec  |
| QRL, QRW       | Leeward and windward radiation<br>heating distribution; ratio of local<br>to zero angle-of-attack stagnation<br>point value. |                           |
| QRS ALØ        | Radiation heating rate at stagnation<br>point at zero angle of attack; used to<br>normalize all laminar heating rates.       | Btu/ft <sup>-2</sup> -sec |

# 1885B OUTPUT

| External Name                                  | Parameter                                                                                                              | • Units                  |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|--------------------------|
| QTL, QTW                                       | Leeward and windward turbulent heat-<br>ing distribution; ratio of local to zero<br>angle-of-attack sonic point value. |                          |
| QTS ALØ                                        | Turbulent heating rate at sonic point<br>at zero angle of attack, used to normal-<br>ize all turbulent heating rates.  | Btu/ft <sup>2</sup> -sec |
| REL, REW                                       | Leeward and windward Reynolds number<br>distribution; ratio of local to free stream<br>value.                          |                          |
| REYA                                           | Free stream Reynolds number based<br>on vehicle diameter (2RC); used to<br>normalize all Reynolds numbers.             |                          |
| SECT                                           | Section Number                                                                                                         |                          |
| THETBL, THETBW                                 | Body slope of windward and leeward meridians.                                                                          | degrees                  |
| THETOTBL                                       | Body angle in zero angle-of-attack axes.                                                                               | degrees                  |
| THET ST                                        | Body angle at stagnation point in zero angle-of-attack coordinates.                                                    | degrees                  |
| THETW SN<br>THETL SN                           | Windward and leeward somc point angle in wind axes.                                                                    | degrees                  |
| XBL, YBL, SBL<br>XBW, YBW, SBW                 | Body windward and leeward coordinates<br>and surface distance in wind axes.                                            | feet                     |
| XBWSN, TBWSN,<br>SBWSN, XBLSN,<br>YBLSN, SBLSN | Coordinates and surface distance to<br>windward and leeward sonic points<br>measured in wind axes.                     | feet                     |
| XƠL, YỢL<br>XƠW, YƠW                           | Body windward and leeward coordi-<br>nates at angle of attack measured<br>in zero angle-of-attack axes.                | feet                     |
|                                                |                                                                                                                        |                          |

| External Name                 | Parameter                                                                                                                       | Units |  |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-------|--|
| XØTBL, YØTBL,<br>SØTBL        | Body coordinates and surface distance<br>at zero angle of attack as measured in<br>zero angle-of-attach axes.                   | feet  |  |
| xøwsn, yøwsn,<br>xølsn, yølsn | Location of windward and leeward<br>somc point at angle of attack in<br>zero angle-of-attack axes.                              | feet  |  |
| XSIL, XSIW                    | Leeward and windward shock de-<br>tachment distance.                                                                            | feet  |  |
| XST, Y <i>ST</i> , SST        | Body coordinates and surface<br>distance to stagnation point at<br>angle of attack as measured in<br>zero angle-of-attack axes. | feet  |  |

## E. SAMPLE PROBLEM

# 1. Statement of Problem

Determine the pressure and heating distributions on a blunt cone configuration for the trajectories obtained in the Sample Problem for Program 1880. The angle of attack range is specified as 0 to 180 degrees.

## 2. Input Forms

The input forms for Programs 1885A and B containing all the necessary input data are shown on following pages. All the variable names should be keypunched where data is specified; decimals are used throughout. Additional input forms are also provided on following pages for the program user.

## 3. Output

The output of Program 1885A is also included in following pages. The oblique shock data are given as a function of the wave angle. In this case, only limited radiation intensity data is given as it is so low; an automatic test on IW and IB is done in the program such that their calculation is dropped if the last value calculated is less than 1.0.

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The output of Program 1885B is shown on following pages. The first tabular array contains the basic geometric data of the vehicle.

Following the first array of data are rows of data summarizing pertinent results contained in the subsequent data array, such as the locations of the stagnation and sonic points. The distribution of pressure, laminar heating, turbulent heating, Reynolds number, and radiation heating are given along with a list of axial coordinates in the zero angle of attack axes which identifies each point. The transformed body coordinates, meridian distance, and local body angles are also given for each point. The shock detachment distance (XSI) is given, permitting the shock shape to be drawn. Tests are provided on (QR) and (XSI) to terminate these quantities when QR becomes less than one percent of the stagnation point value and when (XSI) exceeds (RC), or if the shock angle becomes negative or less than the Mach angle. In the present case, as only one point was found for IB and IW, the radiation is interpolated between these values and zero until the shock angle decreases more than two degrees and the body pressure drops slightly, beyond which the IB and IW are both zero and hence QR is zero.

The values of (B) and ( $\Delta_{\rm s}$ ) and (RW) which were used for the shockwave calculation are indicated.

Two cases are present for which the program was unable to determine shock shapes. These cases are the windward meridian at  $\alpha = 20$  degrees the leeward meridian at  $\alpha = 40$  degrees. For these two points, inputs are required for (RW) and (B).

### F. DIAGNOSTICS

#### 1885A

A number of messages are given in the printcut reflecting the following program diagnostics.

## 1. NØ VALID SØLUTIØN

The equilibrium gas dynamics (1883) solution was not able to obtain a solution with positive concentrations for all the species satisfying the element and charge conservation relationships. In this case the data 1s linearly interpolated between the last and the next point, for which a solution 1s found.

#### 2. NØT CØNVERGED IN 30 ITERATIØNS

The equilibrium gas dynamics (1883) solution was unable to converge within 30 iterations to within 1 percent on the enthalpy, uses last value found.

### 1885B

#### CANNØT FIND THETA FOR RW ØR B, SKIP CASE

A shock shape cannot be found satisfying continuity for the assumed flow model; Requires input DELT,  $RW\phi$ , BSH $\phi$ CT.

## 2. SIN(THETAW) NEG. FOR XB = ().

The shock shape curves toward body beyond given XB, stops the calculation at the last prior XB output.

## 3. THETAW BELØW LIMIT AT XB = .( ).

The shock shape calculation is stopped, as at the next output point, the wave angle is less than the mach angle.

## 4. YW LESS THAN YB:

The shock wave calculation is stopped as, at the next output point, the wave ordinate is less than the body ordinate.  $A_{2,2} = A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2} + A_{2,2$ 

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|        |                 | PROBLEM NO                            | MENO NO.     | SECTION NO                             | CONTINUATION SHI                       | EET           |   |
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| REQUES | T FORM          | 1885B                                 | PL169        | K420                                   | PAGE 2 OF                              | PAGES         | 3 |
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| 4. SFINDT 07405 FINDT                        | 07636               |                            |                                             |                                         | · ····                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 5. SHVST 07752 HVST                          | 13741               |                            |                                             |                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 6. SZONES 14757 ZONES                        | 20513               |                            |                                             |                                         | ,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 8- SGETK 23054 GETK                          | 22132               |                            |                                             |                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 9. SFINDH 23546 FINDH                        | 24135               |                            |                                             |                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 10. SHEAT2 24222 HEAT2                       | 25031               |                            |                                             | · · · · · · · · · · · · · · · · · · ·   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 11. SPHIL 25214 PHIL<br>12. SGETN 25274 CETN | 25430               |                            |                                             |                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 13. SARTLU 27443 ARTLU                       | 27655               |                            |                                             |                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 14. LXCON 30026 .LXST                        | 30026 ¥ ∙LXSTP      | 30032 .LXDUT               | 30100 .LX3TN                                | 30112 IBEXIT 30112 *                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| •LXCAI                                       | . 30115 * LXERR     | 30115 .DBCLS               | 33277 * .LXARG                              | 30446 .L0 30471 *                       | ······                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1510DEF 30506 .DEFI                          | 30505 ATTAC         | 30512 * .CLISE             | 30514 .JPEN                                 | 30516 _READ 30520                       | . +                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| .WRITE                                       | 30522 • B SR        | 30532 * .READ3             | 30542 .XELES                                | 30544 * .LAREA 30555                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                              | 30573 •LTSX         | 30576 * .AREA1             | 33610 LJN8L                                 | 30616 .ENTRY 30622                      | l                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| •6UA<br>•EX34                                | 30722               | 30661 .DERR                | 33675 •VJPX1                                | 30576 .CUMXI 30730                      | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 16. LXSL 30727 .LXSE                         | 30727 LXCSEL        | 30730 .LXTST               | 33733 * .LXOVL                              | 30773 * .LXRCT 31004 *                  | and the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second s |
| LXINE                                        | 31053 * .LXD1S      | 31056 * .LXFL3             | 31057 * .LTCH                               | 31050                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 17. • FPIKP 31066 • FFPI.                    | 31056 # •FPUUT      | 31225 •FPAR3               | 31244 /.CJUNT/                              | 31246 * OVFLOW 31317 *                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 19. XCC. 31332 CC.1                          | 31332 CC.2          | 31333 CC.3                 | 31334 CC.4                                  | 31335                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 20. XIT 31336 EXIT                           | 31336 .EXIT.        | 31336 *                    | ·                                           |                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 21. FXEM 31337 .FXEM                         | 31337 •FXOUT        | 31674 .FXAR3               | 317)2 /.JPT4./                              | 31756                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 23. FCNV 32330 .FCDN                         | 32330 .FCNV.        | 32353 .ENDES               | 32365 .CNVSW                                | 32370 -FDX1 32374                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| •FDX2                                        | 32375 .DBC          | 32377 .DBC1)               | 32535 .08020                                | 32563 .DDSW 32573                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| •DOF I)                                      | 32602 .FIXSW        | 32610 .DDBC                | 32655 .00981                                | 33130 .DDRS2 33132                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                              | 33360 .000          | 33427 .DELT                | 33224 * • • • • • • • • • • • • • • • • • • | 33257 +UNPT 33275<br>33601 -DEXEN 33671 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| .FXD                                         | 33672 .HDUT         | 34072 .INTG                | 34072 LJUT                                  | 34210 .00UT 34227                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| •XCF                                         | 34250 • TFST        | 34767 •KOUNT               | 34772 .LIST                                 | 34775 .DONE 35026                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| - OUT BE                                     | 35106 - 60F         | 35102 •0STD<br>35116 •0305 | 35103 .4IOTH                                | 35104 .GAIN 35105                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| -DATO                                        | 35145 •FEXP         | 35146 .DIG                 | 35147                                       | <b>&gt;</b> ⊋14> •/1√() 55144           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 24. FIOB 35165 .FIOB.                        | 35165 .FCNT         | 35270 * .FBLT.             | 35355 .=9DT.                                | 35406 .FRLR. 35432                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| PRLR.                                        | (35432) •FWLR.      | 35476 .FWLR.               | (35476) .F3IBF                              | 35536 .FRITE 35630                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 22+ FIUS 00000 +FIUS                         | 50055 •FSEL•        | 30110 .FILR.               | 35032 (r3.                                  | 30J11 .FRTD. 36316                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                              |                     |                            |                                             |                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

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|                  | IBLDR                                                                  |                                                                                           |                                               | 12/01/54                                                             | PAGE 2                                            |  |
|------------------|------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------|--|
|                  |                                                                        |                                                                                           |                                               |                                                                      |                                                   |  |
|                  | 26. FIOH 36272                                                         | .FILL. 36021 .FCLS<br>.RFFD 36204 * .BIN<br>.FIDH. 36272 .FFIL.                           | 36023 * .F3PN<br>36205 * .FCT<br>37057 .FRTN. | 35027 * REDF 36033 *<br>36235 .FCKSZ 36210<br>37135 *                | .TOUT. 36176                                      |  |
|                  | 27. FWRD 37302<br>28. FWRB 37326<br>29. FWRU 37352                     | .FWRD. 37302<br>.FWRB. 37326<br>.FWRU. 37352                                              |                                               | 2                                                                    |                                                   |  |
| •                | - 30. FWRO 37376<br>- 31. FROU 40003<br>- 32. UN05 40044               | .FWRO. 37376 .FREST<br>.FRDU. 40003<br>.UN05. 40044                                       | 37701 *                                       |                                                                      |                                                   |  |
|                  | 33. UN06 40045<br>34. FIOU 40051<br>35. JASIN 42276<br>36. JIMOP 42403 | .UND6. 40045 .BUFSZ<br>.FIDU. 40051 .CTUID<br>ASINR 42356 * ASIN<br>ATANOP 42641 ATANO    | 40046<br>40524 .NMLST<br>42365 * ASIND        | 40547 .NAME. 41652<br>42374                                          | .INTAP 41653                                      |  |
| •                | 37. JPLRT 42506<br>38. JCDIV 43746<br>39. JPRT1 44045                  | POLRT1 44230                                                                              | 42410 T ATANGS                                | +2+()                                                                |                                                   |  |
| -                | 40. FLOG 44327<br>41. FXPF 44533<br>42. FSCN 44653                     | ALOG10 44327 * ALDG<br>EXP 44533<br>COS 44653 SIN                                         | 44330<br>44655                                |                                                                      | · · · · · · · · · · · · · · · · · · ·             |  |
| рл ·             | 43. FSUK 45064<br>44. FATN 45171<br>45. FXP3 45377<br>46. FRWT 45524   | SQRT 45064<br>ATAN2 45171 ATAN<br>.XP3. 45377<br>.FRWT. 45524                             | 45173 *                                       |                                                                      |                                                   |  |
| Ň <sup>ŗ</sup> . | 47TOCS 45631                                                           | .L(0) 45631 .MONSW<br>.CLDS. 46063 .ATTC.<br>.OP4 46421 * .OP7                            | 45651 .TEDR<br>46076 .S41<br>46452 * .DP9.2   | 45720 .DE=1. 45000<br>45313 * .SH9 45352 *<br>45455 * .LSE. 46540    | • JOINX 46044 *<br>• DPEN• 46373<br>• RER2• 45540 |  |
| -                |                                                                        | .READ. 46541 .RER1,<br>.FEEIT 47135 .GTIDX<br>.SEL59 50332 * .BSR.<br>.TCHEY 51426 .BASIO | 46564 .WRIT.<br>47126 .RW7<br>50743 .EOTOF    | 45556 .4NT14 46754 *<br>47244 * .2E7 47867 *<br>51073 .ET3F3 51076 * | EDFEX 47735 *<br>ENDTR 50330<br>SWITC 51125       |  |
|                  | 48IOCSM 51432                                                          | •1000X 51425 •BASIO                                                                       | 51451 *                                       | -                                                                    |                                                   |  |
|                  | 1/0 BUFFERS                                                            | 51432 THRU                                                                                | 77613                                         |                                                                      |                                                   |  |
|                  | UNUSED CORE                                                            | 77614 THRU                                                                                | 77777                                         |                                                                      |                                                   |  |
|                  |                                                                        |                                                                                           |                                               | -                                                                    |                                                   |  |
|                  |                                                                        |                                                                                           |                                               | -                                                                    |                                                   |  |
|                  |                                                                        |                                                                                           |                                               |                                                                      |                                                   |  |
| -                |                                                                        |                                                                                           |                                               |                                                                      |                                                   |  |
| -                | <u>}</u>                                                               |                                                                                           |                                               |                                                                      |                                                   |  |
|                  | -                                                                      |                                                                                           |                                               |                                                                      |                                                   |  |
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|   | V =       | +0.12874000E+05. |   |                           |                                         |                                       |         |
|---|-----------|------------------|---|---------------------------|-----------------------------------------|---------------------------------------|---------|
|   | XA =      | +0.0000000E-38+  |   |                           | **                                      | -                                     |         |
|   |           | -+0.2000000E+00. |   |                           |                                         |                                       |         |
|   |           | +0.8000000E+00,  |   |                           |                                         |                                       |         |
|   | xo=       | *0.0000000E-38.  | - |                           | · · · · · · · · ·                       |                                       |         |
|   |           | +0.0000000E-38.  | - |                           |                                         |                                       |         |
|   | XPEVER =  | +0.0000000E-33.  |   | -                         |                                         |                                       |         |
|   | DECAL =   | +0.2000000E+01.  |   |                           |                                         |                                       |         |
|   |           | +0.20000000E+03. |   |                           |                                         |                                       |         |
|   |           | +0-1000000E+01.  |   |                           | -                                       |                                       |         |
|   | PRTAPE =  | +0.10000000F+01. |   |                           |                                         | <u>_</u>                              |         |
|   |           |                  |   |                           |                                         |                                       | ·       |
| ե | TINGTOD - | +0.1000000000000 |   |                           |                                         |                                       | •       |
| ÷ | INSTOR -  | +0.750000005+01  |   |                           |                                         |                                       | · · · · |
|   |           |                  | c |                           |                                         |                                       |         |
|   |           | +0.000000000-38  | - |                           |                                         | · · · · · · · · · · · · · · · · · · · |         |
|   | CASE =    | +0.1000000E+01,  |   |                           |                                         |                                       |         |
|   | \$ END    |                  |   |                           |                                         | ~                                     |         |
|   |           |                  |   |                           | • • • • • • • • • • • • • • • • • • • • |                                       |         |
|   |           |                  | - | ··· / ····                |                                         |                                       |         |
|   |           |                  |   | ·····                     |                                         |                                       |         |
|   |           |                  |   | · · · · · · · · · · · · · |                                         | ~                                     | -       |
|   |           |                  |   |                           |                                         |                                       |         |
|   |           | • •              |   |                           |                                         |                                       |         |
|   | <u>,</u>  |                  |   |                           | <b>.</b> .                              |                                       |         |
|   |           |                  |   |                           |                                         |                                       |         |
|   | 5         |                  |   |                           |                                         |                                       |         |
|   |           |                  |   |                           |                                         |                                       |         |
|   | 3         |                  |   |                           |                                         |                                       |         |
|   | 2         |                  |   |                           |                                         |                                       |         |

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\$INPUT RHOA =

+0.44000000F-06,

|           | тн พ     | RW/RA     | RWUW/RAV  | TH WL  | GAMMA W   | ΥW                | PW/PO     | нили       | 245/24     | PWS/P0    | TWS         | IW        | IB         |   |
|-----------|----------|-----------|-----------|--------|-----------|-------------------|-----------|------------|------------|-----------|-------------|-----------|------------|---|
|           | +90 00   | 11 215401 | +1 005+00 |        |           |                   |           |            |            |           |             |           |            |   |
|           | +88.00   | +1 136+01 | +1.075+00 | +0.00  | +1.186+00 | +3.65(+03         | +3.17E-02 | +9.93E-01  | +1.255+01  | +3.325-32 | +3.696+03   | +1.74E-03 | +1.74E-03  |   |
|           | +86.00   | +1,10E+01 | +1.245+00 | +17.40 | +1 105+00 | + +++ > / E + 0 3 | +3.15E-02 | 49.91E-0L  | +[.[32+]]  | +3.33E-32 | +4.615+03   | +0.00E-39 | +2.035-39  |   |
|           | +84.00   | +1 086+01 | +1 505+00 | 133.02 | +1.196+00 | +4.656+03         | +3.13P-02 | +9.87F-01  | +1+13E+31  | +3.39E-02 | +4.71E+03   | +0.006-30 | +n.00E-39  |   |
|           | +87.00   | +1.046+01 | +1.50E+00 | +42+58 | +1.192+03 | +4./1E+D3         | +3.10F-02 | +9.815-01  | +1.195+01  | +3.49=-02 | +4.81E+03   | +7.375-39 | +0.00F-39  |   |
|           | +80.00   | +1 026+01 | +2 055.00 | +48.01 | +1.232+05 | +4.77E+03         | +3.07E-02 | +9,73E-01  | +L.212+31  | +3.63E-02 | +4.90E+03   | +0.005-39 | +0.00E-39  |   |
|           | +78 00   | +1.030+01 | +2 335+00 | +51+24 | +1+202+00 | +4.81E+03         | +3.03E-02 | +9.52E-01  | +1.252+01  | +3.82F-02 | +5.032+03   | +0.006-39 | +0.00E-39  |   |
|           | +76 00   | +1.010+01 | +2.522+00 | +53.08 | +1.212+00 | +4+84E+03         | +2.98F-D2 | +9.49E-01  | +1.305+01  | +4.05E-02 | +5.10F+03   | +0.00E-39 | +0.00E-39  |   |
|           | - +76.00 | +9.920+00 | +2.59E+00 | +53.99 | +1.216+30 | +4.85E+03         | +2.93E-02 | +9.346-01  | +1.373+31  | +4.33E-02 | +5.205+03   | +0.00E-39 | +0.00E-39  |   |
|           | +72 00   | 49.75E+00 | +2.856+00 | +54+28 | +1.22E+30 | +4.85F+03         | +2.87F-02 | +9.15E-01  | +1,45E+31  | +4.68E-02 | +5.29E+03   | +0.00E-39 | +0.00F-39  |   |
|           | - 170.00 | +9+946+00 | +5.102+00 | +54.12 | +1+555+00 | +4.83E+03         | +2.80F-02 | +8.97E~01  | +1.55E+01  | +5.09E-02 | +5.39E+03   | +0.00E-39 | +0.00F-39  |   |
|           | +10.00   | +9.000+00 | +3.346+00 | +53.64 | +1.23E+00 | +4.80E+03         | +2,73F-02 | +8.75E-01  | +1.63Ξ+31  | +5.58E-02 | +5.48E+03   | +0.00E-39 | +0.00E-39  |   |
|           | - +60.00 | +9.185+00 | +3+560+00 | +52,91 | +1+235+00 | +4.76E+03         | +2.65E-02 | +8.53E-01  | +1.922+01  | +6.17E-02 | +5.57E+03   | +0.00E-39 | +0.00E-39  |   |
|           | +00.00   | +4*01E+00 | +3.782+00 | +52.01 | +1.24E+00 | +4.70E+03         | +2.57E-02 | +8,29E-01  | +1.995+31  | +6.86E-02 | +5.678+03   | +0.00E-39 | +0.00E-39" |   |
|           | +64.00   | +8,85E+00 | +3.98E+00 | +50.95 | +1.24E+00 | +4.62E+03         | +2.43E-02 | +8.02E-01  | +2.208+01  | +7.69E-02 | +5.76E+03   | +0.07E-39 | +0.00F-39  |   |
|           | +62.00   | +8.69E+00 | +4+17E+00 | +49.79 | +1.25E+00 | +4.53E+03         | +2.39E-02 | +7.756-01  | +2.45E+31  | +8,67E-02 | +5.85E+03   | +0.07E-39 | +0.00E-39  |   |
|           | +60.00   | +8.53E+00 | +4.35E+00 | +48.53 | +1.25E+00 | +4.43E+03         | +2.295-02 | +7.45E-01  | +2.742+01  | +9.88E-02 | +5.945+03   | +0.17E-39 | +0.00E-39  |   |
|           | +58.00   | +8.38E+00 | +4.52E+00 | +47.19 | +1.26E+00 | +4.32E+03         | +2.19F-02 | +7.15E-01  | +3.395+31  | +1.13E-01 | +6.03E+03   | +0.105-39 | +0.00E-39  |   |
|           | +56.00   | +8.24E+00 | +4.68E+00 | +45.BO | +1.26E+00 | +4.19E+03         | +2.09E-02 | +6.85E-01  | +3.525+31  | +1.312-01 | +6.12E+03   | +0.00F-39 | +0.005-39  |   |
|           | +54.00   | +8.09E+00 | +4.82E+00 | +44.35 | +1.27E+30 | +4.05F+03         | +1,99F-02 | +6.53F-01  | +4.03E+01  | +1.52E-01 | +6.21E+03   | +0.005-39 | +9-09F-39" |   |
|           | +52.00   | +7,95E+00 | +4.96E+00 | +42.85 | +1.27E+00 | +3.91E+03         | +1.886-02 | +6.21E-01  | +4.55E+31  | +1.77E-01 | +6.30E+03   | +0.035-39 | +0-005-30  |   |
|           | +50.00   | +7.81E+00 | +5.08E+00 | +41.33 | +1.27E+00 | +3.75E+03         | +1.78E-02 | +5.87E-01  | +5.412+01  | +2.09E-01 | +6.38E+03   | +0-006-39 | +0.006-39  |   |
|           | +48.00   | +7.68E+00 | +5.19E+00 | +39.77 | +1.28E+00 | +3.58E+03         | +1.675-02 | +5.54E-01  | +5.348+31  | +2.49E-01 | +6.47E+03   | +0.005-39 | +0.00E-39  |   |
|           | +46.00   | +7.54E+00 | +5.29E+00 | +38.18 | +1.28E+00 | +3.41E+03         | +1.56E-02 | +5.20E-01  | +7.505+01  | +2.98E-01 | +6-565+03   | +0.116-39 | +0.000-30  |   |
|           | +44.00   | +7.41E+00 | +5.37E+00 | +36,57 | +1.29E+D0 | +3.23E+03         | +1.45E-02 | +4.87E-01  | +8.95=+01  | +3-605-01 | +6.64F+03   | +0.00E-39 | +0.00E-39  |   |
|           | +42.00   | +7.27E+00 | +5.45E+00 | +34.94 | +1.29E+00 | +3.05E+03         | +1.34E-02 | +4.53E-01  | +1+09=+02  | +4-39E-01 | +6.736+03   | +0.015230 | 10.000-37  |   |
| L .       | +40.00   | +7.14E+00 | +5.51E+00 | +33.30 | +1.30E+00 | +2.86E+03         | +1.24E-02 | +4.206-01  | +1.315+02  | +5-47E-01 | +6.815+03   | A0-01E-39 | +0-00E-39  |   |
| - 15<br>N | +38.00   | +7.01E+00 | +5.56F+00 | +31.64 | +1.30E+00 | +2.65E+03         | +1.13E-02 | +3.87E-01  | +1.512+12  | +6.71E-01 | +6-89F+03   | +0.005-30 | 10100C-39  |   |
| î.        | +36.00   | +6.87E+00 | +5.59E+00 | +29.96 | +1.31E+00 | +2.47E+03         | +1.03F-02 | +3-54E-01  | +1.395+02  | +8.42E-01 | +6.095+03   | AD 005-30 | AD 00E-30  |   |
|           | +34.00   | +6.73E+00 | +5.61E+00 | +28.28 | +1.31E+00 | +2.28E+03         | +9.295-03 | +3-235-01  | +2.505+02  | 41.075400 | 10. 902103  | +0.002-09 | 101000-39  |   |
|           | +32.00   | +6.59E+00 | +5.61E+00 | +26.58 | +1.32E+00 | +2.08F+03         | +8.33E-03 | +2.925-01  | +3.17E+02  | +1.375+30 | +7.145+03   | +0.000-30 | +0.002-39  | , |
|           | +30.00   | +6-44E+00 | +5.60E+00 | +24.87 | +1.32E+00 | +1.89F+03         | Ŧ7.40F-03 | 42-62 F=01 | 14.08-102  | 1 705403  | 47 YTCENT   | +0-00037  | +0.00039   |   |
|           | +28.00   | +6.28E+00 | +5.56E+00 | +23.16 | +1.33E+00 | +1.715+03         | +6.51E-03 | +2.345-01  | 15 315132  | 12 265100 | +7 226+03   | +0.036-39 | +0+002-39  |   |
| -         | +26.00   | +6.11E+00 | +5.51E+00 | +21.43 | +1.335+00 | +1.536+03         | +5_66E=03 | 12+37E-01  | 17 325132  | +2 165+00 | +7 205+03   | +0.038-39 | +U+UUE=39  |   |
|           | +24.00   | +5.92E+00 | +5.42F+00 | +19.70 | +1.34E+00 | +1.35E+03         | +4 845-03 | -1 915-01  | +0 442+02  | +4 305+00 | TT. 355 TUS | +0.105-39 | +0.002-39  |   |
| -         | +22.00   | +5.71E+00 | +5.31E+00 | +17.95 | +1.34E+00 | +1.186+03         | +4 116-03 | A) 575-01  | +1 205+33  | +5.000100 | T1.402700   | +0.035-39 | +0.002-39  |   |
|           | +20.00   | +5.48E+00 | +5.16E+00 | +16.20 | +1.35E+00 | +1.03E+03         | +3.415-03 | 11 355-01  | +1 735+03  | 19 30E100 | +7.54.+05   | +0.336-39 | +0.002-39  |   |
| -         | +18.00   | +5.21E+00 | +4.96F+00 | +14.43 | +1.356+00 | +8.78E+02         | 42 70E-03 | A1 146-01  | 12 636.03  | +0+252+01 | 77.0224119  | +0-000-09 | +0.002-39  |   |
|           | +16.00   | +4.89E+00 | +4.71E+00 | +12.64 | +1.365+00 | +7 415+02         | +2 205-03 | +0 525.01  | +2.925+39  | +1.185+01 | +7.705+03   | +0.006-39 | +0.002-39  |   |
|           | +14.00   | +4.50E+00 | +4-37E+00 | +10.83 | +1.346+33 | +6 175+07         | 11 (05-03 | 194956-02  | +3.332+33  | +1.102+01 | +1.77++03   | +0.016-39 | +0.00F-39  |   |
|           | +12.00   | +4.03E+00 | +3-95E+00 | +8.98  | +1 37E+00 | +6 04 5403        | +1 345.03 | +1+05E-02  | *3.232+33  | +2.485+01 | +7.855+03   | +1.038-39 | +0.008-39  |   |
| -         | +10.00   | +3.446+00 | +3-40E+00 | +7.07  | +1.375+00 | +4 10E+02         | 10 676-04 | +6.391-02  | F/++35+J3  | 75.03E+31 | +7-428+03   | +0.JJF-39 | +0.00E-39  |   |
|           | +8.00    | +2.73E+00 | +2.716+00 | +5.05  | +1.386+00 | +2 29E+02         | +5 427-04 | +2.138-02  | +1.05E+34  | +5.11E+01 | +8.006+63   | +0.076-39 | +0+00E-39  |   |
| -         |          | +1.895+00 | +1.89F+00 | +2.82  | +1.395+00 | +2 415+02         | +2 075-04 | +++J/E-02  | +1+396+34  | +5.81E+71 | +8.08E+03   | +0.03E-39 | +0.00E-39  |   |
|           | +4.00    | +1.01E+00 | +1-01E+00 | +0.05  | +1.395+00 | +2.01010+02       | +1 215-04 | TD+20E-02  | +L+33=+34  | +8.016+01 | +5+15E+03   | +0.00E-39 | +0.00E-39  |   |
| -         | +3.97    | +1.00F+00 | +1.00E+00 | +0.00  | +1 395+00 | +2.010+02         | TI-216-04 | TZ+44E-02  | +1.055=+04 | +/.73E+01 | +5.22E+03   | +0.335-39 | +0.00E-39  |   |
|           |          |           |           | 10.00  |           | T4+00E702         | +r.19E-04 | *Z. +3E-02 | +1.9(6+34  | +7.72E+01 | +8.22F+03   | +0.00E-39 | +D.00E-39" |   |
| -         | -        |           |           |        |           |                   |           |            |            |           |             |           |            |   |

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| 158 LINES OUTPUT.                                   |                                       |
|-----------------------------------------------------|---------------------------------------|
| \$PAUSE<br>OPER. ACTION PAUSE                       |                                       |
| . CONTINUING                                        | _                                     |
| SPAUSE                                              |                                       |
| CONTINUING                                          |                                       |
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| I LINES DUIVAIT THIS JUB.                           |                                       |
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| \$IBLDR SGETB<br>\$IBLDR SGETOR<br>\$IBLDR SFINDR<br>\$DATA | 12/31/64<br>12/31/64<br>12/31/54 | 53ET3330<br>53ET3333<br>55IN3333 |
|-------------------------------------------------------------|----------------------------------|----------------------------------|
|-------------------------------------------------------------|----------------------------------|----------------------------------|

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|     | IBLDR                            |                    |                  |                            | 12/01/6          | • 4                |           | PAGE 20   |                                       |
|-----|----------------------------------|--------------------|------------------|----------------------------|------------------|--------------------|-----------|-----------|---------------------------------------|
|     | - ,                              |                    |                  |                            |                  |                    |           |           |                                       |
|     |                                  | * MEMORY MAP *     |                  |                            |                  |                    |           |           |                                       |
|     | SYSTEM                           | 00000              | THRU 02717       |                            |                  |                    |           |           |                                       |
|     | FILE BLOCK ORIGIN                | 02720              |                  |                            |                  |                    |           | -         | •                                     |
|     | 2. UNITO                         | 5                  |                  |                            | -                |                    |           | -         |                                       |
|     | 3. UNITO                         | 6.                 |                  |                            |                  |                    |           |           |                                       |
|     | PRE-EXECUTION INITIALIZ          | ATION 02764        |                  |                            |                  |                    |           |           |                                       |
|     | CALL ON OBJECT PROGRAM           | 03023              |                  |                            |                  |                    | -         |           |                                       |
|     |                                  | 03030              | INKU 10131       |                            | -                |                    |           |           |                                       |
|     | DECK ORIGIN                      | CONTROL SECTIONS ( | (/NAMF/=NDN      | O LENGTH, (LC              | C)=DELETED       | + *= NOT REFERENCE | 01        | •         |                                       |
|     | 1. 1885 03030                    | /// /(75154)       | 164              | 37 * '                     |                  |                    |           |           |                                       |
|     | 2. SARTLU 16455                  | ARTLU 16667        |                  | -                          |                  |                    |           |           |                                       |
|     | 4. SPREP 22360                   | /// /(75154) p     | REP 245          | 36                         |                  |                    | -         |           |                                       |
|     | 5. UN08 25146                    | .UN08. 25146       |                  |                            |                  |                    |           |           |                                       |
|     | 7. SDERQ5 30451                  | /// /(75154) E     | DER05 306        | 14                         |                  |                    |           |           |                                       |
|     | 8. SWIND 30637                   | /// /(75154)       | IND 316          | 50                         |                  |                    | •         |           | · · · · · · · · · · · · · · · · · · · |
| 456 | 10. SSUB11 33143                 | 777 7 7(75154) 7   | <b>USI10 402</b> | 67                         |                  |                    |           |           |                                       |
|     | 11. SHDPRN 40305                 | HDPRN1 40367       |                  |                            |                  |                    |           |           |                                       |
|     | 13. SQRCLE 41423                 | QRCLER 41446       |                  |                            |                  |                    |           |           |                                       |
| Λ'. | 14. SQRNMA 41474                 | QRNMAD 41523       |                  | -                          |                  |                    |           |           | <u>, <u>*</u></u>                     |
|     | 16. SGETPR 42574                 | GETPRE 42656       | SIA3PI 424       |                            |                  |                    |           |           |                                       |
|     | 17. SGETNU 42723                 | GETNU 43005        |                  |                            |                  |                    |           |           | `                                     |
|     | 19. SLEE 43306                   | /// /(75154) L     | .EE 443          | 03                         |                  |                    |           |           |                                       |
|     | 20. SACOSH 44524                 | ACOSH 44671        |                  |                            | -                | • •                |           |           |                                       |
|     | 22. SGETQR 45167                 | GETORS 46451       |                  |                            |                  | -                  |           |           |                                       |
|     | 23. SFINDR 46670                 | FINDRW 50413       |                  |                            |                  |                    | _         |           |                                       |
|     | 24. 12200 50808                  | LXCAL 50675 *      | LXERR 506        | 12 .LXOUT<br>75 .DBCLS     | 50650<br>51057 * | •LXRTN 50672       | IBEXIT    | 50672 *   |                                       |
|     | 25 LODEE 51244                   | .CLSE 51257        | LF8L 512         | 60 * .LUNB                 | 51251            | .DFOUT 5126?       | •••       |           |                                       |
|     | 23IUDEF 51286                    | WRITE 51302        | BSR 512          | /2 * .CLJSE<br>12 * .RÉADR | 51274<br>51322   | .JPEN 51276        | •READ     | 51300     |                                       |
|     |                                  | .LFBLK 51353       | LTSX 513         | 56 * .AREA1                | 51370            | LJN8L 51376        | .ENTRY    | 51432     |                                       |
|     |                                  | .EX34 51502        | GU 514-          | 4L •DERR                   | 51455            | •NJPXI 51456       | •C04X1    | 51450     |                                       |
|     | 26. LXSL 51507                   | .LXSEL 51507 1     | XCSEL 515        | 10 .LXTST                  | 51513 *          | .LX3VL 51553 *     | .LXRCT    | 51554 *   |                                       |
|     | 27FPTRP 51646                    | •FFPT• 51645 *     | FPOUT 520        | 36 # .LXFL3<br>05 .FPAR3   | 51637 *<br>52024 | •LTCH 51640        |           | 52077 # - |                                       |
|     | 28. ERAS. 52106                  | E.1 52106          | .2 521           | 07 E.3                     | 52110            | E.4 52111          |           |           |                                       |
|     | 30. XIT 52116                    | EXIT 52115         | EXIT. 521        | 15 LL.5                    | 52114            | 52115              |           |           |                                       |
|     | 31. FXEM 52117<br>32. FOUT 52547 | .FXEM. 52117       | FXUUT 524        | 54 .FXARG                  | 52452            | /.JPT4./ 52536     |           |           |                                       |
|     | 33. FCNV 53110                   | .FCON. 53110       | FCNV. 531        | 33 .ENDES                  | 5314,            | .CNVSW 53150       | -EDX1     | 53154     |                                       |
|     | 3                                | •FDX2 53155        | DBC 531          | 57 .D3C10                  | 53315            | J3C20 53343        | •DU2M     | 53353     |                                       |
|     | 2                                | .0001X 55552 .     | PIXSW 533        | 10 •D08C                   | 53445            | .JORS1 53710       | • DDR 5 7 | 53712     |                                       |
|     |                                  |                    |                  |                            |                  |                    |           |           |                                       |

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|             |         | -01     | 53715   | .02     | 53717   | .FF882   | 54034 * | . 4 4 7 1     | 54040   | .0VPT                     | 54055   |       |   |  |
|-------------|---------|---------|---------|---------|---------|----------|---------|---------------|---------|---------------------------|---------|-------|---|--|
|             |         | INTP    | 54340   | Anur    | 54207   | DEL T    | 54225   | -=LT          | 54341   | .DEXPN                    | 54451   |       |   |  |
|             |         | EYD     | 54452   | нопт    | 54602   | INTG     | 54552   | 1111          | 54770   | .0°UT                     | 55007   |       |   |  |
|             |         | YCE.    | 55040   | TEST    | 55547   | - KOUNT  | 55552   | LIST          | 55555   | DONF                      | 55555   |       |   |  |
|             |         | ONTRE   | 55632   | BUE     | 55662   | -0510    | 55653   | ALDTH         | 55664   | GAIN                      | 55655   |       |   |  |
|             |         | GAINI   | 55655   | FROME   | 55676   | DODE     | 55722   | DDFLG         | 55723   | . 400                     | 55724   |       |   |  |
|             |         | - P 5 Y | 55725   | FEYP    | 55726   | DIG      | 55727   |               |         |                           |         |       |   |  |
| ~ 34. ELOB  | 55745   | FIOR.   | 55745   | FONT    | 56050   | ERIT.    | 55145   | .FB0T.        | 56166   | .FSLP.                    | 56212   |       |   |  |
| 544 1100    | 10110   | . 5818. | (56212) | EWIR.   | 56256   | EN R.    | (55255) | .=318F        | 55315   | FRITE                     | 55410 * |       | • |  |
| - 35 ELOS   | 56416   | .FIDS.  | 56416   | - ESEL  | 56556   | FILE     | 55552   | .= 3 13.      | 56571 × | . FRTD.                   | 56576   |       |   |  |
| 55. 1103    | 20410   | FUL     | 56631   | FCLS    | 56603 * | . FOPN   | 55627 * | 3=15          | 55513 * | . TOUT.                   | 56755   |       |   |  |
|             |         | REED    | 56764 * | BIN     | 56765 * | FCT      | 55755   | FCKSZ         | 56770   |                           |         |       |   |  |
| 36. ET0H    | 57052   | ETOH.   | 57052   | .FFIL.  | 57637   | FRTN.    | 57654 * |               |         |                           |         |       |   |  |
| 37. EWRD    | 60062   | -FWRD.  | 60062   | ••••••• | 51051   | •••••••  |         |               |         |                           |         |       |   |  |
| 38. FR08    | 60106   | -FROB-  | 60105   |         |         |          |         |               |         |                           |         |       |   |  |
| - 39, FWRII | 60132   | -EWRU-  | 60132   |         |         |          |         |               | 9       |                           |         |       |   |  |
| 40. FWRD    | 60156   | -FWRD-  | 60156   | FREST   | 60451 * |          |         |               |         |                           |         |       |   |  |
| - 41. FROU  | 60563   | -FRDU-  | 60563   |         |         |          |         |               |         |                           | •       |       |   |  |
| 42. UN05    | 60624   | .UN05.  | 60624   |         |         |          |         |               |         |                           |         |       |   |  |
|             | 60625   | -UN06-  | 60625   | -BUES7  | 60625   |          |         |               |         |                           |         |       |   |  |
| 44. FIDU    | 60631   | -FIDU-  | 60631   | CTUIN.  | 61304   | - NML ST | 61327   | .NAME.        | 62432   | .INTAP                    | 62433   |       |   |  |
| 45. JASTN   | 63056   | ASINR   | 63135 # | ASIN    | 63145   | ASIND    | 53154   |               |         |                           |         |       |   |  |
| 46 JINOR    | 63163   | ATANOR  | 63241   | ATANO   | 63250 * | ATANOD   | 63257   |               |         |                           |         |       |   |  |
| 47. FLOG    | 63266   | AL DG10 | 63255 * | A1. 0G  | 63267   |          | •       |               |         | -                         |         |       |   |  |
| 1 48 EXPE   | 63472   | EXP     | 63472   |         |         |          |         |               |         |                           |         |       |   |  |
| 49. FSCN    | 63612   | cos     | 63612   | SIN     | 63614   |          | -       |               | -       |                           |         | • • • |   |  |
| 1 50 - FSQR | 64 02 3 | SORT    | 64023   |         | -       |          |         |               |         |                           |         |       |   |  |
| 51. FATN    | 64130   | AT AN 2 | 64130   | ATAN    | 64132 * |          |         |               |         |                           |         |       |   |  |
| 52. FXP2    | 64336   | .XP2.   | 64336   |         |         |          |         |               |         |                           |         |       |   |  |
| 53. FXP3    | 64454   | •XP3•   | 64454   | •       |         |          |         |               |         |                           |         |       |   |  |
| 54. FRWT    | 64601   | FRWT.   | 64601   |         |         |          |         |               |         |                           |         |       |   |  |
| 55. FTNC    | 64706   | COTAN   | 64705   | TAN     | 64707   | CRIT     | 65052 * |               |         |                           |         |       |   |  |
| 56IOCS      | 65131   | .L(0)   | 65131   | . MONSW | 65151   | TEOR     | 6522D   | .JEFI.        | 65300   | .JOINX                    | 65344 * |       |   |  |
|             |         | .CLOS.  | 65363   | .ATTC.  | 65376   | • SH1    | 65610 * | .549          | 65552 * | .OPEN.                    | 65673   | -     |   |  |
|             |         | ·0P4    | 65721 * | .OP7    | 65752 * | .DP9.2   | 65755 * | .₹LSE.        | 66040   | •RE92•                    | 66040   |       |   |  |
|             |         | .READ.  | 66041   | .RER1.  | 66064   | .WRIT.   | 65055   | . 4NT1A       | 66254 * | EOFEX                     | 66335 * | _     | - |  |
|             |         | .FEEIT  | 66405   | .GTIOX  | 66426   | .RW7     | 65544 * | • <b>R</b> E7 | 67167 * | <ul> <li>ENDTR</li> </ul> | 67530   |       |   |  |
|             |         | •SEL 59 | 67632 * | .BSR.   | 70243   | .F910=   | 73373   | .ETOF3        | 70376 × | • SHITC                   | 70425   |       |   |  |
|             |         | TCHEX   | 70725   | .BASIO  | 70731 * |          |         |               |         |                           |         |       |   |  |
| 57IOCSM     | 70732   |         |         |         |         |          |         |               |         |                           |         |       |   |  |
| 58. //      | 75154   |         |         |         |         |          |         |               |         |                           |         |       |   |  |
|             |         |         |         |         |         |          |         |               |         |                           |         |       |   |  |
| I/O BUFFERS |         |         | 73732   | THRU    | 75044   |          |         |               |         |                           |         |       |   |  |
| •           |         |         |         |         |         |          |         |               |         |                           |         |       |   |  |
| UNUSED COPE |         |         | 75045   | THRU    | 75153   |          |         |               |         |                           |         |       |   |  |

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| +0.1000000E+01,                      |                                      |                                         |                                      |                                          |
| +0.10000000E+02,<br>+0.00000000E-38, | +0.00000000E-38,<br>+0.00000000E-38, | +0.101000000000000000000000000000000000 | +0.10000000E+32,<br>+D.10000000E+32, | +3.00000000E-38,<br>+0.10200000E+02,     |
| +0.12500000E+01,                     |                                      |                                         |                                      |                                          |
| +0.0000000E-38,                      |                                      |                                         |                                      |                                          |
| +0.0000000E-38,                      |                                      |                                         |                                      |                                          |
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| +0.00000000E-38,                     |                                      |                                         |                                      |                                          |
| +0.0000000E-38,                      |                                      |                                         |                                      | a gatayan an                             |
| +0.0000000E-38,                      |                                      |                                         |                                      |                                          |
| +0.00000000E-38,<br>-0.00000000E-19, | -0.00000000E-19,<br>-0.00000000E-19, | -0.00000005-19.                         | -3.03000030F-19,<br>-0.00000030E-19, | -3.30003000E-19,<br>-3.10000000E-19,     |
| +0.00000000E-35,                     |                                      |                                         |                                      |                                          |

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5 \$INPUT OATE = \*\* MEMO

CASE ÷.

> RSN =

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+0.0000000E-38,

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+0.1000000E+04,

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12 ...

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n

| YTRI   | =   | +0.0000000E=38.                         | +0.0301000-38.                           | +0.00000005-33.                          | +0.000011105-38.                        | +0.100000005-38.                        |   |
|--------|-----|-----------------------------------------|------------------------------------------|------------------------------------------|-----------------------------------------|-----------------------------------------|---|
| A 11/4 |     | 40 000000006-28                         | A 1 00000005-28                          | +0.000000000000000                       | +0.00000000E=38.                        | +1.000000005-38-                        |   |
|        |     | +0.000000000-39                         | +0.011.0000-38                           | +0.000000000000000                       | +0.00000006-38                          | +0.000000005-38.                        |   |
|        |     | +0.000000000000000000000000000000000000 | +0. 00000000 - 78+                       | +0.00000000102-304                       | 10.000000000.39                         | +0.000000005-38                         |   |
|        |     | +0.00000000000000                       | +0.0000000-38,                           | +0.000000000000000                       | + J. 000000000 - 20                     | +0.000000000000                         |   |
|        |     | +0.0000000E-38,                         | +0.0000000000-38,                        | +0.00000002-98,                          | +0.0000000000                           | +0.000.00000-38,                        |   |
| 8 T81. | -   | +0.0000000F-35.                         | +0.0000000E-38.                          | +0.00000000=-33.                         | +0.00000000E-38.                        | +0.00000000E-38.                        |   |
|        |     | +0.00000005-38-                         | + 3, 03000300E=38-                       | +0.00000000=-33.                         | +0.00000000E=38.                        | +1, 100010005-38-                       |   |
|        |     | +0.000000005-38.                        | +3.00000006-39.                          | +0.00000000000000                        | +0.000000005-38.                        | +3,30000000E-38-                        |   |
|        |     | +0.00000000000                          | +0.00000000E=38.                         | +0.00000005-338.                         | +0.00000000E=38-                        | +3,000000005-38.                        |   |
|        |     | +0.000000000000                         | +0.0000000000000                         | +0 000000000000000000000000000000000000  | +0.00000000E-39                         | +0.000000006-38-                        |   |
|        |     | +0.05000000-344                         | +0.00000000-504                          | +0.00000002-551                          | +0:00000000000                          | + 7.0000000 700 - 507                   |   |
| DTDSTR | 3 = | +0.0000000F-38.                         | +0.0000000F-38,                          | +0.000000000000000000000000000000000000  | +0.000000008-38,                        | +0,00010000F-38,                        |   |
|        |     | +0.0000000E-38,                         | +0.000000008-38.                         | +0.00000000000000-33.                    | +0.00000000E-39,                        | +0.00000000-38.                         |   |
|        |     | +0.0000000E-38.                         | +0.0000000E-38.                          | +0.000000003-38.                         | +0.00000000F-38.                        | +0.00000000E-38,                        |   |
|        |     | +0.00000000000-38.                      | +0.00000000E-38.                         | +0.000000000-33.                         | +0.00000000F-38.                        | +0.0000000E-38.                         |   |
|        |     | +0.000000005-38.                        | +0.0000000E-38.                          | +0.0000000033.                           | +0.000000000-38.                        | +0.0000000E-38.                         |   |
|        |     |                                         |                                          |                                          |                                         |                                         |   |
| ALPHA  | =   | +0.0000000E-38,                         | +0.1000000F+02,                          | +0.2000002+02,                           | +0.3000000E+32.                         | +0.40000700E+02,                        |   |
|        |     | +0.6000000E+02,                         | +0.9000000E+02.                          | +0.1200000000000000000000000000000000000 | +0.15000000E+03,                        | -0.0000000E-19.                         |   |
|        |     |                                         |                                          |                                          |                                         |                                         |   |
| NALPHA |     | 9,                                      |                                          |                                          |                                         |                                         | • |
| TTO    | =   | +0.0000000E=38.                         |                                          |                                          |                                         |                                         |   |
|        |     | 10.000000000000                         |                                          | -                                        |                                         |                                         |   |
| PN     | =   | +0.7000000E+00,                         |                                          |                                          |                                         |                                         |   |
|        |     |                                         |                                          |                                          |                                         |                                         |   |
| LE     | . = | +0.14000000E+01,                        |                                          |                                          |                                         | . = -                                   |   |
|        | _   | 10 E2000005100                          |                                          |                                          |                                         |                                         |   |
| L      |     | +0.520000000+004                        |                                          |                                          |                                         | 2 <u></u>                               |   |
| THETAT | -   | +0,0000000E-38,                         |                                          |                                          |                                         |                                         |   |
|        |     |                                         |                                          |                                          |                                         |                                         |   |
| NN     | =   | +0.5000000E+00,                         | +0.5000000F+00,                          | +0.500000002+00,                         | +0.50000000F+00,                        | +3.5000000E+00,                         |   |
| -      |     | <ul> <li>+0.5000000E+00,</li> </ul>     | +0.50000000F+00,                         | +0.500000002+00.                         | +0.50000000E+00,                        | +0.50000000F+0C.                        | - |
|        |     | +0.5000000E+00,                         | +0.5000000E+00.                          | +0.500000001+00,                         | +0.50000000000+00.                      | +0.50000000F+00,                        |   |
|        |     | +0.5000000E+00,                         | +0.500000000+100,                        | +0.50000000000000,                       | +0.5000000000+00.                       | +0.50000000E+00,                        |   |
| • •••  | _   | 10 100000005101                         |                                          |                                          |                                         |                                         |   |
| mm.    | -   | +0.10000000000000                       | +0.100000000000000000000000000000000000  | +0.100000000000000000000000000000000000  | +0.100000000000000000000000000000000000 | +0.100000000000000000000000000000000000 |   |
|        |     | +0.100000000000000000000000000000000000 | +5.1000000000000000000000000000000000000 | +3.103033332+31,                         | +).100300008+31,                        | +0.10000000+01                          |   |
|        |     | +0.100000000000000000000000000000000000 | +0.1300000000000000000000000000000000000 | +0.100000000000000000000000000000000000  | +0.1000000000000000                     | +0.10000000F+01.                        |   |
| •      |     | +0.1000000E+01.                         | +0.13009000E+01,                         | +0.10000002+01,                          | +0.100000000000000000000000000000000000 | +0.19909000E+91.                        |   |
| TABLE  | =   | -0.0000000E-19.                         | -0-0000000E-19-                          | -0.00000000-13.                          | -0.00001000E-19-                        | -0.0000000E-19.                         |   |
|        |     | -0.0000000E-19.                         | -0.0000000F-19.                          | -0.00000000-19.                          | -1.00031010F-19.                        | -0.200020205-19.                        |   |
|        |     | -0.0000000E-19.                         | -0.00000000E-19.                         | -0.00000000-19.                          | -0-0000000F-19-                         | -0.0000000E-19.                         |   |
|        |     | -0.00000006-19-                         | -0.00000000000000                        | -0.000000000000000000000000000000000000  | -0.00000005-18-                         | -0.000000000-19.                        |   |
|        |     | -0.00000005-19.                         | -0.0000000E=19.                          | -0.000000000000000000000000000000000000  | -0.00000005-19                          | -0 300000006-19                         |   |
|        |     | -0.00000000E-10                         | -( ))0000005-19                          | -0.000000000100                          | -0.000000000=10                         | -3.330300305-10                         |   |
|        |     | -0.0000000000000                        | -0.0000000000000                         | -0.000000000000000000000000000000000000  | -0.00000000000000                       | -3.3300000006-10                        |   |
|        |     | -0.0000000000000                        | -0.0.1.00000000-191                      | -0.000000000000000000000000000000000000  | -0.0000000000000                        | -3.300030305-10                         |   |
|        |     | -3.00000005-10                          | -0.000000000000000000000000000000000000  | -0.00000000000000000                     | -0.0000000000                           | -0.0000000000000                        |   |
|        |     | -0.00000005-10                          |                                          | -0.000000000000000000000000000000000000  |                                         |                                         |   |
|        |     | -0.000000000-10                         |                                          | -0.0000000000000000                      | -0.000000005-10                         | -0.000000000-14.                        |   |
|        |     | -9.00000000-19,                         | -0. 00000000 -19.                        | -0.0000000000-19+                        | -9.000000000-19,                        | -7. 10000000 -19,                       |   |
|        |     | -0.0000000-19,                          | -0                                       | -0.0000005-17,                           | -0.0000000000-10,                       | -0.0000000E-19.                         |   |
|        |     | -0.100000000-13.                        |                                          | -0.00000075-19,                          | -J. TTTTTTTTTTF-17.                     | -0.0000000E-19,                         |   |
|        |     | -1.0 00000000-19.                       | -v. 0000000F-19.                         | -0.30003^3vE-19,                         | -0.01011010E-19,                        | -0.200012005-19,                        |   |
|        |     | -9.69 960605-12,                        |                                          | -4.7^3^3()01-19,                         | -n.17011010F-10,                        | -n.10010101E-19,                        |   |

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XOTBL =

+0.0000000F-38,

|   | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.000000002-19.                        | -0.0000000000-19.                       | -0.0000000F-19.                         |                    |
|---|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|--------------------|
|   | -0.0000000E-19,                         | -0.0000000E-19,                         | -0.000000005-19.                        | -0.0000000E-19.                         | -3-33003030F-19.                        |                    |
|   | -0.0000000E-19,                         | -0.00000000F-19.                        | -0.000000005-19.                        | -0.000000C0E-19.                        | -0.000000005-19.                        |                    |
|   | -0.00000000E-19.                        | -0.0000)J00F-19.                        | -0.000000005-19.                        | -0.000000005-19.                        | -0.100000005-19-                        |                    |
|   | -0.00000000F-19.                        | -0.00000000E-19.                        | -0.00000000=-19.                        | -0.000330305-19.                        | -2. 300000005-19.                       |                    |
|   | -0.0000000E-19.                         | -0-00000000E-19-                        | -0.000000000000000000000000000000000000 | -0.00000005-10                          | -2.000000006-10                         |                    |
|   | -0.0000000E-19.                         | +3-20780176E-24-                        | +0.003170045+00                         | -0.00000000000000                       | +0.000000000000000000000000000000000000 |                    |
|   | +0.00000000E-38.                        | +0.00000006-38.                         | AD 000000000-22                         | *0.000000005.20                         | +0.000000000000000000000000000000000000 |                    |
|   | +0.0000000E-38.                         | +0.000000005-38.                        | +0 000000000-39                         | +0 000000000000000000000000000000000000 | +0.00000000000000                       | -                  |
|   | +0-0000000E-38-                         | +0.0000000000 300                       | +0.0000000000000000                     | +0.00000000000000                       | +0.000000000000                         |                    |
| • | +0.000000000-38.                        | +0.00000000E=38.                        | +0.000000000000000000000000000000000000 | +0.0000000000000000                     | +0.000000000000000000000000000000000000 |                    |
|   | +0.0000000E=38.                         | +0.00000000000000                       | +0.000000000000000000000000000000000000 | +0.000000000-38,                        | +0.10000000038,                         |                    |
|   | +0.000000005-38.                        | +0 00000000000000                       | +0.000000000000000000000000000000000000 | +0.0000000000000                        | +0.0000000000-38.                       | -                  |
|   | +0.00000000000                          | +0.00000000000000                       | +0.00000000000000                       | +0.000030305-38+                        | +0.000000000-38,                        |                    |
|   | 40-0000000E-38-                         | +0.00000000000000                       | +0.000000000000000000000000000000000000 | +0.000000000000000000000000000000000000 | +0.0000000000000000                     |                    |
|   | +0.00000000000000                       | +0.000000000000000000000000000000000000 | +0.00000000                             | +0.00000000E-38.                        | +D.0000000E-38.                         |                    |
|   | +0.00000005-38                          | +0.000000000000000000000000000000000000 | +0.000000002-33,                        | +J.00000000E-38,                        | +0.0000000F-38.                         |                    |
|   | +0.000000000000                         | +0.00000000000                          | +0.000030302-33,                        | +0.0000000E-34,                         | +0.0000000F-38.                         |                    |
|   | +0.0000000000000                        | +0.0000000000000                        | +0.000030302-33,                        | +0.00000000E-38,                        | +0.00000000F-38,                        |                    |
|   | +0.0000000000000000                     | +0.000000002-38,                        | +0.00000000000-38,                      | +0.00000700F-38,                        | +0.00000001F-38,                        |                    |
|   | +0.00000000000000                       | +0.00000000-38,                         | +0.00000000=-33,                        | +0.0000000F-38+                         | +0.0000000000-38.                       |                    |
|   | +0.000000000000000000000000000000000000 | +0.0000000E-38,                         | +0.000000002-33,                        | +0.00000000F-38,                        | +0.00000000E-38.                        | and an instants of |
|   | +0.000000000000000000000000000000000000 | +3.0000000E-38,                         | +0.000000705-33,                        | +0.00000000E-38,                        | 40.00000008-38,                         |                    |
|   | +0.0000000E-38,                         | +0.0000000E-38.                         | +0.000000000000000000000000000000000000 | +0.0000000E-38,                         | +0.0000000E-38,                         |                    |
|   | +0.000000000000000000000000000000000000 | +0.0000000F-38,                         | +0.000000002-38,                        | +0.00000000E-38,                        | +0.00000000E-38,                        |                    |
|   | +0.0000000E-38,                         | +0.0000000E-38,                         | +0.000000000000000000000000000000000000 | +0.00000000E-38,                        | +0.0000000000000                        |                    |
|   | +0.00000000E-38,                        | +0.0000000E-38,                         | +0.000000000000000000000000000000000000 | +0.00000008-38.                         | +0.0000000E-38,                         |                    |
|   | +0.000000000-38,                        | +0.0000C000E-38,                        | +D.00000000E-39,                        | ÷0.0000000E-38,                         | +0.000000000-38,                        |                    |
|   | +0.0000000E-38,                         | +0.00000000E-38,                        | +0.00000000000000,                      | +0.0000000E-38,                         | +0.00000000E-38.                        |                    |
|   | +0.0000000E-38,                         | +0.0000000E-38,                         | +0.00000000000-38,                      | +0.00000000E-38.                        | +0.0000000E-38.                         |                    |
|   | +0.0000000E-38,                         | +0.00000000E-38,                        | +0.000000000000000000000000000000000000 | +0.0000000E-38.                         | +0.00000000E-38.                        |                    |
|   | +0.0000000E-38,                         | +0.0000000E-38,                         | +0.00000000000-33,                      | +0,00000000E-38,                        | +0.0000000E-38.                         |                    |
|   | +0.0000000E~38;                         | +0.0000000E-38.                         | +0.00000000E-38,                        | +0.00000000E-38.                        | +0.0000000E-38.                         |                    |
|   | +0.0000000E-38.                         | +0.0000000E-38,                         | +0.00000000=-39,                        | +0.00000000F-38.                        | +0.0000000F-38.                         |                    |
|   | +0.0000000E-38,                         | +0.000000000-38,                        | +0.000000000000000000000000000000000000 | +0.00000000E-38.                        | +0.0000000F-38.                         |                    |
|   | +0.0000000E-38.                         | +J.0000000E-38,                         | +0.000000000000000000000000000000000000 | +0.00000000E-38.                        | +0.00000000-38.                         |                    |
|   | +0.0000000E-38.                         | +0.0000000F-38,                         | +0.000000002-33.                        | +0.00000000F-38.                        | +0.00000000E-38.                        |                    |
|   | +0.0000000E-38.                         | +3.0000000C0E-38,                       | +0.000000002-38.                        | +0.0000000E-38.                         | +0,100000000E-38.                       |                    |
|   | +0.0000000E-38,                         | +0.00000000E-38,                        | +0.0000000002-35.                       | +0.00000000F-38.                        | +0.30000000F-38.                        |                    |
|   | +0.00000000E-38,                        | +0.00000000E-38.                        | +0.000000005-38.                        | +0.000000005-38.                        | +0.000000000==38-                       |                    |
|   | +0.0000000E-38,                         | +0.0000000E-38.                         | +0.00000000E-39.                        | +0.000000005-38                         | +0-000000005-38-                        |                    |
|   | +0.0000000E-38,                         | +0.0000000E-38.                         | +0.00000000=-33.                        | +0.00000000E=38.                        | 40 0000000000-20                        | -                  |
|   | +0.0000000E-38,                         | +0.0000000E-38.                         | +0.00000000=-38.                        | +0.00000000E=38.                        | 40 00000000E-38                         |                    |
|   | +0.0000000000-38,                       | +0.00000006-38.                         | +0.00000000-33.                         | +0.00000000E=38.                        | +0.0000000000000                        | -                  |
|   | +0.0000000E-38.                         | +0.00000000F-38.                        | +0.00000000=-38.                        | +0.00000005-38                          | +0.000000000000000                      |                    |
|   | +0.0000000E-39.                         | +0.000000006-38.                        | +0.000030305-33.                        | +0 00000000F=38                         | +0.0000000000000                        |                    |
|   | +0.0000000F-38.                         | +0.000000005-38.                        | +0.000000000000000000000000000000000000 | +0.000000000E-38                        | +0.000000000000000                      |                    |
| - | +0.0000000E-38.                         | +0.00000000E-38.                        | +0.000030305-33                         | +0.0000000000E=39                       | +0.00000000000000                       |                    |
|   | +0.0000000E-38.                         | +0.000000005-38-                        | +0 000000000000000000000000000000000000 | +0.0000000000000                        | +0.100000000000000                      |                    |
| • | +0.00000006-33.                         | +0-000000005-38-                        | +0.000000005-39                         | +0.00003030202                          | +0.00000000000000                       |                    |
|   | +0.00000006-38.                         | +0.00000000000000                       | +0.000000000000000000000000000000000000 | +0.000000000000000                      | +0.0000000000000                        |                    |
|   | +0.00000000E=38.                        | +0. 336336005-28.                       | 10 003030305-23                         | +0.000000000000000                      | +0.0000000E-38,                         |                    |
|   | +0.00000000F-38.                        | +3-000010005-38-                        | +0 000000000000000000000000000000000000 | +0.000000000000000                      | +0.000000000000000000000000000000000000 |                    |
|   | +0.00000000F-38.                        | +0-0000000E=38-                         | +0.00000000000000                       | +0.0000000000000                        | +0.000000096-38,                        |                    |
|   | +0.00000000E-38.                        | +0.00000000000000                       | AC 303030305-33                         | +0.00000000E+38+                        | +U.0000000F-38,                         |                    |
|   | +0.000000000-38.                        | +0 00000000000000                       | +0.000000000000000000000000000000000000 | +0.00000000E-38+                        | +0.00000000E-38,                        |                    |
|   | +0.000000000-38.                        | +0.00.0000005-30.                       | +0.000000000000000000000000000000000000 | +0.000307306-38,                        | +0.0000000F-38,                         |                    |
|   | +0.0000000E-38.                         | +R 030000000-28.                        | +0.00000005-39                          | +0.00000000E=38,                        | +0.000000E-38,                          |                    |
|   | +0.00000005-20                          | +5 0050000000-30                        | +0.000000000000000000000000000000000000 | +0.00003000E-38,                        | +0.0000000E-38,                         |                    |
|   | +0.0000000000000                        | +0.000000000000                         | +0.000000005-005                        | +0.00077700E-38,                        | +0.70070000E-38,                        |                    |
|   | +0.00000000000                          | + 0.00000000000000                      | +0.00000002-35,                         | +1,00000730F-39;                        | +3.30000000E-38.                        |                    |
|   | 10.0000000P=34;                         | +3+0/00000E=98+                         | +0+0030303005-33,                       | +9.0000000F-39.                         | +1.10000005-38,                         |                    |

|              | -        |   | +0.0000000E-38,  | +0.00000000E-38, | +0.000000002-39,       | +0.0000000038.       | +0.0000000F-38.   |   |
|--------------|----------|---|------------------|------------------|------------------------|----------------------|-------------------|---|
|              |          |   | +0.0000000E-39,  | +J.00000000E-38, | +0.000000005-33,       | +0.000000002-39.     | +0.00001000F-38.  |   |
|              |          |   | +0.0000000E-38,  | +3.0000000F-38,  | +0.000070005-38,       | +0.000000005-39,     | +0.0000000E-38,   |   |
|              |          |   | +0.0000000E-38,  | +0.0J000000E-38, | +0.00010005-33,        | +0.0000000F-39,      | +3.0000000000-38. |   |
|              |          |   | +0.0000000E-38,  | +0.00000070E-38, | +0.000000005-38,       | +0.0000000E-38.      | +0.0000000E-38,   |   |
|              |          |   | +0.0000000E-38,  | +0.00000000E-38, | +0.00000005-33,        | +0.00000000-38,      | +0.00000000E-38.  |   |
|              |          |   | +0.0000000E-38,  | +0.00000000E-38, | +0.00000000000000.     | +0.00000000E-38.     | +0.00000000E-38,  |   |
|              |          |   | +0.0000000E-38,  | +0.0000000E-38,  | +0.0000000E-38,        | +0.0000000E-38,      | +0.00000464E-26.  |   |
| -            |          |   | +0.00000986E-38, | +0.33167918E-23, | +0.33135606=-23,       | +0.33119474E-23,     | +0.00001105-26,   |   |
|              |          |   | +0.10359951E-24, | +0.00000281E-24, | +0.161635135-25,       | -0.00091520F+19,     | -0.00063110E-26.  |   |
| -            | -        |   | +0.00028537E-38, | +0.18844856E-36, | -0.000000235-38,       | +0.00053110E-26,     | +0.00028536E-38.  |   |
|              |          |   | +0.00007877E-26, | +0.10380148E-24, | +0.188448565-35,       | -0.00000023E-38,     | +0.000631108-26.  |   |
| -            |          |   | +0.00028541E-38, | +0.10339781E-24, | +0.000078885-25,       | +0.10340039E-24;     | +0.13584931F-19,  |   |
|              |          |   | +0.13572358E-19, | +0.33947493E-?0. | -0.000306525-29,       | +0.03975120E-29,     | +0.041361875-23.  |   |
| -            | - ·      |   | +0.11858461E-19, | -0.00000018-20,  | +0.015336422-19,       | +0.26645677E-14,     | +0.33167960E-23+  |   |
|              |          |   | -0.00007328E-35, | +0.)4417637E-27, | +0.000320305-25,       | +0.00028619E-38,     | +0.00031514E-26,  |   |
| -            |          |   | +0.00028579E-38, | +0.12943596E-25. | +0.000157775-25,       | +0.04143971E-23,     | -0.35276303E-37.  |   |
|              |          |   | +0.03388135E-19. | +0.04143959E-23, | +0.033881335-19,       | -0.00000222E-31.     | -0.04045821E-26,  |   |
| -            |          | - | +0.04143976E-23, | -0.35264838E-37, | -0.000479035-31,       | -D.D4045916E-26,     | +0.08279875F-23.  |   |
|              |          |   | +0.00007851E-26, | -0.47325514E-37, | +0.000078532-26,       | +0.10359898E-24,     | +0.30005131E-24.  |   |
| -            |          |   | -0.00008056E-23, | +0.49841258E+00, | +0.135716955-19,       | +0.13579000E-19.     | +0.00031515E-26+  |   |
|              |          |   | +0.00028615E-38, | +0.00015777E-26, | -0.000019352-31,       | +0.08312195E-23,     | +0.331194758-23,  |   |
| -            |          | • | +0.33135631E-23, | +0.12943596E-25, | +0.135656985-19,       | +0.20687552E-23,     | +D.33881318E-20,  |   |
|              |          |   | +0.13559145E-19, | +0.13571696E-19, | -0.000616305-29,       | +D.04176272E-23,     | -0.00007860E-26.  |   |
| -            |          |   | +0.00080777E-23, | -0.03015777E-26. | -0.000480895-31,       | -0.00000001E-20,     | +0.00028605E-38.  |   |
|              |          |   | -0.00585335E+19, | +0.00007878E-26, | +0.315545785-29,       | +0.00018313E-36,     | +0.04143971E-23.  |   |
|              |          |   | +0.00317302E+00, | +0.49938915E+00, | +0.000183132-35,       | - ~i+0.03388132F-19, | -0.000480915-31,  |   |
|              |          |   | -0.00018310E-36, | -0.04046848E-26, | -0.040458472-25,       | +0.20699710E-24,     | -0.00007880E-26,  |   |
| - ún ·       | ······   |   | +0.20780487E-24, | +0.49963344E+00, | -0.000078805-23,       | +0.00083777E-23,     | -0.00000020E-26,  |   |
| Ϋ́           |          |   | +0.20780487E-24, | +0.49938931E+00, | +0.331356255-23,       | -0.705354016-37,     | +0.10164450E-19,  |   |
| <sup>-</sup> | <b>.</b> |   | +0.00012614E-25, | +0.13585490E-19, | +0.00114795=-38, "     | -0.47019780E-37,     | +0.00114797E-38,  |   |
|              |          |   | -0.70529706E-37, | +0.00028629E-38, | +0.303330365-25,       | +0.04144116E-23,     | +0.000005655-38,  |   |
| -            |          |   | +0.16181135E-25. | +0.00007878E-26, | +0.315545785-29,       | +0.10359927E-24,     | -0.00000362E-36.  |   |
|              |          |   | +0.04417637E-27, | +0.47111610E-37, | +0.303286382-38,       | +0.00087780E-24.     | +0.00028622E-38.  |   |
| -            |          |   | +0.13579004E-19, | -0.70535401E-37, | <b>∔0.135789985-19</b> | -0.33167972E-23,     | +0,18844881E-36,  |   |
|              |          |   | +0.0000023E-38,  | +),16940659E-20, | +0.000078772-2.,       | +0.10359941E-24,     | +0.13578997E-19,  |   |
| -            |          |   | +0.33167983E-23, | +0.00031515E-26, | +0.001720321-19,       | -0.33103371E-23,     | -0.20687583E-23.  |   |
|              |          |   | +0.00000565E-38, | -0.33167994E-23, | +0.000201702-24,       | +0.18844959E-36,     | -0.18370027F-19;  |   |
| -            |          |   | +0.01486144E+19, | +0.18844998F-35; | +0.16131135E-25,       | +0.000837815-24,     | +D.12621977E-27,  |   |
|              |          |   | +0.41439810E-24, | +0,0028630E-38,  | +0.00000001.33,        | +0.0000000E-38,      | -0.00000000E-37,  |   |
| -            |          | - | +0.03673420E-38, | -0.11513579E+24, | +0.000000000-37,       | +0.26864381F-14,     | -0.00119114E-19,  |   |
|              |          |   | -0.06095238E+02, | -0.06095238E+02, | +0.210797015-33.       | -0.17220459E-27,     | -0.94603335E-26,  |   |
| -            |          |   | -0.89297371E+06, | +0.00000000E-38, | +0.000000002-38,       | +0.00000000F-38,     | +0.000000000-38,  |   |
|              |          |   | +0.0000000E-38,  | +0.00000000E-38, | -0.000000302+19,       | +0.00010474E+10,     | -9.00121962F-38,  |   |
| -            |          | 2 | -0.01483510E-19, | +0.0000036E-19,  | +0.000000365-19,       |                      |                   |   |
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| \$ END           CASE         +1.00           +0.000000E=2           +1.7130934=0           +6.8476424=0           +1.536954=0           +2.7315505=0                                                                                                                                                                                                                                                                                                                                                                                 | MEM0 +0.00<br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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| \$ END<br>CASE +1.00<br>+0.0000000E-2<br>+1.7130934E-0<br>+6.8476424E-0<br>+1.539584-0<br>+2.7315505E-0<br>+4.2592725E-0                                                                                                                                                                                                                                                                                                                                                                                                              | MEM0 +0.00<br>• Y0TBL<br>• 0.0000000E-39<br>3 *655419983E-02<br>3 *1.3066062E-01<br>2 *1.2598962E-01<br>2 *2.598962E-01<br>2 *3.2323181=01                                                                                                                                                                                                                                                                                                                                                     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| XOY6L           +0.0000000E-3           +1.7130934-2           +1.7130934-2           +1.7130934-2           +1.7130934-2           +1.7130934-2           +1.7130934-2           +1.7130934-2           +1.7130934-2           +1.7139734-2           +1.7173627-2           +6.847642522725E-2           +6.11793627-2                                                                                                                                                                                                              | MEM0 +0.00<br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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| S END           CASE         +1.00           +0.0000000E-2         +1.7130934E           +1.7130934E         +1.53954E           +2.73159054C         +2.73159054C           +4.2592725E         +4.1179362F           +8.3024932E         +8.3024932E                                                                                                                                                                                                                                                                                | MEM0 +0.00<br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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| S END           CASE         +1.00           +0.0000000E-2         +1.7130934E           +1.7130934E         +1.53954E           +2.73159054C         +2.73159054C           +4.2522725E         +4.5252725E           +1.030248352         +1.0302819E           +1.0302819E         +1.362819E                                                                                                                                                                                                                                      | MEM0 +0.00<br>9 +0.000000E-39<br>3 +6.5419083E-02<br>3 +6.5419083E-02<br>4 1.954309E-01<br>2 +1.954309E-01<br>2 +3.252381E-01<br>2 +3.252381E-01<br>2 +3.475294E-01<br>1 +5.0842081E-01<br>1 +5.6748813E-01                                                                                                                                                                                                                                                                                    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| XOY6L           +0.000000E-2           +1.7130934c-2           +1.7130934c-2           +1.7130934c-2           +1.739534c-2           +4.7315505E-2           +4.252725E-2           +8.307243819-2           +1.0806819-2           +1.6764826E-2           +1.6764826E-2           +1.676826E-2                                                                                                                                                                                                                                     | MEM0 +0.00<br>Y0TBL<br>9 +0.0000000E-39<br>3 +6;5419983E-02<br>3 +1.3066062E-01<br>2 +2.5980962E-01<br>2 +3.232381E-01<br>1 +3.627125E-01<br>2 +4.475994E-01<br>1 +5.0842081E-01<br>1 +5.0942081E-01<br>1 +5.0940813E-01<br>1 +5.09001E-01<br>1 +5.0001E-01                                                                                                                                                                                                                                    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| \$ END           CASE         +1.00           +0.0000000=-         -           +1.7130934=-         -           +0.8476424=-         -           +1.7339545         -           +4.2577225-         -           +4.2577225-         -           +1.3624263=         -           +1.03064315         -           +1.6746825=         -           +1.6746825=         -           +1.67666445         -                                                                                                                                 | MEM0 +0.00<br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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| XOY6L           +0.000000E-2           +1.710934E-2           +1.7130934E-2           +1.7130934E-2           +1.7130934E-2           +1.730954E-2           +42.7315505E-2           +42.7315505E-2           +42.7315502E-2           +42.7315502E-2           +42.7315502E-2           +42.7315502E-2           +42.7315502E-2           +43.3024382E-2           +1.36741862E-2           +5.6606644E-2           -5.6606644E-2           -7.5266461E-2           -7.5266461E-2                                                   | MEM0 +0.00<br>YOTBL<br>9 +0.0000000E-39<br>3 +6.5419983E-02<br>3 +1.3066062E-01<br>2 +2.5980962E-01<br>2 +3.2325381E-01<br>2 +3.2325381E-01<br>1 +5.0842081E-01<br>1 +5.0942081E-01<br>1 +5.6748813E-01<br>1 +5.6748813E-01<br>1 +5.6750001E-01<br>1 +3.4550000E+00<br>1 +1.955000E+00<br>1 +1.95500E+00<br>1 +1.955000E+00<br>1 +1.955000E+00<br>1 +1.95500E+00<br>1 +1.95500E | DATE +7.50<br>SOTBL DT.<br>+0.0000000E-39 -8.<br>+0.5449845E-02 -8.<br>+1.9634954E-01 -8.<br>+2.617993E-01 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| S END           CASE         +1.000           +0.000000E=2         +1.7130934=0           +1.7130934=0         +1.7389584=0           +2.7319509=0         +4.2592729=0           +4.2592729=0         +6.8476424E0           +1.3008619=0         +6.8476424E0           +1.3008619=0         +6.8476424E0           +4.2592729=0         +6.417936270           +4.2592729=0         +6.417936270           +1.3624186E=0         +1.674828260           +1.352452624         +1.326243264           +1.37365075         +1.3262484 | MEM0 +0.00<br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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-B.<br>+3.25907E-01 -B.<br>+5.390495E-01 -B.<br>+5.390495E-01 -B.<br>+5.395495E-01 -B.<br>+6.5449845E-01 -B.<br>+6.5449845E-01 -B.<br>+6.5449845E-01 -B.<br>+7.2243911F+00 +0.<br>+7.2243917F+00 +0.<br>+3.0120876E+00 +0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 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| XOYEL           ••••••••••••••••••••••••••••••••••••                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | MEM0 +0.00<br>- Y0T8L<br>9 +0.0000000000000<br>3 +6;54199838=02<br>3 +6;54199838=02<br>3 +1.3066062E-01<br>2 +2.5588962E-01<br>2 +3.2325381E-01<br>1 +3.0827125E-01<br>2 +3.4759945E-01<br>1 +5.0842081E-01<br>1 +5.0945813E-01<br>1 +5.095994E-00<br>1 +1.9850000E+00<br>0 +2.6649999E+00<br>0 +2.649999E+00<br>0 +3.3449999E+00                                                                                                                                                              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| XOY6L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | MEM0 +0.00<br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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-8.<br>*1.3089054E-01 -8.<br>*3.2724928E-01 -8.<br>*3.2724928E-01 -8.<br>*5.395907E-01 -8.<br>*5.39597E-01 -8.<br>*5.39575E-01 +0.<br>*5.355754E-00 +0.<br>*5.355754E+00 +0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 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| XOY6L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | MEM0 +0.00<br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | DATE +7.50<br>SOTBL DT<br>40.0000000E-39 E.<br>+6.5449846E-02 -8.<br>+1.308969E-01 -8.<br>+1.308969E-01 -8.<br>+3.22724938E-01 -8.<br>+3.225990TE-01 -8.<br>+3.225990TE-01 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| XOYBL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | MEM0 +0.00<br>• Y0TBL<br>9 -0.000000E=39<br>9 -85.5419983E=02<br>3 +1.3066062E=01<br>2 +2.598962E=01<br>2 +3.2352381E=01<br>1 +3.08627125E=01<br>2 +3.4827381E=01<br>1 +5.0842081E=01<br>1 +5.095996E=01<br>1 +5.0000E=01<br>1 +1.3050000E+00<br>0 +2.6649999E+00<br>0 +4.0249999E+00<br>0 +4.049999E+00<br>0 +5.3149999E+00<br>0 +5.3149999E+00<br>0 +5.3449999E+00<br>0 +5.344999E+00<br>0 +5.34499E+00<br>0 +5.344999E+00<br>0 +5.344999E+00<br>0 +5.344999E+00<br>0 +5.34499E+00<br>0 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AT ALPHA = +0.0000F-39 WINDWARD, RW = +1.4258E+00 DFLS = +9.3391E-32 334324 = +4.7070E+34 - PLS ALD = +2.5867E+01 DTS ALO = +4.4360E+00 REYA = +3.1086F+05 DRS ALD = +2.9783E-04 SEC XO W XB W YB W SB al THETBW PE/PS W be/os a DI N OT W 06 W 38 4 XSI W 1 +0.000E-39 +0.000E-39 +0.000E-39 +0.000E-39 +0.000E-39 +90.00 +1.000E+00 +4.809E-03 +1.000E+00 +0.000E-39 +0.000E-39 +1.000E+00 +9.089E-02 1 +1.713E-03 +1.713E-03 +6.542E-02 +6.545E-02 +87.00 +9.973E-01 -5.8575+00 +9.957E-01 +4.899E-01 +1.473E-04 +8.21E-01 +9.101E-02 1 +6.848E-03 +6.848E-03 +1.307E-01 +1.309E-01 +84.00 +9.891E-01 -1.157E+01 +9.872E-01 +7.380E-01 +5.857E-04 +6.832F-01 +9.142E=02 1 +1.539E-02 +1.539E-02 +1.955E-01 +1.955E-01 +1.963E-01 +9.755E-01 -1.735E+01 +9.532E-01 +9.294E-01 +1.301E-03 +4.532E-01 +9.233E-02 1 +2.732E-02 +2.732E-02 +2.599E-01 +2.618E-01 +78.00 +9.568E-01 -2.233E+01 +9.478E-01 +1.089E+00 +2.282E-03 +1.278E-01 +4.402E=02 1 +4.259E-02 +4.259E-02 +3.235E-01 +3.272E-01 +75.00 +9.330E-01 -2.8365+31 +9.376E-01 +1.223E+33 +3.506F-03 +0.000E-39 +9.681E-02 T +6.118E-02 +6.118E-02 +3.863E-01 +3.927E-01 +72.00 +9.045E-01 -3.2795+11 +9.217E-01 +1.335E+00 +4.942E-33 +0.000E-39 +1.011E-01 1 +8.302E-02 +8.302E-02 +4.480E-01 +4.531E-01 +69.00 +8.715E-01 -3.756E+01 +9.011E-01 +1.425E+00 +5.559E-03 +0.000E-39 +1.071E-01 -T +1.081E-01 +1.081E-01 +5.084E-01 +5.235E-01 +66.00 +8.346E-01 -4.171E+31 +8.752E-01 +1.497E+30 +8.317E-03 +0.000E-39 +1.[33E-0] 1 +1.362E-01 +1.362E-01 +5.675E-01 +5.890E-01 +63.00 +7.939E-01 -4.5%1E+11 +8.477E-01 +1.550E+00 +1.017E-02 +0.000E-39 +1.259E-01 3 +1.675E-01 +1.675E-01 +6.250E-01 +6.545E-01 +60.00 +7.500E-01 +0.000=-39 +7.516E-01 +1.586E+00 +1.209E-02 +0.000E-39 +1.392E-05 3 +5.601E-01 +5.601E-01 +1.305E+00 +1.445E+00 +60.00 +7.500E-01 +0.0305-33 +4.345E-01 +1.354E+00 +2.654E-02 +0.000E-39 +2.611E-01 3 +9.527E-01 +9.527E-01 +1.985E+00 +2.225E+00 +60.00 +7.500E-01 +0.000-39 +3.739E-01 +1.241E+00 +4.103E-02 +0.000E-39 +3.525E-01 3 +1.345E+00 +1.345E+00 +2.665E+00 +3.010E+00 +60.00 +7.502E-01 +3.0302-33 +3.218E-01 +1.149F+00 +5.557E-02 +0.000F-39 +4.347E-01 3 +1:738E+00 +1:738E+00 +3.345E+00 +3.795E+00 +60.30 +7.500E-01 +0.000E-39 +2.382E-01 +1.116E+00 +7.007F-02 +0.000F-39 +5:130E-01 3 +2.130E+00 +2.130E+00 +4.025E+00 +4.583E+00 +60.00 +7.500E-01 +0.0302-33 +2.533E-01 +1.074E+30 +8.455E-02 +0.030E-39 +5.893E-01 3 +2:523E+00 +2.523E+00 +4.705E+00 +5.355E+00 +50.00 +7.500E-01 +0.000E-39 +2.538E-01 +1.041E+00 +9.905E-02 +0.006E-39 +6.644E-01 3 +2.916E+00 +2.916E+00 +5.385E+00 +5.151E+00 +60.00 +7.500E-01 +0.000-33 +2.21E-01 +1.013E+00 +1.136E-01 +0.000E-39 +7.389E-01 3 +3.308E+00 +3.308E+00 +6.065E+00 +6.936E+00 +6.000 +7.500E-01 +0.000E-39 +2.151E-01 +9.839E-01 +1.28EE-01 +0.000E-39 +8.128E-01 3 +3.701E+00 +3.701E+00 +6.745E+00 +7.721E+00 +60.00 +7.500E-01 +0.000E-39 +2.041E-01 +9.679E-01 +1.425E-01 +0.000E-39 +8.364E+01 4 4 44.093E+00 +4.093E+00 +7.425E+00 +8.506E+00 +6.00 +7.500E-01 -4.05IE+02 +3.547E-01 +9.493E-01 +1.570E-01 +0.000E-39 +9.507E-01 4 +4.102E+00 +4.102E+00 +7.438E+00 +8.522E+00 +5.545E-01 -4.449E+12 +3.475E-01 +9.960E-01 +1.721E-01 +0.000E-39 +9.769E-01 62-4 +4-102E+00 +4.110E+00 +7.449E+00 +0.535E+00 +48.94 +5.685E-01 =4.635E+02 +3.382E-01 +1.300E+00 +1.786E-01 +0.000E-39 +1.002E+00 4 +4.112E+00 +4.112E+00 +7.450E+00 +8.53BE+00 +48.00 +5.539E-01 -4.652E+02 +3.423E-01 +9.976E-01 +1.791E-01 +0.000E-39 +1.007E+00 + 4 +4-123E+00 +4.123E+00 +7.461E+00 +8.554E+00 +4.497E-01 -4.652E+02 +3.383E-01 +9.556E-01 +1.778E-01 +0.000E-39 +1.053E+00 4 +4.135E+00 +4.135E+00 +7.471E+00 +8.563E+00 +3.60 +3.478E-01 -4.449E+32 +2.713E-01 +8.729E-01 +1.681E-01 +0.000E-39 +1.117E+00\* 4 +4.148E+00 +4.148E+00 +7.480E+00 +8.535E+00 +3.00 +2.706E-01 -3.037E+02 +2.237E-01 +7.800E-01 +1.545E-01 +0.000E=39 +1.204E+00 4 +4.162E+00 +4.162E+00 +7.487E+00 +8.601E+00 +2.097E-01 -2.452E+02 +1.882E-01 +6.853E-01 +1.391E-01 +0.000E-39 +1.321E+00 4 +4-177E+00 +4.177E+00 +7.493E+00 +8.615E+00 +18.00 +1.599E-01 -1.957E+02 +1.555E-01 +5.900E-01 +1.225E-01 +0.2000E-39 +1.480E+00 4 +4.192E+00 +4.192E+00 +7.497E+00 +8.532E+00 +12.30 +1.213E-01 -1.573E+02 +1.273E-01 +5.009E-01 +1.062E-01 +0.000E-39 +1.700E+00 4 +4.208E+00 +4.208E+00 +7.499E+00 +8.648E+00 +6.00 +8.933E-02 -1.227E+02 +1.018E-01 +4.160E-01 +9.006E-07 +0.000E-39 +2.015E+00 8 +4.223E+00 +4.223E+00 +7.500E+00 +8.664E+00 +0.00 +6.548E-02 -9.516E+01 +8.106E-02 +3.415E-01 +7.538E-02 +0.000E-39 +2.495E+00 8 +4-244E+00 +4.244E+00 +7.499E+00 +8.684E+00 -8.00 +4.157E-02 -5.530E+01 +5.555E-02 +2.535E-01 +5.749E-02 +0.000E-39 +5.637E+00 8 +4.265E+00 +4.265E+00 +7.494E+00 +8.735E+00 -16.00 +2.573E-02 -4.352E+01 +3.351E-02 +1.833E-01 +4.253E-02 +0.000E-39 +7.151E+00 8 +42284E+00 +4.284E+00 +7.487E+00 +8.726E+00 -24.00 +1.533E-02 -2.836E+31 +2.534E-02 +1.281E-01 +3.043E-02 +3.004E=09 +8.55TER61 8 +4.303E+00 +4.303E+00 +7.477E+00 +8.747E+00 -32.00 +8.790E-03 -1.739E+01 +1.783E-02 +8.652F-02 +2.104E-02 +0.000E-39 +0.000E-39 8 +4-320E+00 +4-320E+00 +7.465E+00 +8.763E+00 -40.00 +4.847E-03 -1.036E+01 +1.150E-02 +5.645F-02 +1.403E-02 +0.000E-39 +0.000E-39 8 +4.335E+00 +4.335E+00 +7.450E+00 +8.789E+00 -48.00 +3.598E-03 +3.030E-39 +3.352E-03 +4.547E-02 +1.144E-02 +0.000E-39 +0.000E-39 8 +4:348E+00 +4.348E+00 +7.434E+00 +8.810E+00 -5.00 +3.598E-03 +0.000E-39 +3.332E-03 +4.545F-72 +1.147E-72 +0.000E-39 +0.000E-39 8 +4.358E+00 +4.358E+00 +7.416E+00 +8.831E+00 -64.00 +3.598E-03 +3.030E-39 +3.344E-03 +4.543E-02 +1.151E-02 +0.030E-39 +0.000E-39 B +4.366E+00 +4.366E+00 +7.396E+00 +8.852E+00 -72.00 +3.598E-03 +0.000E-39 +3.335E-03 +4.541E-02 +1.152E-02 +0.000E-39 +0.000E-39 9 +4.371E+00 +4.371E+00 +7.376E+00 +8.873E+00 -80.30 +3.598E-03 +3.0302-39 +3.3255-03 +4.539E-02 +1.155E-02 +0.000E-39 +0.000E-39 9 +4.435E+00 +4.435E+00 +7.013E+00 +9.241E+00 -80.00 +3.598E-03 +3.000=-39 +3.159E-03 +4.502E-02 +1.203E-02 +0.000E-39 +0.000E-39 9 +4.499E+00 +4.499E+00 +6.651E+00 +9.609E+00 -80.00 +3.598E-03 +0.000E-39 +2.993E-03 +4.447E-02 +1.251E-02 +0.000E-39 +0.000E-39 9 74.5638+00 +4.5638+00 +6.2888+00 +9.9788+00 -80.00 +3.5980-03 +0.0008-39 +2.3278-03 +4.4448-02 +1.2088-02 +0.0008-39 +0.0008-39 9 +4.627E+00 +4.627E+00 +5.926E+00 +1.035E+01 -80.00 +3.598E-03 +2.030E-33 +2.552E-03 +4.402E-22 +1.347E-02 +0.000E-39 +0.000E-39 9 +4.691E+00 +4.691E+00 +5.553E+00 +1.671E+01 -80.00 +3.598E-03 +3.030E-39 +2.498E-03 +4.371E-32 +1.395E-32 +0.000E-39 +0.000E-39 9 +4.755E+00 +4.755E+00 +5.700E+00 +1.108E+01 -80.00 +3.598E-03 +2.030E-33 +2.334E-03 +4.341E-32 +1.443F-77 +0.000E-39 +0.000E-39 9 +4.819F+00 +4.819F+00 +4.838F+00 +1.145E+01 -80.00 +3.598E-03 +0.0005-3) +2.(75E-03 +4.313E-72 +1.497F-02 +7.070F-39 +0.000E-39 9 +4.883E+00 +4.883E+00 +4.475E+00 +1.182E+01 -80.00 +3.599E-03 +0.000E-39 +2.005E-03 +4.286E-02 +1.538E-07 +0.000E-39 +0.000E-39 +4.947E+00 +4.947E+00 +4.113E+00 +1.219E+01 -80.30 +3.509E-03 +1.350E-03 +1.353E-03 +4.957E-37 +1.585E-02 +1.579E-39 +3.000E-39
 +3.947E+00 +4.947E+00 +4.113E+00 +1.219E+01 -80.30 +3.509E-03 +1.300E-39 +1.353E-03 +4.957E-37 +1.585E-02 +1.000E-39
 +3.947E+00 +4.947E+00 +4.947E+00 +4.113E+00 +1.219E+01 -80.30
 +3.509E-03 +1.300E-39
 +3.947E+00 +4.947E+00 +4.113E+00 +1.219E+01 -80.30
 +3.509E-03 +1.300E-39
 +3.947E+00 +4.947E+00
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 +3.500E-39
 0 +5.010E+00 +5.010E+00 +3.750F+00 +1.255E+01 -90.00 +3.598E-03 +0.000E-39 +1.530E-03 +4.214E-12 +1.634E-02 +0.000E-39 +0.000E-39 10 +5.010F+00 +5.010E+00 +3.375E+00 +1.293E+01 -90.00 +3.599E-03 +0.000E-39 +1.512E-03 +4.210E-02 +1.683E-02 +0.000E-39 +0.000E-39 1 10 +5.010E+00 +5.010E+00 +3.000E+00 +1.330E+01 -90.00 +3.598E-03 +0.001E-39 +1.345E-33 +4.196E-32 +1.732E-32 +3.000E-39 +5.000F-39

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|   | 10 +5.010E+00 +5.010E+00 +2.625E+00 +1.358E+01<br>10 +5.010E+00 +5.010E+00 +2.250E+00 +1.405E+01<br>10 +5.010E+00 +5.010E+00 +1.875E+00 +1.443E+01 | -90.00 +3.598E-03 +0.000E-39 +L.175E-03 +4<br>-90.00 +3.598E-03 +0.000E-39 +L.107E-03 +4<br>-90.00 +3.598E-03 +0.000E-39 +8.394E-04 +4 | .142F-32 +1.781E-02 +0.000E-39 +0.000E-39<br>.143F-32 +1.833F-02 +0.930E-39 +3.900E-39<br>.18F-32 +1.878E-02 +0.000E-39 +0.000E-39 |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
|   | 10 +5.010E+00 +5.010E+00 +1.500E+00 +1.480E+01<br>10 +5.010E+00 +5.010E+00 +1.125E+00 +1.518E+01<br>10 +5.010E+00 +5.010E+00 +7.500E=01 +1.558E+01 | -90.00 +3.598E-03 +0.000E-39 +5.715E-04 +4<br>-90.00 +3.598E-03 +0.000E-39 +5.035E-04 +4                                               | .097E-72 +1.927E-72 +0.000E-39 +0.000E-39<br>.077E-72 +1.976E-02 +0.000E-39 +0.000E-39                                             |
|   | 10 +5.010E+00 +5.010E+00 +3.750E-01 +1.593E+01<br>10 +5.010E+00 +5.010E+00 +0.000E-39 +1.630E+01                                                   | -90.30 +3.598E-03 +0.030E-39 +1.57E-04 +4<br>-90.30 +3.598E-03 +0.030E-39 +1.57E-04 +4                                                 | .038E-02 +2.074E-02 +0.000E-39 +0.000E-39<br>.019E-02 +2.122E-02 +0.000E-39 +0.000E-39                                             |
|   | IST X ST Y ST S ST                                                                                                                                 | DTDS ST THET ST SECT ALPHA                                                                                                             |                                                                                                                                    |
|   | 5 +1.89903E-02 +2.17060E-01 +2.18166E-01                                                                                                           | -8.00000E-01 +8.00000E+01 1 +10.00                                                                                                     | · · · · · · · · · · · · · · · · · · ·                                                                                              |
|   | IW SN XOW SN YOW SN XBW SN                                                                                                                         | YBW SN SBW SN T+ET+ SN SE                                                                                                              | CT ALPHA                                                                                                                           |
|   | 22_ +4.12298E+00 +7.46147E+00 +2.78877E+30                                                                                                         | +7.85319E+00 +8.34344E+)) +4.89372E+01                                                                                                 | 4 +10.00                                                                                                                           |
|   | IL SN XOL SN YOL SN XBL SN                                                                                                                         | YBL SN SBL SN THETL SN SE                                                                                                              | CT ALPHA                                                                                                                           |
|   | 27 +4.09345E+00 +7.42500E+00 +5.34140E+00                                                                                                          | +6.82055E+00 +8.72741E+)) +4.89372E+01                                                                                                 | 4 +10.00                                                                                                                           |
|   |                                                                                                                                                    |                                                                                                                                        |                                                                                                                                    |
|   | ······ · · · · · · · · · · · · · · · ·                                                                                                             |                                                                                                                                        | ········                                                                                                                           |
|   |                                                                                                                                                    |                                                                                                                                        |                                                                                                                                    |
|   | Littlementer, a reaction of an and a support                                                                                                       | · · · · · · · · ·                                                                                                                      |                                                                                                                                    |
| ĩ |                                                                                                                                                    | ····· · · ·                                                                                                                            |                                                                                                                                    |
|   |                                                                                                                                                    |                                                                                                                                        |                                                                                                                                    |
|   | ••••••••••••••••••••••••••••••••••••••                                                                                                             |                                                                                                                                        |                                                                                                                                    |
|   | Vergravy                                                                                                                                           |                                                                                                                                        | · · · · · ·                                                                                                                        |
|   |                                                                                                                                                    |                                                                                                                                        | •                                                                                                                                  |
|   |                                                                                                                                                    |                                                                                                                                        |                                                                                                                                    |
|   |                                                                                                                                                    |                                                                                                                                        |                                                                                                                                    |
|   |                                                                                                                                                    |                                                                                                                                        |                                                                                                                                    |
|   |                                                                                                                                                    |                                                                                                                                        |                                                                                                                                    |

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AT ALPHA = +1.0000E+01 WINDWARD, RW = +2.4949E+01 DFLS = +5.3343F-03 3343C = -7.3225F+00 SIN(THFTAW) NEG. FOR XB = +2.9581E+00 RW = +2.4949E+01 DFLS = +5.33548E-03 3343C( = -7.3225F+00

| SEC | X0 W        | ХВ М               | YB W        | SR W        | тнетви | PF/PS W    | DP/DS A     | <b>ว</b> เฟ   | и тс             | RE W       | W 20        | XSI W       |        |
|-----|-------------|--------------------|-------------|-------------|--------|------------|-------------|---------------|------------------|------------|-------------|-------------|--------|
| - 1 | +1.8998-02  | +0.000E-39         | +0.000E-39  | +0.007E-39  | +90.00 | +1.0005+00 | +4.839=-35  | +L.033E+00    | +0.7708-39       | +0.001E-39 | +5.9035-02  | +5.365E-03  |        |
| i   | +4.2595-02  | +4.7575-03         | +1.0895-01  | +1 0016-02  | +88.00 | +9.9885-01 | -3.415=+JJ  | +1.3322+00    | +3.7855-71       | +5.4276-05 | +0.5175-02  | +6.0912-03  |        |
|     | 46 118F-02  | +1.216E-02         | +1.7405-01  | +1.7456-01  | +82.00 | +9.9246-01 |             | +1.J242+00    | +0.1295-01       | +1 0325-04 | +9.3036-02  | +9.9176-03  |        |
| ī   | +8.302E-02  | +2-297E-02         | +2.385E-01  | +2.400E-01  | +79-00 | +9.6345-01 | -2.1335+31  | +2 3275-01    | +0.072F-J1       | +1 0275-03 | +1 0235-01  | A2 7455-02  |        |
| 1   | +1.081E-01  | +3.713E-02         | +3.024E-01  | +3.054E-01  | +76.00 | +9-4355-01 | ~2.6356+)1  | +9.3215-01    | +1,1816+00       | +3.0735-03 | 43.914E-02  | +4.1795-02  |        |
| 1   | +1.362E-01  | +5.462E-02         | +3.655E-01  | +3.7395-01  | +73.00 | +9.1458-01 | -3,1395+31  | +9.377E-01    | +1.330E+30       | +4-442E-03 | +4.882E-02  | +5.9655-02  |        |
| 3   | +1.675E-01  | <b>∔7.</b> 538E-02 | +4.275F-01  | +4.3>3E-01  | +70.00 | +8.830E-01 | +0.0305-39  | +8.557E-01    | +1.397E+00       | +5.003E-03 | +5-577E-02  | +8.151F-02  |        |
| 3   | +5.601E-01  | +3.439E-01         | +1.165E+00  | +1.222E+00  | +70.00 | +8.830E-01 | +3.0302-39  | +4.4>9E-01    | +1.137F+30       | +1.690E-02 | +0.0005-39  | +3.366E-01  |        |
| 3   | +9.527E-01  | +6.125E-01         | +1.903F+00  | +2.007E+00  | +70.00 | +8.9308-01 | +0.0005-39  | +3.5956-01    | +1.030F+30       | +2.761E-02 | 40.000E-39  | +5.626E-01  |        |
| 3   | +1.345E+00  | +8.810E-01         | +2.641E+00  | +2.7925+00  | +70.00 | +8.830E-01 | +3.3305-33  | +3.087F-01    | +9.6405-01       | +3.8416-02 | +0.0005-39  | +7.592F-01  |        |
| 3   | +1.738E+00  | +1.150E+00         | +3.379E+00  | +3.5772+00  | +70.00 | +8.830E-01 | +7.3305-39  | +2.744E-31    | +9.1745-01       | +4.921E-02 | +0.000E-39  | +9.2516-01  |        |
| 3   | +2.130E+00  | +1.418E+00         | +4.117E+00  | +4.352E+00  | +70.20 | +8.830E-01 | +0.0008-39  | +2.4945-01    | +9.9175-01       | +5.001F-72 | +0.000E-39  | +1.058E+00  |        |
| 3   | +2.5235+00  | +1.687E+00         | +4.855E+00  | +5.148E+00  | +70.00 | +8.830E-01 | +0.0005-39  | +2.301E-01    | +8.530F-01       | +7.081F-02 | +0.000E-39  | +1.155E+00  |        |
| 2   | -2.910C+00  | +1.935000          | +5+5926+00  | +5.9336+00  | +70.00 | +8.8306-01 | +0.0001-39  | +2.1+5=-01    | +8.2916-01       | +8.152E-32 | +0.030E-39  | +1.211E+00  |        |
| 2   | +3.3000000  | +2 4025+00         | +0. 3502+00 | +0.7182+00  | +70.00 | +9.830E-01 | +3.0305-39  | +2.0198-01    | +8.088F-91       | +9.2426-07 | +0.000E-39  | +1.218E+00  |        |
| Å   | #4.002E+00  | +2 761 E+00        | +7+0082+00  | +7.5035+09  | +70.00 | +8.830E-31 | +3.339=-39  | +1.912E-01    | +7.9118-71       | +1.032E-01 | +0.000E-39  | +1.160E+00  |        |
| 4   | +4.1026+00  | +2 7675+00         | +7 8305+00  | +0.200E+00  | +10.00 | +8.8302-01 | -3.00/=+J2  | +3.512E-01    | +/./558-31       | +1.1478-01 | +0.000E-34  | +1.012E+00  |        |
|     | +4.1126+00  | \$2.775E+00        | +7 8345+00  | T0. 304CTU0 | +64.00 | +8.075E-J1 | -3.556=+32  | +3.3326-31    | +8.9726-01       | +1.3986-01 | +0.000E-39  | +9.8458-01  |        |
| 4   | +4.1236+00  | +2.7845+00         | +7.8475+00  | +0.3200+00  | +58.00 | +7.1926-01 | -4.204:+32  | +3.9500-01    | +9.7442-01       | +1.5928-01 | +0.000E-39  | +9.672E-01  |        |
|     | +4-123E+00' | 72.789F+00         | TT. 853ET00 | +9-363ELOO  | +48.94 | +6-2130-01 | -4. 4335+32 | +3.9392-01    | +1.0066+00       | +1.7140-01 | +0.00000-39 | +9.588E-UL  | ۲ ۲۰۰۰ |
| 4   | +4-135E+00  | +2.794E+00         | +7.859E+00  | +8 3516+00  | +40.94 | +5 1025-01 | -4.6753.03  | +3.3720-01    | +1.0056+70       | +1.75/5-01 | +0.00000-39 | +9.578E-01  |        |
|     | +4.148E+00  | 72-805F+00         | 7.8705+00   | FR 3675+00  | +40.00 | +4.1535-01 | -4. 6162+02 | 12 1012-01    | +9.9200-01       | +1 7345-01 | TO 0000-39  | 19.509E-UL  | ·      |
| 4   | +4.162E+00  | +2.818E+00         | +7.879E+00  | +8-383E+00  | +34.00 | +3.1525-01 | -4.3375+32  | +2 3175-01    | +9.3300-11       | +1 5045-01 | +0.0000-39  | 10 03EE-01  |        |
| 4   | +4-177E+00  | +2.831E+00         | +7.887E+00  | +8.398F+00  | +28.00 | +2.457E-01 | -2.7975+12  | 12. 182=-01   | +7 472E-01       | +1.4546-01 | 10 0006-37  | A1 0085400  |        |
| 4   | +4.192E+00  | +2.846E+00         | +7.894E+00  | +8.414E+00  | +22.00 | +1-890E-01 | -2.253=+12  | +1.2015-01    | +6.509E-01       | +1.2075-01 | A0 000E-39  | A1 0606400  |        |
| 4   | +4-208E+00  | +2.861E+00         | +7.899E+00  | +8.430E+00  | +15.00 | +1.4405-01 | -1.878-+72  | +1.5405-01    | +5.579E+01       | +1.137E-01 | 40.000E-39  | +1.0795+00  |        |
| 8   | +4.223E+00  | +2.876E+00         | +7.902E+00  | +8.445E+00  | +10.00 | +1.081E-01 | -1.4336+12  | +1.3295-01    | +4-7005-01       | +9.7785-02 | +0.0002-39  | +1-1268400  |        |
| 8   | +4.244E+00  | +2.897E+00         | +7.905E+00  | +8.4562+00  | +2.00  | +7.201E-02 | -1.0295+32  | +7.5778-02    | +3.546E-01       | +7.789E-02 | +0.000E-39  | +1.196F+00  |        |
| 8   | +4.265E+00  | +2.918E+00         | +7.904E+00  | +8.487E+00  | -6.00  | +4.587E-02 | -7+038E+01  | +5.9525-02    | +2.718E-01       | +5.951E-02 | +0-000F-39  | +1.274E+00  |        |
| 8   | +4.284E+00  | +2.938E+00         | +7.900E+00  | +8.508E+00  | -14.00 | +2.852F-02 | -4.7592+31  | +4.735E-02    | +1.975E-01       | +4.439E-02 | +0.000E-39  | +1.352E+00  |        |
| 8   | +4.303E+00  | +2.958E+00         | +7.894F+00  | +8.529E+00  | -22.00 | +1.697E-02 | -3.0512+01  | +3.2245-02    | +1.3815-01       | +3.187E-02 | +0.000E-39  | +1.427E+00  |        |
| 8   | +4.320E+00  | 72.977E+00         | +7.885E+00  | +8.550E+00  | -30.00 | +9.7126-03 | -1.8955+31  | +2.1228-02    | +9.329E-32       | +2.1995-02 | +0.000E-39  | +0.000F-39  |        |
|     | +4.335E+00  | +2.994E+00         | +7.873E+00  | +8.571E+00  | -38.00 | +5.325E-03 | -l.125E+01  | +1.352E-02    | +6.069E-02       | +1.464F-32 | +0.000E-39  | +0.000E-39  |        |
| 8   | +4.348E+00  | +3.010E+00         | +7.859E+00  | +8.592E+00  | -46.00 | +3.598E-03 | +).0002-39  | +4.0005-03    | +4.568F-02       | +1.118E-02 | +0.000F-39  | +0.000E-39  |        |
| 8   | +4.358E+00  | +3.023E+00         | +7.843E+00  | +8.513E+00  | -54.00 | +3.598E-03 | +).0005-39  | +3.992E-03    | +4.556F-)?       | +1.1216-02 | +0.000E-39  | +0.000E-39  |        |
| 8   | +4.366F+00  | +3.034E+00         | +7.825E+30  | +8.634E+00  | -62.00 | +3.598E-03 | +3.0305-39  | +3.9835-03    | +4.554E-72       | +1.124E-02 | +0.000F-39  | +0.000E-39  |        |
| - 9 | +4.371E+00  | +3.043E+00         | +7.806E+00  | +8.555E+00  | -70.00 | +3.5998-03 | +3.0305-39  | +3.973E-03    | +4.562F-32       | +1.127E-02 | +0.000F-39  | +0.000E-39  |        |
| 9   | +4.4356+00  | +3.1692+00         | +7.460E+00  | +9.023E+00  | -70.00 | +3.598E-03 | +0.0005-39  | +3.7915-03    | +4.524F-72       | +1.175F-32 | +0.000F-39  | +0.000E-39  |        |
|     | +4.499E+00  | +3.2956+00         | +1.1146+00  | +9.391E+00  | -70.00 | +3.598E-03 | +0.0005-39  | +3.5116-03    | +4.4B8E-02       | +1.222E-02 | +0.010E-39  | +0.000E-39  |        |
| 9   | +4.00000+00 | +3.421E+00         | +6.768E+00  | +9.7592+00  | -70.00 | +3.598E-03 | +3.0305-39  | +3.432E-03    | +4.453F-32       | +1.273E-02 | +0.000E-39  | +0.000E-39  |        |
| 0   | +4.6270+00  | +3.3477+00         | +6.4222+00  | +1.0136+01  | -75.00 | +3.598E-03 | +3.0302-39  | +3.253E-03    | +4.4275-72       | +1.318E-32 | +0.000E-39  | +0.000E-39  |        |
| . 9 | +4.0910+00  | +3.0720+00         | +6.0766+00  | +1.05000+01 | -70.00 | +3.598E-03 | +0.0005-39  | +3.075E-03    | +4.3595-02       | +1.366E-02 | +0.000E-39  | +0.000E-39  |        |
| á   | +4.8196+00  | +3.0245+00         | +5.284E+00  | +1 1225+01  | -70,30 | +3.5985-93 | +0.0002-39  | +2.3786-03    | +4.3595-02       | +1.4148-02 | +0.000E-39  | +0.000E-39  |        |
| ó   | +4.8836+00  | +4.0505+00         | +5 0385+00  | +1.1435+01  | -70.00 | +3.5000-03 | +1.0102-39  | +2.7212-03    | +4. 3395-02      | +1.4526-02 | +3.0006-39  | +0.000E-39  |        |
| ģ   | +4.9476+00  | +4.176E+00         | +4.6925+00  | +1.1976+01  | -70.00 | +3.5996-03 | +3.0302-39  | +2 3 4 45 -03 | +4.3026-02       | +1.5136-02 | +0.0001-39  | +0.0008-39  |        |
| 10  | +5.010E+00  | +4-302F+00         | +4-346E+00  | +1-2345+01  | -87.10 | +3.508[-13 | +1 0102-134 | 42.1935-03    | + + + / / - = 1/ | +1 404E-02 | +0.00000-39 | +0.0002-39  |        |
| 10  | +5.010E+30  | +4.367E+00         | +3.977E+00  | +1.271E+01  | -90.00 | +3.5985-03 | +7.010=-34  | +2. 3345-32   | +4.7246-07       | +1.655E=02 | +0.0005-30  | +0.0002~39  | •      |
| 10  | +5.0106+00  | +4.432F+00         | +3.607E+00  | +1.3096+01  | -83.00 | +3.598E-03 | +0.000=-39  | +1.8195-03    | +4-199F=02       | +1.7030=32 | +0 0005-39  | +0.00000-39 |        |
| 10  | +5.010E+00  | +4.497E+00         | +3.738E+00  | +1.345E+U1  | -80.00 | +3.598E-03 | +2.2205-33  | +1.5325-03    | +4.174E-02       | +1.7525-02 | +0.000E-39  | +0-0005-39  |        |
| 10  | +5.010F+00  | +4.563F+00         | +2.869E+00  | +1.394E+01  | -80.00 | +3.598E-03 | +2.22037    | +1-+++503     | +4.1535-02       | +1-8016-02 | +0.00000-39 | +0.000E=39  |        |
| 10  | +5.010E+00  | +4.628E+00         | +2.500E+00  | +1.4218+01  | -87,70 | +3.5996-03 | +2.070=-39  | +1.2578-03    | +4.1315-12       | +1.8505-02 | +0. 000F-39 | +0.000F-39  | ,      |
| 10  | +5.0106+00  | +4.693E+00         | +2.13JE+00  | +1.4595+01  | -80.00 | +3.593F-03 | +2.0005-37  | +1.0735-03    | +4.10972         | +1.803F-12 | +2.0206-39  | +2.0005-39  |        |

10 +5.010E+00 +4.758E+00 +1.761E+00 +1.496E+01 -80.00 +3.598E-03 +0.000E-39 +8.370E-04 +4.088E-02 +1.948E-02 +0.000E-39 +0.000E-39 4.00 P. 10 +5.010E+00 +4.758E+00 +1.761E+00 +1.496E+01 -80.00 +3,598E-03 +0.000E-39 +4.371E-04 +4.988E-02 +1.948E-02 +1.048E-39 +0.000E-39 10 +5.010E+00 +4.873E+00 +1.392E+00 +1.534E+01 -80.00 +3.598E-03 +0.00E-39 +5.149E-04 +4.049E-02 +2.045E-02 +0.000E-39 +0.000E-39 10 +5.010E+00 +4.888E+00 +1.022E+00 +1.571E+01 -80.00 +3.598E-03 +0.010E-39 +5.149E-04 +4.049E-02 +2.045E-02 +0.000E-39 +0.000E-39 10 +5.010E+00 +4.953E+00 +6.530E-01 +1.539E+01 -80.00 +3.598E-03 +0.010E-39 +5.239E-04 +4.030E-07 +2.394E-02 +0.000E-39 +0.000E-39 10 +5.010E+00 +5.018E+00 +2.837E-01 +1.645E+01 -80.00 +3.598E-03 +0.010E-39 +4.332E-04 +4.01E-07 +2.394E-02 +0.000E-39 +0.000E-39 10 +5.010E+00 +5.084E+00 +8.561E-02 +1.534E+01 -80.00 +3.598E-03 +0.002E-39 +4.312E-05 +3.993E-12 +7.192E-02 +0.000E-39 +0.000E-39 10 +5.010E+00 +5.084E+00 +8.561E-02 +1.534E+01 -80.00 +3.598E-03 +0.002E-39 +4.312E-05 +3.993E-12 +7.192E-02 +0.000E-39 +0.000E-39 ..... ----¢ -----65-- -------------

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7
AT ALPHA = +1.00006+01, LEFWAPD, RW = +2.25996+00 DELS = +5.3148E-03 354034 = +1.51986+00

| \$ EC | X0 L       | X9 L       | YB L       | SB L        | THETBL | PE/PS L    | OP/DS _    | 96 L        | QT L        | ۲ <b>۲</b> L | 09 L        | XST L       |        |
|-------|------------|------------|------------|-------------|--------|------------|------------|-------------|-------------|--------------|-------------|-------------|--------|
| 1     | +1.899E-02 | +0.000F-39 | +0.000E-39 | +3.003E-39  | +90.00 | +1.100F+70 | +4.8395-35 | +1.0332+00  | +0.110F-30  | +1.0008-39   | +5.9038-02  | +5.365F-03  |        |
| 1     | +1.539E-02 | +1.904F-04 | +2.182E-02 | +2.1825-02  | +89.00 | +9.997F-01 | -1.9592+33 | +1,3338+00  | +2.9495-01  | +1.894F-05   | +5.7435-02  | +5.4508-03  | 1      |
| 1     | +6.848E-03 | +3.045E-03 | +8.720E-02 | +8.7278-02  | +86.00 | +9.9518-01 | -7.8122+00 | +L.J27E+00  | +6.5245-01  | +3.0276-04   | +5.798F-02  | +6.727F-03  | 1      |
| 1     | +1.713E-03 | +9.3175-03 | +1.523E-01 | +1.5276-01  | +83.00 | +9.851F-01 | -1.3535+01 | +3.9416-01  | +8, 149F-11 | +7.923F-04   | +5.4265-02  | +9.549F-03  | 1      |
| - 1   | +0.000E-39 | +1.899F-02 | +2.1718-01 | +2.182E-01  | +80.30 | +7.698E-01 | -1.9205+01 | +7.)455-01  | +9.8595-01  | +1.630F-03   | +5.346E-02  | +1.395E-02  |        |
| 1     | +1.713E-03 | +3.204E-02 | +2.812E-01 | +2.835E-01  | +77.00 | +9.494E-01 | -2.4515+31 | +9.3535-01  | +1.137F+00  | +2.6655-03   | +7.030F-39  | +1.997E-02  |        |
| 1     | +6.848E~03 | +4.842E-02 | +3.445E-01 | +3.491E-01  | +74.00 | +9.2432-01 | -2.9745+01 | +3.9535-01  | +1.2635+00  | +3.962F-03   | +0.000=-39  | +2.7675-02  |        |
| 1     | +1.539E-02 | +6.810E-02 | +4.077F-01 | +4.143E-01  | +71.00 | +8.940E-01 | -3.4555+01 | +3.7925-01  | +1.3575+00  | +5.463F-03   | +7.0005-39  | +3.7136-02  |        |
| - 1   | +1.899E-02 | +7.538E-02 | +4.275E-01 | +4.353E-01  | +70.00 | +8,830F-01 | -3.638E+31 | +9.7396-01  | +1.3975+30  | +5.01303     | +7.700=-39  | +4.059E-02  |        |
| 1     | +2.732E-02 | +9.102E-02 | +4.683E-01 | +4.8006-01  | +68.00 | +9.597E-01 | -3.8992+01 | +3.594E-01  | +1.4510+00  | +7.132E-03   | +0.000E-39  | +4.846E-02  |        |
| 1     | +4.259E-02 | +1.171E-01 | ∔5.283E-01 | +5.4548-01  | +65.00 | +8.214F-01 | -4.330E+31 | +8.3395-01  | +1.5178+00  | +8.929E-33   | +0.000F-39  | +6+176E-02  |        |
| 1     | +6.118F-02 | +1.463E-01 | +5.868E-01 | +6.1095-01  | +62.00 | +7.796F-01 | -4.6535+31 | +8.3536-01  | +1.554=+00  | +1.0815-02   | +0.000E-39  | +7.717E-02  |        |
| - 1   | +8.302E-02 | +1.785E-01 | +6.438E-01 | +6.753E-01  | +59.00 | +7.3476-01 | -4,9565+31 | +7.7358-01  | +1.593E+00  | +1.272E-12   | +7. 000E-30 | +9.4846-02  |        |
| 1     | +1.081E-01 | +2.137E-01 | +6.990E-01 | +7.419E-01  | +56.00 | +6.873E-01 | -5,2345+31 | +7.3395-01  | +1.606F+00  | +1.462E-02   | +0.000F-39  | +1.150E-01  |        |
| 1     | +1.362E-01 | +2.517E-01 | +7.523E-01 | +8.072E-01  | +53.00 | +6.378E-01 | -5.3962+)1 | +7.015E-01  | +1.401E+10  | +1.545E-02   | +0.000E-39  | +1.378E-01  |        |
| 3     | +1.675E-01 | +2.924E-01 | +8.035E-01 | +8.727E-01  | +50.00 | +5.868F-01 | +1.0002-39 | +5.1558-01  | +1.5815+71  | +1.917E-02   | +9.000E-39  | +1.634E-01  |        |
| 3     | +5.601F-01 | +7.972E-01 | +1.405F+00 | +1.6582+00  | +50.00 | +5.869E-01 | +0.0002-39 | +4.1595-01  | +1.3975+30  | +3.457E-02   | +0.0005-39  | +3.783E-01  |        |
| 3     | +9.527E-01 | +1.302F+00 | +2.006E+00 | +2.443E+00  | +50.00 | +5.868E-01 | +0.0302-39 | +3.4395-01  | +1.2975+00  | +5.0876-02   | +0.000E-39  | +5.065E-01  |        |
| ~ 3   | +1.345E+00 | +1.807E+00 | +2.608F+00 | +3.2285+00  | +50.00 | +5.868E-01 | +3.000E-39 | +3.0345-01  | +1.2175+20  | +6.722E-02   | +0.200E-39  | +5.931E-01  |        |
| 3     | +1.738E+00 | +2.311F+00 | +3.209E+00 | +4.0132+00  | +50.00 | +5.868E-01 | +0.0002-39 | +2.740E-01  | +1.1555+30  | +8,359E-02   | +0.000E-39  | +6.570E-01  |        |
| ··· 3 | +2+130E+00 | +2.816F+00 | +3.811E+00 | +4.799E+00  | +50.00 | +5.868E-01 | +2.0302-39 | +2.5175-01  | +1.124=+22  | +9.993F-32   | +0.000E-39  | +7.0735-01  |        |
| 3     | +2.523E+00 | +3,321E+00 | +4.412E+00 | +5.584E+00  | +50.30 | +5.868E-01 | +3.0302-39 | +2.3415-01  | +1.000E+00  | +1.1638-31   | +0.000E-39  | +7.487E-01  |        |
| 3     | +2.916E+00 | +3.825E+00 | +5.014E+00 | +6.359E+00  | +50.00 | +5.868E-01 | +0.0302-39 | +2.193E-71  | +1.052E+00  | +1.324E-01   | +0.000E-39  | +7.840F-01  |        |
| 3     | +3.308E+00 | +4.330E+00 | +5.615E+00 | +7.154E+0D  | +50.00 | +5.868E-D1 | +0.0002-39 | +2.0735-01  | +1.038E+00  | +1.490E-01   | +1.000F-39  | +8-150E-01  |        |
|       | +3.701E+00 | +4.835F+00 | +6.217E+00 | +7.9392+00  | +50.00 | +5.868E-01 | +0.0005-39 | +1.9756-01  | +1.016E+00  | +1.553E-01   | +0-0008-39  | +8-429E-01  |        |
| 4     | +4.093E+00 | +5.3406+00 | +6.818E+00 | +8.725E+00  | +50.00 | +5.868E-01 | -4-606=+32 | +3.2745-01  | +9.974F-01  | +1-817E-01   | +0.0005-39  | +8.6835-01  |        |
|       | +4.093E+00 | +5.341E+00 | +6.821F+00 | +8.727E+00  | +48.94 | +5.6856-01 | -4.633=+32 | +3-2376-01  | +9.9565-01  | +1-8265-01   | +0.000E-39  | +8.691 -01  |        |
| 4     | +4.102E+00 | +5.350E+00 | +6.830E+00 | +8.740E+00  | +44.00 | +4.844E-01 | -4.675=+02 | +2-9985-11  | +9.700E-11  | +1-8326-01   | +0.0000-39  | +8.7736-01  |        |
| 4     | +4.112E+00 | +5.362E+00 | +6.840E+00 | +8.756E+00  | +38.00 | +3-813E-01 | -4.539=+32 | +2-5655-01  | +9.0075-01  | +1 - 762E-01 | +0.000E-39  | +8.9796-01  |        |
| 4     | +4+123E+00 | +5.375F+00 | +6.849E+00 | +8.7722+00  | +32.00 | +2.981E-01 | -3,3105+12 | +2.235E-01  | +8.1275-11  | +1-6375-01   | +0.0005-30  | +9.315F-01  |        |
| 4     | +4-135E+00 | +5.389E+00 | +6.857E+00 | +8.737E+00  | +26.00 | +2.309E-01 | -2.6551+02 | +1.881E-01  | +7-1758-01  | +1.482E+01   | +1.0006-39  | +9.800E-01  |        |
| 4     | +4.148E+00 | +5.403E+00 | +6.863E+00 | +8.803E+00  | +20.00 | +1.776E-01 | -2,142=+32 | +1-5595-01  | +6.2335-01  | +1.318E-01   | +0.0005-39  | +1-047E+00  |        |
| 4     | +4.162E+00 | +5.418F+00 | +6.868E+00 | +8.819E+00  | +14.00 | +1.343E-01 | -1.738=+32 | +1.2855-01  | +5.3776-71  | +1.1475-01   | +0.000E-39  | +1 1376+00  |        |
| 4     | +4.177E+00 | +5.434E+00 | +6.871E+00 | +8.835E+00  | +8.00  | +1.004E-01 | -1-3502+32 | +1-0425-01  | +4.4545-01  | +3.9746-32   | +0.1115-30  | +1-258E+00  |        |
| - 4   | +4.192F+00 | +5.449E+00 | +6.872E+00 | +8.8505+00  | +2.00  | +7.401F-32 | -1.0525+32 | +3.3275-02  | +3.4785-01  | +8.2746-12   | +0.0005-39  | +1.423F+00  |        |
| 4     | +4+208E+00 | +5.465E+00 | +6.872E+00 | +9.865E+00  | -4.00  | +5.310E-J2 | -8-034-+31 | +5.503E-02  | +2.3575-11  | +6.9366-32   | +0.0005-39  | +1.6555+00  |        |
| 8     | +4.223E+00 | +5.481E+00 | +6.870E+00 | +8.8825+00  | -10.00 | +3.743E-02 | -5.9315+31 | +5.0195-02  | +2.3536-01  | +5.500E-12   | +0.000E-39  | +1,9936+00  |        |
| 8     | +4.244E+00 | +5.501E+00 | +6.865E+00 | +8.933E+00  | -18.00 | +2.269E-02 | -3.921-+11 | +3.3755-02  | +1-5745-11  | +4.3115-12   | +1.000E-39  | +2.7706+00  |        |
| 8     | +4.265E+00 | +5.520E+00 | +6.857E+00 | +8.924E+00  | -25.00 | +1-324E-02 | -2.474=+31 | +2.255=-72  | +1.1516-01  | +2.8248-02   | +0.0005-39  | +4.5585+00  | -      |
| 8     | +4.284E+00 | +5.538E+00 | +6.846E+00 | +8.9452+00  | -34.00 | +7.405F-03 | -1.498=+11 | +1.48272    | +7.4736-12  | +1-9156-92   | +0 0005-20  | +1.2305+01  |        |
| 8-    | +4.303F+00 | +5.555E+00 | +6.833E+00 | +8.965E+00  | -42.00 | +3.958E-03 | -8-676-+33 | +9-4-85-03  | +4.8546-17  | +1.247E=02   | +0.000E-39  | +0.0006-39  |        |
| 8     | +4.3201+00 | +5.569E+00 | +6.818E+00 | +8,9852+00  | -50.00 | +3.598E-03 | +7.000=-37 | +3.395E-03  | +4.5275-12  | +1.170E-02   | +0.000E-39  | +0.00000-39 | ,      |
| 8     | +4.335E+00 | +5.582F+00 | +6.802E+00 | +9.0075+00  | -58.00 | +3.598E-03 | +0.0105-37 | +3.097=-03  | +4-5255-12  | +1.1725-12   | +0.000E-39  | +0.0008-30  | ·      |
| 8     | +4.348E+00 | +5.592F+00 | +6.783F+00 | +9.U28E+00  | -66.00 | +3.598E-03 | +0.000=-39 | +3-0795-03  | +4-5236-12  | +1 - 1756-02 | +0.000E-39  | +0.0005-39  | ,<br>, |
| 8     | +4.358F+00 | +5.599E+00 | +6.763E+00 | +9.049E+00  | -74-20 | +3.599E-03 | +2-03032   | +3-3735-03  | +4-5215-72  | +1.179E-02   | +0.000E-39  | +0.0006-39  |        |
| 8     | +4.366E+00 | +5.603E+00 | +6.743F+00 | +9. J73E+33 | -82.00 | +3.598=-03 | +0.000=-39 | +3-0575-13  | +4.519E-12  | +1.181E-02   | +0-000E-39  | +0.0006-39  |        |
| 9     | +4.371E+00 | +5.604E+00 | +6.722E+00 | +9.0918+00  | -90.01 | +3.598E-03 | +7.0275-39 | +3.3510-"3  | +4.517E-72  | +1.1935-02   | +0.0005-29  | +0.0005-39  |        |
| 9     | +4.435E+00 | +5.604F+00 | +6.354F+00 | +9.459E+00  | -90.00 | +3.598E-03 | +2.0305-37 | +2.1315-01  | +4.4915-12  | +1.2315-12   | +1.0005-39  | +0.000E-39  |        |
| 9     | +4.499E+00 | +5.604F+00 | +5.986F+10 | +7.8245+33  | -90.30 | +3.598E-03 | +3.0305-39 | +2.712=-13  | +4.4475-12  | +1.2775-02   | +2.2105-39  | +0.000E~39  |        |
| 9     | +4.5638+00 | +5.604E+02 | +5.6175+00 | +1.0232+01  | -90.20 | +3.593E-03 | +2.022-39  | +2.54313    | +4.4145-17  | +1.3276-32   | +1.110F-10  | +0.000E-39  | ,      |
| 9     | +4.627E+00 | +5.6040+01 | +5.249E+00 | +1.)56++ 11 | -90.00 | +3.5985-03 | +1.00039   | +2.37-13-13 | +4.143=-07  | +1.375E-32   | +7.000-20   | +0.00000-00 | ,      |
| 9     | +4.591E+00 | +5.6040+00 | +4.881E+00 | +1.093-+01  | -90.00 | +3.5938-03 | +1.0005-39 | +2.2070-03  | +4.7536-02  | +1.423E=02   | +0.10020    | +1.1016-39  |        |
| 9     | +4.7556+00 | +5.604E+00 | +4.5136+03 | +1.1325+01  | -90,00 | +3.5935-03 | +0.0005-39 | +2.3435-13  | +4-3255-12  | +1.4716-02   | +1.110=-20  | +1.000E-39  | ,      |
| 9     | +4.819F+00 | +5.604E+00 | +4.145++00 | +1.1575+01  | -90.05 | +3.598E-03 | +0.0005-39 | +1.373=-03  | +4. 2275-12 | +1.5135-02   | +7.010F-10  | +0.0005-39  | ,      |
| 9     | +4.883-+00 | +5.604[+00 | +3.775F+00 | +1.204 +91  | -00.11 | +3.5935-33 | +3.0005-39 | +1.735=-33  | +4.2705-12  | +1-5676-12   | +0. 110=-20 | +0.0035-19  |        |
| 9     | +4.947E+00 | +5.604[+00 | +3.408E+00 | +1.2+35+31  | -90.70 | +3.598E-73 | +0.0005-39 | +1.539=-73  | +4.7455-00  | +1.6155-12   | +1. 200E-39 | +0.300E-39  |        |
|       |            |            |            |             |        |            |            |             |             |              |             |             |        |

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|   |     | •                                     |                             |                                |                         |              |                 |             |         | 205-22 A1 6635 | -02 40.000E-39 +0.000E-39 *"                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---|-----|---------------------------------------|-----------------------------|--------------------------------|-------------------------|--------------|-----------------|-------------|---------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |     | · · · · · · · · · · · · · · · · · · · | 0108+00 +5.6                | 04E+00 +3.040E                 | +00 +1.277E+01          | ***** +3.598 | 3E-03 +0.000:-4 | · · · · · · | AL DUA  | 201-12 +1:0001 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     | ĨSŤ                                   | X ST                        | Y ST                           | S ST                    | DTDS ST      | 1H=1 ST         | Se.,        | ALPHA   |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     | - 8 -                                 | -7.53842E-02                | +4.27525E-01                   | +4.36332E-01            | -8.00000F-01 | +7.030302+31    |             | +20+00  | r 41 DHA       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     | Ĩ ŬW ŜN                               | XOW SN                      | YOW SN                         | XBW SN                  | YBW SN       | SBW SN          | 14614       | SN SEL  | ALPHA          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       | 4.14835E+00                 | "+7.47990E+00                  | +1.41709E+30            | +8.02222E+00 | +8.15145E+))    | +4.87       | 372E+01 | 4 +20.00       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     | TT SN                                 | T XOL SN                    | YOL SN                         | XBL SN                  | YBL SN       | SBL SN          | 1957L       | SN SECT | r alpha        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     | CANNOT                                | 8.30245E-02<br>FIND THETA F | +4.47960E-01<br>OR RW OR B, SK | +3.37513E-01<br>IP CASE | +8.21108E-01 | +9.953522-)1    | +4.89       | 372E+01 | 1 +27.00       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       | -                           |                                |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       |                             |                                |                         |              |                 |             |         | -              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| P |     |                                       |                             |                                | **                      |              |                 |             |         | • -            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 8 | ۴,  |                                       |                             |                                |                         |              |                 | -           |         |                | ······································                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| ň | -7- |                                       | <del>.</del>                |                                |                         |              |                 | · · ·····   |         |                | • • • • • • • • • • • • • • • • • • • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|   |     |                                       |                             |                                |                         | -            |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       | -                           | ·                              |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       |                             | -                              |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                | · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                | · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|   |     |                                       | _                           |                                |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                | and the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second se |
|   |     |                                       |                             |                                |                         |              |                 |             |         |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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AT ALPHA = +2.0000E+01 WINDWARD, RW = +0.0000E-39 DELS = +7.4505F-02 354034 = +0.0000F-39

|     | S  | EC   | XO W       | XB W              | ¥8 W       | SB 🚽       | THFT8W  | PE/PS W    | DP/DS A    | 9- 4         | NT M       | 7F W       | 98 H       | XSI W       |
|-----|----|------|------------|-------------------|------------|------------|---------|------------|------------|--------------|------------|------------|------------|-------------|
|     |    |      |            |                   |            |            |         |            |            |              |            |            |            |             |
|     |    | 1 1  | +1.538E-UZ | +0.000E-39        | +0.0005-39 | +0.0305-39 | +93.10  | +1.000E+33 | +4.8395-35 | +L.1235+00   | +0.0^02-39 | +0.707E-39 | +0.0005-39 | +3.0032E-39 |
|     |    | 11   | -8-302E-02 | +1.904E-04        | +2.182E-02 | +2.182E-02 | +89.00  | +9.997E-01 | -1.9595+33 | +1.127E+00   | +3.251F-91 | +2.233F-05 | +0.000E-39 | +0.000E-39  |
|     |    | 1 +  | +1.081E-01 | +3.045E-03        | +8.720E-02 | +8,727E-02 | +86.00  | +9.951E-01 | -7.8125+30 | +L.121E+07   | +7.4426-71 | +3.541E-04 | +D.000F-39 | +0.000E-39  |
|     |    | 1 +  | +1.362E-01 | +9.317E-03        | +1.523E-01 | +1.527E-01 | +83.00  | +9.851E-01 | -1.3595+31 | +3.5738-01   | +8.049F-01 | +7.9235-04 | +0.000E-39 | +0.000E-39  |
|     |    | 3 +  | +1.675E-01 | +1.899E-02        | +2.171E-01 | +2.1825-01 | +80.00  | +9.698E-01 | +3.0302-39 | +8.4449-01   | +9.B59E-01 | +1.600F-03 | +0.000E-39 | +0.0006-39  |
|     |    | 3 4  | +5.601E-01 | +1.553F-01        | +9.903E-01 | +1.003E+00 | +80.00  | +9.698E-01 | +0.0005-39 | +3.229E-01   | +7.2665-01 | +7.357E-03 | +0.000E-39 | +0.000E-39  |
|     |    | 3.4  | +9.527E-01 | +2.917E-01        | +1.764E+00 | +1.789E+00 | +80.00  | +9.698E-01 | +3.0305-39 | +2.534E-01   | +6.473F-01 | +1.311E-02 | +0.0005-39 | +0.000E-39  |
|     |    | 34   | +1.345E+00 | +4.280E-01        | +2.537E+00 | +2.574E+00 | +80.30  | +9.698E-01 | +3.0302-39 | +2.1975-01   | +6.018E-71 | +1.887E-02 | +0.000E-39 | +0.000E-39  |
|     |    | -3-4 | +1.738E+00 | <b>∓5.644E-01</b> | +3.310E+00 | +3.3596+00 | +80.00  | +9.693E-01 | +3.0302-39 | +1.7398-01   | +5.706E-01 | +2.4636-02 | +0.000E-39 | +0.000E-39  |
|     |    | 34   | +2.130E+00 | +7.007E-01        | +4.083E+00 | +4.144E+30 | +80.00  | +9.698E-01 | +3.0305-39 | +1.7535-01   | +5.47?E-01 | +3.039E-32 | +1.000E-39 | +0.000E-39  |
|     |    | 3-1  | +2.523E+00 | F8.371E-01        | ¥4.857E+00 | +4.929E+00 | +80.00  | +9.698E-01 | +0.0002-39 | +1.5112-01   | +5.285E-01 | +3.614E-32 | +).000F-39 | +0.000E-39  |
|     |    | 3 1  | +2.916E+00 | +9.734E-01        | +5.630E+00 | +5.715E+00 | +80.00  | +9.698E-01 | +).))05-39 | +1.4972-01   | +5.131F-91 | +4.1936-32 | +0.000E-39 | +0.000E-39  |
|     |    | 34   | +3-308E+00 | +1.110E+00        | ∔6.403E+00 | +6.500E+00 | +87.00  | +9.698E-01 | +0.0395-39 | +L.407E-01   | +5.0016-01 | +4.765F-02 | +0.000E-39 | +0.000E-39  |
|     |    | 3 +  | +3.701E+00 | +1.246E+00        | +7.176E+00 | +7.285E+00 | +80.00  | +9.693F-01 | +3.0301-39 | +1.330E-01   | +4.888F-01 | +5.342E-0? | +0.000E-39 | +0.000E-39  |
|     |    | 4 4  | +4.093E+00 | +1.382E+00        | +7.950E+00 | +8.070E+00 | +80.00  | +9.698E-01 | -1.6005+32 | +2.9928-01   | +4.789E-01 | +5.917E-02 | +0.000E-39 | +0.000E-39  |
|     |    | 4 +  | +4.102E+00 | +1.386E+00        | +7.965E+00 | +8.086E+00 | +74.09  | +9.243E-01 | -2.4792+32 | +3.535E-01   | +5.734E-01 | +9.178E-02 | +0.0005-39 | +0.000E-39  |
|     |    | -4-4 | 4.112E+00  | +1.391E+00        | +7.980E+00 | +8.102E+00 | +68.00  | +8.597E-01 | -3.2492+32 | +4.0538-01   | +8.248E-01 | +1.204E-01 | +0.000E-39 | +0.000E-39  |
|     |    | 4 +  | +4.123E+00 | +1.398E+00        | +7.994E+00 | +8.117E+00 | +62.00  | +7.796E-01 | -3.8782+02 | +4.357E-01   | +9.323F-01 | +1.436E-01 | +0.000E-39 | +0.000E-39  |
|     |    | 4 4  | +4.I35E+00 | +1.406E+00        | +8.008E+00 | +8.133E+00 | +56.00  | +6.873E-01 | -4.337E+32 | +4.404E-01   | +9.9468-01 | +1.603E-01 | +0.000E-39 | +0.000E-39  |
|     |    | 4 4  | +4•148E+00 | +1.415E+00        | +8.020E+00 | +8.1492+00 | +50+00  | +5.868E-01 | -4.6063+02 | +4.375E-01   | +1.011E+30 | +1.697E-01 | +0.000E-39 | +0.000E-39  |
|     |    | 4 +  | +4.148E+00 | +1.417E+00        | +8.022E700 | +8.151E+00 | +48.94  | +5.685E-01 | -4.633:+32 | +4,413E-01   | +1.0005+70 | +1.705E-01 | +0.000E-39 | +0.000E-39  |
| 5   |    | 4 +  | +4.162E+30 | +1.426E+00        | +8.032E+00 | +8.164E+00 | +44.00  | +4.844E-01 | -4.675E+32 | +4.122E-01   | +9.833F-01 | +1.711E-01 | +0.000E-39 | +0.000E-39  |
| 7   | _  | 4 4  | +4.177E+00 | +1.438E+00        | +8.042E+00 | +8.180E+00 | 7+38+00 | +3.813E-01 | -4.539±+j2 | #3.555E-01   | +9.131E-01 | +1.546E-01 | +0.000E-39 | +0.000E-39  |
| ∿2. |    | 4 +  | +4+192E+00 | +1.451E+00        | +8.051E+00 | +8.1952+03 | +32.00  | +2.981E-01 | -3.310E+32 | +3.094E-01   | +8.2395-01 | +1.529E-01 | +0.000E-39 | +0.0082-39  |
| Ô   |    | 4 4  | +4.208E+00 | +1.464F+00        | +8.059E+00 | +8.212E+00 | +26.00  | +2.309E-01 | -2.6552+32 | +2.5008-01   | +7.273E-01 | +1.385E-01 | +0.000E-39 | +0.000E-39  |
| A m |    | 8 +  | +4-223E+00 | +1.479E+00        | +8.065E+00 | +8.227E+00 | +20.00  | +1.776E-01 | -2.1425+32 | +2.1502-01   | +6.3178-01 | +1.2326-01 | +0.000E-39 | +0.000E-39  |
| · ^ | -  | 8 +  | 4.244E+00  | +1.499E+00        | +8,070E+00 | +8.2455+00 | +12.00  | +1.226E-01 | -1.587E+32 | +1.527E-01   | +5.096E-01 | +1.0226-01 | +0.000E-39 | +0.000E-39  |
|     |    | 8 +  | 4.265E+00  | +1.520E+00        | +8.073E+00 | +8.269E+00 | +4.30   | +8.230E-02 | -1.1485+32 | +i.201E-01   | +3.987E-01 | +8,219E-02 | +0.000E-39 | +0.000E-39  |
|     |    | 8 +  | +4.284E+00 | 71.541E+00        | +8.073E+00 | +8.290E÷00 | -4.00   | +5.341E-02 | -8.0435+31 | +3.591E-02   | +3.019F-01 | +6.387E-02 | +0.000E-39 | +0.000F-39  |
|     |    | 8 4  | +4.303E+00 | +1.561E+00        | +8.070E+00 | +8.3112+00 | -12.00  | +3.367E-02 | -5.4722+31 | +5.3946-02   | +2.220E-01 | +4.816E-02 | +0.000E-39 | +0.000E-39  |
|     |    | 8 4  | +4+320E+00 | +1.581E+00        | +8.065E+00 | +8.332E+00 | -20.00  | +2.039E-02 | -3.5902+01 | +4.0468-02   | ÷1.576E-01 | +3.503E-02 | +7.000E-39 | +0.000E-39  |
|     |    | 8 +  | +4.335E+00 | +1.601E+00        | +8.056E+00 | +8.353E+00 | -28.00  | +1.194E-02 | -?.254E+)1 | +2+5715-02   | +1.084F-01 | +2.457F-02 | +0.000E-39 | +0.000E~39  |
|     |    | 8 +  | +4.348E+00 | +1.618E+00        | +8.045E+00 | +8.374E+00 | -36.00  | +6.728E-03 | -1.3795+31 | +1.7215-02   | +7.7128-02 | +1.579E-02 | +0.000E-39 | +0.000E-39  |
|     |    | 8 4  | +4.358E+00 | +1.634E+00        | +8.032E+00 | +8.395E+00 | -44.10  | +3.627E-03 | -8.037E+00 | +1.0318-02   | +4.6168-02 | +1.099F-72 | +0.000E-39 | +3.003E-39  |
|     |    | 8 4  | +4•366E+00 | +1.648E+00        | +8.016E+00 | +8.415E+00 | -52.00  | +3.598E-03 | +3.0205-39 | +4.915E-03   | +4.587F-02 | +1.095E-02 | +0.000E-39 | +0.000E-39  |
|     |    | 9 1  | +4-371E+00 | +1.660E+00        | +7.999E+00 | +8.437E+00 | -60.00  | +3.598E-33 | +3.0001-39 | +4.9042-03   | +4.5958-02 | +1.793E-02 | +0.0006-39 | +0.000E-39  |
|     |    | 91   | +4+435E+00 | +1.844E+00        | +7.680E+00 | +8.805E+00 | -60.00  | +3.598E-03 | +0.0005-39 | +4.597E-03   | +4.546F-02 | +1.146E-0? | +0.000E-39 | +0.000E-39  |
|     |    | 9 +  | 4.4998+30  | +2.028E+00        | +7.361E+00 | +9.173E+00 | -60.00  | +3.598E-03 | ►3.0305-39 | +4.493=-03   | +4.519E-32 | +1.194E-72 | +0.000F-39 | +0.000E-39  |
|     |    | 9 +  | 4.563E+00  | +2.212F+00        | +7.042F+00 | +9.541E+00 | -40.00  | +3.599E-03 | +7.030=-39 | +4.2895-03   | +4.473E-02 | +1.247E-7? | +1.000E-39 | +0.000E-39  |
|     |    | -9 + | +4.627E+00 | +2.396E+00        | +6.723E+00 | +9.9092+00 | -60.00  | +3.598F-03 | +3.0305-39 | +4.333E-03   | +4.4436-02 | +1.2976-32 | +1.000E-39 | +0.000E-39  |
|     |    | 94   | +4.691E+00 | +2.581E+00        | +6.404E+00 | +1.028E+01 | -60.00  | +3.598F-33 | +3.0002-39 | +3.888E-03   | +4.4075-72 | +1.338E-72 | +0.000E-39 | +0.000F-39  |
|     |    | -9-1 | +4.755E+00 | +2.765E+00        | +6.085E+00 | +l.065E+01 | -60.00  | +3.598E-03 | +3.3305-39 | +3.5378-03   | +4.375=-92 | +1.386E-0? | +0.000E-39 | +0.000E-39  |
|     |    | 94   | +4.819E+00 | +2.949E+00        | +5.767E+00 | +1.101E+01 | -60.00  | +3,598E-03 | +0.0005-39 | +3.4912-33   | +4.347E-72 | +1.434E-02 | +0.000E-39 | +0.000E-39  |
|     |    | 94   | +4+883E+00 | +3.133E+00        | +5.448E+00 | +L.139F+J1 | -60.00  | +3.598E-03 | +).0305-39 | +3.2945-03   | +4.318E-02 | +1.492E-02 | +1.010E-39 | +0.0002-39  |
|     |    | 94   | +4.947E+00 | +3.317E+00        | +5.129E+00 | +1.1755+01 | -60.00  | +3.5986-03 | +0.0005-39 | +3.0995-03   | +4.291E-72 | +1.530E-02 | +0.000E-39 | +0.000E-39  |
|     |    | 10 4 | +5.010E+00 | +3.501E+00        | +4.810E+00 | +1.212E+01 | -70.00  | +3.598E-03 | +3.0305-39 | +2.9022-03   | +4.255E-02 | +1.577F-02 | +0.000E-39 | +0.000E-39  |
|     |    | 10 4 | +5.010E+00 | +3.629E+00        | +4.453E+00 | +1.2+9E+01 | -70.00  | +3.598E-03 | +0.0005-33 | +2.5375-03   | +4.2395-02 | +1.626E-02 | +0.0005-39 | +0.000E-39  |
|     |    | 10 4 | +5.010E+00 | +3.758F+00        | +4.105E+00 | +1.287E+01 | -70.00  | +3.598E-03 | +0.0001-39 | +2+ +7 3=-33 | +4+214F-07 | +1.575E-02 | +0.000F-39 | +0.000E-39  |
|     |    | 10 4 | +>.UIOE+00 | +3.856E+00        | +3.753F+00 | +1.3242+71 | -70.10  | +3.599E-03 | +2.2202-39 | +2.2575-03   | +4.1995-02 | +1.724E-02 | +1.0105-39 | +0.000E-39  |
|     |    | 10 4 | +>.010E+00 | +4.014E+00        | +3.400E+00 | +1.352E+01 | -70+00  | +3.5998-03 | +3.0005-39 | +2.345-33    | +4.1665-72 | +1.773E-02 | +0.000E-39 | +0.000F-39  |
|     |    | 10 1 | +> 010++00 | +4.142E+00        | +3.048E+00 | +1.399E+J1 | -70.00  | +3.593E-93 | +7.0005-39 | +1.3345-03   | +4.1445-02 | +1.322F-02 | +0.00039   | +3.00DE-39  |
|     |    | 10 4 | +>+0105+00 | +4.271E+00        | +2,696E+00 | +1.4375+01 | -77.20  | +3.599F-03 | +0.0002-39 | +1.521E-03   | +4.1725-77 | +1.870E-02 | +0.0005-39 | +0.000E-39  |
|     |    | 10 4 | +>.010E+00 | +4.399F+00        | +2.343F+00 | +1.4745+01 | -70.00  | +3.599E-03 | +0.0005-39 | +1.4075-03   | +4.1716-72 | +1.919E-32 | +7.000E-39 | +0.0005-39  |
|     | ٠. | 10 - | +>.010E+00 | +4.527E+00        | +1.991E+70 | +1.512E+01 | -70.00  | +3.598F-03 | +7.0005-39 | +1.1978-03   | +4.0375-02 | +1.9435-32 | +).010F-39 | +0.000E-39  |
|     |    | 10 4 | +5.010E+00 | +4.6550+00        | +1.639E+00 | +1.5493+01 | -70.00  | +3.598F-03 | +7.0005-39 | +7.3475-04   | +4.7575-77 | +2.017E-02 | +9.0005-39 | +0.0006-39  |
|     | •  | 10 1 | +>.010E+00 | +4.784E+00        | +1.286E+00 | +1.537E+01 | -70.00  | +3.598E-03 | +).0302-39 | +7.7308-34   | +4.7411-72 | +2.055E-02 | +1.0006-39 | +0.000F-39  |

10 +5.010E+00 +4.912F+00 +9.338E-01 +1.624E+01 -70.00 +3.598E-03 +0.000E-39 +5.512E-04 +4.072F-07 +7.114E-07 +0.000E-39 +0.000E-39 10 +5.010E+00 +5.040E+00 +5.040E+00 +5.040E+01 +1.652E+01 -70.00 +3.598E-03 +0.000E-39 +3.454E-04 +4.074F-02 +2.163E-02 +0.000E-39 +0.000E-39 10 +5.010E+00 +5.168E+00 +2.290E-01 +1.592E+01 -70.00 +3.598E-03 +0.000E-39 +1.374E+04 +3.998E+02 +7.212E-22 +0.000E-39 +0.000E-39 10 +5.010E+00 +5.297E+00 +1.234E+01 +1.575E+04 +3.098E+03 +7.415E+05 +3.948E+02 +7.212E-24 +0.000E-39 +0.000E-39 10 +5.010E+00 +5.297E+00 +1.234E+01 +1.737E+01 -70.00 +3.598E+03 +7.000E-39 +7.415E+05 +3.948E+02 +7.212E+02 +0.000E-39 +0.000E-39



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AT ALPHA = +2.0000E+01, LEEWARD, RW = +1.5237E+00 DELS = +7.4505E-02 35400K = +5.5318F-01

SEC XO L XB L Y8 L SB L THETRE PE/PS L DP/DS L JL L DT L 8E | XST L 98 L 1 +7.538E-02 +0.000E-39 +0.000E-39 +0.000F-39 +90.00 +1.000E+00 +4.839E-05 +1.1236+00 +0.000F-39 +0.000F-39 +8.197=-01 +7.450E-02 1 +6.118F-02 +7.615E-04 +4.362E-02 +4.353E-02 +88.00 +9.983E-01 -3.915E+00 +1.125E+00 +4.375E-01 +7.745E-05 +7.090E-01 +7.661E-02 1 +4.259E-02 +4.757E-03 +1.089E-01 +1.091E-01 +85.00 +9.924E-01 -9.747E+00 +1.13E+00 +7.579E-01 +4.819E-04 +6.091E-01 +7.517E-02 1 +2.732E-02 +1.216E-02 +1.740E-01 +1.745E-01 +82.00 +9.806E-01 -1.547E+01 +9.575E-01 +8.492E-01 +1.032E-03 +4.480E-01 +7.626E-02 T+F-539E-02 #2.297E-02 +2.385E-01 +2.400E-01 +79.00 +9.636E-01 -2.103E)1 #9.755E-01 +1.339E+00 +1.927E-03 +2.055E-01 +7.793E-02 1 +6.848E-03 +3.713E-02 +3.024E-01 +3.054E-01 +76.00 +9.415E-01 -2.635E+11 +9.730E-01 +1.181E+00 +3.073E-03 +0.000E-39 +B.028E-02 I +1.713E-03 +5.462E-02 +3.655E-01 +3.739E-01 +73.00 +9.145E-01 -3.139E+31 +3.535E-01 +1.330E+31 +4.442E-03 +3.030E-39 +8.343E-02 1 +0.000E-39 +7.538E-02 +4.275E-01 +4.353E-01 +70.00 +8.830E-01 -3.638E+31 +3.4155-01 +1.397E+30 +6.003E-03 +3.000E-39 +8.750E-02 1-+1.713E-03 +9.937E-02 +4.884E-01 +5.018E-01 +67.00 +8.473E-01 -4.038E+01 +9.175E-01 +1.475F+00 +7.718E-03 +9.200E-39 +9.265E-02 1 +6.848E-03 +1.265E-01 +5.480E-01 +5.572E-01 +64.00 +8.078E-01 -4.423E+01 +8.394E-01 +1.535E+10 +0.547E-03 +0.000E-39 +9.902E-02 1-\*1-539E-02 \*1.567E-01 +6.060E-01 +6.327E-01 +61.00 +7.659E-01 -4.750E+01 +3.575E-01 +1.576E+00 +1.144E-02 +0.000E-39 +1.068E-01 1 +2.732E-02 +1.899E-01 +6.624E-01 +6.981E-01 +58.00 +7.192E-01 -5.045E+01 +3.223E-01 +1.599E+07 +1.335E-02 +0.000F-39 +1.161E-01 1 +4-259E-02 +2.261E-01 +7.170E-01 +7.635E-01 +55.00 +6.710E-01 -5.274E+01 +7.840E-01 +1.606E+00 +1.524E-02 +0.000E-39 +1.273E-01 1 +6-118E-02 +2-650E-01 +7-696E-01 +8-290E-01 +52-00 +6-210E-01 -5-445E+01 +7-429E-01 +1-596F+07 +1-705E-07 +0-000F-39 +1-403E-01 1 +7-538E-02 +2-924E-01 +8.035E-01 +8.727E-01 +50.00 +5.868E-01 -5.528E+01 +7.147E-01 +1.531E+07 +1.817E-02 +0.000E-39 +1.502E-01 1 +8.302E-02 +3.066E-01 +8.201E-01 +8.945E-01 +49.00 +5.696E-01 -5.558E+01 +7.005E-01 +1.570E+07 +1.871E-02 +0.000E-39 +1.555E-01 1 +8.302E-02 +3.075E-01 +8.211E-01 +8.959E-01 +48.94 +5.685E-01 -5.550E+01 +7.))1E-01 +1.570E+09 +1.974E-02 +0.000E-39 +1.558E-01 1 +1.081E-01 +3.508E-01 +8.683E-01 +9.599E-01 +46.00 +5.192E-01 -5.610E+01 +5.341E-01 +1.530E+00 +2.019E-02 +0.000E-39 +1.731E-01 T #1.362E-01 +3.975E-01 +9.142E-01 +1.025E+00 +43.00 +4.670E-01 -5.599E+01 +5.055E-01 +1.476F+07 +2.142E-02 +0.000E-39 +1.932E-01 3 +1.675E-01 +4.465E-01 +9.576E-01 +1.091E+00 +40.30 +4.153E-01 +3.000E-39 +5.145E-01 +1.478E+00 +2.237E-02 +0.000E-39 +2.163E-01 3 +5.601E-01 +1.048E+00 +1.462E+00 +1.875E+00 +40.00 +4.153E-01 +0.000E-39 +3.355E-01 +1.263E+00 +3.848E-07 +0.000E-39 +4.017E-01 3 +9.527E-01 +1.650E+00 +1.967E+00 +2.661E+00 +40.00 +4.153E-01 +0.030E-39 +3.235E-01 +1.178E+00 +5.458E-32 +0.000E-39 +5.098E-01 3 +1.345E+00 +2.25IE+00 +2.472E+00 +3.445E+00 +40.00 +4.153E-01 +3.000E-39 +2.933E-01 +1.118E+00 +7.068E-32 +0.000E-39 +5.794E-01 3 +1.738E+00 +2.952E+00 +2.976E+00 +4.232E+00 +4.232E+00 +40.00 +4.153E-01 +3.030E-39 +2.571E-01 +1.073E+00 +8.579E-02 +0.000E-39 +6.269E-01 3 +2.130E+00 +3.454E+00 +3.481E+00 +5.017E+00 +40.00 +40.53E-01 +3.030E-39 +2.470E-01 +1.037E+70 +1.029E-01 +0.000E-39 +6.604E-01 3 +2.523E+00 +4.055E+00 +3.986E+00 +5.802E+00 +40.00 +4.153E-01 +0.0002-37 +2.303E-01 +1.008E+00 +1.190E-01 +0.000E-39 +5.846E-01 3 +2.916E+00 +4.657E+00 +4.491E+00 +6.587E+00 +40.00 +4.153E-01 +0.000E-39 +2.175E-01 +9.825E-01 +1.351E-01 +0.000E-39 +7.021E-01 3 +3.308E+00 +5.258E+00 +4.995E+00 +7.372E+00 +40.00 +4.153E-01 +0.000E-39 +2.353E-01 +9.606F-01 +1.512E-01 +0.000E-39 +7.147E-01 3 +3.701E+00 +5.860E+00 +5.500E+00 +8.1536+00 +40.00 +4.153E-01 +3.000E-39 +1.357E-01 +9.413E-01 +1.673E-01 +0.000E-39 +7.236E=0T 4 +4.093E+00 +6.461E+00 +6.005E+00 +8.943E+00 +40.00 +4.153E-01 +0.000E-39 +1.883E-01 +9.242E-01 +1.834E-01 +0.000E-39 +7.297E-01 4 44.102E +00 +6.474E+00 +6.014E+00 +8.959E+00 +34.00 +3.152E-01 -4.337E+02 +2.553E-01 +8.999E-01 +1.704E-01 +0.000E-39 +7.351E-01 4 +4.112E+00 +6.487E+00 +6.022E+00 +8.974E+00 +28.00 +2.457E-01 -2.797E+02 +2.152E-01 +7.374E-01 +1.554E-01 +0.007E-39 +7.505E-01 4 #4.123E+D0 +6.502E+00 +6.029E+00 +8.990E+00 +22.00 +1.890E-01 -2.233E+02 +1.304E-01 +5.423E-01 +1.386E-01 +0.000E-39 +7.767E-01 4 +4.135E+00 +6.517E+00 +6.034E+00 +9.006E+00 +16.00 +1.443E-01 -1.838E+02 +1.483E-01 +5.506F-01 +1.214E-01 +0.000E-39 +8.153E-01 4 74-148E+00 +6.038E+00 +0.038E+00 +9.021E+00 +10.00 +1.081E-01 -1.433E+02 +1.2095-01 +4.639F-01 +1.045F-01 +0.000E-39 +8.689E-01 4 +4.162E+00 +6.547E+00 +6.039E+00 +9.037E+00 +4.00 +8.001E-02 -1.122E+12 +0.7)JE-02 +3.848F-01 +8.838E-02 +0.0003-39 +9.415E-01 + 4 +4.177E+00 +6.563E+00 +6.040E+00 +9.053E+00 -2.00 +5.769E-02 -8.573E+01 +7.501E-02 +8.119E-01 +7.305F-07 +0.000E-39 +1.639E400 4 +4.192E+00 +6.579E+00 +6.038E+00 +9.063E+00 -8.00 +4.102E-02 -6.456E+01 +5.022E-02 +2.491E-01 +5.944E-02 +0.000E-39 +1.171E+00 4 +4.208E+00 +6.594E+00 +6.035E+00 +9.084E+00 -14.00 +2.867E-02 -4.733E+01 +4.327E-02 +1.056F-01 +4.755F-02 +0.000E-39 +1.355F+00 8 +4+223E+00 +6+609E+00 +6+031E+00 +9+100E+00 -20.00 +1+956E-02 -3.456E+01 +3.407E-72 +1+555E-71 +3.773E-02 +7.070E-39 +1+621E+00 8 +4.244Ef00 +6.628E+00 +6.022E+00 +9.121E+00 -28.00 +1.139E-02 -2.175E+01 +2.225E-02 +1.031E-01 +2.611E-02 +0.000E-39 +2.215E+00 8 +4.265E+00 +6.646E+00 +6.011E+00 +9.142E+00 -36.00 +6.378E-03 -1.316E+01 +1.453E-02 +6.820F-02 +1.767E-02 +0.000E-39 +3.507E+00 8 +4.284E+00 +6.662E+00 +5.998E+00 +9.163E+00 -44.00 +3.598E-03 +0.000E-39 +3.452E-03 +4.510E-02 +1.193E-02 +0.000E-39 +8.098E+00 8 +4.303E+00 +6.676E+00 +5.982E+00 +9.184E+00 -52.00 +3.593E-03 +3.030E-39 +3.443E-03 +4.503E-12 +1.195E-02 +0.000E-39 +0.000E-39 8 +4-320E+00 +6-688E+00 +5-965E+00 +9-205E+00 -60-00 +3-598E-03 +0-000E-39 +3-4335-03 +4-506E-02 +1-198E-07 +0-000E-39 8 +4.335E+00 +6.697E+00 +5.946E+00 +9.225E+03 -68.00 +3.598E-03 +3.000E-37 +3.422E-03 +4.574E-07 +1.201E-07 +0.000E-39 +0.000E-39 8 +4-348E+00 +6-703E+00 +5-926E+00 +9-246E+00 -76-00 +3-598E-03 +0-000E-39 +3-410E-03 +4-502E-07 +1-204E-02 +0-000E-39 8 +4.358E+00 +6.707E+00 +5.905E+00 +9.267E+00 -84.00 +3.598E-03 +0.000E-39 +3.398E-03 +4.500F-02 +1.205E-07 +0.000E-30 +0.000E-39 B +4.366E+00 +6.708E+00 +5.885E+00 +9.288E+00 -92.00 +3.599E-03 +0.000E-39 +3.385E-03 +4.498E-02 +1.209E-02 +0.000E-39 +0.000E-39 I ST X ST Y ST 5 S T DTDS ST THET ST SECT ALPHA 16 +2.13046E+00 +4.02500E+00 +4.58048E+00 +0.0000000-30 +5.00000E+31 3 +37.00

IN SN XON SN YON SN XBN SN YBN SN SN SN SN THETH SN SFCT ALPHA

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-70-

13 +4.162348+00 +7.487038+00 +3.590158-02 +4.024518+00 +4.033488+)) +4.893728+01 4 +30.00 THETL SN SECT ALPHA IL SN XOL SN YOL SN XBL SN YBL SN SBL SN -20 +1.53896E-02 +1.95543E-01 +3.37513E-01 +4.74709E+00 +4.82133E+0) +4.33372E+01 1 +30.00 - -- ---71 -3.6 - --

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|    | AT ALPHA = +3<br>Thetaw less th | AN LIMIT                               | RD, RW = +1.3235                       | E+01 DE          | LS = +1.38               | 156+00 3540:             | C< = -7.71               | 75F+7^                   |                          |                          |                          |   |
|----|---------------------------------|----------------------------------------|----------------------------------------|------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|---|
|    | SEC XO W                        | хв w ү                                 | в₩ Ѕ₿୶                                 | тнетви           | PE/PS W                  | 6 2C/90                  | JL 4                     | OT W                     | në M                     | OR W                     | XSI W                    |   |
|    | 3 +2.130F+00<br>3 +2.523E+00    | +0.000E-39 +0.0                        | 005-39 +0.000E-39<br>52E-01 +7.852E-01 | +90.00           | +1.000E+00               | +4.839=-35               | +1.717E-01               | +0.000E-39               | +1.000E-39               | +1.520E+01               | +1.381E+00               |   |
|    | 3 +2.916E+00                    | -2.235E-08 +1.5                        | 70E+00 +1.570E+00                      | +90.00           | +9.845E-01               | -2.1345+33               | +1.597E-01               | +3.6135-01               | +5.357F-03               | +8.497E+00               | +1.286E+00               |   |
|    | 3 +3.701E+00                    | -1.490E-08 +3.1                        | 41E+00 +3.141E+00                      | +90.00           | +8.309E-01               | -1.392E+01               | +2.597E-01               | +1.053E+00               | +5.032F-02               | +0.000E-39               | +9.561E-01               |   |
|    | 4 +4.102E+00                    | +8.217E-04 +3.9                        | 42E+00 +3.942E+00                      | +90.00           | +6.046E-01               | -2.657E+31               | +2.5182-01               | +1.170E+00               | +8.16JE-02               | +0.000E-39               | +6.384E-01<br>+6.001E-01 |   |
|    | 4 +4.112F+00<br>4 +4.123E+00    | ) +3.278E-03 +3.9<br>) +7.341E-03 +3.9 | 57E+00 +3.957E+00<br>72E+00 +3.973E+00 | +78.00<br>+72.00 | +5.985E-01<br>+5.925E-01 | -2.5985+31               | +2.527E-01<br>+2.515E-01 | +1.159E+00<br>+1.158E+00 | +8.210F-02<br>+8.259E-02 | +0.000E-39<br>+0.000E-39 | +5.706E-01<br>+5.486E-01 |   |
|    | 4 +4.135E+00                    | ) +1.297E-02 +3.9<br>) +2.010E-02 +4.0 | 87E+00 +3.989E+03<br>01E+00 +4.305F+00 | +66.00           | +5.864E-01<br>+5.801E-01 | -2.7502+31               | +2.535=-71               | +1.165E+00               | +8.307F-02               | +0.000E-39               | +5.331E-01               |   |
|    | 4 +4.162E+00<br>4 +4.162E+00    | ) +2.865E-02 +4.0<br>+3.690E-02 +4.0   | 14E+00 +4.020E+00<br>25E+00 +4.033E+00 | +54.00           | +5.739E-01               | -2.8245+01               | +2.487=-01               | +1.163F+00               | +8.400F-02               | +0.000E-39               | +5.187E-01               |   |
|    | 4 +4.177E+00                    | +3.853E-02 +4.0                        | 26E+00 +4.036E+00                      | +48.00           | +5.539E-01               | -4-6525+02               | +3.156=-01               | +1.1595+00               | +3.465E-32               | +0.000E-39               | +5.191E-01               |   |
|    | 4 +4.208E+00                    | +6.183E-02 +4.0                        | 47E+00 +4.067E+00                      | +36.00           | +3.478E-01               | -4.4495+32               | +2.5735-01               | +1.013E+10               | +7.981E-32               | +0.000E-39               | +5.2422-01<br>+5.338E-01 |   |
|    | 8 +4.244E+00                    | +9.381E-02 +4.0                        | 65E+00 +4.104E+00                      | +22.00           | +2.705E-01               | -2.278=+32               | +1.535E-01               | +7.5598-31               | +7.343E-32<br>+6.369E-02 | +0.000E-39               | +5.475E-01<br>+5.771E-01 |   |
|    | 8 +4.284E+00                    | +1.343E-01 +4.0                        | 75E+00 +4.145E+00                      | +14.00           | +1.326E-01<br>+8.915E-02 | -1.6915+32               | +9.2495-01               | +6.132F-71<br>+4.913F-71 | +5.307F-02<br>+4.313F-02 | +0.000E-39               | +6.026E-01<br>+6.367E-01 |   |
| ₩  | - 8 +4.303E+00                  | +1.552E-01 +4.0<br>+1.760E-01 +4.0     | 76E+00 +4.167E+00<br>74E+00 +4.183E+00 | -2.00            | +5.814E-02<br>+3.660E-02 | -8.6275+01<br>-5.8598+01 | +5.5395-02               | +3.6515-01<br>+2.6945-01 | +3.379E-02<br>+2.557E-02 | +0.000E-39<br>+0.000E-39 | +6.712E-01<br>+7.023E-01 |   |
| 24 | 8 +4.335E+00<br>8 +4.348E+00    | +1.964E-01 +4.0                        | 69E+00 +4.209E+00<br>61E+00 +4.230E+00 | -18.00           | +2.220E-02<br>+1.296E-02 | -3.849E+)L<br>-2.431E+)1 | +3.1150-02<br>+2.0456-02 | +1.916E-01<br>+1.317F-01 | +1.971F-02<br>+1.327E-02 | +0.000E-39<br>+0.000E-39 | +0.000E-39<br>+0.000E-39 |   |
| Λ, | 8 +4.358E+00<br>8 +4.366E+00    | +2.339E-01 +4.0                        | 50E+00 +4.251E+00<br>37E+00 +4.272E+00 | -34.00           | +7.264E-03               | -1.474E+01<br>-8.544E+00 | +1.306E-02               | +8.725F-12               | +8.981E-03               | +0.000E-39               | +0.000E-39               |   |
|    | 9 +4.371E+00<br>9 +4.435E+00    | +2.649E-01 +4.0                        | 22E+00 +4.293E+00<br>40E+00 +4.561=+00 | -50.00           | +3.598E-03               | +0.000E-39               | +3.5795-03               | +5.248F-12               | +5.587E-03               | +3.000E-39               | +0.000F-39               |   |
|    | 9 +4.499E+00                    | +7.383E-01 +3.4                        | 58E+00 +5.029E+00                      | -50.00           | +3.598E-03               | +2.0202-39               | +3.0535-03               | +5.0455-02               | +6.545F-73               | +0.000E-39               | +0.000E-39               |   |
|    | 9 +4.627E+00                    | +1.212E+00 +2.8                        | 94E+00 +5.765E+00                      | -50.00           | +3.598E-03               | +0.0002-39               | +2.5555=-03              | +4.943E-12               | +7.575F-33               | +0.0005-39               | +0.000E-39               |   |
|    | 9 +4.755E+00                    | +1.685E+00 +2.3                        | 30E+00 +6.502E+00                      | -50.00           | +3.598E-03               | +3.0302-39               | +2.352E-13               | +4.9375-72               | +9.4635-03               | +2.0008-39               | +0.000E-39               |   |
|    | 9 +4.883E+00                    | +2.158E+00 +1.7                        | 66E+00 +7.238E+00                      | -50.00           | +3.598E-03               | +0.0002-39               | +1.5535-03               | +4.729=-10               | +9.472E-03               | +0.0006-39               | +0.000E-39<br>+0.000F-39 | _ |
|    | 10 +5.010E+00                   | +2.632E+00 +1.2                        | 02E+00 +7.974E+00                      | -50.00           | +3.598E-33<br>+3.598E-03 | +0.0002-39               | +1.3055-03               | +4.6375-12               | +9.301F-03<br>+1.339F-72 | +0.000E-39<br>+0.000E-39 | +0.000E-39<br>+0.007E-39 |   |
|    | 10 +5.010E+00<br>10 +5.010E+00  | +2.819E+00 +8.7<br>+3.007E+00 +5.5     | 71E-01 +8.349E+00<br>23E-01 +8.724E+00 | -60.00           | +3.598E-03<br>+3.598E-03 | +3.0002-39               | +7.7373-34               | +4.5545-72               | +1.126F-02               | +0.0005-39<br>+0.000E-39 | +0.000E-39<br>+0.000E-39 |   |
|    | 10 +5.010E+00<br>10 +5.010E+00  | +3.194E+00 +2.2<br>+3.382E+00 +9.7     | 76E-01 +9.099E+00<br>20E-02 +9.474E+00 | -60.00           | +3.598E-03<br>+3.598E-03 | +0.000E-39<br>+0.000E-39 | +1.393E-04<br>+8.341E-05 | +4.514"-11<br>+4.4976-17 | +1.194#-07<br>+1.233E-02 | +7.000F-39<br>+0.000F-39 | +0.000E-39<br>+0.000E-39 |   |

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|     | AT A<br>THET | Ĩ₽ĤA = +3<br>AW LESS TH | .0000E+01.<br>AN LIMIT | LEEWARD, RW  | = +1.5081  | F+01 DE | LS = +1.38 | 156+00 3543  | C< = -1.53   | 38E+00      |            |                    |             |                |
|-----|--------------|-------------------------|------------------------|--------------|------------|---------|------------|--------------|--------------|-------------|------------|--------------------|-------------|----------------|
| -   | SEC          | X0 L                    | XB L                   | YB L         | 58 L       | THETBL  | PE/PS L    | DP/DS _      | ລູເ ເ        | QT L        | 96 L       | OR L               | XST L       |                |
|     | 3            | +2,130E+00              | +0.000F-39             | +0.000E-39   | +0.000E-39 | +93.00  | +1.000F+00 | +4.8095-05   | +1.717E-01   | +0.000F~39  | +0.0005-39 | +1.520E+01         | +1.381E+00  | D              |
|     | 3 .          | +1.738E+00              | -0.007E-39             | +7.852E-01   | +7.8525-01 | +90.00  | +9.985E~01 | -3.0961-31   | +1.71 ¥E-01  | +2.1115-01  | +1.149E-03 | +1.2515+71         | +1.361E+00  |                |
|     | 3            | +1.345E+00              | -0.000E-39             | +1.570E+00   | +1.570E+00 | +90.00  | +9.909E-01 | -1.202E+33   | +1.731E-01   | +3.181E-01  | +4.566E-33 | +1.016E+01         | +1.299E+00  |                |
|     | 3            | +9.5278-01              | -0.0002-39             | +2.356E+00   | +2.3335+00 | +90.00  | +9.673E-01 | -3.2512+33   | +2.4125-01   | +5.3205-01  | +1.797E-32 | +4.003E+00         | +1.1956+00  | <u>,</u>       |
| —   | 2            | +1.675E-01              | -0.0002-39             | *3.141E+00   | +3.1+1E+00 | +90+00  | +9.1146-01 | -1 2212431   | +2+3910-01   | +8.5841-01  | +3+8232-02 | +0.0002-39         | +1.0496400  |                |
|     | í.           | +1.362E-01              | +1-713E-03             | +3-9916+00   | +3.991E+00 | +87.00  | +7.8776-01 | -1.3855+31   | +2.5886-01   | +1.0655+00  | +6.968E=02 | +0.0006-39         | +0.9092-01  |                |
|     | î -          | +1.081E-01              | +6-848E-03             | +4.057E+00   | +4.057E+00 | +84-00  | +7.745E-01 | -1.450=+11   | +2-535E-01   | +1.0776+00  | +7.2355-02 | +0-0000-39         | +8.068F-01  |                |
|     | ī            | +8.302E-02              | +1.539E-02             | +4.122E+00   | +4-122E+00 | +81.00  | +7.607E-01 | -1.5185+01   | +2.579E-01   | +1.087F+D0  | +7.502E-02 | +0.000E-39         | +7.898E-01  | i              |
|     | · 1          | +6.118E-02              | +2.732E-02             | 44.186E+00   | +4.1885+00 | +78.00  | +7.462E-01 | -1.538-101   | +2.571E-D1   | +1.297E+20  | +7.769E-02 | +0.000E-39         | +7.778E-01  | ř –            |
|     | 1            | +4.259E-02              | +4.259E-02             | +4.250E+00   | +4.253E+00 | +75.00  | +7.310E-01 | -1.6502+01   | +2.550E-01   | +1.106F+00  | +8.035E-02 | +0.0005-39         | +7.706E-01  | i              |
|     | 1            | +2.732E-02              | ¥6.118E-02             | +4.312E+00   | +4.319E+00 | +72.00  | +7.152E-01 | -1.7345+31   | +2.645E-01   | +1.113E+00  | +8.299E-02 | +0.000E-39         | +7.582E-01  | i "            |
| _   | 1            | +1.539E-D2              | +8.302E-02             | +4.374E+00   | +4.384E+00 | +69.00  | +6.987F-01 | -1.8102+01   | ▶2.629E~01   | +1.120E+00  | +8.559E-02 | +0.000E-39         | +7.706E-01  | 1              |
|     | 1            | +6.848E-03              | +1.0818-01             | +4.434E+00   | +4.4532+03 | +56.00  | +6.814E-01 | -1.8395+31   | +2.6098-01   | +1.125E+00  | +8.314E-02 | +0.0008-39         | +7.777E-01  | L              |
|     | 1            | +1.713E-03              | +1.362E-01             | +4.493E+00   | +4.515E+00 | +63.00  | +6.634E-01 | -1.9702+31   | +2.5358-01   | +1.128E+30  | +9.0622-02 | +0.000E-39         | +7.895E-01  | L              |
|     | 1            | +0.000E-39              | +1.675E-01             | +4.551E+00   | +4.530E+00 | +60.00  | +6.447E-01 | -2.0535+01   | +2.5585-01   | +1.130E+00  | +9.303E-02 | <b>₽0.000E-3</b> 9 | +8.065E=01  | [              |
|     |              | +1.713E-03              | +2.0176-01             | +4.607E+00   | +4.5452+00 | +57.00  | +6.251E-01 | -2.1395+31   | +2.525E-01   | +1.130E+00  | +9.534E-02 | +0.000E-39         | +8.285E-01  |                |
|     | -            | +0.8482-03              | +2.3876-01             | +4.5512+00   | +4.711E+00 | +54.00  | +6.0482-01 | -2.2275+31   | +2.4918-01   | +1.129E+30  | +9.752E-02 | +0.000E-39         | +8.559E-01  | •              |
|     |              | +1.5396-02              | +2.7860-01             | +4-21132+00  | +4.7772+00 | +51.00  | +5+835E-01 | -2.31/2+31   | +2.+310-01   | +1.1256+00  | +9.9556-02 | +0.0002-39         | +8.8896-01  | L.             |
|     | 1            | +2.7326-02              | +3 2116-01             | +4.7476+00   | +4.0222700 | +40.94  | +5.0070-01 | -Z. 3312+JL  | +2 - 4220-01 | +1.1175+00  | +1.0092-01 | +0+0002~39         | +9.101000   |                |
|     |              | +4.2595-02              | +3 661E-01             | +4.8105+00   | +4 0085400 | +45.00  | +5 0186-11 | -5. 61 35437 | -2 61 SE-01  | -1.11/C+JO  | +1.010E-01 | TO DODE-39         |             |                |
|     | î.           | +6.118E-02              | +4-136E-01             | +4-855E+00   | +4.9736+00 | +42.00  | +4.4975+01 | -5.512=+31   | +2.2315-01   | +1.0456+30  | +1-0345-01 | +0.00002-39        | 11 026EA00  |                |
|     | î            | +8.302F-02              | +4-633E-01             | +4-8976+00   | +5.039E+00 | +39.00  | +3.982E-01 | -5-4905+01   | +2.1636-01   | +1.0225+00  | +1.024F=01 | +0.000E-39         | +1.0865+00  | ·              |
|     | ī.           | +1.081E-01              | +5.153E-01             | +4.937E+00   | +5.104E+00 | +35.00  | +3.515E-01 | -4.6585+31   | +1.972E-01   | +9.7236-01  | +1.005E-01 | +0-000E-39         | +1.1546+00  | <u>.</u>       |
|     | 1 -          | +1.362E-01              | +5.692E-01             | +4.974E+00   | +5.170E+00 | +33.00  | +3.102E-01 | -4.1213+01   | +1.311E-01   | +9.198E-01  | +9.780E-02 | +0.000E-39         | +1.232E+00  | 7              |
|     | 3.           | +1.675E-01              | +6.250E-01             | +5.009E+00   | +5.235E+00 | +30.00  | +2.734E-01 | -3,6782+01   | +1.556E-01   | +8.654E-01  | +9.460E-02 | +0.000E-39         | +1.320E+00  | ;              |
|     | 3.           | +5.601E-01              | +1.305E+00             | +5.401E+00   | +6.020E+00 | +30.00  | +2.500E-01 | -1.6575455   | +1.297E-01   | 46.057E-01  | +1.050E-01 | +0.0008-39         | +1.822E+00  | )              |
|     | 3 -          | +9.527E-01              | +1.985E+00             | +5.794E+00   | +6.805E+00 | +30.00  | +2.349E-01 | -1.0945+33   | +1.1548-01   | +7.618E-01  | +1.157E-01 | +0.000E-39         | +2.248E+00  | )              |
|     | 3 -          | +1.345E+00              | +2.665E+00             | +6.186E+00   | +7.591E+00 | +30+00  | +2.248E-01 | -7.2452-01   | +1.0515-01   | +7.288E-01  | +1.256E-01 | +0.000E-39         | +2.603E+00  | )" - <u></u> - |
| _   | 3            | +1.738E+00              | +3.345F+00             | +6.579E+00   | +8.375E+00 | +30.00  | +2.183E-01 | -4.6551-01   | +9.9315-02   | +7.036E-01  | +1.379E-01 | +0.030E-39         | +2.889E+00  | )              |
|     | 3.           | +2.130E+00              | +4.025F+00             | +6.972E+00   | +9.161E+00 | +30.00  | +2.142E-01 | -2.757=-01   | +9.413E-02   | +6.843E-01  | +1.495E-01 | +7.000E-39         | +3.110E+00  | ) -            |
|     |              | +2. 52 5E+00            | +4.7052+00             | + /+ 3046+00 | +9.9455+00 | +30.00  | +2.1196-01 | -1.329:-31   | +9.332E-02   | +6.6948-01  | +1.616E-01 | +0.0005-39         | +3+267F+00  | 2              |
|     | 3            | +2.3085+00              | +5.0655+00             | +9 169E+00   | 41 1625401 | +30.00  | +2 112-01  | -2.4001-12   | +3.370E-02   | +6.4005-01  | +1 9605-01 | +0.00000-39        | +3.3592+00  |                |
|     |              | +3.701F+00              | +6.745E+00             | +8.5426+00   | +1.230E+01 | +30.00  | +2.1235-01 | +1.184=+11   | *3.5136E-02  | +6 4215-01  | +1.009E=01 | +0.0002-39         | +3 3635+00  | ,              |
|     | <b>4</b> .   | +4.093E+00              | +7.425E+00             | +8.934E+00   | +1.3095+01 | +30.00  | +2-103E-01 | -1.2736-11   | +8-357E-02   | +6.3715-01  | +2.1105-01 | +0.00002-39        | +3. 2285400 | Ś              |
|     | - 4-         | +4.102E+00              | +7.439E+00             | +8.942E+00   | +1.310E+91 | +24.00  | +1.604E-01 | -1.972=+32   | +1.0735-01   | +5.4348-01  | +1.865F-01 | +0.000E-39         | +3-172E+00  | í              |
|     | 4 .          | +4.112E+00              | +7.454F+00             | +8.947E+00   | +1.312E+01 | +18.00  | +1.213E-01 | -1.573:+32   | +8.7985-02   | +4.615E-01  | +1.517E-01 | +0.000E-39         | +3.138E+00  | Ś              |
|     |              | +4.123E+00              | +7.469E+00             | +8.951E+00   | +1.3135+01 | +12.00  | +8.957E-02 | -1.230E+32   | +7.J52E-72   | +3.833E-01  | +1.373E-01 | +0.000E-39         | +3.125F+00  | 5              |
|     | 4 .          | +4.135E+00              | +7.484E+00             | +8.954E+00   | +1.315E+01 | +6.00   | +6.567F-02 | -9.539EF01   | +5.528E-02   | +3.1478-01  | +1.146E-01 | +0.000E-39         | +3.135E+00  | ,              |
|     | - 4          | +4.148E+00              | +7.500E+00             | +8.955E+00   | +1.3175+31 | +0.00   | +4.6612-02 | -7.1335+317  | F4.353E-02   | +2.516E-01  | +9.337E-32 | +0.000E-39         | +3.166E+00  | )              |
|     | 4.           | +4.162E+00              | +7.516E+00             | +8.954E+00   | +1.3135+01 | -6.00   | +3.2848-32 | -5.3592+31   | +3.379E-02   | +1.991F-01  | +7.5201-02 | +0.0005-39         | +3.719E+00  | )              |
|     | 4 ·          | +4.177E+00              | +7.531E+00             | +8.951E+30   | +1.320E+01 | -12.00  | +2.245E-02 | -3.8382+01   | +2.554E-02   | +1.537E-01  | +5.909F-72 | +0.000F-39         | +0.000E-39  | <b>;</b>       |
| 2   | ; `          | +4.192E+00              | +7.546E+00             | +8.947F+00   | +1.321E+01 | -18.00  | +1.514E-02 | -2.7765+31   | +1.9195-02   | +1.169E-01  | +4.569E-02 | +0.000F-39         | +0.000E-39  | )              |
|     | 4.           | +4.2086+00              | +7.5512+00             | +8.9426+00   | +1.3232+01 | -24.00  | +9.941E-03 | -1.934=+31   | +1+4175-02   | +8.591E-72  | +3.457F-02 | +0.070E-39         | +0.000E-39  |                |
| • - | - 8          | 14.2238+00              | +7.5025+00             | +8.934E+00   | +1.3242+01 | -30.00  | +0.403E-03 | -1.3215+31   | +1.037=-02   | +5.3516-02  | +2.557E-32 | +0.000E-39         | +0.000E-39  |                |
|     | 8            | +4.2655+00              | +7-608E+00             | +8,9095+00   | +1.3205+01 | -20.00  | +3 5085-03 | +1 0105-31   | +2 2235-02   | +4 1975-02  | +1 720E-02 | +0.0005-30         | +0.0002-39  |                |
|     | 8            | +4.2846+00              | +7-6216+00             | +8.8935+00   | +1.331=+01 | -54.10  | +3 5095-03 | +3.3302-39   | +2 210E-00   | +4. 1055-00 | +1 7336-02 | +0.0005-30         | +0.00000-39 |                |
|     | 8.           | +4.303E+00              | +7.632E+00             | +8.9756+00   | +1.3335+01 | -62.00  | +3-598E-03 | +1.030=-33   | +2.2156-03   | +4.1845-72  | +1.7256-07 | +0.0005-30         | +0.000E-39  |                |
|     | ã.           | +4.3200+00              | +7.641 F+00            | +8.856E+00   | +1.335E+01 | -70.00  | +3.5935-03 | +3.0305-39   | +2.210=-03   | +4.183E-02  | +1.7316-12 | +1.0106-20         | +0.00000-19 |                |
|     | 8.           | +4.335F+00              | +7.547F+00             | +8.836E+00   | +1.3375+.1 | -78.00  | +3.599E-03 | +)-6302-39   | +2.205E-03   | +4.1825-12  | +1.7416-02 | +1.0005-29         | +0.0305-39  |                |
|     | - 8 -        | +4-348F+00              | +7.650E+00             | +8.815E+00   | +1.3395+01 | -26.00  | +3.593E-03 | +0.010=-33   | +2.2005-03   | +4-1805-02  | +1 7435-32 | AD 0005-30         | +0 0005-30  | ,<br>,         |
|     |              |                         |                        |              |            |         |            |              |              |             |            |                    |             |                |

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| 1 57   | X S        | г        | Y ST                   |         | S ST       | ntos      | ST      | Tł   | HET ST   | S              | SECT        | ALPHA  |        |       |            |             |            |   |
|--------|------------|----------|------------------------|---------|------------|-----------|---------|------|----------|----------------|-------------|--------|--------|-------|------------|-------------|------------|---|
| 2 7    | +4.1084    | 5E+00 +  | 7.446426+              | FON +8  | .532543+00 | -6.656    | 67E+00  | +5.( | 00000E+: | 21             | 4           | +40.   | 00     |       |            |             |            |   |
| 1W S   | и хож      | SN       | YOW SN                 |         | XBW SN     | YBW       | SN      | SB   | W 5 N    | t              | r HE T A    | SN.    | SECT   | ALPY  | •          |             |            |   |
| 9      | +4.1921    | 7E+00 +  | 7.49672E+              | +00 +3  | •59315E-02 | +9.853    | 296-02  | +1.0 | 075025-0 | )l +           | 4.89        | 372F+0 | 1      | 4 +   | 49.00      |             |            |   |
| ~ 1L S | N XOL      | SN       | YOL SN                 |         | XBL SN     | YBL       | SN      | \$81 | LSV      | Ŧ              | FHETL       | 5 N    | SECT   | 4LPH  | A          |             |            |   |
| 24     | +0.0000    | 06-39 +  | 0.0000E-               | -39 +1  | •55428E+00 | +8.36?    | 77E+00  | +9.5 | 535332+: | )) <b>i</b>    | +++393      | 372E+0 | 1      | 1 +   | 47.00      |             |            |   |
|        | -          |          |                        |         |            |           |         |      |          |                |             |        |        |       |            |             |            |   |
|        |            |          |                        |         |            |           |         |      |          |                |             |        |        |       |            |             |            |   |
|        |            |          |                        |         |            |           |         |      |          |                |             |        |        |       |            |             |            |   |
|        |            | 000000   |                        |         | - +1 020   | 45-01 DE  |         |      | 0/F 03 - |                |             |        | 775 01 |       |            |             |            |   |
| SINC   | THETAW) N  | G. FOR   | XB = +2                | 7315E-0 | 02 RN = +  | 1.8284E-  | 01 DELS | = 1  | +8.9406  | 55-13.<br>E-03 | 35400       | :< =   | -8.727 | 75-31 |            |             |            |   |
| SEC    | xo w       | XB       | W Y                    | /B W    | SB ₩       | THETBW    | PE/PS   | W    | 0P79S    | A              | ວເ          | . н    | D.     | W     | REW        | OR H        | XSI W      |   |
| 4      | +4.108E+04 | +0.000   | E-39 +0.0              | 000E-39 | +0.000E-3  | 9 +90.00  | +1.000  | E+00 | +4.038   | 2-)5           | +1.61       | DE+00  | +2.00  | 06-39 | +0.000E-39 | +9.8375-02  | +8-9415-03 |   |
| 4      | +4+112E+0  | +9.135   | E-05 +5.2              | 235E-03 | +5.236E-0  | 3 +88.00  | +9.988  | E-01 | -3.253   | E+31           | +1.50       | 07E+00 | +5.71  | 6F-31 | +9.293E-36 | +8.5075-32  | +8.953E-03 |   |
|        | +4.123E+0  | +1.460   | E-03 +2.0              | 088E-02 | +2.094E-0  | 2 +82.00  | +9.805  | E-01 | -1.239   | <u>z+32</u>    | +1.5]       | 73E+00 | +1.52  | 25+20 | +1.467F-04 | +5.371E-02  | +9.144E-03 |   |
| 2      | +4.1002+0  | J +4.496 | E-03 +3.0<br>E-03 +5 1 | 295-02  | +3.0056-0  | 2 +76.00  | +9.415  | E-01 | -2.196   | =+32           | +1.32       | 205+00 | +1.83  | 56+70 | +3.587E-04 | +0.000E-39  | +9.565E-03 | 1 |
|        | +4-162E+0  | 1 41.518 | E-02 +6.5              | 576E-02 | +6.8375-0  | 2 + 64 00 | 49 078  | E-01 | -2-23    | 2112           | + 3         | 102+00 | +2+12  | 52+00 | +/+2J3E-04 | +0.000E-39  | +1.0226-02 |   |
| 4      | +4.177E+0  | +2.279   | F-02 +7.9              | A9E-02  | +8.3785-0  | 2 +54,00  | +7 102  | E-01 | -4 234   | 2132           | TL+ C2      | 16400  | 17 66  | 45+00 | +1 +125-02 | +0.00000-39 | +1.1100-02 |   |
|        | +4-1928+0  | +3.180   | E-02 +9.2              | 35F-02  | +9,9435-0  | 2 +52.00  | +6.210  | E-31 | ~4.510   | F+12           | <b>F1.1</b> | 545+00 | 47.47  | 95+00 | +2.0655-03 | +0.00002-34 | 1122725-02 |   |
| 4      | +4.192E+0  | +3.690   | E-02 +9.8              | 353E-02 | +1.075E-0  | 1 +48.94  | +5.685  | F-01 | -4.633   | =+32           | +9.9        | 395-01 | +2.39  | 9F+00 | +2.249E-03 | +0.000E-39  | +1-457F-02 |   |
|        | +4.208E+0  | +4.210   | E-02 +1.0              | 042E-01 | +1.152E-0  | 1 +46.00  | +5.192  | E-01 | -4.675   | FF 37          | +9.31       | 158-01 | +2.33  | 9E+00 | +2.422E-03 | +0.000F-39  | +1.5455-07 |   |
| 8      | +4.223E+0  | ) +5.358 | E-02 +1.1              | 149E-01 | +1.309E-0  | 1 +40.00  | +4.153  | E~01 | -4.636   | =+32           | +7.92       | 226-01 | +2.15  | 10+00 | +2.585F-03 | +3.000E-39  | +1.748E-02 |   |
| 8      | +4.244E+0  | j +7.051 | E-02 +1.2              | 2726-01 | +1.518E-0  | 1 +32.00  | +2.834  | E-01 | -4.204   | 112            | 15.9        | 718-01 | +1.79  | 7E+10 | +2.781E-03 | +0.000E-39  | +2.068E-02 |   |
| 8      | +4.265F+0  | ) +8.899 | E-02 +1.3              | 3705-01 | +1.723E-0  | 1 +24.00  | +2.014  | E-01 | -2.372   | 3+32           | +4.4        | 778-01 | +1.45  | 5=+30 | +2.744F-03 | +0.000E-39  | +2.450E-02 |   |
| 8      | +4.284E+0  | 0 +1.087 | E-01 +1.4              | 42E-01  | +1.937E-0  | 1 +16.00  | +1.400  | E~01 | -1.757   | 5 C + E        | +3.3        | ))Ė-01 | +1.15  | 7E+20 | +2.5750-03 | +2.0005-39  | +2.897F-02 | - |
| 8      | +4.303E+0  | 9 +1.291 | E-01 +1.4              | 85E-01  | +2.1+7E-0  | 1 +8.00   | +9.488  | F-32 | -1.239   | ế+32           | +2.3        | 59E-01 | +9.34  | 4F-21 | +2.313F-13 | +0.010E-39  | +3.411E-02 |   |
| 8      | +4.320E+0  | ) +1.500 | E-01 +1.5              | 500E-01 | +2.355E-0  | 1 +0.00   | +5.244  | F-02 | -9.152   | ミナブユ           | +1.53       | 238-01 | +6.81  | 1E-01 | +1.993F-23 | +0.000E-39  | +3.993E-02 |   |
| 8      | +4.335F+0  | +1.709   | E-01 +1.4              | 85E-01  | +2.556E-0  | 1 -8.00   | +3.950  | E-02 | -6.255   | 5+31           | +1.07       | 728-01 | +4.95  | 5F-01 | +1.543E-03 | +0.0005-39  | +4-642E-02 |   |
|        | +4.348E+0  | ) +1.913 | E-01 +1.4              | 42E-01  | +2.7758-0  | 1 -16.00  | +2.421  | E-02 | -4.142   | 5+31           | +5.78       | 38E-02 | +3.51  | 25-21 | +1.3040-03 | +0.0005-39  | +5-353E-02 | - |
| 8      | +4.358E+0  | +2.110   | E-01 +1.3              | 370E-01 | +2.985E-0  | 1 -24.00  | +1.427  | E-02 | -2.639   | =+21           | +4.0        | 948-02 | +2.39  | 35-11 | +9.925E-04 | +0.000E-39  | +0.000E-39 |   |
|        | 4.366E+0   | ) +2.295 | E-01 +1.2              | 2726-01 | +3.194E-0  | 1 -32.00  | +8.075  | E-03 | -1.615   | ≟+jî           | +2.3        | 54E-02 | +1.57  | 1-11  | +7.2520-04 | +2.2205-39  | +0.000E-39 |   |
| 9      | +4.371E+0  | +2.464   | E-01 +1.1              | 49E-01  | +3.403E-0  | 1 -40.00  | +4.378  | E-03 | -7.476   | Ē+22           | +1.29       | 925-02 | +1.21  | 4F-11 | +5.177F-04 | +2.000E-39  | +0.000E-39 |   |
| 9-     | ¥4.435E+0  | +5.285   | E-01 +1.2              | 218E-01 | +7.085E-0  | 1 -40.00  | +4.378  | E-03 | +0.000   | 2-39           | +9.75       | 54E-03 | +8.67  | 4F-32 | +1.057E-03 | +D. 000F-39 | +0.000F-39 |   |
| _ CANN | OT FIND T  | HETA FOR | RW OR B,               | SKIP    | CASE       |           | ,       |      |          |                |             |        |        |       |            |             |            |   |
|        |            |          |                        |         |            |           |         |      |          |                |             |        |        |       |            |             |            |   |

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AT ALPHA = +4.0000E+01, LEEWARD, RW = +0.0000E-39 DFLS = +8.9405F-03 35405K = +0.0000F-39

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|    | SFC XO L                      | XB L       | YB L       | SB L       | THETAL   | PE/PS L                                 | n°∕os _       | QL L               | OT L                                    | REL        | DR L        | XSI L       |   |
|----|-------------------------------|------------|------------|------------|----------|-----------------------------------------|---------------|--------------------|-----------------------------------------|------------|-------------|-------------|---|
|    | 4 +4.108E+00                  | +0.000E-39 | +0.000E-39 | +0.000F-39 | +90.00   | +1.000E+00                              | +4.0382-35    | +1.5105+00         | +0.0000-39                              | +3.3376-39 | +1.0005-39  | +7.000E-39  | - |
|    | 4 +4.102E+00                  | +3.654E-04 | +1.046E-02 | +1.0475-02 | +86.00   | +9.951E-01                              | -5.5102+01    | +1.501E+00         | +9.541F-02                              | +1.955E-05 | +0.0008-39  | +0.000E-39  |   |
|    | - 4 +4.093F+30                | +2.279E-03 | +2.605E-02 | +2.618E-02 | +80.00   | +9.698E~01                              | -1.6002+02    | +1.5535+00         | +1.639F-01                              | +1.199E-05 | +0.000F-39  | +0.0008-39  |   |
|    | 3 +3.701E+00                  | +1.386F-01 | +7.993F-01 | +8.114E-01 | +80.00   | +9.6985-01                              | +).0)05-39    | +7.559E-01         | +7.5815-01                              | +5.949E-03 | +0.000E-39  | +0.000E-39  |   |
|    | 3 F3.308E700                  | +2.750E-01 | +1.573E+00 | +1.5975+00 | +80.00   | +9.698F-01                              | +3.3335-39    | +5.2275-01         | +5.622E-01                              | +1.171E-02 | +0.000E-39  | #0.000E-39  |   |
|    | 3 +2.916E+00                  | +4.113E-01 | +2.346E+90 | +2.3825+00 | +80.00   | +9.698E-01                              | +2.0205-39    | +5.2545-01         | +5.112E-01                              | +1.746E-02 | +0.000E-39  | +0.000E-39  |   |
|    | 3 +2,523E+00                  | +5.477E-01 | +3.119E+00 | +3.167E+00 | +80.00   | +9.69BE-01                              | +0.0005-39    | ₩4.537E-01         | "+5.774E-01                             | +2.322F-0? | ¥0.000E-39  | +0.000E-39  |   |
|    | 3 +2.130E+00                  | +6.840F-01 | +3.892F+00 | +3.952E+00 | +80.00   | +9.698E-01                              | +0.0002-37    | +4.1452-01         | +5.5248-01                              | +2.898E-02 | +0.000E-39  | +0.000E-39  |   |
|    | 3 +1.738E+00                  | +8.204E-01 | +4.666E+00 | +4.7375+00 | +80.00   | +9.693E-01                              | +3.030E-39    | <b>∔3.7</b> 982-01 | +5.327E-01                              | +3.474E-02 | +0.000E-39  | +0.000E-39  |   |
|    | 3 +1.345E+00                  | +9.567E-01 | +5.439E+00 | +5.5232+00 | +80.00   | +9.693E-01                              | +0.0002-39    | +3.524E-01         | +5.1568-71                              | +4.049F-02 | +0.000E-39  | +0.000E-39  |   |
|    | 3"+9.527E-01                  | +1.093E+00 | +6.212E+00 | +6.308E+00 | +80.00   | +9.698E-01                              | +3.0305-39    | +3.3015-01         | +5.0316-01                              | +4.525E-02 | +0.010E-39  | +0.000E-39  |   |
|    | 3 +5.601E-01                  | +1.229E+00 | +6.985E+00 | +7.3935+00 | +80.00   | +9.699E-01                              | +3.0302-39    | +3.1155-01         | +4.9148-01                              | +5.201E-0? | +0.000E-39  | +0.000E-39  | - |
|    | 3 +1.675E-01                  | +1.366E+00 | +7.759E+00 | +7.878E+00 | +80.00   | +9.698E-01                              | +3.0305-39    | +2.9535-01         | +4.812E-01                              | +5.777F-02 | +0.000E-39  | +0.000E-39  | - |
|    | 1 *+1.362E-01                 | +1.379E+00 | +7.823E+00 | +7.9448+00 | +77.00   | +9.4948-01                              | -2.4515+31    | +5.1055-01         | +5.836E-01                              | +7.453E-72 | +0.000F-39  | +0.000E-39  | _ |
|    | 1 +1.081E-01                  | +1.395E+00 | +7.886E+00 | +8.D09E+00 | +74.00   | +9.243E-31                              | -2.9745+31    | <b>▶5.7</b> 32~01  | +6.747E-01                              | +9.091E-02 | +0.0005-39  | +0.000E-39  |   |
|    | 1 +8.302E-02                  | +1.415E+00 | +7.949E+00 | +8.074E+00 | +71.00   | +8.940E-01                              | -3.4562+01    | +5.3828-01         | +7.549E-01                              | +1.064E-01 | +0.000E-39  | +0.000E-39  |   |
|    | 1 +6.118E-02                  | +1.438E+00 | +8.010E+00 | +8.1405+00 | +68.30   | +8.597E-01                              | -3.8995+31    | +5.3535-01         | +8.240E-01                              | +1.209E-01 | +0.010E-39  | +0.000E-39  |   |
|    | 1 +4.259E-02                  | +1.464E+00 | +8.070E+00 | +8.205E+00 | +65.00   | +8.214E-01                              | -4.3305+31    | +7.2315-01         | +8.820F-01                              | +1.343E-01 | +0.000F-39  | +0.000E-39  |   |
|    | 1 +2.732E-02                  | +1.493E+00 | +8.1296+00 | +8.271E+00 | +62.00   | +7.796E-01                              | -4.6532+31    | +7.485=-01         | +9.298E-01                              | +1.4536-01 | +0.000E-39  | +0.000E-39  |   |
|    | 1 +1.534E-02                  | +1.525E+00 | +8.1856+00 | +8.3365+00 | +59.00   | +7.347E-01                              | -4.9565+01    | +7.527=-01         | +9.642E-01                              | +1.568E-01 | +0.000E-39  | +0.000E-39  |   |
|    | 1 +1 7125-02                  | +1.5602+00 | +8.2410+00 | +8.4026+00 | +56.00   | +6.873E-01                              | ~5.204:+01    | +7.5536-01         | +9.882E-01                              | +1.656E-01 | +0.000F-39  | +0.000E-39  |   |
|    | 1 +1.7136-03                  | +1.598E+00 | +8+2946+00 | +8.4576+00 | +53.00   | +6.378E-01                              | -5.396=+31    | +7.5928-01         | +1.001E+00                              | +1.725E-01 | +0.000E-39  | +0.000E-39  |   |
|    | 1 +0.0002-39                  | +1.0392+00 | +8.3436+00 | +8.3335+00 | +50+00   | +5.8652-01                              | -5.528=+JI    | +7.423E-01         | +1.002E+00                              | +1.7776-01 | +0.000E-39  | +0.000E-39  |   |
|    | 1 +0.0000-39                  | 11 6035+00 | +0.3030+00 | +8.5552+00 | +48+94   | +5.685E-01                              | -5.550:+JI    | +/.3/46-01         | +9.9955-01                              | +1.7956-01 | +0.000E-39  | +0.000E-39  |   |
| 22 | 1 +4 04 95-03                 | +1 7205+00 | +9 4415+00 | +0.598E+00 | ++1.00   | +2+305E-JI                              | -2.249211     | #7.2JJE-01         | +9.922E-JI                              | +1.8076-01 | +0.00000-39 | +0.0002-34  |   |
| ĉ  | 1 +1 5295-02                  | +1.7776+00 | +0.4412400 | +9.3042+00 | +44.00   | +4+0446-01                              | ~5.6LU:+JI    | *3.3520-01         | +9.1178-01                              | +1.5156-01 | +0.0000-39  | +0.0002-39  |   |
|    | 1 +2 7326-02                  | +1 927E+00 | +0.4000+00 | +0.7045+00 | 438 00   | +4.5252-01                              | -5.5586+31    | +5. +/20-01        | +9.4080-01                              | +1.8046-01 | +0.000E-39  | +0.000E-39  |   |
|    | 1 46 2505-02                  | +1 0406+00 | 10.5210100 | +P P42+00  | +35 00   | +2 2725-01                              | 12 7678 - 131 | TE ETGE_01         | TD. 99975-31                            | +1 707F-01 | TO 00000-39 | +0.00000-39 |   |
|    | 1 +6.118E+02                  | +1 0346+00 | +8 6025+00 | +0.0352+00 | +32 10   | 13.5725-01                              | -3 0725431    | +5-3192-01         | +8.0005-01                              | +1 +455-01 | +0.00000-39 | +0.00002-39 |   |
|    |                               | +1.9916+00 | +8.635E+00 | +8.9916+00 | +29.00   | +2 627E-01                              | -3 55(200)    | 14 6325-01         | +7 4205-31                              | +1 6005-01 | 10.00000-39 | 10 0005-30  |   |
|    | 1 +1.081E-01                  | +2.049E+00 | +8.665E+00 | +9.055=+00 | +26.00   | +2-309F-01                              | -3.1862+01    | +4.2025-01         | +7.1375-01                              | +1.5286-01 | +0.0006-39  | +0.000E-39  |   |
|    | 1 +1.362E-01                  | +2.108E+00 | +8.692E+00 | +9-1225+00 | +23.00   | +2.028E-01                              | -2.853=+11    | +3.3125-01         | +6.6546-01                              | +1-453E-01 | +0-000E-39  | +0.0006-39  |   |
|    | 3 +1.675E-01                  | +2.169E+00 | +8.716E+00 | +9.187E+00 | +20.00   | +1.777E-01                              | -2-570-+01    | +3.443=-01         | +6.180E-01                              | +1.375E-01 | +0-0005-39  | +0.0005-39  |   |
|    | 3 +5.601E-01                  | +2.907E+00 | +8.985E+00 | +9.9725+00 | +20.00   | +1.668E-01                              | -8.83031      | +2-735-01          | +5-868E-01                              | +1.443E-01 | +0.0005-39  | +0.000E-39  |   |
|    | 3 +9.527E-01                  | +3.645E+00 | +9.253E+00 | +1.076E+01 | +20.00   | +1.577E-01                              | -7.4225-01    | +2.447E-01         | +5.6005-01                              | +1.519E-01 | +0.000E-39  | +0.000E-39  |   |
|    | 3 +1.345E+00                  | +4.383E+00 | +9.522E+00 | +1.154E+31 | +20.00   | +1.509E-01                              | -5.723E-01    | +2.2538-01         | +5.3825-01                              | +1.594E-01 | +0.000E-39  | +0.200E-39  |   |
|    | 3 +1.738E+00                  | +5.121E+00 | +9.790E+00 | +1.2335+01 | +20.00   | +1.510E-01                              | +2.0205-39    | +2.0935-01         | +5.3145-71                              | +1.703E-01 | +0.0005-39  | +0.000E-39  |   |
|    | 3 +2. 130E+00                 | +5.858E+00 | +1.006E+01 | +1.311E+01 | +20.00   | +1.450E-01                              | -4.9965-01    | +2.0295-01         | +5.1775-01                              | +1.774E-01 | +0.000E-39  | +0.0005-39  |   |
|    | 3 +2.523E+00                  | +6.596E+00 | +1.033E+01 | +1.390E+01 | +20.00   | +1.397E-01                              | -4,4192-31    | +1.9125-01         | +4.9505-71                              | +1.845E-01 | +0.0002-39  | +0.000E-39  |   |
|    | 3 +2.916E+00                  | +7.334E+00 | +1.060E+01 | +1.468E+01 | +20.00   | +1.351E-01                              | -3.9302-01    | +1.3135-01         | +4.8395-01                              | +1.915E-01 | +0.000E-39  | +0.000E-39  |   |
|    | 3 +3.308E+00                  | +8.072E+00 | +1.086E+01 | +1.547E+01 | +20.00   | +1.306E-01                              | -3.7932-01    | +1.7275-01         | +4.6655-01                              | +1.982E-01 | +0.000E-39  | +0.000E-39  |   |
|    | 3 +3.701E+00                  | +8.810E+00 | +1.113E+01 | +1.625E+01 | +20.00   | +1.2668-01                              | -3.3362-31    | +L.549E-01         | +4.535E-01                              | +2.047F-01 | +0.000E-39  | +0.000E-39  |   |
|    | 4 +4.093E+00                  | +9.548E+00 | +1.140F+01 | +1.704E+01 | +20.00   | +1.231E-01                              | -2.9542-31    | +1.5325-01         | +4.4178-01                              | +2.115E-01 | +0.0008-39  | +0.000F-39  |   |
|    | 4 +4.102E+00                  | +9.563E+00 | +1.1418+01 | +1.705E+01 | +14.00   | +9.093E-02                              | -1.2455+32    | +2.1058-01         | +3.672E-01                              | +1.794E-01 | +0.000E-39  | +0.007F-39  |   |
|    | 4 +4.108E+30                  | +9.573E+00 | +1.141E+01 | +1.707E+01 | +10.00   | +7.420E-02                              | -1.0352+32    | +1.3545-01         | +3.2305-91                              | +1.598E-01 | +0.000E-39  | +0.000F-39  |   |
|    | 4 +4.112E+00                  | +9.578E+00 | +1.1418+71 | +1.707E+01 | +8.00    | +6.666E-02                              | -9.6572+01    | +T.750E-01         | +3.016F-01                              | +1.551F-01 | +0.000E-39  | +0.000E-39  |   |
|    | 4 +4.123E+00                  | +9.594F+00 | +1.141E+01 | +1.739E+01 | +2.00    | +4.729E-02                              | -7.2392+31    | +1.3045-01         | +2.411F-71                              | +1.222E-01 | +0.000E-39  | +0.000E-39  |   |
|    | 4 +4.135E+00                  | +9.609E+00 | +1.141++01 | +1.7136+01 | -4.00    | +3.332E-02                              | -5.425:+31    | +1.0125-01         | +1.909F-71                              | +9.947F-02 | +0.000E-39  | +0.000E-39  |   |
|    | 4 +4.148F+00                  | +9.525++00 | +1.141E+01 | +1.7120+31 | -10.00   | +2.279E-02                              | -3.9355+01    | +1.553E-02         | +1.473E-01                              | +7.735E-02 | +0.000E-39  | +0.000E-39  |   |
|    | 4 +4+1022+00                  | +7.0402+00 | TI-1416+01 | +1.7136+01 | -10.00   | +1.5376-02                              | -2.8122+31    | +>./528-02         | +1.1216-01                              | +5.995F-02 | +0.000E-39  | +0.000F-39  |   |
|    | 4 +4.1776+00                  | T7.6557+00 | +1.140E+91 | +1./15++01 | -27.70   | +1-011E-02                              | -1.9522+31    | ++.2532-02         | +8.3495-02                              | ++.531E-07 | +0.000E-39  | +0.000E-39  |   |
|    | 4 +4.1922+00                  | +7.0090+00 | *1.139E+01 | +1.7152+01 | -24.00   | +0.0146-03                              | -1.3+0:+01    | +3+1335-02         | +6.115F-72                              | +3.3578-37 | +1.1105-39  | +0.000F-39  |   |
|    | - 4 +4.208E+00                | +7.0832+00 | +1.139F+01 | +L+/15E+J1 | - 14. 10 | *************************************** | -8.433:+33    | *2+257=-02         | +++++++++++++++++++++++++++++++++++++++ | +/.4451-72 | +0.070=-39  | +0.000E-39  |   |
|    | 0 TT++223ETU0<br>8 +4.244E+00 | +9 7105+00 | +1 1366+01 | +1 700E+01 | -40.00   | 13 E00E_01                              | * 3. 3332-39  | *3. +312-J3        | + 3. 4762-32                            | +2 2415-02 | +0.0006-30  | +".003F-39  |   |
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| 6         +4.265E+00         +9.1           8         +4.284E+00         +9.1           8         +4.303E+00         +9.1           8         +4.320E+00         +9.1           8         +4.320E+00         +9.1           8         +4.320E+00         +9.1           8         +4.348E+00         +9.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| AT AL'PHA = 46,0000           SIN(THETAW) NEG. 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| AT ALPHA = +6.0000           SIN(THETAW) NEG. 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| AT ALPHA = *6.0000           SIN(THETAW) NEG. 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| AT ALPHA = *6.0000           SIN(THETAW) NEG. 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                                                                                                 | QR W<br>+2.018E-01<br>+1.39RE-01<br>+2.688F-02<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39                                                                                                                                                                         | XSI W<br>+1.834E-02<br>+1.970E-02<br>+1.9776E-02<br>+2.159E-02<br>+2.411E-02<br>+2.735E-02<br>+3.274E-02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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لاسېــــــــــــــــــــــــــــــــــــ |
| AT ALPHA ≅ ~46.0000           SIN(THETAW) NEG. FOI           SEC         X0 W           4         X4.162E400 *60.20           4         X4.162E400 *60.20           4         X4.162E400 *60.20           4         X4.162E400 *60.20           4         X4.162E400 *61.20           4         X4.162E400 *61.20           8         44.208E+00 +1.20           8         ¥4.246E+00 +31.10           8         ¥4.246E+00 +33.10           8         ¥4.266E+00 +34.20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | E+01 WINDWARD,<br>R XB = +2.7315<br>R W YB W<br>00E-39 +0.000E-<br>78E-03 +3.119E-<br>42E-03 +3.119E-<br>42E-03 +4.1358E-<br>78E-03 +4.1358E-<br>78E-03 +4.1358E-<br>78E-02 +7.500E-<br>10F-02 +7.500E-<br>00E-02 +9.235E-<br>90E-02 +9.633E-<br>00E-02 +9.635E-<br>00E-02 +9.635E-<br>00E-02 +9.035E-<br>00E-02 +9.035E-<br>00E-02 +9.035E-<br>00E-02 +9.035E-<br>00E-02 +9.035E-<br>00E-02 +9.035E-<br>00E-02 +9.035E-<br>00E-02 +9.035E-<br>00E-02 +9.035E-<br>00E-02 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 +9.035E-<br>00E-03 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                                                                                                                                                                                                                                                                                                                                                                            | -01 DELS = +<br>7633E-01 DELS<br>THETBW PE/PS<br>+90.30 +1.000<br>+84.00 +9.891<br>+70.00 +9.688<br>+72.00 +9.045<br>+66.00 +8.346<br>+50.30 +7.500<br>+52.00 -6.213<br>+48.94 +5.692                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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-2.749E+02\\ E-01 & -2.749E+02\\ E-01 & -4.051E+02\\ E-01 & -4.051E+02\\ E-01 & -4.051E+02\\ E-01 & -4.053E+02\\ E-01 & -4.033E30\\ E-01 & -4.032E30\\ E-01 & -4.03$                                                                                                                                                                                                                                                                                                                                        | 2( = -1.34)<br>334D2( =<br>2L N<br>+1.573E+00<br>+1.50E+00<br>+1.50E+00<br>+1.33E+00<br>+1.33E+00<br>+1.35E+00<br>+1.259E+00<br>+1.045E+00                                                                                                                                                                                                                                                                                                                                                                                 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W<br>+0.000E-39<br>+1.122E+00<br>+1.659E+00<br>+1.659E+00<br>+1.992E+00<br>+2.128E+00<br>+2.128E+00<br>+2.128E+00<br>+2.128E+00<br>+2.128E+00<br>+2.128E+00<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E-39<br>+0.00E             | RF W<br>+0.000F-39<br>+8.305F-05<br>+3.243E-04<br>+5.931E-04<br>+1.450E-03<br>+2.045F-03<br>+2.243E-04                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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W<br>+1.834E-02<br>+1.870E-02<br>+2.159E-02<br>+2.159E-02<br>+2.411E-02<br>+2.735E-02<br>+3.274E-02<br>+3.512E-02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | لريب<br>                                 |
| AT ALPHA = "6.0000           SIN(THETAW) NEG. FOO           SEC         X0 W           4 +4.148E+00 +0.00           4 +4.162E+00 +8.2           4 +4.177E+00 +3.2           4 +4.177E+00 +3.2           4 +4.223E+00 +1.2           8 +4.224E+00 +2.0           8 +4.224E+00 +3.3           8 +4.224E+00 +3.3           8 +4.256E+00 +4.5           8 +4.256E+00 +4.5           8 +4.256E+00 +6.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | E+01 HINDWARD,<br>R XB = +2,7315<br>B W YB W<br>00E-39 +0.000E-<br>17E-04 +1.558E-<br>78E-03 +3.119E-<br>78E-03 +3.119E-<br>77E-02 +6.101E-<br>10F-02 +7.500E-<br>80E-02 +9.235E-<br>80E-02 +1.078E-<br>80E-02 +1.078E-<br>83E-02 +1.274E-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | RW = +2.7533E<br>E-02 RW = +2.<br>SB W<br>39 +0.000E-33<br>02 +1.571E-02<br>02 +3.142E-02<br>02 +4.712E-02<br>02 +4.712E-02<br>02 +6.283E-02<br>02 +5.854E-02<br>02 +1.075E-01<br>01 +1.204E-01                                                                                                                                                                                                                                                                                                                                                                                                                                              | -01 DELS = +<br>7633E-01 DELS<br>THETBW PE/PS<br>+90.30 +1.000<br>+84.00 +9.508<br>+72.00 +9.508<br>+72.00 +9.508<br>+72.00 +8.346<br>+50.30 +7.500<br>+52.00 +6.213<br>+48.94 +5.685<br>+44.00 +4.844                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | $\begin{array}{c} 1.8342E-02^{}35.1;\\ =&+1.8342E-02^{}35.1;\\ =&+1.8342E-02^{}48.879E-04\\ E+00-4.879E-04\\ E=01^{}9.7255+01\\ E=01-1.903E+02\\ E=01-2.74765+02\\ E=01-2.74765+02\\ E=01-4.539E+02\\ E=01-4.539E+02\\ E=01-4.6755+02\\ E=01-4.675+02\\ E=01-4.6$                                                                                                                                                                                                                                                                                                                            | 2L M<br>2L M<br>4L.573E+00<br>+1.557E+00<br>+1.550E+00<br>+1.550E+00<br>+1.339E+00<br>+1.343E+00<br>+1.259E+00<br>+1.259E+00<br>+1.259E+00<br>+1.259E+00<br>+1.259E+00<br>+1.259E+00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 02E+00<br>-1-3402E+00<br>0T W<br>+0.000E-39<br>+1.122E+00<br>+1.659F+00<br>+1.659F+00<br>+1.992F+00<br>+2.123F+00<br>+2.123F+00<br>+2.982F+00<br>+1.989E+00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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                                         | لريب<br>                                 |
| AT ALPHA = *6.0000           SIN(THETAW) NEG. FOO           SEC         X0 W           4         *14284           162240         *822           4         *1622400           4         *1724400           4         *1724400           4         *1724400           4         *4.1772400           4         *4.1724400           8         *4.2234400           8         *4.2448400           8         *4.2456400           8         *4.2456400           8         *4.23654400           8         *4.3035400           8         *4.3035400                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | E+01 HINDWARD,<br>R XB = +2.7315<br>B W YB W<br>00E-39 +0.000E-<br>17E-04 +1.558E-<br>77E-03 +3.119E-<br>07E-02 +6.101E-<br>10F-02 +7.500E-<br>90E-02 +9.235E-<br>90E-02 +9.235E-<br>90E-02 +1.079E-<br>83E-02 +1.214E-<br>1.214E-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | RW = +2.7533E<br>E-02 RW = +2.<br>SB W<br>39 +0.000E-30<br>2 +1.57IE-02<br>02 +3.142E-02<br>02 +4.712E-02<br>02 +4.712E-02<br>02 +4.712E-02<br>02 +7.85KE-02<br>02 +3.949E-02<br>02 +3.949E-02<br>02 +1.075E-01<br>1 +1.204E-01<br>01 +1.414E-01<br>1 +1.623E-01                                                                                                                                                                                                                                                                                                                                                                             | -01 DELS = +<br>7633E-01 DELS<br>THETBW PE/PS<br>+90.30 +1.000<br>+78.00 +9.501<br>+78.00 +9.508<br>+72.00 +9.045<br>+56.00 +8.346<br>+52.00 +6.213<br>+48.94 +5.685<br>+44.00 +3.478<br>+36.00 +3.478<br>+36.00 +3.478                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | $\begin{array}{r} 1.8342E-02^{}3542\\ =& +1.83422-02^{}\\ 1.83422-02^{}\\ \hline &= +1.83422-02^{}\\ \hline &= 020000000000000000000000000000000000$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2C = -1.34<br>35402 ( = -<br>2L N<br>+1.573E+00<br>+1.555E+00<br>+1.555E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.335E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00<br>+1.355E+00                              | 02E+00<br>-1.3402E+10<br>OT W<br>+0.000E-39<br>+1.122E+00<br>T1.775C+00<br>+1.99E+10<br>+2.192E+10<br>+2.123F+10<br>+2.123F+10<br>+2.98F+10<br>+1.989E+10<br>+1.989E+10<br>+1.645E+10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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                                                                                                          | QR M<br>+2.018E-01<br>+1.35RE-01<br>+2.688F-02<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39                                                                                                   | XSI W<br>+1.834E-02<br>+1.876E-02<br>+2.411E-02<br>+2.411E-02<br>+2.411E-02<br>+3.274E-02<br>+3.512E-02<br>+3.512E-02<br>+3.930E-02<br>+4.688E-02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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| $\begin{array}{c} \text{AT ALPHA} = - 46.0000\\ \hline \text{SIN(THETAW)} \text{ NEG. FO}\\ \hline \text{SEC} XO W \\ 4 + 4.148E+00 + 9.00\\ \hline 4 + 4.162E+00 + 8.22\\ \hline 4 + 4.162E+00 + 7.32\\ \hline 4 + 4.208E+00 + 7.32\\ \hline 4 + 4.208E+00 + 7.32\\ \hline 8 + 4.224E+00 + 2.10\\ \hline 8 + 4.224E+00 + 2.10\\ \hline 8 + 4.224E+00 + 3.26\\ \hline 8 + 4.224E+00 + 4.32\\ \hline 8 + 4.302E+00 + 4.3\\ \hline 8 + 4.302E+00 + 4.3\\ \hline 8 + 4.320E+00 + 4.9\\ \hline 8 + 4.320E+00 + 4.9\\ \hline 8 + 4.320E+00 + 4.9\\ \hline 8 + 4.32E+00 + 4.3\\ \hline 8 + 4.32E+00 + 4.32E+00 + 4.3\\ \hline 8 + 4.32E+00 + 4.3\\ \hline 8 + 4.32E+00 + 4.3\\ \hline 8 + 4.32E+00 + 4.3\\ \hline 8 + 4.32E+00 + 4.3\\ \hline 8 + 4.32E+00 + 4.3\\ \hline 8 + 4.32E+00 + 4.3\\ \hline 8 + 4.32E+00 + 4.3\\ $ | E+01 HINDWARD,<br>R XB = +2.7315<br>B W YB W<br>005-39 +0.000E<br>17E-04 +1.568E<br>78E-03 +3.119E<br>77E-02 +6.101E<br>77E-02 +7.500E<br>80E-02 +9.235E<br>80E-02 +1.214E<br>88E-02 +1.214E<br>58E-02 +1.324E<br>58E-02 +1.324E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | RW = +2.7539E<br>E-02 RW = +2.<br>SB W<br>39 +0.000E-39<br>02 +1.571E-02<br>02 +3.142E-02<br>02 +4.12E-02<br>02 +4.12E-02<br>02 +4.285E-02<br>02 +4.945E-02<br>02 +1.075E-01<br>01 +1.44E-01<br>01 +1.623E-01                                                                                                                                                                                                                                                                                                                                                                                                                                | -01 DELS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | $\begin{array}{c} 1.8342E-02^{}3542\\ =& +1.8342E-02^{}3542\\ =& +1.8342E-02^{}3542\\ =& +1.8342E-02^{}3542\\ =& +1.8522E-02^{}3472E-02^{}3472E-02^{}3472E-02^{}252E-02^{}142E-02^{}3472E-02^{}252E-02^{}142E-02^{}32E-02^{}142E-02^{}32E-02^{}142E-02^{}32E-02^{}142E-02^{}32E-02^{}142E-02^{}32E-02^{}122E-02^{}32E-02^{}122E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02^{}32E-02}-02^{}32E-02^{}32E-02^{}32E-02}-02^{}32E-02^{}32E-02^{}32E-02}-02^{}32E-02^{}32E-02^{}32E-02}-02^{}32E-02^{}32E-02^{}32E-02}-02^{}32E-02^{}32E-02}-02^{}32E-02}-02^{$ 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N<br>+1.573E+00<br>+1.555E+00<br>1.555E+00<br>1.555E+00<br>1.33BE+00<br>1.33BE+00<br>1.33BE+00<br>1.33BE+00<br>1.345E+00<br>1.345E+00<br>+1.255E+00<br>+1.255E+00<br>+1.255E+00<br>+1.455E+01<br>+3.465E+01<br>+3.465E+01<br>+3.465E+01<br>+3.465E+01<br>+3.465E+01<br>+3.465E+01<br>+3.465E+01<br>+3.455E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+1.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+00<br>+5.555E+                           | 02E+00<br>-1.3402E+30<br>OT W<br>+0.030E-39<br>+1.122E+00<br>1.1.659F+10<br>T1.775C+00<br>+2.123F+10<br>+2.123F+10<br>+2.989E+10<br>+1.989E+10<br>+1.430E+20<br>+1.472F+10<br>+1.170F+10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>RF W</b><br>+0.000F-39<br>+8.305F-05<br>+3.243E-04<br>+5.931E-04<br>+1.450E-03<br>+2.457E-03<br>+2.457E-03<br>+2.574E-03<br>+2.574E-03<br>+2.574E-03<br>+2.574E-03                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | QR H<br>+2.018E-01<br>+1.39RE-01<br>+2.688F-02<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39                                                                       | XSI W<br>+1.834E-02<br>+1.970E-02<br>+1.970E-02<br>+2.1395-02<br>+2.411E-02<br>+2.411E-02<br>+2.735E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.52E-02<br>+5.52E-02<br>+5.52E-02                                                                                                                                                                                                                                                                                                                                                                                                                                                       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| AT ALPHA = "46.0000           SIN(THETAW) NEG. FOO           SEC         X0 W           4         4.148E+00           4         4.162E+00           4         4.162E+00           4         4.162E+00           4         4.177E+00           3         4           4         4.177E+00           2         4           4         172E+00           8         4.223E+00           8         4.223E+00           8         4.224E+00           8         4.225E+00           8         4.225E+00           8         4.305E+00           8         4.305E+00           8         4.305E+00           8         4.305E+00           8         4.335E+00           8         4.335E+00           8         4.335E+00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | E+01 HINDWARD,<br>R XB = +2.7315<br>B W YB W<br>00E-39 +0.000E-<br>17E-04 +1.58E-<br>78E-03 +3.119E-<br>77E-02 +6.101E-<br>10F-02 +7.500E-<br>80E-02 +9.23E-<br>80E-02 +1.214E-<br>83E-02 +1.214E-<br>55E-02 +1.224E-<br>70E-02 +1.401E-<br>70E-02 +1.401E-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | RW = +2.7533E<br>E-02 RW = +2.<br>SB W<br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | -01 DELS = +<br>7633E-01 DELS<br>THETBW PE/PS<br>+90.30 +1.000<br>+70.00 +9.891<br>+70.00 +9.691<br>+70.00 +9.64<br>+72.00 +9.045<br>+66.00 +8.346<br>+65.20 +7.500<br>+52.00 +6.213<br>+46.94 +56.621<br>+46.00 +3.474<br>+28.00 +2.493<br>+28.00 +2.493<br>+22.00 +1.718                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | $\begin{array}{c} 1.8342E-02^{}35.41\\ =& +1.8342E-02^{}35.41\\ =& +1.8342E-02^{}\\ W & DP/0S_{-}4\\ E+00 & -4.879E-04\\ E-01 & -4.879E-04\\ E-01 & -4.973E+03\\ E-01 & -4.9745E+03\\ E-01 & -4.6539E+03\\ E-01 & -4.639E+03\\ E-01 & -4.639E+03\\ E-01 & -4.639E+03\\ E-01 & -4.637E+03\\ E-01 & -4.637E+03\\ E-01 & -4.637E+03\\ E-01 & -4.637E+03\\ E-01 & -4.872E+03\\ E-01 & -4.872E+03\\ E-01 & -2.82E+03\\ E-01 & -2.12E+03\\ E-01 & -2.12$                                                                                                                                                                                                                                                                                                                                           | 22 - 1.32<br>33-02 - 2<br>- 32 - M<br>- 33-02 - 2<br>- 33-02 - 2                                                        | 02E+00<br>-1.3402E+30<br>OT W<br>+0.000E-39<br>11.122E+00<br>+1.459F+10<br>+1.99E+10<br>+2.123F+10<br>+2.28F+10<br>+2.98BF+10<br>+1.98BF+10<br>+1.77E+10<br>+1.43F(+20<br>+1.43F(+20<br>+1.43F(+20)<br>+1.17F+00<br>+1.43F(+20)<br>+1.17F+00<br>+1.43F(+20)<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.17F+00<br>+1.   | <b>RF W</b><br>+0.000F-39<br>+8.305F-05<br>+3.243E-04<br>+5.931E-04<br>+1.450E-03<br>+2.945F-03<br>+2.574E-03<br>+2.574E-03<br>+2.574E-03<br>+2.774E-03<br>+2.774E-03                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | QR H<br>+2.018E-01<br>+3.956E-01<br>+2.688F-02<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39                                                         | XSI W<br>+1.8345-02<br>+1.9705-02<br>+1.9705-02<br>+2.1395-02<br>+2.411E-02<br>+2.735E-02<br>+3.274E-02<br>+3.274E-02<br>+3.512E-02<br>+3.688E-02<br>+5.524E-02<br>+5.524E-02<br>+6.403E-02<br>+7.277E-02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                          |
| $\begin{array}{c} \mbox{AT ALPHA $=$-$6,0000$ \\ \mbox{SIN(THETAW) NEG. FO} \\ \mbox{SIN(THETAW) NEG. FO} \\ \mbox{SEC $X0 $W$ $X1$ \\ \mbox{A + 4,148E+00 +0,0.0} \\ \mbox{4 + 4,162E+00 +0,2.2} \\ \mbox{4 + 4,162E+00 +3,2.2} \\ \mbox{4 + 4,162E+00 +3,2.2} \\ \mbox{4 + 4,162E+00 +1,2.2} \\ \mbox{4 + 4,162E+00 +1,2.2} \\ \mbox{4 + 4,162E+00 +1,2.2} \\ \mbox{4 + 4,20E+00 +1,2.2} \\ \mbox{8 + 4,22AE+00 +4,5.3} \\ \mbox{8 + 4,33E+00 +4,3.3} \\ \mbox{8 + 4,33E+00 +1,3.3} \\ \mbo$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | E+01 HINDWARD,<br>R XB = +2.7315<br>B H YB + 0.00E-<br>17E-04 +1.558E-<br>17E-03 +4.635E-<br>17E-03 +4.635E-<br>10F-02 +6.101E-<br>10F-02 +7.500E-<br>80E-02 +7.500E-<br>80E-02 +1.078E-<br>80E-02 +1.078E-<br>58E-02 +1.324E-<br>58E-02 +1.410E-<br>58E-01 +1.449E-<br>58E-01 +                                                                                                                                                                       | $ \begin{array}{cccccccccccccccccccccccccccccccccccc$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -01 DELS'= +<br>7633E-01 DELS<br>THETBW PE/PS<br>+90.30 +1.000<br>+84.00 +9.891<br>+72.00 +9.658<br>+72.00 +9.045<br>+66.00 +8.346<br>+50.30 +7.500<br>+52.00 +6.213<br>+48.94 +5.685<br>+44.00 +4.844<br>+36.00 +3.478<br>+22.00 +1.178<br>+12.30 +1.213                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $\begin{array}{c} 1.8342E-02^{-}3542\\ =& +1.8342E-02^{-}3542\\ =& +1.8342E-02^{-}8542\\ =& +1.8342E-02^{-}85428\\ =& +1.85428& -1.85428& -1.85428\\ =& +1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& -1.85428& 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M<br>33.402 ( = -1.34)<br>34.402 ( = -<br>21. M<br>+1.55 0 = 000<br>+1.55 0 = 000<br>+1.35 3 = 000<br>+1.35 3 = 000<br>+1.35 3 = 00<br>+1.35 = 01<br>+7.33 = -01<br>+7.33 = -01<br>+2.33 = -01                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 02E+00<br>-1.3402E+30<br>0T W<br>+0.000E-39<br>+1.122E+00<br>+1.559E+10<br>T1.775E+00<br>+1.952E+10<br>+2.123E+10<br>+2.123E+10<br>+1.98E+10<br>+1.727E+10<br>+1.727E+10<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.77E+00<br>+1.75E+00<br>+1.75E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.55E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+00<br>+1.75E+0   | RF H<br>+0.001F-39<br>+8.305F-05<br>+3.243E-04<br>+5.931E-04<br>+1.451E-03<br>+2.947E-03<br>+2.947E-03<br>+2.974E-03<br>+2.974E-03<br>+2.974E-03<br>+2.172E-03<br>+2.172E-03<br>+2.172E-03                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | QR W<br>+2.018E-01<br>+1.359E-01<br>+2.688F-02<br>+0.070E-39<br>+0.070E-39<br>+0.070E-39<br>+0.070E-39<br>+0.070E-39<br>+0.070E-39<br>+0.070E-39<br>+0.070E-39<br>+0.070E-39<br>+0.070E-39                                                                       | XSI W<br>+1.834E-02<br>+1.870E-02<br>+1.970E-02<br>+2.479E-02<br>+2.479E-02<br>+2.471E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.51 |                                          |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | E+01 HINDWARD,<br>R XB = +2.7315<br>B W YB W<br>00E-39 +0.000E-<br>17E-04 +1.568E-<br>78E-03 +3.119E-<br>78E-03 +3.119E-<br>77E-02 +6.101E-<br>10F-02 +7.500E-<br>80E-02 +9.235E-<br>80E-02 +1.214E-<br>58E-02 +1.214E-<br>58E-02 +1.214E-<br>58E-01 +1.495E-<br>95E-01 +1.495E-<br>95E-01 +1.495E-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $RW = +2.7533E \\ E = 02 RW = +2. \\ SB W \\ 39 +0.000E \\ 37 +1.571E \\ -02 +1.571E \\ -02 \\ 21 +1.571E \\ -02 \\ 22 +1.571E \\ -02 \\ 22 +1.47E \\ -02 \\ 22 +7.854E \\ -02 \\ 22 +7.854E \\ -02 \\ 22 +1.075E \\ -01 \\ 11 +2.04E \\ -01 \\ 11 +2.933E \\ -01 \\ 11 +2.251E \\ -01 \\ 12 +2.51E \\ -01 \\ -0 \\ -0 \\ -0 \\ -0 \\ -0 \\ -0 \\ -$ | -01 DELS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | $\begin{array}{c} 1.8342E-02^{}3542\\ =& +1.8342E-02^{}3542\\ =& +1.8342E-02\\ W & DF/QS & W\\ E+00 & -4.879E-04\\ E=01 & -5.755+51\\ E=01 & -1.938E+52\\ E=01 & -2.93EE+52\\ E=01 & -4.539E+52\\ E=01 & -4.539E+52\\ E=01 & -4.675E+52\\ E=01 & -4.675E+52\\ E=01 & -4.675E+52\\ E=01 & -2.832E+52\\ E=02 & -7.955E+51\\ E=02 & -7.955E+51\\ \end{array}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 10 ( = -1.34)<br>354024 = -<br>-24_M<br>+1.5738=400<br>+1.5506=400<br>+1.5506=400<br>+1.358=400<br>+1.358=400<br>+1.358=400<br>+1.358=400<br>+1.258=400<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.388=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.5888=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01<br>+2.588=01 | 02E+00<br>-1-3402E+00<br>-0T W<br>+0.000E-39<br>1.122E+00<br>1.559F+10<br>2.138F+10<br>+2.198E+10<br>+2.98F+10<br>+1.989E+10<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438F+20<br>+1.438                               | RF N<br>+0.000F-39<br>+3.243E-04<br>+5.931E-04<br>+5.931E-04<br>+1.450E-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454-03<br>+2.454 | QR M<br>+2.018E-01<br>+2.688F-02<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39                                                         | XSI W<br>+1.834E-02<br>+1.870E-02<br>+1.970E-02<br>+1.970E-02<br>+2.473E-02<br>+2.473E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.548E-02<br>+5.524E-02<br>+5.488E-02<br>+5.403E-02<br>+8.409E-02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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| AT ALPHA ≅ → 6,0000           SIN(THETAN) NEG, FO           SEC         X0 M           X         X4           4+4,148E+00 +0,00           4+4,162E+00 +0,00           4+4,162E+00 +0,00           4+4,162E+00 +0,00           4+4,162E+00 +3,20           4+4,162E+00 +3,20           4+4,162E+00 +3,20           8+4,208E+00 +1,20           8+4,264E+00 +3,20           8+4,265E+00 +4,5           8+4,335E+00 +4,5           8+4,335E+00 +1,1           8+4,35E+00 +1,1           8+4,35E+00 +1,2           8+4,35E+00 +1,2           8+4,35E+00 +1,2           8+4,35E+00 +1,2           8+4,35E+00 +1,2           8+4,35E+00 +1,2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | E+01 HINDWARD,<br>R XB = +2.7315<br>B H YB +<br>00E-39 +0.000E-<br>17E-04 +1.558E-<br>77E-03 +3.119E-<br>47E-03 +4.735E-<br>17E-04 +0.151E-<br>10F-02 +7.500E-<br>00F-02 +7.500E-<br>00F-02 +9.235E-<br>00F-02 +1.214E-<br>00F-02 +1.214E-<br>00F-02 +1.214E-<br>00F-02 +1.244E-<br>00F-02 +1.410E-<br>05E-01 +1.445E-<br>12F-01 +1.445E-<br>12F-01 +1.445E-<br>12F-01 +1.415E-<br>12F-01 +1.415E                                                                                                                                                                        | $ \begin{array}{cccccccccccccccccccccccccccccccccccc$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -01 DELS'= +<br>7633E-01 DELS<br>THETBW PE/PS<br>+90.30 +1.000<br>+84.00 +9.861<br>+78.00 +9.68<br>+72.00 +9.64<br>+52.00 +8.346<br>+55.20 +6.213<br>+55.20 +5.85<br>+44.04 +5.885<br>+44.04 +5.885<br>+44.04 +3.478<br>+20.00 +1.718<br>+20.00 +1.718<br>+20.00 +1.718<br>+20.00 +3.478<br>+20.00 +3.478+20.00 +3.478<br>+20.00 +3.4788<br>+20.00 +3.47888<br>+20.00 +3.47888<br>+20.00 +3.47888<br>+20.00 +3.4 | $ \begin{array}{c} 1.8342 \pm 0.02^{-3}34 \\ = & +1.8342 \pm -02^{-3}34 \\ = & +1.8342 \pm -27 \\ \hline & & & & & & & \\ 8.00 & -4.873 \pm -31 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -27.793 \pm -37 \\ \pm -31 & -17.733 \pm -37 \\ \pm -32 & -11.773 \pm -37 \\ \pm -32 & -11.773 \pm -37 \\ \pm -32 & -11.773 \pm -37 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & -7.959 \pm -31 \\ \pm -32 & 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 672E+00<br>-1.3402E+30<br>0T W<br>-0.030E-39<br>+1.62540<br>-0.030E-39<br>+1.62540<br>-1.725400<br>+1.925400<br>+1.925400<br>+2.1928+00<br>+2.238F+00<br>+1.925400<br>+1.7276+00<br>+1.47276+00<br>+1.476450<br>+3.6327E-01<br>+5.566E-01<br>+5.566E-01<br>+5.566E-01                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>RF W</b><br>+0.0007E-39<br>+8.305F-05<br>+3.243E-04<br>+9.931E-04<br>+9.931E-04<br>+2.4745-03<br>+2.4745-03<br>+2.4745-03<br>+2.5745-03<br>+2.5745-03<br>+2.5745-03<br>+2.5745-03<br>+1.5845-03                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | QR M<br>+2.018E-01<br>+1.3987-01<br>+2.6887-02<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39                             | XSI W<br>+1.834E-02<br>+1.978E-02<br>+1.978E-02<br>+2.159E-02<br>+2.411E-02<br>+2.736E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.51 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | E+01 HINDWARD,<br>R XB = +2.7315<br>B W YB W<br>005-39 +0.000E-<br>71E-04 +1.568E-<br>71E-03 +3.119E-<br>72E-03 +3.119E-<br>72E-03 +3.119E-<br>71E-02 +6.101E-<br>97E-02 +9.235E-<br>80E-02 +9.235E-<br>80E-02 +1.945E-<br>83E-02 +1.324E-<br>58E-02 +1.324E-<br>58E-02 +1.324E-<br>58E-01 +1.49E-<br>05E-01 +1.49E-<br>05E-01 +1.49E-<br>05E-01 +1.49E-<br>13E-01 +1.40E-<br>13E-01 +1.40E-<br>13E-01 +1.40E-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | RW = +2.7539E<br>E-02 RW = +2.<br>SB W<br>39 +0.00E-37<br>02 +1.57[E-02<br>02 +3.142E-02<br>02 +3.142E-02<br>02 +3.142E-02<br>02 +4.712E-02<br>02 +6.283E-02<br>02 +7.854E-02<br>02 +9.948E-02<br>02 +7.854E-02<br>02 +1.075E-01<br>01 +1.423E-01<br>01 +1.423E-01<br>01 +1.423E-01<br>01 +2.452E-01<br>01 +2.452E-01<br>01 +2.480E-02<br>01 +2.880E-02<br>01 +2.880E-02<br>01 +2.880E-02                                                                                                                                                                                                                                                    | -01 DELS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | $\begin{array}{c} 1.8342E-02^{}3542\\ =& +1.8342E-02^{}3542\\ =& +1.8342E-02\\ \hline && & & & & & & \\ 8.6322E-222E+23E-23E-23E-23E-23E-23E-23E-23E-23E-23E-$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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-<br>-1.353E+DCC<br>+1.552E+DCC<br>+1.552E+DCC<br>+1.552E+DCC<br>+1.353E+DCC<br>+1.353E+DCC<br>+1.353E+DCC<br>+1.353E+DCC<br>+2.53E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+2.93E+DCC<br>+3.53E+DCC<br>+2.93E+DCC<br>+3.53E+DCC<br>+3.53E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC<br>+3.552E+DCC                                                     | 02E+00<br>-1.3402E+00<br>AT W<br>+0.000E-39<br>1.122E+00<br>*1.559F+10<br>21.75C+00<br>*1.92E+00<br>+1.989E+10<br>+1.989E+10<br>+1.989E+10<br>+1.77E+10<br>*0.236E-11<br>*5.756E-01<br>+3.812F-01<br>*2.652E-11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    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W<br>+1.834E-02<br>+1.870E-02<br>+1.970E-02<br>+1.970E-02<br>+2.473E-02<br>+2.473E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.512E-02<br>+3.51 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | E+01 HINDWARD,<br>R XB = +2.7315<br>B W YB W<br>00E-39 +0.000E-<br>17E-04 +1.58E-<br>78E-03 +3.119E-<br>77E-02 +6.101E-<br>77E-02 +0.23E-<br>77E-02 +0.23E-<br>80E-02 +0.23E-<br>80E-02 +1.224E-<br>70E-02 +1.410E-<br>58E-02 +1.4214E-<br>58E-01 +1.49E-<br>58E-01 +1.49E-<br>05E-01 +1.49E-<br>12F-01 +1.41E-<br>12F-01 +1.41E-<br>13E-01 +1.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>14.41E-<br>1 | RW = +2.7533E<br>E-02 RW = +2.<br>SB W<br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | -01 DELS - +<br>7633E-01 DELS<br>THETAW PE/PS<br>+90.00 +1.000<br>484.00 +9.891<br>+78.00 +9.691<br>+78.00 +9.695<br>+72.00 +9.045<br>+66.00 +8.346<br>+65.00 +8.346<br>+65.00 +4.644<br>+36.00 +3.478<br>+28.00 +2.493<br>+20.00 +2.493<br>+20.00 +1.213<br>+4.00 +8.133<br>-4.00 +5.274<br>-12.00 +3.222<br>-20.00 +2.009<br>-20.00 +2.009                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | $\begin{array}{c} 1.8342E-02^{}35.41\\ =& +1.8342E-02^{}35.41\\ =& +1.8342E-02^{}\\ &= +1.8342E-02^{}\\ &= -1.8422E-02^{}\\ &= -1.842E-02^{}\\ &= -1.84$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 21 - 1.34<br>33-024 = -<br>-34-024 = -<br>-34-024 = -<br>-34-024 = -<br>-34-024 = -<br>-34-024 = -<br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 672E+00<br>-1.3402E+30<br>0T W<br>+0.030E-39<br>+1.122E+00<br>+1.122E+00<br>+1.122E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+1.22E+00<br>+ | <pre>RF W +0.000nE-39 +8.2015-005 +3.243E-04 +9.911-04 +9.911-04 +2.4745-03 +2.4745-03 +2.4745-03 +2.4745-03 +2.4745-03 +2.4745-03 +2.4745-03 +2.41175-03 +1.4515-03 +1.4515-03 +1.4515-03 +1.4515-03</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | QR M<br>+2.018E-01<br>+1.3965-01<br>+2.688F-02<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39<br>+0.000E-39 | XSI W<br>+1.834 E-02<br>+1.976 =-02<br>+2.1576 =-02<br>+2.1576 =-02<br>+2.735 =-02<br>+3.5125 =-02<br>+5.5125 =-02<br>+5.5125 =-02<br>+5                                                                                     | · · · · · · · · · · · · · · · · · · ·    |

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AT ALPHA = +6.0000E+01, LEEWARD, RW = +1.6970E+01 DELS = +1.8342E-02 35403 < = -2.7396F+09 \_\_SIN(THETAW) NEG. FOR XB = +4.0572E+00 3W = +1.6970E+01 DELS = +1.3342E-02 35403 < = -2.7396E+00</p>

| S EC  | XO I        | XB L        | YB L                                    | SB L       | THETBL | PE/PS L             | OP/DS L             | DE L                                    | OT L          | REL          | QR L        | XSIL         |
|-------|-------------|-------------|-----------------------------------------|------------|--------|---------------------|---------------------|-----------------------------------------|---------------|--------------|-------------|--------------|
|       |             |             |                                         |            |        |                     |                     |                                         |               |              |             |              |
| 4 4   | +4.148E+00  | +0.000E-39  | +0.000E-39                              | +0.0005-39 | +90.00 | +1.000E+30          | -5.1535-04          | +1.573E+00                              | +0.000=-39    | +0.000E-39   | +2.018E-01  | +1-834E-02   |
| 4 4   | +4+135F+00  | +8.217E-04  | +1.568E-02                              | +1.571E-02 | +84.00 | +9.891E-01          | -9.725=+31          | +L.55JE+90                              | +2.384E-01    | +1.198E-05   | +1.7125-01  | +1.925E-02   |
| 4 1   | 4.1236+00   | +3.278E-03  | +3.119E-02                              | +3.1422-02 | +78.00 | +9.568E-01          | -1.9335+32          | +1.506E+00                              | +3.524E-01    | +4.577E-05   | +6.028E-02  | +2.205E-02   |
| 4 1   | 4.112F+00   | +7.342E-03  | +4.635E-02                              | +4.712E-02 | +72.00 | +9.045E-01          | -2.7495+32          | +5.5948+30                              | +1.775E+00    | +5.9316-04   | +3.5712-02  | +2-691E-02   |
| - 4-1 | +4.102E+00  | +1.297E-02  | +6.101E-02                              | +6.283E-02 | +66.00 | +8.345E-01          | -3.4762+02          | +4.401E+00                              | +1.992E+00    | +9.981E-04   | +4.353E-02  | +3.409E-02   |
| 4 1   | 4.093E+00   | +2.010E-02  | +7.500E-02                              | +7.8546-02 | +60.00 | +7.500E-01          | -4.051E+32          | +3,3375+00                              | +2.109E+00    | +1.450E-03   | +5.3856-02  | +4.406E-02   |
|       | +3.701E+00  | +4.1276-01  | +/.550E-01                              | +8.6378-01 | +60.00 | +7.500F-01          | +0.000=-39          | +7.2452-01                              | +1.306E+J0    | +1.5956-02   | +0.000E-39  | +4.645E-01   |
| 31    | +3.3086+00  | +8.0536-01  | +1.435E+00                              | +1.5492+00 | +50.00 | +7.5006-01          | +3.030=-39          | +5.1806-01                              | +1.1478+30    | +3.044E-02   | +0.000E-39  | +8.3341-01   |
| 3     | 2.9166+00   | +1.198E+00  | +2.115E+00                              | +2.4342+00 | +60.00 | +7.500E-31          | +3.3302-39          | ++.2+5=-01                              | +1.061E+30    | +4.4946-02   | +0.0008-39  | +1-153E+00   |
| 21    | 2.523E+UU   | +1.5906+00  | +2. /95E+00                             | +3.219E+00 | +60.00 | +7.500E-01          | +0.030=-39          | +3.5336-01                              | +1.004E+00    | +5.9436-02   | +0.0001-39  | +1.4265+00   |
|       | F2.130E+00  | +1.9832+00  | +3.4756+00                              | +4.0052+00 | +60.00 | +7.500E-01          | +3.3302-34          | +3.2988-01                              | +9.6385-31    | +7.393E-02   | +0.0002-39  | +1.5512+00   |
| 21    | F1.738E+00  | +2.3766+00  | +4.1556+00                              | +4.790=+00 | +60.00 | +7.5002-01          | +3.0302-39          | -3.0136-01                              | +9.2708-01    | +8.8435-02   | +0.0002-39  | +1.829E+00   |
| 3 1   | F1.345E+00  | +2.168E+00  | +4.835E+00                              | +5.5752+00 | +50.00 | +7.500E-01          | +3.0302-39          | +2.7912-01                              | +8.9936-91    | +1.0292-01   | +0.000E-39  | +1.9572+00   |
| 31    | F9.527E-01  | +3.161E+00  | +5.5152+00                              | +6.3636+00 | +60.00 | +7.5006-01          | +3.0302-39          | +2.5116-01                              | +8.7596-01    | +1.1746-01   | +0.000E-39  | +2.032E+00   |
|       | -5.6012-01  | +3.553E+00  | +6.195E+00                              | +7.1452+00 | +50.00 | +7.500E-01          | +3.030=-39          | +2.4336-31                              | +8.5555-01    | +1.319E-01   | +0.000E-39  | +2.0502+00   |
| 3 1   | 1.0/52-01   | +3.946E+00  | +6.8752+00                              | +7.9312+00 | +50.00 | +7.5002-01          | +0.000E-39          | +2.3372-01                              | +8.3816-01    | +1.4546-01   | +0.000E-39  | +2.0046+00   |
| 1 4   | 1.3628-01   | +3,980E+00  | +6.931E+00                              | +7.9962+03 | +57.00 | +7.034E-01          | -5.128:+31          | +3.454E-01                              | +8.6258-01    | +1.554E-01   | +0.0302-39  | +1.9892+00   |
|       | -1.081E-01  | +4.0171+00  | +6.9852+00                              | +8.061E+00 | +54.00 | +6.545E-01          | -5.338:+31          | +3.4548-01                              | +8.7576-31    | +1.6292-01   | +0+000E-39  | +1.979E+00   |
|       | -8-302E-02  | +4.0576+00  | +1.0376+00                              | +8.1272+00 | +51.00 | +6.0432-31          | -5.490=+JL          | +3.4148-01                              | +8.810E-01    | +1.6836-01   | +0.000E-39  | +1.975E+00   |
| 1 1   | +8.302E-02  | +4.0866+00  | +7.071E+00                              | +8.1722+00 | +48.94 | +5.6850-01          | -5+550:+31          | +3.3758-01                              | +8.7826-01    | +1.7106-01   | +0.000E-39  | +1.975E+00   |
| 1 1   | +6.118E-02  | +4.1006400  | +7.0866+00                              | +8.1922+00 | +48.00 | +5.5396-01          | -5.5522+01          | +3.3552-01                              | +8.7562-01    | +1.7182-01   | +0.0002-39  | +1.975E+00 / |
| 1 1   | +4+239E-02  | +4.145E+00  | +7.1342+00                              | +8.2585+00 | +45.00 | +5-0186-01          | -5.613:+J1          | +3.2296-01                              | +8.607E-01    | +1.7356-01   | +0.0002-39  | +L-981E+00   |
|       | 2.7326-02   | +4.1926+00  | +7.179E+00                              | +8.323E+00 | +42.00 | +4.497E-01          | -5.532:+31          | +3.0858-01                              | +8.3556-31    | +1.730E-01   | +0.000E-39  | +1.992E+00   |
| 1 1   | 1.539E-02   | +4.242E+00  | +7.2212+00                              | +8.389E+00 | +39.00 | +3.982E-01          | -5.4902+31          | +2.913E-01                              | +8.034E-01    | +1.705E-01   | +0.0008-39  | +2.007E+00   |
| 1 4   | -0.848E-03  | +4.294E+00  | +7.2616+00                              | +8.454E+30 | +35.00 | +3.5158-01          | -4.6585+31          | +2.577E-01                              | +7.6526-01    | +1.664E-01   | +0.000E-39  | +2.027E+00   |
| 1 1   | F1.713E-03  | +4.348E+00  | +7.298E+00                              | +8.520E+00 | +33.00 | +3.102E-01          | -4.121E+31          | +2.455E-01                              | +7.246E-01    | +1.612E-01   | +0.000E-39  | +2.052E+00   |
| 1 4   | F0.000E-39  | +4.4042+00  | +1.3335+00                              | +8.5556+00 | +30.00 | +2.1346-01          | -3.6/8=+JL          | +2.2555-01                              | +6.8246-01    | +1.5512-01   | +0.0002-39  | +2.0812+00   |
| 11    | 1.7132-03   | +4.4616+00  | +7.3642+00                              | +8.550E+00 | +27.00 | +2.4102-01          | -3.333:+31          | +2.3792-01                              | +6.405F-J1    | +1.4861-01   | +0.000E-39  | +2.1146+00   |
|       | +6.848E-03  | +4.520E+00  | +7.3922+00                              | +8.7152+00 | +24.00 | +2.1298-91          | -2.9592+31          | +1.900E-01                              | +5.9846-01    | +1.416E-01   | +0.000E-39  | +2.152E+00   |
| 1 1   | 1.3396-02   | +4.5816+00  | +7.417E+00                              | +8.781E+00 | +21,00 | +1.855E-01          | -2.553:+31          | +1.7272-01                              | +5.5516-31    | +1.3426-31   | +0.0002-39  | +2.1948+00   |
|       | FZ.132E-U2  | +4.042E+00  | +1.4398+00                              | +8.8472+00 | +18.00 | +1.61/E-JI          | -2.3315+31          | +1.0522-01                              | +5.1418-01    | +1.2056-01   | +0.0008-39  | +2.2392+00   |
|       | 4.2598-02   | +4.7052+00  | +7.4576+00                              | +8.9122+00 | +15.00 | +1.4082-01          | -2.129:+11          | +1. +126-01                             | +4.7596-11    | +1.1886-01   | +0.0008-39  | +2.2886+00   |
|       | TO.1102-02  | +4.189F+00  | +7.4756+00                              | +8.9/82+00 | +12-00 | +1.2246-01          | -1.9322+31          | +1.2728-01                              | +4.3578401    | +1-1128-01   | +0.000E-39  | +2.3402+00   |
|       | 1 0015 01   | +4.83352+00 | +7.4850+00                              | +9.0432+00 | +9.00  | +1.0556-01          | -1.558:+JI          | +1.1396-01                              | +3.9808-11    | +1.0346*01   | +0.0002-39  | +2.3956+00   |
|       | 1.0816-01   | +4.8982+00  | +7.4932+00                              | +9.1096+09 | +0.00  | +9.0546-02          | -1.4392+31          | +1. J130-01                             | +3.5142-01    | +9.5576-32   | +0.0005-39  | +2.454E+00   |
| 1 1   | 1.0020-01   | +4.905E+00  | +7.4902+00                              | +9.1748+03 | +5.00  | +1.1952-02          | -1. 5185+J1         | +9.J44=-02                              | +3.7850-01    | +9.558E-J2   | +0.000E-39  | +2.5146+00   |
|       |             | +5.0296+00  | +7.5002+00                              | +9.2432+00 | +0.00  | +6.0592-02          | -1.1552+31          | +5.J11E-J2                              | +2.4575-11    | +8.1192-02   | +0.0002-39  | +2.5752+00   |
| 21    | -5.801E-01  | +5.8142+00  | +7.5000000                              | +1.JU2E+01 | +0.00  | +6.6576-02          | + 3.030=-39         | +5.++52-02                              | +2.4185-71    | +8.3038-02   | +0.0005-39  | +2.7352+00   |
|       | -9.52 (E-01 | +0.0992+00  | +7.5000+00                              | +1.0516+01 | +0.00  | +0.00JE-J2          | -9. 1541-J2         | +2.223E-UZ                              | +2.8435-31    | +9.4172-07   | +0.0000=-39 | +2.1296+00   |
|       | 1.3452400   | +1.304E+00  | +7.5002+00                              | +1.1000+01 | +0.00  | +5.4476-02          | -9.0322-32          | F3.4230-02                              | +2.1110-01    | +9.995E-02   | +3.0006-39  | +0.0032-39   |
|       | T T30C.00   | +8.169E+00  | +7.5002+00                              | +1.2356+01 | +0.00  | +6.3488-02          | -8.730=-32          | +2.2975-07                              | +2.7130-01    | +1.0586-01   | +0.0002-39  | +0.00012-39  |
|       | 2.1502+00   | +8.935E+00  | +7.5000+00                              | +1.31/2+01 | +0.00  | +0.205E-J2          | -1.2522-31          | *2.19/2-02                              | +2.0410-01    | +1.1136-31   | +0.0008-39  | +0.0002-39   |
|       | 2. 2255+00  | +9.1400+00  | +7.5002+00                              | +1.3950+01 | +0.00  | +6.0720-02          | -1.1282-11          | +2.3555-02                              | +2+5/46-11    | +1.151E-JL   | +0.0008-39  | +0.0096-39   |
|       | 2.3005400   | +1.0526+01  | +7.5002+00                              | +1.4/42+01 | +0.00  | +7.94+E-J2          | -1.1102-31          | +4.713E-02                              | +2.511F-91    | +1.2116-01   | +0.0006-39  | +0.000E-39   |
|       | 3.30000000  | +1.1516+01  | +7.5002+30                              | +1.3528+01 | +0.00  | +5.8258-32          | -1.0202-11          | ++./932-02                              | +2.4728-01    | +1+2598-01   | +1.000E-39  | +0.000E-39   |
|       |             | +1.2100+01  | +7.5000+00                              | +1.5510+01 | +0.00  | +2.7456-02          | -5.841E-J2          | +++++++++++++++++++++++++++++++++++++++ | +2.4070-01    | +1.313E-JI   | +1.0008-39  | +0.000E-39   |
| 77    |             | +1 200E+01  | +7.5000+00                              | +1.7115+01 | -6 00  | 14 0775-02          | + J+ JJ 02 - 39     | F + + + J + 2 ~ UZ                      | rc. 3325~01   | +1.0748-01   | +9-9002-39  | +9.000E-39   |
| 4 1   | 112C+00     | +1 201 E+01 | +7 4075+00                              | +1 717C+01 | -12 00 | +2 9406-02          | - 3 + 4 4 5 + 3 1   | *3.331E*J2                              | +1 404E-31    | +1+11/1-01   | TO. 000E-39 | +0.0008-39   |
|       |             | +1 202EL01  | +7 4035+00                              | +1 7145+31 | -19.00 | +1 049E-01          | ~ ++ / 7 4 = + ) 1  | +3.3232402                              | +1. 140E-01   | TT+9278-02   | FU.J /0E-39 | +J.JUJE-39   |
| 4 4   | 135C+00     | +1 20/6+01  | +7.4935+00                              | +1 7166401 | -16.30 | +1 205E-32          | -2 4295121          | +2 730E-02                              | TI . 14984 JI | TO . YOSE-0/ | TU. UUUE-39 | +0.0001-39   |
| 4 1   |             | +1.206E+01  | 17.4805+00                              | +1+717E+01 | -30.00 | + I + C - J C - U 4 | -2+4202#J1          | +2 2525-02                              | +6+600000000  | +/ 0755-72   | +0.0002-39  | +0.00000-39  |
| 4 7   | 4.1626100   | +1 2076+01  | 17 4716+00                              | A1 710CAN  | -36 00 | AS 204E-02          | -1 1345+31          | + + + + + + + + + + + + + + + + + + + + | + A 4366-33   | ++++0/07-12  | +0.0008-39  | +0.0005.30   |
|       |             | +1 2096+A1  | 17 461E+00                              | +1 7205+01 | -42 20 | +3 509E-03          | -1+1305+31          | +2 5315-02                              | ++++000000000 | +2.920E-02   | +0.0006-30  | +0.0001-39   |
| 4 4   | 4 1976±00   | +1 200CLAI  | + 7 4505+00                             | A1 7225421 | -48 20 | +3 5095-03          | +0.0002-07          | +                                       | +3+47112      | +2 2615-02   | +1.0100-39  | +0.0001-39   |
| -4 9  |             | TICC775711  | + +++++++++++++++++++++++++++++++++++++ | +1012227JL | -40.00 | イン・フラウビー しう         | * 3 * 3 3 3 3 7 5 7 |                                         | T704715716    | T4+4411 = 02 |             | TV+UUUE-39   |

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4 +4-208E+00 +1-300E+01 +7-438E+00 +1.723E+01 -54.00 +3.598E-03 +0.000E-39 +3.531E-03 +3.450E-07 +7.243E-02 +0.000E-39 +0.000E-39 8 +4.223E+00 +1.301E+01 +7.425E+00 +1.725E+01 -60.00 +3.598E-03 +).000E-39 +3.531E-03 +3.439E-02 +2.245E-12 +7.000E-39 +0.000E-39 8 +4.244F+00 +1.302E+01 +7.406E+00 +1.727E+01 -68.00 +3.598E-03 +0.000E-39 +3.530E-03 +3.459E-07 +7.249E-07 +7.000E-39 +0.000E-39 8 +4+265E+00 +1+303E+01 +7,386E+00 +1+729E+01 -76.00 +3,598E-03 +0.000E-39 +3,530E-03 +3,438E-02 +2,251E-02 +3,000E-39 +0.000E-39 8 +4+284E+00 +1+303E+01 +7+366E+00 +1+731E+01 -84+00 +3+598E-03 +0+000E-39 +3+530E-03 +3+457E-12 +2+253E-02 +0+000E-39 +0+000E-39 8 +4.303±+00 +1.303++01 +7.345±+00 +1.733±+01 -92.50 +3.595±-03 +0.002±-37 +3.533±-03 +3.454±-72 +2.535±-27 +0.300±-39 +0.302±-39 IST XST YST S ST DTDS ST THET ST SECT ALPHA -----31 +4.22335E+00 +7.50000E+00 +8.66354E+00 -6.65667E+00 +0.0000E-33 8 +90.00 IW SN XOW SN SBW SN THETY SN SECT ALPHA YOW SN XBW SN YBW SN 7 +4.31977E+00 +7.46491E+00 +3.69015E-02 +9.85329E-02 +1.07502E-01 +4.33372E+01 8 +91.11 IL SN XOL SN YOL SN KBL SN YBL SN SBL SN THERE SN SECT ALPHA 8 +4.13519E+00 +7.47135E+00 +3.69015E-02 +9.85328E-02 +1.07502E-01 +4.33372E+01 4 +97.00

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| THETAW LESS T                   | 9.0000E+01 W<br>HAN LIMIT    | INDWARD, RW | = +2.7533   | E-01 DEI | LS = +1.83 | 42E-02 3540  | CK = −2.56    | 19E-12      |            |             |              |
|---------------------------------|------------------------------|-------------|-------------|----------|------------|--------------|---------------|-------------|------------|-------------|--------------|
| <u>S</u> EC XO W                | XB W                         | YB W        | SB W        | THETBW   | PE/PS W    | DP/DS N      | ≎L vi         | มา พ        | RE W       | QR W        | XSI W        |
| 8 +4.223E+0                     | 0 -0.000E-39                 | +0.000E-39  | +0.000E-39  | +90.00   | +1.000F+00 | +4.038E-35   | +2.219E+00    | +3.0005-39  | +0.0078-39 | +2.0185-01  | +1.834E-02   |
| 8 +4.244E+0                     | 0 +1.460E-03                 | +2.088E-02  | +2.094E-02  | +82.70   | +9.805F-31 | -1.2392+32   | +2.1755+00    | +1.325E+37  | +1.467E-04 | +1.115E-01  | +1.899E-02   |
| 8 +4.265E+0                     | 0 +5.8116-03                 | +4.135E-02  | +4.189E-02  | +74.00   | +9.240E-01 | -2.4795+32   | +2.050E+00    | +1.920F+39  | +5.671E-04 | +0.000F-39  | +2.095E-02   |
| 8 +4.284E+0                     | ) +1.29/E-02                 | +6.1012-02  | +6.2832-02  | +65,00   | +8.3455-01 | ~3.476E+J2   | +L.725E+30    | +1.9922490  | +7.9816-04 | +0,00000-39 | +2 0765-02   |
| 8 46 300E+0                     | 0 +2.2/98-02<br>0 43 5095-02 | +7.9492-02  | +0.0100-02  | +50.00   | +7.1920-01 | -4.6165+32   | 1.389=+00     | +2.1035+00  | +2.181E-03 | +0.000E=39  | +3.5966-02   |
| 8 +4.3205+0                     | 1 +3.690F-02                 | +9.853E-02  | +1.075E-01  | +48.94   | +5.6856-11 | -4.633=+32   | +1.359E+00    | +2.088E+30  | +2.249E-03 | +0.000E-39  | +3.701E-02   |
| 8 +4 335E+0                     | 0 +4.963E-02                 | +1.115E-01  | +1.257E-01  | +42.00   | +4-497E-01 | -4.6522+02   | +1.1495+00    | +1.935E+10  | +2.513F-03 | +0.000E-39  | +4.4816-02   |
| 8 +4.348E+0                     | 0 +6.612E-02                 | +1.244E-01  | +1.465E-01  | +34.00   | +3.152E-01 | -4.337=+)2   | +3.3196-01    | +1.5445+00  | +?.789E-03 | +0.000E-39  | +5.623E-02   |
| 8 +4.358E+0                     | 0 ∔8.424F-02                 | +1.348E-01  | +1.676E-01  | +26.00   | +2.252E-01 | -2.6005+02   | +5.513E-01    | +1.361F+D3  | +2.795E-03 | +0.000E-39  | +7.085E-02   |
| 8 +4.366E+D                     | D +1.036F-01                 | +1.427E-01  | +1.885E-01  | +18.30   | +1.577E-01 | -1.9455+32   | +4.912E-01    | +1.094F+90  | +2.5625-33 | +0.000E-39  | +B.954E-02   |
| 9 +4.371E+0                     | 0 +1.240E-01                 | +1.477E-01  | +2.094E-01  | +10+00   | +1.080E-01 | -1.4325+32   | +3.573E-01    | +8.557E-01  | +2.424E-03 | +0.0008-39  | +1.1356-01   |
| 9 +4.435E+01                    | 0 +4.866E-01                 | +2.1176-01  | +5.775E-01  | +10.00   | +7.9816-02 | -3.3562+33   | +1.587=-01    | +5. (972-11 | +5.5410-03 | +0.0002-39  | +2.5576-01   |
| 9 +4.4992+0                     | 0 +8.492E-01                 | +2. /565-01 | +9. +986-01 | +10.00   | +0.0800-02 | -1.8246+JJ   | F1.3956-01    | +4.092F-01  | +0.0010-00 | +0.000E-39  | +4.4395-01   |
| 9 +4.5052+0                     | 5 +1.212E+00                 | +4.0356-01  | +1.5142+00  | +10.00   | +5.4166-02 | -1.1502+JJ   | - 19.5745-07  | +3.648F-01  | +1.307E-02 | +0.000E-39  | 44-845E-01   |
| 9 44.691640                     | 1 +1.937E+00                 | +4.6748-01  | +2-050E+00  | +10.00   | +5-0526-32 | -5.945=-31   | +3.5325-02    | +3.3515-01  | +1.527E-02 | +0.000E-39  | +5.1116-01   |
| 9 +4.755E+0                     |                              | +5.313E-01  | +2.419E+00  | +10.00   | +4.779E-02 |              | ¥7.592E-02    | +3.1258-01  | +1.742E-02 | F0.000E-39  | +5.2716-01   |
| 9 +4.819E+0                     | +2.662E+00                   | +5.953E-01  | +2.787E+00  | +10.00   | +4.566E-02 | -3.6352-31   | +7.347E-32    | +2.948E-01  | +1.951E-02 | +0.000E-39  | +5.347E-01   |
| 9 +4.8830+01                    | +3.025E+00                   | +6.592E-01  | +3.155E+00  | +10.00   | +4.3966-02 | -2.9142-01   | +5.533E-02    | +2.804E-01  | +2.153E-02 | +0.000E-39  | +5.353E-01   |
| 9 +4.947E+0                     | ) +3.387E+00                 | +7.232E-01  | +3.523E+00  | +10.00   | +4.257E-02 | -2.397E-)1   | +5.1155-02    | +2.685E-01  | +2.363E-02 | +0.000E-39  | +5.299E-01   |
| 10 +5.010E+00                   |                              | 7.871E-01   | +3.891E+00  | +0.00    | +4.202E-02 | -1.0042-01   | +3.7335-02    | +2.610E-01  | +2.589E-02 | +0.000E-39  | +5-240E-01   |
| 10 +5.010E+0                    | 0 +4.125E+00                 | +7.871E-01  | +4.265E+00  | +0.00    | +4.150E-02 | -9-2285-32   | +5.546E-02    | +2.541E-01  | +2-817E-02 | +0.000E-39  | +5.7316-01   |
| 10 +5.010E+0                    | 0 +4.500E+00                 | +7.871E-01  | +4.541E+00  | +0.00    | +4.102E-02 | -8.5341-32   | +5.329E-02    | +2.4792-01  | +3.042E-02 | +0.0008-39  | +6.179E-01   |
| 10 +5.010E+00                   | +4.875E+00                   | +7.8716-01  | +5.015E+00  | +0.00    | +4.057E-02 | -7.8552-32   | +5.1332-02    | +2.4236~31  | +3.2568-02 | +0.0002-39  | +6.5892-01   |
| 10 +5.0100+00                   | J +5.250E+00                 | +7.8716-01  | +5.3912+00  | +0.00    | +4.0100-02 | -1.2122-32   | ++. 7355-02   | +2.3720-01  | +3 7025-02 | +0.00002-39 | +7 2055-01   |
| 10 +5.0102+0                    | J +5.825E+00                 | TT 8716-01  |             | +0.00    | +3.9/0E-J2 | -5.26812     | +4.547=-02    | +2-2835-01  | +3.978-02  | +0.0006-39  | +7-5155-01   |
| 10 +5-0100+0                    | +6.375E+00                   | +7.8716-01  | +6.5145+00  | +0.00    | +3.9106-02 | -5.834=-32   | +4.5125-02    | +2.2445-01  | +4.1475-02 | +0-0006-39  | +7-8976-01   |
| 10 +5-0105+0                    | 7 76.750F+00                 | +7-871E-01  | +6.891E+00  | +0.00    | +3-880E-02 |              | F4.387E-02    | +2.207E-01  | +4.3645-02 | F0.000E-39  | +0.0008-39   |
| 10 +5.010E+0                    | +7.125E+00                   | +7.871E-01  | +7.265E+00  | +0.00    | +3.851E-02 | -5.0782-32   | +4.2728-02    | +2.173E-01  | +4.583E-02 | +0.000E-39  | +0.000E-39 ' |
| 10 +5.010E+0                    | 7.500E+00                    | +7.871E-01  | +7.541E+00  | +0.00    | +3.824E-02 | -4.747=-32   | T FA. [345-72 | +2-141F-01  | 44.795E-02 | +0.0008-39  | +0.000E-39   |
| 10 +5.010E+0                    | 0 +7.875E+00                 | +7.871E-01  | +8.015E+00  | +0.00    | +3.800E-02 | -4.4442-32   | +4.3558-02    | +2.112E-01  | +5.011E-02 | +0.000E-39  | +0.000E-39   |
| 10 +5.010E+0                    | 7 +8.250E+00                 | ∔7.871E-01  | +8.391E+00  | +0.00    | +3.776E-02 | -4.1548-)2   | +3.971E-02    | +2.0845-01  | +5.225E-0? | +0.000E-39  | +0.0008-39   |
| 10 +5.010E+0                    | +8.625E+00                   | +7.871E-01  | +8.755E+00  | +0.00    | +3.754E-02 | -3.9365-32   | +3.3848-07    | +2.058E-71  | +5.439E-02 | +0.000E-39  | +0.00DE-39   |
| 10 +5.010E+0                    | 0 +9.000E+00                 | +7.871E-01  | +9.1418+00  | +0.00    | +3.734E-32 | -3.658E-J2   | +3.502=-02    | +2.0335-01  | +5.5526-02 | +0.0005-39  | +0.00012-39  |
| 10 +5.0102+0                    | J +9.315E+00                 | +7.8716-01  | +9.0100+00  | +0.00    | +2 4045-02 |              | F3.1031-J2    | +1 0995-01  | +5,0330-02 | +0.00002-39 | 10.0000-39   |
| 10 +5 0105+0                    | 0 +1 012E+01                 | +7 9716-01  | +1 027E+00  | +0.00    | +3.6705-02 | -3.0545-32   | +3.5355=02    | +1.9575-31  | +6.2936-02 | +0.000E-39  | +0.0005-39   |
| 10 +5-0105+0                    | 0 +1.0120+01                 | +7-871E-01  | +1.0645+01  | +0.00    | +3.6635-02 | -2.9785-12   | +3.5238-02    | +1.947E-01  | +5.501E-02 | +0.000E-39  | +0-000E~39   |
| 10 +5,010E+0                    | +1.087E+01                   | +7.8716-01  | +1.102E+01  | +0-00    | +3.648E-02 | -2.714E-32   | +3.458E-02    | +1.928E-01  | +5.713E-D? | +0.000E-39  | +0.000E-39   |
| 10 +5.010E+0                    |                              | +7.871E-01  | +1.1392+01  | +0.00    | +3.634E-02 | -2.551 - 12  | +3.4005-02    | +1.910E-01  | +5.925E-02 | +0.0005-39  | +0.000E-39   |
| 9 +4.947E+0                     | 0 +1.161E+01                 | +7.232E-01  | +1.176E+01  | -10.30   | +3.634E-02 | +0.0305-39   | +3.300E-02    | +1.898F-01  | +7.149E-02 | +0.000F-39  | +0.0008-39   |
| 9 +4.883E+0                     | D 71.198E+01                 | ∔6.592E-01  | +1.213E+01  | -10.00   | +3.634E-02 | +3.3305-39   | +3.2508-02    | +1.9875-01  | +7.372E-02 | +0.000E-39  | +0.000E-39   |
| <ul> <li>9 +4.819E+0</li> </ul> | 0 +1.234E+01                 | +5.953E-01  | +1.2505+01  | -10.00   | +3.634E-02 | +0.0008-39   | +3.2205-02    | +1.8758-01  | +7.595E-02 | +0.000E-39  | +0.000E-39   |
| 9 +4.755E+0                     | 0 +1.270E+01                 | +5.313E-01  | +1.285E+01  | -10.00   | +3.634E-0? | +0.030=-39   | +3.1335-02    | 71.854E-01  | +7.823E-02 | +0.000E-39  | +0.000E-39   |
| 9 +4.691E+D                     | D +1.306E+01                 | +4.674E-01  | +1.3235+01  | -10.00   | +3.634E-02 | +2.0305-39   | +3.145E-02    | +1.854E-01  | +8.044F-02 | +0.00DE-39  | +0.000E-39   |
| 9 +4.627E+0                     | U +1.343E+01                 | +4.035E-01  | +1.35JE+01  | -10.00   | +3.6348-02 | +0.030=-39   | +3.1112-07    | +1.8948-01  | +8.25/2-32 | +0.0008-39  | +0.000E-39   |
| 9 +4.563E+0                     | 0 +1.3/9E+01                 | +3.3956-01  | +1.39/2+01  | -10.JO   | +3 4345-02 | +3 030=-33   | +3.J//E-02    | +1 924E-31  | +9 7155-02 | +0.0008-39  | 10.0002-39   |
| 9 +4.4992+0                     | 0 +1.4516+01                 | +2.117E-01  | +1.4716+01  | -10.00   | +3.6342-02 | +1-010=-39   | +3-312E=02    | +1.9156-01  | +8-9395-02 | +0.000E-39  | +0.0006-39   |
| 9 +4.3716+0                     | 0 +1.488E+01                 | +1-4775-01  | +1.5375+01  | -10.00   | +3.634F-12 | +0.000 =- 37 | +2.3815-02    | +1.936E-31  | +9.1535-12 | +0.0005-39  | +0.000F-39   |
| 8 +4.366E+D                     | 0 +1.490E+01                 | +1.427E-01  | +1.509F+01  | -18.00   | +2.204E-02 | -3.8265+31   | +3.505E-02    | +1.295E-71  | +5.6758-02 | +0.000E-39  | +0.000F-39   |
| 8 +4.358E+0                     | 0 +1.492E+01                 | +1.348E-01  | +1.5125+01  | -26.00   | +1.288E-02 | -2.4175+)1   | +2.4145-02    | +8.9435-12  | +4.697E-02 | +0.1005-39  | +0.000E-39   |
| 8 +4.348E+0                     | 0 +1.493F+01                 | +1.244E-01  | +1.514E+01  | -34.00   | +7.219F-03 | -1.4-65+01   | +1.5755-02    | +5.9458-72  | +3.195F-02 | +1.0105-39  | +0.000E-39   |

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|          | <pre>8 +4.335E+00 +1.495F+01 +1.115E-01 +1.515E+01 -42.00 +3.807F-03 -6.511E+00 +1.305E-02 +3.741E-02 +2.075E-02<br/>8 +4.330E+00 +1.496Fe01 +0.642E-02 +1.518E+01 -50.00 +3.598E-03 +0.300E-39 +3.553E-03 +3.549E-02 +1.976F-02<br/>8 +4.303E+00 +1.498E+01 +7.499E+02 +1.522E+01 -58.00 +3.598E-03 +0.000E-39 +3.553E-03 +3.544E-07 +1.978E-02<br/>8 +4.265F+00 +1.499E+01 +4.101E-02 +1.522E+01 -58.00 +3.598E-03 +0.000E-39 +3.553E-03 +3.554E-07 +1.978E-02<br/>8 +4.265F+00 +1.499E+01 +4.135E-02 +1.522E+01 -58.00 +3.598E-03 +0.000E-39 +3.553E-03 +3.554E-07 +1.981F-02<br/>8 +4.265F+00 +1.499E+01 +4.135E-02 +1.524E+01 -74.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.225F+00 +1.500E+01 +2.088E-02 +1.525E+01 -82.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.225F+00 +1.500E+01 +3.912E-07 +1.525E+01 -80.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.226E+00 +1.500E+01 +3.912E-07 +1.525E+01 -80.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.226E+00 +1.500E+01 +1.568E-02 +1.556E+01 -80.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.226E+00 +1.500E+01 +1.568E-02 +1.553E+01 -80.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.226E+00 +1.500E+01 +1.568E-02 +1.553E+01 -80.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.226E+00 +1.500E+01 +1.568E-02 +1.556E+01 -80.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.206E+00 +1.500E+01 +1.568E-02 +1.556E+01 -80.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.206E+00 +1.500E+01 +1.568E-02 +1.556E+01 -80.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.206E+00 +1.500E+01 +1.568E-02 +1.556E+01 -80.00 +3.598E-03 +0.000E-39 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.206E+00 +1.500E+01 +1.568E-02 +1.556E+01 -80.00 +3.598E-03 +3.502E-03 +3.552E-03 +3.554E-07 +1.981F-02<br/>8 +4.206E+00 +1.500E+01 +1.568E-02 +1.556E+01 +2.558E-03 +3.558E-03 +3.552E-03 +3.554E-07 +1.991F-02<br/>8 +4.206E+00 +1.500E+01 +1.568E-02 +1.556E+01 +3.598E-03 +3.598E-03 +3.552E-03 +3.554E-07 +1.991F-02<br/>8 +</pre> | +3.900F-30 +0.000E-39<br>+3.177-30 +3.007F-39<br>+0.000E-39 +0.000E-39<br>+0.000E-39 +0.007E-39<br>+0.000E-39 +0.000E-39<br>+0.000E-39 +0.000E-39<br>+0.000E-39 +0.000E-39<br>+1.000E-39 +0.000E-39 |
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|          | · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                     |
|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | ~                                                                                                                                                                                                   |
|          | annan ya tatu - a                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                     |
|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                     |
|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1-                                                                                                                                                                                                  |
|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                     |
|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                     |
| k −a     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                     |
| <u>0</u> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                     |
| Λ Ξ΄     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                     |
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|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                     |
| •        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                     |
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|          | • # 1 West # ~                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                     |
|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                     |
|          | <b>-</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                     |
|          | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                     |
|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                     |

AT ALPHA = +9.0000E+01, LEFWARD, RW = +2.7533E-01 DELS = +1.8342F-02 334025 = +4.8575F-01

| - | S EC | XO L        | ΧΒ L        | YB L       | SBL               | THETBL | PE/PS L    | D0/35 L     | 3. L             | OT L        | 9F L        | DR L         | XST L'                                 |
|---|------|-------------|-------------|------------|-------------------|--------|------------|-------------|------------------|-------------|-------------|--------------|----------------------------------------|
|   |      |             |             |            |                   |        |            |             |                  |             |             |              | -                                      |
|   | 8    | +4.223E+00  | -0.000E-39  | +0.000F-39 | +0.0008-39        | +90.00 | +1.003E+30 | +4.0382-)5  | +2.2192+00       | +2.0006-39  | +1.000E-39  | +2.018E-01   | +1.834E-02                             |
|   | 4    | +4.208E+D0  | +8.218E-04  | +1.568E-02 | +L.571E-02        | +84.00 | +9.891E-01 | -9.7252+01  | +2.L94E+70       | +1.1225+00  | +8.305E~05  | +1.398E-01   | +1.870E-02                             |
|   | 4    | +4.192E+00  | +3.278F-03  | +3.119E-02 | +3.1425-02        | +78.00 | +9.568E-01 | -1.9032+02  | +2.1235+00       | +1.659E+00  | +3.243E-04  | +2.591E-02   | +1.980E-02                             |
| - | 4    | +4.177E+00  | +7.342E-03  | +4.6358-02 | +4.712E-02        | +72.00 | +9.045E-01 | -2.7492+32  | +1.8355+00       | +1.775E+00  | +5.931E-04  | +0.000E-39   | +2.167E-02                             |
|   | 4    | +4.162E+00  | +1.297E-02  | +6.101E-02 | +6.2B3E-02        | +66.00 | +8.345E-01 | -3.476±+32  | +1.7762+00       | +1.972E+70  | +9.981E-04  | +0.000E-39   | +2.439E-02                             |
| _ | 4    | +4.148E+00  | +2.010E-02  | +7.500E-02 | +7.854E-02        | +60.00 | +7.500E-01 | -4.051E+02  | +1.5545+00       | +2.139F+00  | +1.453E-03  | +0.000E-39   | +2.803E-02                             |
| - |      | +4-135E+00  | +2.8656-02  | +8.817E-02 | +9.125E-02        | +54.00 | +6.545E-01 | -4.449E+J2  | +l.519E+70       | +2.1342+00  | +1.903E-03  | '∓0.000E-39' | +3.274E-02                             |
|   | 4    | +4.135E+00  | +3.690E-02  | +9.853E-02 | +1.075E-01        | +48.94 | +5.685E-01 | -4.633E+)2  | +1.377E+00       | +2.098E+00  | +2.2496-03  | +0.000E-39   | +3.765E-02                             |
|   | 4    | +4.123E+00  | +3.853F-02  | +1,0046-01 | +1.100E-01        | +48.00 | +5.539E-01 | -4.652Ĕ+J2  | +1.3575+00       | +2.074F+00  | +2.305E-03  | +0.0005-39   | +3.966E-02                             |
|   | 4    | +4.112E+00  | +4.963E-02  | +1.115E-01 | +1.257E-01        | +42.00 | +4.497E-01 | -4.6522+02  | +1.150E+00       | +1.935E+10  | +2.613E-03  | +0.0008-39   | +4.602E-02                             |
|   | - 4  | +4.102E+00  | +6.183E-02  | +1.214E-01 | +1.414E-01        | +36.00 | +3.478E-01 | -4.4495+32  | *+¥.595E-01      | +1.7275+30  | +2.774E-03  | +0.000E-39   | +5.508E-02                             |
|   | 4    | +4.093E+00  | +7.500E-02  | +1.299E-01 | +1.571E-01        | +30.00 | +2.705E-01 | -3.037E+32  | +7.755E-01       | +1.512E+00  | +2.827E-03  | +0.000E-39   | +6.620E-02                             |
| - | 3    | +3.701E+00  | +7.550E-01  | +5.225E-01 | +9.423E-01        | +30.00 | +2.529E-01 | -8.0301-32  | +2.3192-01       | +1.022E+00  | +1.651E-D2  | +0.000F-39   | +2.587E-01                             |
|   | 3    | +3,308E+00  | +1.435E+00  | +9-151E-01 | +1-727E+00        | +30.00 | +2.527E-01 | -9.2557-14  | +2-0395-01       | +9-0515-01  | +3.026E-02  | +0-000E-39   | +3.554E-01                             |
|   | 3    | +2.9165+00  | +2.1156+00  | +1.308E+00 | +2.5132+00        | +30.00 | +2.527E=11 | +3.942=-35  | 41.7346-01       | +8.3985-01  | +4.4025-02  | +0.0005-39   | +4-3615-01                             |
|   | 1    | +2.523E+00  | +2.7955+00  | +1.700E+00 | +3-298E+00        | +30 00 | +2-5276-01 | +2 148=-35  | +1-5185-01       | +7.9536-01  | +5.777E-02  | +0.000E-39   | +5-1105-01                             |
|   |      | +2.1305+00  | 475E+00     | +2.0935400 | +4.0935+00        | 130 00 | A2 5276-01 | 12 5535-35  | 1 2666-01        | 27 6716-11  | 17 1535-02  | +0.0005-40   | 45.8316-01                             |
|   | 2    | +1.7385+00  | +4.1556+00  | +2.4856+00 | +4. 9625400       | +30.00 | +2-5275-01 | -2.0305-33  | 11.2525-01       | +7 3575-01  | A8 5285-02  | 10.0000 39   | +6 5375-03                             |
|   |      | 11 2465100  | +2 9255+00  | 12 0705400 | LE (E2E+D0        | +30.00 | +2 5275-01 | -0.00002-33 | AL 1620-01       | A7 3610-01  | +0.0006-02  | 1010002-39   | 17 226-01                              |
|   |      | +0 5375 01  | 44.0350700  | 12.0700100 | +5.55550+00       | +50.55 | 12.5276-01 | -0.0302-39  | +1+1325-01       | +/.1+10-01  | 11 1205 01  | +0.0000-39   | 17.0355.01                             |
|   |      | +9.027E-01  | +5.515E+00  | T3.2/10+00 | 10.1392100        | 130.00 | +2+5270-01 | -0.0002-59  | +L.J392-01       | +0.93/2-31  | *1.125E-01  | +0.0002-39   | +7+923E=UI                             |
|   | 3    | +5.601E-01  | +6.1952+00  | +3.6636+00 | +7.224E+00        | +30.00 | +2.5276-01 | ~0.000=-39  | +1.3295-01       | +6. (996-)1 | +1,2652-01  | +0.0002-39   | +8.0116-01                             |
|   |      | +1.0756-01  | +6.8/5E+00  | +4.0562+00 | +8.3096+00        | +30.00 | +2.52/6-01 | +0.030=-34  | +3.//3E-02       | +5.6506-31  | +1.4032-01  | +0.0002-39   | 49.2945-01                             |
|   | 1    | +1.362E-01  | +6.933E+00  | +4.087E+00 | +B.074E+00        | +27.00 | +2.221E-01 | -3.0352+31  | +1.149E-01       | +6.227E-01  | +1.343E-01  | +0.000E-39   | +9.424E-01                             |
|   |      | +1.081E-01  | +6.992E+00  | +4.115E+00 | +8.1+0E+09        | +24.00 | +1.945E-01 | -2.757E+31  | +1.3445-01       | +5.793E-01  | +1.272E-01  | +0.000E-39   | 49.616E=01',                           |
|   | 1    | +8.302E-02  | +7.052E+00  | +4.140E+00 | +8.205E+00        | +21.00 | +1.701E-01 | -2.4325+31  | +9.454E-02       | +5.371E-01  | +1.203E-01  | +0.000E-39   | +9.874E-01                             |
| _ | 1    | +6.118E-02  | +7.114E+00  | +4.162E+00 | +8.271E+00        | +18.00 | +1.484E-01 | ~2.2222+31  | +8.549E-02       | +4.963E-31  | +1.132E-01  | +0.0002-39   | +1.020E+00                             |
|   | 1    | +4.259E-02  | +7.1766+00  | +4.181E+00 | +8.335E+00        | +15.00 | +1.288E-01 | -1.9935+31  | +7.533E-02       | °∓4.560E-31 | +1.061E-01  | +0.000E-39   | +1.060E+00                             |
| _ | 1    | +2.732E-02  | +7.240E+00  | +4.196E+00 | +8.402E+00        | +12.00 | +1.114E-01 | -1.7522+01  | +5.8795-02       | +4.172E-01  | +9.890E-02  | +0.000E-39   | +1.108E+00                             |
| _ | 1    | +1.539E-02  | +7.304E+00  | +4.208E+00 | +8.457E+00        | +9.00  | +9.581E-02 | -1.5595+31  | +5.1272-02       | +3.798E-01  | +9.171E-02  | +0.000E-39   | +1.165E+00                             |
|   | 1    | +6.848E-03  | +7.369E+00  | +4.217E+00 | +8.533E+00        | +6.00  | +8.257E-02 | -1.3312+31  | +5.4548-02       | +3.456E-01  | +8.495E-02  | +0.000E-39   | +1.231 2+00 -                          |
|   | 1    | +1.713E-03  | 7.435E+00   | ₹4.222E+00 | +8.598E+00        | +3.00  | ∔7.082E-02 | -1.2182731  | +4.347E-02       | +3.1318-01  | +7.834E-02  | +0.000E-39   | +1.309E+00                             |
|   | 1    | +0.000E-39  | +7.500E+00  | +4.223E+00 | +8.564E+00        | +D.00  | +5.965E-02 | -1.057E+01  | +4.233E-02       | +2.799E-01  | +7.132F-02  | +0.000E-39   | +1.399E+00                             |
|   | 1    | +1.713E-03  | +7.565E+00  | ∓4.222E+00 | <b>∔8.729E+00</b> | -3.00  | +5.033E-02 | -9.1382+33  | +3.737E-02       | +2.502E-01  | 76.487E-02  | +0.000E-39   | +1.504E+00                             |
|   | 1    | +6.848E-03  | +7,631E+00  | +4.217E+D0 | +8.794E+00        | -6.00  | +4-244E-02 | -7.9725+33  | +3.2442-02       | +2.232E-01  | +5.8888E-02 | +0.000E-39   | +1.625E+00                             |
|   | 1    | +1.539E-02  | +7.696E+00  | ÷4.208E+00 | <b>∔8.860E+00</b> | -9.00  | +3.562E=02 |             | +2:3256-02       | ∔1.982E-01  | +5.319E-02  | F0.000E-39   | +1.766E+00                             |
|   | 1    | +2.7328-02  | +7.760E+00  | +4.196E+00 | +8.925E+00        | -12.00 | +2.967E-02 | -5.904E+30  | +2.4455-02       | +1.749E-)1  | +4.775E-02  | +0.000E-39   | +1.931E+00                             |
|   | 1    | +4.259E-02  | +7.824E+00  | #4,181E+00 | +8.991E+00        | -15.00 | +2.458E-02 | -5.0355+00  | ¥2.108E-02       | +1.537E-01  | +4.255E-02  | +0.000E-39   | +2.124E+00                             |
|   | 1    | +6.118E-02  | +7.886E+00  | +4.162E+00 | +9.055E+03        | ~18.00 | +2.032E-02 | -4,2352+))  | +1.317E-02       | +1.346E-01  | +3.7995-02  | +0.000E-39   | +2.353E+00                             |
| _ |      | +8.302E-02  | +7.948E+00  | +4.140E+00 | +9.1225+00        | -21.00 | +1.673E-02 | -3.6293730  | f1.5595-02       | +1.1746-01  | +3.359F-02  | +0.000E-39   | +2.627E+00                             |
|   | 1 .  | +1.081E-01  | +8.008E+00  | +4.115E+00 | +9.1875+00        | -24.20 | +1.362E-02 | -3.0435+30  | +1.327E-02       | +1.016=-01  | +2-963E-02  | +0.000E-39   | +2,9585+00                             |
|   |      | +1.362F-01  | +8-067F+00  | +4.087F+00 | +9.253E+00        | -27.00 | +1.106E-02 | -2.543=700  | +17123E-02       | +8.752E-12  | +2-597E-02  | +0.000F-39   | +3.365F+00                             |
|   | 3 -  | +1.6756-01  | +8.125E+00  | +4-056E+00 | +9.313=+00        | -30.00 | 48.957E-03 | -2.1205+33  | +9.3995-03       | +7.5375-12  | +2.269E+02  | +0.000E-39   | +3.875F+00                             |
| - |      | +5.601F-01  | +87805F+00  | +3.663F+00 | +1.010E+01        | ~30.00 | +8.957E-13 | +0.000=-33  | +5.5156-03       | ¥7.4165-12  | +2.461 5-02 | +0.000E=39   | +5-552F+00                             |
|   | 2    | +9.527E-01  | +9.485F+00  | +3.271E+00 | +1.0895+01        | -30.00 | +8.9575-03 | +1.010=-32  | +5.5006-03       | +7.3066-12  | +2.652E-02  | +0.0005-39   | +7.2286+00                             |
|   |      | F1. 345F-00 | +1.016E+01  | 12.878E+00 | +1.1675+01        | -30.10 | +8.9575-03 | +1.010=-30  | +5. 1835-03      | 17.2055-02  | +2.9435-02  | +0. 0005-30  |                                        |
|   | 2.   | +1.7396+00  | +1 0846+01  | 12 4855100 | +1 244E+01        | -20.00 | 10 0575-03 | ND 0002-30  | 65 4715-02       | +7 1125-12  | 12 0265-02  | A0 0000 39   | 40 000E-20                             |
| 4 |      | F2 T10E+00  | 1111576101  | +2 0036+00 | A1 3245+01        | -30.00 | AD 0576-03 |             | 65 65 75-03      | 17 D255-02  | 13 3346-02  |              | ************************************** |
|   | 2    | +2.5236+00  | +1 220E+01  | +1 700E+00 | +1 4022+01        | -30.00 | 40.0571-03 | +3 0302-39  | +5 443C=03       | +4 0455-02  | +3.2200-02  | +0.0002-39   | +0.0005-30                             |
| • | -2-2 | 12.0145100  | +1.2886+01  | +1.3086+00 | +1.6815401        | -30.00 | +0+9976-03 | +3 3305-33  | + 5 + + 5C - U 5 | +3.940E-J2  | +2++1/E-UZ  | +0.0002-39   | ************************************** |
|   | 2    | +3 300E+00  | +1 2545+01  | +0 1616-01 | -19401C+01        | -20.00 | +0+7710-03 | +3 3302-39  | + J++c00~03      | +0.0102-02  | +2.0000-02  | +0.00000-39  | 10.0002-34                             |
|   | 3    | +3+3000+00  | +1 606E+01  | TT 1010101 | +1.470C+01        | -20.33 | +0.0575-00 | +0.000=-00  | F0. +102-00      | TO. 1792-37 | +2 0015 22  | 10.0002-39   | -U.UUJE-19                             |
|   | 2    | +/ 0025420  | *1.**24C+U1 | +>+245F-01 | +1.000E+UI        | -30.00 | +8.95/2-33 | FU-010=*39  | P2++J12-03       | +6./336-12  | +3.991E-02  | +0.0000-39   | +0.0002-39                             |
|   | - 4  | *** 0732+00 | +1.492E+01  | +1.299E-01 | *1./1/E+01        | -30.10 | +8.95/E-03 | +J.0J0E-39  | +2.35/=~03       | +0.6701-02  | ++.182E-02  | +0.0002-39   | +U.000E-39                             |
|   | 4    | +4.1021+00  | +1.4946+01  | +1.2140-01 | +1.7192+01        | -36.00 | +>./51E-03 | ~1.2035+31  | +1.1935-02       | +4.859E-02  | +3.095E-02  | +0.000E-39   | +0.000E-39                             |
|   | 4    | +4.112E+00  | +1.445E+01  | +1.115E-01 | +1.7236+01        | -42.30 | +3.599E-03 | +3.0301-33  | +2.2935-03       | +3.451F-12  | +2.239F-02  | +0.000E-39   | +0.000E-39                             |
|   | 4    | +4.123E+00  | +1.496E+01  | +1.004E-01 | +1.722=+01        | -48.00 | +3.598E-03 | +3.3303-39  | +2.2935-03       | +3.4515-02  | +?.241F-17  | +0.000E-39   | +0.000E-39                             |
|   | 4    | +4.135E+00  | +1.497E+01  | +8.817E-02 | +1.7235+01        | -54.00 | +3.599E-03 | +0.0005-39  | +2.293E-03       | +3.46)F-72  | +2.243E-02  | +0.000E~39   | +D.000E-39                             |

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4 +4.148E+00 +1.498E+01 +7.500E-02 +1.725E+01 -60.00 +3.598F-03 +0.000E-39 +2.293E-03 +3.459E-02 +2.245F-02 +0.000E-39 +0.000E-39 4 +4.162E+00 +1.499E+01 +6.101E-07 +1.725E+01 -66.07 +3.598E-03 +0.000E-39 +2.293E-03 +3.459E-07 +2.2477-07 +0.000E-39 +0.000E-39 4 +4.162E+00 +1.499E+01 +6.35E-02 +1.728E+01 -72.00 +3.598E-03 +0.000E-39 +2.293E-03 +3.458E-07 +2.2477-07 +0.000E-39 +0.000E-39 4 +4.192E+00 +1.500E+01 +3.19E-02 +1.733E+01 -78.00 +3.598E-03 +0.00E-39 +2.293E-03 +3.458E-07 +2.2471-07 +0.00E-39 +0.000E-39 4 +4.192E+00 +1.500E+01 +3.19E-02 +1.733E+01 -84.00 +3.598E-03 +0.00E-39 +2.293E-03 +3.458E-07 +2.251E-07 +0.00E-39 +0.000E-39 4 +4.223E+00 +1.500E+01 +3.912E-07 +1.733E+01 -90.00 +3.598E-03 +0.00E-39 +2.293E-03 +3.456E-02 +2.255E-07 +0.00DE-39 +0.000E-39 8 +4.223E+00 +1.500E+01 +3.912E-07 +1.733E+01 -90.00 +3.598E-03 +0.00E-39 +2.293E-03 +3.456E-02 +2.255E-07 +0.00DE-39 +0.00DE-39 8 +4.223E+00 +1.500E+01 +3.912E-07 +1.733E+01 -90.00 +3.598E-03 +0.00E-39 +2.293E-03 +3.456E-02 +2.255E-07 +0.00DE-39 +0.00DE-39 8 +4.223E+00 +1.500E+01 +3.912E-07 +1.733E+01 -90.00 +3.598E-03 +0.00E-39 +2.293E-03 +3.456E-02 +2.255E-07 +0.00DE-39 +0.00DE-39 8 +4.223E+00 +1.500E+01 +3.912E-07 +1.733E+01 -90.00 +3.598E-03 +0.00DE-39 +2.293E-03 +3.456E-02 +2.255E-07 +0.00DE-39 +0.00DE-39 4 +4.223E+00 +1.500E+01 +3.912E-07 +1.732E+01 -90.00 +3.598E-03 +0.00DE-39 +2.293E-03 +3.456E-02 +2.255E-07 +0.00DE-39 +0.00DE-39 4 +4.223E+00 +1.500E+01 +3.912E-07 +1.732E+01 -90.00 +3.598E-03 +0.00DE-39 +2.293E-03 +3.456E-02 +2.255E-07 +0.00DE-39 +0.00DE-39 4 +4.223E+00 +1.500E+01 +3.912E-07 +1.732E+01 -90.00 +3.598E-03 +0.00DE-39 +2.293E-03 +3.456E-02 +2.255E-07 +0.00DE-39 +0.00DE-39 4 +4.223E+00 +1.500E+01 +3.912E-07 +1.732E+01 -90.00 +3.598E-03 +0.00DE-39 +2.293E-03 +3.456E-02 +2.255E-07 +0.00DE-39 +0.00DE-39 4 +4.223E+00 +1.500E+01 +3.912E-07 +1.732E+01 -90.00 +3.598E-03 +0.00DE-39 +2.293E-03 +3.456E-02 +2.255E-07 +0.00DE-39 +0.00DE-39 4 +4.223E+00 +1.500E+01 +3.912E-07 +1.732E+01 -90.00 +3.598E-03 +0.00DE-39 +2.293E-03 +3.456

|               | THET ST SECT ALPHA        | DTOS ST      | S ST         | Y ST         | <u> </u>        |
|---------------|---------------------------|--------------|--------------|--------------|-----------------|
|               | -3.0)000E+01 3 +120.00    | ~6.66667E+00 | +8.742082+00 | +7.47990E+00 | 35 +4.29835E+00 |
| <br>T ALPHA   | SBW SN THETH SN SEC       | YBW SN       | XBW SN       | YOW SN       | IW SN XOW SN    |
| <br>8 +120.00 | +1.075)2E-)1 +4.39372E+01 | +9.85329E-02 | +3.59015E-02 | +7.41576E+00 | 7 +4.35817E+00  |
| <br>T ALPHA   | SBL SN FHETL SN SFC       | YBL SN       | XBL ŞN       | YOL SN       | IL SN XOL SN    |
| <br>4 +120.00 | +1.075022-01 +4.89372E+01 | +9.85327E-02 | +3.69014E-02 | +7.49918E+00 | 7 +4.20767E+00  |
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AT ALPHA = +1.2000E+02 WINDWARD, RW = +2.7533E-01 DELS = +1.9342E-02 3543C = +5.7912F-91

| AT ALPHA = +1.2000E+02 WINDW  | ARD, RW = +2.7533E-01 D     | ELS = +1.93     | 426-02 354334 = +5. | 7912F-71       |            |             |              |
|-------------------------------|-----------------------------|-----------------|---------------------|----------------|------------|-------------|--------------|
| SEC XO W XB W                 | YBW SBW THETBI              | H PE/PS W       | DP/DS # 2_ #        | OT W           | RF W       | OR W        | XSI W        |
| 8 +4.298E+00 -C.000E-39 +0.   | 000E-39 +0.000E-39 +90.00   | +1.000E+30      | +4.0385-35 +3.1335+ | 00 +3.370E-39  | +0.000E-39 | +2.018E-01  | +1.834E-02   |
| 8 +4.303E+00 +9.137E-05 +5.   | 235E-03 +5.235E-03 +88.00   | 0 +9.983E-01    | -4.5355+31 +3.13264 | 00 +5.844E-71  | +9.290E-05 | +1.798E-01  | +1.838E-02   |
| 8 +4.320E+00 +2.279E-03 +2.   | 605E-02 +2.618E-02 +80.00   | 0 +9.573F-01    | -2.231E+32 +3.334E  | 00 +1.487F+00  | +2.253E-04 | +2,8195-02  | +1.935E-02   |
| 8 +4.335E+00 +7.341E-03 +4.   | 635E-02 +4.712E-32 +72.00   | 0 +8.695E~01    | -3.5502+02 +2.1595  | 00 +1.9558+90  | +5.(936-04 | +0.00000000 | +2.108E-02   |
| 8 +4.3480+00 +1.5180-02 +6.   | 2005 02 +0.80/E=02 +04.00   | J + (. 5 55E-UL | -4.0372+32 +2.3322- | 00 +2,1050+30  | +1.251C=03 | +0.000E-39  | +3.100E=02   |
|                               | 2002-02 T0: 9012-02 T00: J0 | 5 +5.580E-01    | -1 6275132 41 8635  | 0 +2.1336+33   | +2.249E-03 | AG. 010E-39 | +3.776F=02   |
| 8 +4.3665+00 +3.8535=02 +1.   | 004E-01 +1.100E-01 +48.00   | +5.539E-01      | -4.652=+32 +1.899E  | 00 +2.074F+00  | +2.306E-03 | +0.000E-39  | +3-878E-02   |
| 9 +4-371E+00 +5-358E-02 +1.   | 149E-01 +1-309E-01 +40-00   | +4-153E-01      | +0.010=-37 +1.353E  | 00 #1.873E+02  | +2.585E-03 | +0.000F-39  | +4.908E-02   |
| 9 +4.435E+00 +3.356E-01 +3.   | 516E-01 +4.991E-01 +40.00   | +4.153E-01      | +3.0302-39 +3.553E- | 01 +1.433E+00  | +1.024E-02 | +0.000E-39  | +1.206E-01   |
| 9 +4,499E+00 +6,177E-01 +5.   | 883E-01 +8.573E-01 +40.00   | 3 +4.153E-01    | +3.030E-39 +4.929E  | 01 +1.283E+30  | +1.779E-02 | 40.000E-39  | +1.349E-01   |
| 9 +4.563E+00 +8.998E-01 +8.   | 249E-01 +1.235E+00 +40.00   | 0 +4.153E-01    | +3.0)02-39 +4.114E- | 01 +1.195E+00  | +2.534E-02 | +3.3005-39  | +1.341E-01   |
| 9 +4.627E+00 +1.182E+00 +1.   | 062E+30 +1.534E+00 +40.00   | D +4.153E-DI    | +0.000=-39 +3.504E- | 01 +1.135E+30  | +3.289E-02 | +0.000E-39  | +1.269E-01   |
| 9 +4.691E+00 +1.464E+00 +1.   | 298E+00 +1.972E+00 +40.00   | 0 +4.153E-01    | +0.000E-39 +3.246E- | 01 +1.089E+00  | +4.044E-02 | +0.000E-39  | +1.164E-01   |
| 9 +4.755E+00 +1.746E+00 +1.   | 535E+00 +2.340E+00 +40.30   | 0 +4.153E-01    | +3.0302-39 +2.9776- | 01 +1.052E+00  | +4,7996-02 | +0.0002-39  | +1.0392-01   |
| 9 +4.8192+30 +2.0282+00 +1.   | 772E+00 +2.738E+00 +40.00   | ) +4.153E-01    | +3.0302-39 +2.7555  | 01 +1.0222+00  | +5.5546-02 | +0.0002-39  | +9.0242-02   |
| 9 +4.8835+00 +2.3105+00 +2.   | 008E+00 +3.075E+00 +40.JC   | J +4.1530-01    | +3.0302-33 +2.03422 | 01 +9.9002-01  | +7 0455-02 | +0.00000-39 | +6 063E-02   |
| 10 +5 010F+00 +2.874F+00 +2.  | 4825+00 +3.8135+00 +30.00   | +4.1536-01      | +1.010-39 +2.328-   | 01 +0.5416-01  | 47.8205-02 | 40.000F-39  | +4-5446-02   |
| 10 +5-010E+00 +3-199E+00 +2-  | 669E+00 +4.1882+00 +30.00   | 1 +4.153E-01    | +3-370=-39 +2-221=- | 01 +9.354E-01  | +8.589F-02 | +0.000E-39  | +9-5026-02   |
| 10 +5.010E+00 +3.524E+00 +2.  | 857E+00 +4.563E+00 +30.00   | 0 +4 153E-01    | +0.0002-39 +2.1275- | 01 + 9.205E-01 | +9.358F-02 | +0.000E-39  | +1.443E-01   |
| 10 +5.010E+00 +3.848E+00 +3.  | 044E+00 +4.933E+00 +30.00   | +4.153E-01      | +0.0002-39 +2.0452- | 01 +9.060E-01  | +1.013E-01 | +0.000E-39  | +1.934E-01   |
| 10 +5.010E+00 +4.173E+00 +3.  | 232E+00 +5.313E+00 +30.00   | +4.153E-01      | +0.0002-39 +1.9718- | 01 +8.929E-01  | +1.090E-01 | +0.0008-39  | +2.424E-01 1 |
| 10 +5.010E+00 +4.498E+00 +3.  | 419E+00 +5.588E+00 +30.00   | +4.153E-01      | +0.0002-39 +1.9052- | 01 +8.808F-01  | +1.167E-01 | +0.000E-39  | +2.912E-01   |
| 10 +5.010E+00 +4.823E+00 +3.  | 607E+00 +6.063E+00 +30.00   | +4.153E-01      | +3.33DE-39 +L.345E- | 01 +8.696E-01  | +1.243E-01 | +0.000E-39  | +3.3996-01   |
| 10 +5.010E+00 +5.147E+00 +3.  | 794E+00 +6.438E+00 +30.00   | +4.153E-01      | +0.030=-39 +1.790E- | 01 +8.592E-01  | +1.323E-01 | +0.000E-39  | +3-885E-01   |
| 10 +5.010E+00 +5.472E+00 +3.  | 9826+00 +6.8132+00 +30.00   | ) +4.153E-0L    | +3.030E-39 +L.740E- | 01 +8.496E-01  | +1.3976-31 | +0.0002-39  | 44.310C701   |
| 10 +5.0105400 +5.1975400 +4.  | 1092+00 +7.1882+00 +30.00   | 4.1525-01       | +0.0102-33 +1.6512  | 01 +8 3205-01  | +1.5516-01 | +0.0000-39  | +5.3395-01   |
| 10 +5-0105+00 +6-4475+00 +4-  | 544F+00 +7-938F+00 +30-00   | +4-153E-01      | +0.000=-39 +1.5115  | 01 +8.240E-01  | +1.628E-01 | +0.000E-39  | +5-8226-01   |
| 10 +5.010E+00 +6.771E+00 +4.  | 732F+00 +8.313E+00 +30.00   | £4.153E-01      | +0.0001-39 +1.5758  | 01 +8-154E-01  | +1.705E-01 | +0.000E-39  | +6.305E-01   |
| 10 +5.010E+00 +7.096E+00 +4.  | 919E+00 +8.558E+00 +30.00   | +4.153E-01      | +0.0302-39 +1.5402- | 01 +8.092E-01  | +1.792E-D1 | +0.000E-39  | +6.787E-01   |
| 10 +5.010E+00 +7.421E+00 +5.  | 107E+00 +9.0635+00 +30.00   | ) +4.153E-01    | "+).))01=39 F[.509E | 01 +8.0246-01  | +1,859E-01 | +0.000E-39  | +7-270E-01   |
| 10 +5.010E+00 +7.746E+00 +5.  | 294E+00 +9.435E+00 +30.00   | ) +4.153E-01    | +0.0302-39 +L.478E- | 01 +7.959E-01  | +1.936E-01 | +0.000E-39  | +7.752E-01   |
| 10 +5.010E+00 +8.070E+00 +5.  | 482E+00 +9.813E+00 +30.00   | ) +4.153E-01    | +0.0002-39 +L.449E- | 01 #7.898E-01  | +2.013E-01 | +0.000E-39  | +8.233E-01   |
| 10 +5.010E+00 +8.395E+00 +5.  | 669E+00 +1.019E+01 +30.00   | 0 +4.153E-01    | +0.0005-37 +1.422E  | 01 +7.839E-01  | +2.089E-01 | +0.0008-39  | +8.715E-01   |
| 10 +5.0100+00 +8.7200+00 +5.  | 8572+00 +1.0562+01 +30.00   | J +4.153E-01    | +3.0302-33 +1.3962- | 01 +7.782E-01  | +2.1358-01 | +0.00000-39 | +9.1952-01   |
| 10 +5.0102+00 +9.0452+00 +8.  | 2225+00 +1 1215+01 +20 00   | J +4.155F-01    | +0.000=-39 +1.0720- | 01 +7.6765-01  | +2.245F-01 | +0.00000-39 | 49.077E+00   |
| 9 +4.9476+00 +9.7156+00 +6.   | 3586+00 +1.1686+01 +20.30   | ) +4.153E-01    | +0.010=-39 +1.3285- | 01 +7.627E~01  | +2.396E-01 | +0.0005-39  | +1.170E+00   |
| 9 +4-883F+00 +1-006F+01 +6-   | 484F+00 +1.205F+01 +20.00   | +4.153E-01      | +0.0005-37 +1.3076- | 01 +7.530E-01  | +2.471E-01 | +0.000E-39  | +1.285E+00   |
| 9 +4.819E+00 +1.041E+01 +6.   | 609E+D0 +1.242E+01 +20.00   | +4.153E-01      | +0.000E-39 +1.293E- | 01 +7.5345-01  | +2.547E-01 | +0.000E-39  | +1.399E+00   |
| 9 +4.755E+00 +1.075E+01 +6.   | 735E+00 +1.279E+01 +20.00   | ) +4.153E-01    | +3.0301-37 +1.1576- | 01 +7.491E-01  | +2.622E=01 | +0.000E-39  | +1.514E+00   |
| 9 +4.691E+00 +1.110E+01 +6.   | 861E+00 +1.315E+01 +20.00   | ) +4.153E-01    | +3.0302-39 +1.2512- | 01 +7.4488-01  | +2.598E-01 | +0,000E-39  | +1.629E+00   |
| 9 +4.627E+00 +1.145E+01 +6.   | 987E+00 +1.352E+01 +20.00   | 0 +4.153E-01    | +0.000==39 +[-2346  | 01 #7.407E-01  | +2.773E-01 | +0.000E-39  | +1.743E+00   |
| 9 +4.563E+00 +1.179E+01 +7.   | 113E+00 +1.389E+01 +20.00   | 0 +4.153E-01    | +0.000=-37 +1.217=- | 01 +7.357E-01  | +2.849E-31 | +0.000E-39  | +1.858E+00   |
| 9 +4.4996+00 +1.2146+01 +7.   | 2396+00 +1.4256+01 +20.00   | ) +4.153E-01    | +3.0302-39 +1.2322- | 01 +7.3298-01  | +2.9242-01 | +0.000E-39  | +1.9732+00   |
| 9 74-4550 T1-2400 T1-2400 T1- | /015+00 +1 4005+01 +20+00   | J +4.1536-01    | +0 0002-39 FL+L032- | 01 47.4720-01  | +2 0755-01 | +0.0000-39  | 12 2025100   |
| 8 +4.366E+D0 +1.285E+01 +7.   | 4976+00 +1.5025+01 +12.30   | 3 +4.667E-12    | ~1.933E+32 +5.168E- | 02 +2.135E-01  | +1.066E-01 | +0.0005~39  | +2.334E+00   |
| 8 +4.358E+00 +1.287F+01 +7.   | 500E+00 +1.504E+01 +4.00    | +2.900E-02      | -4.827=+21 +4.313=- | 02 +1.552F-01  | +7.937F-02 | +2.000E-39  | +2.537E+00   |
| 8 +4.348E+00 +1.289E+01 +7.   | 500E+00 +1.506E+01 -4.00    | +1.723E-02      | -3.102E+01 +3.015E  | 02 +1.085F-01  | +5.572F-02 | +0.0005-39  | +2.839E+00   |
|                               | 497E+00 +1.538E+01 -12.00   | ) +9.854E-03    | -1.919E+01 #2.058E- | 02 +7.325E-02  | +3.917F-02 | +0.0008-39  | +3.293EF00   |
| 8 +4.320E+00 +1.293E+01 +7.   | 491E+00 +1.510E+01 -20.00   | +5.397E-03      | -1.138E+01 +1.397E- | 02 +4.763E-72  | +2.673E-02 | +0.000E-39  | +4.006E+00   |
| 8 +4.303E+00 +1.295E+01 +7.   | 482E+00 +1.512E+01 -28.3    | 7 +3.598E-03    | +3.0002-39 +2.1756- | 03 +3.5525-02  | +1.969F-02 | +0.0005-39  | +5.222E+00   |
| 8 +4.298E+00 +1.296E+01 +7.   | 480E+C0 +1.513E+01 -30.00   | J +3.598E-03    | +0.000E-39 +2.L75E- | 03 +3.5516-52  | +1.9598-32 | +0.0305-39  | +>.5552+00   |

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8 +4.284E+00 +1.297E+01 +7.471E+00 +1.514F+31 -36.00 +3.598F-03 +3.030E-39 +2.175E-03 +3.551E-17 +1.971E-07 +1.070E-39 +7.658E+00 8 +4.265E+00 +1.298E+01 +7.458E+00 +1.515E+01 -44.10 +3.598E-33 +2.175E-03 +3.4557E-77 +1.974E-07 +3.300E-39 +3.300E-39 8 +4.244E+00 +1.300E+01 +7.442E+00 +1.513E+01 -52.00 +3.558E-03 +3.000E-39 +2.175E-03 +3.649E-12 +1.375F-07 +0.000E-39 +0.000E-39 8 +4.223E+00 +1.301E+01 +7.425E+00 +1.520E+01 -60.00 +3.598E-03 +0.000E-39 +2.175E-03 +3.548F-07 +1.979F-02 +0.000E-39 +0.000E-39 4 +4.208E+00 +1.302E+01 +7.411F+00 +1.522E+01 -66.00 +3.598E-03 +0.000E-39 +2.175E-03 +3.547F-07 +1.681F-07 +0.000E-39 +0.000E-39 4 +4.1926+30 +1.3026+01 +1.306+30 +1.5250+01 -30.00 +3.598E-03 +0.000=39 +2.175E-03 +3.546E-02 +1.983E-02 +0.000E-39 +0.000E-39 4 +4.177E+00 +1.303E+01 +7.381E+00 +1.5250+01 -78.00 +3.598E-03 +0.000E-39 +2.1750-03 +3.546E-02 +1.985E-02 +0.000E-39 +0.000E-39 4 44.162E+00 +1.303E+01 +1.36E+00 +1.525E+01 -10.00 +3.598E-03 +0.000E-39 +2.117E-03 +3.598E-02 +1.987E-02 +9.007E-39 +0.007E-39 +0.000E-39 4 44.162E+00 +1.303E+01 +7.350F+00 +1.528E+01 -90.00 +3.598E-03 +0.050E-39 +2.175E-03 +3.544E-02 +1.989E-02 +0.000E-39 +0.000E-39 4 +4.135E+00 +1.303E+01 +7.334E+00 +1.530E+01 -96.00 +3.598E-03 +0.000E-39 +2.175E-03 +3.543E-02 +1.991E-02 +0.000E-39 +0.000E-39 ..... -----. ... ..... . .... 72 - -----. .....

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| SEC XC         | ) L 🔅                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | KBL                                                                                                                      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L<br>000F-39<br>217E-04<br>456E-03<br>992E-02<br>100E-02<br>865E-02<br>953E-02<br>953E-02<br>953E-02<br>953E-02<br>953E-02<br>953E-02<br>953E-02<br>953E-02<br>953E-02<br>953E-01<br>163E-02<br>953E-01<br>176E+00<br>506E+00<br>506E+00<br>506E+00<br>506E+00<br>506E+00<br>506E+00<br>506E+00<br>506E+00<br>506E+00<br>516E+00<br>525E+00<br>388E+05<br>516E+00<br>516E+00<br>516E+00<br>516E+00<br>516E+00<br>516E+00<br>516E+00<br>516E+00<br>516E+00<br>517E+00<br>516E+00<br>516E+00<br>516E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+00<br>517E+0 | YB L<br>+0.000E-39<br>+1.568E-02<br>+3.629E-02<br>+7.500E-02<br>+7.500E-02<br>+7.500E-02<br>+7.500E-02<br>+9.853E-02<br>+1.004E-01<br>+1.15E-01<br>+1.214E-01<br>+1.214E-01<br>+1.229E-01<br>+1.209E-01<br>+1.407E-01<br>+1.407E-01<br>+1.407E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.500E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E-01<br>+1.432E | SB L<br>+0.000E-39<br>+1.571E-02<br>+3.665E-02<br>+7.854E-02<br>+7.854E-02<br>+1.1075E-01<br>+1.207E-01<br>+1.277E-01<br>+1.4146-01<br>+1.4146-01<br>+1.4146-01<br>+1.4146-01<br>+1.4146-01<br>+1.4146-01<br>+1.4146-01<br>+1.2216-00<br>+2.042E-01<br>+2.042E-01<br>+2.042E-01<br>+2.042E-01<br>+2.042E-01<br>+2.042E-01<br>+2.042E-01<br>+3.7376E-00<br>+3.7376E-00<br>+3.7376E-00<br>+3.5476E+00<br>+8.545E+00<br>+8.5476E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.545E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00<br>+8.55E+00 | THETBL<br>+90.00<br>+88.00<br>+68.00<br>+68.00<br>+54.00<br>+48.94<br>+48.00<br>+35.00<br>+22.00<br>+35.00<br>+22.00<br>+35.00<br>+22.00<br>+35.00<br>+24.00<br>+0.00<br>+0.00<br>+0.00<br>+0.00<br>+0.00<br>+0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0.00<br>-0 | PE/PS L<br>+1.0005+30<br>+9.8445-01<br>+9.8445-01<br>+9.8445-01<br>+9.8445-01<br>+9.8485-01<br>+9.8485-01<br>+5.5395-01<br>+5.5395-01<br>+3.4785-01<br>+3.4785-01<br>+3.4785-01<br>+3.4785-01<br>+3.4785-01<br>+3.4785-01<br>+3.4785-01<br>+3.4785-01<br>+3.4785-01<br>+3.4785-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.1085-02<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3.5985-03<br>+3. | DP/DS L<br>+ ++.0385-9:<br>-1.3332;<br>-2.9595:0:<br>-3.9515;<br>-3.9515;<br>-4.6525;<br>-4.6525;<br>-4.6525;<br>-4.6525;<br>-4.6525;<br>-5.3955-0;<br>-5.3955-0;<br>-5.3955-0;<br>-5.3955-0;<br>-1.5735;<br>-1.5735;<br>-1.5735;<br>-1.5735;<br>-1.5735;<br>-1.5735;<br>-1.5735;<br>-1.5735;<br>-1.5735;<br>-1.5735;<br>-1.5735;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1.5355;<br>-1. | 2L         L           5         +3.138           2         +2.931           2         +2.981           2         +2.981           2         +2.981           2         +2.981           2         +2.981           2         +2.981           2         +2.981           2         +2.931           2         +2.931           2         +2.9331           2         +1.9356           2         +1.9356           2         +1.9356           2         +1.9356           2         +1.9356           2         +1.9356           1         +5.947           2         +5.9547           1         +5.947           2         +5.947           1         +7.948           2         +2.7486           2         +2.7486           2         +2.7487           2         +2.7487           2         +2.7487           2         +2.7487           2         +2.7487           2         +2.7487           2         +2.7487< | 0<br>+00 +0.0<br>+00 +0.0<br>+00 +1.0<br>+00 +1.7<br>+00 +2.1<br>+00 +2.0<br>+00 +2.0<br>+00 +2.0<br>+00 +2.0<br>+00 +1.9<br>-01 +1.5<br>-01 +1.5<br>-01 +1.5<br>-01 +1.5<br>-01 +1.5<br>-01 +1.5<br>-01 +1.5<br>-01 +1.5<br>-02 +1.8<br>-02 +3.9<br>-03 | T L<br>30E-39 +<br>64E+00 +<br>95E+00 +<br>95E+00 +<br>85E+00 +<br>85E+00 +<br>85E+00 +<br>84E+00 +<br>84E+00 +<br>35E+20 +<br>35E+20 +<br>35E+20 +<br>35E+20 +<br>84E+01 +<br>51E-01 +<br>84E+01 +<br>51E-01 +<br>84E+01 +<br>52E-01 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>84E+02 +<br>8 | RE L<br>H0.000E-39: 44<br>RE 2765-05<br>H4.2845-04<br>H5.2765-05<br>H4.2845-04<br>H5.2765-05<br>H1.541E-03<br>H1.541E-03<br>H1.541E-03<br>H1.541E-03<br>H1.545-03<br>H1.545-03<br>H1.545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5545-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03<br>H1.5555-03 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| -              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                          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AT ALPHA = +1.5900E+02 WINOWARD, RW = +3.1389++01 DELS = +1.83425-02 354UC4 = -3.1534E+00 SIN(THETAW) NEG. FOR XB = +7.3969E+00 RW = +3.1389F+01 DELS = +1.8347E-D2 354UC4 = -3.1534E+00

| SEC    | X0 W          | XB W       | YB W       | SB w        | THETOW  | PE/PS W     | DP/DS A      | J∟ #            | OT W         | PE W        | OR W         | XSI W         |
|--------|---------------|------------|------------|-------------|---------|-------------|--------------|-----------------|--------------|-------------|--------------|---------------|
|        |               |            |            |             |         |             |              |                 |              |             |              |               |
| 8      | +4.353E+00    | -0.000F-39 | +0.0008-39 | +0.000E-39  | +90.00  | +1.000E+30  | +4.0382-35   | +3.JJ2E+00      | +0.000F-39   | +0.000F-39  | +2.018E-01   | +1.934E-02    |
| 8      | +4.358E+00    | +3.654E-04 | +1.046E-02 | +L.047E-02  | +85.00  | +9.951E-01  | -5.5102+01   | +2.937E+00      | +7.613F-91   | +3.077E-05  | +1.9876-01   | +1.975E-02    |
| 8      | +4.3555+00    | +3.2786-03 | +3.119E-02 | +3.142E-02  | +78.00  | +9.568F-01  | -1.9335+32   | +2.872E+00      | +1.429E+00   | +2.591F-04  | +6.123E-02   | +2.208E-02    |
| 9      | +4.3712+00    | +9.0468-03 | +5.130E-02 | +5.236E-37  | +70.00  | +8.830E-01  | +7.0202-39   | +2.5002+00      | +1.8595+00   | +7.203E-04  | +4.0135-02   | +2.908E-02    |
| 2      | +4.4.5000.000 | +1.3506-01 | +3.9/31-01 | +4.2066-01  | +70.00  | +8.830E-01  | +3.0308-39   | +5.355E-01      | +1.225F+30   | +5.785E-03  | +1.3718-01   | +1.597E-01    |
| 3      | +4.4992+30    | +2.6098-01 | +/.4332-01 | +7.8896-01  | +75.00  | +8.830P-01  | +0.0005-39   | ++.9+1=-71      | +1.0816+00   | +1.785E-02  | +9.567E-02   | +2.852F-01    |
| 2      | +4.005E+00    | +3.5682-01 | +1.089F+00 | +1.1575+00  | +75.50  | +8.8306-01  | +3.0008-39   | +4.0578-01      | +1.001F+00   | +1.592E-02  | +0.000E-39   | +4.056F-01    |
| 9      | +4.6216400    | +5,1/85-01 | +1.4352+00 | +1.525=+00  | +73.00  | +8.830E-01  | +0.0002-39   | +3.5252-01      | +9.4715-11   | +2.798E-12  | +0.0005-39   | +5.210E-01    |
|        | +4.0710+30    | +7 4448-01 | +1.7010+00 | +1.8990+00  | +73.30  | +8.833F-01  | +1.0102-39   | +3+1292-91      | +9.1708-01   | +2.5051-02  | +0.0000-39   | +6.314F-01    |
|        | +4 9195+00    | +1.0405-01 | +2.12/2+00 | +2+2525+00  | +70.00  | +9.430E-01  | + 3. 0302-37 | +2.3338-91      | +8.7535-11   | +3.11102    | +0.0005-39   | +7.1686-01    |
|        | +4.8835+00    | +1 016E+00 | +2+4/38+00 | +2.5502+39  | +70.00  | +8.840E=01  | +3.030=-39   | F2.5755-01      | + 4. 4434-11 | +3.5186-02  | +0.0005-34   | +8.373E-01    |
| ,<br>a | +4.9476+00    | +1 1426+00 | +2 1465+00 | +2.9995+00  | +70.00  | +8+83JE-JI  | +3.030=-37   | +2.5056-11      | +2.774(1)    | +4.124F-02  | +0.0006-39   | +9.3306-01    |
| - 1ó   | +5.0105+00    | +1 7406+00 | +3.1056+00 | +3.3332+33  | +10.00  | + 7.05Je-JI | +3.0302-39   | +2.25211        | ********     | +4.5016-02  | +0.0002-39   | +1.0242+00    |
| 10     | +5.0106+00    | +1 4545+00 | +3 9346+00 | +4 1005400  | +60.00  | +7.5000001  | +1.0302-39   | +2.3545-01      | +9.74401     | +5.9941-02  | +1.0006-34   | +1.1/32+00    |
| 10     | +5.010E+00    | +1.643E+00 | +4.1616+00 | +4.1092+00  | +60.00  | +7 5005-01  | FD 0205-39   | +2+3712-71      | +9.559-01    | +1.5818-02  | +9.9008-39   | +1.324E+00    |
| 10     | +5-0100+00    | +1.8316+00 | +4.1012+00 | +4.950E+00  | 100.00  | +7.5005-01  | +0.000000000 | +2.0012-11      | +9.3938-01   | +8.2/96-02  | +0.0000-39   | +1.4696+00    |
| - 10   | +5.010E+00    | +2.0186+00 | +4 8105+00 | AE 2365+00  | +50.00  | +7 5000-01  | +0.000=30    | +2.435-11       | +9.234)[     | +8+9/12-02  | +0.0002-39   | +1.5092+00    |
| 10     | +5.0108+00    | +2.2066+00 | +5.135E+10 | +5 6005400  | +60.00  | +7.5000-01  | +0.030=-33   | +2-3735 -1      | +9.1377-31   | +9.0346-02  | + ). 0305-39 | +1.1422+00    |
| 10     | +5.010E+00    | +2.3036+00 | +5 4605+00 | 45 00/E+00  | +00.00  | +7.5000-01  | +3.0302-39   | +2.1521-71      | +R.992       | 11 1055 01  | +0.0000 20   | +1.009E+00    |
| 10     | +5-010E+00    | +2-5815+00 | +5.785E+00 | +6.3536+00  | +63.00  | +7.50000-01 | FJ. JJ02-39  | +2 - 19 J2 - 01 | +0.00/0-01   | +1.1765-01  | +0.0002-39   | +1.991C+00    |
|        | '75.010F+00   | +2.768E+00 | +6.1095+00 | 14.734E+00  | 460 00  | 17 500C-01  | +0.000=-37   | 12 3335-01      | +9 4405-01   | +1 2625-01  | +0.0005-30   | -10-105E+00   |
| 10     | +5-0105+00    | +2.9565+00 | +6.4346+00 | 17 1005100  | +60.00  | A7 5005-01  | F3-0302-39   | +1 3636-01      | 10 545 01    | +1 -2495-01 | +0.0002-39   | 12.210CTU0 ** |
|        | +5-010E+00    | +31143E+00 | +6.7595+00 | +7.4846+00  | +60.00  | +7.5006-01  | F0 000       | +1 303E-01      | +0.00000-71  | 11 2020201  | +0.00000-19  | 42.520CTUD    |
| 10     | +5+010E+00    | +3,331E+00 | +7.0845+00 | +7.8595+00  | +60.00  | +7.5005-01  | FD 000 - 37  | ×1.35350-01     | +0.4190-01   | +1 6615-01  | +0.0002-39   | 12 ED0E400    |
| 10     | +5-0106+00    | +3-5186+00 | +7-4085+00 | +8.234E+00  | +60 00  | A7 5005-01  | 40 0002-37   | 11.7955-01      | +0.00000001  | +1 62AC_01  | +0.0002-39   | 42 5035400    |
| 10     | +5.010E+00    | +3.706E+00 | +7.733E+00 | +8.5392+00  | +60.00  | +7.500E=01  | +1.0305-33   | +1.751=-01      | +8 2455-01   | +1.5202-01  | +0.0302-39   | 12.375C+00.   |
| 10     | +5.010E+00    | +3-893E+00 | +8-058E+00 | +8.9845+00  | +60.00  | +7.5008-01  | +0.0101-39   | +1.7116-01      | +8.1755-01   | +1.5546-01  | +0.000E-39   | 42-745FA00    |
| 10     | +5.010E+00    | +4.081E+00 | +8.3835+00 | +9-3535+00  | +60.00  | +7.5005-01  | A1 0101-39   | L1 6735-01      | +0 1085-01   | A1 779E-01  | +0.0005-39   | 12 010EL00    |
|        | +5.010E+00    | +4-268E+00 | +8.707E+00 | +9.734=+00  | +50,00  | +7.5006-01  | +2-0205-34   | +1-537=-01      | +8.0456-01   | +1.7976-01  | 10.000L-39   | +2.8705400    |
| 10     | +5.010E+00    | +4.456E+00 | +9.032E+00 | +1.011E+01  | +60.00  | +7.500E-01  | +0.000=-39   | +1->345-01      | +7.984E-01   | +1-856E-01  | +0.0006-39   | +2.9225+00    |
| 10     | +5.010E+30    | +4.643E+00 | +9.357F+00 | +1.0435+01  | +60.00  | +7.500E-01  | +2.0205-39   | +1.5735-01      | +7.9265-01   | +1.936E-01  | +0.000E-39   | +2-967E+00    |
| 10     | +5.010E+00    | +4.831E+00 | +9.682E+00 | +1.086E+01  | +60.00  | +7.5036-31  | +0.0305-39   | +1.5436-01      | +7.870E-D1   | +2.005E-01  | +0.000E-39   | +3.006E+00    |
| 10     | +5.010E+00    | +5.018E+00 | +1.001E+01 | +1.123E+01  | +60.00  | +7.500E-01  | +2.0005-39   | +1.515E-01      | +7.817E-01   | +2.074F-01  | +0.000E-39   | +3-037F+00    |
| 9      | +4.947E+00    | +5.255E+00 | +1.029E+01 | +1.1605+01  | +57.00  | +5.8698-71  | +7.0302-37   | +1.5718-01      | +8.201E-01   | +2.415E-01  | +0.000E-39   | +3.193E+00    |
| ···· 9 | +4.883E+00    | +5.492E+00 | +1.057E+01 | +1.197E+01  | +50.00  | +5.868E-01  | +3.0305-39   | +1.5435-01      | +8.150E-01   | +2.493E-01  | +0.000E-39   | +3,262E+D0    |
| 9      | +4.819E+00    | +5.728E+00 | +1.085E+01 | +1.2345+01  | +50.00  | +5.869E-01  | +0.0305-39   | +1.5178-01      | +8.101E-01   | +2.559F-01  | +0.000E-39   | +3,322E+00    |
| 9      | +4.755E+00    | +5.965E+00 | +1.113E+01 | +1.2715+01  | +50.00  | +5.868E-01  | +0.0002-39   | +1.4925-11      | +8.0545-01   | +2.545F-01  | +0.000F-39   | +3.373F+00    |
| 9      | +4.691E+00    | +6.202E+00 | +1.1426+01 | +1.308E+01  | +50.00  | +5.8688-01  | +2.0005-39   | +1.459E-01      | +8.008F-01   | +2.723F-01  | +0.0005-39   | +3.415E+00    |
| - 9    | +4.627F+90    | +6.438E+00 | +1.170E+01 | +1.3445+01  | +50.00  | +5.868E-01  | +0.0002-39   | +1.+4>=-71      | +7.9535-01   | +2.799E-01  | +0.000E-39   | +3.448E+00    |
| 9      | +4.563E+00    | +6.675E+00 | +1.198E+01 | +1.381E+01  | +50.00  | +5.868E-01  | +0.0002-39   | +1.4248-01      | +7.920E-01   | +2.876E-01  | +0.000F-39   | +3.470E+00    |
| 9      | +4.499E+00    | +6.912E+00 | +1.226E+01 | +1.4195+31  | +50.00  | +5.868E-01  | +3.0305-39   | +1.4345-01      | +7.879E-01   | +2.953E-01  | +0.0005-39   | +3.483E+00    |
| 9      | +4.435E+00    | +7.148E+00 | +1.254E+01 | +1.455E+01  | +50.00  | +5.863F-01  | +0.0002-39   | ▶1.394F-01      | +7.839F-01   | +3.029E-01  | +0.000F-39   | +3.484E+00    |
| 9      | +4.371E+00    | +7.385E+00 | +1.283E+01 | +1.492E+01  | +50.70  | +5.863E-01  | +3.0305-39   | +1.3552-01      | +7.7396-31   | +3.106F-31  | +0.000E-39   | +3.474E+00    |
| 9      | +4.371E+00    | +7.387E+00 | +1.283E+01 | +1.492E+01  | +48.94  | +5.685E-01  | -4.6332+32   | +3.445E-01      | +7.786E-01   | +3.121E-01  | +0.000E-39   | +3.471E+00    |
| 8      | +4.366F+30    | +7.400E+00 | +1.284E+01 | +1.494E+01  | +42.00  | +4.497F-31  | ~4.5522+)2   | +3.))35-01      | +7.441F-71   | +3.106E-01  | +0.000F-39   | +3.475E+00    |
| 8      | +4.358E+30    | +7.416E+00 | +1.285E+01 | +1.496E+01  | +34.00  | +3.1526-01  | -4.3375+)2   | +2.4755-01      | +6.52001     | +2.945E-01  | +0.000E-39   | +3.523F+00    |
| 8      | +4.353E+30    | +7.425F+00 | +1.286F+01 | +1.4975+11  | +30.00  | +2.669E-01  | -3.0025+02   | +2.1755-01      | +6.036F-01   | +2.6878-01  | +0.000E-39   | +3.565E+00    |
| 8      | +4.348E+00    | +7.434E+00 | +1.287E+01 | +1.498E+31  | +24.00  | +2.252E-31  | -2.6315+32   | +1.9415-01      | +5.542=-1    | +2.500E-01  | +0.000E-39   | +3.618E+00    |
| 8      | + 4.335E+30   | +7.454F+00 | +1.287E+01 | +1.5305+01  | +18.00  | +1.577F-)1  | -1.9452+)2   | +1.4>35-01      | +4.551E-71   | +2.118E-01  | +).000F-39   | +3.760E+00    |
| 8      | +4.320E+00    | +7.474F+00 | +1.238F+01 | +1+502E+)1  | +10.00  | +1.08JE-01  | -1.4325+32   | +1.1275-01      | +3.645E-01   | +1.739E-01  | +0.000E-39   | +3.951E+00    |
| 8      | +4.303E+00    | +7.495E+00 | +1.288E+01 | +1.5745+ 11 | +2.30   | +7.197E-02  | -1.0292+02   | +3.5026-02      | +2.9285-01   | +1.393F-01  | +3.3135-39   | +4.191F+00    |
| 8      | +4.284++00    | +1.516E+63 | +1.288E+01 | +1.5367+01  | -6.00   | +4.584E-02  | -7+0345+31   | +5.1936-72      | +2.109E-71   | +1.057F-01  | +^.000E-39   | +4.478F+00    |
| 8      | +4.2070+00    | +1.5361+00 | +1.2445+01 | +1.538E+01  | -14.70  | +2.8575-32  | -4.7552+31   | ++++705-02      | +1.5335-71   | +7.957 - 12 | +3.300F-39   | +4.806E+00    |
| 8      | +++2442+90    | TI. 735+00 | +1+5816+01 | +1•210±+11  | -55* 10 | +1.5965-02  | -1.7592+31   | +3.127E-02      | +1.7728-01   | +5.630=-72  | +0.0008-39   | +5.165F+30    |

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|             | 8 +4  | 2236+00   | +7-5756+00 | +1,286E+01  | +1.513E+01 | -30-00 | +9.7078-03   | -1.8945+)1 | +2.147E-02  | +7.243E-02   | +3.889E-02  | +0.000E-39   | +5.543E+00 |  |
|-------------|-------|-----------|------------|-------------|------------|--------|--------------|------------|-------------|--------------|-------------|--------------|------------|--|
|             | 4 +4  | 2086+00   | +7.5885+00 | +1.2856+01  | +1.5145+01 | -36.00 | +5-248E-03   | -1.2935+31 | +1.5318-02  | +5.239E-02   | +2.395E-02  | +3.000E-39   | +0.000E-39 |  |
| -           | 1.12  | 10000000  | +7 4005+00 | A1 20/E+01  | 11 5165403 | -62 00 | 43.005E-03   | -8.5755411 | +1.211E-02  | +3.7585-32   | +2-089E-02  | +0.000F-39   | +0.000E-39 |  |
|             | 7.17  | 1726+00   | +1.0002+00 | +1 2025.01  | 11 5172101 | -40.00 | 13 E09E-03   | +0 3305-33 | 12 2.75-12  | A2 5405-72   | +1.975E-02  | +0.0005-39   | +0.000F-39 |  |
|             | 4 + 4 | .1/12+00  | +7.611E+00 | +1.2000-01  | +1.51/2+01 | -48.00 | +3 FOOF 07   | 10.000-20  | 12 2676-03  | -2 5/05-02   | +1 9776-02  | 40.0005-30   | 40.000E-39 |  |
|             | 4 +4  | • 162E+00 | +7.6216+00 | +1.2828+01  | +1.5196+01 | -54+00 | +3.5900-05   | +3.0302-37 | +2.2570-05  |              | 11.0705-02  | 10.0000 37   | AD 000E-20 |  |
|             | 4 +4  | •148E+00  | +7.630E+00 | +1.281E+01  | +1.520E+01 | -60.00 | +3.5986-03   | +3-3335-33 | +2+2572-33  | +3.548E-J2   | +1.9195-02  | TO.00000-39  | +0.000C-37 |  |
|             | 4 +4  | •135E+00  | +7.637E+00 | +1.279E+01  | +1.522E+01 | ~66.00 | +3.598E-03   | +0.0005-39 | +2.2576-03  | +3.5475-92   | +1.9816-02  | +0.000E-39   | +0.0000-54 |  |
|             | 4 +4  | 123E+00   | +7.643E+00 | +1.278E+01  | +1.524E+01 | -72.30 | +3.598E-03   | +3.030E-39 | +2.267E-03  | +3.546E-02   | +1.983E-02  | +0.000E-39   | +0.000F-39 |  |
|             | 4 +4  | 112E+00   | +7.647E+00 | +1.276E+01  | #1,525E+01 | -78.00 | +3.598E-03   | +0.0005-39 | +2-2578-03  | 73.546E-02   | +1.985E-02  | +3.030E-39   | +0.000E-39 |  |
|             | 4 +4  | - 102E+00 | +7.649E+00 | +1.275E+01  | +1.527E+01 | -84.0D | +3.598E-03   | +3.D30E-39 | +2.257E-03  | +3.545E-02   | +1.987E-02  | +0.000E-39   | +0.000E-39 |  |
|             | 4 14  | 0936+00   | 47.650E+00 | +1.273E+01  | +1,5295+01 | -90,00 | +3.598E-03   | 13.00039   | +2.2578-03  | +3.544E-32   | +1.989E-02  | `+0.000Ë-39` | +0,000E-39 |  |
|             | 3 13  | 7015+00   | 17.650E+00 | +1 1956+01  | +1.607E+01 | -90-00 | +3.598E-03   | +0.000=-39 | +2.255E-03  | +3.509E-02   | +2-092E-02  | +0.000E-39   | +0.000E-39 |  |
|             |       | 2000 100  | 17 6605100 | +1 114E+01  | 11 CD55101 | -00 00 | +3.508E-03   | A1 010=-39 | +2.265E-03  | +3.475F-02   | +2. 194F-32 | +0. 200F-39  | +0.000E-39 |  |
|             | 2 7 2 | 5002700   | +7.0502+00 | -1.0275.01  | +1.3552+01 | -90.00 | A3 E096-03   | 10 0005-30 | +2.2645-03  | +3. 444E-12  | +2.296E~02  | +0.0305-39   | +0.000E-39 |  |
|             | 3 +2  | .9166+00  | +1.0500+00 | +1.05/6+01  | +1.1042101 | -90.00 | +3+3+3+0C-03 | 10.0000000 | 12 16 0     | 12 4145-02   | 42 200E-12  | To 2005-20   | +0 0015-30 |  |
|             | 3 +2  | • 523E+00 | +7.650E+00 | +9.5902+00  | +1.8425+01 | ~90.30 | +3.5982-03   | +0.000=-39 | +2.2525-09  | + >. 4140-02 | 12.5700-32  | +0.0002-37   | +0.0000-30 |  |
|             | 3 +2  | -130E+00  | +7.650E+00 | +8,805E+00  | +1.921E+01 | ~90.00 | +3+598E-03   | +0.030E-39 | +2.2516-03  | +3.3862-02   | +2.5000-02  | +0.0008-34   | -0.0000-39 |  |
|             | 3 +1  | •738E+00  | +7.650E+00 | +8.019E+00  | +1.999E+01 | -90.00 | +3.598E-03   | +0.0005-39 | +2.2535~03  | +3.3596-02   | +2.603E-32  | +0.000E-34   | +0.000039  |  |
|             | 3 +1  | .345E+00  | +7.650E+00 | +7,234E+00  | +2.078E+01 | -90.00 | +3.598E-03   | +3.0305-39 | +2.259E-03  | +3.3338-02   | +2.705E-02  | +0.0006-39   | +0.000E-39 |  |
|             | 3 +9  | .527E-01  | +7.650E+00 | +6.449E+00  | +2.156E+01 | -90.00 | +3.598E-03   | +3.33039   | `#2.253E-03 | +3.308E-J2   | +2.807E-02  | +0.000E-39   | +0.000E-39 |  |
|             | 3 +5  | -601E-01  | +7.650E+00 | +5-664E+00  | +2.2358+01 | -90.00 | +3.598E-03   | +3.0302-39 | +2.237E-03  | +3.285E-02   | +2.909E-02  | +0.0008-39   | +0.000E-39 |  |
| <del></del> | 3 +1  | 675E-01   | +7.650F+00 | +4.879E+00  | +2.313=+01 | -90.00 | +3.5986-03   | +).0)0=-37 | +2.255E-03  | +3.252E-02   | +3.011E-02  | +0.0005-39   | +0.0006-39 |  |
|             | 1 41  | 2626-01   | +7.648E+00 | +4.8135+00  | +2.3205+01 | -93.00 | +3-598E-03   | F0-000=-39 | +2-255E-03  | +3.250E-02   | +3.020E-02  | +0.000E-39   | +0.000E-39 |  |
|             | 1 7 1 | - JOZE-01 |            | *********** |            |        |              |            |             |              |             |              |            |  |



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|     |             |       |      |           |      | • •     |      |     |     |     |                |     |       |      |          |       |      |      |             |      |     |       |               |      | -    |      |      |     |       |      |                  |          |      |     |     |     | •    |               |       |                                         |
|-----|-------------|-------|------|-----------|------|---------|------|-----|-----|-----|----------------|-----|-------|------|----------|-------|------|------|-------------|------|-----|-------|---------------|------|------|------|------|-----|-------|------|------------------|----------|------|-----|-----|-----|------|---------------|-------|-----------------------------------------|
| EC  |             | X0 I  | -    |           | ХB   | L       |      |     | ΥB  | L   |                | 5   | SĦ    | L    | τŀ       | IETB  | L    | PF/  | 'PS         | ٤    | Ð.  | P/0   | 5 -           |      | ş    | ԼԼ   |      |     | OT    | L    |                  | R        | ЕĽ   |     |     | QR  | L    | X             | ST L  | ••••••••••••••••••••••••••••••••••••••• |
| 8   | <b>+</b> 4. | 3536  | +00  | -0        | .00  | )E-3    | 9 -  | ۰٥. | 000 | E-3 | 9 +            | 0.0 | 000   | E-39 | + + 9    | 70.0  | 0 +  | 1.0  | 0038        | + 22 | +4  | . 021 | 38-3          | 5 +  | 3.0  | 325  | +00  | +0. | . 00: | 75-3 | 9 + P            | <b>.</b> | DDE- | -39 | +2. | 018 | F-01 | +1.5          | 136F  | ÷0                                      |
| 8   | Ŧ4.         | 348E  | +00  | +3        | .65  | 4E-0    | 4 -  | ·1. | 046 | E-0 | 2 +            | 1.0 | 047   | E-02 | +8       | 35.0  | õ +  | 9.9  | <b>5</b> 18 | -01  | -ŝ  | . 51  | 5≣∓3          | E F  | ž. 9 | 375  | +DO  | ÷8. | 83    | 3E-Ő | 1 +              | 5.7      | OBE  | -35 | ŧī. | 595 | -01  | +1.1          | 350E  | -0                                      |
| 8   | +4.         | 335E  | +00  | +3        | .27  | 8 E⊷0   | 3 -  | +3. | 119 | E-0 | 2 +            | 3.  | 142   | E-02 | +1       | 78.0  | 0 +  | 9.5  | 568         | E-01 | -1  | . 90  | 32+3          | 2 +  | 2.8  | 726  | +00  | +1. | . 65  | 9E+0 | 0 +              | 3.2      | 43E  | -04 | +2. | 688 | E-02 | +1.           | 9786  | -0                                      |
| -8- | +4.         | 32.05 | +00  | +9        | • 04 | 5E-0    | 13 1 | ÷5. | 130 | E-0 | 2 <del>i</del> | 5.  | 235   | E-02 | : +1     | 70.0  | 0 +  | 8.8  | 3301        | -01  | ~-3 | . 55  | 7=+3          | 2 +  | 2.4  | 55E  | 40'0 | Ŧ1. | 85    | 9E+0 | 0 +              | 1.2      | 03E  | -04 | +0. | 000 | E-39 | +2.           | 2346  | -0                                      |
| 8   | +4.         | 3038  | -+00 | +1        | •75  | 66-0    | 12 . | ۲7. | 042 | E-0 | 2 +            | 7.  | 330   | E-02 | 2 + 6    | 52.0  | 0 4  | 17.7 | 7961        | E-01 | -3  | . 87  | 9E+3          | 2 +  | 2.3  | ) 2E | +00  | +2. | . 08  | 1E+0 | 0 +              | 1.2      | 97E  | -03 | +2. | 000 | E-39 | +2.           | 517E  | -0                                      |
| 8   | +4.         | 284E  | +00  | +2        | 86   | 5F-0    | 2 .  | ⊦₿. | 817 | E-0 | 2 +            | 9.7 | +25   | È-02 | - ÷ :    | \$4.0 | 0 +  | 5.5  | 5451        | -01  | -4  | .44   | ₽E+Ĵ          | 2 +  | 2.5  | 5IE  | F00  | +2. | ī i 3 | 4Ë+0 | 0 +              | 1.9      | 03E  | -03 | +0. | 000 | E-39 | +3.           | 216   | -                                       |
| 8   | +4.         | 284E  | +00  | +3        | .69  | 0E-C    | 12 1 | •9. | 853 | E-0 | 2 +            | 1.  | 075   | E-01 | +4       | 8.9   | 4 +  | 5.6  | 851         | E-01 | -4  | . 63  | 35+0          | 2 +  | 1.3  | 63E  | +90  | +2. | .08   | 8E+0 | 0 +:             | 2.2      | 49E- | -03 | +0. | 000 | E-39 | +3.           | 500E  | -0                                      |
| 8   | Ŧ4.         | 2658  | +00  | +4        | -21  | DE-C    | 12-4 | ÷1. | 042 | 6-9 | 1 +            | 1.  | 152   | E-Ő] | +4       | ÷5.0  | 0 4  | ·5•1 | 921         | E-01 | -4  | . 67  | 55+3          | Ž Ŧ  | 1.7  | 48E  | +00  | +2. | 03    | 5E+0 | 0 <del>+</del> 3 | 2.4      | 22E  | -03 | +0. | 000 | E-39 | +3.           | 739E  |                                         |
| 8   | +4.         | 244   | +00  | +5        | •76  | 5E-0    | 2    | +1. | 182 | E-0 | 1 +            | 1.  | 351   | E-01 | . +2     | 38.0  | 0 1  | -3.8 | 3139        | E-01 | -4  | . 53  | 9E+3          | 2 +  | 1.3  | 86E  | +00  | +1. | . 80  | 3E+0 | 0 +:             | 2.7      | 39E  | -03 | +0. | 000 | E-39 | +4.           | \$558 | -(                                      |
| 8   | +4.         | 2238  | +00  | +7        | • 50 | 0E-C    | 12.1 | -1. | 299 | E-0 | 1 +            | 1.  | 571   | E-01 | L #3     | 30.0  | 0    | ř2.7 | 7351        | E-01 | -3  | .05   | 62ŦĴ          | 2 +  | 1.3  | 532  | +00  | +1. | . Š1  | 9F+N | 0 +:             | 2.B      | 39E  | -03 | +0. | 000 | E-39 | +5.           | 241Ê  | -(                                      |
| 4   | +4.         | 208   | +00  | +8        | 89   | 9E-0    | 2 1  | 1.  | 370 | E-0 | 1+             | 1.1 | 729   | E-01 | . +2     | 24.0  | 0 +  | 2.1  | 216         | E-01 | -2  | . 47  | 5E+)          | 2 +  | 3.5  | 55E- | -01  | +1. | 31    | LE+O | 0 +;             | 2.8      | 09E- | -03 | +0. | 000 | E-39 | +5.1          | 153E  | -0                                      |
| 4   | +4.         | 1928  | +30  | +1        | •03  | 6F-0    | 1 -  | ۰1. | 427 | E-0 | 1 +            | 1.  | 385   | E-01 | . +)     | 18.0  | 0 4  | 1.6  | 5178        | 3-01 | 1   | . 98  | 5Ë+J          | 2" ÷ | 5.3  | 2 ¥E | -91  | +1. | . 11: | DE+0 | 0 ¥:             | 2.B      | 95E  | -03 | +0. | 000 | E-39 | +5.           | +61E  | -0                                      |
| 4   | +4.         | 1776  | +00  | +1        | • 18 | 86-0    | 1 -  | -1. | 467 | E-0 | 1+             | 2.1 | 042   | E-01 | . +1     | 12.0  | 0 4  | 1.2  | 2238        | 5-01 | -1  | . 53  | 4±+)          | 2 +  | 5.4  | DIE  | -01  | +9. | . 28  | 4E-0 | 1 +              | 2.5      | 28E  | -03 | +0+ | 000 | E-39 | +7.1          | 340E  | -0                                      |
| 4   | +4.         | 1626  | +00  | +1        | •34  | 3e-c    | 1 4  | +1. | 492 | E-0 | 1 +            | 2.  | 199   | E-01 | . 4      | 16.0  | 10 Î | 9.0  | 311         | =02  | -1  | . 23  | BE+J          | 2 +  | 4.l  | 83E  | -01  | +7. | . 59  | 9E-0 | 1 +              | 2.3      | 04E  | -03 | +0. | 000 | E-39 | +7.           | 564E  | -0                                      |
| -4  | +4.         | 148   | +00  | +1        | .50  | DE-0    | 1.   | 11. | 500 | E-0 | 1 +            | 2.  | 355   | E-01 | -        | -0.0  | 0 1  | 6.6  | 5251        | E-D2 | -9  | . 60  | 92+3          | 1 +  | 3.2  | 225  | -01  | +5. | . 16  | DE-0 | 1 +)             | 2.0      | 64E  | -03 | +0. | 000 | E-39 | +8.           | 009E  | -1                                      |
| 1   | +4+         | 1356  | +00  | +1        | .65  | 7E-0    | 1 -  | -1. | 492 | E-0 | 1 +            | 2.  | 513   | F-01 |          | 6.0   | 0 +  | 4.7  | 008         | -02  | -7  | . 23  | 3E+)          | 1 +  | 2.4  | 07E  | -01  | +4. | . 86  | ŻÊ-O | î +              | 1.7      | 91 E | -03 | +0. | 000 | E-39 | +8.           | 1586  | <u>-</u>                                |
| 4   | +4.         | 123t  | +00  | <u>+1</u> | .81  | 2E-0    | 1    | 1.  | 467 | E-0 | 1+             | 5.5 | 573   | E-01 | 1        | 12.0  | 0 4  | -3.3 | 3128        | 5-02 | -5  | . 39  | 7=+3          | 1 +  | ι.7  | 30E  | -91  | +3. | 80:   | 2E-0 | 1 +              | 1.5      | 32E  | -33 | +0. | 000 | E-39 | +0.1          | 000E  | -1                                      |
| 2   | +4.         | 1126  | +00  | +1        | • 96 | 4E-0    | 1 -  | +1. | 427 | E~0 | 1 +            | 2.  | 827   | E-01 | 1        | 18.0  | 0 1  | 2.2  | 2656        | E-32 | -3  | • 91  | 5EŦ)          | 17   | 1.2  | 96E  | -01  | +Ż. | • 90: | 2F-0 | 1 +              | 1.2      | 73E  | -03 | ŧō. | 000 | E-39 | +0.           | DODE  |                                         |
| 4   | +4.         | 1026  | +00  | +2        | .11  | DE-0    | 1 1  | -1. | 370 | E-0 | 1.+            | 2.  | 985   | E-01 | <u> </u> | 24.0  | 0 +  | 1.5  | 5278        | -02  | -2  | . 79  | 7 <u>=</u> +) | 1 +  | 9.2  | 74E  | -02  | +2. | .18   | 4E-0 | 1 +              | 1.0      | 39E  | -03 | +0. | 000 | E-39 | +0.1          | 3006  | -1                                      |
| 4   | +4.         | 0935  | +00  | +2        | 25   | 05-0    | 1.   | -1. | 299 | E~0 | 1+             | з.: | 1 1 2 | E-01 | [ −3     | 30.0  | 0 1  | 1.0  | 0038        | -92  | -1  | . 94  | 9370          | 1 +  | 5.4  | 98E  | -02  | +1. | • 6Ö  | 9E-0 | 1 +              | 8.2      | 59E  | -04 | +0. | 000 | E-39 | +0+           | DODE  | -                                       |
| 3   | +3.         | 1015  | +00  | +9.       | 05   | DE-0    | 1 1  | 2.  | 627 | E-0 | 1+             | 1.4 | 299   | 2+OC | ) -3     | 30.0  | 0 +  | 1.0  | 038         | E~32 | +)  | • 221 | )=-3          | 9 ÷  | ÷.÷  | 99E- | -02  | +1. | . 25: | 2E~3 | 1 +:             | 2.8      | 90 E | -03 | +0. | 000 | E-39 | +0.1          | 300E  | -                                       |
|     |             |       |      |           |      |         |      |     |     |     |                |     |       |      |          |       |      |      |             |      |     |       |               |      |      |      |      |     |       |      |                  |          |      |     |     |     |      | -             |       |                                         |
|     |             |       |      |           |      |         |      |     |     |     |                |     |       |      |          |       |      |      |             |      |     |       |               |      |      |      |      |     |       |      |                  |          |      |     |     |     |      | - <b>*</b> .* | 10    | ۵.                                      |
|     |             |       |      |           |      |         |      |     |     |     |                |     |       |      |          |       |      |      |             |      |     |       |               |      |      |      |      |     |       |      |                  |          |      |     |     |     |      |               |       | ~                                       |
|     |             |       |      |           |      |         |      |     |     |     |                |     | _     |      |          | _     |      |      |             |      |     |       |               |      |      |      |      |     |       |      |                  |          |      |     |     |     |      |               | 11.0  |                                         |
|     |             |       |      |           |      |         |      |     |     |     |                |     |       |      |          |       |      |      |             |      |     |       |               |      |      |      |      |     |       |      |                  |          |      | •   |     |     |      |               |       |                                         |
|     |             |       |      |           |      |         |      |     |     |     |                | -   |       |      | - ~ -    |       |      |      |             |      |     |       |               |      |      |      |      |     |       |      |                  |          |      |     |     |     |      |               | -     |                                         |
|     |             |       |      |           |      |         |      |     |     |     |                |     |       |      |          |       |      |      |             |      |     |       |               |      |      |      |      |     |       |      |                  |          |      |     |     |     |      |               |       |                                         |
|     |             |       | ~-   |           | -    | · · • • | -    |     |     |     |                |     |       |      |          |       |      | -    |             |      |     |       |               |      |      |      |      |     |       |      |                  | -        |      |     |     |     |      |               |       |                                         |
|     |             |       |      |           |      |         |      |     |     |     |                |     |       |      |          |       |      |      |             |      |     |       |               |      |      |      |      |     |       |      |                  |          |      |     |     |     |      |               |       |                                         |
|     |             |       | -    |           |      |         |      |     |     |     |                |     |       |      |          |       |      |      |             |      |     |       |               |      |      |      |      |     |       |      |                  |          |      |     |     |     |      |               |       |                                         |

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|        |      |                                                                                                    |                        | <br>1                  |
|        |      | OPER. ACTION PAUSE                                                                                 |                        | <br>                   |
|        |      | CONTINUING                                                                                         |                        | <br>                   |
|        |      |                                                                                                    |                        | <br>                   |
|        |      |                                                                                                    |                        | <br>                   |
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|        |      | ·                                                                                                  |                        | <br>                   |
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| ي<br>م | -73- |                                                                                                    |                        |                        |

#### III. COMPUTATIONS

### A. BLOCK DIAGRAM

The block diagram for Program 1885 is shown in Figure 11. The overall program is divided into five basic calculations:

1. The body geometry routine, depicted in Figure 11a, computes the body coordinates at zero angle-of attack, locates the stagnation point at angle of attack, defines the wind axes, and thereafter computes the body coordinates in the transformed axis system. The array of body coordinates so generated is thereafter utilized to compute the pressure and heating distributions.

2. The pressure distribution routine, depicted in Figure 11b, computes the pressures utilizing several calculation models by testing the local slope, curvature, and previous pressure value. The local slope and curvature are given in the coordinate tables.

3. The laminar and turbulent heating routine, depicted in Figure llc,utilizes the pressure distributions, surface distance information from the coordinate tables, and thermochemical data from the oblique and normal shock routine to evaluate the appropriate heat-transfer relationships.

4. The oblique and normal shock routine, depicted in Figure 11d, evaluates all the necessary flow conditions behind oblique waves assuming equilibrium thermodynamics.

5. The radiation heating routine, depicted in Figure lle, requires that the shock layer thickness be defined everywhere and that the radiation intensities be determined at the body and at the shock.

#### B. SYMBOLS

| a              | exponent on Lewis Number in stagnation point heating equation | Units<br>                                          |
|----------------|---------------------------------------------------------------|----------------------------------------------------|
| C <sub>p</sub> | specific heat at constant pressure                            | ft <sup>2</sup> /sec <sup>2</sup> - <sup>o</sup> K |
| <sup>h</sup> D | dissociation enthalpy                                         | ft <sup>2</sup> /sec <sup>2</sup>                  |
| h <sub>w</sub> | static enthalpy behind oblique wave                           | $ft^2/sec^2$                                       |
| н              | stagnation enthalpy                                           | $ft^2/sec^2$                                       |



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Figure 11a BLOCK DIAGRAM FOR PROGRAM 1885 -- BODY GEOMETRY ROUTINE







Figure<sub>[</sub>11 c



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Figure 11 e

| г <sub>ь</sub>   | radiation intensity at edge of boundary layer | Btu/ft <sup>3</sup> - sec |
|------------------|-----------------------------------------------|---------------------------|
| I.w              | radiation intensity behind oblique shock      | Btu/ft <sup>3</sup> - sec |
| t                | index for body shape; ; = 1 is axisymmetric;  |                           |
|                  | 0 is two dimensional                          |                           |
| L                | Lewis Number                                  |                           |
| LC               | cylinder length                               | feet                      |
| М                | mean molecular weight of atmosphere           |                           |
| m                | polynomial exponent for radiation profile     |                           |
| Ma               | flight Mach number                            |                           |
| n                | polynomial exponent for mass flow profile     |                           |
| Pa               | ambient pressure                              | lb/ft <sup>2</sup>        |
| Pe               | pressure at edge of boundary layer            | lb/ft <sup>2</sup>        |
| Po               | reference pressure; $P_o = 2116.2$            | lb/ft <sup>2</sup>        |
| Pw               | pressure behind oblique shock                 | lb/ft <sup>2</sup>        |
| P<br>ws          | stagnation pressure behind oblique shock      | lb/ft <sup>2</sup>        |
| P <sub>s</sub>   | stagnation pressure behind normal shock       | lb/ft <sup>2</sup>        |
| Pe*              | sonic point pressure                          | lb/ft <sup>2</sup>        |
| <sup>р</sup> т   | stagnation pressure at edge of boundary layer | lb/ft <sup>2</sup>        |
| $q_{L}$          | laminar heat rate                             | Btu/ft <sup>2</sup> - sec |
| <sup>q</sup> LS  | stagnation point heat rate                    | Btu/ft <sup>2</sup> - sec |
| $^{q}\mathrm{T}$ | turbulent heat rate                           | Btu/ft <sup>2</sup> - sec |
| <sup>q</sup> R   | radiative heating rate                        | Btu/ft <sup>2</sup> -sec  |

| R                           | universal gas constant; R = 89500 '                                                                | $ft^2/sec^2-K$ |
|-----------------------------|----------------------------------------------------------------------------------------------------|----------------|
| RA ·                        | radius of rear spherical cap                                                                       | feet           |
| RB                          | radius of flare                                                                                    | feet           |
| RC                          | radius of cylinder; reference radius                                                               | feet           |
| RN                          | radius of nose cap                                                                                 | feet           |
| RSB                         | toroidal radius at flare base                                                                      | feet           |
| RSC                         | toroidal radius of fore cone base                                                                  | feet           |
| RSN                         | toroidal radius following nose cap                                                                 | feet           |
| RT                          | base radius of truncated after body                                                                | feet           |
| So                          | surface distance in zero angle-of-attack coordinates<br>measured from stagnation point             | feet           |
| s <sub>b</sub>              | surface distance in wind coordinates measured from stagnation point                                | feet           |
| S <sub>os</sub>             | surface distance from zero angle-of-attack stagnation point to stagnation point at angle of attack | feet           |
| s <sup>*</sup> <sub>b</sub> | surface distance to sonic point                                                                    | feet           |
| Τ <sub>a</sub>              | ambient atmospheric temperature                                                                    | °K             |
| ть                          | body surface temperature                                                                           | oK             |
| Т <sub>е</sub>              | temperature at edge of boundary layer                                                              | °ĸ             |
| T <sub>o</sub>              | reference temperature; $T_o = 273.16$                                                              | °K             |
| T <sub>w</sub>              | temperature behind oblique shock •                                                                 | °к             |
| T <sub>ws</sub>             | stagnation temperature behind oblique shock                                                        | °K             |
| Ts                          | stagnation temperature behind normal shock                                                         | ۰ <sub>K</sub> |

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| $T_T$                             | stagnation temperature at edge of boundary layer                                             | οK                   |
|-----------------------------------|----------------------------------------------------------------------------------------------|----------------------|
| U <sub>e</sub>                    | velocity at edge of boundary layer                                                           | ft/sec               |
| U <sub>w</sub>                    | velocity behind normal shock                                                                 | ft/sec               |
| v                                 | flight velocity                                                                              | ft/sec               |
| x <sub>o</sub> , y <sub>o</sub>   | body coordinates at zero angle of attack                                                     | feet                 |
| <sup>ж</sup> ь, у <sub>Ь</sub>    | body coordinates in wind axes                                                                | feet                 |
| $x_b^*, y_b^*$                    | sonic point coordinates in wind axes                                                         | feet                 |
| <sup>x</sup> os <sup>, y</sup> os | angle-of-attack stagnation point coordinates<br>measured in zero angle of attack coordinates | feet                 |
| z                                 | compressibility factor; number moles per<br>initial mole                                     |                      |
| a                                 | angle of attack                                                                              | degrees              |
| β                                 | pressure gradient parameter                                                                  |                      |
| γ <sub>a</sub>                    | ratio of specific heats for ambient atmosphere                                               |                      |
| $\gamma_{\rm w}$                  | adiabatic exponent behind oblique shock                                                      |                      |
| γ <sub>s</sub>                    | adiabatic exponent behind normal shock                                                       |                      |
| γ <sub>e</sub>                    | adiabatic exponent at edge of boundary layer                                                 |                      |
| ρ <sub>a</sub>                    | ambient density of atmosphere                                                                | slug/ft <sup>3</sup> |
| ρ <sub>w</sub>                    | density behind oblique shock                                                                 | slug/ft <sup>3</sup> |
| ρ <sub>e</sub>                    | density at edge of boundary layer                                                            | slug/ft <sup>3</sup> |
| P <sub>ws</sub>                   | stagnation density behind oblique shock                                                      | slug/ft <sup>3</sup> |
| ρ <sub>s</sub>                    | stagnation density behind normal shock                                                       | slug/ft <sup>3</sup> |
| ρ <sub>b</sub>                    | density at body surface                                                                      | slug/ft <sup>3</sup> |
| $\rho_{\rm bs}$                   | density at body surface at stagnation point                                                  | slug/ft <sup>3</sup> |

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| ρ <sub>T</sub>              | stagnation density at edge of boundary layer | slug/ft <sup>3</sup>            |
|-----------------------------|----------------------------------------------|---------------------------------|
| $\theta_{\rm b}$            | angle corresponding to local body slope      | degrees                         |
| $\theta_{_{_{\mathbf{W}}}}$ | oblique shock angle                          | degrees                         |
| $\theta_{\rm wL}$           | flow deflection angle behind oblique shock   | degrees                         |
| μ <sub>b</sub>              | viscosity evaluated at $(T_b)$               | $lb-sec/ft^2$                   |
| μ <sub>e</sub>              | viscosity evaluated at $(T_e)$               | $\dot{lb}$ -sec/ft <sup>2</sup> |
| μ <sub>s</sub>              | viscosity evaluated at $(T_s)$               | $lb-sec/ft^2$                   |
| ξ                           | coordinate normal to body surface            | feet                            |
| $\xi_{\rm w}$               | shock standoff distance normal to body       | feet                            |
| σ                           | Prandtl Number                               |                                 |

## C. EQUATIONS

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The equations for generating each section of the shape are summarized below:

1. Shape Generation Equations

Section 1. (Nosecap)

| Coordinates           | Formula Indepe                        | endent Variable Limits                                     |
|-----------------------|---------------------------------------|------------------------------------------------------------|
| x <sub>o</sub>        | $x_0 = 0$                             | $\theta_{\rm o}$ = 90, $\theta_{\rm 1}$ = $\theta_{\rm N}$ |
| $x_0 \rightarrow x_1$ | $x = R_{N(1 - \sin \theta)}$          | $\theta_1 \leq \theta \leq \theta_0$                       |
| x1                    | $x_1 \approx R_N (1 - \sin \theta_N)$ | (1)                                                        |
| У <sub>о</sub>        | У <sub>0</sub> =0                     |                                                            |
| $y_0 \rightarrow y_1$ | $y = R_N \cos \theta$                 |                                                            |
| Уl                    | $y_1 = R_N \cos \theta_N$             |                                                            |

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Section 2. (Torus) Ind. Var  $(\theta)$  $x_1 \rightarrow x_2$  $x = x_1 + R_{SN} (\sin \theta_N - \sin \theta), \theta_1 = \theta_N$ (2)  $x_2 = x_1 + R_{SN} (\sin \theta_N - \sin \theta_2)$ x2  $\theta_2 \leq \theta \leq \theta_N$  $y = y_1 + R_{SN} (\cos \theta - \cos \theta_N), \theta_2 = \theta_c$  cone  $y_1 \rightarrow y_2$  $y_2 = y_1 + R_{SN} (\cos \theta_2 - \cos \theta_N), \theta_2 = \beta$  tension shell У2  $\theta_2 = \theta_{2G}$  general shell Section 3. (Cone) Cone: Input  $\theta_c = \theta_2$  $x_2 \rightarrow x_3$  $x = x_2 + (y - y_2) \cot \theta_2$ (3)  $x_3 = x_2 + (y_3 - y_2) \cot \theta_2$ ×3 y<sub>2</sub> → y<sub>3</sub> y = y  $y_2 \leq y \leq y_3$ y3  $y_3 = R_c - R_{sc} (1 - \cos \theta_2)$ Section 3. Tension Shell:  $y = \begin{cases} y_3^2 + (y_2^2 - y_3^2) & \frac{\ln \left(\frac{1 + \cos \theta}{\sin \theta}\right)}{\ln \left(\frac{1 + \cos \beta}{\cos \theta}\right)} \end{cases}^{1/2} & \beta \le \theta \le 90 \end{cases}$ (4) $x - x_2 = \int_{y_-}^{y} \cot \theta \, dy \qquad y_2 \le y \le y_3$  $\frac{\mathrm{d}S}{\mathrm{d}\theta} = \frac{-\left(y_2^2 - y_3^2\right)}{2\,y\,(\sin^2\theta)\,\ln\left(\frac{\mathrm{l}\mathrm{rcos}\,\beta}{\sin\theta}\right)} \qquad y_3 = \mathrm{R_c} - \mathrm{R_{sc}}$ 

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Section 3., General Shape: Input Coordinates Table of x Table of y  $\left. \begin{array}{c} 25 \text{ points} \end{array} \right\}$ (5) First pair of coordinates  $\operatorname{arex}_2$ ,  $y_2$ Last pair of coordinates are  $x_3$ ,  $y_3$ Also,  $\theta_{2G}$  ,  $\theta_{3G}$  .  $y_3 = R_c - R_{sc} (1 - \cos \theta_{3G})$  $y_2 = y_1 + R_{SN} (\cos \theta_{2G} - \cos \theta_N)$ Section 4. (Torus) Formula Independent Variable Limits Coordinates  $x = x_3 + R_{sc} (\sin \theta_3 - \sin \theta)$ ×3 → ×4  $x_4 \approx x_3 + R_{sc} \sin \theta_3 \qquad 0 \le \theta \le \theta_3 \qquad (6)$ ×4  $y = y_3 + R_{sc} (\cos \theta - \cos \theta_3)$   $\theta_3 = \theta_c$ , cone y<sub>3</sub> → y<sub>4</sub>  $\theta_3 = 90$ , tension shell  $y_4 = R_c$ У4  $\theta_3 = \theta_{3G}$ , Gen. Shell Section 5. (Cylinder) Ind. Var. (X)  $x_4 \le x \le x_4 + \Delta x$  $x_4 \rightarrow x_5$ x ⇒ x  $\Delta x \leq L_c$  (7)  $x_5 = x_4 + \Delta x$ ×5  $y = R_c$ y<sub>4</sub> → y<sub>5</sub> Section 6. (Flare) Ind. Var. (y)  $x = x_5 + (y - R_c) \cot \theta_B$ •x5 → x6  $x_6 = x_5 + (y_6 - R_c) \cot \theta_B$ ×6  $y_5 \le y \le y_6$  (8) y5 → y6 y = y  $y_6 = R_B - R_{SB} (1 - \cos \theta_B)$ Уб -83-

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Section 7. (Torus)

Section 8. (Torus)

$$y_8 = y_7 - R_{SB} (1 - \cos \theta_A)$$

Section 9. (Aft Cone)

 $y_8 \rightarrow y_9$  y = y

$$y_9 = R_A \cos \theta_A$$
, or  $y_9 = R_T$  (optional)

Section 10. (Aft Cap)

$$x_{9} \rightarrow x_{10} \qquad \therefore x = x_{9} + R_{A} (\sin \theta_{A} - \sin \theta)$$

$$x_{10} \qquad x_{10} = x_{9} + R_{A} (\sin \theta_{A} + 1) \qquad -90 \le \theta \le \theta_{A} \qquad (12)$$

$$y_{9} \rightarrow y_{10} \qquad y = R_{A} \cos \theta$$

$$y_{10} \qquad y_{10} = 0$$
Section 10. (Truncated Base)

 $x = x_9$   $y = y \qquad 0 \le y \le R_T$   $y_{10} = 0$ 

 $y_9 = R_T$ 

## 2. Surface Distance Equations

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Section 1.

|                                 | Formula                                             | Limits                                    |
|---------------------------------|-----------------------------------------------------|-------------------------------------------|
| s <sub>o</sub>                  | S <sub>o</sub> = 0                                  |                                           |
| s <sub>o</sub> → s <sub>1</sub> | $S = R_{\rm N} \frac{(90 - \theta_{\rm N})}{57.3}$  | $\theta_{\rm N} \leq \theta \leq 90$ (13) |
| s <sub>1</sub>                  | $S_1 = R_N \frac{(90 - \theta_N)}{57.3}$            |                                           |
| Section 2.                      |                                                     |                                           |
| $s_1 \rightarrow s_2$           | $S = S_1 + R_{SN} \frac{(\theta_N - \theta)}{57.3}$ | $\theta_2 \leq \theta \leq \theta_1$ (14) |
| s <sub>2</sub>                  | $S_2 = S_1 + R_{SN} (\theta_N - \theta_2)/57$       | 7.3                                       |
| Section 3.                      |                                                     |                                           |
| $s_2 \rightarrow s_3$           | $S = S_2 + \frac{(x - x_2)}{\cos \theta_2}$         | $x_2 \leq x \leq x_3 \tag{15}$            |
| s <sub>3</sub>                  | $S_3 = S_2 + \frac{(x_3 - x_2)}{\cos \theta_2}$     | $\theta_2 = \theta_c$                     |
|                                 |                                                     |                                           |
|                                 |                                                     |                                           |

$$S = S_2 + \int_{y_2}^{y_3} \frac{dy}{\sin\theta}$$
(16)

Section 4.

| s <sub>3</sub> → s <sub>4</sub> | $S = S_3 + R_{SC} (\theta_3 - \theta)/57.3$ | $0 \leq \theta \leq \theta_3$ | (17) |
|---------------------------------|---------------------------------------------|-------------------------------|------|
| Section 5.                      |                                             |                               |      |
| s <sub>4</sub> → s <sub>5</sub> | $S = S_4 + (x - x_4)$                       | $x_4 \le x \le x_5$           | (18) |

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| Section                          | 6.  |                                                    |                                     |      |
|----------------------------------|-----|----------------------------------------------------|-------------------------------------|------|
| s <sub>5</sub> → s <sub>6</sub>  |     | $S = S_5 + (x - x_5)/\cos \theta_B$                | $x_5 \le x \le x_6$                 | (19) |
| Section                          | 7.  |                                                    |                                     |      |
| s <sub>6</sub> → s <sub>7</sub>  |     | $S = S_6 + R_{SB} \frac{(\theta_B - \theta)}{573}$ | $0 < \theta < \theta_{6}$           | (20) |
| Section                          | 8.  |                                                    |                                     |      |
| s <sub>7</sub> → s <sub>8</sub>  |     | $S \approx S_7 - R_{SB}(\theta/57.3)$              | $\theta_{\rm A} \leq \theta \leq 0$ | (21) |
| Section                          | 9.  |                                                    |                                     |      |
| s <sub>8</sub> → s <sub>9</sub>  |     | $S = S_8 + (y - y_8)/\sin \theta_A$                | y <sub>9</sub> ≤ y ≤ y <sub>8</sub> | (22) |
| Section                          | 10. |                                                    |                                     |      |
| s <sub>9</sub> → s <sub>10</sub> | 1   | $S = S_9 + R_{SA} (\theta_A - \theta)/57.3$        | $-90 \leq \theta \leq \theta_9$     | (23) |
|                                  | or  | $S = S_9 + (R_T - y)$                              | $0 \le y \le R_T$                   |      |

## 3. Axes Transformation

$$y_{b} = |(y_{o} - y_{os}) \cos \alpha + (x_{o} - x_{os}) \sin \alpha|$$
(24)  
$$x_{b} = (x_{o} - x_{os}) \cos \alpha - (y_{o} - y_{os}) \sin \alpha$$
(25)

Body slope and surface distance at angle of attack.

```
4. Windward Meridian
```

Proceeding from  $x_0 = x_{0S}$  in direction of increasing ( $x_0$ ),

 $\theta_{\rm b} = \theta_{\rm o} + \alpha$ 

,

 $S_b = S_o - S_{os}$ 

When (  $\boldsymbol{x}_{o})_{\max}$  is reached, reverse direction to decreasing (  $\boldsymbol{x}_{o}$  ), and use,

$$\theta_{b} = \alpha - \theta_{o} - 180$$

$$-y_{o} used$$

$$S_{b} = 2(S_{o})_{max} - S_{os} - S_{o}$$
(28)

## 5. Leeward Meridian

Proceeding from  $x_0 = x_{os}$  in direction of decreasing  $(x_0)$   $\theta_b = 180 - \theta_0 - \alpha$  <sup>+</sup> $y_0$  used
(29)  $S_b = S_{os} - S_0$  When  $(x_0 = 0)$  is reached, reverse direction increasing  $(x_0)$ , and use,  $\theta_b = \theta_0 - \alpha$  <sup>-</sup> $y_0$  used
(30)  $S_b = S_{os} + S_0$  6. <u>Sonic Point Location</u>  $\frac{\gamma_S}{\gamma_S}$ 

$$\theta_{\rm b}^* = \sin^{-1} \left[ \frac{2}{\gamma_{\rm S} + 1} \right]^{2(\gamma_{\rm S} - 1)}$$
(31)

## 7. Equation and Logic for Stagnation Point Location

Test each section for all possible cases of  $_{\alpha}$  +  $_{\theta_{o}}$  = 90. Select stagnation point at maximum  $\bar{x}_{\alpha}$  ,

$$x_a = y_{os} \sin a - x_{os} \cos a , \qquad (32)$$

$$M = 28 X_{N} + 32 X_{O} + 44 X_{C} + 40 X_{A}$$
(33)

$$C_{p} = (R/M) (3.5 X_{N} + 3.5 X_{O} + 2.5 X_{A})$$
(34)  
$$H = (V^{2}/2) + C T$$

$$n = (v^{-}/2) + C_p T_a$$
 (35)

$$M_{a} = \frac{V}{\left[\frac{C_{p} T_{a}}{\frac{C_{p} M}{R} - 1}\right]^{1/2}}$$
(36)

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$$\gamma_a = \frac{(C_p M/R)}{[(C_p M/R) - 1]}$$
(37)

$$\frac{h_{w}M}{RT_{o}} = \frac{HM}{RT_{o}} \left\{ 1 - \frac{V^{2}}{2H} \left[ \left( \frac{\rho_{a}}{\rho_{w}} \right)^{2} \sin^{2} \theta_{w} + \cos^{2} \theta_{w} \right] \right\}$$
(38)

$$\frac{P_{w}}{P_{o}} = \frac{\rho_{a} V^{2}}{P_{o}} \sin^{2} \theta_{w} \left(1 - \frac{\rho_{a}}{\rho_{w}}\right) + \frac{P_{a}}{P_{o}}$$
(39)

9. Oblique Shock Solution

$$\rho_{\rm w} = \frac{P_{\rm w} M}{Z R T_{\rm w}}$$
(40)

$$\left(\frac{U_{\rm w}}{V}\right)^2 \approx \cos^2 \theta_{\rm w} + \left(\frac{\rho_{\rm a}}{\rho_{\rm w}}\right)^2 \sin^2 \theta_{\rm w}$$
(41)

$$\cot \theta_{w1} = \frac{\cos^2 \theta_w + (\rho_a/\rho_w) \sin^2 \theta_w}{\sin \theta_w \cos \theta_w (1 - \rho_a/\rho_w)}$$
(42)

$$\gamma_{\rm w} = \frac{\rho_{\rm w}/\rho_{\rm a} + 1}{\rho_{\rm w}/\rho_{\rm a} - 1}$$
(43)

$$\frac{\rho_{\rm ws}}{\rho_{\rm a}} = \frac{\rho_{\rm w}}{\rho_{\rm a}} \left(\frac{P_{\rm ws}}{P_{\rm w}}\right)^{\frac{1}{\gamma_{\rm w}}}$$
(44)

$$\frac{P_{ws}}{P_{o}} = \frac{P_{w}}{P_{o}} \left[ \frac{1}{1 - \frac{V^{2}}{2H} \left(\frac{U_{w}}{V}\right)^{2}} \right]$$
(45)

Start oblique shock calculation at  $\theta_w = 90$  degrees When  $I_w \leq INST \phi P$  cease calculation of  $I_w$  at smaller  $\theta_w$ 's At this time the value of  $y_w$  is taken as

$$\gamma_{\rm w} = \gamma_{\rm w}' + \frac{(\gamma_{\rm w}' - \gamma_{\rm a})}{(\theta_{\rm w}' - \mu_{\rm a})} (\theta_{\rm w} - \theta_{\rm w}')$$

$$\tag{46}$$

where  $\theta_{w}$  is first angle where  $I_{w} \leq INST \phi P$  and  $\gamma_{w}$  is corresponding  $\gamma_{w}$ .

$$\mu_{a} = \sin^{-1} \frac{1}{M_{a}}$$
(47)

$$\frac{\rho_{\rm w}}{\rho_{\rm a}} = \frac{(\gamma_{\rm w} + 1) \,{\rm M}_{\rm a}^2 \,\sin^2 \,\theta_{\rm w}}{[(\gamma_{\rm w} - 1) \,{\rm M}_{\rm a}^2 \,\sin^2 \,\theta_{\rm w} + 2]} \tag{48}$$

 $I_{w}$  is taken as zero for  $\theta_{w} < \theta'_{w}$ 

 $\theta_{w} < \theta'_{w}$ 

Remainder of shock variables via Equations (38), (39), (40), (41), (42), and (44)

10. Equations for Pressure Distribution 
$$0 \le S_b \le S_b^*$$
  

$$\frac{P_e^*}{P_s} = \left(\frac{2}{\gamma_s + 1}\right)^{\frac{\gamma_s}{\gamma_s - 1}}$$
(49)

$$\frac{P_{e}}{P_{s}} = 1 - \frac{\rho_{s}}{\rho_{a}} \left(\frac{\rho_{a} V^{2}}{2 P_{s}}\right) \left(\frac{S_{b}^{*}}{V} \cdot \frac{du}{ds}\right)^{2} \left(\frac{S_{b}}{S_{b}^{*}}\right)^{2} + \left[\frac{P_{e}^{*}}{P_{s}} - 1 + \frac{\rho_{s}}{\rho_{a}}\left(\frac{\rho_{a} V^{2}}{2 P_{s}}\right) (50) \right] \left(\frac{S_{b}}{V} \cdot \frac{du}{ds}\right)^{2} \left[\left(\frac{S_{b}}{S_{b}^{*}}\right)^{4}\right]$$

$$\frac{e}{P_{s}} = \sin^{2} \theta_{b}$$
(51)

## 11. <u>Pressure Distribution</u> $S_b > S_b^*$

Equations for

Newtonian

$$\frac{P_e}{P_s} = \sin^2 \theta_b + \frac{P_a}{P_s} \cos^2 \theta_b$$
(52)

PC: Pressure is constant = last value

Prandtl - Meyer: Use table look up

$$P_{e}/P_{s} \quad \text{initial val.} \quad \rightarrow \quad \text{initial } \nu_{i}$$

$$\nu_{j} = \nu_{i} + (\theta_{i} - \theta_{j}) \quad (53)$$

ν<sub>j</sub> → P<sub>e</sub>/P<sub>s</sub> Pressure Limit

$$\frac{P_e}{P_s} > \frac{P_a}{P_s}$$
(54)

Entropy Layer

$$\frac{P_1}{P_s} = \frac{P_1}{P_s} + \left(\frac{dp}{dx}\right)_i (x_j - x_i) \frac{1}{P_s}$$
(55)

Entropy Layer Equations,

$$\frac{d(P_e/P_s)}{dx_b} = \frac{\gamma_s}{B_2} \cdot \left(\frac{P_e}{P_s}\right) \xrightarrow{\gamma_s + 1} \cdot \left[ \tan \theta_b - \sqrt{\frac{P_e}{P_s} - \frac{P_a}{P_s}} \right]$$
(56)

$$B_2 = (\gamma_s - 1) \left(\frac{P_{eb}}{P_s}\right) \xrightarrow{\frac{1 - \gamma_s}{\gamma_s}} \cdot \int_0^{\gamma_{bb}} \frac{P_e}{P_s} dy_b$$

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RE-GRDER No. 66-417

$$j \approx 1$$

$$\frac{d(P_{e}/P_{s})}{dx_{b}} = \frac{\gamma_{s}}{B_{1}} \left(\frac{P_{e}}{P_{s}}\right)^{\gamma_{s}} \left\{ y_{bb} \tan \theta_{b} + \tan^{2} \theta_{b} (x - x_{bb}) \right\}.$$

$$\sqrt{\frac{P_{e}}{P_{s}} - \frac{P_{a}}{P_{s}}} \left\{ 2B_{1} \left(\frac{P_{e}}{P_{s}}\right)^{-1} + \left[y_{bb} + \tan \theta_{b} (x_{b} - x_{bb})\right]^{2} \right\}$$

$$\sqrt{\frac{P_{e}}{P_{s}} - \frac{P_{a}}{P_{s}}} \left\{ 2B_{1} \left(\frac{P_{e}}{P_{s}}\right)^{-1} + \left[y_{bb} + \tan \theta_{b} (x_{b} - x_{bb})\right]^{2} \right\}$$

$$B_{1} = (\gamma_{s} - 1) \left(\frac{P_{eb}}{P_{s}}\right) \xrightarrow{\frac{1 - \gamma_{s}}{\gamma_{s}}} \int_{0}^{Y_{bb}} \frac{P_{e}}{P_{s}} y_{b} dy_{b}$$

(bb) subscripts refer to start of straight section  $\left(\frac{d\theta}{ds}=0\right)$  and to conditions there.

## 12. Stagnation Point Velocity Gradient

An average stagnation point velocity gradient is needed to evaluate heating. A velocity gradient is obtained for both the windward and leeward meridians. For

$$0 \leq a \leq 90 - \theta_{\rm N} \qquad \text{and} \qquad (180 + \theta_{\rm A}) \leq a \leq 180$$

$$\left(\frac{\mathrm{du}}{\mathrm{ds}}\right)_{\rm S} = \left(\frac{\mathrm{du}}{\mathrm{ds}}\right)_{\rm S} = \frac{1}{2} \left(\frac{\mathrm{du}}{\mathrm{ds}}\right)_{\rm wind} + \frac{1}{2} \left(\frac{\mathrm{du}}{\mathrm{ds}}\right)_{\rm lee} \qquad (58)$$

For  $(90 - \theta_N) \leq a \leq (180 + \theta_A)$ 

$$\begin{pmatrix} du \\ ds \end{pmatrix}_{s} = \frac{1}{2} \frac{\overline{du}}{ds_{s}} + \frac{1}{2} \frac{\sin \alpha}{(y_{os})} \sqrt{\frac{3 \rho_{a}}{\rho_{s}}}$$
(59)

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where (  $y_{\rm os}$  ) is the value of  $y_{\rm os}$  in zero angle of attack coordinates corresponding to the new stagnation point.

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13. Laminar Heating

$$q_{\rm LS} = \frac{0.76}{\sigma^{0.6}} \left(\frac{\rho_{\rm bs}}{\rho_{\rm s}} \frac{\mu_{\rm b}}{\mu_{\rm s}}\right)^{0.1} \sqrt{\rho_{\rm s}} \frac{H}{\rho_{\rm s}} \frac{H}{\sqrt{q_{\rm s}}} \sqrt{\left(\frac{du}{ds}\right)_{\rm s}}$$
(60)

$$\left[ 1 + (L^{2} - 1) \frac{h_{D}}{H} \right]$$

$$\frac{q_{L}}{q_{LS}} = \frac{y_{b}^{J} \rho_{b} \mu_{b} U_{e}}{(1.068) \sqrt{2\xi}} \qquad \underbrace{\frac{(1+0.096 \sqrt{\beta})}{\sqrt{2 \rho_{bs} \mu_{b}} \left(\frac{du}{ds}\right)}}_{W, L} \sqrt{\frac{2}{j+1}}$$
(61)

$$\frac{\mathbf{q}_{\mathrm{L}}}{(\mathbf{q}_{\mathrm{LS}})_{\alpha=0}} = \left( \frac{\mathbf{q}_{\mathrm{L}}}{\mathbf{q}_{\mathrm{LS}}} \right) \times \frac{\mathbf{q}_{\mathrm{LS}}}{(\mathbf{q}_{\mathrm{LS}})_{\alpha=0}}$$
(62)

$$\rho_{\rm bs} = \frac{P_{\rm s}M}{R T_{\rm b}} \tag{63}$$

 $\mu = \mu(T) \qquad \text{Table took up} \tag{64}$ 

$$\rho_{\rm b} = \frac{P_{\rm e} M}{R T_{\rm b}} \,. \tag{65}$$

14. Equations Modified by THETAT Input

$$U_{e} = \sqrt{2 H} \sqrt{1 - \frac{T_{e}}{T_{T}}}$$
(66)

$$T_{T} = T_{ws}(\text{THETATT})$$
(67)

$$\frac{T_{e}}{T_{T}} = \left(\frac{P_{e}}{P_{s}}, \frac{P_{e}-1}{P_{T}}\right)$$
(68)

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$$\gamma_e = \gamma_w (\text{IHETATT})$$
 (69)

 $P_{T} = P_{ws} (THETATT)$ (70)

$$\frac{\rho_{e}}{\rho_{T}} = \left(\frac{P_{e}}{P_{s}} - \frac{P_{s}}{P_{T}}\right)^{\frac{1}{\gamma_{e}}}$$
(71)

 $\rho_{\rm T} = \rho_{\rm ws} \, (\text{THETATT}) \tag{72}$ 

$$Re = \frac{\rho_e U_e S_b}{\mu_e}$$
(73)

16. Laminar Heating Parameters

$$\xi = \int_{s_1}^{s_1} \rho_b \mu_b U_e y_b^{2j} dS_b + \xi_1$$
 (74)

For,

$$S_{b} \leq S_{1}$$

$$\begin{cases} \xi = \rho_{bs} \ \mu_{b} \ \left(\frac{dU}{dS}\right) \quad \frac{S_{b}^{2}}{(2j+2)} \end{cases}$$

$$(75)$$

$$\beta = \frac{-2\xi}{(\rho_{e} U_{e}^{3} \rho_{b} \mu_{b} y_{b}^{2})} \qquad \frac{d P_{e}}{d S_{b}} , \quad \beta \ge 0$$
(76)

17. Turbulent Heating  
$$q_{T} = \frac{C_{f}}{2(778)} \rho_{e} U_{e} H$$
(77)

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$$C_{f} = C_{f_{1}} \cdot \frac{C_{f}}{C_{f_{1}}}$$
 (78)

$$C_{f_1} = \frac{0.0296 \ (2)^{0.2j}}{\sigma^{2/3} Re^{0.2}}$$
(79)

$$\frac{C_f}{C_{f_i}} = \left(\frac{\rho^*}{\rho_e}\right)^{0.8} \qquad \left(\frac{\mu^*}{\mu_e}\right)^{0.2} \tag{80}$$

$$\mu^* = \mu (T^*)$$
 (81)

$$\frac{\rho^*}{\rho_e} = \frac{T_e}{T^*} \tag{82}$$

$$T^* = T_e \left\{ 1 + 1/2 \left( \frac{T_b}{T_e} - 1 \right) + 0.22 (\sigma)^{-1/3} \left( \frac{T_T}{T_e} - 1 \right) \right\}$$
(83)

## 18. Radiation Heating

$$q_{R} = \frac{\xi_{w}}{2} \left[ \frac{m}{m+1} I_{b} + \frac{1}{m+1} I_{w} \right]$$
(84)

## 19. Shock Shape

$$\xi_{\rm w} = \frac{({\rm x}_{\rm b} + \Delta_{\rm s}) \cos \theta_{\rm w} - {\rm y}_{\rm b} (1 - \sin \theta_{\rm w})}{\cos \theta_{\rm b} - \sin (\theta_{\rm w} - \theta_{\rm b})}$$
(85)

where,

x<sub>b</sub>, y<sub>b</sub>, are taken as

$$\begin{aligned} \mathbf{x}_{\mathrm{b}} &= \mathbf{x}_{\mathrm{b}}^{*} \quad \mathrm{and} \quad \mathbf{y}_{\mathrm{b}} &= \mathbf{y}_{\mathrm{b}}^{*} \begin{cases} \frac{\mathrm{d}\theta}{\mathrm{d}\mathrm{s}} &< 0 & 0 \leq \mathrm{S} < \mathrm{S}_{\mathrm{b}}^{*}, \, \mathrm{or} \\ \frac{\mathrm{d}\theta}{\mathrm{d}\mathrm{s}} &= 0 \quad \mathrm{and} \quad \mathrm{x}_{\mathrm{b}}^{*} \leq (\Delta_{\mathrm{s}}_{\mathrm{o}}) \end{cases} \\ \mathbf{x}_{\mathrm{b}} &= \mathbf{x}_{\mathrm{b}\mathrm{b}} \quad \mathrm{and} \quad \mathbf{y}_{\mathrm{b}} &= \mathbf{y}_{\mathrm{b}\mathrm{b}} \begin{cases} \frac{\mathrm{d}\theta}{\mathrm{d}\mathrm{s}} &= 0 \quad \mathrm{and} \quad \mathrm{x}_{\mathrm{b}}^{*} \leq (\Delta_{\mathrm{s}}_{\mathrm{o}}) \end{cases} \end{cases} \end{aligned}$$

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$$R_{w} = \frac{\xi_{w} \cos \theta_{b} + y_{b}}{\cos \theta_{w}}$$

$$j = 1$$

$$C_{1} \xi_{w}^{2} + C_{2} \xi_{w} + C_{3} = 0$$
(86)
(Positive Root)
$$C_{1} = 2 \cos \theta_{b} \left\{ \frac{1}{2} - \frac{\rho_{e}}{\rho_{a}} - \frac{U_{e}}{V} + \frac{1}{n+2} \left[ \frac{\rho_{w}}{\rho_{a}} - \frac{U_{w}}{V} \cos (\theta_{wL} - \theta_{b}) - \frac{\rho_{e}}{\rho_{a}} - \frac{U_{e}}{V} \right] \right\} - \cos^{2} \theta_{b}$$

$$C_{2} = 2y_{b} \left\{ \frac{\rho_{e}}{\rho_{a}} - \frac{U_{e}}{V} + \frac{1}{n+1} \left[ \frac{\rho_{w}}{\rho_{a}} - \frac{U_{w}}{V} \cos (\theta_{wL} - \theta_{b}) - \frac{\rho_{e}}{\rho_{a}} - \frac{U_{e}}{V} \right] \right\} - 2y_{b} \cos \theta_{b}$$

$$C_{3} = -y_{b}^{2}$$

j = 0

ş

$$\xi_{\rm w} = \frac{y_{\rm b}}{\frac{\rho_{\rm e}}{\rho_{\rm a}} \frac{U_{\rm e}}{V} + \frac{1}{n+1} \left[ \frac{\rho_{\rm w}}{\rho_{\rm a}} \frac{U_{\rm w}}{V} \cos \left(\theta_{\rm wL} - \theta_{\rm b}\right) - \frac{\rho_{\rm e}}{\rho_{\rm a}} \frac{U_{\rm e}}{V} \right] - \cos \theta_{\rm b}}$$
(88)

Determination of  $\xi_w$  :

$$Y_{w}^{2} (1 - B\tan^{2}\theta_{b}) + Y_{w} [2R_{w} \tan\theta_{b} + 2B(X_{b} + \Delta_{s})\tan\theta_{b} + 2BY_{b} \tan^{2}\theta_{b}]$$

$$-2R_{w} [X_{b} + \Delta_{s} + Y_{b} \tan\theta_{b}] - B(X_{b} + \Delta_{s})^{2} - BY_{b}^{2} \tan^{2}\theta_{b} - 2B(X_{b} + \Delta_{s})Y_{b} \tan\theta_{b} = 0 (89)$$

$$Tan \theta_{w}^{T} = \frac{2R_{w} + 2B[X_{b} + \Delta_{s} - (Y_{w} - Y_{b}) \tan\theta_{b}]}{2Y_{w}}$$
(90)

Evaluate B at first point where  $\theta_{\rm b}~\leq 0$ .

$$B = \frac{(Y_b + \xi) \tan \theta_w - R_w}{(X_b + \Delta_s)}$$
(91)

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$$\operatorname{Tan} \theta_{w} = \frac{(Y_{b} + \hat{\xi})}{X_{b} + \Delta_{s}} - \frac{R_{w}}{(Y_{b} + \hat{\xi})}$$
(92)

(93)

$$\xi( heta_{
m w},0)$$
 from equations 87, 88

Solve for  $\xi_{\rm w}, \theta_{\rm w}, ({\rm S_b})$ 

.

$$\hat{\xi}_{w} = \frac{Y_{w} - Y_{b}}{\cos \theta_{b}}$$
(94)

#### A. PROGRAM FLOW

The program flow for the A and B parts of Program 1885 is illustrated in Figure 12 below.

1885A PROGRAM FLOW



#### 1885B PROGRAM FLOW



Figure 12 PROGRAM FLOW

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#### B. COMMON STORAGE

Common data in 1885B is transferred between subroutines and the main program for two primary purposes, the first for computing zero angle-of-attac: co-

ordinates, (SUB110) and for computing the derivatives  $\frac{d(P_e/P_s)}{dx}$  (PREP) or  $\frac{d\xi}{ds}$ 

(DXSIDT), where the ADM4RB and DEREQB predictor-corrector system 1s used to solve numerically one or the other of these differential equations. Note that the C $\emptyset$ MM $\emptyset$ N DATA variables XMEM $\emptyset$  and THETAC appear in equivalence statements, and are thus the first items in common storage core locations.

| ALPHA  | a                                                                                 | Program<br>Input             | SUB110<br>Input  | Array of angles of attack.                                               |
|--------|-----------------------------------------------------------------------------------|------------------------------|------------------|--------------------------------------------------------------------------|
| BETA   | β                                                                                 | Program<br>Input             | SUB110<br>Input  | Tension shell angle.                                                     |
| CTHSTT |                                                                                   | DXSIDT                       | DEREQB<br>Input  | Value of cos (THSTRT) at start of integration interval.                  |
| DATE   |                                                                                   | Program<br>Input             | In to<br>SUB110  | Identification number.                                                   |
| DNI    |                                                                                   | Not currently                | used.            |                                                                          |
| DN2    |                                                                                   | Program<br>Input             | PREP<br>Input    | Lower bound for accuracy in integrating $d(P_e/P_s)/dx$ .                |
| DTDSO  | $\frac{\mathrm{d}\theta_{\mathrm{o}_{1}}}{\mathrm{d}\mathrm{S}_{\mathrm{o}_{1}}}$ | SUB110                       | SUB110<br>Output | Array of $\frac{d\theta_{o_1}}{dS_{o_1}}$ for $a = 0$ coordinates.       |
| DTDSST |                                                                                   | DXSIDT                       | DEREQB<br>Input  | Value of $\frac{d\theta_b}{dS_b}$ at start of inte-<br>gration interval. |
| DTDSTB | $\frac{\mathrm{d}\theta_{\mathrm{i}}}{\mathrm{d}\mathrm{S}_{\mathrm{i}}}$         | Program<br>Input             | SUB110<br>Input  | Array of $\frac{d\theta_1}{dS_1}$ for general shape.                     |
| GAMS   | $\gamma_{\rm S}$                                                                  | Program<br>Input or<br>1885A | DEREQB<br>Input  | Value of $\gamma_{\rm S}$ for calculation Input.                         |
| GM IØG |                                                                                   | Main                         | DEREQB<br>Input  | $(\gamma_{_{S}}-1)/\gamma_{_{S}}$                                        |

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| GP1ØG  |                          | Main                         | DEREQB<br>Input    | $(\gamma_{\rm S}+1)/\gamma_{\rm S}$                                            |
|--------|--------------------------|------------------------------|--------------------|--------------------------------------------------------------------------------|
| GSØB   | $\gamma_{\rm s}/{\rm B}$ | PREP                         | DEREQB<br>Input    | $\gamma_s/B_1$ or $\gamma_s/B_2$ used to integrate $d(P_e/P_s)/ds$             |
| HAMB   | н                        | Program<br>Input or<br>1885A | DEREQB<br>Input    | Enthalpy used to compute $U_e/V$ , etc., for shock and radiation.              |
| ICASE  | CASE                     | Program<br>Input             | In to<br>SUB110    | Identification number.                                                         |
| ILINE  |                          | Main                         | SUB110<br>In & Out | The page number on printing $a = 0$ coordinates.                               |
| 101    |                          | SUB110                       | SUB110<br>Output   | Sentinel 1, 2, 3, 1f section 3 is<br>cone, tension shell, or general<br>shape. |
| IOZ    |                          | SUB110                       | SUB110<br>Output   | Sentinel 1, 2, if section 10 is sphere of flat base.                           |
| IOTBL  |                          | Program<br>Input             | SUB110<br>Input    | If = 1, $\alpha = 0$ coordination are printed.                                 |
| IPAGE  |                          | Main                         | SUB110<br>In & Out | Page number on printing $\alpha = 0$ coordinates.                              |
| JFLØ₩  | х <sub>Ј</sub>           | Program<br>Input             | DEREQB<br>Input    | Sentinel for 1-D or 2-D flow.                                                  |
| JOMAX  |                          | SUB110                       | SUB110<br>Output   | Number of points in $\alpha = 0$ coordinate tables.                            |
| KINDEQ |                          | DXSIDT<br>or PREP            | DEREQB<br>Input    | If 0, integrate $\frac{d(P_e/P_s)}{dx}$ , if >0,<br>integrate $d\xi/dS_b$ .    |
| М      | M <sub>o1</sub>          | SUB110                       | SUB110<br>Output   | Array of section numbers for $\alpha = 0$ coordinates.                         |
| NALPHA | L                        | Program<br>Input             | SUB110<br>Input    | Number of angles of attack on the array ALPHA.                                 |
| NUMBER | ٤                        | Program<br>Input             | In to<br>SUB110    | Identification number.                                                         |

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| ØØGS   |                 | Maın                         | DEREQB<br>Input | $1/\gamma_{s}$ .                                                              |
|--------|-----------------|------------------------------|-----------------|-------------------------------------------------------------------------------|
| PAPØS  |                 | PREP                         | DEREQB<br>Input | Value of $P_A/P_S$ as a lower pressure limit for $d(P_e/P_s)/dX$ integration. |
| PIR    |                 | Main                         | SUB110<br>Input | deg/rad.                                                                      |
| PSTART |                 | DXSIDT                       | DEREQB<br>Input | Value of $P_e/P_s$ at start of integration interval.                          |
| PSTØP  |                 | DXSIDT                       | DEREQB<br>Input | Value of $P_e/P_s$ at end of integration interval.                            |
| RA     | R <sub>A</sub>  | Program<br>Input             | In to<br>SUB110 | Aft cap radius.                                                               |
| RAD    |                 | Main                         | DEREQB<br>Input | rad/deg.                                                                      |
| RB     | ₽ <sub>₿</sub>  | Program<br>Input             | In to<br>SUB110 | Flare and aft cone base radius.                                               |
| RC     | <sup>R</sup> C  | Program<br>Input             | In to<br>SUB110 | Cylinder and cone base radius.                                                |
| REYT   |                 | Not currently                | used.           |                                                                               |
| RHØA   | P <sub>A</sub>  | Program<br>Input or<br>1885A | DEREQB<br>Input | Ambient densıty.                                                              |
| RN     | R <sub>N</sub>  | Program<br>Input             | In to<br>SUB110 | Nose radius.                                                                  |
| RSB    | R <sub>SB</sub> | Program<br>Input             | In to<br>SUB110 | Toroidal radius.                                                              |
| RSC    | R <sub>SC</sub> | Program<br>Input             | In to<br>SUB110 | Toroidal radius at base of cone.                                              |
| RSN    | R <sub>SN</sub> | Program<br>Input             | In to<br>SUB110 | Toroidal radius aft of nose.                                                  |

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| RSØRA  | $\rho_{\rm s}/\rho_{\rm A}$ | Program<br>Input or<br>1885A | DEREQB<br>Input  | Value of $\rho_{\rm g}/\rho_{\rm A}$ for calculation.                                     |
|--------|-----------------------------|------------------------------|------------------|-------------------------------------------------------------------------------------------|
| RT     | <sup>R</sup> T              | Program<br>Input             | In to<br>SUB110  | Base truncation radius.                                                                   |
| RTBL   | Y                           | Program<br>Input             | SUB110<br>Input  | Array of $y_1$ for general shape.                                                         |
| SECTN  |                             | Maın                         | SUB110<br>Input  | Section number for labeling.                                                              |
| SO     | S <sub>01</sub>             | SUB110                       | SUB110<br>Output | Array of $S_0$ for $a = 0$ coordinates.                                                   |
| SQ2HV2 |                             | Maın                         | DEREQB<br>Input  | (2H/V <sup>2</sup> ) <sup>1/2</sup>                                                       |
| SSTART |                             | PREP or<br>DXSIDT            | DEREQB<br>Input  | Value of $S_b$ at start of integra-<br>tion interval.                                     |
| SSTØP  |                             | DXSIDT                       | DEREQB<br>Input  | Value of $S_b$ at end of integration interval.                                            |
| ТА     | TA                          | Program<br>Input or<br>1885A | DEREQB           | Ambient temperature.                                                                      |
| TABLE  |                             | Program<br>Input or<br>1885A | DEREQB<br>Input  | Two-dimensional array of oblique<br>and normal shock properties.                          |
| TANTB  |                             | PREP                         | DEREQB<br>Input  | Value of tan ( $\theta_b$ ) at start of straight section for $d(P_e/P_s)/dx$ integration. |
| TANTB2 |                             | PREP                         | DEREQB<br>Input  | tantb <sup>2</sup>                                                                        |
| ТВ     | т <sub>в</sub>              | Program<br>Input             | DEREQB<br>Input  | Body temperature.                                                                         |
| THET   |                             | GETTWG                       | DEREQB<br>Output | Value of $\theta_{b}$ corresponding to $S_{b}$<br>in integrating $d\xi/dS_{b}$ .          |

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| THETAA  | $\theta_{\rm A}$ | Program<br>Input             | In to<br>SUB110   | Aft cone angle.                                                                            |
|---------|------------------|------------------------------|-------------------|--------------------------------------------------------------------------------------------|
| THETAC  | θ <sub>C</sub>   | Program<br>Input             | In to<br>SUB110   | Fore core angle.                                                                           |
| THETAN  | $\theta_{\rm N}$ | Program<br>Input             | In to '<br>SUB110 | Nose cap angle.                                                                            |
| THETAO  | $\theta_{o_1}$   | SUB110                       | SUB110<br>Output  | Array of $\theta_0$ for $\alpha = 0$ coordinates.                                          |
| THETB   | $\theta_{\rm B}$ | Program<br>Input             | In to<br>SUB110   | Flare angle.                                                                               |
| THET2G  | $\theta_{2_{G}}$ | Program<br>Input             | SUB110<br>Input   | Angle at first point on general shape.                                                     |
| THE T3G | $\theta_{3_{G}}$ | Program<br>Input             | SUB110<br>Input   | Angle at last point on general shape.                                                      |
| THSTRT  |                  | DXSIDT                       | DEREQB<br>Input   | Value of $\theta_b$ at start of integration interval.                                      |
| THWGS   |                  | GETTWG                       | DEREQB<br>Output  | Value of $\theta_{W}$ corresponding to $\xi$ from $d\xi/dS_{b}$ .                          |
| THWLIM  |                  | Main                         | GETTWG<br>Input   | l.l Sin <sup>-1</sup> ( <u>1</u> ),<br>MACH<br>lower limit to $\theta_w$ for $d\xi/dS_b$ . |
| тwøвв   |                  | PREP                         | DEREQB<br>Input   | 2B, or 2B <sub>2</sub> used to integrate $d(P_e/P_s)/dx$                                   |
| UP1     |                  | Not currently                | used.             |                                                                                            |
| UP2     |                  | Program<br>Input             | PREP<br>Input     | Upper bound for accuracy in integrating $d(P_{\rm e}/P_{\rm s})/dx$ .                      |
| V       | v                | Program<br>Input or<br>1885A | DEREQB<br>Input   | Vehicle velocity.                                                                          |
| XA      | x <sub>A</sub>   | Program<br>Input or<br>1885A | DEREQB<br>Input   | Mole fraction of Argon in<br>undissociated mixture.                                        |

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| xc     | х <sub>С</sub>  | Program<br>Input or<br>1885A | DEREQB<br>Input                 | Mole fraction of $C\phi_2$ in undissociated mixture.                         |
|--------|-----------------|------------------------------|---------------------------------|------------------------------------------------------------------------------|
| XGB    |                 | Not currently                | used.                           |                                                                              |
| XLC    | Ľc              | Program<br>Input             | In to<br>SUB110                 | Cylinder length.                                                             |
| хмемø  | MEMØ            | Program<br>Input             | In to<br>SUB110                 | Identification number.                                                       |
| XMMX   | ММ              | Program<br>Input             | FINDRW<br>or<br>DXSIDT<br>Input | Used by FINDRW or DXSIDT<br>to compute QR.                                   |
| XN     | N               | Program<br>Input             | In to<br>SUB110                 | Array of divisions per body segment.                                         |
| XNN    | x <sub>N</sub>  | Program<br>Input or<br>1885A | DEREQB<br>Input                 | Mole fraction of $N_2$ in undissociated mixture.                             |
| XNNX   | NN              | Program<br>Input             | DEREQB<br>Input                 | Used to compute shock shape.                                                 |
| хо     | X <sub>o1</sub> | SUB110                       | SUB110<br>Output                | Array of $x_0$ for $\alpha = 0$ coordinates.                                 |
| хø     | ×ø              | Program<br>Input or<br>1885A | DEREQB<br>Input                 | Mole fraction of $\phi_2$ in undissociated mixture.                          |
| XSTART |                 | PREP                         | DEREQB<br>Input                 | Value of $x_b$ at start of straight section for $d(P_e/P_s)/dx$ integration. |
| XTBL   | X,              | Program<br>Input             | SUB110<br>Input                 | Array of $x_1$ for general shape.                                            |
| YGB    |                 | Not currently                | used. · ·                       | . *                                                                          |
| YO     | y <sub>o1</sub> | SUB110                       | SUB110<br>Output                | Array of $y_0$ for $a = 0$ coordinates.                                      |
| YSTART |                 | PREP or<br>DXSIDT            | DEREQB<br>Input                 | Value of $Y_{b}$ at start of integration interval.                           |

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#### C. 1885A SUBROUTINES

#### CALLING SEQUENCES

| ØBLIK                                           | Variable                                              | RHØA, Sa,<br>ambient density                   | XA, argon mole<br>fraction in atmos-<br>phere       | XC, CO <sub>2</sub> mole<br>fraction in<br>atmosphere | XN, N <sub>2</sub> mole frac-<br>tion in atmosphere |
|-------------------------------------------------|-------------------------------------------------------|------------------------------------------------|-----------------------------------------------------|-------------------------------------------------------|-----------------------------------------------------|
|                                                 | Input or Output                                       | Input                                          | Input                                               | Input                                                 | Input                                               |
|                                                 | Source                                                | Program Input                                  | Program Input                                       | Program Input                                         | Program Input                                       |
| XØ, Oz mole<br>fraction in at-<br>mosphere      | XPL, print sen-<br>tinel for con-<br>verged iteration | XPE, print senti-<br>nel for each<br>iteration | DELAL, move-<br>ment in wave<br>angle table         | TA, Ta, am-<br>bient tempera-<br>ture                 | V, velocity                                         |
| Input                                           | Input                                                 | Input                                          | Input                                               | Input                                                 | Input                                               |
| Program Input                                   | Program Input                                         | Program Input                                  | Program Input                                       | Program Input                                         | Program Input                                       |
| TABLE, table of<br>oblique shock<br>data        | IGØØF, senti-<br>nel >1 if solu-<br>tion impossible   | PATAB, print<br>sentinel                       | PA, ambient<br>pressure                             | HA, ambient<br>enthalpy                               | AM, Mach<br>number                                  |
| Output                                          | Output                                                | Input                                          | Output                                              | Output                                                | Output                                              |
| ØBLIK                                           | ØBLIK                                                 | Program Input                                  | ØBLIK                                               | ØBLIK                                                 | ØBLIK                                               |
| XM, mean mo-<br>lecular weight<br>of atmosphere | HDHS90, dis-<br>sociation energy<br>for normal shock  | QINSTP, lowest<br>radiation<br>intensity       |                                                     |                                                       |                                                     |
| Output                                          | Output                                                | Input                                          |                                                     |                                                       |                                                     |
| ØBLK                                            | ØBLIK                                                 | Program Input                                  |                                                     |                                                       |                                                     |
| PHIL                                            | Variable                                              | TABLE, table of shock data                     | ITH, index of<br>last TABLE com-<br>puted intensity | DELAL, increment in $\phi_w$                          | IGOOF, sentinal<br>>1 if solution<br>impossible     |
|                                                 | Input or Output                                       | Input/Output                                   | Input                                               | Input                                                 | Output                                              |
|                                                 | Source                                                | ØBLIK/PHIL                                     | ØBLIK                                               | Program Input                                         | PHIL                                                |

Calling sequences for all other subroutines are as in Section 1883

#### ØBLIK

Purpose: To perform the oblique shock calculation and prepare a table of shock data, TABLE.

Method: TABLE is a two-dimensional array 46 x 13. The 13 columns contain the variables  $\theta_W$  (THW),  $\rho_W/\rho_a$  (DENINV),  $\rho_W U_W/\rho_a$  v (DENINV·UW $\phi$ V),  $\theta_{WL}$  (THWL),  $\gamma_W$  (GAMW),  $T_W$ (T),  $P_V/P_o$  (PRS),  $H_W/H$  (ENT.R.TO/(XM.HH)),  $\rho_WS/\rho_A$  (RWS $\phi$ RA),  $P_{WS}/P_o$  (PWS $\phi$ P $\phi$ ), TWS (T-HM $\phi$ RT Z/ENT), IW (2.QSUM/DEL), and IB (2.QSUM/DEL), where IB is evaluated at the enthalpy ENTB.

After initializing TABLE, defining output names (ZNAMI and ZNAM2), ØBLIK computes ambient conditions and selects the proper set of tables of temperature and enthalpy for the atmosphere. This is done before HVST is called after statement 1001. A loop from 1002 to the statement before 1024 then decrements the value of  $\theta_W$  in decrements of DELAL until the lower limit in  $\theta_W$  is reached and solved (If test before 1006), or until the wave intensity [TABLE(ITH, 12)] is less than the input INSTØP (test after 2005).

The first  $\theta_{w}$  is for the normal shock (90 degrees), and the calculation is done in the same way as described in Program 1883. Provision for this special case is made by the IF test before statement 1017. For all other values an iteration on the density ratio is performed, convergence being determined of by two successive values of the density ratios differ by less than 1 percent (IF test before Statement 1022). The iteration for such value  $90 > \theta_{W} \ge THWL$ is as follows. Given a first guess for the density ratio (DENR) from the preceding computation, the pressure and enthalpy are expressed as PRS and ENT (after Statement 1021) in terms of DENR,  $\theta_w$ , and the ambient condition. HEAT2 is called which, as in 1883, converges on the pressure and enthalpy and in the process computes a new density ratio which, for convergence, approaches the estimated value. Corresponding to the last iteration is the radiation QSUM, which is simply related to IW [ TABLE(ITH, 12)]. After convergence, IB [TABLE(ITH, 13)] is computed at the converged pressure PRS and a new enthalpy ENTB by HEAT2 before Statement 2004. If the problem fails to converge for the normal shock (test of 2000) IG $\phi\phi$ F is set to 1 and control passed to the math program for the next case. If no convergence is obtained for other values of  $\theta_{\rm W},$  a transfer is made to Statement 1004 which sets the tabular value of THW [TABLE(ITH, 1)] = 0, and the increments of the computation IINT. At the conclusion of the calculation subroutine PHIL is called if IINT > 0. This subroutine searches for values of THW which are zero and if there are any provides linear interpolation for the 12 shock property columns with  $\theta_{W}$  as the independent variable. The output for each iteration (XPE>1) for every converged iteration (XPL>1) is provided by the tests between 1022 and 1024 and the Statements between 1009 and 1016.

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If the body radiation intensity drops below the input INST $\phi$ P, a transfer is made out of the loop to Statement 1024. D $\phi$  loop 1028 provides an interpolation between the ambient  $\gamma$ (GAMA) and the last  $\gamma_{W}$  (GAMW) computed by the iterative procedure, using THW as the independent variable. All shock properties, except IW (which is set to 0) and IB (which is still computed until it also falls below INST $\phi$ P, then set to zero for smaller  $\theta_{W}$ ) are then expressed in terms of the interpolated value of  $\gamma$  (GAMI), the  $\theta_{W}$ , and the ambient conditions.

#### 2. PHIL

Purpose: To interpolate values of the shock properties using  $\theta_W$  as the independent variable.

Method: Where TABLE(ITH, 1) are zero the solution was not found by iteration, the TABLE(ITH, 2-13) are linearly interpolated between successive successful iteration. If successive successful values are not found in TABLE(ITH, 1),  $IG\phi\phi F$  is set to 1 and control is returned to DBLIK, then the math program for the next case.

#### 3. <u>HEAT 2</u>

Purpose: Described in Section 1883.

Method: Same as 1883, but the detachment distance is now computed and is always set = 0.1 by DBLIK.

All other subroutines are the same as 1883.

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## D. 1885 B SUBROUTINES

## CALLING SEQUENCE

|               | Variable                            | KKL, Section iden-<br>tification array | XIL, X <sub>O</sub> array<br>corres to X <sub>b</sub> | YIL, Y <sub>o</sub> array<br>corres to Y <sub>b</sub> | XBL, X <sub>b</sub> array         |
|---------------|-------------------------------------|----------------------------------------|-------------------------------------------------------|-------------------------------------------------------|-----------------------------------|
| LEE           | Input or Øutput                     | Øutput                                 | Øutput                                                | Øutput                                                | Øutput                            |
|               | Sources                             | LEE                                    | IEE                                                   | LEE                                                   | LEE                               |
| YBL, Yb array | SBL, S <sub>b</sub> array           | THET BL,<br>array                      | ISTAG, No of stag<br>pt in XI, array                  | IGOOF, If = 0,<br>calculation o k                     | XI<br>stag pt                     |
| Øutput        | Øutput                              | Øutput                                 | Input                                                 | Øutput                                                | Input                             |
| LEE           | LEE                                 | LEE                                    | STAGPT                                                | LEE                                                   | LEE                               |
| Yl<br>stag pt | Sl<br>stag pt                       | DTDSI,<br>stag pt                      | THETA<br>stag pt                                      | M1<br>stag pt                                         | INQ, number of<br>entries in XIL. |
| Input         | Input                               | Input                                  | Input                                                 | Input                                                 | Øutput                            |
| STAGPT        | STAGPT                              | STAGPT                                 | STAGPT                                                | STAGPT                                                | LEE                               |
| ALPH current  | ISØNL, number at<br>sonic pt in XIL | THEBST, sonic<br>point                 | DTDSL<br>array                                        |                                                       |                                   |
| Input         | Øutput                              | Input                                  | Øutput                                                |                                                       |                                   |
| Program Input | LEE                                 | MAIN                                   | LEE                                                   |                                                       |                                   |

| PREP                                             | Variable<br>Input or Output<br>Source                | X, X <sub>b</sub> array<br>Input<br>WIND or LEE                | Y, Y <sub>b</sub> array<br>Input<br>WIND or LEE                 | S, S <sub>b</sub> array<br>Input<br>WIND or LEE                           | DTDS, d6 <sub>b</sub> /dS <sub>b</sub><br>Input<br>WIND or LEE             |
|--------------------------------------------------|------------------------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------|
| THETS, 0 array                                   | ISØNQ, number of<br>sonic pt, in table               | PRE, array of<br>Pe/Ps                                         | THEBSQ, some                                                    | RSØRAQ, p <sub>s</sub> /p <sub>A</sub>                                    | PWSQ, Pg                                                                   |
| Input<br>WIND or LEE                             | Input<br>WIND or LEE                                 | Output<br>PREP                                                 | Input<br>MAIN                                                   | Input<br>Prog Input or<br>1885A                                           | Input<br>Prog Input or<br>1885A                                            |
| V, velocity                                      | RHOA, PA                                             | IPTSQ, number of<br>points in X array                          | gams $\gamma_s$                                                 | rc, <sub>rc</sub>                                                         | JFLOW, j flow<br>sentinal                                                  |
| Input<br>Prog Input or<br>1885A                  | Input<br>Prog Input or<br>1885A                      | Input<br>WIND or LEE                                           | Input<br>Prog Input or<br>1885A                                 | Input<br>Prog Input                                                       | Input<br>Prog Input                                                        |
| KKW, body identi-<br>fication array              | DSY, $\Delta_s$<br>array $y_{c=0}$                   | RWY, (R <sub>y</sub> /y <sup>*</sup> ) <sub>e=0</sub><br>array | RSA p <sub>3</sub> /p <sub>3</sub> array<br>with DSY, RWY       | RARST, p <sub>s</sub> /p <sub>s</sub><br>array with XSYST<br>& DUTB       | XSYST, X*/Y*<br>array for DUTB                                             |
| Input<br>WIND or LEE                             | Input<br>MAIN                                        | Input<br>MAIN                                                  | Input<br>MAIN                                                   | Input<br>MAIN                                                             | Input<br>MAIN                                                              |
| DUTB, $rac{V_{T}}{V} rac{du}{ds}$<br>2-D array | GMTB, y array<br>with PMPSTB                         | PMPSTB, PMPSTB<br>array with GMTB                              | XNT, v array for<br>Prandtl-Meyer                               | XNTI, P <sub>e</sub> /P <sub>s</sub> array,<br>XNGM(1), Prandtl-<br>Meyer | XNT2 P <sub>6</sub> /P <sub>3</sub><br>array<br>XNGM(2), Prandtl-<br>Meyer |
| Input                                            | Input                                                | Input                                                          | Input                                                           | Input                                                                     | Input                                                                      |
| MAIN                                             | MAIN                                                 | MAIN                                                           | MAIN                                                            | MAIN                                                                      | MAIN                                                                       |
| XNT3, Pe/Ps array,<br>XNGM(3), Pranötl-<br>Meyer | XNT4, Pe/Ps array<br>XNGM(r), Prandtl-<br>Meyer      | XNGM, v array för<br>use in Prandtl-<br>Meyer                  | DPØDS <u>(dPe/Ps)ds</u><br>array ds                             | PA, P <sub>A</sub>                                                        | DUDSSS, du/ds<br>at stag pt                                                |
| Input                                            | Input                                                | Input                                                          | Øutput                                                          | Input                                                                     | Øutput                                                                     |
| MAIN                                             | MAIN                                                 | MAIN                                                           | PREP                                                            | Prog Input or<br>1885A                                                    | PREP                                                                       |
| XIW, non-trans<br>X1 geometry array              | UP2, upper (limit to<br>d(Pe/Ps)/dx inte-<br>gration | DN2, lower lumit to<br>d(Pe/Ps)/dx inte-<br>gration            | IG $\phi \phi F$ , if $\leq 0$<br>computation satis-<br>factory |                                                                           |                                                                            |
| Input                                            | Input                                                | Input                                                          | Output                                                          |                                                                           |                                                                            |
| Sub110                                           | MAIN                                                 | MAIN                                                           | PREP                                                            |                                                                           |                                                                            |



|                                                                             | Variable                           | PREW, pe/ps<br>array                     | XMULPS, factor =<br>Ps/PT          | RHOBS, PBS                                       | TB, T <sub>B</sub>                    |
|-----------------------------------------------------------------------------|------------------------------------|------------------------------------------|------------------------------------|--------------------------------------------------|---------------------------------------|
| QCØNV                                                                       | Input or Output                    | Tubnt                                    | mput                               | input                                            | Program                               |
|                                                                             | Source                             | PREP                                     | MAIN                               | MAIN                                             |                                       |
| XMAMB, mean<br>molecular weight                                             | rhot, $\rho_{\rm T}$               | GAMĒ, y <sub>e</sub>                     | xmubb $\mu_{T_B}$                  | YBW, Y <sub>B</sub> array                        | VISC, Viscocity<br>table (with TMPVS) |
| Input                                                                       | Input                              | Input                                    | Input                              | Input                                            | Input                                 |
| 1885A                                                                       | MAIN                               | MAIN                                     | MAIN                               | WIND or LEE                                      | MAIN                                  |
| TMPVS, temp<br>table (with visc)                                            | HAMB, enthalpy<br>H                | TT, T <sub>T</sub>                       | DPDSW, d(Pe/Ps)/<br>ds array       | QLW, QL array                                    | QTW, QT array                         |
| Input                                                                       | Input                              | Input                                    | Input                              | Output                                           | Output                                |
| MAIN                                                                        | Program Input<br>or 1885A          | Program Input<br>or 1885A                | PREP                               | QCØNV                                            | QCQNV                                 |
| INØW, number of<br>entries th XBW                                           | REW, REY array                     | JFLOW, flow                              | QLSAO, (QLS)/a=0                   | QLSW, QL'nor-<br>malizing factor                 | PWS, PS                               |
| Input                                                                       | Output                             | Input                                    | normalization<br>Input             | Input                                            | Input                                 |
| WIND or LEE                                                                 | QCØNV                              | Input                                    | MAIN                               | MAIN                                             | or 1885A                              |
| SBW, S <sub>b array</sub>                                                   | ISONW, number of<br>some pt th XBW | DUDSW, du/ds<br>windward or lee-<br>ward | SIGMA, input PN,<br>Prandtl Number | QTSTAO, (QTS)<br>$\alpha = 0$ normali-<br>zation | RYNORM, REY<br>normalization          |
| Input                                                                       | Input                              | Input                                    | Input                              | Input                                            | Input                                 |
| WIND or LEE                                                                 | WIND or LEE                        | PREP                                     | Program<br>Input                   | MAIN                                             | MAIN                                  |
| DTDSW,<br>db <sub>b</sub> /ds <sub>b</sub><br>Array<br>Input<br>WIND or LEE |                                    |                                          |                                    |                                                  |                                       |

|        | Variable        | INØW, number of<br>entries in QRAD | QRAD, or array            | ORADNM, normal-<br>ization factor |
|--------|-----------------|------------------------------------|---------------------------|-----------------------------------|
| QRNMAD | Input or Øutput | Input                              | Input-Øutput              | Input                             |
|        | Source          | WIND or LEE                        | GETQRS & DXSIDT<br>QRNMAD | MAIN                              |

|        | Variable        | INOW, number of X <sub>b</sub> 's in array | QRAD, QR array | STAND, array |
|--------|-----------------|--------------------------------------------|----------------|--------------|
| QRCLER | Input or Output | Input                                      | Output         | Output       |
|        | Source          | WIND or LEE                                | QRCLER         | QRCLER       |

|                          | <u> </u>                         |                                 |                                       |                                    |                                         |
|--------------------------|----------------------------------|---------------------------------|---------------------------------------|------------------------------------|-----------------------------------------|
| GETTØT                   | Variable<br>Input or Output      | TI, Indep.<br>Variable<br>Input | TTB, Indep<br>Variable array<br>Input | PD, 1st dep.<br>variable<br>Output | PTB, 1st dep<br>variable array<br>Input |
|                          | Source                           | Calling<br>Program              | Calling<br>Program                    | GETTØT                             | Calling<br>Program                      |
| ROD, 2nd dep<br>variable | ROTB, 2nd dep.<br>variable array | TTD, 3rd dep.<br>variable       | TTAB, 3rd dep<br>variable array       | GAD, 4th dep.<br>variable          | GATB, 4th dep.<br>variable array        |
| Output                   | Input                            | Output                          | Input                                 | Output                             | Input                                   |
| GETTØT                   | Calling<br>program               | GETTØT                          | Calling<br>program                    | Calling<br>program GETTØT          |                                         |
|                          | Variable                         | ICASE                           | IPAGE                                 | ILINE                              | NUMBER                                  |
| hdprn~                   | Input or Output                  | Input                           | Input                                 | Input                              | Input                                   |
|                          | Source                           | Program input                   | Main                                  | Program input                      | Main                                    |
| мемф                     | DATE                             | KPRINT                          |                                       |                                    |                                         |
| Input                    | Input                            | Output                          |                                       |                                    |                                         |
| Program input            | Program input                    | HDPRNI                          |                                       |                                    |                                         |
|                          | Variable                         | NZ                              | XEQ                                   | XIND                               | DXEQ                                    |
| DERQ5                    | Input or output                  | Input                           | Input                                 | Input                              | Output                                  |
|                          | Source                           | ADAMS4                          | ADAMS 4                               | ADAMS 4                            | DERQ5                                   |
| L                        | PAR                              | NPAR.                           |                                       |                                    |                                         |
| Input                    | Input                            | Input                           |                                       |                                    |                                         |
| ADAMS4                   | Dummy variable                   | Dummy variable                  |                                       |                                    |                                         |

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| TABLES                   | Variable                 | RASDØY                   | EPDØY  | DØY    | TMPVS  |
|--------------------------|--------------------------|--------------------------|--------|--------|--------|
|                          | Input or Output          | Output                   | Output | Output | Output |
|                          | Source                   | TABLES                   | TABLES | TABLES | TABLES |
| VISC                     | DSY                      | RWY                      | RSA    | DUTB   | RARST  |
| Output                   | Output                   | Output                   | Output | Output | Output |
| TABLES                   | TABLES                   | TABLES                   | TABLES | TABLES | TABLES |
| XSYST                    | GMTB                     | PMPSTB                   | XNGM   | XNT    | XNTI   |
| Output                   | Output                   | Output                   | Output | Output | Output |
| TABLES                   | TABLES                   | TABLES                   | TABLES | TABLES | TABLES |
| XNT2<br>Output<br>TABLES | XNT3<br>Output<br>TABLES | XNT4<br>Output<br>TABLES |        | 1      |        |

|                           | Variable                            | KKW, Section<br>identification<br>array | X1W, X <sub>o</sub> array, X1W, array<br>corres to X <sub>b</sub> corres. to |                                   | XBW, X <sub>b</sub> array       |  |
|---------------------------|-------------------------------------|-----------------------------------------|------------------------------------------------------------------------------|-----------------------------------|---------------------------------|--|
|                           | Input or Output                     | Output                                  | Output                                                                       | Output                            | Output                          |  |
| WIND                      | Source                              | WIND                                    | WIND                                                                         | WIND                              | WIND                            |  |
| YBW, Y <sub>b</sub> array | SBW, S <sub>b</sub> array           | THETBW,                                 | ISTAG, No of<br>stag pt mX <sub>I,</sub><br>etc                              | IGØØF, If = 0<br>calculation O K  | X1<br>stag pt                   |  |
| Output                    | Output                              | Output                                  | Input                                                                        | Output                            | Input                           |  |
| WIND                      | WIND                                | WIND                                    | STAGPT                                                                       | WIND                              | STAGPT                          |  |
| Y1<br>stag pt             | S1<br>stag pt                       | DTDS1<br>stag pt                        | THETA1<br>plus stag pt                                                       | M1 = 0 sections,<br>plus stag. pt | INØ, number of<br>entries m XIW |  |
| Input                     | Input                               | Input                                   | Input                                                                        | Input                             | Output                          |  |
| STAGPT                    | STAGPT                              | STAGPT                                  | STAGPT                                                                       | STAGPT                            | WIND                            |  |
| ALPH 1 current            | ISØNW, number at<br>sonic pt th XIw | THEBST, sonic<br>point                  | DTDSW,                                                                       |                                   |                                 |  |
| Input                     | Output                              | Input                                   | Output                                                                       | 1                                 |                                 |  |
| Program<br>Input          | WIND                                | MAIN                                    | WIND                                                                         |                                   |                                 |  |

| <br>GETNU | Variable<br>Input or Output | XNT, dependent<br>variable array<br>Input | XNT1, independent<br>variable array<br>Input | XNU, dependent<br>variable<br>Output | PØPT, independent<br>variable<br>Input |
|-----------|-----------------------------|-------------------------------------------|----------------------------------------------|--------------------------------------|----------------------------------------|
|           | SOURCE                      | PREP                                      | PREP                                         | GETNU                                | PREP                                   |
|           |                             |                                           |                                              |                                      |                                        |
| ACØSH     | Variable                    | ARG, argument<br>of cosh <sup>-1</sup>    | ANS, cosh <sup>-1</sup> (ARG)                | IGOOF, $1f \ge 0$ , calculation O.K. |                                        |
|           | Input or Output             | Input                                     | Output                                       | Output                               |                                        |
|           | SOURCE                      | Calling Program                           | ACØSH                                        | ACØSH                                |                                        |

The subroutine SUB110 receives all input and provides all output through C $\mathcal{G}MM\mathcal{G}M$  DATA. In addition to their calling sequences, the following subroutines use C $\mathcal{G}MM\mathcal{G}M$  for some input and output; GETTWG, PREP, WIND, LEE, STAGPT, DXSIDT, and DEREQB.

Subroutine UN08 has no calling sequence.

The calling sequences for the general purpose routines ADAMS4 and ARTLU are explained in the section on special routines.

|                             | Variable                                  | XIW, X <sub>o</sub> corres<br>to X <sub>b</sub> array | XIW, Y <sub>o</sub> corres<br>to X <sub>b</sub> array         | XBW, X <sub>b</sub> array                  | YBW, Yb array                              |
|-----------------------------|-------------------------------------------|-------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------|--------------------------------------------|
| FINDRW                      | Input or Øutput                           | Input                                                 | Input                                                         | Input                                      | Input                                      |
|                             | Source                                    | WIND or LEE                                           | WIND or LEE                                                   | WIND or LEE                                | WIND or LEE                                |
| SBW, Sbarray                | THETBW, array                             | DTDSW,<br>array                                       | KKW, Section I.D<br>array                                     | ISONW, Index of<br>sonic pt MXb            | INØW, number of<br>entries MX <sub>b</sub> |
| Input                       | Input                                     | Input                                                 | Input                                                         | Input                                      | Input                                      |
| WIND or LEC                 | WIND or LEE                               | WIND or LEE                                           | WIND or LEE                                                   | WIND or LEE                                | WIND or LEE                                |
| RSØRA,                      | DOY, 2D array of RASDØY,<br>array for DØY |                                                       | $IG \emptyset \emptyset F$ , $if \leq 0$ ,<br>calculation o k | IFLOW, flow<br>sentincl                    | INDDUM, index of<br>YT in YWB              |
| Input                       | Input                                     | Input                                                 | Øutput                                                        | Input                                      | Input                                      |
| Prog Input or<br>1885A      | MAIN                                      | MAIN                                                  | FINDRW                                                        | Prog Input                                 | GETDS                                      |
| dels,                       | THW, 1st col of<br>table                  | RUØRV, column 3<br>of table                           | THWL, column 4<br>of table                                    | XNNX, NN used to<br>compute                | PREW,<br>array                             |
| Input                       | Input                                     | Input                                                 | Input                                                         | Input                                      | Input                                      |
| GETDS                       | Prog Input or<br>1885A                    | Prog Input or<br>1885A                                | Prog Input or<br>1885A                                        | Prog Input                                 | PREP                                       |
| HAMB, enthalpy              | GAMS,                                     | V, velocity                                           | THETAW, at<br><sup>Y</sup> T                                  | RW, R <sub>W</sub> , radius<br>of bow wave | X512, at<br>Y <sub>T</sub>                 |
| Input                       | Input                                     | Input                                                 | Øutput                                                        | Øutput                                     | Øutput                                     |
| Prog Input or<br>1885A      | Prog Input or<br>1885A                    | Prog Input or<br>1885A                                | FINDRW                                                        | FINDRW                                     | FINDRW                                     |
| TDUMI, comunm<br>5 of TABLE | TDUM2, column<br>6 of TABLE               | BSHOCK, B <sub>S</sub> SHOCK<br>Parameter             | THWLIM<br>Smallest                                            |                                            |                                            |
| Input                       | Input                                     | Øutput                                                | Input                                                         |                                            |                                            |
| 1885A                       | 1885A                                     | FINDRW                                                | MAIN                                                          |                                            |                                            |

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| GETB                                                 | Variable<br>Input or Øutput<br>Source                                             | PRE, array<br>Input<br>PREP                | Y, Yb array<br>Input<br>WIND or LEE             | GAMS,<br>Input<br>Prog Input or<br>1885A                                                          | RC, R <sub>C</sub><br>Input<br>Program<br>Input |
|------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------|
| MS, number of sec-<br>tion on which I falls<br>Input | MB 2EL, number of<br>section of end of B <sub>1</sub><br>B2 integration<br>Øutput | I, index of pt in<br>Y considered<br>Input | JJJJ, flow index<br>(JFLOW)<br>Input<br>Program | BB, B <sub>1</sub> or B <sub>2</sub> for<br>d(P <sub>e</sub> /P <sub>5</sub> )/dx calc.<br>Øutput | M, array of sec-<br>tion I, D<br>Input          |
| PREP                                                 | GETB                                                                              | PREP                                       | Input                                           | PREP                                                                                              | WIND or LEE                                     |
| THET, array                                          | ISTOP, index of last<br>pt in integration of                                      |                                            |                                                 |                                                                                                   |                                                 |
| Input                                                | Øutput                                                                            |                                            |                                                 |                                                                                                   |                                                 |
| WIND or LEE                                          | PREP                                                                              |                                            |                                                 |                                                                                                   |                                                 |

|                                                  | Variable          | XIW, X <sub>o</sub> corres<br>to XBW | YIW, Y <sub>o</sub> array<br>corres to YBW | XBW, X <sub>b</sub> array         | YBW, Ybarray            |
|--------------------------------------------------|-------------------|--------------------------------------|--------------------------------------------|-----------------------------------|-------------------------|
| GETDS                                            | Input or Øutput   | Input                                | Input                                      | Input                             | Input                   |
|                                                  | Sources           | WIND or LEE                          | WIND or LEE                                | WIND or LEE                       | WIND or LEE             |
| SBW, S <sub>b</sub> array                        | THETBW,<br>array  | KKW, Section I D<br>array            | ISONW, number of<br>sonic pt. in XBW       | INOW, number of<br>entries in XBW | ALPHAI,                 |
| Input                                            | Input             | Input                                | Input                                      | Input                             | Input                   |
| WIND or LEE                                      | WIND or LEE       | WIND or LEE                          | WIND or LEE                                | WIND or LEE                       | Program Input           |
| RSORA,                                           | rn, <sub>rn</sub> | JFLØW, flow<br>sential               | DØY, 2D array of                           | RASDOY,<br>array for DØY          | EPDOY, array<br>for DØY |
| Input                                            | Input             | Input                                | Input                                      | Input                             | Input                   |
| Prog Input or<br>1885A                           | Program<br>Input  | Program<br>Input                     | MAIN                                       | MAIN                              | MAIN                    |
| IG $ abla \phi$ F, if $\leq 0$ , calculation o k | DTDSW<br>array    | DELS, , stag<br>pt detachment        | INDDUM, index of                           |                                   |                         |
| Øutput                                           | Input             | Øutput                               | Øutput                                     |                                   |                         |
| GETDS                                            | WIND or LEE       | GETDS                                | GETDS                                      |                                   |                         |
| 1                                                |                   |                                      |                                            |                                   |                         |

|        | Variable        | XNT, independant<br>variable table | XNT1, dependent<br>variable table | XNU, independent<br>variable | PRES, dependent<br>variable |
|--------|-----------------|------------------------------------|-----------------------------------|------------------------------|-----------------------------|
| GETPRE | Input or Øutput | Input                              | Input                             | Input                        | Input                       |
|        | Source          | PREP                               | PREP                              | PREP                         | GETPRE                      |

|                                          |                                                    |                           |                           |                           |                                      | -                                            |
|------------------------------------------|----------------------------------------------------|---------------------------|---------------------------|---------------------------|--------------------------------------|----------------------------------------------|
|                                          | Variable                                           | XBW, Xb array             | YBW, Yb array             | THETBW,                   | RW, R <sub>w</sub> at Y <sub>T</sub> |                                              |
| GETQRS                                   | Input or Output                                    | Input                     | Input                     | Input                     | Input                                |                                              |
|                                          | Source                                             | WIND or LEE               | WIND or LEE               | WIND or LEE               | FINDRW                               |                                              |
| DELS, from<br>stag pt                    | BSHOCK, B <sub>S</sub><br>shock shape<br>parameter | QRAD, QR array            | STAND, array              | THW O <sub>W</sub> array  | TIW I <sub>w</sub> array             | PREW P <sub>e</sub> /P <sub>s</sub><br>array |
| Input                                    | Input                                              | Øutput                    | Øutput                    | Input                     | Input                                | Input                                        |
| GETDS                                    | Program Input or<br>FINDRW                         | GETQRS                    | GETORS                    | Program Input<br>or 1885A | Program Input<br>or 1885A            | PREP                                         |
| TPR P <sub>w</sub> /P <sub>o</sub> array | TIB I <sub>B</sub> array                           | XMMX, MM to<br>compute QR | TRW array                 | PWS, PS<br>Input Program  | INØW, No of<br>points in XBW array   | RC, R <sub>C</sub> radius                    |
| Input                                    | Input                                              | Input                     | Input                     | Input                     | Input                                | Input                                        |
| Program Input<br>or 1885A                | Program Input<br>or 1885A                          | Program Input             | Program Input<br>or 1885A | Program Input<br>or 1885A | WIND or LEE                          | Program Input                                |
| THWLIM.                                  |                                                    |                           |                           |                           |                                      |                                              |

THW LIM,  $\theta_{wLIMIT}$ smallest value of  $\theta_w$ 

Input MAIN

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-112770

#### 1885B SUBROUTINE DESCRIPTIONS

#### 1. PREP

Purpose To compute the pressure distribution and velocity gradient for the body.

Method. The pressure distribution is divided into two parts, one the area between stagnation point and sonic point, and two the area aft of the sonic point.

If there is no straight section before the sonic point, (see tests near Statement 1000), and if the ratio X/Y sonic point  $\geq (1-\sin(\theta_b^*))/\cos(\theta_b^*)$ , then the forward pressure distribution is assumed Newtonian (DØ LØØP 1003). The velocity gradient is computed with JGØ = 1 by the correlation using the input tables DUTB, XSYST, and RARST. (Statements 1008 to 1021).

If there is no straight section, but X/Y sonic point  $< \frac{1 - \sin(\theta_b^*)}{\cos \theta_b^*}$ , then the above velocity gradient is computed (1008 to 1021), but with JG $\phi = 2$ , which then uses du/ds to compute a polynomial distribution (Statements 1024 to 1026).

If a straight section exists before the sonic point, then a polynomial pressure distribution is computed,

If  $\frac{d\theta}{ds} = 0$  at stagnation point; then du/ds is computed by the correlation at Statement 1007. Otherwise du/ds is computed as above.

After the distribution to the sonic point is computed (by Statement 1027) the DØ 1067 loop beginning after Statement 2008 computes all the following pressures. First, however, a table lookup is done to compute the pressure ration PMØPS , a function of  $\gamma_S$ . Statements 2000 to 2008 establish indexes used with the Prandtl-Meyer calculation. After the  $D\emptyset1067$  the Statements 3002 to 2013 are used to assure that the first pressure computed on Section 5 or a flatbased section 10 is done by Prandtl-Meyer. If the  $d\theta/ds > 0$ , for the current point, the pressure is computed by the Newtonian approximation (1028). If  $d\theta/ds = 0$ ,  $\theta < 0$ , the pressure is constant (1031). If  $d\theta/ds = 0$ ,  $\theta > 0$ , then a test is made (1032). If the previous pressure was < PMØPS, the Entropy-Layer formulation is used (Statements 1033 to 3008). This involves the use of the ADAMS4 integration system to integrate the differential equation  $d(P_e/P_s)/dx$ . This derivative involves a constant BB, which itself is an integral from the stagnation point to the beginning of the straight section. Subroutine GETB computes this constant, and the quantity MB2EL assures that it is computed only once per straight section.

If  $d\theta/ds = 0$ , and the previous pressure was > PM $\phi$ PS at Statement 1032, then constant pressure is assumed (Statement 1031).

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If  $d\theta/ds < 0$ , a test is made at Statement 1040. If the previous pressure > PMØPS, Newtonian is assumed (1028). Otherwise, Prandtl-Meyer is assumed (Statements 1041 to 1064).

As each pressure  $PRE_i$  is computed, so is its derivative  $DP\phi DS_i$ . If the pressure ever becomes less then  $P_A/P_S$  (PA $\phi$ PS), then the pressure is held constant at PA $\phi$ PS (loop 1005) for the rest of the body.

#### 2. QRCLER

Purpose: To set each entry of the arrays QRAD and STAND to zero before the calculation QR, and XSI, are initiated.

Method: DØ LØØP 1000.

#### 3. QCØNV

Purpose: To compute the heating quantities  $QL_i$ ,  $QT_i$ , and  $REY_i$  for each point on the body.

Method: The distributions  $QL_i$ ,  $QT_i$ , and  $REY_i$  are computed by the DØ LØØP 1011. Between entry and the DØ 1011, all constants independent of the body are computed. The  $QL_i$  computed uses the term BETA (1004, 1003), involving the trapezoidal integration of the function  $\rho_b u_e \gamma_i^{24}$ , and  $\xi$  (not related to the shock  $\xi$ ). When the surface distance  $S_{b_i} \leq 0.2 S_{b_i \text{ sonic}}$ , a limiting form of  $\xi$  and BETA is provided (Statements 1000 to 1001). If  $S_{b_i} > 0.2 S_{b_i \text{ sonic}}$ , then the  $\xi$  and BETA are computed between 1001 and 1004, where the trapezoidal integration also is done. The  $QL_i$ ,  $QT_i$ , and REY<sub>i</sub> are computed between Statements 1002 and 1011.

#### 4. GETTØT

Purpose: To perform table look-up using columns of the table of normal and oblique shock properties TABLE

Method: It was necessary to write GETTØT because two columns of independent variables on TABLE,  $\theta_W$  (column 1) and PW/PO (column 7) are monotonically decreasing and thus not suitable for ARTLU. The maximum number of dependent variables is 4, when the subroutine is called by the MAIN program to compute "total" conditions. When it is called with fewer dependent variables of interest (e.g. by FINDRW, GETQRS), dummy variables are included.

#### 5. WIND

Purpose: To compute the transformed body coordinates for the wind ward side at angle of attack, and include in these tables the coordinates of the sonic point.

Method: The DØ LØØP 1012 first transforms the zero angle-of-attack coordinates by using the input values of  $\alpha$  (ALPHI), and the XBRAL and YBRAL included in the zero angle-of-attack tables by STAGPT as the alpha = 0 coordinates of the stagnation point of the body at the current a. The difference in definition of  $x_b$ ,  $y_b$ ,  $\theta_b$  done at the Statement 1002 reflects the fact that the windward side must go around the a = 0 rearward point and back up the other ( $\alpha = 0$ ) side. The table is considered complete whenever  $|\theta_{\rm b}| > 90$ (Statement 1010), or y, passes through zero (1006). The statements between 1014 and 1029 compute the co-ordinate of the sonic point ( $\theta_{\rm b} = \theta_{\rm b} *$ ). If the sonic point falls on a straight section, it is defined to be the start of that section (1023). Otherwise an interpolation is done using  $d\theta/ds$  of the section containing the sonic point (DØ LØØP 1020), and the sonic point coordinates are computed at Statement 1026. The DØ LØØP 1027 rearranges the x<sub>b</sub>, y<sub>b</sub>, etc., tables so that the sonic point co-ordinates fall in their proper sequence, with index = ISØNW. Proper sequence is determined by the fact that the SBW table must be monotonically increasing.

6. LEE

Purpose: Same as WIND above, but for leeward side.

Method: Same as WIND above, except for co-ordinate defuntions at Statements 1002 to 1005.

#### 7. GETDS

Purpose: To compute the detachment distance of the bow wave normal to the body at the stagnation point.

Method: GETDS computes the detachment  $\Delta_s$  by choosing among several correlations involving the density ratio  $\rho_A/\rho_s$  and body geometry.

If there are no straight sections between the stagnation point and the sonic point, and JFLOW = 0, then the  $\Delta_s$  is computed from a simple algebraic evaluation involving  $\cosh^{-1}$  (between Statements 1001 to 1008). For the purposes of  $\cosh^{-1}$  only, if the inverse of the argument is  $\geq 1$ , it is set to a limit 3/3. 1.

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If there were no straight sections and JFLØW > 0, then the  $\Delta_s$  is computed from a correlation involving the tables RASDØY, EPDØY, and DØY. The table DØY is  $\Delta_s/Y_T = f(\epsilon, \rho_A/\rho_s)$ ,  $Y_T$  here is defined as  $y_b^*$  at the sonic point,  $\rho_A/\rho_s = RAØ$  RS, and  $\epsilon = EPSLT = x_b^*/y_b^*$  at the sonic point.

If there is a straight section before the sonic point, and JFLØW  $\leq 0$ , the  $\Delta S$  is computed from the function using  $\cosh^{-1}$ , but with the (DTDSMP) redefined between Statements 1020 and 1026. If JFLØW > 0 and  $x_b^* \geq \Delta_{so}$ , then the correlation from tables DØY, EPDØY, and RASDØY is performed with  $\gamma_{\rm T}$  and  $\epsilon$  = EPSLT redefined between Statements 1028 and 1032. If JFLØW > 0 and  $x_b^* < \Delta_{so}$ , DELS =  $\Delta_{so} - x_b^*$  at Statement 1037.

The index INDDUM is either the index of the sonic point or the beginning of a straight section, depending on which point was used to determine  $Y_{T}$ .

#### 8. GETQRS

Purpose: To compute the radiation QRAD and normal detachment distance STAND along the meridion.

Method: The detachment distance  $\text{STAND}_1$  and  $\text{QRAD}_i$  are computed in D $\phi$  L $\phi\phi$ P 1010 by solving a quadratic which is a function of RW, the body coordinates and the shock parameter BSHOCK, between the D $\phi$  1010 and Statement 1033. Given the distance and the pressure distribution, subroutine GETT $\phi$ T is used to look up the intensities, first from the wave angle THWW and then from the local pressure PARG. Three dummies are used in each table, look up (see GETT $\phi$ T). The QRAD<sub>1</sub> is computed prior to 1010.

#### 9. STAGPT

Purpose: To locate in the zero angle-of-attack co-ordinates the co-ordinates of the new stagnation point at  $a \neq 0$ , and place this point in the tables.

Method: In the IF LØØP between 1030 and 1029, the program finds all points for which the local body angle  $\theta_b + \alpha = 90$ . It does this by seeking a change of sign in the residual. If the point is not identical to a point in the  $\alpha = 0$  tables,  $d\theta/ds$  is computed and the co-ordinates are interpolated (1022 to 1025). If the point is identical to a point in the  $\alpha = 0$  table, this fact is noted (1026). If the point falls on a straight section, the new stagnation point is arbitrarily defined to be at the middle of the straight section (1003 to 1007).

For each candidate for the stagnation point, the quantity XBRAL is computed (1027). The point which maximizes this quantity is defined to be the stagnation point (1028 to 1029). The statements between 1033 and 1040 are used to define the arrays X1, Y1, etc., which contam the a = 0 co-ordinates (X0, Y0, etc.) plus the stagnation point, whose index in X1, etc. is ISTAG. It is placed in the co-ordinate tables in such fashion that S1 is monotonically increasing.

#### 10. GETB

Purpose: To compute the constants B1 or B2 used in computing the pressures by integrating the differential equation  $d(P_a/P_c)/dx$ 

Method: GETB computes BB which involves an integral of the pressures and geometry between the stagnation point and the beginning of the straight section on which the i<sup>th</sup> (current) point lies. Since the integral is only to the start of the section, IST $\phi$ P, the index of the starting point in the x<sub>b</sub> table, and MB2EL, the identification number of the straight section are computed in the DO 1003 loop. These quantities are used to guarantee that the calculation is done once for each straight section on which the entropy layer equations are used, and not once for each output point on the section. The integration is done trapezoidally in D $\phi$  L $\phi$  $\phi$ P 1008. The integrand depends on JJJJ, which is the flow index JFLOW. The argument BB in the calling sequence is the value of either BI or B2, whichever is appropriate.

#### 11. QRNMAD

Purpose: To normalize the array QRAD by QRADNM.

Method: If QRADNM is > 0, each entry in QRAD is divided by it in DØ LØØP 1002.

#### 12. GETPRE

Purpose: Given a value of  $\nu$  (XNU) and a  $\nu$  table (XNT), to compute a corresponding Pressure (PRES) from the table XNT1.

Method: Linear interpolation in DØ LØØP 1002 and Statement 1003.

#### 13. FINDRW

Purpose: To compute the bow wave radius RW, and the parameter BSHOCK by computing the detachment distance and wave angle (XSI2 and THETAW) at the body point whose index is INDDUM, and at the first point where  $\theta_{w} \leq 0$ .

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Method: FINDRW computes the shock-shape parameters RW and BSHOCK by computing the shock angle and detachment distance at two points on the body, the first (ICØMP = 0) defined as the point on the geometry tables with index INDDUM, and the second (ICØMP = 1) being the most forward point with  $\theta_b \leq 0$ . The point indexed by INDDUM is either the sonic point or the start of a straight section if it occurs ahead of the sonic point and if  $x_b^* \geq DELTST$  as defined by Statement 1003.

The method of iteration is to compute for a point on the body and a value of  $\theta_{\rm w}$  (initially set to  $\theta_{\rm b}$ ) two values of detachment distance XSI1 and XSI2. When IC $\phi$ MP = 0, XSII is obtained from Statement 1071, and when IC $\phi$ MP > 0 from the (largest) positive root of a quadratic (Statements 1044 to 1047). XSI2 is always obtained from the (largest) positive root of the quadratic computed between 1052 and 1057. If the relative difference between XSI1 and XSI2 is  $\leq 10^{-4}$ , the computation has converged (after 1022). If it has not converged, then the value of THET =  $\theta_w$  is modified until a change of sign in the residual indicates a near root (Statement 1026). At this time the  $\Delta \theta_{m}$  is decreased and the successive approximations continued. If a successive redidual is larger in absolute value than the former value (divergence) the sign of  $\Delta\theta_{w}$  is changed (1029). If this happens twice, then the residual has passed through a minimum without finding a root, and transfer is made to Statement 1041 which sets  $IG\phi\phi F = 1$  and prints the message CANNØT FIND THETA FØR RW ØR B, SKIP CASE. Control then is passed to the main program. If no solution is found in 600 iterations,  $IG\phi\phi F$  is set to 1 and the return is executed (1034 et. seq.). After the first pass (ICOMP = 0) RW is computed and the reference geometry is changed to the most forward point at which  $\theta_{\rm b} \leq 0$  (Statements 1038 to 1070). After the second pass (IC $\phi$ MP = 1), the shock shape parameter BSH $\phi$ CK is computed (1070) and a normal RETURN 1s executed.

#### 14. GETNU

Purpose: Given a value of pressure  $P \phi PT$  and a pressure table XNTI, to compute a corresponding  $\nu$  from the table XNT.

Method: Linear interpolation in DØ LØØP 1002 and statement 1003.

#### 15. ACØSH

Purpose: To compute cosh-1 (ARG).

Method: Expansion in DØ LØØP 1000 for ARG > 1.

16. DERQ5

Purpose: To compute the derivatives  $d(P_p/P_p)/dx$  or  $d\xi/dS_p$ .

Method:  $d(P_e/P_s)/dx$  is computed between 1002 and 1008 by using the current values of  $P_e/P_s$  (PRS), X (XIND), and data in CØMMØN storage computed by PREP. DERQ5 is called by the predictor-corrector routine ADAMS4.

17. SUB110

Purpose: To compute a = 0 coordinates

Method: SUB110 computes a = 0 body data in the large DØ LØØP 20. For each of 10 segments, the input array N (XN) contains a number. For each of the segments but 3 and 10 this should be of the form X where X is an integer giving the number of increments in the section. For the third section X. 1 is a cone, X. 2 is a tension shell, and X. 3 is a general shape (statement 50), X still being the number of increments. For Section 10 X. 1 is an aft sphere, and X. 2 is a flat base (statement 120). The index J1 counts the points, and the total number of points in each X0, Y0, etc. array is JOMAX. The appropriate equations for each section are determined by the computed GØTØ at statement 10, and if XN<sub>1</sub> = 0, the i<sup>th</sup> section is omntted. If the input sentinel IOTBL  $\neq$  1, the co-ordinates are printed out (statement 131).

#### 18. ADAMS4

Purpose: To numerically integrate differential equations by a predictorcorrector method.

Method: See the writeup of ADAMS4 in the section special subroutines.

## 19. TABLES

Purpose: To define tables used in the computations.

Method: Each element of each table 1s set to the appropriate numerical value in an arithmetic statement.

#### 20. HDPRNI

Purpose: To print identification material at the beginning of each case.

Method: The appropriate "WRITE" and "FORMAT" statements are used.

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#### 21. UNO8

Purpose: To define logical tape 8 as the binary input-output tape SYSUT5.

Method: UNO8 is a MAP subroutine containing the necessary FILE information.

#### E. 1885 A MAIN PROGRAM

Purpose: To acquire input for the oblique shock calculation and prepare a binary tape of shock data for Program 1885B.

Method: Having acquired the values of the input, control is passed to subroutine OBLIK which performs the shock calculation. If a binary tape is to be prepared for 1885B, the tape is rewound for a first case (XFIRST = 0, Statement 1001) and not rewound for successive cases until ILAST is input > 0 (Statement 1005).

#### F. 1885 B MAIN PROGRAM

Purpose: The purpose of the main program is to acquire tables and input used by the calculation, provide output, and control the order of the calculations of the heating and pressure distribution at each angle of attack for both leeward and windward sides.

Method: Common data, dumension statements, and definition of the Namelist array INPUT occur in the MAIN program before input is acquired. CALL TABLES provides the constant tables to be used by the program. Preset variables are then set, and the data read in through the Namelist array INPUT. The CALL SUB110 statement provides for the computation and subsequent output of the zero angle of attack coordinates.

The statements between CALL SUB110 and 1035 provide for oblique and normal shock data to be read from TAPE 38, if the input quantity TAPE (XTP) > 0, implying that these data are to come from an 1885A calculation. After Statement 1035 pertinent gas properties are defined from these data taken at wave angle ( $\theta_w$ ) = 90 degrees.

In the statements preceding 1017, "total conditions",  $P_{\rm T}$ ,  $\rho_{\rm T}$ ,  $T_{\rm T}$ ,  $\gamma_{e}$  are defined at  $\theta_{\rm w} = 90$  or by table look-up (CALL GETTØT) at  $\theta_{\rm w} =$  THETAT (THTØT), depending on the input TTØ. Before the DØ 10 statement further gas properties are defined, as is the Reynolds number normalization RYNØRM.

The DØ LØØP 10 extends to the end of the MAIN program, and controls as a monitor the sequence of calculations performed for each angle of attack. The first entry of the array ALPHA must be 0. The flow diagram (Section

A above) should be helpful, as the entire function of the MAIN program in this loop to control the logic. Since the leeward and windward sides of the vehicle at angle of attack are nearly independent of each other, there are virtually no significant equations in the loop.

When  $\alpha = 0$  or 180, the body is symmetric and only one side need be computed. At  $\alpha = 0$  it is the windward side, Statements 1018 to 1000, in which four normalizing factors are computed, QLSAO and DUDSAO for QL, QTNØRM for QT, and QRADNM for QRAD, if the radiation is to be computed (CØMQRD > 0 in the input).

When a = 180, the same sequence is performed for the leeward side, Statements 1023 to 1001, using the previously computed normalization.

When 0 < a < 180, calculations are performed in the proper sequence first for the windward side and then for the leeward side, and all but the coordinates are computed between Statements 1026 and 1025. When both sides are computed two averages must be found, one a mean value of du/ds (DUDSD) between Statements 1026 and 1022, which assures continuity of heating at the stagnation point (common to windward and leeward sides), and the other is the detachment distance (DELS) from the stagnation point, which is computed between Statements 4002 and 1029.

There are several co-ordinate tables used. XO, YO, SO, DTDSO, THETAO, and M in CØMMØN are the zero angle-of-attack coordinates. The tables X1, Y1, S1, DTDS1, THETA1, and M1 are these tables plus one additional point, the stagnation point at the current value of  $\alpha$ . The tables XBW, YBW, SBW, THETBW, and KKW are the body coordinates of the windward side after the translation and rotation implied by the angle of attack, and the tables X1W and Y1W are the  $\alpha = 0$  coordinates from which the body coordinates were transformed. On the leeward side the tables are analagous to the above seven, except the letter "W" is replaced by "L".

For each side of the body, the sequence is as follows

1) Obtain the stagnation point coordinates in the  $\alpha = 0$  reference by calling STAGPT (Statement 1009) if  $\alpha \neq 0$ , acquiring the tables X1, Y1, etc., and the index of the stagantion point ISTAG.

2) Obtain the windward (leeward) body coordinates by transforming X1, Y1, etc., to XBW (XBL), YBW (YBL), etc., by calling subroutine WIND (LEE). The first point in XBW (XBL) will be the stagnation point at the current a, and in addition the coordinate tables include the coordinates of the sonic point, whose index is IS  $\phi$ NW (IS $\phi$ NL). There are IN $\phi$ W (IN $\phi$ L) entries in each of these tables.

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3) Compute the pressure distribution and du/ds for the windward (leeward) side by calling PREP to obtain the array PREW (PREL), and the quantities DUDSW (DUDSL).

4) From this point the windward and leeward sides data are completely indepedent. CALL QCGNV provides for the computation of the heating data QLW, QTW, and REY. This is provided as output for the windward side, and when the leeward calculation is made the distributions are stored in the same arrays.

5) If COMORD in input is < 0, go to Step 10.

6) If RWØ, BSHØCT, DELT are input, SKIP to Step 9.

7) Obtain the detachment distance DELS from the stagnation point, which is provided by GETDS.

8) Obtain the shock detachment distance XSI2 and the shock angle THETAW from the point whose index is INDDUI from the windward side and INDDU2 from the Leeward side. This point is either the sonic point or the start of a straight section if there is such a section between the stagnation point and the sonic point. Also obtain the bow wave radius RW, and shock parameter BSHQCK, these quantities coming from the subroutine FINDRW.

 Obtain the radiation heating (QRAD) and detachment distance (STAND), (Windward or leeward). This is done by subroutine GETQRS.

10) Provide the pressure and heating quantities as output for the windward and leeward side.

Most of the subroutines have as an argument the sentual IG $\phi\phi$ F, which if >0 indicates that the computation is unsatisfactory and the next angle of attack is considered.

#### G. 1885A SIGNIFICANT EQUATIONS

l. Main

None.

2. PHIL

None.

#### 3. ØBLIK

$$\rho_{\rm w}/\rho_{\rm a} = \text{DENINV from iteration of } IW \ge \text{INST}\emptysetP$$
$$= (\text{GAMI} + 1) + \text{AM}^2 \cdot \sin^2\theta_{\rm w}/\{(\text{GAMI} - 1) \cdot \text{AM}^2 \cdot \sin^2\theta_{\rm w} + 2\}$$

GAMI interpolated when IW < INSTØP

$$\rho_{\rm W} U_{\rm W} / \rho_{\rm a} V = \text{DENINV} + U W \phi V$$
,

$$UWØV = [\cos^2 \theta_w + DENR^2 \sin^2 \theta_w]^{1/2}$$
,  $DENR = 1/DENINV$ 

$$\theta_{WL} = \tan^{-1} \left\{ \frac{\left[\sin \theta_{W} \cos \theta_{W} (1 - \text{DENR})\right]}{\left[\cos^{2} \theta_{W} + \text{DENR} \cdot \sin^{2} \theta_{W}\right]} \right\}$$

$$\gamma_{\rm w} = (\text{DENINV} + 1.)/(\text{DENINV} - 1)$$
 if IW  $\geq$  INSTOP

= GAMI, interpolated if IW < INSTOP

 $T_w = T$  from HEAT2 iteration if  $IW \ge INSTOP$ 

= HWMRTZ · R · TO/XM if IW < INSTOP, where HWMRTZ = HMØRTZ {  $1 - V^2 \times 0.5$  [DENR<sup>2</sup> × sin<sup>2</sup>  $\theta_w + \cos^2 \theta_w$ ]/HH}

HMØRTZ and HH from ambient condition (after 1001).

$$P_w/P_o = PRS = RHØR \cdot V^2 \times sin^2 \theta_w (1 - DENR)/P_o + PA/P_o$$
  
HW/H = ENT • R • T<sub>o</sub> / (XM HH) when ENT=f(DENR) if IW  $\geq$  INSTØP

= HWMRTZ R  $T_o/(XM HH)$  if IW < INSTOP

 $\rho_{ws}/\rho_a = \text{DENINV} \cdot (\text{PWS} \phi/\text{PRS})^{(1/\text{GAMW})}$ 

$$\overline{PWS}\overline{\emptysetP} \phi = \overline{PRS} \left[ \frac{1}{\left[1 - \frac{V^2}{2*HH} \left(\frac{U_w}{V}\right)^2\right]} \right]^{\frac{GAMW}{GAMW - 1}} \text{ if } IW \ge INST\overline{\emptysetP}$$

$$\overline{PWS}\overline{\emptysetP} \phi = \overline{PW}\overline{\emptysetPZ} \left[ \frac{1}{\left[1 - \frac{V^2}{2*HH} \left(\frac{U_w}{V}\right)^2\right]} \right]^{\frac{GAMI}{GAMI - 1}} \text{ if } IW < INST\overline{\emptysetP}$$

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$$\begin{split} P_{WS}/P_{0} &= PWS \tilde{O}P \tilde{O} \text{ , see above} \\ TWS &= T \cdot HM \tilde{O}RTZ/ENT \text{ if } IW \geq INST \tilde{O}P \\ &= T \cdot HM \tilde{O}RTZ/HWM \tilde{O}RTZ \text{ if } IW < INST \tilde{O}P \\ IW \text{ from } HEAT2 &= \frac{2 \cdot QSUM}{DEL} \text{ evaluated at } P = PRS \text{ and } H = ENT \text{ if } IW \geq INST OP \\ &= 0 \text{ if } IW < INST \tilde{O}P \\ IB \text{ from } HEAT2 &= \frac{2 \cdot QSUM}{DEL} \text{ evaluated at } P = PRS \text{ and } \\ H &= ENTB = HM \tilde{O}RTZ \text{ (PRS/PWS } \tilde{O}P \tilde{O}) \\ [(GAMMA - 1)/GAMMA)] \\ PWS \tilde{O}P \tilde{O} \text{ and } GAMMA \text{ here evaluated only at } \theta_{W} = 90 \end{split}$$

#### H. 1885B SIGNIFICANT EQUATIONS

1. MAIN

 $REYA = RYNØRM = \frac{RHØA V \cdot 2 \cdot RC}{XMUAAA} , XMUAAA = \mu|_{TA}$  1017

STATEMENT

NUMBERS

$$\theta_{\rm b}^{*} = \text{THEBST} = \text{ASIN} \left[ \frac{2}{(\overline{\text{GAMS} + 1})} \frac{\overline{\text{GAMS}}}{\overline{\text{GAMS} - 1}} \right]$$
 1017

$$QL_{s}|_{a=0} = QLSAO = \frac{0.76}{SIGMA^{0.6}} \cdot \left(\frac{RHØBS \cdot XMUBBB}{RHØSS \cdot XMUSSS}\right)^{0.1} (RHØSS \cdot XMUSSS)^{0.5}$$

$$\frac{\text{HAMB}}{778.} \cdot (\text{DUDSAO})^{0.5} \cdot [1 + (\text{EL}^{\text{ALPQ}} - 1) \cdot \text{HDHS90}]$$
 1018

$$\rho_{\rm BS} = \text{RHOBS} \approx \frac{\text{PWS} \cdot \text{XMAMB}}{89516 \cdot \text{TB}}$$
,  $\mu_{\rm B} = \text{XMUBBB} = \mu|_{\rm TB}$ ,

$$\mu_{\rm s} = \text{XMUSSS} = \mu|_{\rm TWS}$$
,  $\frac{du}{ds}\Big|_{\alpha=0} = \text{DUDSAO, HDHS90} = \frac{H_{\rm D}}{H_{\rm s}}\Big|_{\theta_{\rm W}=90}$ 

-126-

$$QT_{s}|_{\alpha=0} = QT (ISQNW)|_{\alpha=0}$$
 2012

•

$$QRS|_{\alpha=0} = QRADNM = QRAD(1)|_{\alpha=0}$$
 2014

$$\frac{du_{j}}{ds} = DUDSD = \frac{1}{2} DUDSW + \frac{1}{2} DUDSL, \qquad 1020$$

$$\frac{du}{ds}\Big|_{s} = DUDSD = \frac{\frac{du}{du}}{ds} \quad \text{if} \quad \begin{array}{c} a - 90 - \theta_{N} < 0 \quad \text{and} \\ 180 + \theta_{A} - a < 0 \end{array} \quad 1020$$

$$\frac{du}{ds}\Big|_{s} = \frac{1}{2} \frac{du}{ds} + \frac{0.5 \sin \alpha}{YIW(1)} \left(\frac{3}{RSØRA}\right)^{1/2}, \quad \alpha \text{ otherwise than above} \qquad 1021$$

YIW(1) is  $\alpha = 0$  value of  $y_0$  for the stag. pt. at the current  $\alpha$ 

2. PREP

$$P_e/P_s = PRE(I) = sin^2(\theta_b)$$

$$\frac{dP_{e}/P_{s}}{dS} = DP \phi DS(I) = PWS \cdot sin(2\theta_{b}) \frac{d\theta_{b}}{dS_{b}}$$
Newtonian,  $S_{b} \leq S_{b}^{*}$  1003

$$C_{1} = C \emptyset ED1 = \frac{RH\emptyset A}{2 PWS} \frac{V^{2}}{2 PWS} RS \emptyset RA \cdot S_{b}^{*} \left(\frac{DUDS}{V}\right)^{2}$$

$$C_{2} = C \emptyset ED2 = Sin^{2} (\theta_{b}^{*}) - 1 + C \emptyset ED1$$

$$\frac{P_{e}}{P_{s}} = PRE(I) = 1 - C \emptyset ED1 \cdot \left(\frac{S_{b}}{S_{b}^{*}}\right)^{2} + C \emptyset ED2 \cdot \left(\frac{S_{b}}{S_{b}^{*}}\right)^{4} Polynomial, S_{b} \leq S_{b}^{*}$$

$$\frac{d(P_{e}/P_{s})}{dS} = DP \emptyset DS(I) = -2 \cdot C \emptyset ED1 \cdot PWS = \frac{S_{b}}{S_{b}^{*2}}$$

$$1026$$

$$+ 4 \cdot C \emptyset ED2 \cdot PWS \cdot \frac{S_{b}^{3}}{S_{b}^{*4}}$$

-127-

$$P_e/P_s = PRE(I) = sin^2(\theta_b) + PAOPS \cdot cos^2(\theta_b)$$

Newtonian,  $S_{\rm b} > S_{\rm b}^*$ 

$$\frac{d(P_e/P_s)}{dS} = DPQDS(I) = PWS \cdot \sin(2\theta_b) \frac{d\theta_b}{dS_b}$$

The entropy-layer pressure formulation is done by integrating a differential equation, Statement 3003. See DEREQB and GETB significant equations.

The Prandtl-Meyer pressures are obtained by two dimensional table look ups (GETNU and GETPRE subroutines) and the logic between Statements 1042 and 1066.

3. QCØNV

$$QL_{1} = QLW(I) = YBW^{JFL} OW \cdot ROB \cdot UED \cdot \left[(1. + 0.096 \sqrt{BETA}) / \sqrt{2 \cdot XSI}\right] \frac{QLSW}{QLSAO}$$

$$\frac{\text{XMUBBB}}{(\text{RH} \emptyset \text{BS} \cdot \text{XMUBBB} \cdot \text{DUDSW} \cdot (\text{JFL} \emptyset \text{W} + 1))^{1/2} \cdot 1.068}$$

$$p_{\text{B}} = \text{R} \emptyset \text{B} = \text{PREW}(\text{I}) \cdot \frac{\text{XMAMB} \cdot \text{PWS}}{\text{39516} \cdot \text{TB}}$$

$$U_{\text{e}} = \text{UED} = \text{DUDSW} \cdot \text{SBW}(\text{I}), \qquad S_{\text{b}} < S_{1}$$

$$\left( \frac{\text{GAME} - 1}{1} \right)$$
1002

$$= \left(1 - PREW(I) \xrightarrow{\text{GAME}} \right) \sqrt{2 \cdot \text{HAMB}}, S_b > S_1 .$$
 1001

$$\beta = \text{BETA} = 0.5, \qquad S_{\text{b}} < S_{\text{i}} \qquad 1000$$

$$\beta = -\frac{2}{\text{XMUBBB}} \cdot \frac{\text{DPDSW}(I) \cdot \text{XSI}}{\text{R}\emptyset \in \text{UED}^3 \cdot \text{R}\emptyset \text{B} \cdot \text{Y}_b^{2}\text{JFL}\emptyset \text{W}}, \quad \text{S}_b > \text{S}_i = \frac{\text{d}(\text{P}_e/\text{P}_s)}{\text{d}\text{S}} < 0 \text{ 1004}$$

= 0 
$$S_b > S_L$$
,  $\frac{d(P_e/P_s)}{dS} \ge 0$  1003

-128-546<

$$\xi$$
 = XSI = RHØBS · XMUBBB · DUDSW ·  $\frac{1}{2 \operatorname{JFL} \emptyset \mathbb{W} + 2}$  ,  $S_b \leq S_1$  1000

= XSISUB + XMUBBB. 
$$\int_{S_1}^{S_b} R \phi B \cdot UED \cdot Y_b^{2JFL \phi W} dS = 1001$$

where

 $S_{1} = S_{b} \text{ evaluated at second output point}$   $XSISUB = \xi \text{ evaluated at largest SBW(I) < S_{2}$   $\rho_{e} = R \phi E = RH \phi T \quad PREW(I)^{1/GAME}$   $REY_{1} = REW(I) = R \phi E \quad UED \quad SBW(I)/(XMUE \cdot RYN \phi RM)$   $XMUE = \mu_{TE}, TE = TT \cdot \left(\frac{GAME - 1}{GAME}\right)$ 

$$QT_{i} = QTW(I) = 0.0296 \left(\frac{2^{0.2} (JFL \emptyset W)}{SIGMA^{2/3}}\right) \cdot RSRE^{0.8} \cdot \left(\frac{XMUST}{XMUE}\right)^{0.2} REY^{0.2}$$

$$\cdot R \not = * UED \cdot \frac{HAMB}{(1556 + QTSTAD)} 1006$$

RSRE = TE/TSTR

$$\text{ISTR} = \text{TE} \quad \left[1 + \frac{1}{2} \left(\frac{\text{TB}}{\text{TE}} - 1\right) + 0.22 \cdot \text{SIGMA}^{1/3} \left(\frac{\text{TT}}{\text{TE}} - 1\right)\right]$$

4. WIND

٠

$$\begin{split} \mathbf{y}_{\mathbf{b}} &= & \mathrm{YBW}(\mathbf{I}) = (\mathbf{y}_{\mathbf{o}_{1}} - \mathrm{YBRAL}) \cdot \cos\left(\alpha\right) + (\mathbf{x}_{\mathbf{o}_{1}} - \mathrm{XBRA2}) \cdot \sin\left(\alpha\right), \ \mathbf{x}_{\mathbf{o}_{1}} < \mathbf{x}_{\mathbf{o}_{1}\mathrm{argest}} \\ &= & (-\mathbf{y}_{\mathbf{o}_{1}} - \mathrm{YBRAL}) \cdot \cos\left(\alpha\right) + (\mathbf{x}_{\mathbf{o}_{1}} - \mathrm{XBRAL}) \cdot \sin\left(\alpha\right), \ \mathrm{after} \ \mathbf{x}_{\mathbf{o}_{1}} = \mathbf{x}_{\mathbf{o}_{1}\mathrm{argest}} \\ \mathbf{x}_{\mathbf{b}} &= & \mathrm{XBW}(\mathbf{I}) = (\mathbf{x}_{\mathbf{o}_{1}} - \mathrm{XBRAL}) \cdot \cos\left(\alpha\right) - (\mathbf{y}_{\mathbf{o}_{1}} - \mathrm{YBRAL}) \cdot \sin\left(\alpha\right), \ \mathbf{x}_{\mathbf{o}_{1}} < \mathbf{x}_{\mathbf{o}_{1}\mathrm{argest}} \\ &= & (\mathbf{x}_{\mathbf{o}_{1}} - \mathrm{XBRAL}) \cdot \cos\left(\alpha\right) - (-\mathbf{y}_{\mathbf{o}_{1}} - \mathrm{YBRAL}) \cdot \sin\left(\alpha\right), \ \mathrm{after} \ \mathbf{x}_{\mathbf{o}_{1}} = \mathbf{x}_{\mathbf{o}_{1}\mathrm{argest}} \end{split}$$

XBRAL, YBRAL, SBRAL = values of  $x_{\rm o}$ ,  $y_{\rm o}$ , and  $S_{\rm o}$  for stagnation point of current  $\alpha$ , in zero angle of attack system.

=  $2 S_{o_{1argest}} - SBRAL - S_{o_1}$  after  $x_{o_1} = x_{o_{1argest}}$ 

# 5. <u>LEE</u>

$$y_{\mathbf{b}} = \text{YBL}(\mathbf{I}) = (y_{\mathbf{0}_{1}} - \text{YBRAL}) \cos(\alpha) + (x_{\mathbf{0}_{1}} - \text{XBRAL}) \cdot \sin(\alpha), \qquad x_{\mathbf{0}_{1}} > 0$$

.

$$= (-y_{o_1} - YBRAL) \cdot \cos(\alpha) + (x_{o_1} - XBRAL) \sin(\alpha) \qquad \text{after} \qquad x_{o_1} = 0$$

$$x_b = XBL(I) = (x_{o_1} - XBRAL) \cdot \cos(a) - (y_{o_1} - YBRAL) \cdot \sin(a)$$
  $x_{o_1} > 0$ 

$$= (x_{o_1} - XBRAL) \cdot \cos(\alpha) - (-y_{o_1} - YBRAL) \cdot \sin(\alpha) \qquad \text{after} \qquad x_{o_1} = 0$$

$$\theta_{b} = \text{THETBL}(I) = 180 \cdot -\theta_{o_{1}} - \alpha \qquad x_{o_{1}} > 0$$

 $= \theta_{o_1} - a$  after  $x_{o_1} = 0$ 

$$S_b = SBL(I) = SBRAL - S_{o_1} \cdot x_{o_1} > 0$$

= SBRAL + 
$$S_{o_1}$$
 after  $x_{o_1} = 0$ 

6. <u>GETDS</u>

DELS = RAØRS · EF

$$EF = ACOSH \frac{1}{\sqrt{3 RAORS}} - DTDSMP \cdot \frac{1}{\sqrt{1-3 RAORS}}$$

$$if \frac{d\theta_b}{dS_b} < 0, \ 0 \le S_b \le S_b^*, \text{ and } JFLOW \le 0$$

$$-130-$$

$$548 \le 1000$$

DTDSMP = 
$$1 / \frac{d\theta_b}{ds_b} |_{current stag point}$$
  
IF  $\frac{d\theta_b}{ds_b} = 0, 0 \le S_b \le S_b^*$ , and JFLØW < 0, the equation is the same but  
 $= -RN$  if  $\alpha = 0$ ,  $\gamma$  1025

$$DTDSMP = -\frac{Y1\Psi(1)}{\sin(\alpha)} \text{ if } \alpha \neq 0, \qquad 1026$$

where Y1W (1) is the y coordinate of the stagnation point for the current  $\alpha$ in the zero angle of attack system I

DTDSM P = 
$$1/\frac{d\theta_b}{dS_b}$$
 | current stag point if  $\frac{d\theta_b}{dS_b}$  | current stag point  $\neq 0$  1036

If  $JFL\phi W > 0$ , DELS is computed from a two dimensional table look up

(1009 to 1018) for  $\frac{\Delta s}{V_T}$  ( $\epsilon$ ,  $\rho_A / \rho_s$ ), where  $Y_T$  and  $\epsilon$  are either referenced to

the sonic point (1008) or the beginning of a straight section if there is such a section in  $0 \leq S_b \leq S_b^*$  (1028 to 1031, if  $x_b^* \geq \Delta_{so}$ . If  $x_b^* < \Delta_{so}$  DELS =  $\Delta_{so} - x_b^*$  at 1037.

7. GETQRS

If  $\theta_w = 90$ ,  $\xi = \text{STAND}(I) =$  $XBW (I) - \left\{ \frac{-RW + SQRTF (RW^2 + BSHØCK YBW (I)^2)}{BSHØCK} - DELS \right\}$ 1036

If  $\,\theta_{_{\mathbf{W}}}\,\neq\,\,90\,,\,\,\operatorname{compute}\,Y_{_{\mathbf{W}}}\,=\,\,Y\mathbb{W}\,=\,\,\operatorname{pos}\,\,\operatorname{root}\,\operatorname{of}\,\operatorname{the}\,\,\operatorname{quadratic}\,\,\operatorname{given}\,\operatorname{by}\,$ 

 $A = 1 - BSHØCK TANN^2$ 

r

 $B = 2 RW \cdot TANN + 2 BSHØCK DM TANN + 2 \cdot BSHØCK YBW (I) TANN<sup>2</sup>$  $C \approx 2 \text{ RW} \{DM + YBW(I) \cdot TANN\} - BSH \phi CK \cdot DM^2 - BSH \phi CK YBW(I)^2 TANN^2$ - 2 · BSHØCK · DM YBW (I) · TANN -131-

where,

$$TANN = tan(\theta_{w_1}), DM = XBW(I) - DELS$$
 1040-1003

SSS = STAND (I) = 
$$\frac{[YW - YBW(I)]}{\cos(THWT)}$$
 if BSHØCK  $\leq 0$  1025

$$SSS = STAND (I) = \frac{AINT + ARGUI \cdot DM - YBW (I)}{\cos (THWT) + ARGUI \cdot \sin (THWT)}$$
 if BSHØCK > 0

where,

$$\begin{split} \text{AINT} &= \text{YBW} \left( I - 1 \right) + \text{STAND} \left( I - 1 \right) \cdot \text{ cos (THETBW } \left( I - 1 \right) - \text{ARGUI } \left[ \text{XBW} \left( I - 1 \right) - \text{STAND} \left( I - 1 \right) \cdot \text{ sin (THET BW} \left( I - 1 \right) + \text{DELS } \right] \end{split}$$

ARGUI = SQRTF (BSHØCK)

$$\theta_{w} = THWW = \tan^{-1} \frac{2 \cdot RW + 2 \cdot BSHOCK \cdot [DM - (YW - YBW(I)) \cdot TANN}{2 \cdot YW}$$

 $P = PARG = PREW (I) \cdot \frac{PWS}{2116} \cdot$ 

$$QRAD_1 \approx QRAD(I) \approx \frac{1}{2} STAND(I) - \frac{XMMX}{XMMX+1} \cdot XINB + \frac{1}{XMMX} \cdot XINW$$

XINB = table (1, 12)  $| \theta_w = THT$ , XINW = table (1, 13) | P = PARG,

independent variable tables being TABLE (1, 1) and (1, 7), respectively.

#### 8. STAGPT

XBRAL = YBR  $\cdot \sin(\alpha) - XBR \cdot \cos(\alpha)$ , 1027 XBR, YBR are x and y co-ordinates in the zero angle of attack system of a point where  $\theta_b + \alpha = 90$ . The stagnation point is that which maximizes XBRAL, and the candidates are found by the IF LØØP from 1030 to 1008.

## 9. GETB

$$BB = (GAMS - 1) \cdot (PRCON) \frac{(I - GAMS)}{GAMS} \cdot XINT$$

$$PRC \not DN = \frac{P_e}{P_s} \text{ at start of straight section}$$

$$XINT = \int_0^{y_{SS}} PRE \ dy_b \ , \ y_{SS} = y_b \text{ at start of straight section, } JFL \not DW \le 0$$

XINT = 
$$\int_{0}^{y_{ss}} PRE \cdot y_b \, dy_b , JFLOW > 0.$$

10. FINDRW

•

$$\xi_2 = XSI2 = \text{largest root of } C_1 \xi^2 + C_2 \xi + \phi = 0$$
, If J FLÓW > 0 1014

where

.

$$C_1 = 2 \cdot TBR\left[ \cdot 5 \cdot RE \not ORA \cdot UE \not OV + \frac{1}{XNNX + 2} \cdot TERM \right] - 2 \cdot YB \cdot TBR$$

TBR = cos (TB), TB =  $\theta_b$  = body angle

$$\rho_{e} / \rho_{a} = \text{RE} \emptyset \text{RA} = \text{RS} \emptyset \text{RA} \cdot \text{PREW} (I) \left(\frac{1}{\text{GAMS}}\right)$$
$$U_{e} / V = \left\{ \frac{2 \cdot \text{HAMB}}{V^{2}} \left[ 1 - \text{PREW} (I) \frac{(\text{GAMS} - 1)}{\text{GAMS}} \right] \right\}^{1/2}$$

TERM ≈ RURV · CØSF (TWL - TB) - REØRA · UEØV

TWL and RURV =  $\theta_{\rm w\,L}$  and  $\rho_{\rm U}/\rho_{\rm a\,V}$  evaluated from oblique data at  $\theta_{\rm w}$  = THET

$$YB = body y$$
  
$$\xi_2 = XSI2 = (If J FL \phi W \le 0) YB / \left[ RE \phi RA \cdot UE \phi V + \frac{1}{XNNX + 1} \quad TERM - TBR \right]$$
  
For the forward point, (IC  $\phi$ MP = 0)

$$\frac{\xi_1 = XSI1 = [(XB + DELS) \cos (THETR) - YB \cdot (1 - \sin (THETR))]}{TBR - \sin (THET - TB)}$$
1071

where

THETR =  $\theta_w$  of iteration, XB = body X - coordinate, DELS = detachment distance

 $RW = [XSI2 \cdot TBR + YB] / cos (THETAW), THETAW = converged \theta_w 1066$ 

For the most forward point with  $\theta_{\rm b} \leq 0$  (IC $\phi$ MP = 1)

$$\begin{split} \xi_1 &= \text{XSII} &= \text{largest root of } A \xi^2 + B \xi + C \\ A &= 1/(\text{XB} + \text{DELS}) \\ B &= 2 \cdot \text{YB} \cdot A - \text{tan (THETR}) \\ C &= \text{YB}^2 \cdot A - R \mathbb{W} - \text{YB} \cdot \text{tan (THETR}) \\ BSH \phi CK &= [(\text{YB} + \text{XSI2}) \cdot \text{TANTR} - R \mathbb{W}]/(\text{XB} + \text{DELS}), \text{ TANTR} &= \text{tan (THETR}), \\ \text{THETR} &= \text{converged } \theta_{\text{W}} . \end{split}$$

11. ACØSH

ACOSH (ARG) = 
$$ln (2 \cdot ARG) - \frac{1}{2} \cdot \frac{1}{2 ARG^2} - \frac{1}{2} \cdot \frac{3}{4} \cdot \frac{1}{4 ARG^4} - \cdots$$

12. DERQ5

$$\frac{d(P_e/P_S)}{dx} = \tan \theta_b - \sqrt{\frac{P_e/P_S - P_A/P_S}{1 - P_e/P_S - P_A/P_S}},$$
 1006

$$P_{A}/P_{S} = PA \phi PS P_{e}/P_{S} = XEQ(1)$$

$$JFL \phi V > 0.$$

$$\frac{d (P_{e}/P_{S})}{dx} = \frac{GAMS}{BB} \cdot \left(\frac{P_{e}}{P_{S}}\right) \xrightarrow{GAMS + 1}{GAMS} \cdot XTERM$$

$$XTERM = y_{ss} \cdot \tan \theta_{b} + \tan^{2} \theta_{b} (x - x_{ss}) - \sqrt{ARG}$$

$$ARG = \left[\frac{P_{e}/P_{S} - P_{A}/P_{S}}{1 - P_{e}/P_{S} - P_{A}/P_{S}}\right] \left[2 \cdot BB \cdot \left(\frac{P_{e}}{P_{S}}\right)^{-\frac{1}{GAMS}} + (y_{ss} + \tan \theta_{b} (x - x_{ss}))^{2}\right]$$

 $x_{ss}^{}$  ,  $y_{ss}^{}$  ,  $\theta_{b}^{}$  ;  $x_{b}^{}$  ,  $y_{b}^{}$  ,  $\theta_{b}^{}$  at start of straight section, x = independent variable.

## 13. SUB110

The zero angle of attack co-ordinate equations are obvious by inspection, and have been documented in Program 1882.

#### V. REFERENCES

- 1. Properties of Argon Free Air, Report No. GM-TM-76, The Ramo-Wooldridge Corp. (October 1956).
- Vinokur, M. Hypersonic Flow Around Bodies of Revolution Whose Shock Waves are Generated by Conic Sections, LMSD, TR-LMSD-288139 General Research in Flight Sciences, <u>I</u>, Part 1, Fluid Mechanics (January 1959 to 1960).
- Kaattarı, G. F., Shock Envelopes of Blunt Bodies at Large Angles of Attack, NASA TND-1980 (December 1963).
- Hayes, W. D., and R. F. Probstein, <u>Hypersonic Flow Theory</u>, Academic Press, N.Y. p. 160 (1959).
- RAD, Mars-Venus Capsule Parameter Study Vol. I. Introduction and Analysis, Avco/RAD TR 64-1, JPL Contract No. JPL-950626 (21 March 1964).
- Salathe, E. P., Entropy-Layer Theory For Pressure Distributions in Hypersonic Flow, Avco/RAD TM-62-79 (1962).
- Wang, C. J., J. B. Peterson, and R. Anderson, Gas Flow Tables, Space Technology Laboratories, GM-TR-154 (14 March 1957).
- Lees, L. and T. Kubota, Inviscid Hypersonic Flow Over Blunt Nosed Slender Bodies JAS Vol. 24, No. 3, p.-195 (March 1957).
- Ferri, A., The Influence of the Shock Curvature on the Behaviour of Hypersonic Boundary Layer, PIBAL Report No. 542, AD No. 236242 (February 1960).
- Kemp, N. H., P. H. Rose, and R. W. Detra, Laminar Heat Transfer Around Blunt Bodies in Dissociated Air, JAS <u>26</u>, No. 7 pp. 421-430 (July 1959).
- 11. Reshotko, E., Heat Transfer to a General Three Dimensional Stagnation Point, Jet Propulsion Labs., pp.58 to 59 (January 1958).
- Rose, P., R. F. Probstein, and M. C. Adams, Turbulent Heat Transfer Through A Highly Cooled Partially Dissociated Boundary Layer, JAS Vol. 25, No. 12 (December 1958).
- Larson, H. K., Heat Transfer in Separated Flows, JAS pp. 731 to 738, 26, No. 11 (November 1959).

-136-

- Chapman, D. R., A Theoretical Analysis of Heat Transfer in Regions of Separated Flow, NACA TN 37 2 (October 1956).
- Berman, R. J., Bow Shock Shape About a Spherical Nose, AIAA 3, No. 4, pp. 778 to 780 (April 1965).
- 16. Seiff, A., and E. E. Whiting, Calculation of Flow Fields From Bow-Wave Profiles for the Downstream Region of Blunt-Nosed Circular Cylinders in Axial Hypersonic Flight, NASA TND-1147, (November 1961).
- Terry, J. E. and C. S. James, Parametric Study of Hypersonic Flow Fields About Blunt-Nosed Cylinders at Zero Angle of Attack, NASA TND-2342 (July 1964).
- Lomáx, H. and M. Inouye, Numerical Analysis of Flow Properties About Blunt Bodies Moving at Supersonic Speeds in an Equilibrium Gas, NASA TN TR R-204, Washington, D.C. (July 1964).
- Inouye, M., J. V. Rakich, and H. Lomax, A Description of Numerical Methods and Computer Programs for Two-Dimensional and Axisymmetric Supersonic Flow Over Blunt-Nosed and Flared Bodies, NASA TN-D-2970, Washington, D. C. (August 1965).

PROGRAM 1886

# PRELIMINARY STRUCTURES WEIGHT PROGRAM (1886)

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i.

#### I. INTRODUCTION

#### A. GENERAL DESCRIPTION

The purpose of this program is to determine the unit area structural weight requirements for shells to resist the critical aerodynamic loads incurred during entry. The general inputs include:

1. The aerodynamic load in terms of the peak pressure which may occur on each section of the vehicle.

2. The mechanical properties of the material, including modulus of elasticity, yield stress, Poisson's ratio, and density.

3. Geometric parameters describing the size and shape of the elemental sections, including spherical caps, conical frustra, cylinders, and the tension shell.

- 4. The following types of construction can be handled by the program.
  - a. Cylinders and conical frustra-honeycomb or ring stiffened.
  - b. Spherical caps -- honeycomb or monocoque
  - c. Tension shell--monocoque

5. The program treats the case of a hot structure, using the thin skin assumption, for which the convective and radiative heating tables and a stagnation enthalpy table are required as input. Additional material properties must be specified for this case, including the specific heat, and emissivity. The variation of material properties with temperature is handled by input values. The program will obtain the unit area weight necessary to resist the combined aerodynamic and thermal loads.

6. The design criteria utilized include buckling and/or yield stress criteria, and allowable temperature rise.

#### B. CALCULATION MODEL

1. Honeycomb Sandwich

The calculation model for the honeycomb analysis is described in detail in Reference 1, and hence only a brief summary is given here. The analyses considered five modes of failure: (1) general instability; (2) yielding of face sheets, (3) core crushing; (4) dimpling of face sheets; and (5) wrinkling. Since little test data and theoretical analysis are available on the buckling of sandwich spherical caps, derivation of the general instability criteria was limited to transformation of isotropic buckling data  $^{2-4}$  to sandwich shells; the data was correlated as shown in Figure 1. Transformation of these data employed the use of equivalent bending and extensional rigidity moduli for sandwich shells. The equivalent extensional (B) and bending (D) rigidities have the form:

$$B = \frac{2 E_f t_f}{(1 - \nu_f^2)}$$
$$D = \frac{E_f t_f t_c^2}{2 (1 - \nu_f^2)}$$

where  $E_f$ ,  $\nu_f$  and  $t_f$  are the modulus of elasticity, Poisson ratio and thickness of the face sheets and  $t_c$  is the core height. The experimental data for the buckling of homogeneous spherical shells was taken from References 2, 3, and 4. The spherical cap geometry is depicted in Figure 2.

The conical and cylindrical sandwich analyses were based on the approach of Reference 5 utilizing the equivalent rigidities discussed above. The conical shell geometry used is depicted in Figure 3.

The honeycomb calculated provides an optimum face sheet, and core height to resist buckling with minimum weight. The optimum values to prevent buckling are compared with those required for the yield or minimum gauge criteria, then the honeycomb sandwich is re-analyzed with the heavier face sheets and the results given for the core height and total unit weight.

The calculation model allows for the combined interaction of lateral pressure and axial loads. The effects of body forces due to the deceleration experienced during entry, for example, are also included in the calculation model. The body forces due to the heat shield are included. The inclusion of the body forces results in an iterative solution as the effect depends on the structural weight which is, of course, unknown initially. Besides the buckling criteria of Reference 5, the meridional  $(\sigma_E)$  and circumferential  $(\sigma_{\theta})$  stresses are incorporated into an elastic yield criteria, where in the allowable stress is given by

$$\sigma_{\rm y} = \sqrt{\sigma_{\theta}^2 + \sigma_{\xi}^2 - \sigma_{\theta} \sigma_{\xi}}$$

In the case of forward facing cones, it is possible that the maximum stress will not be at the base of the cone due to the body forces; hence, the resultant stress ( $\sigma_y$ ) is tested over the whole length of the cone to ascertain its maximum value.



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Figure 1 EXPERIMENTAL BUCKLING OF SPHERICAL SHELLS



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Figure 2 SPHERICAL CAP GEOMETRY

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Figure 3 CONICAL SANDWICH SHELL GEOMETRY

#### 2. Ring-Stiffened

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The calculation model for the ring-stiffened analysis is that suggested in Reference 5. The method of solution is based on an application of the principle of minimum potential energy of an equivalent orthotropic shell, utilizing a set of displacement relationships to describe the deflected shape. The range of application of shell geometries is approximately given by,

$$10^2 < 2 \left(\frac{L}{R_2}\right)^2 \quad \frac{\cos \theta}{\left(1 + \frac{R_1}{R_2}\right)} \quad \frac{R_2}{\tau} < 10^4$$

where (L) is the slant length, ( $R_1$ ) and ( $R_2$ ) are the minimum and maximum radii, (t) is the shell thickness, and <sup>( $\theta$ )</sup> is the cone angle of the shell section.

A particular stiffener geometry, that of a (Z) section as shown in Figure 4, is fixed in the program. The effective width of the stiffener is controlled by input, as well as the proportions of the stiffener.

The solution is programmed so as to satisfy local and overall stability and to solve for the number of rings which minimize the total shell weight. Tests are provided to ensure minimum gauge and yeild criteria are satisfied.

The program provides for the option of either specifying the stiffener height and satisfying both local (inter-bay) and general stability, which in general will require different shell thicknesses or the program can solve for the stiffener height which yields equal shell thickness requirements for local and general stability. The calculation model assumes that the stiffeners have the same thickness as the shell. The spacing between stiffeners is limited to a value not smaller than the effective width.

The calculation model provides for lateral pressure and axial loads as well as for body forces. The body forces include those due to the structure as well as those arising due to a heat shield attached to the structure. The inclusion of the body forces results in an iterative solution as the body force depends on the structural weight which is unknown initially.

The method of solution starts by considering a shell without rings and satisfying the buckling, yield stress and minumum gage limitations. If the minimum gage and/or yield stress limits are not excluded then rings are added in a sequence controlled by input, i.e., rings may be added one at a time or in a progressive manner given by the expression

 $N_{K} = N_{j}$  (NFAC) + NTERM



Figure 4 RING STIFFENED CONE GEOMETRY

where NFAC and NTERM are program input integers. Each ring configuration solution is tested against the limits on minimum gage and/or yield stress and if either of these two conditions are excluded, the calculation stops, with the last weight being evaluated on the largest of the thickness requirements.

The yield stress criteria is based on the combined criteria wherein the maximum stress is given by

.

$$\sigma_{\rm y} = \sqrt{\sigma_{\xi}^2 + \sigma_{\theta}^2 - \sigma_{\theta} \sigma_{\xi}}$$

In the case of forward facing cones, it is possible that the maximum stress will not be at the base of the cone due to the body forces, hence, the resultant stress  $(\sigma_y)$  is tested over the whole length of the cone to ascertain its maximum value.

#### 3. Tension Shell

The calculation model for the tensión shell utilizes the membrane equations to determine the stress distribution in the shell, as done in Reference 6. The calculation model assumes that the vehicle mass all exists forward of the tension shell. Two options are provided, one being the case of a Newtonian pressure distribution and zero hoop stress and the second being the more general case wherein the coordinates are input, and the hoop tension is taken as a fraction of the meridional tension, i.e.,  $N_{d} = aN_{d}$ .

Along with the tension shell analysis, the compression ring weight is evaluated using the criteria of lateral stability as derived in Reference 7, and that of buckling of a long cylinder in compression as suggested in Reference 8. A circular cross section is used to estimate the compression ring weight.

#### 4. Monocoque

An option is provided to compute the weight of spherical caps of monocoque construction. The approach is empirical, utilizing the buckling data correlated in Figure 1 and the shell model in Figure 2. General instability and yielding modes of failure are considered, and the resulting shell thickness is compared with practical minimum gage limitations.

#### 5. Geometry

The overall vehicle geometry for which the program is intended is shown in Figures 5 and 6. The toroidal sections defined by RSN, RSC, and RSB cannot be handled with the program; however, these parameters are required as input to define the fore and aft radii of each conical section. The tension shell geometry considered is shown in Figure 6 wherein the tension shell replaces Section 23, as shown in Figure 5.





Figure 5 VEHICLE SHAPE PARAMETERS

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 $<sup>\</sup>beta$  - TENSION SHELL INPUT PARAMETER R<sub>3</sub> - BASE RADIUS OF TENSION SHELL (NOT INPUT)



Figure 6 TENSION SHELL AND GENERAL SHAPE PARAMETERS

#### 6. Body Forces

The calculation model provides for the inclusion of body forces resulting from the structure and the heat shield during entry.

The formulation of the sandwich buckling analysis for cones can handle a limited range of body forces when the body forces cause a tensile stress. The limitations are due to the fact that  $K_1$  and  $K_2$  must be greater than zero as the equations are formulated. The limits take the form

$$\frac{(\overline{\mathbb{W}HS} + \overline{\mathbb{W}})G}{144 P_{CR} \sin \theta} \leq 1 + \frac{\overline{\gamma}(1 - \beta)^2}{\beta(1 - \beta + \beta/3 + \beta/2\pi)^2} .$$

$$\frac{(\overline{\mathbb{W}HS} + \overline{\mathbb{W}})G \sin \theta}{144 P_{CR}} \leq 1$$

In general, these limits are automatically fulfilled for entry vehicles where the fore body pressures are sufficiently large to decelerate the payload internal structure and afterbody as well as the heat shield and structure of the forebody.

#### 7. Hot Structures

The option to compute the temperature rise for a specified heat pulse is contained within the program. Both the convective and radiation heat pulses may be input. Provision is made to account for the hot wall reduction on the convective heating and for reradiation. The structure is assumed to be at a uniform temperature equal to the surface temperature. In the event the structure temperature rise exceeds the allowable input value, the structural weight is increased. The material properties are treated as a function of temperature.

C. LIMITATIONS

The following basic limitations exist in the program:

1. The effects of bending and edge conditions are not treated.

2. The sandwich core is assumed rigid so that transverse shear deformation has a negligible influence on the buckling load; consequently the results would not be valid for a weak core.

- 3. The sandwich construction must have equal face sheet thicknesses.
- Axisymmetric loading is assumed.

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## II. USAGE

## A. INPUT DEFINITIONS

| Name   | Preset<br>Values | Symbol         | Parameter                                                                                                     | Units               |
|--------|------------------|----------------|---------------------------------------------------------------------------------------------------------------|---------------------|
| A      | 0.               | a              | Ratio of Circumferential to<br>meridional stress for ten-<br>sion shell.                                      |                     |
| BETA   | 0.               | β              | Leading edge angle for tension shell.                                                                         | degrees             |
| CASE   | 0.               |                | Identification number of the form XX.XX.                                                                      |                     |
| CBAR   | 1.               |                | An empirical factor which<br>modifies the value of used<br>in the calculation model for<br>combined loadings. |                     |
| СРТАВ  | 0.               | C <sub>p</sub> | Specific heat table.                                                                                          | Btu/lb-°F           |
| DATE   | 4.01             |                | Identification number of the form XX.XX.                                                                      |                     |
| DELKI  | 0.               |                | Additive term in calculation of $K_1$ .                                                                       | in.3                |
| DELK2  | 0.               |                | Additive term in calculation of $K_2$ .                                                                       | inches              |
| DELTAU | 0.1              |                | Time increment used for<br>integration of temperature<br>rise equation.                                       | seconds             |
| DTHDY  | 0.               | d <i>θ/</i> dY | Derivative of body angle<br>with radial coordinates for<br>general shape.                                     | rad/ft              |
| EF     | 0.               | Ef             | Modulus of elasticity for<br>honeycomb face sheets and<br>monocoque skin.                                     | <sub>lb/1n</sub> ,2 |
| EFTAB  | 0.               | E <sub>f</sub> | Face sheet modulus table.                                                                                     | 1b/in. <sup>2</sup> |

| Name   | Preset<br>Values | Symbol              | Parameter                                                           | Units              |
|--------|------------------|---------------------|---------------------------------------------------------------------|--------------------|
| EM     | 0.               | m                   | Effective width factor.                                             |                    |
| EN     | 0.               | n                   | Stiffener proportionality factor.                                   |                    |
| EMISTR | 0.               | E                   | Emissivity of structure.                                            |                    |
| EPS    | 0.01             |                     | Thickness iteration factor.                                         |                    |
| ER     | 0.               | E <sub>R</sub>      | Modulus of elasticity for compression ring.                         | lb/1n.2            |
| GAMF   | 0.               | $\nu_{\rm f}$       | Poisson ratio for honey-<br>comb face sheets and<br>monocoque skin. |                    |
| G      | 0.               |                     | Deceleration.                                                       | Earth g            |
| GAMR   | 0.               | ν <sub>R</sub>      | Poisson's ratio for core<br>ribbon.                                 |                    |
| GAMBAR | 0.               | $\overline{\gamma}$ | Axial load factor.                                                  |                    |
| GFTAB  | 0.               | ν <sub>f</sub>      | Face sheet Poisson's ratio table.                                   |                    |
| GRTAB  | 0.               | ν<br>r              | Ribbon Poisson's<br>ratio table.                                    |                    |
| HS     | 0.               | н                   | Height of stiffener.                                                | inches             |
| HTBL   | 0.               | hm/rt <sub>o</sub>  | Stagnation enthalpy table.                                          |                    |
| HTST   | 0.               |                     | Hot-structure option sentinel.                                      |                    |
| нтфр   | 1.               |                     | Stiffener optimization sentinel.                                    |                    |
| KADHES | 0.               | к                   | Honeycomb adhesive weight.                                          | lb/ft <sup>2</sup> |
| LC     | 0.               | LC                  | Cylinder length.                                                    | feet               |

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|        |                  | ·····              |                                                             |                         |
|--------|------------------|--------------------|-------------------------------------------------------------|-------------------------|
| Name   | Preset<br>Values | Symbol             | Parameter                                                   | Units                   |
| мемф   | 0.               |                    | Identification number of of the form XX.XX.                 |                         |
| MØN    | 0.               |                    | Monocoque option sentinel.                                  |                         |
| NFAC   | 2.               |                    | Constants which specify ring frequency.                     |                         |
| NTERM  | 0.               |                    | $(N_{K} = N_{j} NFAC + NTERM)$                              |                         |
| PCR    | 0.               | PCR                | Aerodynamic pressure.                                       | lb/in. <sup>2</sup>     |
| QCMULT | 0.               |                    | Convective heat pulse multiplier.                           |                         |
| QRMULT | 0.               |                    | Radiative heat pulse<br>multiplier.                         |                         |
| QTBL   | 0.               | ۹ <sub>c</sub>     | Convective heating table.                                   | Btu/ft <sup>2</sup> sec |
| RA     | 0.               | RA                 | Aft Cap radius.                                             | feet                    |
| RB     | 0.               | R <sub>B</sub>     | Base radius.                                                | feet                    |
| RC     | 0.               | R <sub>C</sub>     | Cylinder radius.                                            | feet                    |
| RN     | 0.               | R <sub>N</sub>     | Nose Cap radius.                                            | feet                    |
| RØCMAX | 0.               | Pmax               | Maximum core density.                                       | lb/ft <sup>3</sup>      |
| RØCMIN | 0.               | ρ <sub>min</sub>   | Minimum core density.                                       | lb/ft <sup>3</sup>      |
| RØF    | 0.               | $ ho_{\mathrm{f}}$ | Density of honeycomb<br>face sheet and monoco-<br>que skin. | lb/ft <sup>3</sup>      |
| RØR    | 0.               | ρ <sub>R</sub>     | -<br>Density of core ribbon.                                | lb/ft <sup>3</sup>      |
| RØRG   | 0.               | ρ <sub>g</sub>     | Density of compression<br>rıng skin.                        | lb/ft <sup>3</sup>      |
| RSB    | 0.               |                    | Shoulder radius.                                            |                         |

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| Name   | Preset<br>Values | Symbol                          | Parameter                                    | Units                   |
|--------|------------------|---------------------------------|----------------------------------------------|-------------------------|
| RSC    | 0.               | R <sub>SC</sub>                 | Shoulder radius.                             | feet                    |
| RSD    | 0.               |                                 | Ring-stiffened option<br>sentinel.           |                         |
| RSN    | 0.               | R <sub>SN</sub>                 | Shoulder radius                              | feet                    |
| RT     | 0.               | <sup>к</sup> т                  | Truncation radius at base.                   | feet                    |
| RTBL ' | 0.               |                                 | Radiative heating table.                     | Btu/ft <sup>2</sup> sec |
| SECTN  | 0.               |                                 | Ordered array of section numbers.            |                         |
| SGFTAB | 0.               | σ <sub>f</sub>                  | Face-sheet yield stress table.               | lbs/in. <sup>2</sup>    |
| SGRTAB | 0.               | $\sigma_{r}$                    | Ritbon yield stress table.                   | 1b/1n. <sup>2</sup>     |
| SIGCAL | 0.               | σ <sub>f</sub>                  | Yield stress of honeycomb face sheet.        | 1b/1n.2                 |
| SIGCYR | 0.               | σ                               | Yield stress of core<br>ribbons.             | lb/in.2                 |
| SIGRG  | 0.               | σg                              | Yield stress of compres∸<br>sion rıng skın.  | 1b/in. <sup>2</sup>     |
| TCMAX  | 0.               | <sup>t</sup> c <sub>max</sub> . | Maxımum core thickness.                      | inches                  |
| TCMIN  | 0.               | tc <sup>min</sup>               | Minimum core thickness.                      | inches                  |
| TEMPA  | 0.               |                                 | Maximum allowable<br>structural temperature. | °F                      |
| TEMPI  | 0.               |                                 | Initial structural temperature.              | °F                      |

| Name              | Preset<br>Values | Symbol            | Parameter                                                                                   | Units              |
|-------------------|------------------|-------------------|---------------------------------------------------------------------------------------------|--------------------|
| TFMIN             | 0.01             | <sup>t</sup> fmin | Minimum honeycomb face<br>sheet and monocoque skin<br>thickness.                            | inches             |
| THA               | 0.               | $\theta_{A}$      | Afterbody cone angle.                                                                       | degrees            |
| THB               | 0.               | $\theta_{\rm B}$  | Flare angle.                                                                                | degrees            |
| THC               | 0.               | θ <sub>C</sub>    | Forebody cone angle.                                                                        | degrees            |
| THN               | 0.               | $\theta_{ m N}$   | Nosecap angle.                                                                              | degrees            |
| TH2G              | 0.               | $\theta_{2G}$     | Initial angle for general tension shell.                                                    | degrees            |
| TH3G              | 0.               | θ <sub>3G</sub>   | Final angle for general tension shell.                                                      | degrees            |
| TIME              | 0.               |                   | Time.                                                                                       | seconds            |
| TINIT             | 0.               |                   | Initial temperature at<br>which structural properties<br>are selected.                      | ۴                  |
| TSTØP             | 0.               |                   | Maximum thermal design<br>time during which T <sub>W</sub> <<br>T <sub>W</sub> max          | °F                 |
| TTAB              | 0.               | t                 | Temperature table.                                                                          | °F                 |
| WHS               | 0.               |                   | Unit heat shield weight.                                                                    | lb/ft <sup>2</sup> |
| ΧΑ, ΧΝ,<br>ΧC, ΧΦ | 0.               |                   | Mole fractions of argon,<br>nitrogen, carbon dioxide,<br>and oxygen in the atmos-<br>phere. |                    |
| X, R              | 0.               | X, R              | Coordinates for general shell.                                                              | feet               |

#### B. INPUT PROCEDURES

#### 1. General

a. Decimal points may be used on all numerical input data, although they are not necessary on integer values.

b. RC must always be specified.

c. If RB 1s not specified, then RB=RC.

d. Contour angles ( $\theta$ ) are measured relative to free stream and a positive value indicates an increasing body radius whereas a negative value indicates a decreasing body radius.

e. If several cases are run on a single memo, only changed inputs need be specified following the first case.

f. Input QTBL, HTBL, and RTBL as a function of TIME. For each value of TIME input there must be corresponding values of QTBL, HTBL, and RTBL (maximum of 150 values in each table). In stacking cases, it is necessary to add at least one 0. value at the end of the TIME table if the number of entries is <u>decreased</u>. This 0. value is used internally as an indication of the end of the table.

#### 2. Shell Geometry

The section numbers and section parameters are identical to those of Programs 1881, 1882, and so forth. Although tori cannot be handled by the program, the tori parameters are nevertheless required in many cases to compute the fore and aft section radii.

#### SECTIØNS

The vehicle sections are specified by an ordered list of numbers which identify them and place them in the desired sequence. The number list is given below, and the corresponding sections are further described by Figures 5 and 6.
| Number | Section       | Input Required   |
|--------|---------------|------------------|
| 1.     | NOSE SPHERE   | RN, THN          |
| 2.     | TORUS         | RSN              |
| 3.     | CONE          | THC              |
| 4.     | TENSION SHELL | BETA             |
| 5.     | GENERAL SHAPE | TH2G, TH3G, X, R |
| 6.     | TORUS         | RSC, RC          |
| 7.     | CYLINDER      | LC               |
| 8.     | FLARE         | THB              |
| 9      | TORUS         | RSB, RB          |
| 10.    | TORUS         | RSB              |
| 11.    | AFTCØNE       | THA              |
| 12.    | AFTSPHERE     | RA               |
| 13.    | BASE          | - RT             |

#### 3. Construction Options

a. Monocoque analysis for the spherical cap for flat base is used when the option sentinel  $M \emptyset N = 1$  is specified.

b. Rung-stiffened analysis for the conical and cylindrical sections is used when the option sentinel RSD = 1 is specified.

c. The hot structure analysis is utilized when the option sentinel HTST = 1 is specified.

d. The program will use honeycomb if and only if, no option sentinels are specified.

e. Ring depth optimized if  $HT\phi P = 2.0$ .



#### 4. Design Factors

#### a. Conical Shell Buckling

The calculation model for an unstiffened cylinder under external pressure reduces to the expression

PCR = 
$$\frac{0.92 E_f r_f^{5/2}}{R_c^{3/2} L_c} = (P_e)$$
 Reference 9

which agrees precisely with equation (3) of Reference 9. The data summary given in Reference 9 indicates that the theoretical critical pressure is too large, and should be reduced, and a design factor of (0.8) is reasonable. Calculations using Program 1886 for cones under hydrostatic pressure are summarized:

| $\beta = 1 - \frac{R_1}{R_2} \qquad .$ | $P_{cr}/P_{e}$<br>$\theta_{c} = 30 \text{ degrees}$ | $P_{cr}/P_{e}$<br>$\theta_{c} = 60$ |
|----------------------------------------|-----------------------------------------------------|-------------------------------------|
| 0.1                                    | 0.99                                                | 0.97                                |
| 0.3                                    | 1.00                                                | 0.98                                |
| 0.5                                    | 1.05                                                | 1.02                                |
| 0.7                                    | 1.12                                                | 1.08                                |
| 0.8                                    | 1.20                                                | 1.14                                |
| 0.9                                    | 1.18                                                | 1.15                                |
| 1.0                                    | 1,18                                                | 1.16                                |

Using the recommended design criteria of Reference 9 would require factors on the aerodynamic pressure ranging from (1.2) at small values of ( $\beta$ ) to (1.5) at large values of ( $\beta$ ).

b. Interaction Effects

The calculation model for buckling under combined lateral pressure and axial loading yields a theoretical interaction curve similar to those presented in Reference 9. Typical results obtained from Program 1886 are given in the following table for cylinder with t/R = 0.01

| γ   | P <sub>CR</sub> /P <sub>cro</sub> | $F/2\pi E_f t_f^2$ |
|-----|-----------------------------------|--------------------|
| 0   | 1.00                              | 0.00               |
| 4   | 0.88                              | 0.08               |
| 10  | 0.81                              | 0.18               |
| 20  | 0.61                              | 0.27               |
| 40  | 0.43                              | 0.38               |
| 100 | 0,22                              | 0.48               |
| 200 | 0.11                              | 0.48               |
| 400 | 0.05                              | 0.48               |

where F is the axial load and  ${\tt P_{cro}}\,$  is the critical lateral buckling pressure with zero axial load.

The agreement with experiment for small values of ( $\overline{\gamma}$ ) is reasonably good; however, a correction factor is needed at large values. An empirical correction factor is formulated for cylinders in Reference 10 which is a function of the (t/R) ratio. In order to facilitate an empirical correction to the program model, an additional optional input, designated CBAR is provided, which modifies the value of  $\overline{\gamma}$ used in the equations, such that

 $(\vec{y})_{used} = CBAR (\vec{y})_{input}$ 

The value of CBAR is preset to 1.0.

c. Spherical Cap Buckling

<sup>'</sup> The empirical correlation of available buckling data used in Program 1886 is shown in Figure 1. The value of  $\lambda$  for sandwich shells is generally smaller than for monocoque shells, being given by

$$\lambda = 2(1 - \nu_f)^{1/4} \left(\frac{h}{t_c}\right)^{1/2}$$

Hence, it appears that the formulation utilized results in smaller knockdown factors due to imperfections, for sandwich shells than for monocoque shells.

## 5. Input Forms

An input form is provided for the user. All the information shown is keypunched provided the variable is specified All numerical values have decimal points.

### C. OUTPUT DEFINITIONS

| Name  | Parameter                                                                | Units               |
|-------|--------------------------------------------------------------------------|---------------------|
| AG    | Area of general shell.                                                   | ft <sup>2</sup>     |
| AT    | Area of tension shell.                                                   | $ft^2$              |
| н     | Height of stiffener.                                                     | inches              |
| N     | Number of stiffeners.                                                    |                     |
| RØC   | Core density.                                                            | lb/ft <sup>3</sup>  |
| RR    | Radius of compression ring.                                              | inches              |
| SIGH  | Circumferential stress.                                                  | 1b/1n.2             |
| SIGM  | Meridional stress.                                                       | 1b/in. <sup>2</sup> |
| SIGMH | Resultant yield stress criteria.                                         | 1b/1n.2             |
| Т3    | Thickness of tension and for general shell adjacent to compression ring. | inches              |
| тс    | Core height required.                                                    | inches              |
| ТСҮ   | Face sheet thickness required to satisfy yield criteria.                 | inches              |
| TF    | Face sheet thickness used.                                               | inches              |
| TFØPT | Face sheet thickness designed for optimum under buckle criteria.         | inches              |
| TIME  | Time at which TWMAX occurs,                                              | seconds             |
| TNG   | Thickness of face sheet based on local and general stability.            | inches              |
| TNL   | Thickness of face sheet based on local stability.                        | inches              |

#### D. SAMPLE PROBLEM

#### 1. Statement of Problem

Determine the external structural weight for a blunt cone configuration using the heating and loads obtained from the sample trajectory problem of Program 1880. A heat shield is to be used on the forebody, but the afterbody is to be a heat sink.

#### 2. Computer Input Forms

The necessary input computer forms, shown in the following pages, contain all the necessary input. The nosecap and forecone are considered to be of aluminum honeycomb construction. The aft cone is of stiffened beryllium and the flat base section is of beryllium honeycomb.

#### 3. Output

The program output is given on the succeeding pages. The nosecap is designed on minimum gage for the face sheets and core height. The face sheets of the forecone are minimum gage, but the core height is 0.479 inch. The afterbody design indicates a minimum weight for 64 stiffeners of 0.17 inch height. The maximum temperature achieved by the afterbody is 1168°F, which satisfies the allowable temperature limit. The weight required for the heating (temperature limit) is seen to be larger (WTQ > WT) than that required for the structural loads; hence weight reductions can be achieved by increasing the allowable temperature. The base cover is designed on minimum gage considerations.

The total skin weight is then

| Section  | Weight (pounds) |
|----------|-----------------|
| Nose     | 0.7             |
| Forecone | 104.6           |
| Aft Cone | 52.1            |
| Base     | 18.3            |
| Total    | 175.7 pounds    |

The weight calculated does not include the torus section; Program 1888 provides for inclusion of the complete shell.

| RAD 2-0963<br>5 63 | DIGITAL   | COMPUTE   | R INPUT  | PROBLE  | 4 NO          | 1886      |       |          | P   | ROGRAMME | R       |      |        |              |
|--------------------|-----------|-----------|----------|---------|---------------|-----------|-------|----------|-----|----------|---------|------|--------|--------------|
|                    | REC       | QUEST FO  | RM       | TITLE   | Struc         | tural I   | Preli | ninary.  | Des | ign Pro  | gram    | -    |        |              |
|                    | MEMO NO   | SECTION N | WORKO    | KDER NO |               | 16240 USE | ONLY  | REQUESTE | UBY | EXT      | POI IMC | PAGE | 1 of 6 | PAGES        |
|                    |           | L         |          |         |               | l         |       |          |     |          |         |      |        |              |
|                    | \$1NI     | PUT       |          |         |               |           |       |          |     |          |         |      |        |              |
|                    | DAT       | `Е =      |          | ,       | ME            | мØ        | =     |          | ر   | CASE     | =       |      |        | -            |
|                    | A         | =         |          |         | $\mathbf{LC}$ |           | =     |          | _,  | SIGCY    | F' =    |      |        | _,           |
|                    | BEI       | 'A =      |          | ,       | мфì           | Ň         | =     |          | _,  | SIGCY    | R =     |      |        | _,           |
|                    | СВА       | R =       |          | ,       | NFA           | C         | =     |          | _,  | SIGRG    | =       |      |        |              |
|                    | DEL       | -Kl =     |          | ,       | NTE           | ERM       | =     |          | _,  | TCMA     | X =     |      |        | ~~           |
|                    | DEI       | -K2 =     |          | ,       | PCF           | ι         |       |          | _,  | TCMIN    | r =     |      |        | ~            |
|                    | DEL       | TAU =     |          | ,       | QCM           | AULT      | =     |          | _,  | TEMP.    | A =     |      |        |              |
|                    | DTH       | IDY =     |          |         | QRM           | AULT      | =     |          | _,  | TEMP     | [ =     |      |        | _ <b>_</b> , |
|                    | EF        | =         |          |         | RA            |           | =     |          | _,  | TFMIN    | 1 =     |      |        | •            |
|                    | EM        | =         |          | ,       | RB            |           | =     |          | _,  | THA      | =       |      |        | - <b>-</b> • |
|                    | EN        | =         |          | ·       | ŔĊ            |           | =     |          |     | THB      | =       |      |        | <b>ہ</b>     |
|                    | EMI       | STR =     | ····     | ·       | RN            |           | =     |          | '   | THC      | =       |      |        | <sup>0</sup> |
|                    | EPS       | =         |          | ,       | RØC           | CMAX      | =     |          | _,  | THN      | =       |      |        |              |
|                    | ER        | =         |          |         | RØC           | CMIN      | =     |          | _'  | TH2G     | =       |      |        | •            |
|                    | G         | =         | ·        |         | RØÐ           | r         | =     |          | _,  | TH3G     | =       |      |        |              |
|                    | GAN       | /F =      |          | ,       | RØF           | ٤         | =     | <u></u>  | _,  | TINIT    | =       |      |        | '            |
|                    | GAM       | /R =      |          | ,       | RØF           | ١G        | =     |          | _,  | TSTØF    |         |      |        |              |
|                    | GAN       | ABAR =    |          |         | RSE           | 3         | =     |          | _,  | WHS      | =       |      |        | <b>'</b>     |
|                    | HS        | =         |          |         | RSC           | ;         | =     |          | _,  | XA       | =       |      |        | <b>'</b>     |
|                    | HTC       | ØP =      | <u> </u> | ,       | RSE           | )         | =     |          | _'  | xc       | =       |      |        | و            |
|                    | HTS       | ST =      |          | ,       | RSN           | Ĩ         | =     |          | -,  | XN       | =       |      |        | '            |
|                    | KAI       | OHES =    |          |         | RT            |           | =     |          | _,  | XØ       | =       |      |        | <u></u>      |
|                    | CPI       | ſAB =     |          |         |               | ,         |       | ,        |     |          |         |      | _,     |              |
|                    |           | -         |          | ,       |               |           |       | ,        |     |          |         |      | _,     |              |
|                    | ।<br>एच्य | - AB      |          |         |               |           |       |          |     |          |         |      |        |              |
|                    |           |           |          | · .     |               | '         |       | ,        | _   |          |         |      | _,     |              |
|                    | 1         |           |          |         |               |           |       | ,        |     |          |         |      | '      |              |
|                    |           |           |          |         |               |           |       |          |     |          |         |      |        |              |
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| RAD 2-0964<br>5-03 | DIGITAL COMPUTER INF<br>REQUEST FORM | PUT                                    | MEMO NO                               | SECTION NO.                            | CONTINUATION SHEET<br>PAGE 2 OF 6 PAGES                                                                                                                                                                                                                                                                             |
|--------------------|--------------------------------------|----------------------------------------|---------------------------------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    | GFTAB =                              | 3                                      |                                       | ······································ | وو                                                                                                                                                                                                                                                                                                                  |
|                    | GRTAB =                              |                                        |                                       | ······································ | ,,                                                                                                                                                                                                                                                                                                                  |
|                    | SECTN =                              | ,,                                     | ,                                     | ,                                      | ، ،<br>ب ،                                                                                                                                                                                                                                                                                                          |
|                    | <br>SGFTAB =                         | ,,                                     |                                       |                                        | ,,                                                                                                                                                                                                                                                                                                                  |
|                    | SGRTAB =                             | •                                      |                                       | ,                                      | و و<br>ر و                                                                                                                                                                                                                                                                                                          |
|                    | <br>TTAB =                           | ;                                      | ,                                     | ,                                      | ······· ········· ····················                                                                                                                                                                                                                                                                              |
|                    | R =                                  | ······································ | •                                     |                                        | ، ، ســــــــــــــــــــــــــــــ                                                                                                                                                                                                                                                                                 |
|                    |                                      | ,                                      | ,                                     | ف                                      | ، ب<br>ب ب                                                                                                                                                                                                                                                                                                          |
|                    | × =                                  |                                        |                                       | ,<br>,                                 | ····· ································                                                                                                                                                                                                                                                                              |
|                    | ···                                  | ,<br>,                                 |                                       | ,<br>,                                 | , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , |
|                    |                                      | ,                                      | ,                                     | ,                                      | ، و<br>و و                                                                                                                                                                                                                                                                                                          |
|                    | HTBL =                               | •                                      |                                       | •                                      | ، ، ، ، ، ، ، ، ، ، ، ، ، ، ، ،                                                                                                                                                                                                                                                                                     |
|                    |                                      | ,                                      | ـــــــــــــــــــــــــــــــــــــ | ,                                      | ······································                                                                                                                                                                                                                                                                              |
|                    |                                      |                                        |                                       | ,                                      | ······ <sup>2</sup> ······························                                                                                                                                                                                                                                                                  |
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| AD 2 0964 | DIGITAL COMPUTER IN | PROBLEM NO                             | MENO NO                                                                                                                                                                                                                                                                                                       | SECTION NO                             | CONTINUATION SHEET                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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|           | REQUEST FORM        |                                        |                                                                                                                                                                                                                                                                                                               | ]                                      | PAGE 3 OF 6 PAGES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|           |                     |                                        |                                                                                                                                                                                                                                                                                                               |                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|           | HTBL =              |                                        |                                                                                                                                                                                                                                                                                                               | ,                                      | ·,,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|           | (Continued)         |                                        |                                                                                                                                                                                                                                                                                                               | ,                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|           |                     | ,                                      | ,                                                                                                                                                                                                                                                                                                             | ,                                      | · • • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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|           | ļ .                 |                                        | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, |                                        | ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|           |                     | ,                                      |                                                                                                                                                                                                                                                                                                               |                                        | · • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • \bullet \bullet \bullet \bullet |
|           |                     |                                        | و                                                                                                                                                                                                                                                                                                             | ,                                      | د و                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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|           |                     |                                        | ······································                                                                                                                                                                                                                                                                        | ,                                      | ·,,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|           |                     |                                        | ······································                                                                                                                                                                                                                                                                        | '                                      | · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|           |                     | ''''''                                 | ,                                                                                                                                                                                                                                                                                                             | ,,                                     | · • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|           |                     |                                        |                                                                                                                                                                                                                                                                                                               | ·                                      | · • • • • • • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|           |                     |                                        | ,                                                                                                                                                                                                                                                                                                             |                                        | · • • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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|           |                     | ······································ |                                                                                                                                                                                                                                                                                                               | ,                                      | ·,,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|           |                     | ······································ | , _                                                                                                                                                                                                                                                                                                           | ,                                      | ·,,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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|           |                     |                                        |                                                                                                                                                                                                                                                                                                               |                                        | · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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|           |                     | ······································ | ······································                                                                                                                                                                                                                                                                        |                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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|           | QTBL =              | ·                                      |                                                                                                                                                                                                                                                                                                               |                                        | · • • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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|           |                     | <sup>2</sup>                           |                                                                                                                                                                                                                                                                                                               |                                        | ,,,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| RAD 2-0064 | DIGITAL COMPLETED IND | PROBLEMING                             | MENO NO                                | SECTION NO                             | CONTINU                               | TION SHEET                             |
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| 5-63       | REQUEST FORM          | ''  `                                  |                                        |                                        | PAGE 4                                | OF 6 PAGES                             |
|            | <u> </u>              |                                        | ·····                                  |                                        |                                       |                                        |
|            | QTBL =                | ······                                 |                                        | <u> </u>                               | ·,                                    |                                        |
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| RAD 2 0964 | DIGITAL COMPLETER MAR | PROBLEM N                              | O MEMO NO.                             | SECTION NO                             | CONTINUATION SHEET                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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| 5-03       | REQUEST FORM          | " -                                    |                                        |                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|            |                       |                                        |                                        |                                        | PAGE 5 UF 6 PAGES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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|            | RTBL =                | ,                                      |                                        |                                        | · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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|            |                       |                                        | ••                                     | <u></u>                                | · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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|            |                       | ·······                                | ,                                      |                                        | ·, ·,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| RAD 2 0964 | DIGITAL COMPUTER INPI | РКОВСЕН НО                             | . HENO NO.  | SECTION NO | CONTINUA                              | TION SHEET                             |
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| • ••       | REQUEST FORM          |                                        |             |            | PAGE 6                                | OF 6 PAGES                             |
|            |                       |                                        |             | i          |                                       |                                        |
|            | TIME =                | ·•                                     |             | ·          | ••                                    | ·                                      |
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| DIGITAL C | OMPUTER  | เมะคบช        | PROBLES    | 4 NO          | 886   |     |         | P        | ROJRAMME | b              |                                        |
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| REQ       | UEST FOR | M<br>Troer of | TITLE      | Struc         | tural | Pie | lininar | y Do     | ign Pic  | EST THE        | 1                                      |
| PL-179    | W610     | W305          | -050-0     | 0005          |       |     | P. L    | evine    | 2996     |                | PAGE 1 OF                              |
| \$INP     | UT       |               |            |               |       |     |         |          |          |                |                                        |
| DAT       | E =      | 4.1           |            | MEN           | лØ    | = . |         | ,        | CASE     | =              |                                        |
| А         | =        |               |            | LC            |       | = _ |         |          | SIGCYI   | r =            | 40000,                                 |
| BET       | A. =     |               |            | MØI           | ĩ     | = _ |         | <i>,</i> | SIGCYI   | R =            | 40000.                                 |
| CBA       | R =      | 1.0           | ,          | NFA           | С     | =   | 2.0     | ,        | SIGRG    | =              |                                        |
| DEL       | Kl =     |               |            | NTE           | RM    | =   |         | ,        | TCMA     | X =            | 3 0                                    |
| DEL       | K2 =     |               | ,          | PCR           |       | = _ | 1.67    | ,        | TCMIN    | í =            | 0.25                                   |
| DEL       | TAU =    | 01            | ,          | QCM           | ULT   | = _ |         | ,        | TEMP     | A =            | 1200.                                  |
| DTH:      | DY =     |               |            | QRM           | IULT  | = . |         | ,        | TEMP     | =              | 100.                                   |
| EF        | =        | 8 E           | 6,         | RA            |       | = . |         | ,        | TFMIN    | r =            | 01                                     |
| EM        | =        |               |            | RB            |       | = . |         | ,        | THA      | =              | -80.                                   |
| EN        | =        |               | ,          | RC            |       | =   | 7.5     | ,        | THB      | =              |                                        |
| EMIS      | STR =    |               | ,          | RN            |       | =   | 1 25    | ,        | THC      | =              | 60                                     |
| EPS       | =        | 01            | , <u> </u> | RÓC           | мах   | = . | 10.     | ,        | THN      | =              | 60.                                    |
| ER        | =        |               | ,          | RØC           | MIN   | = . | 1.      | ,        | TH2G     | =              |                                        |
| G         | =        | 25.8          | ,          | RØF           |       | = . | 172.    | ,        | TH3G     | =              |                                        |
| GAM       | F =      | . 33          | ,          | RØF           |       | =   | 172.    | ;        | TINIT    | =              | 100                                    |
| GAM       | R =      | .33           | ,          | RØR           | .G    | = . |         |          | tstøf    | · =            | 411 6                                  |
| GAM       | BAR =    |               |            | RSB           |       | =   | 0.15    | ,        | WHS      | Ŧ              | 1.0                                    |
| нs        | =        |               | ,          | RSC           |       | =   | 0.15    | ,        | XA       | =              | 0.                                     |
| нтø       | P =      | 1.0           | ,          | RSD           |       | = . |         | ,        | xc       | =              | 0.2                                    |
| HTS       | r =      |               | ,          | RSN           |       | ≠.  |         |          | XN       | =              | 0.8                                    |
| KAD       | HES =    | 20            |            | $\mathbf{RT}$ |       | ۶.  | 3.75    |          | ХØ       | =              | 0                                      |
| CPT       | AB = _   | 4             | ' -        | 5             | ,     |     | 57      | ہے ہ     | 61       | _,             | <u>65</u> ,                            |
|           |          | 67            | / _        | .7            |       |     | 73      | نے م     | 76       | _'             | ······································ |
| EFT       | AB = _   | 44.E6         |            | 42.E6         | ,     |     | 40.E6   | 3        | 7.E6     | _, <u></u> 32. | <u>E6</u> ,                            |
| 1         | -        | 26.E6         |            | 15.E6         | ·'    |     | 8.E6    | , 1      | .E6      |                |                                        |

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| DI | GITAL COMPL | ITE | R ILIPUT | PROBLE                                 | M NO                                          | HENO NO                                |          | LCTION N                                      | 2        | СОНТ       | INUATION S | нсет        |
|----|-------------|-----|----------|----------------------------------------|-----------------------------------------------|----------------------------------------|----------|-----------------------------------------------|----------|------------|------------|-------------|
|    | REQUEST     | FC  | IRM      | 1886                                   | <u>,                                     </u> | PD-17                                  | 9        | w 610                                         |          | PAGE       | 2 OF       | 7 PAGE      |
|    |             |     |          |                                        |                                               |                                        |          |                                               |          |            |            |             |
|    | GFTAB       | =   |          | 024,                                   |                                               |                                        |          | ·                                             |          |            | ·          | ······      |
|    |             |     |          | ·,                                     |                                               | ,                                      |          | ,                                             |          | ,          |            |             |
|    | GRTAB       | =   | 102      | . 32                                   |                                               |                                        |          |                                               |          |            |            |             |
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|    |             |     |          | <b>'</b>                               |                                               | '                                      |          |                                               | ·        | ,          |            | ''          |
|    | SECTN       | =   | 1 0      | ······'                                | 3.                                            | <u> </u> ,                             |          | ,                                             |          | ,          | ·          | '           |
|    |             |     |          | •                                      |                                               | <b>·</b> ·                             |          | ,                                             |          | ,          |            | ,           |
|    | SGFTAB      | =   | 60       | 000.,                                  | 58000                                         | <b>,</b>                               | 5200     | io. ,                                         | 46000    | . ,        | 40000.     | ,           |
|    |             |     | 32       | 000.,                                  | 20000.                                        | ·                                      | 1000     | .,                                            | 1000     | ). ,       |            | ,           |
|    | SGRTAB      | _   | 05000    |                                        | 05000                                         |                                        | 9500     | n                                             | 02000    |            |            |             |
|    | 00101110    |     | 90000    | ••                                     | 85000                                         |                                        | 7000     | · <u>·</u> ·································· | 10000    |            | 90000      | ·,          |
|    |             |     | 90000    | ·'                                     | 05000.                                        | ·• .                                   | 10000    | ······································        | 10000.   | ·'         | <b></b>    | '           |
|    | TTAB        | =   | 0        | ·'                                     | 200.                                          | · .                                    | 400      | <u>.                                    </u>  | 600      | ······,    | 800.       | ,           |
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|    | B           | _   |          |                                        |                                               |                                        |          |                                               |          |            |            |             |
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|    |             |     |          | ······'                                |                                               | ······································ | <u> </u> |                                               | <u> </u> |            |            | ·······'    |
|    |             |     |          | ,                                      |                                               | '                                      |          | '                                             |          | <b>'</b>   |            | ······'     |
|    |             |     | •        | ,                                      |                                               | ·•                                     |          | ······,                                       | ••••••   | ••         |            |             |
|    | x           | =   |          |                                        |                                               | ······································ |          | ,                                             |          | ,          |            | ······      |
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|    |             |     |          | ,                                      | · · · · · ·                                   |                                        |          | ,                                             |          |            |            | ·*          |
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|    |             |     |          |                                        |                                               |                                        |          |                                               |          |            |            |             |
|    | HTBL        | =   | 127.     | <u>5</u> ,                             | 130                                           | <u>.9</u> ,                            | 131      | · <u> </u>                                    | 131.     | <u>4</u> , |            | 7,          |
|    |             |     | 132.     | <u> </u>                               | 132                                           | .2_, .                                 | 132      | .5,                                           | 132.     | <u>7</u> , | 132.       | <u>9_</u> , |
|    |             |     | 133.     | <u></u> ,                              | 133                                           | <u>.1</u> , _                          | 133      | .0,                                           | 132.     | B,         | 132.       | 3,          |
|    |             |     | 131.     | <u>4</u> ,                             | 129                                           | <u> </u>                               | 128      | . <u>0</u> ,                                  | 126.     | <u> </u> , | 122.       | 8,          |
|    |             |     | 116      | 7,                                     | 108                                           | .2_,                                   | 98.      | 6,                                            | 89       | 4,         | 80.7       | ,           |

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| RAD 2-0964 | DIGITAL COMPLETED IN | 0115    | PPOBLEH NO                             | -       | NEMO NO  |     | SECTION NO                            | 1   | CONTINU | TION SHEET                             |
|------------|----------------------|---------|----------------------------------------|---------|----------|-----|---------------------------------------|-----|---------|----------------------------------------|
| 5 63       | REQUEST FORM         | .01     | 1886                                   |         | PL-179   |     | W610                                  |     | PAGE 3  | OF 7 PAGES                             |
|            |                      |         |                                        |         |          |     | J                                     | 1   |         |                                        |
|            | HTBL =               | 72      | 5,                                     | 64      | 7,       | 5   | <u>74</u> ,                           |     | 505,    | 44 1,                                  |
|            | (Continued)          | 38      | 2_,                                    | 32      | 7_,      | 2   | 7.6                                   |     | 23.1    | 190,                                   |
|            |                      | 15      | 3,                                     | 12      | 9,       | 1   | 0.8                                   | · _ | ,       | 72,                                    |
|            |                      | 5       | 8,                                     | 4.      | 7,       | 3   | .9,                                   |     | 3.7,    | 40,                                    |
|            |                      |         | ,                                      |         | ,        | _   |                                       | ,   | ,       | e                                      |
|            |                      |         |                                        |         |          |     |                                       |     |         |                                        |
|            |                      |         | ······································ |         | ,        | _   |                                       | '   | ,       | ·,                                     |
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|            |                      |         |                                        |         | ,        | _   |                                       | ,   |         | <sup>2</sup>                           |
|            |                      |         | ,                                      |         | ,        | _   |                                       |     |         | ,                                      |
|            |                      |         | ,                                      | _       | ,        |     |                                       | , _ |         | <u> </u>                               |
|            |                      |         | ,                                      |         | ,        | _   |                                       | , _ |         | وو                                     |
|            |                      |         |                                        |         |          |     |                                       |     |         |                                        |
|            |                      |         | ······,                                |         | ,        |     |                                       | '   | ·       | ,                                      |
|            |                      |         | ••                                     |         | ,        |     |                                       | ' - |         | وو                                     |
|            |                      |         | '                                      | _       | ,        | -   |                                       | '   | f       | ·,                                     |
|            |                      |         | ,                                      |         | ,        | -   |                                       | '   |         | '                                      |
|            |                      |         | ·,                                     |         | ,        |     |                                       | '   |         | ·                                      |
|            |                      |         | وو                                     |         | ,        | -   |                                       | ·   |         | ······································ |
|            |                      |         |                                        | <i></i> | <u> </u> |     |                                       | •   |         | ·,                                     |
|            |                      |         | ,                                      |         |          | _   |                                       | •   |         |                                        |
|            |                      |         |                                        |         | ,        | ~   |                                       | ,   |         | و                                      |
|            |                      |         |                                        | _       |          | _   |                                       | , _ |         |                                        |
|            | QTBL =               | 0.      | 1,                                     | •••     | 1.0      | . 1 | 1.2                                   | ,   | 1.5     | , 1.8 ,                                |
|            |                      | 2.      | .3 ,                                   |         | 2.8      | - 3 | 3.4                                   | , - | 4.1     | , 5.1 ,                                |
|            |                      | 6.      | 2,                                     |         | 7.6      |     | 9.4                                   | , - | 11.4    | 14.1                                   |
|            |                      | 16      | ,                                      |         | 20.3     | . 2 | 23.8                                  | , - | 27.2    | 28.3 ,                                 |
|            |                      | 29      | 9.4 ,                                  |         | 30.4     | , 7 | 28.7                                  | , ] | 26.4    | , 23.8 ,                               |
|            | ]                    |         |                                        |         |          |     |                                       |     |         |                                        |
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| RAD 2 0964<br>5-63 | DIGITAL COMPUTER IN<br>REQUEST FORM | PUT        | PROBLEM HO<br>1886                     | мењо но<br>PL-179 |   | SECTION NO<br>W610                     |                                       | ATION SHEET                            |
|--------------------|-------------------------------------|------------|----------------------------------------|-------------------|---|----------------------------------------|---------------------------------------|----------------------------------------|
|                    |                                     |            |                                        |                   |   | L.,                                    | TAGE                                  |                                        |
|                    | QTBL =                              | 21         | .1,                                    | ,                 | 1 | 5.9,                                   | 13.5                                  | , 11.2 ,                               |
|                    | (Continued)                         | 9.         | 2,                                     | 7.4,              | 5 | .8,                                    | 4.4                                   | , <u>3.2</u> ,                         |
|                    |                                     | 2.         | 3,                                     | 1.7 ,             | 1 | .2,                                    | 0.8                                   | , 0.6 ,                                |
|                    |                                     | 0          | <u> </u>                               | 0.2 ,             | 0 | .1,                                    | 0.                                    | , <u>0.     </u> ,                     |
|                    |                                     | •          |                                        | ,                 | - | ,                                      |                                       | ,,                                     |
|                    |                                     |            | ,                                      | . <u></u> ,       | _ | ,                                      | • • • • • • • • • • • • • • • • • • • | و                                      |
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|                    |                                     |            | ,                                      | ,                 | _ | ب                                      |                                       | ·                                      |
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|                    |                                     |            | ' -                                    | ,                 |   | ······································ |                                       | ·                                      |
|                    |                                     | •          | ' -                                    | ,                 |   | ,                                      | <u></u>                               | ·•                                     |
|                    |                                     | <u> </u>   |                                        | ·,                |   | ·,                                     |                                       | ·                                      |
|                    |                                     |            | ^ -<br>,                               | ·,                |   | ······,                                | -                                     | ······································ |
| ĺ                  |                                     |            |                                        |                   |   |                                        |                                       |                                        |
|                    |                                     | <u> </u>   | ······································ | ·,                | - | •                                      |                                       |                                        |
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|                    |                                     | . <u> </u> |                                        |                   |   | ,                                      |                                       | ,                                      |
|                    |                                     |            | , _                                    | ,                 |   |                                        |                                       |                                        |
|                    |                                     |            | ·                                      |                   |   | ,                                      |                                       | ,                                      |
|                    | RTBL =                              | 45         | * 0,                                   | ,                 |   |                                        |                                       | 7                                      |
|                    |                                     |            | ······································ | ,                 |   |                                        |                                       | ·                                      |
|                    |                                     |            | ·· .                                   | ,                 |   |                                        |                                       | ,                                      |
|                    |                                     |            | ······································ | ,                 |   | ,                                      |                                       | · /                                    |
|                    |                                     |            |                                        | ,                 |   | ,                                      |                                       | ·                                      |
|                    |                                     |            |                                        |                   |   |                                        |                                       |                                        |

| RAD 2-0934 | DIGITAL COMPUTED PIPU | PROULEN NO                              | MENO NO                                | SECTION NO | CONTINUATION SHEET                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------|-----------------------|-----------------------------------------|----------------------------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 63       | REQUEST FORM          | 1886                                    | PL-179                                 | w510       | PAGE 5 OF 7 PAGES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|            |                       |                                         |                                        |            | · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|            | RTBL =                |                                         | ,                                      | ,          | · •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|            | (Continued)           | ,                                       | ,                                      | ,          | · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|            | -                     | ·                                       | ,                                      | ,          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       |                                         | · , .                                  |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       | · ·                                     | ·                                      | ··         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       | ,, _                                    | ······································ | /          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       |                                         | ······································ |            | · • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|            |                       | · .                                     |                                        |            | · • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|            |                       |                                         | ,                                      |            | · •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|            |                       |                                         |                                        |            | · • • • • • • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       |                                         | ,                                      |            | · • • • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|            |                       |                                         |                                        |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       | ······································  | ······································ |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       | ······································  | ······································ | ·          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            | _                     | ° .                                     | '                                      | '          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       | ' ·                                     | ,                                      |            | ''''                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|            |                       | ,                                       | ,                                      |            | ·,,,,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 1          |                       | · .                                     | '                                      |            | · • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|            |                       | ,                                       | ,                                      |            | · · · · · /                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|            |                       | ······································  |                                        |            | · • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|            | -                     | , .                                     |                                        |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       |                                         | ,                                      |            | ·,,,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|            |                       |                                         |                                        |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       |                                         | ,                                      |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|            |                       | ,                                       | ,                                      |            | · · · · · · · · · · · · · · · · · · · · · · · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ · _ = _ · _ · |
|            |                       | ······································  | ··································     | <u></u>    | ·,,,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|            | )                     | . فـــــ                                | ·                                      |            | · · / /                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|            |                       | ••••••••••••••••••••••••••••••••••••••• | ·•                                     | ·          | · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|            | TIME = _(             | ••                                      | 83 59 ,                                | 91.01      | ,9 <u>8.59</u> , <u>106.29</u> ,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|            |                       | 14.11 ,                                 | 122.04 ,                               | 130.15     | , <u>138.41</u> , <u>146.83</u> ,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|            |                       | 55.43 ,                                 | 164.26 ,                               | 173.32     | , <u>182.60</u> , <u>192.13</u> ,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|            |                       | .01.94 ,                                | 212.11 ,                               | 221.42     | <u>, 229.50</u> , <u>236.71</u> ,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|            |                       | 43.49 ,                                 | 250.18 ,                               | 256.24 -   | , <u>261.31</u> , <u>265.89</u> ,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|            |                       |                                         |                                        |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| •          | 1                     |                                         |                                        |            | i                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| RA5 2 0241 | DIGUAL COMPLETE IN | PILL | PROJLET, NO                            | 1121.0 110                             | SECTION NO                             | CONTINUA                               | TION SHEET                             |
|------------|--------------------|------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| 3.07       | REQUEST 1021       |      | 1886                                   | PL-179                                 | W610                                   | PAGE 6                                 | OF 7 PAGES                             |
|            |                    |      |                                        |                                        |                                        | 1,                                     |                                        |
|            | TIME =             | 27   | <u>0 19 </u> .                         | 274.35                                 | 278.41                                 | _282.47;                               | 28662*                                 |
|            | (Continued)        | 29   | 0.91                                   | 295.42                                 | 300.24                                 | 305.47                                 | _311.25                                |
|            |                    | 31   | 7 80                                   | 323.33                                 | 329.62                                 | 336.92 ,                               | 345.61                                 |
|            |                    | 35   | 6.33                                   | <u> </u>                               | 389.41 ,                               | 426.40 ,                               | 473.00                                 |
|            |                    |      | . و                                    |                                        | ,                                      |                                        |                                        |
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|            |                    |      | ••••••                                 | ······································ | •                                      | ,                                      | '                                      |
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|            |                    |      | ······································ | °                                      |                                        |                                        |                                        |
|            |                    |      | ······································ | '                                      | ·                                      | •                                      |                                        |
|            |                    |      |                                        | ••                                     |                                        |                                        | ·                                      |
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|            |                    |      | ,                                      | ,                                      | <u> </u>                               | ······································ | <u> </u>                               |
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|            |                    |      | ······································ | ······································ | ·,                                     | '                                      | ·,                                     |
|            |                    |      | ' .                                    | ••••••••••••••••••••••••               | ··································     | ······································ | ··································     |
|            |                    |      | ••••••••                               | ······································ | ······································ |                                        | '                                      |
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|            |                    |      | ······································ | •                                      | ,                                      |                                        | ·•                                     |
|            |                    |      |                                        |                                        |                                        | ······································ |                                        |
|            | · .                |      | ······································ | ,                                      | ······································ |                                        | ,                                      |
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|            |                    |      |                                        |                                        |                                        |                                        |                                        |
|            |                    |      |                                        |                                        |                                        |                                        |                                        |
|            | \$                 |      |                                        |                                        |                                        |                                        |                                        |
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| 1          | l                  |      |                                        |                                        |                                        |                                        |                                        |

| RAD 2 0964 | DIGITAL COMPUTER INPUT | PROBLEM NO | MEMO NO | SECTION NO | CONTINUATION SHEET |
|------------|------------------------|------------|---------|------------|--------------------|
| 0-00       | REQUEST FORM           | 1886       | PL-179  | W610       | PAGE 7 OF 7 PAGES  |
|            |                        |            |         |            |                    |
|            | \$INPUT                |            |         |            |                    |
|            | CASE =                 | 2.0        | 9       |            |                    |
|            | SECTN =                | <u> </u>   | ,       |            |                    |
|            | EM =                   |            | ,       |            |                    |
|            | EPS =                  | 05         | ,       |            |                    |
|            | htýp =                 | 20         | ,       |            |                    |
|            | HTST =                 | 1.0        | ,       |            |                    |
|            | PCR =                  | 8 3.E-3    | ,       |            |                    |
|            | QCMULT =               | 0 1        | ,       |            |                    |
|            | RØF =                  | _116.      | ,       |            |                    |
|            | rør =                  | 500        | ,       |            |                    |
|            | RSD =                  | 10         | ,       |            |                    |
|            |                        |            |         |            |                    |
| 1          | \$                     |            |         |            |                    |
|            |                        |            |         |            |                    |
|            |                        |            |         |            |                    |
|            | \$INPUT                |            |         |            |                    |
|            | CASE =                 | 3.0        | ,       |            |                    |
|            | SECTN =                | _13        | ,       |            |                    |
|            | HTØP =                 | 0.0        | ,       |            |                    |
|            | HTST =                 | 0.0.       | ,       |            |                    |
|            | QCMULT =               | 0.05       |         |            |                    |
|            | RSD =                  | 0.0        | , ,     |            |                    |
|            |                        |            |         |            |                    |
|            | \$                     |            |         |            |                    |
|            |                        |            |         |            |                    |
|            |                        |            |         |            |                    |
|            |                        |            |         |            |                    |
|            |                        |            |         |            |                    |
|            |                        |            |         |            |                    |
|            |                        |            |         |            |                    |
|            |                        |            |         |            |                    |
|            | 1                      |            |         |            |                    |
|            |                        |            | - 36 -  |            |                    |

|           |                        | * READRY    | - MAP *    |          |            |           |           |                   |                |           |          |
|-----------|------------------------|-------------|------------|----------|------------|-----------|-----------|-------------------|----------------|-----------|----------|
| SYSTEM    | CY 091618              |             | 00000      | THRU     | 02717      |           |           |                   |                |           |          |
| FILES     | 1. U/                  | NITO5       |            |          |            |           | •         |                   |                |           |          |
| FUELTS    |                        | 41T06       | 02750      |          | ••••       |           |           |                   |                |           |          |
| PRE-EXEC  | UTION INITI            | AL IZATION- |            |          |            |           |           |                   |                | · · ·     |          |
| CALL ON   | OBJECT PROG            | RAM         | 02777      |          |            |           |           |                   |                |           |          |
| -08JECT P | ROGRAH                 |             | 03004      | -THRU    | 41-54-7    |           |           |                   |                |           |          |
|           | CK ORIGIN-             | CONTROL     | -SECTIONS- | -(-////  | /~NON_0_LE | NGTH, (LC | C)-DELETE | 0 <b>*</b> =NOT-I | EFERENCE       | <b>,,</b> |          |
| <u></u>   | IES 03004-             |             | (76252) -  | STIFS    | 06034      |           |           |                   |                |           |          |
| 2. 188    | 6 06050                | 111 1       | (76252)    |          | 07064 *    |           |           |                   |                |           |          |
|           | CKL-07100-             |             | (176252)   | BUCKLE   |            |           |           |                   |                |           |          |
| 4. SR0    | NOC 11341              | /// /       | 12415      | HUNUC    | 12154      |           |           |                   |                |           |          |
| 6 SPI     | NG 14017               | RING        | 14211      |          |            |           |           |                   |                |           |          |
| 7-500     | NE-14270               | -CONE       |            | _        |            |           |           |                   |                |           |          |
| 8. STE    | NSN 15773              | TENSON      | 16661      |          |            |           |           |                   |                |           |          |
|           | <del>SE 16766 -</del>  | BASE        | 17:24-1    |          |            |           |           |                   |                |           |          |
| 10. SGN   | RLS 17374              | GNRL SH     | 20050      |          |            |           |           |                   |                |           |          |
| 11. SGY   | LAD 20202 -            |             | 22033      |          |            |           |           |                   |                |           |          |
| 12 500    | 131 21445<br>TUU 22144 |             | 22400      |          |            |           |           |                   |                |           |          |
| 14LX      | CON 22551              | -LXSTR      | 22551 *    | .LXSTP   | 22555      | +LXOUT    | 22623     | .LXRTN            | 22635          | IBEXIT    | 22635 *  |
|           |                        | -LXGAL      |            | LXERP    | 22640      |           | 23022 *   | L-XARG            | 23171          |           | 23214 *  |
|           |                        | .CLSE       | 23222      | +LFBL    | 23223 *    | LUNB      | 23224     | -DFOUI            | 23225          | PEAD      | 23242    |
| _1510     | 0EE 23231              |             | 22265      | 0.00     | 23255 #    | PEADS     | 23265     | PELES             | 23267 #        | LAREA     | 23300    |
|           |                        | -NKLIC      | 23245      | - USK    | 23321-*-   | AREAL     | 23333     | -LUNBL            | 23341          | ENTRY-    | -23345   |
|           |                        | -GOA        | 23400      | .60      | 23404      | +DERR     | 23420     | •NOPXI            | 23421          | •CDHXI    | 23423    |
|           |                        | EX34        | 23445      |          |            |           |           |                   |                |           |          |
| 16LX      | SL 23452               | LXSEL       | 23452      | LXCSEL   | 23453      | .LXTST    | 23456 *   | -LXOVL            | 23516 *        | .LXRCT    | 23527 *  |
|           |                        |             | 23576 *    | - LX013  | 23601 8    | EDADO     | 22767     | / COUNT/          | 23771 #        | UNEL UN   | 24042 #  |
| 17        | TRP 23611              | 5 1         | 25011 +    | 6 2      | 23150      | 5 2       | 24053     | 5-4               | 24054          | 011.204   | 21012    |
| 19        | C 24055                | CC-1        | 24055      | CC.2     | 24056      | CC.3      | 24057     | CC.4              | 24060          |           |          |
|           | 24061-                 | EXIT        | 24061      | .EXIT.   | 24061 *    |           |           |                   |                |           |          |
| 21. FXE   | M 24062                | .FXEN.      | 24062      | • F XOU1 | 24417      | .FXARG    | 24425     | /.OPTW./          | 24501          |           |          |
| 22. EOU   | r24512                 |             | 24512      |          |            | CHOTC     | 26112     | CHILCH            | 26714          | E0.7.1    | 25120    |
| 23. FCN   | V 25054                | +FCON-      | 25054      | -PUNV-   | 25077      | -ENDES    | 25112     | -0809             | 25114          | -186.10-  | -25254   |
|           |                        | DBC 20      | 25302      | .0054    | 25312      | DOFIX     | 25321     | FIXSW             | 25327          | -DDBC     | 25404    |
|           |                        | DDR\$1      | 25656      | DORS     | 25660      |           | 25663     | 02                | 25665          | -FERR2    | -25752 * |
|           |                        | -ANPT       | 26006      | . ONPT   | 26023      | .LNTP     | 26077     | -AUUT             | 26146          | +OFLT     | 26164    |
|           |                        | FLT         | _2632.0    | .DEXPN   | 26410      | FXD       | 26411     | -HOUT-            | 2654           | -INTG     | 26611-   |
|           |                        | -LOUT       | 26/27      | +080T    | 20140      | OUTPE     | 27567     | -1651             | 27615          | -NUUNI    | 27616    |
|           |                        |             | 27617      | GAIN     | 27620      | -GAIN1    | 27621     | FBDBF             | 27631          | .DDDFL    | 27654    |
|           |                        | DDFLG-      | 27655      | HQD_     | 27656      | PEX       | 27657     | FEXP              | 27660          | D1G       | 27661-   |
| 24. FIO   | S 27701                | .FIDS.      | 27701      | .FSEL    | 30041      | +FILR+    | 30045     | .FRTB.            | 30054 *        | .FRTD.    | 30061    |
|           |                        |             | 30064      | FCLS     | 30056 *    | FOPN      | _30072 *  | PEOF              | 30076.*        | TOUT      | 30241    |
|           |                        | -REED       | 30247 *    | +BIN     | 30250 *    | +FUT      | 50251     | *FCK5Z            | 50253 <b>#</b> |           |          |
| EIN       | ы апаак                |             |            |          |            |           |           |                   |                |           |          |

|              |           |           |                |         |           |            |                  | 10     |           |          |           |             |
|--------------|-----------|-----------|----------------|---------|-----------|------------|------------------|--------|-----------|----------|-----------|-------------|
|              |           |           |                |         |           |            |                  | •••    |           |          |           |             |
| 26. FWRD     | 31336 .6  | FWRD.     | 31336          |         |           |            |                  |        |           |          |           |             |
| 28. FWR0     | 31406 •F  | -WRO.     | 31362          | +FREST  | 31711     | •          |                  |        |           |          |           |             |
|              |           | ROU.      | 3201-3         |         |           |            |                  |        |           |          |           |             |
| UN06         | 32055 1   | 1406      | 32055          | BUESZ   | 32056     |            |                  |        | -         |          |           |             |
| 32. FLOU<br> | -34306 A  | FTOU.     | 32061<br>34364 | ATANO   | 32534<br> | ATANOD     | 32557<br>34402.* | .NAME. | 33662     | • INTAP  | 33663     |             |
| 34. JRSIN    | 34411 AF  | NSI KP    | 34452          | AL.00   | 34505     |            | •                |        |           |          |           |             |
| 36. FXPF     | 34644 E)  | (P        | 34644          |         |           |            |                  |        |           |          |           |             |
| 38. FSQR     | 35175 SC  | JS<br>DRT | 35175          | -\$1N   | - 34766   |            |                  |        |           |          |           |             |
|              |           | FAN2      | -35302         | -ATAN   | -35304-1  | •          |                  |        | _         |          |           |             |
| - 41. FXP3   |           | KP3       | -35626         |         |           | Naca       |                  |        |           |          |           | ······      |
| 421005       | 35753 -1  | - (0)<br> | 35753          | -ATTC-  | 35773     | SH1        | 36042            | *DEF1* |           | -JUINX   | 36515 *   |             |
|              | •         | 3P4       | 36543 *        | - 0P7   | 36574 3   | * .0P9.2   | 36610 *          | -RLSE- | 36662     | •RER 2 • | 36662     |             |
|              |           | TIBB      | 37227          | .GTIDX  | 37250     | .RH7       | 37366 *          | -RE7   | 40005 *   | - ENDTR  | 40446     |             |
|              | .1        | FCHEX     | 41 544         | -BASIO  | 41547     | *          |                  |        | _4:2:4-*_ |          |           |             |
|              | 41550     |           |                | -       |           |            |                  |        |           |          |           |             |
|              |           |           | A1560          | 74011 7 | 6162      |            |                  |        |           |          | ~         |             |
| 170 8011243  |           |           | 41550          |         | 0133      |            |                  |        |           |          |           |             |
| UNUSED CORE  |           |           | 76154          | THRU 7  | 6251      |            |                  |        |           |          |           |             |
|              |           |           |                |         |           |            |                  |        |           |          |           |             |
|              |           |           |                |         |           |            |                  |        |           |          |           |             |
| SINPUT       |           |           |                |         |           |            |                  |        |           |          |           |             |
| 0ATE         | 0.4010000 | JOE 01.   |                |         |           |            |                  | ant.   |           |          |           |             |
| HEND         |           | 00E-38,   |                |         |           |            |                  |        |           |          |           |             |
| CASE         |           | 05-38,    | ,              |         |           |            |                  |        |           |          |           |             |
| SECTN        | 1,        |           | 3              | ,       |           |            |                  |        | ,         |          | _0,       | -0,         |
|              | 0,        |           | 0              | •       |           | ) <b>,</b> | 0,               |        | 0,        |          | 0,        |             |
| MON =        | 01        | ,         |                |         |           |            |                  |        |           |          | `         | -           |
| RSD ≠        | 0,        | ,         |                |         |           |            |                  |        |           |          |           |             |
| HTOP =       | 1,        | ,         |                |         |           |            |                  |        | _         |          |           |             |
| HTST =       | 0,        | , –       |                |         |           |            |                  |        |           |          |           |             |
| GAME =       | 0.3300000 | 0E 00.    |                |         |           |            |                  |        |           |          | · · · · · |             |
| ee -         | 0.000000  | 05 07     |                |         |           |            |                  |        |           |          |           |             |
| EF -         | 0.800000  | JOE 071   |                |         |           |            |                  |        |           |          |           |             |
| ROF =        | 0+1720000 | 00E 03    | ,              |         |           |            |                  |        |           |          |           |             |
| SIGCYF *     | 0.400000  | DOE 05,   | , <u> </u>     |         |           |            |                  |        |           |          |           |             |
| GAMR =       | 0.3300000 | DOE 00,   |                |         |           |            |                  |        |           |          |           |             |
| ER =         | 0.0000000 | 00E-38    | ,              |         |           |            |                  |        |           |          |           |             |
| ROR =        | 0.1720000 | DOE 03    | ,              |         |           | •          |                  |        |           |          |           |             |
| SIGCYR =     | 0.400000  | DOE 05.   | ,              |         |           |            |                  |        |           |          | ·         |             |
| KADHES =     | 0.200000  | 00F 00-   |                |         |           |            |                  |        |           |          |           |             |
|              |           |           |                |         |           |            |                  |        |           |          |           | <del></del> |
| PGK =        | 0-16/0000 | JUE 01,   | ·              |         |           |            |                  |        |           |          |           |             |
| TFHIN =      | 0.1000000 | DOE-01    | , <u> </u>     |         |           |            |                  |        | _         |          |           |             |
| TCHIN =      | 0.250000  | 00E 00    | ,              |         |           |            |                  |        |           |          |           |             |
| TCHAX =      | 0.300000  | DOE 01    |                |         |           |            |                  |        |           |          |           |             |
| ROCMIN =     | 0.100000  | DOE 01,   | ,              |         |           |            |                  |        |           |          |           |             |
| ROCHAX =     | 0.100000  | DOE 02.   |                |         |           |            |                  |        |           |          |           |             |
| GAMBAR =     | 0.000000  | 005-38    |                |         |           |            |                  |        |           |          | -         |             |
| CARDAN -     | 0.000000  |           |                |         |           | -          |                  |        |           |          |           |             |
| UBAR =       | 0.100000  | JUE 01    |                |         |           |            |                  |        |           |          |           |             |
| WHS =        | 0.100000  | DOE 01,   | ,              |         |           |            |                  |        |           |          |           |             |
| G =          | 0.2580000 | DOE 02,   |                |         |           |            |                  |        |           |          |           |             |
| HS =         | 0.000000  | DOE-38    | ,              |         |           |            |                  |        |           |          |           |             |
| EH =         | 0.000000  | 00E-38,   | ,              |         |           | -          |                  |        |           |          |           |             |

| EN        |                                         |                |                  |                                               |                  |
|-----------|-----------------------------------------|----------------|------------------|-----------------------------------------------|------------------|
|           |                                         |                |                  |                                               |                  |
|           | 0                                       |                |                  |                                               |                  |
|           | 0-100000000-01                          |                |                  |                                               |                  |
|           | 0.125000000 01.                         |                |                  |                                               |                  |
|           |                                         |                |                  |                                               |                  |
|           | 0.60000005-02.                          |                |                  |                                               |                  |
|           | 0.00000005-38,                          |                |                  |                                               | · ·              |
|           | -0.8000000E-02,                         |                |                  |                                               |                  |
| THC=      | 0.60000006-02, -                        |                |                  |                                               |                  |
| <u></u> = | 0.0000000000000000000000000000000000000 |                |                  |                                               | <u> </u>         |
|           | 0.150000005-00                          |                |                  |                                               |                  |
|           |                                         |                |                  |                                               |                  |
| RC        | 0,750000000 01,                         |                |                  |                                               |                  |
|           |                                         | ·· <u> </u>    |                  | · <u>· · · · · · · · · · · · · · · · · · </u> |                  |
|           | 0+00000006-38,                          |                |                  |                                               | <u> </u>         |
|           | -0.375000006-01.                        |                |                  |                                               | ·                |
|           | 0.000000005-38,                         |                |                  |                                               |                  |
|           |                                         |                |                  |                                               |                  |
|           | 0.00000005=38,                          |                |                  |                                               |                  |
| tH3G      |                                         |                |                  | · · · · · · · · · · · · · · · · · · ·         |                  |
|           | 0,00000005=38,                          |                | 0.00000005=38,   |                                               |                  |
|           | 0.000000000-38,                         | 0.0000000E-38. | 0+0000000E-38+   | 0.0000000E-38.                                | 0.0000000E-38.   |
|           | 0.0000000E-38.                          | 0.0000000E-38, | 0.00000000E-38.  | 0.000000005-38.                               | 0.00000000000000 |
|           | 0.0000000E-38                           | 0.00000008-38, | 0-00000008-38    | 0-0000000E-38                                 | 0.00000006-38,   |
|           | 0_0000000E=38.                          | 0_0000000E-38+ | -0-00000000E-38- | 0.0000000f=38-                                | 0.0000005=38-    |
|           | 0.0000000E-38,                          | 0.0000000E-38; | 0.000000005-38.  | 0.0000000E-38,                                | 0.0000000E-38.   |
|           | 0.0000000000000000000000000000000000000 | 0.0000000E=38+ |                  | 0.0000000E=38,                                |                  |
|           | 0.00000006=38,                          | 0.0000000E=38+ |                  |                                               |                  |
|           |                                         |                |                  |                                               |                  |
|           | 0,0000000E=38,                          |                |                  |                                               |                  |
|           |                                         |                |                  |                                               |                  |
|           | 0_10000000E_00,                         | ·              |                  |                                               |                  |

| EHISTR - | 0.0000000E-30.                          |                  | · · · ·                           |                                         |                                         |
|----------|-----------------------------------------|------------------|-----------------------------------|-----------------------------------------|-----------------------------------------|
|          | 0.00000000000000                        |                  | ·····.                            | ······································  |                                         |
| -08801-  |                                         |                  |                                   |                                         |                                         |
|          | 0_80000008_00.                          |                  |                                   |                                         |                                         |
| _xo      | 0,00000008-38,                          |                  |                                   |                                         |                                         |
|          | 0-00000008-38-                          |                  |                                   |                                         |                                         |
| _xc      |                                         |                  |                                   |                                         |                                         |
|          | 0.10000000E_03,                         |                  |                                   |                                         |                                         |
|          | 0.12000000E04,                          |                  |                                   |                                         |                                         |
|          | 0-100000008-03-                         |                  |                                   |                                         | ·····                                   |
|          | 0.41160000€_03,                         |                  |                                   |                                         |                                         |
| DELK1    |                                         |                  |                                   |                                         |                                         |
| —DEF.KS  | 0-00000008-38,                          |                  |                                   |                                         | · · · · ·                               |
| T_[NE    | 0.00000005-38.                          | 0-935900005-02-  | D 910100005-02                    | 0 985900005-02                          | 0 106290005 03                          |
|          | 0.11411000E 03,                         | 0.12204000E 03;  | 0.13015000E 03,                   | 0.13841000E 03.                         | 0.14683000E 03;                         |
|          | 0-15543000E-03                          |                  |                                   | 0_18260000E_03,                         |                                         |
|          | 0.201940002 03,                         | 0.21211000E 03.  | 0.22142000E 03,                   | 0.22950000E 03,                         | 0.23671000E 03,                         |
|          | 0 270190005 03                          | 0.276350006-03   |                                   | 0-261310006-03,                         |                                         |
|          | 0 290910005 03-                         | 0 295420006 03   | 0.200240005 03                    | 0 305470005 03                          | 0.211250005 031                         |
|          | 0.31780000F 03.                         | 0-32333000E 03-  | 0.32962000E 03.                   | 0.336920005 03.                         | 0-34561000E 03-                         |
|          | 0-356330005-03                          |                  | 0.329020002 03                    | .0 426400005-02                         | 0.545010002 03,                         |
|          | 0.0000000E-38.                          | 0.0000000E-38.   | 0.000000002-38.                   | 0.000000005-38.                         | 0.000000000-38.                         |
|          | 0.00000005-38,                          | 0.00000008-38,   |                                   |                                         |                                         |
|          | 0.0000000E-38,                          | 0.0000000E-38,   | 0.00000000000-38,                 | 0.0000000005-38.                        | 0.00000002-38.                          |
|          | 0.0000000E=38,                          | 0.00000005-38,   |                                   | 0.00000006-38,                          |                                         |
|          | 0.0000000000-38,                        | 0-0000000E-38.   | 0.0000000000-38,                  | 0.000000000-38,                         | 0.00000002-38,                          |
|          | 0.00000008=38,                          | 0.00000008-38,   | 0.00000006-38,                    | 0_0000000E=38+                          | 0.0000000E-38+                          |
|          | 0.0000000000000000000000000000000000000 | 0.0000000E-38,   | 0,0000000E-38,                    | 0.0000000000000                         | 0.0000000E-38.                          |
|          | 0.000000005-38                          | 0.00000005-38-   | 0.0000000000000000000000000000000 | 0.0000000000000000000000000000000000000 |                                         |
|          | 0.0000000E=38                           | D. 000000000-38  | 0.00000000000000                  | 0.000000000000                          | 0.00000005-38                           |
|          | 0.0000000E-38.                          | 0.0000000E-38-   | 0.00000006-38                     | 0.0000000E=38-                          | 0.0000000000000000000000000000000000000 |
|          | 0.0000000E-38.                          | 0.0000000E-38-   | 0-0000000000-38-                  | 0.0000000000000                         | 0.000000000-38                          |
|          | 0.0000000E-38,                          | 0.0000000E-38,   | 0-0000000E-38,                    | 0.0000000E-38.                          | 0.0000000E-38.                          |
|          | 0.00000006-38.                          | 0.0000000E-38,   | 0.0000000E-38,                    | 0.00000000000000.38,                    | 0.00C00000E-38-                         |
|          | 0.0000000E-38,                          | 0.0000000000-38, | 0.0000000E-38.                    | 0.0000000E-38,                          | 0.0000000E-38,                          |
|          | 0.0000000E-38,                          | 0+0000000E-38+   | 0.0000000£-38,                    |                                         | 0.0000000E=38,                          |
|          | 0.0000000E-38.                          | 0.00000002-38,   | 0.0000000E-38,                    | 0.0000000E-38,                          | 0.0000000E-38,                          |
|          | 0.0000000000000                         | 0.00000005-38,   |                                   | 0.0000000E=38,                          | 0.00C00000E-38,-                        |
|          | 0.000000005-38                          | 0.000000000000   | 0.0000000000000                   | 0.000000000000                          | 0.0000000E-38,                          |
|          | 0.0000000E-38.                          | 0.0000000E-38.   | 0.00000000E-38,                   | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 |
|          | 0.10000005.00                           | 0.10000005.01    | 0.12000005 03                     | 0 16000005 C                            | 0.190000005 01                          |
|          | 0.230000006_01-                         | 0.28000000E_01-  | 0.3600000E-01                     | 0.41000000E 01;                         | 0.51000000E 01                          |
|          | 0.620000005 01-                         | 0.760000000 01   | 0.94000000 01                     | 0.114000006 02                          | 0.14100000E 02                          |
|          | 200000000 DI\$                          |                  | 319400000C 014                    | 5-11-40000C UZ;                         | 5314100V0VE UZ;                         |

|         |                                         | 0-2030000E-02-                          | 0+2300000E-02+                                                                                                  |                   |                      |
|---------|-----------------------------------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------|----------------------|
|         | 0.29400000E 02.                         | 0.30400000E 02,                         | 0.28700000E 0Z,                                                                                                 | 0.26400000E 02,   | 0.23800000E 02,      |
|         | 0,211000005 02,                         | 0_18500000E_02,                         | 0.159000008-02,                                                                                                 | 0.13500000E_02,   | 0.11200000E_02,      |
|         | 0.92000000E 01,                         | 0.74000000E 01,                         | 0.58000000£ 01,                                                                                                 | 0.44000000E 01.   | 0.320000008 01.      |
|         | 0_230000006_01,                         | 0.1700000E-01,                          | 0,120000008.01,                                                                                                 |                   | 0+6000000E-00+       |
|         | 0.3000000E 00,                          | 0.200000000 00,                         | 0.10000000E 00,                                                                                                 | 0.0000000CE-38.   | 0.0000000000000.38,  |
|         |                                         |                                         | 0.00000005-38,                                                                                                  | 0_0000000E=38,    |                      |
|         | 0.0000000E-38,                          | 0+0000000E-38;                          | 0.0000000000.08,                                                                                                | 0.0000000E-38,    | 0.0000000E-38,       |
|         | 0.00000000E-38,                         |                                         | 0.00000008-38,                                                                                                  | 0.00000008-38,    | 0.0000000E=38+       |
|         | 0.00000000000000.                       | 0.0000000E-38.                          | 0.0000000E-38,                                                                                                  | 0_0000000E-38;    | 0.0000000E-38.       |
|         |                                         |                                         | 0.00000008-38,                                                                                                  | 0.00000008-38,    | 0.0000000E=38,       |
|         | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.00000002-38,                                                                                                  | 0.0000000E-38,    | 0.0000000E-38,       |
|         | 0.0000000E=38+                          | 0.00000008-38,                          |                                                                                                                 | 0.0000000E-38,    | 0.0000000E=38+       |
|         | 0.0000000E-38.                          | D.0000000E-38,                          | 0.0000000E-38.                                                                                                  | 0.00000000000-38, | 0.0000000E-38+       |
|         | 0,0000000E=38,                          | 0.0000000E-38,                          | 0.0000000E=38,                                                                                                  | 0.0000000E-38,    | 0.0000000E=38+       |
|         | 0.0000000E-38,                          | 0.0000000000000                         | 0.0000000E-38.                                                                                                  | 0.00000002-38,    | 0.0000000E-38.       |
|         | 0.00000008-38,                          | 0.0000000000000000000000000000000000000 | 0.00000005-38,                                                                                                  |                   |                      |
|         | 0.0000000E-38.                          | 0.0000000E-38.                          | 0.00000008-38,                                                                                                  | 0.00000002-38,    | 0.000000008-38.      |
|         | 0.00000008-38-                          | 0.0000000E=38+                          | 0.00000008=38;                                                                                                  | 0_0000000E=38,    | 0_0000000E=38+       |
|         | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                                                                                                  | 0.00000000000-38, | 0.0000000E-38;       |
|         | 0_0000000E=38,                          |                                         | .0.00000008=38,                                                                                                 | 0.00000008-38,    |                      |
|         | 0,0000000E-38,                          | 0.00000002-38,                          | 0.0000000E-38,                                                                                                  | 0.0000000E-38,    | 0.00000000000000.38, |
|         | 0.0000000E-38.                          | 0_0000000E=38,                          |                                                                                                                 | 0.0000008-38,     | 0-00000008-38        |
|         | 0.0000000E-38,                          | 0.00000006-38,                          | 0.00000008-38,                                                                                                  | 0.0000000E-38,    | 0.0000000E-38,       |
|         | 0.00000006-38.                          | 0-00000008-38,                          |                                                                                                                 | 0_0000000E-38,    | 0+0000000E-38,       |
|         | 0.00000008-38.                          | 0.000000000000-38.                      | 0.0000000E-38,                                                                                                  | 0.000000000-38,   | 0.0000000E-38,       |
|         | 0.0000000E=38,                          | -0-0000000E=38+                         | 0.0000000E=38,                                                                                                  | 0_0000000E=38,    | 0_0000000E=78,       |
|         |                                         |                                         |                                                                                                                 |                   |                      |
| -8781 - |                                         | 0-0000000E-38,                          | -0.0000000E-38,                                                                                                 |                   |                      |
|         | 0.0000000E-38.                          | 0.00000000000.38.                       | 0.00000008-38,                                                                                                  | 0.0000000E-38,    | 0.00000002-38,       |
|         | 0_00000005-38,                          |                                         | 0+00000008-38+                                                                                                  | 0.000000000.38,   |                      |
|         | 0.0000000E-38.                          | 0.0000000000-38.                        | 0.0000000E-38,                                                                                                  | 0.00000000000.38; | 0.00000002-38        |
|         | 0,0000000E=38,                          | 0_00000006=38,                          | 0.00000008-38,                                                                                                  | 0.0000000E-38,    | 0,00000005-38,       |
|         | 0.0000000E-38,                          | 0.000000000-38,                         | 0.00000008-38,                                                                                                  | 0.00000008-38,    | 0.0000000E-38,       |
|         | 0.00000008-38.                          | 0.00000005-38                           | 0.0000000E=38,                                                                                                  | 0.00000005-38,    |                      |
|         | 0.0000000E-38,                          | 0.0000000000-38,                        | 0.00000008-38,                                                                                                  | 0.000000002-38,   | 0.0000000E-38;       |
|         | 0_0000000E=38,                          |                                         | 0.00000008-38,                                                                                                  | 0.0000000E=38,    | 0.0000000E=38,       |
|         | 0.0000000E-38.                          | 0.000000000-38,                         | 0.0000000E-38,                                                                                                  | 0.0000000000-38,  | 0.00000002-38,       |
|         | 0.0000000E=38,                          | 0.00000008=38,                          | 0.0000000000-38,                                                                                                | 0_0000000E=38,    | 0.0000000E=38,       |
|         | 0.0000000E-38.                          | 0.0000000E-38, ,                        | 0.000000002-38,                                                                                                 | 0.0000000000-38,  | 0.0000000E-38,       |
|         |                                         |                                         |                                                                                                                 | 0_0000000E=38;    |                      |
|         | 0.00000000000000,                       | 0.00000002-38,                          | 0.000000008-38,                                                                                                 | 0.0000000E-38,    | 0.0000000E-38.       |
|         | 0.00000006-38,                          | 0.00000008-38,                          | 0.000000000000                                                                                                  |                   | 0.00000006-38,       |
|         | 0.0000000E-38.                          | 0.00000008-38,                          | 0.0000000000000000000000000000000000000                                                                         | 0.000000000-38,   | 0.000000000-38.      |
|         | 0.00000005-38,                          | 0.0000000E=38+                          | 0_00000006=38+                                                                                                  | 0.00000008=38,    | U_0000000E=38,       |
|         | 0.0000000000000.38.                     | 0.0000000E-38.                          | 0.0000000E-38,                                                                                                  | 0.0000000E-38,    | 0.0000000E-38,       |
|         | 0.0000000E=38.                          | 0.0000000E=38+                          | 0.0000000E=38,                                                                                                  | 0.00000006-38,    | 0.0000000E-38        |
|         | 0.00000008-38,                          | 0.0000000E-38.                          | 0.0000000E-38,                                                                                                  | 0.00000000-38,    | . 0.0000000E=38, -   |
|         |                                         |                                         | 0.0000000E=38+                                                                                                  | 0.0000000E=38;    |                      |
|         | 0.0000000E-38,                          | 0.0000000E→38.                          | 0.0000000E-38,                                                                                                  | 0.0000000E-38,    | 0.00000002-38,       |
|         | 0.0000000E=38.                          | 0.000000E=38,                           | 0.00000008=38.                                                                                                  | 0.000000000=38.   |                      |
|         | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38,                                                                                                  | 0.000000002-38,   | 0.0000000E-38, .     |
|         |                                         | 0.0000000E-38                           | 0.000000E~38,                                                                                                   | 0.0000000E=38,    | 0.0000000E=38+       |
|         | 0.0000000E-38,                          | 0+0000000E-38+                          | 0.0000000E-38,                                                                                                  | 0.0000000E-38,    | 0.000000000000       |
|         | 0.0000000E=38,                          | 0.0000000E=38;                          | 0.0000000000000                                                                                                 | 0.0000000E=38,    | 0.0000000E-38+       |
|         | 0.00000000000000                        | 0.0000000E-38.                          | 0.0000000E-38.                                                                                                  | 0.0000000E-38,    | 0.0000000E-38,       |
|         | 0.0000000000000000000000000000000000000 | 0.00000005-38.                          | 0.00000006-38.                                                                                                  |                   | 0.000000E+38,        |
|         | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                                                                                                  | 0.00000000E-38,   | 0.0000000E-38;       |
| HTBL *  | 0.12750000E 03.                         | 0.13090000E 03,                         | 0.13110000E 03,                                                                                                 | 0.13140000E 03,   | 0.13170000E .03.     |
|         | 1.1.11                                  |                                         | the second second second second second second second second second second second second second second second se |                   |                      |

|                      | 0.13300000E 03,                         | 0.13310000E 03;                    | 0.13250000E 03.<br>0.13300000E 03.   | 0.13270000E 03,<br>0.13280000E 03, | 0.13290000E-03.<br>0.13230000E 03.     |
|----------------------|-----------------------------------------|------------------------------------|--------------------------------------|------------------------------------|----------------------------------------|
|                      | 0.13140000E 03.                         | 0.129900008-03,<br>0.10820000E 03. | - 0.12800000E 03,<br>0.98600000E 02. | 0.12640000E 03,<br>0.89400000E 02. | 0.12280000E-03.                        |
|                      |                                         | -0.64700000E-02,                   | 0-57400000E 02,                      |                                    |                                        |
|                      |                                         | - 0.129000008 02,                  | 0.108000008 02,                      |                                    |                                        |
|                      | 0.58000000E 01,<br>0.00000000E=38.      | 0+47000000E 01+                    | 0.39000000E 01,                      | 0.37000000E 01;                    | 0.4000000E 01.                         |
|                      | 0.0000000E-38.                          | 0.0000000E-38,                     | 0.0000000E-38.                       | 0.0000000000000                    | 0.00C00000E-38,                        |
|                      | 0.00000000000000-38.                    |                                    | 0-000000005-38-                      | 0.000000005-38,<br>0.00000005-38,  |                                        |
| <b></b>              | 0.0000000E-38,                          |                                    |                                      | -0+00000000E-38,                   |                                        |
|                      | 0.00000000E-38.                         | 0.00000000000-38.                  | 0.00000000E-38,<br>0.00000000E-38,   | 0.00000000E-38,<br>0.00000000E-38, | 0.00000000E+38,                        |
|                      | 0.9000000E-38,                          | 0.0000000E-38,                     | 0.000000005-38,                      | 0.0000000E-38,                     | 0.0000000E-38,                         |
|                      | 0.0000000000000000000000000000000000000 | 0.0000000E-38,                     | 0.000000000E-38.                     | 0.0000000E-38,                     | 0.000000000000000000000000000000000000 |
|                      |                                         | 0-00000008-38-                     |                                      | -0.00000005-38,                    |                                        |
|                      | 0.00000000E=38,                         | 0.00000005-38,                     |                                      |                                    | 0.000000000000000000000000000000000000 |
|                      | 0.0000000E-38.                          | 0.0000000E-38.                     | 0.000000000-38,                      | 0.0000000E-38,                     | 0.0000000E-38;                         |
|                      | D.0000000E-38.                          | 0.00000000E-38.                    | 0.00000000E-38,                      | 0.00000000000000                   | 0.00000000E-38,                        |
|                      | 0-00000000E-38-                         |                                    | 0-00000000E=38,<br>0-00000000E=38,   | 0.00000000000-38,                  |                                        |
|                      | 0.0000000E-38,                          | 0+00000000E-38,                    |                                      |                                    |                                        |
|                      | 0.00000000E-38.                         | 0.0000000E-38,<br>0.0000000E-38,   | 0.00000000E-38;                      | 0.0000000000-38.                   | 0.00000000E-38,                        |
|                      |                                         |                                    |                                      |                                    |                                        |
| -1-1-48              | 0.1000000E 04,                          | 0,12000000E 04,                    | 0.14000000E 03.<br>0.14000000E 04.   | 0.16000000E 04;                    | 0+80000000E-38+                        |
| CPTAB =              | 0.40000000E 00,<br>0.67000000E 00,      | 0,50000000E 00,<br>0,70000000E-00, | 0.57000000E 00,<br>0.73000000E 00;   | 0.6100000E 00,<br>0.7600000E 00,   | 0.65000000E 00;<br>0.0000000E-38;      |
| _EFTA8               |                                         |                                    | 0.4000000E_08                        | 0.370000005-08,                    |                                        |
|                      | 0.26000000E 08,                         | 0.15000000E 08,                    | 0.8000000E 07.                       | 0.10000000 07,                     | 0.0000000E-38,                         |
| SGFTAB =             | 0.6000000E 05,<br>0.32000000E 05,       | 0.58000000E 05.                    | 0.52000000E 05,<br>0.10000000E 05,   | 0.46000000E 05,<br>0.10000000E 04, | 0.4000000E 05.                         |
| -GFTAB               | 0.24000000E=01.                         | 0.24000000E=01,                    | 0,24000000E=01,                      |                                    | 0.2400000E=01,                         |
|                      | 0.2400000E-01,                          | 0.24000000E-01,                    | 0-240000008-01,                      | 0.24000000E-01,                    | 0.24000000E-01,                        |
| GRTAB =              | 0.32000000E 00.                         | 0.32000000E 00,<br>0.32000000E 00, | 0.32000000E 00.<br>0.32000000E 00.   | 0.32000000E 00,<br>0.32000000E-00, | 0.32000000E 00,<br>0.32000000E 00,     |
| _SGRTAB              | 0.950000005-05                          | 0.95000005 05.                     | 0.95000005 05.                       | 0_920000006_05-                    | 0-90000005-05-                         |
|                      | 0.9000000E 05,                          | 0.85000000E 05,                    | 0.7000000E 05.                       | 0.1000000E 05,                     | 0.0000000E-38.                         |
| \$ END               |                                         |                                    |                                      |                                    |                                        |
| -DATE= 4+01          |                                         | CASE= 0.00                         | ,                                    |                                    |                                        |
| - SECTION            |                                         |                                    |                                      |                                    |                                        |
|                      |                                         |                                    |                                      |                                    |                                        |
| TC Y                 | ROC                                     | y TE                               | тс                                   | UT                                 | -                                      |
| 1-31241E-04          | 1.000005-00                             | -5+075 00E-011+0000                | 1E-02 2-50000E-01                    |                                    |                                        |
| -5.24965E 02         |                                         |                                    |                                      | <u>````````</u>                    | -                                      |
|                      |                                         |                                    |                                      |                                    | •                                      |
| SECTION 3            |                                         |                                    |                                      |                                    |                                        |
| SANDWICH_CONSTRU     | ICTION                                  |                                    |                                      |                                    |                                        |
|                      | RDG<br>1.00000E 00                      | 5.26615E-01 1.00000                | DE-02 4.79382E-01                    | ¥7<br>1+04572E 02                  |                                        |
| SIG4H<br>1-10634E 04 | SIGH<br>-1-27668E-04                    | SIGM<br>5.98852E 03                |                                      |                                    |                                        |

| \$ INPU | F  |                  |                                       |             |          |                                        |          |             |
|---------|----|------------------|---------------------------------------|-------------|----------|----------------------------------------|----------|-------------|
| OATE_   |    | 0-401000005-01   |                                       |             | ······   |                                        |          |             |
|         |    |                  |                                       |             |          |                                        |          |             |
| CASE    |    | 0.2000000E~01.   |                                       |             |          |                                        |          |             |
| SECTN   | -* | <u>11,</u><br>0, | 0,                                    | 0,<br>0,    | 0,<br>0, | 0,<br>0,                               | 0,<br>0, | <u>-</u> 0, |
| MON     | 2  | , 0 <sub>1</sub> |                                       |             |          |                                        |          |             |
| RSD     | *  | 1,               |                                       |             |          |                                        |          |             |
| HTOP    | -  | 2,               |                                       |             |          |                                        |          |             |
| HTST    | =  | 1,               |                                       |             |          |                                        |          | -           |
| GAMF    | =  | 0.33000000E 00,  |                                       |             |          |                                        |          |             |
| EF      | -  | 0.8000000E 07,   |                                       |             |          |                                        |          |             |
| ROF     | -  | 0.11600000E 03,  |                                       |             |          |                                        | -        |             |
| SIGCYP  |    | 0.4000000E 05.   |                                       |             |          |                                        | -        |             |
| GAMR    | =  | 0.33000000E 00,  |                                       |             |          |                                        |          | ~           |
| ER      | =  | 0.0000000E-38,   |                                       |             |          |                                        | -        |             |
| ROR     | •  | 0.5000000E 03,   |                                       |             |          |                                        |          | •           |
| SIGCYR  | -  | 0.4000000E 05,   |                                       |             |          |                                        | -        | -           |
| KADHES  | -  | 0.2000000E 00,   |                                       |             |          |                                        |          | -           |
| PCR     | =  | 0.8300000E-02,   |                                       |             |          |                                        |          |             |
| TEMIN   | Ŧ  | 0.1000000E-01,   |                                       |             |          | · · · · · · · · · · · · · · · · · · ·  |          |             |
| TCHIN   | =  | 0.25000000€ 00,  | ···                                   |             |          |                                        | -        |             |
| TCHAX   | =  | 0.3000000E 01,   |                                       |             |          | · · · · · · · · · · · · · · · · · · ·  |          |             |
| ROCHIN  | =  | 0.1000000E 01,   |                                       |             |          |                                        | -        |             |
| ROCMAX  | =  | 0.1000000E 02.   |                                       |             |          | ·                                      |          | -           |
| GANBAR  | -  | 0.000000000-38,  |                                       |             |          | ······································ |          | ·           |
| CBAR    | =  | 0.1000000E 01,   |                                       |             |          |                                        |          |             |
| WHS     | =  | 0.0000000E-38,   | · · · · · · · · · · · · · · · · · · · |             |          |                                        |          |             |
| G       | -  | 0.25800000E 02,  |                                       | · · · · · · |          |                                        |          | -           |
| HS      | -  | 0.0000000E-38.   |                                       | ·····       |          |                                        |          |             |
| EH      | -  | 0-300000006 02.  |                                       | •           |          |                                        |          |             |

| EN          |                                       | -0.00000000C-30.                        |        |             |      |              |         |               |            |                                         |          |
|-------------|---------------------------------------|-----------------------------------------|--------|-------------|------|--------------|---------|---------------|------------|-----------------------------------------|----------|
| NFAC -      |                                       | 2,                                      |        |             |      |              |         |               |            |                                         | -        |
| -NTERM-     | · · · · · · · · · · · · · · · · · · · | 0,                                      | ·      |             |      |              |         |               |            |                                         | <u>.</u> |
| <del></del> |                                       | -0-500000005-01-                        |        |             |      |              |         |               |            |                                         |          |
| RN          |                                       | -0-125000008 01.                        |        |             |      |              |         |               |            |                                         |          |
|             |                                       | -0-000000000-38-                        |        |             |      |              |         |               |            |                                         | -        |
|             |                                       | -0-60000000E 02.                        |        |             |      |              |         |               | _          |                                         | <u> </u> |
| - 8.4       | · ·                                   | 0-000000008=38-                         |        |             |      |              |         |               |            |                                         |          |
|             |                                       | -0 80000005 02                          |        |             |      |              |         |               |            |                                         |          |
| - THE -     |                                       | 0.600000000 02,                         |        |             |      |              |         |               |            |                                         |          |
| b           |                                       | 0.0000000000000000000000000000000000000 |        |             |      |              |         |               |            |                                         |          |
|             |                                       |                                         |        |             | _    |              |         |               |            |                                         | -        |
|             |                                       | -0.15000000E-00-                        |        |             |      |              | · · · · |               |            |                                         |          |
| TH8 =       |                                       | -0+000000008-38+                        |        |             |      | -            |         |               | _          |                                         |          |
| - RC -      | • • • • • • • • •                     | 0,7500000E_01,                          |        |             |      |              |         |               |            |                                         |          |
| -RSC        |                                       | 0+150000008-00+                         |        |             |      |              |         |               |            |                                         | — ,      |
| -L-C=       |                                       | -0+000000008-38+                        |        |             |      |              |         |               |            |                                         | ·        |
| RT          |                                       | 0.375000005 01,                         |        |             |      |              |         |               | _          |                                         |          |
|             |                                       | 0.00000000E=38,                         |        |             |      |              |         |               |            |                                         |          |
|             |                                       | -0.00000005-38,                         |        |             |      |              |         |               |            |                                         |          |
| TH2G        | ·                                     | 0.0000000E=38,                          |        |             |      |              |         |               |            |                                         |          |
|             |                                       |                                         |        |             |      |              |         |               |            |                                         |          |
| x           |                                       |                                         | 0_000  | 000008-38,  | 0.00 | 0000005-38.  | (       | -00000006-3   | 8,         | 0-0000000E-                             | 8,       |
|             |                                       | 0.00000008-38,                          | 0.000  | 00000E-38   | 0.00 | 000000E-38.  | 9       | -0000000E-3   | B <b>,</b> | 0-0000000E-                             | 8,       |
|             |                                       | 0.00000000E-38.                         | 0.000  | 000000E-38. | 0.00 | 0000008-38.  |         | -000000000000 | 8.         | 0.0000000000000                         | 18.      |
|             |                                       | 0.00000008-38,                          | 0.000  | 000006-38,  | 0.00 | 000000E-38,  | `       | -00000008-3   | 8,         | 0-00000008-                             | 8,       |
| _0          |                                       | 0.00000005-30                           | _0.00/ | 000005-38   |      | 000006-30    |         |               |            | 0.000000000                             |          |
|             |                                       | 0.0000000E-38.                          | 0.000  | 000000E-38. | 0.00 | 000000E=38-  |         | -000000000E-3 | 8.         | 0.0000000000000000000000000000000000000 | 18.      |
|             |                                       |                                         | 0.000  | 000000E-38  | 0.00 | 000000E-38   |         | -000000005-3  |            | 0.0000000E=                             |          |
|             |                                       | 0.00000008-38,                          | 0.000  | 00000E-38,  | 0.00 | 000000E-38,  | - 6     | .0000000E-3   | B <b>,</b> | 0.0000000E-                             | 8,       |
|             |                                       | 0.00000008-38,                          | 0_000  | 000005=38   |      | 0000008-38,- |         | -0000000E=3   | 8,         | 0-CO000000E-1                           | 8        |
| _RORG       |                                       | _0.00000000008=38,                      |        |             |      |              |         |               |            |                                         |          |
| SIGRG -     |                                       | 0.0000000E=38,                          |        |             |      |              |         |               |            |                                         | _        |
| 07H0Y       |                                       | 0.00000006~38,                          |        |             |      |              |         |               | _          |                                         |          |
| -DELTAU-=   |                                       | 0.1000000E_00.                          |        |             |      |              |         | -             |            |                                         |          |

| EHISTR-  |                                         |                                         |                                         |                                         |                                         |
|----------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
|          | 0+10000000800+                          |                                         |                                         |                                         |                                         |
| -QRHUL-T | 0-00000008-38                           |                                         |                                         |                                         |                                         |
| -XN      | 0+8000000E-00+                          |                                         |                                         |                                         |                                         |
| -xo      | 0.000000005-38                          |                                         |                                         |                                         |                                         |
| -X-A     |                                         |                                         |                                         |                                         |                                         |
| -xc      |                                         |                                         |                                         |                                         |                                         |
| -TEMPI   | 0+10000000E-03+                         |                                         |                                         |                                         |                                         |
| TEMPA    | -0-120000005-04                         |                                         |                                         |                                         |                                         |
| -T-INIT  | -0-100000000 03,-                       |                                         |                                         |                                         |                                         |
| _T\$TOP  | 0-41160000E 03;                         |                                         |                                         |                                         |                                         |
| -DELK1=  |                                         |                                         |                                         |                                         |                                         |
| -DEFK5   |                                         |                                         |                                         | ·                                       | · <u> </u>                              |
| -TINE    |                                         |                                         | 0.91010000E_02                          |                                         |                                         |
|          | 0.11411000E 03.                         | 0.12204000E 03.                         | 0.13015000E 03,                         | 0,13841000E 03,                         | 0.14683000E 03.                         |
|          | 0-15543000E03                           |                                         | 0-173320006-03,                         |                                         |                                         |
|          | 0.20194000E 03,                         | 0,21211000E 03,                         | 0.22142000E 03,                         | 0.22950000E 03,                         | 0.23671000E 03,                         |
|          |                                         | 0_25018000E_03,                         |                                         | 0_26131000E-03,                         | 0-26589000E-03+                         |
|          | 0.27019000E 03,                         | 0.27435000E 03,                         | 0-27841000E 03,                         | 0.28247000E 03.                         | 0.28662000E 03,                         |
|          |                                         | 0,295420005 02,                         | 0.300240005 03,                         | 0.30547000E_03,                         |                                         |
|          | 0.317800002 03,                         | 0.323330002 03,                         | 0-32962000E 03,                         | 0.33692000E 03.                         | 0.34561000E D3,                         |
|          | 0.000000005-38                          | 0 0000000E=037                          |                                         |                                         |                                         |
|          | 0.0000000000-38                         | 0.0000000000000                         | 0.000000000000000                       | 0.0000000000000                         | 0.0000000000000-38,                     |
|          | 0.00000005-38                           | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 |                                         |
|          | 0.00000005-38-                          |                                         | 0.00000005-38                           | 0.000000005-38                          | 0.0000000000000000000000000000000000000 |
|          | 0.0000000E-38.                          | 0.0000000F-38.                          | 0-0000000E-38-                          | 0.0000000E-38.                          | 0-0000000E-38-                          |
|          | 0.00000005-38                           | 0.00000005-38-                          | 0_0000000F-38                           | 0-00000005-38                           |                                         |
|          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38                           |
|          | 0.0000000E#38-                          | 0.0000000E=38,                          | 0+000000005=38,                         | 0.0000000E=38                           | - 0.00000000 -38-                       |
|          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0-0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38,                          |
|          | 0.00000005=38,                          | 0.0000000E=38,                          | 0.0000000E=38,                          | 0.0000000E=38                           |                                         |
|          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38.                          | 0.0000000E-38,                          |
|          | 0.00000000000000                        |                                         |                                         | -0.0000000E-38,                         |                                         |
|          | 0.0000000000000000000000000000000000000 | 0.0000000000000-38,                     | 0-000000000-38,                         | 0.00000002-38,                          | 0.0000000E-38,                          |
|          | 0.000000005-38                          | 0.000000005-38                          |                                         |                                         |                                         |
|          | 0.0000000E=38+                          | - 0 0000000E=38;                        | 0.000000000000-38                       | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 |
|          | 0-0000000E-38-                          | 0.0000000E=38.                          | 0-0000000E-38-                          | 0.00000006-38                           | 0_00000000E_30                          |
|          | 0-0000000E=38                           | 9.0000000E=38-                          |                                         | 0.000000005-38-                         | 0 0000000E=38                           |
|          | 0.0000000E-38.                          | 0.00000000E-38.                         | 0.00000000E-38-                         | 0.0000000E-38-                          | 0-0000000E-34-                          |
|          | 0.0000000E=38+                          | 0.0000000E-38,                          | 0-000000000-38                          | 0-000000000-38-                         |                                         |
|          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38.                          | 0.00000008-38.                          |
|          |                                         |                                         |                                         |                                         |                                         |
| GIBL =   | 0.100000000 00,                         | 0.1000000E 01,                          | 0.12000000E 01.                         | 0.15000000E 01,                         | 0.1800000E 01.                          |
|          |                                         | U.28000000E_01+                         |                                         | 0.4100000E-02,                          | 0-51000000E-01+                         |
|          | 0.020000000 01;                         | 0.1000000E 01:                          | 0+94000000E 01,                         | 0.11400000E 02;                         | 0.14100000E 02,                         |

|       | 0+168000000-02+                         |                                         |                                         |                                         |                                         |
|-------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
|       | 0.29400000E 02.                         | 0.30400000E 02.                         | 0.28700000E 02,                         | 0.264000006 02,                         | 0.238000000 02,                         |
|       | 0.211000006 02,                         | 0.18500000E-02,-                        | 0,15900000E_02,                         | 0.13500000E-02.                         | 0;11200000E_02-                         |
|       | 0.9200000E 01,                          | 0.7400000E 01,                          | 0.58000000E 01.                         | 0.44000000E 01,                         | 0.32000000E 01,                         |
|       |                                         | 0.17000005-01,                          | -0+120000006-01,                        | 0-8000000E-00-                          | 0.6000000E-00,                          |
|       | 0.300000000 00,                         | 0.200000000 00,                         | 0.1000000E 00,                          | 0.0000000E-38,                          | 0.0000000E-38,                          |
|       |                                         | 0+0000000E~38+                          |                                         |                                         | 0-00000000E-38,                         |
|       | 0.0000000E-38.                          | D.0000000E~38,                          | 0.0000000E-38,                          | 0.00000008-38,                          | 0.00000008-38.                          |
|       | 0.00000005-38.                          |                                         | -0-0000000E-38,                         | 0.000000000-38,                         | 0,00000008-38,                          |
|       | 0.0000000E-38.                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          |
|       | 0-00000005-38-                          |                                         |                                         | 0-00000008-38-                          |                                         |
|       | 0.0000000E-38.                          | 0.00000006-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          |
|       |                                         | 0.0000000E-38+                          | 0.00000008-38,                          | 0.0000000E=38+                          | 0+0000000E-38+                          |
|       | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.00000000E-38,                         | 0.0000000000000000000000000000000000000 | 0.0000000E-38.                          |
|       |                                         | 0.0000000E~38,                          | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 | 0.00000000.38-                          |
|       | 0.0000000000000000000000000000000000000 | 0-0000000E-38,                          | 0.0000000E-38,                          | 0.0000000000000000000000000000000000000 | 0.000000002-38,                         |
|       |                                         | 0.0000000E=38,                          |                                         | 0.0000000000000000000000000000000000000 | 0_00000000E-38+                         |
|       | 0.0000000E-38.                          | 0.000000002~38,                         | 0.00000000000000                        | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 |
|       |                                         |                                         | 0.0000000000000000000000000000000000000 |                                         | 0-0000000E-38;                          |
|       | 0.0000000E-38,                          | 0-0000000E-38+                          | 0.00000000000000                        | 0.0000000E-38,                          | 0.0000000000000000000000000000000000000 |
|       |                                         | 0.0000000e~38,                          | 0.0000000000000000000000000000000000000 | 0.0000000000000                         | 0.0000000E-38-                          |
|       | 0.0000000E-38;                          | 0.0000000000000000000000000000000000000 | 0.000000000-38,                         | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 |
|       |                                         | 0.0000000000000000000000000000000000000 | 0.000000000-367-                        | 0-00000000-38                           |                                         |
|       | 0.0000000000000                         | 0.00000000000000                        | 0.000000002-38,                         | 0.0000000000000                         | 0.00000000000000                        |
|       | 0.000000002-38,                         | 0.00000000000000                        | 0.000000000000000                       | 0.0000000000000000000000000000000000000 | 0-00000000-30+                          |
|       | 0.0000000000000                         | 0.0000000E-38.                          | 0.0000000000000                         | 0.00000000000000                        | 0-0000000E=38;                          |
|       |                                         |                                         |                                         |                                         |                                         |
| F81,  | 0.00000000E=38,                         |                                         | 0.00000000E-38,                         | Q+0000000E-38,                          | 0.0000000E-38+                          |
|       | 0.0000000E-38.                          | 0.0000000E-38.                          | 0.00000008-38,                          | 0.0000000000000000000000000000000000000 | 0.0000000E-38,                          |
|       | 0.0000000E-38,                          | 0-0000000E-38-                          | 0-00000008-38-                          |                                         |                                         |
|       | 0.0000000000000000000000000000000000000 | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000008-38,                           | 0.0000000E=38,                          |
|       | 0.00000005=38.                          |                                         | 0.00000006-38,                          | 0.00000008-38,                          | 0.00000008-38,                          |
|       | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38,                          |
|       |                                         | 0-00000005-38                           |                                         |                                         | 0-0000000E-38+                          |
|       | 0.00000006-38.                          | 0.0000000E~38,                          | 0.0000000E-38,                          | 0.00000002-38,                          | 0.00000008-38.                          |
|       | 0.0000000E=38,                          | 2.00000000E~38,                         | 0-00000006-38,                          | 0+00000000-38,                          |                                         |
|       | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.0000000000000000000000000000000000000 | 0.00000002-38+                          | 0.000000000-38,                         |
|       | 0.00000000E=38,                         | 0.00000005~38,                          | 0.00000005-38,                          | 0.0000000E=38;                          | 0.00000006-38,                          |
|       | 0.0000000000000000000000000000000000000 | 0.0000000E-38,                          | 0-0000000E-38,                          | 0.0000000E-38,                          | 0.000000E-38,                           |
|       | 0,0000000000000000000000000000000       |                                         |                                         |                                         |                                         |
|       | 0.00000000000000                        | 0.0000000000000                         | 0.000000002-38,                         | 0.0000000000000                         | 0.0000000000000000000000000000000000000 |
|       | D 000000000000000000000000000000000000  | 0.0000000000000000000000000000000000000 |                                         |                                         |                                         |
|       | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 | 0.0000000000000                         | 0.000000000000                          | 0.0000000000000000000000000000000000000 |
|       | 0.000000000-38                          | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 | 0.000000005-38                          | 0.0000000000000000000000000000000000000 |
|       | 0.00000000000000                        | 0.0000000000000                         | 0.0000000000000000000000000000000000000 | 0.00000000000000                        | 0.00000000000-38                        |
|       | 0.0000000000000000000000000000000000000 | 0.000000000000                          | 0.00000000000000                        | 0.000000000000000                       | 0.0000000000000000000000000000000000000 |
|       | 0.00000000000000                        | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 | 0.000000000000                          | 0.00000000000-38,                       |
|       | 0.0000000E=38.                          | 0.0000000E=38.                          | 0-0000000E=38                           | 0.00000005-38-                          | 0.00000005=38                           |
|       | 0.0000000000000                         | 0.0000000E-38;                          | 0.0000000E-38.                          | D.0000000E=38-                          | 0.0000000000000000000000000000000000000 |
|       | 0-00000005-38                           | 0.00000005-32                           | 0.000000005-39                          | n-00000006-39                           | 0.000000000000-39                       |
|       | 0.00000005-30                           | 0.0000000000000                         |                                         | 0.000000000-30                          | 0 0000000000000000000000000000000000000 |
| _     | 0.00000005-29                           | 0_0000000E-30                           | 0-00000000E-39                          | 0.000000005-38-                         | 0.00000000000000000                     |
|       |                                         | 0.000000000000                          | 0.0000000000000                         | 0.000000000000                          | 0.000000005-39                          |
|       | 0.00000005-38                           | 0.0000000E-38                           | 0.00000006-38                           | 0.000000000-38-                         | 0.00000000000000                        |
|       | 0_0000000E=38                           | 0.0000000E-38-                          | 0.0000000000000                         | 0.0000000000000                         | 0.000000000-38                          |
|       | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38.                          | 0.0000000E-38,                          | 0.0000000E-38.                          |
| 70) - | 0 127500005 02                          | A 12000000 07                           | A 131100007 03                          | 0.101/00005.00                          | 0 13130000F 03                          |
|       | U+12120000E 03,                         | 0-1209000E 03+                          | 0.13110000E 03;                         | 0.121400005 03:                         | 0+19110000E 03;                         |

|         |                                                               | 0 122000005 05                                                                            |                                                                                                                 | 0000-03                                                    | -0-199500000-03                              |                                              | 700005-03                              |                                                          |                                              |
|---------|---------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|----------------------------------------------|----------------------------------------------|----------------------------------------|----------------------------------------------------------|----------------------------------------------|
|         |                                                               | 0.133000006 03                                                                            | . 0.13310                                                                                                       | 000F 03.                                                   | 0.13300000F 03                               | 0.132                                        | 80000F 03-                             | 0.132300008                                              | 03.                                          |
|         |                                                               | 0 131600005-03                                                                            | 0 12000                                                                                                         | 0005 03                                                    | 0 12000005 03                                | -0.126                                       | 40000E-03-                             | 0.122800005                                              | -03                                          |
|         |                                                               | 0 116200005 07                                                                            | 0 10920                                                                                                         | 000E 03.                                                   | 0-9860000E 02                                | 0.894                                        | 00000F 02.                             | 0.80700000                                               | 02                                           |
|         |                                                               | 0.725000005-02                                                                            | 0 44700                                                                                                         | 0005 02                                                    | -0.576000005 02                              | 0.505                                        | 000005-02-                             | 0.44100000                                               | -03                                          |
|         |                                                               | 0.383000000                                                                               | 0.22700                                                                                                         | 0005 02                                                    | 0 27600000E 02                               | 0 231                                        | 000006 02.                             | 0.19000000                                               | 02-                                          |
|         |                                                               | 0 152000005 03                                                                            | 0 12000                                                                                                         | 0005 02                                                    | 0 108000005-02                               | 0.890                                        | 000005 01                              | - 0.73000000                                             |                                              |
|         |                                                               | 0 50000000 01                                                                             |                                                                                                                 | 0000 01                                                    | 0 300000000 01                               | 0.370                                        | 000005 01.                             | 0.4000000                                                | 01-                                          |
|         |                                                               | 0.5800000000000000000000000000000000000                                                   | 0.47000                                                                                                         | 0000 014                                                   | 0.3700000000 01                              | , 0.510                                      | 0000000-30                             | 0.00000000                                               | - 29                                         |
|         |                                                               |                                                                                           | 0.00000                                                                                                         |                                                            |                                              |                                              | 000000-301                             |                                                          | - 20                                         |
|         |                                                               | 0.00000006-35                                                                             | 0.00000                                                                                                         | 0006-38,                                                   | 0.00000008-38                                | , 0,000                                      | 00000E-38+                             | 0.00000000                                               |                                              |
|         |                                                               |                                                                                           |                                                                                                                 | 0006-38-                                                   | -0-0000000E-38                               |                                              | 00000E-38-                             |                                                          |                                              |
|         |                                                               | 0.0000000E-36                                                                             | 3, 0.00000                                                                                                      | 000E-36.                                                   | 0.0000000E-38                                | . 0.000                                      | 00000E-38+                             | 0.00000000                                               | -38+                                         |
|         |                                                               |                                                                                           | 0.0000                                                                                                          | 0005-38,                                                   | 0+0000000E-38-                               | + 0+000                                      | 00000E-38+-                            | 0+0000000E                                               | -38,                                         |
|         |                                                               | 0.0000000000000                                                                           | 3. 0.00000                                                                                                      | 000E-38,                                                   | 0+00000000E-38                               | . 0.000                                      | 00000E-38,                             | 0.00000008                                               | -38,                                         |
|         |                                                               |                                                                                           | 3,                                                                                                              | 0005-38,                                                   | -0-0000000E-38                               | . 0.000                                      | 00000E-38-                             |                                                          |                                              |
|         |                                                               | 0-00000005-35                                                                             | a. 0.0000                                                                                                       | 0006-38-                                                   | 0.00000000E-38                               | 0.000                                        | 00000E-38-                             | 0.00000008                                               | 38.                                          |
|         |                                                               | 0-00000006-36                                                                             | 0-00000                                                                                                         | 0005-38-                                                   | -0-0000000E-38                               | 0.000                                        | 00000E-38                              |                                                          | -38,                                         |
|         |                                                               | 0.00000006-38                                                                             | 0.00000                                                                                                         | 0005-38-                                                   | 0-000000005-38                               | 0.000                                        | 000005-38-                             | 0.0000000                                                | -38.                                         |
|         |                                                               | 0.0000000000000000000000000000000000000                                                   | 0.00000                                                                                                         | 0005-38                                                    | 0.0000000000000000000000000000000000000      | 0.000                                        | 00000E-38-                             | 0.0000000                                                | 38                                           |
|         |                                                               | 0.000000000000000                                                                         | 0.00000                                                                                                         | 0005-38                                                    | 0.00000005-38                                | 0.000                                        | 000005-38                              | 0.00000000                                               | -38                                          |
|         |                                                               | 0.00000000000000                                                                          |                                                                                                                 | 0005-38                                                    | 0.00000005-38                                | 0.000                                        | 000005-38.                             | 0,0000000                                                | -28                                          |
|         | -                                                             |                                                                                           | 0.00000                                                                                                         | 0000 30                                                    | 0.000000005-30                               | 0.000                                        | 000005-38                              | 0.0000000                                                | -29.                                         |
|         |                                                               | 0.000000E-36                                                                              | . 0.00000                                                                                                       | 0000-30.                                                   | 0.0000000000000000000000000000000000000      | , 0.000                                      | 000002-38;                             | 0.00000000                                               | -30                                          |
|         |                                                               |                                                                                           |                                                                                                                 | 0000-387                                                   |                                              | ,0.000                                       | 0000002-387                            |                                                          |                                              |
|         |                                                               | 0.000000008-38                                                                            | 0.00000                                                                                                         | 0006-38,                                                   | 0.000000002-38                               | 1 0.000                                      | 000002-38,                             | 0.000000000                                              |                                              |
|         |                                                               |                                                                                           | 0-00000                                                                                                         | 0008-38-                                                   |                                              |                                              | 00000E-38-                             | O+0060000E                                               |                                              |
|         |                                                               | 0.000000000000                                                                            | 3, 0.00000                                                                                                      | 0006-38,                                                   | 0.0000000E-38                                | , 0.000                                      | 0000E-38,                              | 0.00000000                                               | - 38.                                        |
|         |                                                               |                                                                                           | •                                                                                                               | 000E-38,                                                   | -0+00000000E-38-                             | ,0,0004                                      | 000005-38                              |                                                          | -38.                                         |
|         |                                                               | 0.0000000E-38                                                                             | 0.00000                                                                                                         | 000E-38,                                                   | 0.0000000E-38                                | , 0.000                                      | 00000E-38+                             | 0.00000008                                               | -38.                                         |
|         |                                                               | 0-0000000E-38                                                                             |                                                                                                                 | 000E-38                                                    | -0-0000000E-38-                              |                                              | 00000E-38.                             |                                                          | -38                                          |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          | -                                            |
| TTA8-   |                                                               | 0.00000008-38                                                                             | 0,0005+0                                                                                                        | 000E 03,                                                   | -0-40000000E-03                              | . 0.600                                      | 00000E-03-                             |                                                          | -03,                                         |
|         |                                                               | 0.1000000F 04                                                                             | 0.12000                                                                                                         | 000E 04.                                                   | 0-14000000E 04                               | . 0.160                                      | 00000E 04.                             | 0.00000000                                               | -38.                                         |
|         |                                                               | 001000000000000000000000000000000000000                                                   |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
| COTAS   | -                                                             | 0 40000005 00                                                                             | . 0 50000                                                                                                       | 000E 00-                                                   | 0.570000000 00                               | <ul> <li>0-6100</li> </ul>                   | 0000F 00.                              | 0.65000000                                               | 00.                                          |
| GFTRO   | -                                                             | 0.470000000 00                                                                            | 0 70000                                                                                                         | 0005 00.                                                   | 0 730000005-00                               | 0760                                         | 000005 00.                             | 0.0000000                                                |                                              |
|         |                                                               |                                                                                           |                                                                                                                 | 0002 001                                                   |                                              | ,                                            |                                        |                                                          |                                              |
|         |                                                               |                                                                                           |                                                                                                                 | 0005 00                                                    | 0 4000000F 00                                | 0 370                                        |                                        | 0 320000005                                              | 60                                           |
| 54148   |                                                               |                                                                                           |                                                                                                                 | 000E 08,                                                   | -0+40000000 03                               | 0 100                                        | 00000E-007-                            | 0.00000000                                               | -19                                          |
|         |                                                               | 0.260000000 08                                                                            | · 0.15000                                                                                                       | 0005 084                                                   | 0.8000000E 07                                | , 0.1000                                     | 70000E 01*                             | 0.00000000                                               | -30,                                         |
| -       |                                                               |                                                                                           |                                                                                                                 |                                                            | A 53000000                                   | A                                            |                                        | 0 400000000                                              | or                                           |
| SGFTAB  | ×                                                             | u.60000000E 05                                                                            | , 0.58000                                                                                                       | 0002 05,                                                   | 0.520000002 05                               | , 0-460                                      | UUUUUE 05,                             | 0.40000000E                                              |                                              |
|         |                                                               |                                                                                           |                                                                                                                 | 0006-0>                                                    | -0-10000000E-05                              | , 0-1000                                     | JUUUUE 04,                             |                                                          | -904                                         |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        | o <sup>2</sup> 0/ 005                                    | - To                                         |
| GETA8-  |                                                               |                                                                                           | . 0.24000                                                                                                       | 0006=01,                                                   | -U-240000006-01                              | ,0.2400                                      | J00000E-01-                            |                                                          |                                              |
|         |                                                               | 0.24000000E-01                                                                            | , 0.24000                                                                                                       | 000E-01,                                                   | 0_24000000E-01,                              | , 0.2400                                     | JOOOOE-01,                             | 0.240000008                                              | -01,                                         |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
| GRTAB   | =                                                             | 0.320000002 00                                                                            | 0,32000                                                                                                         | 0008 00,                                                   | 0.320000008 00                               | . 0.320/                                     | 00000E 00,                             | 0,32000000                                               | 00, _                                        |
|         |                                                               | 0.3200000E 00                                                                             | 0.32000                                                                                                         | 000E-00,                                                   | 0.32000000E 00                               | 0-3200                                       | 00000E-00                              | 0-32000005                                               | -00,                                         |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          | - 1                                          |
| SCRIAR  | -                                                             | 0.950000005.05                                                                            |                                                                                                                 | 0005 05.                                                   | 0.950000005.05                               | 0_9200                                       | 000005-05                              | 0_90000000                                               |                                              |
| 00.000  |                                                               | 0.90000005 05                                                                             | 0,85000                                                                                                         | 000E 05.                                                   | 0.7000000F 05                                | 0,100                                        | 00000E 05-                             | 0.00000000                                               | -38.                                         |
|         |                                                               | 0                                                                                         | ., 010,000                                                                                                      |                                                            |                                              |                                              |                                        | 22300000000                                              | -11                                          |
| 4 END   |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
| * ENU   |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        | -                                                        |                                              |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
| -       |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
| DATE-   | 4.01                                                          |                                                                                           | CASE= 2.                                                                                                        | 00                                                         |                                              |                                              |                                        |                                                          |                                              |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
| SECTION |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
|         |                                                               |                                                                                           |                                                                                                                 |                                                            |                                              |                                              |                                        |                                                          |                                              |
| N       | TN1.                                                          | TNG                                                                                       | w                                                                                                               | н                                                          | TCY                                          | SIGNH                                        | SIGH                                   | 51GM                                                     | MI                                           |
| ;       | 1 0000005                                                     | -02-1.2040775-0                                                                           | 1 1.1639415-00                                                                                                  | _1.000000E.00.                                             | 4.346327E-03                                 | 7.9060998.02                                 | -9.0453765                             | -02-3-4539155-02                                         | - 1.4979725 02                               |
| 1       | 8.851068F                                                     | -02 8-851068E-0                                                                           | 2 8.632951E-01                                                                                                  | 3-972142E-01                                               | 3-267364E-03                                 | 8-0852738 02                                 | -9+250158E                             | 02 -3.530742E 02                                         | 1.1110465 02                                 |
| 2       | 7 2092505                                                     | -02 - 7 209250E-0                                                                         | 2 7 0763.735-01                                                                                                 | _2_405616E-01                                              | 2 7087305-03                                 | 8 2294075 02                                 | -9-4148795                             | -02 -3-592459E-02                                        | 9-1071705-01-                                |
|         |                                                               | -02 6 2004615-0                                                                           | 2 5. 265356F-01                                                                                                 | 3-0735686-01                                               | 2.0587826-03                                 | 8-508866E 02                                 | -9.7362525                             | 02 -3-712114F 02                                         | 6-776423E 01                                 |
|         | E 700// **                                                    | -02 3.2334016=0                                                                           | 2 3 9656145-01                                                                                                  | 2 4352005-01                                               | 1 6960746-03                                 | 8 0119706 02                                 | -1.0194940                             | 01 3. 8848825 02                                         | -5-0776805 01                                |
| 2       | 5.299461E                                                     |                                                                                           | second second second second second second second second second second second second second second second second |                                                            |                                              |                                              |                                        |                                                          |                                              |
|         | 5.299461E<br>3.8955918                                        | -02 3-8955912-0                                                                           | 3 3 9449135 23                                                                                                  | 3 3E03EEE **                                               | 1 1001215                                    | 0 6017476 44                                 | -1 00404                               |                                                          | 3_6613536 01                                 |
| 8<br>16 | 5.299461E<br>3.8955915<br>2.720436E                           | -02 2.720436E-0                                                                           | 2 2.844912E-01                                                                                                  | 2.259355E-01                                               | 1.190121E-03                                 | 9.5817638 02                                 | -1.096048E                             | 03 -4-1/210/2 02                                         | 3-661353E 01                                 |
| 8<br>   | 5.299461E<br>3.8955918<br>2.720436E<br>1.804793E              | -02 2.720436E-0<br>-02 2.720436E-0<br>-02 1.804793E-0                                     | 2 2.844912E-01<br>2 1.989396E-01                                                                                | 2.259355E-01<br>1.937114E-01                               | 1-190121E-03<br>8-830890E-04                 | 9.581763E 02<br>1.071692E 03                 | -1.096048E                             | -03 -4.172167E 02                                        | 3.661353E 01                                 |
|         | 5.299461E<br>3.8955918<br>2.720436E<br>1.804793E<br>1.260354E | -02 2.720436E-0<br>-02 2.720436E-0<br>-02 1.8047936-0<br>-02 1.260354E-0                  | 2 2.844912E-01<br>2 1.989396E=01<br>2 1.526366E-01                                                              | 2.259355E-01<br>1.937114E=01<br>1.748245E-01               | 1-190121E-03<br>                             | 9.581763E 02<br>1.071692E 03<br>1.246168E 03 | -1.096048E<br>-1.226789E<br>-1.425238E | 03 -4.172167E 02<br>03 -4.659058E 02<br>03 -5.409860E 02 | 3.661353E 01<br>2.560319E 01<br>1.965050E.01 |
|         | 5.299461E<br>3.8955918<br>2.720436E<br>1.804793E<br>1.260354E | -02 3.8955918-0<br>-02 2.720436E-0<br>-02 1.8047936-0<br>-02 1.260354E-0                  | 2 2.844912E-01<br>2 1.9893965-01<br>2 1.526366E-01                                                              | 2.259355E-01<br>1.937114E=01<br>1.748245E-01               | 1.190121E-03<br>8.830890E-04<br>7.170941E-04 | 9.581763E 02<br>1.071692E 03<br>1.246168E 03 | -1.096048E<br>-1.226789E<br>-1.425238E | 03 -4.172167E 02<br>03 -4.659058E 02<br>03 -5.409860E 02 | 3.661353E.01<br>2.560319E.01<br>1.965050E.01 |
|         | 5.299461E<br>3.8955916<br>2.720436E<br>1.804793E<br>1.260354E | -02 3.895.91E=0<br>-02 2.720436E=0<br>-02 1.804793E=0<br>-02 1.260354E=0<br>W= 1.526866E= | 2 2.844912E-01<br>2 1.989396E-01<br>2 1.526366E-01<br>01 WT= 1.                                                 | 2.259355E-01<br>1.937114E-01<br>1.748245E-01<br>965050E 01 | 1-190121E-03<br>8-830890E-04<br>7-170941E-04 | 9.581763E 02<br>1.071692E 03<br>1.246168E 03 | -1.096048E<br>-1.226789E<br>-1.425238E | 03 -4.172167E 02<br>03 -4.459058E 02<br>03 -5.409860E 02 | 3.661353E 01<br>2.540319E 01<br>1.965050E.01 |

| -SINPUT  |                |                 |   |          |          |    |          |            |
|----------|----------------|-----------------|---|----------|----------|----|----------|------------|
| -DATE    | - <del>-</del> |                 |   |          |          |    |          | -          |
| NEMO     |                | 0.0000000E-38,  |   |          |          |    |          |            |
| -CASE    |                | 0.3000000E 01.  |   |          |          |    | •        |            |
| SECTN    | •              | 13,             |   | 0,<br>0, | 0,<br>0, | 0, | C,<br>0, | ······· 0, |
| HON      |                | 0,              |   |          |          |    |          | -          |
| RSD      | -              | ٥, ۰            |   |          | •        |    | -        |            |
| HTOP     | =              | 0,              |   |          |          |    |          | ~          |
| HTST     | =              | 0,              |   |          |          |    |          |            |
| GAHF     | =              | 0.33000000E 00, |   |          |          |    |          |            |
| EF       |                | 0.8000000E 07,  |   |          |          |    | -        | -          |
| ROF      | Ξ              | 0.11600000E 03, |   |          |          |    |          |            |
| SIGCYF   | а              | 0.4000000E 05;  |   |          |          |    |          |            |
| GAHR     | =              | 0.33000000E 00, |   |          |          |    |          | -          |
| ER       | -              | 0+0000000E-38+  |   |          |          |    |          |            |
| ROR      | 7              | 0.5000000E 03.  |   |          |          |    |          |            |
| SIGCYR   | =              | 0.4000000E 05.  | , |          |          |    | •        |            |
| K ADHE S | *              | 0.2000000E 00;  |   |          |          |    |          |            |
| PCR      |                | 0.8300000E-02,  |   |          |          |    |          |            |
| TENIN    | =              | 0.1000000E-01,  |   |          |          |    |          |            |
| TCHIN    | -              | 0.25000000E 00, |   |          |          |    |          |            |
| TCHAX    | a              | 0.3000000E 01,  |   |          |          |    |          |            |
| ROCHIN   | =              | 0.1000000E 01;  |   |          |          |    |          | -          |
| ROCHAN   | -              | 0,10000000E 02, |   |          |          |    |          |            |
| GAMBAR   | =              | 0.0000000E-38,  |   |          |          | -  |          | •          |
| CBAR     | =              | 0.10000000E 01, |   |          |          |    | _        |            |
| WHS      | *              | 0.0000000E-38,  |   |          |          |    |          |            |
| G        | =              | 0.25800000E 02. |   |          |          |    |          |            |
| HS       | -              | 0.0000000E-38,  |   |          |          |    |          |            |
| EM       |                | 0.3000000E 02,  |   |          |          |    |          |            |

| -en    | 0:0000000E-30,     |                                         |                 | _                |                    |
|--------|--------------------|-----------------------------------------|-----------------|------------------|--------------------|
| NEAC-  | 2,                 |                                         | ·               |                  |                    |
|        |                    |                                         |                 |                  |                    |
| -EPS   |                    |                                         |                 |                  |                    |
|        |                    |                                         |                 |                  |                    |
|        |                    |                                         |                 |                  |                    |
|        |                    |                                         |                 |                  |                    |
| RA     |                    |                                         |                 |                  | *                  |
| THA    |                    |                                         |                 |                  |                    |
| THC    | - 0- 6000000F- 02- |                                         |                 |                  |                    |
|        | 0.000000005-38-    |                                         |                 |                  |                    |
|        |                    |                                         |                 |                  |                    |
| R\$8   |                    |                                         |                 |                  | ·                  |
| TH8    |                    |                                         |                 |                  |                    |
| RC     |                    |                                         |                 |                  |                    |
| R \$6= | 0.1500000E-00,     | ·····                                   |                 |                  |                    |
| -LC    | 0.0000000E-38,     |                                         |                 |                  |                    |
| RT     | 0.37500000E 01,    |                                         |                 |                  |                    |
| _8ETA  |                    |                                         |                 |                  |                    |
| _A=    |                    |                                         |                 |                  |                    |
| TH26 - | 0.0000000E=38,     |                                         |                 |                  |                    |
| TH3G=  |                    |                                         |                 |                  |                    |
| ×      | 0_00000005-38-     | 0_0000000E=38+                          | 0.00000000E-38. | 0_0000000E-38,   | 0.0000000E-38,     |
|        | 0.0000000E-38,     | 0.0000000E-38.                          | 0.0000000E-38,  | 0.00000000000000 | 0.0000000000000000 |
|        | 0,0000000E-38,     | 0.0000000E=38-                          | n-0000000F-38-  | 0.0000000000-38  | 0.0000000E-38,     |
|        | 0.00000000000000   | 0.0000000000000000000000000000000000000 | 0.0000000E-38,  |                  |                    |
|        |                    |                                         |                 | 0.00000005-20    | 0.00000000-39      |
| -R=    | 0.0000000E=38,     | 0.0000000000-38+                        | U_0000000E=38,  | 0.000000005=38,  | 0.0000000E-38.     |
|        | 0.0000000E-38.     | 0.000000000-38.                         | 0-000000000-38- | 0.00000006-38-   | 0.0000000000.38,   |
|        | 0.0000000E=38,     | 0.0000000000000                         | 0.0000000E-38.  | 0.0000000E-38.   | 0.00000005-38,     |
|        | 0.00000006-38+     | 0_0000000000-38,                        | 0.0000000E=38,  | -0,00000000E=38, |                    |
| _RORG  |                    |                                         |                 |                  | ,                  |
|        |                    |                                         |                 |                  |                    |
| -DTHDY | 0_00000000E=38+    |                                         |                 |                  |                    |

-DELTAU =\_\_\_\_\_0,10000000E\_00,

| EHISTR +       | 0+0000000E-38+                         |                                         |                                       |                  |                     |
|----------------|----------------------------------------|-----------------------------------------|---------------------------------------|------------------|---------------------|
| -0CHULT =      |                                        |                                         |                                       |                  | · · · ·             |
| QRXUL-T=       |                                        |                                         |                                       |                  |                     |
| ( <del>N</del> | 0~8000000E-00,                         | ····                                    |                                       |                  | •                   |
| X9             | 0.00000008-38,                         |                                         |                                       |                  |                     |
| ×A=            | 0+0000000E-38+                         |                                         | -                                     |                  |                     |
| xe             |                                        |                                         |                                       |                  |                     |
| TEMPI          | 0+10000000E_03+                        | <u></u>                                 | · · · · · · · · · · · · · · · · · · · |                  |                     |
| TEMPA          | 0.12000000E 04.                        |                                         |                                       |                  |                     |
| <u> TINIT</u>  | 0-10000000E 03.                        | ·····                                   | ··· ·                                 |                  | - ·                 |
| F\$T02         | 0-41160000E 03,                        |                                         |                                       |                  |                     |
| DELK1          | 0.00000000E-38,                        |                                         |                                       |                  |                     |
| 0ELK2          | 0+0000000E-38+                         |                                         |                                       |                  |                     |
| -186           | 0.00000006-38,                         |                                         | 0.910100005-02                        |                  |                     |
|                | 0.11411000E 03,                        | 0-12204000E 03,                         | 0.13015000E 03,                       | 0.13841000E 03.  | 0.14683000E 03.     |
|                | 0.20194000E 03.                        | 0.212110005 03-                         | 0.221420006 03-                       | 0 22950000E 03.  | 0 236710005 03.     |
|                | 0-243490005 03.                        |                                         | 0-25624000E-03                        | 0-261310005-03-  | 0.265890005-03-     |
|                | 0.27019000E 03,                        | 0.27435000E Q3,                         | 0.27841000E 03,                       | 0.28247000E 03,  | 0.28662000E 03,     |
|                | 0.290910008 03.                        |                                         | 0.30024000E-03.                       | 0.305470006-03,  | 0.311250008-03.     |
|                | 0.31780000E 03.                        | 0.32333000E 03,                         | 0.32962000E 03,                       | 0.33692000E 03,  | 0.34561000E 03.     |
|                |                                        |                                         | 0-389410005-03,                       |                  |                     |
|                | 0.0000000000000                        | 0.00000000000000                        | 0.0000000000000                       | 0.00000000000-38 | 0.0000000000000-38, |
| ~              | 0,000000000000000000000000000000000000 | 0-00000000-38-                          | 0.000000005-38.                       | 0.0000000000-38  | 0.00000000000000    |
|                |                                        |                                         | 0.00000005-38,                        |                  |                     |
|                | 0.0000000E-38,                         | 9-0000000E-38,                          | 0.000000008-38.                       | 0.0000000E-38,   | 0.0000000E-38,      |
| _              |                                        |                                         | 0.0000000E-38.                        | 0.0000000E-38,   |                     |
|                | 0.0000000E-38,                         | 0.000000000-38,                         | 0.000000000-38.                       | 0.00000000000000 | 0-0000000E-38,      |
|                | 0.0000000000000                        | 0.0000000000000000000000000000000000000 | 0.00000000000000                      | 0.00000000-38.   | 0.000000000-38-     |
|                | 0_0000000E-38.                         | 0.00000005-38                           | 0_0000000E=38                         | 0_0000000E=38    |                     |
|                | 0.0000000E-38,                         | 0.00000002-38,                          | 0.0000000E-38,                        | 0.0000000E-38,   | 0.000000008-38,     |
| · · · ·        | 0.0000000E=38,                         |                                         |                                       | 0-0000000E-38,   | 0-00000008-38-      |
|                | 0.0000000E-38,                         | 0.0000000E-38,                          | 0.0000000E-38.                        | 0.00000002-38,   | 0.0000000E-38,      |
|                | 0,00000000E=38,                        | 0.00000005-38,                          |                                       | 0.0000000E=38,   |                     |
|                | 0.00000000000000                       | 0.00000000000000                        | 0.00000000000000                      | 0.000000005-38-  | 0.000000000000-38;  |
|                | 0-0000000E-38-                         | 0-0000000F-18-                          | 0-00000005-38-                        | 0.0000000E-38    | 0.0000000E-38       |
|                | 0.00000005-38,                         | 0.00000005-18                           | 0.00000005-38                         | 0.000000005-38   |                     |
|                | 0.0000000E-38,                         | 0.0000000E-38.                          | 0.0000000E-38,                        | 0.0000000E-38.   | 0.0000000E-38.      |
|                | 0.00000006-38.                         | 0.000000E=38,                           |                                       | 0.0000000E=38,   | 0-0000000E-38-      |
|                | 0.0000000E-38.                         | 0.0000000E-38.                          | 0.0000000E-38,                        | 0.0000000E-38,   | 0.0000000E-38,      |
| OTBL =         | 0.1000000E 00,                         | 0.10000000E 01,                         | 0.12000000E 01,                       | 0.15000000E 01,  | 0.18000000E 01,     |
|                | 0.2300000E_01,                         | 0.280000005 01,                         | 0.34000008 01+                        | 0.410000005-01.  | 0-510000005-01,     |
|                | 0.62000000E 01;                        | 0.76000000E 01;                         | 0.94000000E 01,                       | 0.11400000E 0Z,  | 0.14100000E 02.     |

-49-.

|        |                                         | 0 1010000E 02                           |                                         | 0-27200000F 02-      |                  |
|--------|-----------------------------------------|-----------------------------------------|-----------------------------------------|----------------------|------------------|
|        | 0. 204000005 02                         | 0.30400000F 02.                         | 0.28700000E 0Z.                         | 0.26400000E 02,      | 0.23800000E 02,  |
|        | 0.211000000 02                          | 0 185000005 02                          | 0.159000005 02.                         | -0-13500000E 02-     | 0,11200000E_02,  |
|        | 0.020000005 01-                         | 0.7400000F 01.                          | 0.5800000E 01.                          | 0.44000000E 01,      | 0.32000000E 01,  |
|        | 0.220000000 01                          | 0_17000000F 01-                         |                                         |                      |                  |
|        | 0.300000005.00.                         | 0.2000000F 00.                          | 0.1000000E 00.                          | 0.0000000E-36.       | 0.000000000-38.  |
|        | 0.000000000-38                          | .0.000000005-38                         | 0.0000000E-38                           |                      |                  |
|        | 0.00000000000000                        | 0.0000000E=38                           | 0-0000000E-38-                          | 0.0000000E-38,       | 0.0000000E-38,   |
|        | 0.000000000000                          | 0.00000000000000                        | 0.0000000000000000000000000000000000000 | 0.0000000E-38,       | 0.0000000E=38    |
|        |                                         | 0.00000005-38-                          | 0.00000008-38.                          | 0.00000000000-36.    | 0.00000002-38,   |
|        | 0.0000000000000                         | 0.00000000000000                        | 0-0000000E-38                           |                      | 0+0000000E38+-   |
|        | 0_00000000000000000000000000000000      | 0.0000000000-38.                        | 0-0000000F-38+                          | 0.0000000E-38,       | 0.0000000000-38, |
|        | 0.0000000000000                         | 2 00000005-38-                          | 0_00000005-38-                          | 0.00000005-38        |                  |
|        | 0.000000000-30                          | 0.0000000E=38.                          | 0.0000000E-38.                          | 0.0000000000-38.     | 0.0000000000-38, |
|        | 0.000000000-38                          | 0.0000000000000000000000000000000000000 | 0.00000005-38                           | 0.00000006-38,       | -0.00000005-38,  |
|        | 0.00000000000000                        | 0.00000005-38-                          | 0.000000000-38.                         | 0.0000000E-38,       | 0.0000000E-38.   |
|        | 0.00000000000000                        | 0.0000000000000                         | 0.000000006-38                          | 0.0000000E-38,       | 0.0000000E-38.   |
|        | 0.0000000000000                         | 0.0000000005-38+                        | 0-0000000E-38.                          | 0.0000000E-38.       | 0.00000008-38.   |
|        | 0.00000002-38;                          | 0.00000000000                           | 0_0000000E-38-                          | 0_0000000E-38-       |                  |
|        | U_UUUUUUUE_387                          | 0.0000000000000                         | n-0000000F-38-                          | 0.0000000E-36;       | 0.0000000E-38;   |
|        | 0.0000000000000                         | 0.000000000-38                          | 0.000000005-38                          | 0_0000000E-38.       | 0.00000008-38-   |
|        |                                         | 0.00000000E_38                          | 0.000000005-38-                         | 0.0000000E-38.       | 0.0000000E-38,   |
|        | 0.0000000000000                         | 0.0000000000000                         | 0.0000000000000                         | -0-0000000E-38-      |                  |
|        |                                         | 0.00000005-38                           | 0.000000000                             | 0.0000000F-38.       | 0.00000008-38,   |
|        | 0.0000000E-38,                          | 0.000000002-381                         | 0.0000000E-38                           | 0-00000006-38        | 0.0000000E-38-   |
|        |                                         | 0.00000000000000                        | 0.0000000000000                         | 0.0000000E-38.       | 0.0000000E-38.   |
|        | 0.000000000000                          | 0.000000000000                          | 0.00000005-38.                          | 0_0000000E-38-       | -0.0000000E-38.  |
|        |                                         |                                         |                                         |                      |                  |
|        |                                         | 0 00000005-38                           | n 00000000E-38-                         |                      |                  |
| RTBL   |                                         | 0.00000000E=38-                         | 0-0000000E-38-                          | 0.0000000E-38.       | 0.0000000E-38,   |
|        | 0.000000002-38,                         | 0.0000000000000                         | 0.000000005-38                          | 0-00000008-38-       | -0.0000000E-38,  |
|        |                                         | 0.00000000E-30,                         | 0.00000000E=38.                         | 0.0000000E-38.       | 0.0000000E-38,   |
|        | 0.000000000-38.                         | 0.00000000E-38                          | 0.000000005-38                          | 0-000000008-38       | 0.0000000E-381   |
|        |                                         | 0.00000000E-38                          | 0-00000005-38-                          | 0.000000000000-38.   | 0.0000000E-38;   |
|        | 0.0000000000000000000000000000000000000 | 0.000000000-30                          | 0.00000005-38                           | 0_0000000E-38        | 0.0000000E-38-   |
|        | 0.00000000000000000000000000000000      |                                         | 0-000000000-38-                         | 0.00000000000000-38. | 0.000000008-38,  |
|        | 0.00000000000000                        | 0.000000005-38                          | 0.00000005-38-                          | -0-00000000E-38.     | 0.0000000E-38+   |
|        |                                         | 0.0000000E=38.                          | 0-0000000E-38+                          | 0.00000000E-38.      | 0.0000000E-38,   |
|        | 0.0000000000000                         | 0.0000000000000                         | 0.00000005-38-                          | 0_0000000E=28        | 0.0000000E-38-   |
|        | 0.000000000000                          | 0.0000000000000000000000000000000000000 | 0.0000000E=38.                          | 0.0000000E-38.       | 0.0000000E-38,   |
|        | 0.000000E-38+                           | 0.00000000000                           | 0.00000000000000                        | 0_00000005-38-       | 0_0000000E-38-   |
|        | 0.00000000000000000000000000000000      | 0.0000000000000                         | 0.00000005-38-                          | 0-000000000-38.      | 0_0000000E-38,   |
|        | 0.0000000000000                         | 0.000000000000-38                       | 0.000000005-38                          |                      | 0_0000000E-38-   |
|        | 0_0000000E-381                          | 0.0000000000000000000000000000000000000 | 0.00000005-38                           | 0.0000000E-38.       | 0.0000000E-38,   |
|        | 0.00000002-38,                          | 0.00000000000000                        | 0.000000005-38                          | 0-0000000E-38-       | 0.0000000E-38.   |
|        |                                         | 0.000000005-38-                         | 0.000000000-38-                         | 0.0000000E-38.       | 0.000000008-38,  |
|        | 0.00000002-38,                          | 0.0000000000000                         | 0.00000005-38                           | 0_0000000E=38,       | 0.00000008-38-   |
|        |                                         | 0.0000000000000000000000000000000000000 | D-0000000E-38.                          | 0-0000000E-38.       | 0.00C00000E-38.  |
|        | 0.0000000000000                         | 0.000000000000                          | 0.0000000E=38                           | 0.0000000E=38+       | 0.00000005-38-   |
|        | 00000000E=38+                           | D. 00000000E=39                         | 0-0000000E-38-                          | 0.0000000E-38.       | 0.0000000E-38.   |
|        | 0.0000000000000                         | D - 000000000-39                        | 0-0000000E=38                           | _0_0000000E-38-      | 0.00000006-38,-  |
|        | 0.0000000000000                         | 0.000000000-38-                         | 0-0000000F-38-                          | 0.0000000E-38.       | 0.0000000E-38,   |
|        | 0.0000000000000                         | 0.0000000000000                         | 0.00000005-38                           | 0-00000008-38        | 0_0000000E=38    |
|        | 0.0000000000000000000000000000000       | 0.0000000000000                         | 0-0000000E-38-                          | 0.0000000E-38.       | 0.0000000E-38.   |
|        | 0.0000000000000                         | 0.0000000000000                         | 0.00000005=38-                          | -0-00000008-38-      | 0.0000000E-38+   |
|        |                                         | 00000000E=38.                           | 0.0000000E=38.                          | 0.0000000E-38.       | 0.0000000E-38,   |
|        | 0.000000000-38,                         | 0.0000000000000                         | 0.00000000000000                        | 0.00000005-38,       | 0.00000005-38-   |
|        | 0.00000008-38,                          | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.00000008-38.       | 0.0000000E-38,   |
| HTBL = | 0.12750000E 03,                         | 0.13090000E 03,                         | 0.13110000E 03,                         | 0.13140000E 03,      | 0.13170000E 03,  |

| TC Y                                  | R8C                                     | W TF<br>4+14167E-01                     | TC<br>0E-022-50000E-01                 | WT<br>                                  |                                         |
|---------------------------------------|-----------------------------------------|-----------------------------------------|----------------------------------------|-----------------------------------------|-----------------------------------------|
| SANDWICH CONST                        | RUCTION                                 |                                         |                                        |                                         |                                         |
| -SECT10N13                            |                                         |                                         |                                        |                                         |                                         |
| -DATE= 4+01                           | HEHO= 0.00                              | CASE=                                   |                                        |                                         |                                         |
|                                       |                                         |                                         |                                        |                                         |                                         |
| S END                                 |                                         | ······                                  |                                        |                                         |                                         |
| ~SGRT48~=                             | 0.9000000E 05.                          | 0.85000000E 05.                         | 0.7000000E 05;                         | 0.1000000E 05,                          | 0.00000000E-38                          |
|                                       | 0.320000005 00,                         |                                         | 0.320000008-00,                        |                                         | 0-32000000E 00-                         |
| GRTAB =                               | 0.32000000E 00-                         | 0.32000000£ 00-                         | 0.32000000E 00.                        | 0.3200000CE 00.                         | 0,32000000E 00                          |
| .GETA3                                | 0.240000005-01,                         |                                         | 0-24000000E-01,                        | 0-24000000E-01,                         | 0-24000000E-01-                         |
| SGFTAB =                              | 0.6000000E 05,<br>0.32000000E 05,       | 0.58000000E 05,<br>                     | 0.52000000E 05.<br>0.1000000E-05.      | 0.46000000E 05,<br>0.10000000E-04,      | 0.4000000000000000000000000000000000000 |
|                                       | 0.2600000E 08,                          | 0.1500000E 08,                          | 0.8000000E 07.                         | 0.1000000E 07.                          | 0.00000008-38                           |
| -EFT48                                |                                         |                                         |                                        |                                         |                                         |
| CPTAB =                               | 0.400000000 00.                         | 0.5000000E 00,                          | 0.57000000E 00+                        | 0.6100000E 00.                          | 0.6500000E CO                           |
| -T-T-AB=                              | 0.10000000E 04;                         | 0.12000000E-03.<br>0.12000000E 04.      | 0+40000000E-03,<br>0+14000000E 04,     | 0.16000000E-03.                         | 0.0000000E-38                           |
|                                       | 0+00000000E=38+                         | 0-00000000E-38,                         | 0+00000000E-38,                        | 0+00000000E-38+                         |                                         |
|                                       | 0.000000005-38,<br>0.00000000E-38,      | 0,00000000E-38,<br>0.00000000E-38,      | 0.00000000E-38,                        | 0.00000000E-38.                         | 0.0000000E-38                           |
|                                       | 0.00000000E-38,                         |                                         | 0.000000000000000000000000000000000000 | 0.00000000E-38,                         | 0+00000000E-38                          |
|                                       | 0.00000000E-38,                         | 0.0000000E-38,                          | 0.0000000E-38,                         | 0.0000000E-38,                          | 0.00000000E-38                          |
|                                       | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 | 0.00000000E-38,                        | 0.00000000E-38,                         | 0.00000000000000                        |
|                                       | 0.0000000000000000000000000000000000000 | 0.0000000000-38.                        | 0.0000000E-38,                         | 0.0000000000000000000000000000000000000 | 0.0000000000000000000000000000000000000 |
|                                       | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.00000000E-38,                        | 0.000000000000-38,                      | 0.0000000E-38                           |
|                                       | 0.0000000E-38,                          | 0.0000000E-38,                          | 0.00000000E-38,                        | 0.0000000E-38,                          | 0.0000000E-38                           |
|                                       | 0.0000000E-38,                          | 0.0000000E-38.                          | 0.0000000E-38,<br>                     | 0.0000000E-38,<br>                      | 0.0000000E-38                           |
| · · · · · · · · · · · · · · · · · · · |                                         |                                         |                                        |                                         | 0-0000000E-38                           |
| <u> </u>                              | 0.00000005-38,                          | 0.0000000E-38,                          |                                        |                                         | 0.000000000E-38                         |
|                                       | 0-000000005-38,<br>0-000000005-38,      | 0.000000005=38,<br>0.00000000E=38.      | 0.00000005-38.                         | 0.00000000E-38,                         | 0.00000000E-38                          |
|                                       | 0.58000000E 01,                         | 0.47000000E 01,                         | 0.39000000E 01.                        | 0.37000000E 01.                         | 0.4000000E 01,                          |
|                                       | 0.38200000E 02,                         | 0.32700000E 02,                         | 0.27600000E 02,                        | 0.23100000E 02,                         | 0.1900000E 02.                          |
|                                       | 0.11670000E 03.                         | 0.10820000E 03.                         | 0-98600000E 02+                        | 0.89400000E 02;<br>                     | 0.80700000E 02;                         |
|                                       | 0.131400005-03,                         |                                         |                                        | 0+12640000E 03,                         |                                         |
|                                       | 0-13200000E 03,                         | 0+13220000E-037                         |                                        | 0.13270000E-03                          | 0.132300008 03.                         |

| \$IBSYS            |      |   |  |
|--------------------|------|---|--|
| OPER. ACTION PAUSE |      |   |  |
| CONT INUING        | <br> | - |  |
| \$IBSYS            |      |   |  |
| OPER. ACTION PAUSE |      |   |  |
| ++CONTINUING       |      |   |  |

#### III. COMPUTATIONS

#### A BLOCK DIAGRAM

The block diagram for Program 1886 is shown in Figure 7. It can be seen from the block diagram that the inputs provide for dealing with conical, spherical, and the tension and general shells with options for considering various construction approaches and for testing the structure to ascertain whether it is suitable as a hot structure



Figure 7 BLOCK DIAGRAM FOR PROGRAM 1886

# B. SYMBOLS

| Symbol         | Parameter                                                                 | Units               |
|----------------|---------------------------------------------------------------------------|---------------------|
| a              | ratio of circumferential to meridianial stress                            |                     |
| AT             | area of tension shell                                                     | ft <sup>2</sup>     |
| AG             | area of general shell                                                     | ft <sup>2</sup>     |
| A <sub>T</sub> | stiffener area                                                            | in. <sup>2</sup>    |
| D              | bending rigidity of shell                                                 | lb-in.              |
| D <sub>θ</sub> | equivalent orthotropic shell bending rigidity of ring-<br>stiffened shell | lb-ın.              |
| E <sub>f</sub> | modulus of elasticity of face sheets                                      | lb/in. <sup>2</sup> |
| ER             | modulus of elasticity for compression ring                                | 1b/1n. <sup>2</sup> |
| h              | height of spherical shell                                                 | inches              |
| н              | height of stiffener                                                       | inches              |
| KAD            | unit weight allowable for adhesives                                       | lb/ft <sup>2</sup>  |
| I <sub>x</sub> | stiffener moment of mertia about neutral axis                             | in.4                |
| $I_{\theta}$   | effective stiffener moment of mertia                                      | in. 4               |
| L <sub>o</sub> | slant length of cone                                                      | inches              |
| Lc             | cylinder length                                                           | inches              |
| m              | effective width factor or stiffener                                       |                     |
| n              | proportionality factor for stiffener                                      |                     |
| N              | number of rings                                                           |                     |
| Р              | stability parameter <sup>5</sup>                                          |                     |
| PCR            | critical pressure load                                                    | $lb/in.^2$          |
| s              | stability parameter <sup>5</sup>                                          |                     |

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| Т                                              | temperature                                                    | °R                       |
|------------------------------------------------|----------------------------------------------------------------|--------------------------|
| <sup>t</sup> c                                 | core height                                                    | inches                   |
| <sup>t</sup> f                                 | face sheet thickness                                           | inches                   |
| tcopt                                          | optimized core height for buckling criteria                    | inches                   |
| tcy                                            | face sheet thickness required for yield criteria               | inches                   |
| <sup>t</sup> R                                 | wall thickness of compression ring                             | inches                   |
| <sup>t</sup> 1, <sup>t</sup> 3, <sup>t</sup> 4 | stability parameters                                           |                          |
| <sup>R</sup> 1, <sup>R</sup> 2                 | minimum and maximum radii of conical shell                     | inches                   |
| R <sub>2</sub> , R <sub>3</sub>                | minimum and maximum radius for tension and general shell       | inches                   |
| у                                              | radial coordinate                                              | ınches                   |
| R <sub>SC</sub>                                | toroidal radius following tension or general shell             | inches                   |
| RR                                             | radius of compression ring                                     | inches                   |
| RC                                             | maximum radius of tension or general shell combined with torus | inches                   |
| R <sub>CAP</sub>                               | spherical cap radius                                           | inches                   |
| <sup>q</sup> c                                 | convective heat rate                                           | Btu/ft <sup>2</sup> -sec |
| $q_{\rm R}$                                    | radiative heat rate                                            | Btu/ft <sup>2</sup> -sec |
| H <sub>w</sub>                                 | enthalpy of gas at wall                                        | Btu/lb                   |
| H <sub>s</sub>                                 | stagnation enthalpy                                            | Btu/lb                   |
| с <sub>р</sub>                                 | specific heat                                                  | Btu/lb- <sup>0</sup> F   |
| We                                             | effective width                                                | inches                   |
| W                                              | unit area weight                                               | lb/ft <sup>2</sup>       |
| WR                                             | total compression ring weight                                  | pounds                   |
| WTG                                            | total general shell weight                                     | pounds                   |

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| WTT                 | total tension shell weight                         | pounds              |
|---------------------|----------------------------------------------------|---------------------|
| $\nu_{\rm f}$       | Poisson's Ratio                                    |                     |
| σ <sub>cy</sub>     | yield stress of face sheets                        | lb/in. <sup>2</sup> |
| $\rho_{\mathbf{f}}$ | face sheet density                                 | lb/ft <sup>3</sup>  |
| ρ <sub>c</sub>      | core densițy                                       | lb/ft <sup>3</sup>  |
| σCR                 | yield stress of core ribbon                        | lb/in. <sup>2</sup> |
| β                   | cone parameter, also tension shell angle (degrees) |                     |
| $\rho_{\rm R}$      | density of core ribbon                             | 1b/ft <sup>3</sup>  |
| θ                   | local body slope angle                             | degrees             |
| θ <sub>3</sub> G    | last angle on general shell                        | degrees             |
| τ                   | time                                               | seconds             |
| ¢                   | emissivity                                         |                     |

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- C. EQUATIONS
  - 1. Sandwich Construction - Spherical Cap
    - a. Face Sheets

$$t_{f \text{ opt}} = \left(\frac{3 K_2}{4 K_1}\right)^{4/7} \tag{1}$$

$$t_{f} = 0.36 (1 - \nu_{f}^{2})^{2/3} \left( \frac{P_{CR}}{E_{f}} \right) \frac{h^{1/3}}{t_{c}^{4/3}} R_{CAP}^{2}$$
(2)

$$t_{cy} = \frac{P_{CR} R_{CAP}}{4\sigma_{cy}}$$
(3)

b. Core

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$$t_{c \text{ opt}} = \frac{12 K_2}{\rho_c} \left[ \frac{4 K_1}{3 K_2} \right]^{3/7}$$
(4)

$$t_{c} = 0.465 (1 - \nu_{f}^{2})^{1/2} \left(\frac{P_{CR}}{E_{f}}\right)^{3/4} \frac{h^{1/4}}{t_{f}^{3/4}} R_{CAP}^{3/2}$$
(5)

$$\rho_{\rm c} = 0.22 \ \rho_{\rm R} \left(\frac{P_{\rm CR}}{\sigma_{\rm CR}}\right)^{0.588} \tag{6}$$

c. Weight

$$W_{opt} = 7/3 K_1 \left[ \frac{3K_2}{4K_1} \right]^{4/7} + KAD$$
 (7)

$$\mathbb{W} = K_1 t_f + \frac{1}{12} \rho_c t_c + KAD \tag{8}$$

$$K_1 = \rho_f / 6 \tag{9}$$

$$K_{2} = \frac{\rho_{c}}{12} \left[ 0.465 \ (1 - \nu_{f}^{2})^{1/2} \left( \frac{P_{CR}}{E_{f}} \right)^{3/4} h^{1/4} R_{CAP}^{3/2} \right]$$
(10)

$$h = R_{CAP} (1 - \sin \theta_{CAP})$$
(11)

$$PCR = P_{AERO} \pm \frac{(\Psi + \Psi HS)}{144} G$$
2. Sandwich Construction--Conical Section

a. Face Sheet

$$t_{\rm f \ opt} = \frac{4.89}{\rho_{\rm f}} \left[ C_1^{0.414} \quad C_2^{0.586} \right]$$
 (12)

$$t_{\rm f} = \frac{P \, k}{18.6 \, (\Lambda \, t_{\rm c}^{1/2})^{2.84}} \tag{13}$$

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$$t_{cy} = \frac{P_{CR} R_2}{4\sigma_{cy} \cos \theta_c} \left\{ 3 + (1 - \overline{\gamma})^2 \left( \frac{R_1}{R_2} \right)^4 \right\}^{1/2}$$
(14)

b. Core

$$t_{\rm c \ opt} = 1156 \left(\frac{C_1}{C_2}\right)^{0.414}$$
 (15)

$$t_c = 0.127 \left(\frac{P k}{t_f A^{2.84}}\right)^{0.704}$$
 (16)

c. Weight

$$W_{opt} = 1971 C_1^{0.414} C_2^{0.586} + KAD$$
 (17)

$$W = \frac{1}{6} \rho_{f} t_{f} + \frac{1}{12} \rho_{c} t_{c} + KAD$$
(18)

 $t_1, t_3, t_4$  evaluated from table 1.

$$A = \left(\frac{\lambda K_1}{k^{3/2} K_2}\right) \left(\frac{2t_1 t_3 t_4}{2t_3 - \nu_f^2}\right)^{1/4}$$
(19)

$$k = \frac{R_2 (1 - \beta/2)}{\cos \theta_c}$$
(20)

$$\beta = \left[1 - \left(\frac{R_1}{R_2}\right)\right] \tag{21}$$

$$K_{2} = K \left[ 1 + \frac{(WHS + W)G}{144 P_{CR}} \sin \theta_{c} \right]$$
(22)

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$$K_{1} = \frac{K^{3}}{2\left(1-\frac{\beta}{2}\right)^{2}} \left\{ 1 - \beta + \frac{\beta^{2}}{3} + \frac{\beta^{2}}{2\pi^{2}} - (1-\overline{\gamma})(1-\beta)^{2} + \frac{\beta}{\sin\theta_{r}} \frac{(\mathbb{W}HS + \mathbb{W})G}{(144)^{P}CB} \left(1 - \beta + \frac{\beta}{3} + \frac{\beta}{2\pi^{2}}\right) \right\}$$
(23)

$$-\frac{\pi \sin \theta_{\rm c}}{2\pi}$$
(24)

$$R_2 \beta$$
  
 $P k \rho_f$  (25)

$$C_1 = \frac{1}{111.9} \frac{1}{A^2} \frac{84}{84}$$
(26)

$$C_2 = \rho_c / 12$$
 . (20)

$$\rho_{\rm c} = 0.22 \ \rho_{\rm R} \left( \frac{P_{\rm CR}}{\sigma_{\rm cy\,R}} \right)^{0.588}$$
(27)

$$P = \left(\frac{32 t_1 t_3 \lambda^2 K_1^3}{k^7}\right) \frac{(1 - \nu_f^2)}{(2 t_3 - \nu_f^2)} = \frac{P_{CR}}{E_f}$$
(28)

## TABLE I

# EVALUATION OF THE CONSTANTS T1, T3, T4 as a FUNCTION OF THE GEOMETRIC PARAMETER $\beta$

| β                                                    | tı                                                                                   | t <sub>3</sub>                                                                       | t4                                                                                   |
|------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| 0.00<br>0.10<br>0.20<br>0.25<br>0.35<br>0.40<br>0.50 | 0.50000<br>0.50074<br>0.50334<br>0.50554<br>0.51242<br>0.51748<br>0.53223<br>0.54273 | 0.50000<br>0.50018<br>0.50134<br>0.50134<br>0.50300<br>0.50417<br>0.50749<br>0.50085 | 0.50000<br>0.50027<br>0.50470<br>0.50803<br>0.51621<br>0.52532<br>0.54946<br>0.56400 |
| 0.55<br>0.60<br>0.65<br>0.70<br>0.75<br>1.00         | 0.55625<br>0.57382<br>0.59704<br>0.62853<br>0.62853                                  | 0.50985<br>0.51276<br>0.51638<br>0.52093<br>0.52670<br>0.52670                       | 0.58430<br>0.61134<br>0.64769<br>0.69795<br>0.69795                                  |

### 3. Sandwich Construction -- Cylindrical Section

-

a. Face Sheet

$$t_{\rm f \ opt} = \frac{4.7 \ x_1^{2/5} \ x_2^{3/5}}{\rho_{\rm f}}$$
(29)

$$t_{f} = \frac{1.75}{P_{B} 3.87 E_{f} \cdot t_{c}^{1.5}} \left\{ P_{CR} \cdot R_{C}^{3/2} L_{C} \cdot (1 - \nu_{f}^{2})^{3/4} \right\}$$
(30)

$$t_{cy} = \frac{P_{CR} R_C}{2\sigma_f}$$
(31)

b. Core Thickness

$$t_{c opt} = 1.176 \left(\frac{x_1}{x_2}\right)^{2/5}$$
 (32)

$$t_{c} = 0.404 \left( \frac{P_{CR} R_{C}^{3/2} L_{c}}{E_{f} t_{f}} \right)^{2/3} \qquad (1 - \nu_{f}^{2})^{1/2} \left( \frac{1.75}{P_{B}} \right)^{2/3}$$
(33)

c. Weight

$$\mathbb{W}_{opt} = 1.959 X_1^{2/5} X_2^{3/5} + KAD$$
or
$$\mathbb{W} = \frac{\rho_f t_f}{6} + \frac{\rho_c t_c}{12} + KAD$$
(34)

$$\begin{array}{c} x_{1} = \frac{\rho_{f} P_{CR} R_{C}^{3/2} (L_{C})}{23.2 E_{f}} & (1 - \nu_{f}^{2})^{3/4} \left( \frac{1.75}{P_{B}} \right) \\ d \end{array}$$

$$\begin{array}{c} \end{array}$$

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and

$$X_2 = \rho_c / 12$$

.

$$P_{B} = \frac{\left[\frac{3+S}{1+S} + 1\right]}{\left[\frac{3+S}{1+S}\right]^{1/2} \left[\left(\frac{3+S}{1+S}\right)^{1/4} + \frac{S}{2}\right]}$$
(36)

$$S = \frac{2.22.t_c^{1/2} \cdot R_c^{1/2}}{L_c^{(1-\nu_f^2)}} \cdot \left[ \frac{\gamma}{\gamma} + \frac{L_c}{R_c} \frac{(WHS + W)G}{(144) P_{CR}} \right]$$
(37)

$$\rho_{\rm c} = 0.22 \ \rho_{\rm R} \left(\frac{P_{\rm CR}}{\sigma_{\rm CR}}\right)^{0.588} \tag{38}$$

# 4. Monocoque Spherical Cap

$$t_{\rm f} = 1.20 \left(\frac{P_{\rm CR}}{E_{\rm f}}\right)^{3/7} (1 - \nu^2)^{2/7} \left(\frac{\rm h}{R_{\rm CAP}}\right)^{1/7} R_{\rm CAP}$$
 (39)

$$t_{cy} = \frac{P_{CR} R}{2\sigma_{cy}}$$
(40)

$$h = R_{CAP} (1 - \cos \theta_{CAP})$$
(41)

$$\mathbb{W} = \frac{\rho_{\rm f} t_{\rm f}}{12} \tag{42}$$

$$P_{CR} = P_{AERO} \pm \frac{(W + WHS)G}{144}$$

# 5. Ring Stiffened Conical and Cylindrical Sections

$$P_{CR}(S) = \frac{P(S) \pi (D_{\theta}/D)^{3/4} t_4 t^{5/2} [12 (2t_3 - \nu_f^2]^{1/4} E_f]}{6 (1 - \nu_f^2) L K_2 K^{1/2} (8 t_1 t_3 t_4)^{1/4}}$$
(43)

$$K = R_2 \frac{(1 - \beta/2)}{\cos \theta_c}$$
(44)

$$\beta = \left[1 - \left(\frac{R_1}{R_2}\right)\right]$$
(45)

$$D = \frac{E_f t_f^3}{(12)(1-\nu^2)}$$
(46)

$$D_{\theta} = (N+1) \frac{I_{\theta} E_{f}}{L_{o}}$$

$$(47)$$

$$L_{o} = \frac{R_{2} - R_{1}}{\sin \theta} \qquad \theta > 0$$
(48)

$$L_{o} = L_{C} \quad \theta = 0 \tag{49}$$

$$L = \frac{L_0}{N+1}$$
(50)

$$P = \frac{\left[\frac{3+S}{1+S} + 1\right]}{\left(\frac{3+S}{1+S}\right)^{1/2} \left[\left(\frac{3+S}{1+S}\right)^{1/4} + \frac{S}{2}\right]}$$
(51)

$$S = B\left(\frac{-v}{D}\right) \qquad t_f^{1/2} \tag{52}$$

$$B = \frac{2\pi K_1 K^{1/2}}{K_2 L K^2} \frac{[8t_1 t_3 t_4]^{1/4}}{[12(2t_3 - \nu^2)]^{1/4}}$$
(53)

$$K_{1} = \frac{K^{3}}{2\left(1-\frac{\beta}{2}\right)^{2}} \left\{ 1-\beta + \frac{\beta^{2}}{3} + \frac{\beta^{2}}{2\pi^{2}} - (1-\overline{\gamma})(1-\beta)^{2} + \frac{L}{R_{2}} \frac{(WHS+W)G}{(144)P_{CR}} \left(1-\beta + \frac{\beta}{3} + \frac{\beta}{2\pi^{2}}\right) \right\}$$
(54)

$$K_{2} = K \left[ 1 \pm \frac{(\text{WHS} + \text{W}) G}{(144) P_{CR}} \sin \theta_{c} \right]$$
(55)

$$I_{\theta} = I_{x} - A_{T} \overline{y}^{2}$$
(56)

$$\mathbb{W}_{e} = \mathrm{mt}_{f}, \text{ and } \mathbf{b} = \mathrm{nH}$$
(57)

$$I_{x} = \frac{m t_{f}^{4}}{3} + t_{f} H(2n+1) \left(\frac{H}{2} + t_{f}\right)^{2} + \left(\frac{n H + t_{f}}{12}\right) H^{3} - \frac{n H (H - 2 t_{f})^{3}}{12}$$
(58)

$$AT = t_{f} H (2n + 1) + m t_{f}^{2}$$
(59)

$$\overline{y} \approx \frac{\frac{mt_f^3}{2} + t_f H (2n + 1) (H/2 + t_f)}{AT}$$
(60)

$$W = \frac{\pi \rho_{f} t_{f} (R_{1} + R_{2}) L_{o} + 2\pi H t_{f} (2n + 1) \rho \left[ NR_{2} - \frac{NL_{o} \sin \theta}{2} \right]}{12 \pi (R_{1} + R_{2}) L_{o}}$$
(61)

6. Monocoque Tension Shell

$$t_{f3} = \frac{P_{CR} R_3}{C_1 \sigma_f}$$
(62)

$$C_{1} = \frac{2}{\left[1 - (R_{2}/R_{3})^{2}\right]} \ln \left(\frac{1 + \cos \beta}{\sin \beta}\right)$$
(63)

$$W = \frac{W_{\rm TT}}{AT}$$
(64)

$$W_{\rm TT} = 2\pi \frac{\rho_{\rm f}}{1728} \int_{\theta=\beta}^{\theta=\pi/2} \frac{t_{\rm f}}{\sin\theta} y\left(\frac{\rm dy}{\rm d\theta}\right) d\theta$$
(65)

$$AT = \frac{2\pi}{144} \int_{\theta=\beta}^{\theta=\pi/2} \frac{1}{\sin\theta} y\left(\frac{dy}{d\theta}\right) d\theta$$
(66)

$$y \frac{dy}{d\theta} = \frac{-(R_2^2 - R_3^2)}{2 \sin \theta \ln \left(\frac{1 + \cos \beta}{\sin \beta}\right)}$$
(67)

$$t_f = \frac{R_3 t_3}{y}$$
(68)

$$y = \begin{cases} R_3^2 + (R_2^2 - R_3^2) - \frac{\ln\left(\frac{1+\cos\theta}{\sin\theta}\right)}{\ln\left(\frac{1+\cos\beta}{\sin\beta}\right)} \end{cases} \end{cases}$$
(69)

# 7. <u>Monocoque General Tension Shell</u> $W = \frac{WTG}{AG}$ (70)

WTG = 
$$\frac{2\pi \rho_{\rm f}}{1728} \int_{R_2}^{R_3} \frac{t_{\rm f} y \, dy}{\sin \theta}$$
(71)

$$\Lambda G = \frac{2\pi}{144} \int_{R_2}^{R_3} \frac{y \, dy}{\sin \theta}$$
(72)

$$\cot \theta = \frac{\mathbf{x}_{j} - \mathbf{x}_{i}}{\mathbf{y}_{j} - \mathbf{y}_{i}}$$
(73)

$$t_f = t_{f3} \frac{R_3^{1-a}}{y^{1-a}}$$
 (74)

$$c_{f_3} = \frac{-P_{CR}}{\left[-\sin\theta_{3G}\left(\frac{d\theta}{dy}\right)_3 + \frac{a\cos\theta_{3G}}{R_3}\right]\sigma_{cy}}$$
(75)

# 8. Compression Ring

WSCST = 
$$\frac{\text{WR (144)}}{2\pi R_{SC} \left[ \frac{R_3 \theta_3}{57.3} + R_{SC} \left( \sin \theta_3 - \frac{\theta_3 \cos \theta_3}{57.3} \right) \right]}$$
(76)

WR = 
$$\frac{4\pi^2 RR}{1728}$$
  $t_R \rho_R (R_C - RR)$  (77)

$$RR = \left(\frac{R_{C}^{3}}{1.7 \pi} \sqrt{\frac{2\pi (0.3) t_{3} \sigma_{f}}{E_{R} R_{C}}}\right)^{1/3}$$
(78)

9. Hot Structures  

$$\mathbb{W} C_p \quad \frac{dT}{d\tau} = q_c \left(1 - \frac{H_w}{H_s}\right) + q_R - \epsilon \left(\frac{T_w}{1200}\right)^4$$
(79)

# 10. Base Section

$$PCR = (P_{CR})_{aero} + \frac{(WHS + W)G}{144}$$
 (80)

Monocoque

$$W = \rho_f \cdot \frac{\mathfrak{c}_f}{12} \tag{81}$$

$$t_{\rm f} = \sqrt{\frac{3}{8}} \frac{{\rm R}_{\rm T} 2 {\rm P}_{\rm CR} \cdot (3+\nu)}{\sigma_{\rm f}}}$$
 (82)

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$$W = \frac{1}{12} \rho_{c} \cdot t_{c} + ZK + \frac{1}{6} \rho_{f} \cdot t_{f}$$
(83)

$$\rho_{\rm c} = 0.22 \cdot \rho_{\rm f} \cdot \left(\frac{P_{\rm CR}}{\sigma_{\rm R}}\right)^{0.58} \tag{84}$$

$$Z1 = \frac{\rho_{\rm f}}{16} \tag{85}$$

$$Z_{3} = \frac{1}{16} \frac{\left[P_{CR} \cdot (R_{T})^{2}\right](3+\nu)}{(\sigma_{f})}$$
(86)

$$(t_{\rm f})_{\rm opt} = \sqrt{\frac{Z_3}{Z_1}} \tag{87}$$

$$(t_c)_{opt} = \frac{Z_3}{t_f}$$
(88)

$$t_{f} = \frac{(P_{CR} \cdot R_{T}^{2})(3 + \nu)}{16 (a_{f}) t_{c}}$$
(89)

## 11. Yield Criteria

•

a. Cones, Cylinders

$$N_{\theta} = \left| - \frac{\left[ P_{CR} - \frac{(WHS + W)}{144} \quad G \sin \theta \right] R}{\cos \theta} \right]$$
(90)

b. Cones  

$$N_{\phi} = \frac{-P_{CR}}{2 R \cos \theta} \left[ R^2 + R_1^2 (\bar{\gamma} - 1) \right] + \frac{G (R^2 - R_1^2) (WHS + W)}{2 R \sin \theta \cos \theta (144)}$$
(91)

.

$$N_{\phi} = \frac{-P_{CR} R_C \bar{\gamma}}{2} - \frac{G (L_C) (WHS + W)}{(144)}$$
(92)

#### d. M-H Criteria

$$N_y^2 = N_\theta^2 + N_\phi^2 - N_\theta N_\phi$$
<sup>(93)</sup>

e. Elastic Yield Requirements (sandwich construction)

$$t_{f} \ge \frac{(N_{y})^{\max}}{2\sigma_{f}}$$
(94)

#### f. Combined stress

$$SIGMH = \frac{(N_y) \max}{2 t_f}$$
(95)

#### g. Meridional stress

$$SIGM = \frac{N_{\phi}}{2\tau_{f}}$$
(96)

#### h. Circumferential stress

$$SIGH = \frac{N_{\theta}}{2 t_{f}}$$
(97)

#### IV. IBM ROUTINES

#### A. PROGRAM FLOW

Given vehicle geometry, structural material properties, and pressure loads, Program 1886 computes the weight of the external structure on each segment of the vehicle which will survive reentry. The segments of the vehicle may include a spherical nose cap, cones, cylinders, rear spherical cap, tension shell, and general shell. The program flow diagram is shown in Figure 8.



Figure 8 Flow Diagram For Program 1886

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#### B. MAIN PRØGRAM

#### 1. Purpose

The purpose of the main program is to acquire the program input, and make any necessary units conversions before transfering control to the appropriate subroutine for the calculation of the structural weight.

#### 2 Method

Initially the types and dimensions of main program variables are specified and common storage is set up for the transmission of data to subroutines BUCKLE, MONOC, and STIFS.

In the first executable statements of the program tables of BT (the geometric Parameter  $\beta$ ) and of the dependent variables T1T, T3T, and T4T are defined element by element in arithmetic statements.

In the DØ 10 loop CØMMØN data (from SECTN through DELK2) is preset to 0. Since most of the program input variables appear in CØMMØN, this loop zeros out a large portion of the namelist data. The remainder of the input is preset in the data and arithmetic statements immediately following Statement 10.

The data is read in through the namelist array INPUT and immediately written on the output tape. The vehicle radii are then converted to inches, and the angles to radians for internal use If RB and TINIT have not been specified, they are taken to be RC and TEMPI, respectively.

In the DØ 30 loop NTAU, the number of elements in the array TIME, is calculated (by searching for the first 0 beyond the first element of the array).

Then for each vehicle section specified in the array SECTN, the DØ 100 loop transfers control to one of the subroutines BUCKLE, MØNØC, or STIFS according to the following criteria: if  $M\emptyset N \ge 1$ , subroutine  $M\emptyset N\emptyset C$  is called; if MON < 1 and  $RSD \ge 1$ , subroutine STIFS is called; if  $M\emptyset N < 1$  and RSD < 1, subroutine BUCKLE is called The first value of SECTN <0 encountered terminates the current case. Control is then transferred back to the READ statement for processing the next case.

#### 3. CØMMØN STØRAGE

The variables in CØMMØN STØRAGE are those input variables (with units modified if necessary) which must be transmitted to one of the subroutines BUCKLE, MØNØC, or STIFS. Unless a modification is specified, the CØMMØN variable is precisely the input value.

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| Variable   | <u>Definition</u> (if not directly input) |
|------------|-------------------------------------------|
| SECTN      |                                           |
| HTST       |                                           |
| HTØP       |                                           |
| GAMFI      | GAMF                                      |
| GFTAB      |                                           |
| EFI        | EF                                        |
| EFTAB      |                                           |
| RØF        |                                           |
| SGFI       | SIGCYF                                    |
| SGFTAB     |                                           |
| GAMRI      | GAMR                                      |
| GRTAB      |                                           |
| ER         |                                           |
| RØR        |                                           |
| SGRI       | SIGCYR                                    |
| SGRTAB     |                                           |
| KADHES     |                                           |
| PCR        |                                           |
| TFMIN      |                                           |
| TCMIN      |                                           |
| TCMAX      |                                           |
| RØCMIN     |                                           |
| RØCMAX     |                                           |
| GAMBAR     |                                           |
| CBAR       |                                           |
| WHS        |                                           |
| G          |                                           |
| HS         |                                           |
| EM         |                                           |
| EN         |                                           |
| NFAC       |                                           |
| NTERM      |                                           |
| EPS        |                                           |
| RNI        | 12. · RN                                  |
| RSNI       | 12. · RSN                                 |
| THNR       | $THN \cdot (\pi / 180)$                   |
| RAL        | 12. · RA                                  |
| THAR       | $THA \cdot (\pi / 180)$                   |
| TUCK       | $\pm HU + (\pi / 180)$                    |
| RDI        | 12. KD IOT KE> 0; 12. $\#$ KC for KE< 0.  |
| ROBI       | 14. · KOD                                 |
| LIDK       | ID ·(7 / 100)                             |
| RUI        | 16, 'KU                                   |
| TOOL VI CI | 12. · KOU                                 |
|            | 16 TO                                     |

| RTI    | 12. RT                                            |
|--------|---------------------------------------------------|
| BETA   |                                                   |
| A      |                                                   |
| TH2G   |                                                   |
| TH3G   |                                                   |
| RØRG   |                                                   |
| SIGRG  |                                                   |
| DTHDY  |                                                   |
| DELTAU |                                                   |
| EMISTR |                                                   |
| QCMULT |                                                   |
| QRMULT |                                                   |
| XN     |                                                   |
| хØ     |                                                   |
| XA     |                                                   |
| XC     |                                                   |
| TEMPI  |                                                   |
| TEMPA  |                                                   |
| х      |                                                   |
| R      |                                                   |
| TTAB   |                                                   |
| CPTAB  |                                                   |
| TIME   |                                                   |
| HTBL   |                                                   |
| QTBL   |                                                   |
| RTBL   |                                                   |
| TINITL | TINIT if TINIT>0; TEMPI if TINIT $\leq 0$         |
| TSTØP  | _                                                 |
| NTAU   | Number of values in TIME array                    |
| DELK1  |                                                   |
| DELK2  |                                                   |
| JJJ    | Index of current vehicle section                  |
| IGØ    | SECTN (JJJ), ie identification of current section |
| DPC    | GAMBAR, CBAR                                      |
| BT     | Table of geometric parameter $\beta$              |
| T1T    | Table of t <sub>l</sub>                           |
| T3T    | Table of t3                                       |
| T4T    | Table of t4                                       |

#### C. SUBRØUTINE CALLING SEQUENCES

| 1. NØSE | Variable | Input or Output | Variable | Input or Output |
|---------|----------|-----------------|----------|-----------------|
|         | R        | INPUT           | WØPT     | OUTPUT          |
|         | THETA    | INPUT           | W        | OUTPUT          |
|         | PCR      | INPUT           | WT       | OUTPUT          |
|         | GAMF     | INPUT           | TFUSED   | OUTPUT          |
|         | EF       | INPUT           | TCUSED   | OUTPUT          |

| 1. NØSE   | Variable                                                                                         | Input or Output | Variable | Input or Output |
|-----------|--------------------------------------------------------------------------------------------------|-----------------|----------|-----------------|
| (Cont'd)  |                                                                                                  |                 |          |                 |
|           | RØF                                                                                              | INPUT           | SIGMH    | OUTPUT          |
|           | SGF                                                                                              | INPUT           | ICHK     | OUTPUT          |
|           | GAMR                                                                                             | INPUT           |          | OUTPUT          |
|           | SGR                                                                                              | INPUT           |          |                 |
|           | RØR                                                                                              | INPUT           |          |                 |
|           | TCMX                                                                                             | INPUT           |          |                 |
|           | TCMN                                                                                             | INPUT           |          |                 |
|           | TFMN                                                                                             | INPUT           |          |                 |
|           | RØMX                                                                                             | INPUT           |          |                 |
|           | RØMN                                                                                             | INPUT           |          |                 |
|           | ZK                                                                                               | INPUT           |          |                 |
|           | WHS                                                                                              | INPUT           |          |                 |
|           | G                                                                                                | INPUT           |          |                 |
|           | IGØ                                                                                              | INPUT           |          | 1               |
|           | TCY                                                                                              | MIT PIT         |          |                 |
|           | RQC                                                                                              | OUTPUT          |          |                 |
|           | 100                                                                                              | <i>\\</i>       | l        |                 |
| 2. CØNE   |                                                                                                  |                 |          |                 |
|           | GAME                                                                                             | INPUT           | WHS      | INPUT           |
|           | EF                                                                                               | INPUT           | G        | INPUT           |
|           | 20F                                                                                              | INPIT           | SINTH    | INPUT           |
|           | SCF                                                                                              | INPIIT          | COSTH    | INPUT           |
|           | GAMR                                                                                             | INPIT           | IGO      | INPUT           |
|           | SGR                                                                                              | INPIT           | DELZI    | INPUT           |
|           | ROR                                                                                              | INPUT           | DELZ2    | INPUT           |
|           | PCR                                                                                              | INPUT           | TCY      | <b>MITPUT</b>   |
|           | DPC                                                                                              | INPUT           | RØC      | ØUTPUT          |
|           | 78                                                                                               | INDIT           | WOPT     | OUTPUT          |
|           | RUMX                                                                                             | INPUT           | w        | <b>MITPUT</b>   |
|           | ROMN                                                                                             | INDUT           | WT       | ØUTPUT          |
|           | TCMY                                                                                             | INDUT           | TEUSED   | OUTPUT          |
|           | TCMN                                                                                             | INDUT           | TCUSED   | durpur          |
|           | TEMN                                                                                             | INPUT           | SIGMH    | ØITTPUT         |
|           | BT                                                                                               | INDUT           | SIGH     | durpur          |
|           | ±<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1 | INPIIT          | SIGM     | durpir          |
|           | T11<br>T2T                                                                                       | INFOI           | ICHK     |                 |
|           | T4T                                                                                              | INDIT           | 201112   | <b>401101</b>   |
|           | 171<br>B1                                                                                        | INDIT           |          |                 |
|           | D2                                                                                               | TNICITT         |          |                 |
|           | x                                                                                                | THEOT           |          |                 |
| 3. CYLIND |                                                                                                  |                 |          |                 |
|           | RC                                                                                               | INPUT           | TCY      | ØUTPUT          |
|           | GAMF                                                                                             | INPUT           | RØC      | ØUTPUT          |
| ]         | EF                                                                                               | INPUT           | WØPT     | ØUTPUT          |
|           | RØF                                                                                              | INPUT           | w        | ØUTPUT          |

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| 3. CYLIND  | Variable | Input or Output                        | Variable | Input or Output |
|------------|----------|----------------------------------------|----------|-----------------|
| (Concl'd)  | SGF      | INPUT                                  | WT       | ØUTPUT          |
|            | GAMR     | INPUT                                  | TFUSED   | ØUTPUT          |
|            | SGR      | INPUT                                  | TCUSED   | ØUTPUT          |
|            | RØR      | INPUT                                  | SIGMH    | ØUTPUT          |
|            | PCR      | INPUT                                  | SIGH     | ØUTPUT          |
|            | DEL      | INPUT                                  | SIGM     | ØUTPUT          |
|            | RØMN     | INPUT                                  | ICHK     | ØUTPUT          |
|            | RØMX     | INPUT                                  |          |                 |
|            | TCMN     | INPUT                                  |          |                 |
|            | TCMX     | INPUT                                  |          |                 |
|            | TFMN     | INPUT                                  |          |                 |
|            | ZK       | INPUT                                  |          |                 |
|            | DPC      | INPUT                                  |          |                 |
|            | WHS      | INPUT                                  |          |                 |
|            | G        | INPUT                                  |          |                 |
|            | DELK1    | INPUT                                  |          |                 |
|            | DELK2    | INPUT                                  |          |                 |
| 4. BASE    |          | •••••••••••••••••••••••••••••••••••••• |          |                 |
|            | р.<br>Т. | INDIT                                  | PAC      | <b>MITPIIT</b>  |
|            | GAME     | INPIIT                                 | TCHK     | OUTPUT          |
|            | RØF      | INPIT                                  | 1.01111  |                 |
|            | RØR      | INPUT                                  |          |                 |
|            | SGF      | INPUT                                  |          |                 |
|            | SGR      | INPUT                                  |          |                 |
|            | PCR      | INPUT                                  |          |                 |
|            | RØMX     | INPUT                                  |          |                 |
|            | RØMN     | INPUT                                  |          |                 |
|            | TCMX     | INPUT                                  |          |                 |
|            | TCMN     | INPUT                                  |          |                 |
|            | TEMN     | INPUT                                  |          |                 |
|            | ZK       | INPUT                                  |          |                 |
|            | WHS      | INPUT                                  |          |                 |
|            | G        | INPUT                                  |          |                 |
|            | WØPT     | ØUTPUT                                 |          |                 |
|            | w        | ØUTPUT                                 |          |                 |
|            | WT       | ØUTPUT                                 |          |                 |
|            | TFUSED   | ØUTPUT                                 |          |                 |
|            | TCUSED   | ØUTPUT                                 |          |                 |
| 5. TENSIØN |          |                                        |          |                 |
|            | BETA     | INPUT                                  |          |                 |
|            | RC       | INPUT                                  |          |                 |
|            | RSC      | INPUT                                  |          |                 |
|            | RSN      | INPUT                                  |          |                 |
|            | RN       | INPUT                                  |          |                 |
|            |          |                                        |          |                 |

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| 5. TENSIØN | Variable    | Input or Output |                          |
|------------|-------------|-----------------|--------------------------|
| (Concl'd)  | PCP         | INDIT           |                          |
|            | THN         | INPUT           |                          |
|            | SIGCYE      | INPUT           |                          |
|            | BOE         | TUPIT           |                          |
|            | WTENST      | ØUTPUT          |                          |
|            | WTT         | QUTPUT          |                          |
|            | AT          | ØUTPUT          |                          |
|            | T3          | OUTPUT          |                          |
|            | WB          | OUTPUT          |                          |
|            | RR          | ØUTPUT          |                          |
|            | TR          | ØUTPUT          |                          |
|            | WSCST       | ØUTPUT          |                          |
|            | ER          | INPIT           |                          |
|            | RORG        | INPUT           |                          |
|            | SIGRG       | INPIIT          |                          |
|            | TEMN        | INPUT           |                          |
|            | 1 1 1 11 11 |                 |                          |
| 6. GNRLSH  | Variable    | Input or Output | Variable Input or Output |
|            | х           | INPUT           | TFMN INPUT               |
|            | Y           | INPUT           | DTHDY3 INPUT             |
|            | A           | INPUT           |                          |
|            | SIGCYF      | INPUT           |                          |
|            | RØF         | INPUT           |                          |
|            | TH2D        | INPUT           |                          |
|            | TH3D        | INPUT           |                          |
| •          | PCR         | INPUT           |                          |
|            | RØRG        | INPUT           |                          |
|            | ER          | INPUT           |                          |
|            | SIGRG       | INPUT           |                          |
|            | RSC         | INPUT           |                          |
|            | RC          | INPUT           |                          |
|            | WR          | ØUTPUT          |                          |
|            | TR          | ØUTPUT          |                          |
|            | RR          | ØUTPUT          |                          |
|            | WSCST       | ØUTPUT          |                          |
|            | T3          | ØUTPUT          |                          |
|            | WGENST      | ØUTPUT          |                          |
|            | WTG         | ØUTPUT          |                          |
|            | AG          | ØUTPUT          |                          |
|            |             |                 |                          |
| 7. RING    |             |                 |                          |
|            | THD         | INPUT           |                          |
|            | R3          | INPUT           |                          |
|            | ТЗ          | INPUT           |                          |
|            | RSC         | INPUT           |                          |
|            |             |                 |                          |

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| 7. RING   | Variable                                                                                                                                        | Input or Output                                                                                                                                                          |            |                 |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------|
| (Concl'd) | ER<br>SIGRG<br>RC<br>SIGCYF<br>RØRG<br>WR<br>RR<br>TR<br>WSCST                                                                                  | INPUT<br>INPUT<br>INPUT<br>INPUT<br>ØUTPUT<br>ØUTPUT<br>ØUTPUT<br>ØUTPUT                                                                                                 |            |                 |
| 8. HØTSTR | Variable                                                                                                                                        | Input or Output                                                                                                                                                          | Variable   | Input or Output |
|           | XN<br>XØ<br>XC<br>XA<br>TTAB<br>TEMPI<br>NTAU<br>TAU<br>TAU<br>TAU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>A | INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>INPUT<br>ØUTPUT | W<br>WSTAR | INPUT<br>ØUTPUT |

D. SUBROUTINES, DESCRIPTIØNS

- 1. Subroutine BUCKLE
  - a. Purpose

The purpose of subroutine BUCKLE is to control the computation of the structure weights for sections having a honeycomb construction, and to provide the program output for those sections.

#### b. Method

Subroutine BUCKLE receives all of its input data from the main program through COMMON. It does not redefine any of this data, or transmit any information back to the main program.

At the first executable statement of BUCKLE the variable ICHK is set to 12345. Any subsequent change in ICHK will be an indication of computational difficulty, and appropriate action will be taken to inform the user of the situation (error messages and the deletion of further computation on the particular section). PI is defined, and the identification number of the current section is written on the output tape, logical tape 6.

There are two possible paths for the computation to take, depending on whether or not the section is to be run under the hot structures option (for which HTST is input as 1.)

If HTST  $\neq 1$ , control is transferred immediately to statement 250 where a computed  $G\phi$   $T\phi$  on the section number picks the correct method of computing the weight. For all sections but tori the appropriate data is supplied to one of the subroutines NOSE, CONE. TENSON, GNRLSH, CYLIND, or BASE which will carry out the actual computation. For the tori, which cannot in reality be handled by the program, the unit section weight is taken as the weight of the immediately preceding section; however, this weight is then multiplied by the torus area in finding the total weight. The weights, face sheet and core thicknesses, and core densities are placed in arrays from which they are finally printed on the output tape. For tori the weights are printed between statements 21 and 25, and return is made to the main program. For the other sections the block of statements between 255 and 2684 provides for writing all the output. This block is entered either at statement 255 or 260 after the return from the particular section subroutine. The computed GØ TØ at 261 controls setting up the correct headings to print only the information applicable for a particular section. The IF test at statement 2645 checks for nonconvergence of the weight iteration. If nonconvergence is detected, an error message 1s written. Return 1s then made to the main program.

In the case of a hot structure not only does the final weight depend upon the temperature rise computed by the program, but the material properties used in the honeycomb analysis are themselves a function of temperature. This second dependence makes an iterative scheme necessary to handle the weight computation. The numerical method used is standard false position applied to the temperature, the initial guesses being TINIT and TEMPA. To ensure convergence it is necessary that the actual temperature he between TINIT and TEMPA. (If TINIT is not specified, it is taken to be TEMPI.) At Statement 230 the temperature TEMP is set to TINIT to start the process. Then NN (the number of iterations), WQ, and FTMP1 are initialized. At 245 the material properties corresponding to TEMP are looked up in tables EFTAB, SGFTAB, GFTAB, GRTAB, and SGRTAB, and control is transferred to the appropriate subroutine for a weight computation. After a transfer back to 260 the hot structures option switches control to 269 where subroutine HØTSTR calculates the maximum temperature TWMAX and, if necessary, the increased weight WQ. After the return form HØTSTR an IF test checks the difference between the original temperature TEMP and TWMAX. If the relative difference is less than 1 percent the iteration is terminated immediately, and control is passed to the output block at Statement 261. If the difference is greater than 1 percent, control is passed back to Statement 240 where NN is updated. The statements following 240 provide, in general for saving the last two temperature estimates TMP1 and TMP2 which bracket the root, along with the differences FTMP1 and FTMP2 between these estimates and their corresponding values of TWMAX. On this first pass TMP1 and FTMP1 are presumably set to TINIT and TINIT-TWMAX. A second pass is then made through the entire computation sequence with TEMP set to the value TEMPA. At 242 TMP2 will be set to TEMPA and FTMP2 to TEMPA-TWMAX. Then the false position algorithm computes a new projected temperature from TMP1, TMP2, FTMP1, and FTMP2 at statement 2425, and tests to make sure that TEMPA is not exceeded. (A value of TEMP>TEMPA results in an error message and return to the main program.) The iteration now continues until the relative difference between TEMP and TWMAX is less than 1 percent. The results are then printed and a return is made to the main program. (If convergence has not occurred within 10 iterations, the process is terminated and the last values printed out.)

- 2. Subroutine MØNØC
  - a. Purpose

The purpose of subroutine  $M \phi N \phi C$  is to calculate the structure weights of those sections having a monocoque construction and to provide the program output for these sections.

b. Method

Subroutine MØNØC receives all of its input data from the main program through CØMMØN. It does not redefine any of this data, or transmit any information back to the main program.

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Like BUCKLE subroutine  $M\emptyset N\emptyset C$  can be called either with or without the hot structures option. However, unlike BUCKLE,  $M\emptyset N\emptyset C$  can handle a vehicle section only if it is a spherical cap or flat base (i.e. one of Sections 1, 12, or 13).

If HTST 1, there is a single level search performed for the weight, taking account of the inertia of the heat shield and structure. After the section number has been written out, control switches down to Statement 250 where an initial value of the unit weight WSTAR is computed using minimum gage thickness, and NIT, the number of iterations, is initialized. The computed  $G\phi T\phi$  on the section number results in an error message and return for any section other than 1, 12, or 13.

For the nose sphere or aft sphere the radius R, the shell height H. and a sign factor PFAC are set at statements 1 and 12, respectively. For either of these sections transfer is then made to Statement 300 where SMATM, an expression appearing in the pressure computations, is calculated, and the face sheet thickness SMAT is set initially to minimum gage. The search method between Statements 400 and 600. looks for a change of sign (from positive to negative) of the expression PCR-PTEST. Until such a change 1s detected, the statements are repeated with SMAT being increased by the factor EPSP1 (1+f). A value of WSTAR is computed to correspond to each SMAT. (A maximum of 500 such increases in SMAT is allowed before an error message and return terminates calculations for the section.) Once the sign change has been detected, a final value of pressure P and yield thickness TY are calculated beginning at Statement 750. The final thickness is taken as the maximum of SMAT and TY, and WSTAR is again computed using this maximum. The total weight W and yield stress criteria SIGMH are then computed. Transfer is made to Statement 850 for the printout of results and return to the main program.

In the case of a flat base a first order iteration scheme is used to compute the unit weight rather than a search. The radius R is set to RT, and the initial estimate for WSTAR (using minimum gage thickness) is stored in W1. W1 will be used to keep track of the last previous iterate, and thus updated on each pass. The pressure and face sheet thickness are computed. An IF test ensures that the thickness is at least minimum gage, and a new weight WSTAR is calculated at Statement 132. If the relative difference between W1 and WSTAR is less than 1 percent, the last value of WSTAR is taken as the unit weight and a transfer is made to Statement 137 for the computation of the total weight, printout of results, and return to the main program. If the difference is greater than 1 percent transfer is made back to Statement 130 for the next iteration. Failure attain convergence within 25 iterations results in an error message at Statement 136 and return to the man program.

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If HTST = 1, the same false position iteration scheme used in subroutine BUCKLE finds the weight as a function of temperature. This iteration is performed outside the iteration or search described above, thus making the entire iterative scheme a two-level process. The call to subroutine HØTSTR is now at Statement 810.

#### 3. Subroutine STIFS

#### a. Purpose

The purpose of subroutine STIFS is to calculate the structure weights of those sections having a ring-stiffened construction, and to provide the program output for these sections.

#### b. Method

Subroutine STIFS receives all of its data from the main program through  $C \phi MM \phi N$ . It does not redefine any of this data, or transmit any information back to the main program.

STIFS can be called with or without the hot structures option. It handles a vehicle section that is a cone, cylinder, flare forecone, or aftcone (Sections 3, 7, 8, 11). At Statement 200 a computed GØ TØtests that the current section is indeed one of these four. If not, a transfer to Statement 2000 results in an error message and immediate return to the main program. If the section can be handled, values of R1, R2, RTHETA, and XKFAC are calculated from the appropriate geometry parameters, beginning at one of the Statements 5551, 5552, 5553, or 5554. Transfer is then made to Statement 5555 where several variables depending on the vehicle geometry are calculated, and the section number and a heading are written out. The program flow beyond Statement 65 depends upon whether or not the section is a hot structure, and whether HTØP has been specified as 1. or 2.

Consider first the case HTST = 0, HTOP = 1. The object will be to find a thickness (t) satisfying both local and general stability conditions and a number (N) of rings which will minimize the structure weight. Since the inertia of the heat shield and structure are to be taken into consideration, an iterative method is again necessary in the weight calculations. In STIFS this iteration is carried out for each number (N) of rings considered.

Since  $HTST^{*}=0$ , the test following Statement 65 transfers control down to 68 where N, the current number of rings, is set to 1 (although the N = O case will actually be handled first), and the control parameters ITEST and IG $\phi T \phi$  are initialized to 1. Since  $HT\phi P = 1$ , H is set to

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the input value HS. Between Statements 683 and 9 an additional block of variables 15 initialized including TL the thickness required for local stability, TG the thickness required for general stability, and SMAT, which is always the current thickness being used in the calculations. The block of statements between 9 and 15 performs the major computations of the routine.

Initially the case N = O is considered. (The routine recognizes this case by the fact that ITEST is still 1.) The computed GØ TØ before Statement 155 transfers control to 155 where PAS, the pressure just computed at Statement 15 is tested against the input value PA(PCR). If PA>PAS, TG is increased by the factor EPSP (1. + EPS), SMAT is set equal to TG and a transfer back to statement 12 begins a repetition of the computations. The loop thus formed is retraced until finally PAS  $\geq$  PA, the variable M keeping track of the number of iterations. At Statement 17 the total weight WN and the unit weight WSTAR are calculated as a function of the current TG.

The computed  $G\phi T\phi$  at Statement 20 transfers control to 28 since  $IG\phi T\phi$  is still 1. Here the first order iteration procedure necessitated by structural inertia considerations tests for convergence of the unit weight WSTAR. WSTAR is compared with W1, the last previous iterate. (W1 was initialized to 0. just after Statement 5555 to take care of the first pass.) Ten iterations are allowed for obtaining convergence of the weight. On each iteration the looping process to obtain TG is repeated. The transfer back to statement 85 ensures that all the necessary reinitialization is included. Convergence is defined as a relative difference of less than 1 percent between W1 and WSTAR. If convergence is not reached within 10 iterations, an error message is written at Statement 295, and return is made to the main program. If convergence is attained, IG $\phi T\phi$  is reset to 2 at Statement 301.

The block of statements between 302 and 312 calculates the yield stress criteria. If the section is one of the cones, its entire length must be searched for the point of maximum allowable stress XNYMAX. XNYMAX is initially set to 0, and R to R2, the largest value of the cone radius. In the DO 305 loop a value of XNY is calculated at each of 10, equally-spaced points along the length of the cone as R decreases to R1, the smallest cone radius. XNYMAX is defined as the maximum of the 10 XNY values obtained in the loop. Values of XNTH and XNPHI to be used in evaluating the stress components are also calculated corresponding to XNYMAX. If the section is a cylinder, XNTH, XNPHI, and XNYMAX are evaluated directly. In either case TCY, the minimum thickness satisfying yield requirements, is calculated at Statement 308, and tested against TG. If TCY>TG, TG is reset to TCY, and the weights must be recalculated at Statement 17 to

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correspond to the new thickness. In this case the computed  $G \not D T \not D$ brings control back to Statement 312 since  $IG \not D T \not D$  is now 2. Here the stress component calculations are completed, the minimum weight WGTMIN is set to the current weight value, TL is set equal to TG, and the N = O results are printed. (ISW was set to 1 following Statement 5555, since HTST = O).

At 321 the N = 1 case is begun. (Statement 32 which ordinarily will compute the next N is skipped since N was set to 1 at the beginning of the routine.) The IF test on DN checks to see that the maximum number of rings is not exceeded. Initializations are completed, ITEST is set to 2 and IG $\phi$ T $\phi$  to 3, and control is transferred back to the computation block at Statement 10. The computed G $\phi$ T $\phi$  with ITEST = 2 chooses the test at Statement 16. This test and the statements starting at Statement 36 decrease TL (which was set to the TG obtained for the last N) by the factor EPSM\*\*M((1.-EPS)<sup>M</sup>), until PA > PAS or TL < TM. The weights are then computed at Statement 17, and the transfer to Statement 37 (IG $\phi$ T $\phi$  = 3) sets up conditions for the general stability calculations. By the time the transfer back to Statement 9 takes place ITEST has been reset to 1 and IG $\phi$ T $\phi$ to 4. The same general stability loop is repeated as in the O-ring case, TG being increased by EPSP until PAS > PA.

The transfer from Statement 20 is now to Statement 39 where the first order iteration is begun for the N = 1 case. Both the TL and TG loops must be repeated for each iteration, as is indicated by the transfer to Statement 322 each time the relative difference between W1 and WSTAR is greater than 1 percent. When convergence has been attained, the stress calculations are repeated starting at Statement 302, but with  $IG\phi T\phi$  now 5. Thus, when the stress calculations have been completed, the test on  $IG\phi T\phi$  before Statement 318 brings control down to Statement 397 where the current weight is tested against WGTMIN the running minimum. WGTMIN is reset if the current WN is smaller. The results for N = 1 are printed, and the computations for the next N are begun at statement 32 where N is calculated as a function of its current value and the input parameters NFAC and NTERM.

The computations are repeated in this same manner for each new N until N exceeds the maximum allowable value  $XL \phi/EM/TG$ . Then at Statement 43 the current minimum weight is taken as the final result. The unit and total weights are printed at statement 44, and return is made to the main program.

If  $HT\phi P = 2$ , the stiffener height (H) is initialized to 1. at Statement 682 before the computations begin. The N = O calculations, and the

-83-638< Iterations for TL when N>O proceed exactly as in the  $HT\PhiP = 1$  case. However, when N>1 and the general stability calculations are set up starting at Statement 37, ITEST is set to 3 instead of 1. The computed  $G\PhiT\Phi$  in the calculation block picks the test at 163. The object now is to find the value of H for which PA = PAS. If initially PA>PAS, ITEST is set to 5 and H is increased by the factor EPSP until a change of sign in PA-PAS occurs. (On the second and succeeding passes the test at 168 is used.) If initially PA< PAS, ITEST is set to 4, and H is decreased by the factor EPSM until a sign change in PA-PAS is detected. (On the second and succeeding passes the test at 169 is used.) Then the weight is calculated at Statement 17 as in the HT $\Phi$ P = 1 case. The remainder of the program logic is not affected by HT $\Phi$ P.

In cases where HTST = 1 false position iteration on the temperature is used in the weight calculations as in subroutines BUCKLE and  $M\emptyset N\emptyset C$ . This iteration is performed outside all the other computations carried out by the routine. The iteration loop itself extends from statement 67 to the IF test at 577. The variable ISW which has the value 2 initially, suppresses the printing of results until convergence has been achieved. Then the final iteration is repeated with ISW reset to 1 to obtain the printout.

#### 4. Subroutine NØSE

#### a. Purpose

The purpose of subroutine NØSE is to calculate the honeycomb structure weights for the nosesphere and aftsphere sections (Sections 1 and 12) of the vehicle when specific geometry conditions and material properties are given.

#### b. Method

First order iteration is used to compute the weight, taking into account the inertia of the heat shield and structure. This iteration starts at Statement 800 after several terms that are to be constant during the looping process have been calculated, and the weights W and WØPT and the number of iterations NIT have been initialized to 0. At 800 W1 which will be the value of the last previous iterate is set equal to W. Then the pressure P, depending on W, is calculated and its sign tested.

If  $P \leq 0$ , the face sheet thickness and core height are taken as minimum gage. The weight (W), total weight (WT), and yield stress criteria (SIGMH) are computed, and an immediate return to the calling routine is executed.

If P > 0, the iteration continues. The core density (R $\phi$ C) is calculated, and tested to make sure that it lies between the minimum and maximum values specified in the program input. If  $R\phi$ C <  $R\phi$ MN ( $R\phi$ CMIN), it is set to  $R\phi$ MN; if  $R\phi$ C >  $R\phi$ MX ( $R\phi$ CMAX), it is set to  $R\phi$ MX. Then TCY the face sheet thickness required to satisfy yield criteria is computed. TEST1 is defined as the larger of TCY and TFMN (TFMIN). Next TF $\phi$ PT, the optimum face sheet thickness satisfying buckling criteria is computed and compared with TEST1.

Case (1). TFØPT > TEST1

Control is transferred to Statement 6 for the computation of  $TC \phi PT$ , the optimum core height. TC $\phi PT$  is then checked to ensure that it lies between TCMN (TCMIN) and TCMX (TCMAX).

a. TCMN  $\leq$  TCØPT  $\leq$  TCMX

TFUSED and TCUSED are set to TF $\phi$ PT and TC $\phi$ PT, respectively, and the weight is computed as W $\phi$ PT. (This is the only case in which W $\phi$ PT is computed, and only if the final iteration computes a value of W $\phi$ PT will a nonzero W $\phi$ PT be returned to the calling routine.) W is set equal to W $\phi$ PT and transfer is made to Statement 103.

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b. TCØPT < TCMN

A value TF of the face sheet thickness is computed as a function of TCMN at Statement 7. TFUSED is defined as the larger of TF and TEST1, and TCUSED is set to TCMN. The weight (W) is then computed as a function of TFUSED and TCUSED at Statement 100.

c. TCØPT > TCMX

TFUSED is set to TFØPT and TCUSED is set to TCMX at Statement 14. Then W is computed as a function of TFUSED and TCUSED at Statement 100.

Case (2). TFØPT < TEST1

TFUSED is set to TESTI at Statement 16. TCUSED is computed as a function of TFUSED, then redefined as TCMN or TCMX if it lies, respectively, below or above the allowable range. (W) is then calculated at Statement 100.

In all cases the relative difference between W and W1 is checked at Statement 103. If this difference is less than 1 percent, the iteration is terminated, the total weight (WT) and the yield stress criteria (SIGMH) are computed, and a return to the calling routine is executed. If the difference is greater than 1 percent, the number of iterations NIT is updated at Statement 105, and tested against 10. If NIT < 10, a new iteration is begun at Statement 800. If NIT  $\geq$  10, ICHK is set to 1 as an error indication, and the last results obtained are returned to the calling routine.

- 5 Subroutine CØNE
  - a. Purpose

The purpose of subroutine CØNE is to calculate the honeycomb structure weights for the cone, flare fore cone, and aftcone sections (Sections 3, 8, and 11) of the vehicle, when specific geometry conditions and material properties are given.

b. Method

Subroutine CØNE uses the same first order iteration scheme used in NØSE, and the same logical procedure for obtaining the final values of TFUSED and TCUSED. (See the description of subroutine NØSE for details.) As far as program flow is concerned, the major difference

-86->641 between the two routines lies in the calculation of the maximum allowable stress XNYMAX. Immediately after Statement800 (the beginning of the iteration loop), XNYMAX is initialized to 0., and R set to R2, the maximum value of the cone radius. In the DØ 805 loop a value of XNY is calculated at each of 10 equally-spaced points along the length of the cone as R decreases to R1, the minimum cone radius. XNYMAX is defined as the maximum of the 10 XNY values obtained in the loop. For the cones the circumferential stress (SIGH) and the meridional stress (SIGM) are calculated in addition to the resultant yield stress criteria (SIGMH) (XNYMAX/(2. TFUSED)).

#### 6. Subroutine CYLIND

a. Purpose

The purpose of subroutine CYLIND is to calculate the honeycomb structure weight for the cylindrical section (Section 7) of the vehicle, when specific geometry conditions and material properties are given.

b. Method

The logical flow of subroutine CYLIND is essentially identical to that of subroutine NØSE. The first order iteration loop extends from Statement 3 to the GØ TØ 3 statement following 250. No loop is required for the calculation of the yield stress criteria as in CYLIND. However, the circumferential stress SIGH and the meridional stress SIGM are computed along with SIGMH before the return to the calling routine.

- 7. Subroutine BASE
  - a. Purpose

The purpose of subroutine BASE is to calculate the honeycomb structure weight for the BASE section (Section 13) of the vehicle, when specific geometry conditions and material properties are given.

b. Method

The first order iteration scheme is the same as in subroutine NØSE. The iteration loop starts at Statement 800 and ends at 240. However, the procedure for obtaining TFUSED and TCUSED is somewhat simpler since no-face sheet thickness is computed to satisfy yield criteria. TFUSED is defined on each iteration as the larger of TFØPT and TFMN (TFMIN). TCUSED, after being calculated as a function of TFUSED, is tested against TCMN (TCMIN) and TCMX (TCMAX). If TCUSED < TCMN it is redefined to be TCMN; if TCUSED > TCMX, it is redefined

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as TCMX. In either of these two cases TFUSED is then redefined to correspond at Statement 9.

#### 8. Subroutine TENSØN

a. Purpose

The purpose of subroutine TENS $\emptyset$ N is to compute the structural weight and area of the tension shell (Section 4).

b. Method

Simpson's rule is used to calculate the total weight WTT and the area AT. In the D0 60 loop the integrands W and A are calculated at 25 equally-spaced points between the initial angle BETA and  $\pi/2$ . Sub-routine ARSIMP is then called twice to apply the Simpson's Rule formula. The unit weight WTENST is calculated as the total weight divided by the area, and subroutine RING is called to obtain the structural weight thickness and radius of the compression ring. Return is then made to the calling routine.

#### 9. Subroutine GNRLSH

a. Purpose

The purpose of subroutine GNRLSH is to compute the structural weight and area of the general shell (Section 5).

b. Method

The Trapezoidal rule is used to calculate the total weight WTG and the area AG. In the 3-statement loop starting at Statement 10 the number of values of the coordinates X and Y which have been input are counted. The counting procedure assumes that a 0. follows the last value of the Y array. (Therefore, special care must be taken in stacking cases). Between Statements 123 and 60 an array AFUNCT of integrands for the area and an array WFUNCT of integrands for the total weight are generated. (Each element in these arrays corresponds to a point in the original X and Y arrays.) The trapezoidal rule is applied to AFUNCT and WFUNCT in the 5 statements starting at 61. The results of the integration WTG and AG are multiplied by appropriate factors, and the unit weight WGENST is calculated. A call to subroutine RING obtains the structural weight, thickness, and area of the compression ring. Return is then made to the calling routine.

#### 10. Subroutine RING

a. Purpose

The purpose of subroutine RING is to compute the structural weight, thickness, and radius of the compression ring.

b. Method

Straightforward evaluation of the formulas in arithmetic statements.

#### 11. Subroutine HØTSTR

a. Purpose

The purpose of subroutine HØTSTR is to compute the maximum structural temperature TWMAX, and increase the structure weight if necessary to ensure that TWMAX is no greater than the input value TEMPA.

b. Method

Starting with W supplied by the calling routine, the initial temperature TEMPI, and the initial time value TAU(1) (input as TIME (1)), the routine calculates the temperature rise DELTAT in successive intervals of time (each of length DELTAU). The heating factors QCI, QRI, and HG $\phi$ RI which are used in the expression for DELTAT are looked up in tables QC, QR, and HG $\phi$ RT (input as QTBL, RTBL, and HTBL, respectively) for each new point in time. Should TAUMAX (TST $\phi$ P) be specified as larger than the final value of the TAU table, these heating factors are set to 0. in the region beyond the ends of the tables.

After DELTAT has been computed, its sign is tested to check for a change from positive to negative, signifying a maximum temperature point. If DELTAT is initially negative, two sign changes must be encountered before it is assumed that the maximum temperature has been found. The computed  $G\phi T\phi$  controlled by IDEL at Statement 40 handles such a case.

If a particular value of DELTAT is positive, of if DELTAT is negative, but there has been no previous positive value, the current time TAUT in increased by DELTAU, and checked to make sure that it is less than TAUMAX.

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If TAUT < TAUMAX, TW the current temperature 1s computed at Statement 60, and checked against TEMPA. If TW < TEMPA, the transfer to Statement 25 continues the process at the new time value. If TW  $\geq$  TEMPA, WSTAR, the current weight, 1s increased by the factor EPSP1 (1. + EPS), and the process 1s restarted at the initial point in time and temperature.

If TAUT  $\geq$  TAUMAX, (i.e., no maximum is found within the specified time interval), the temperature and weight at the final time point are taken as the result. A return to the calling routine is executed.

When a change in the sign of DELTAT from positive to negative is detected, an immediate return is made to the calling routine with the current values of weight, time, and temperature.

#### E. SIGNIFICANT EQUATIONS

1. MAIN Program

DPC = GAMBAR · CBAR

2. BUCKLE

 $TEMP = TMP1 - FTMP1 \left( \frac{TMP1 - TMP2}{FTMP1 - FTMP2} \right)$ 

(False position algorithm for hot structures temperature iteration.)

3. MØNØC

$$TEMP = TMP1 - FTMP1 \left( \frac{TMP1 - TMP2}{FTMP1 - FTMP2} \right)$$

a. Spherical Caps

nose sphere R = RN  $H \approx R (1 - sin(THN))$ aftsphere R = RA H = R(1 + sin(THA))

$$PTEST = \frac{-}{+} \frac{(WHS + WSTAR)G}{144} + E \left(\frac{SMAT}{SMATM}\right)^{7/3}$$

where SMAT is the current  $t_{f}$ .

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SMATM = 
$$1 2 (1 - XNU^2)^{2/7} \left(\frac{H}{R}\right)^{1/7} R$$

$$WSTAR = \frac{RH\emptyset \cdot SMAT}{12}$$

$$P = PCR \pm \frac{(WHS \div WSTAR)G}{144}$$

$$TY = \frac{P \cdot R}{2 \cdot SGF}$$

$$SIGMH = \left[ - PCR + \frac{(WHS + WSTAR)G}{144} \right] \frac{R}{2 \cdot SMAT}$$

$$\mathbb{W} = \frac{\mathbb{W}SAR(2\pi) H \cdot R}{144}$$

$$P = PCR + \frac{(WHS + WSTAR)G}{144}$$

SMAT = 
$$\left[\frac{0.375 (R)^2 P (3 + XNU)}{SGF}\right]^{1/2}$$

$$WSTAR = \frac{RH\phi \cdot SMAT}{12}$$
$$W = \frac{WSTAR}{\pi R^2}$$

4. <u>STIFS</u>

$$\text{TEMP} = \text{TMP1} - \text{FTMP1} \left( \frac{\text{TMP1} - \text{TMP2}}{\text{FTMP1} - \text{FTMP2}} \right)$$

$$BETAG = 1 - \frac{R1}{R2}$$

$$BETA = \frac{BETAG}{DN + 1}$$

$$XL\emptyset = \begin{cases} \frac{R2 - R1}{SINT} & Cones \\ XLC & Cylinder \end{cases}$$

$$TTT = (8 \cdot T1 \quad T3 \cdot T4)^{1/4}$$

$$XK = R2 \left(1 - \frac{BETA}{2}\right) / CØST$$

$$XK1 = \frac{XK^3}{2\left(1 - \frac{BETA}{2}\right)^2} [GAMBAR + BETA (1 - 2 \cdot GAMBAR) + BETA^2 (GAMBAR - 0.61600607) + \frac{XL}{R_2} XKTM (1 - 0.61600607) BETA]]$$

,

+ DELK1

$$XK2 = XK (1 + XKTM \cdot SINT) + DELK2$$

where,

$$XKTM = \pm \frac{(WHS + W) G}{144 \cdot PA}$$

$$B = \frac{2\pi \cdot XK1 \quad TTT}{XL \left[12(2 \quad T3 - XNU^2)\right]^{1/4} \quad XK^{3/2} \cdot XK2}$$

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$$S = B (DTH \phi D)^{1/4} (SMAT)^{1/2}$$

$$PS = \frac{WS1 + 1}{(WS1)^{1/2} (WS1^{1/4} + \frac{S}{2})}$$

where,

$$WS1 = \frac{3+S}{1+S}$$

$$RHØT = \frac{RØF SMAT}{1728}$$

$$WS2 \approx 1 - XNU^2$$

$$PAS = \frac{\pi (PS) (DTH \phi D)^{3/4} \cdot T4 (SMAT)^{5/2} [12 (2 T3 - XNU^2)]^{1/4} \cdot E}{6 (WS2) XL XK2 \cdot XK^{1/2} \cdot TTT}$$

$$WN = \pi \cdot RH \phi T \left[ (R1 + R2) XL \phi + 2 \cdot H(2 \cdot EN + 1) \cdot DN \cdot \left( R2 - XL \phi \cdot \frac{SINT}{2} \right) \right]$$

$$WSTAR = \frac{WN \cdot 144}{PI(R1 + R2) XL\emptyset}$$

cones:

$$XNTH = \begin{bmatrix} -PA \mp & \frac{(WHS + WSTAR) \cdot G \cdot SINT}{144} \end{bmatrix} & \frac{R}{CØST}$$

$$\begin{aligned} \text{XNPHI} &= \left[ -\text{PA} \left( \text{R}^2 + \text{R1}^2 \left( \text{GAMBAR} - 1 \right) \right) \mp \frac{\text{G} \left( \text{R}^2 - \text{R1}^2 \right) \left( \text{WHS} + \text{WSTAR} \right)}{144 \text{ SINT}} \right] \frac{1}{2 \cdot \text{R} \cdot \text{C} \text{ØST}} \\ \text{XNY} &= \left[ \left( \text{XNTH} \right)^2 + \left( \text{XNPHI} \right)^2 - \text{XNTH} \cdot \text{XNPHI} \right]^{1/2} \end{aligned}$$

XNYMAX is the largest value of XNY, XNTHM, XNPHIM correspond

cylinders:

$$XNTHM = -PA RC$$

$$XNPHIM = -\frac{PA RC GAMBAR}{2} - \frac{G \cdot XLC (WHS + WSTAR)}{144}$$

$$XNYMAX = [(XNTHM)^2 + (XNPHIM)^2 - XNTHM \cdot XNPHIM]^{1/2}$$

$$TCY = \frac{XNYMAX}{SGF}$$

$$SIGM = \frac{XNYMAX}{TG}$$

$$SIGH = \frac{XNTHM}{TG}$$

$$SIGH = \frac{XNPHIM}{TG}$$

$$D = \frac{E \cdot TLC}{12 \cdot WS2}$$

$$THT = TL \cdot H (2 \cdot EN + 1)$$

$$AT = THT + EM \cdot TLS$$

$$YBAR = \left[\frac{EM \cdot TLC}{2} + THT \left(\frac{H}{2} + TL\right)\right] \frac{1}{AT}$$

$$XIX = \frac{EM TLC \cdot TL}{3} + THT \left(\frac{H}{2} + TL\right)^2 + (EN H + TL) \frac{H^3}{12}$$

$$= \frac{EN \cdot H (H - 2 \cdot TL)^3}{12}$$

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$$XITH = XIX - AT \cdot YBAR^{2}$$
$$DTH = \frac{(DN + 1) \cdot XITH \cdot E}{XL\emptyset}$$
$$DTH\emptyset D = \frac{DTH}{D}$$

5. <u>NØSE</u> H = R(1 - sin (THEATA))  $P = PCR \pm \frac{(WHS + W) G}{144}$   $\rho_{c} = RØC = 0.22 \cdot RØR \left(\frac{P}{SGR}\right)^{0.588}$   $t_{cy} = TCY = \frac{P \cdot R}{4(SGF)}$   $Z1 = \frac{RØF}{6}$ 

$$Z2 = Z2T \cdot R\emptyset C \cdot P^{3/4}$$

where,

$$Z2T = \frac{0.465 \sqrt{1 - GAMF^2} \cdot H^{1/4} \cdot R^{3/2}}{12 \cdot EF^{3/4}}$$

$$t_{fopt} = TF \emptyset PT = \left(0.75 \frac{Z2}{Z1}\right)^{4/7}$$

$$t_{copt} = TCOPT = \frac{12 \cdot Z2}{ROC} \left(\frac{4}{3} - \frac{Z1}{Z2}\right)^{3/7}$$

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$$t_{f} = TSUBF(TC) = \frac{TFTM \cdot P}{TC^{4/3}}$$

where,

$$TFTM = \frac{0.36(1 - GAMF^2)^{2/3} H^{1/3} \cdot R^2}{EF}$$

$$t_c = TSUBC(TF) = TCTM \left(\frac{P}{TF}\right)^{3/4}$$

where,

$$TCTM = \frac{0.465 \sqrt{1 - GAMF^2} + H^{1/4} R^{3/2}}{EF^{3/4}}$$

$$\mathbb{W} = \mathbb{W} \text{EIGT}(\text{TF}, \text{TC}) = Z1 \cdot \text{TF} + \frac{\text{R} \emptyset \text{C} \cdot \text{TC}}{12} + ZK$$

$$\Psi T = \Psi \cdot \frac{\pi R^2}{72} (1 - \sin (THETA))$$

$$SIGMH = \left[-PCR \neq \frac{(WHS + W)G}{144}\right] \frac{R}{4 \text{ TFUSED}}$$

where TFUSED 1s the value of  $\boldsymbol{t}_f$  chosen by the routine.

6. CØNE  

$$B = 1 - \frac{RI}{R2}$$

$$ZLAMD = \frac{\pi \cdot SINTH}{R2 \cdot B}$$

$$ZLILK = \frac{R1 + R2}{2 C \emptyset STH}$$

$$R \phi C = 0.22 \cdot R \phi R \left(\frac{PCR}{SGR}\right)^{0.588}$$

$$XNTH = \left[-PCR \mp \frac{(WHS + W) G SINTH}{144}\right] \frac{R}{C \phi STH}$$

$$XNPHI = \frac{1}{2R \cdot C \phi STH} \left[-PCR \left(R^2 + R1^2 \cdot (DPC - 1)\right) \mp \frac{G \left(R^2 - R1^2\right) (WHS + W)}{144 SINTH}\right]$$

$$XNY = \sqrt{(XNTH)^2 + (XNPHD^2 - XNTH XNPHI)}$$

$$TCY = \frac{XNYMAX}{2 \cdot SGF}$$

where XNYMAX is the largest value of XNY.

where,

~

$$ZTERM = \frac{(WHS + W) G}{144 PCR} .$$

$$ZI = ZLILK^{3} \left[ DPC + B (1 - 2 \cdot DPC) + B^{2} (DPC - 0.61600607) + \frac{B \cdot ZTERM \cdot (1 - 0.61600607 \cdot B)}{SINTH} \right] \frac{1}{2 (1 - \frac{B}{2})^{2}} + DELZ I$$

$$A = ATM\left(\frac{Z_1}{Z_2}\right)$$

where,

ere,  

$$ATM \frac{ZLAMD}{ZLILK^{3/2}} \left( \frac{2 \cdot TI \cdot T3 \cdot T4}{2 \cdot T3 - GAMF^2} \right)^{1/4}$$

$$P = PTM \left( \frac{Z1}{Z2} \right)^2 \cdot Z1$$

where,

$$PTM = \frac{32 \cdot T1}{(ZLILK)^5} \left( \frac{1 - GAMF^2}{2 \cdot T3 - GAMF^2} \right) \left( \frac{PCR}{EF} \right)$$

~

$$C1 = \frac{P \cdot ZLILK \quad R\phi F}{111.9 \quad A^2 \quad 84}$$

 $C2 = \frac{R\emptyset C}{12}$ 

$$t_{fopt} = TF @PT = \frac{4.89}{ROF} (C1)^{0.414} (C2)^{0.586}$$
  
 $t_{copt} = TC @PT = 1.156 \left(\frac{C1}{C2}\right)^{0.414}$ 

$$t_{f} = \text{TSUBF}(\text{TC}) = \frac{P \text{ ZLILK}}{18.6 (A \sqrt{\text{TC}})^{2.84}}$$

$$t_{c} = TSUBC (TF) = 0.127 \left(\frac{P ZLILK}{TF A^{2.84}}\right)^{0.704}$$

WEIGT (TF, TC) =  $\frac{R \phi F \cdot TF}{6} + \frac{R \phi C TC}{12} + ZK$ 

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.

$$WT = \frac{W (R1 + R2) (R2 - R1) \pi}{SINTH 144}$$

$$SIGMH = \frac{XNYMAX}{2 \cdot TFUSED}$$

$$SIGH = \frac{XNTHM}{2 \text{ TFUSED}}$$

 $SIGM = \frac{XNPHIM}{2 \cdot TFUSED}$ 

where TFUSED is the value of  $\boldsymbol{t}_f$  chosen by the routine.

7. CYLIND  

$$\rho_{c} = R \phi C = 0.22 (R \phi R) \left(\frac{P_{CR}}{SGR}\right)^{0.588}$$
  
 $X2 = \frac{R \phi C}{12}$   
 $X1 = \frac{X1T}{PB}$ 

where,

$$PB = \frac{(ST + 1)}{\sqrt{ST} \left(ST^{1/4} + \frac{S}{2}\right)} \left(1 + \frac{DELK2}{RC}\right)$$

$$ST = \frac{3 + S}{1 + S}$$

$$XNTH = -PCR \cdot RC$$

$$XNPHI = -\frac{PCR \cdot RC}{2} - \frac{G (DEL) (WHS + W)}{144}$$

$$XNY = [(XNTH)^2 + (XNPHI)^2 - (XNTH)(XNPHI)]^{1/2}$$

$$t_{cy} = TCY = \frac{XNY}{2 (SGF)}$$

$$t_{fopt} = TF ØPT = \frac{4.7 (X1)^{0.4} (X2)^{0.6}}{RØF}$$

$$TCOPT = 1.176 \left(\frac{X1}{X2}\right)^{0.4}$$

$$S = STM (TCUSED)^{1/2} \left[ DPC + \frac{DELKI}{RC^3} + \frac{DEL (WHS + W) G}{(RC) (144) (PCR)} \right]$$

where,

$$STM = \frac{2 22 (RC)^{1/2}}{DEL (1 - GAMF^2)^{1/4} \left(1 + \frac{DELK2}{RC}\right)}$$

$$t_{f}$$
 = TSUBF (TC) =  $\frac{\text{TFTM}}{(\text{TC})^{3/2} (\text{PB})}$ 

where,

TFTM = 
$$\frac{PCR (RC)^{3/2} (DEL) (1 - GAMF^2)^{3/4} (0.45219638)}{EF}$$

$$t_c = TSUBC (TF) = \frac{TCTM}{(TF PB)^{2/3}}$$

where,

ere,  
TCTM = 
$$0.404 \left[ \frac{PCR (RC)^{3/2} (DEL) (1.75)}{EF} \right]^{2/3} (1 - GAMF^2)^{1/2}$$

$$W = WEIGT$$
 (TF, TC) =  $\frac{R\varphi F}{6}$  +  $\frac{R\varphi C \cdot TC}{12}$  + ZK

$$WT = \frac{W \cdot RC \cdot DEL}{72}$$

$$SIGMH = \frac{XNY}{2 (TFUSED)}$$

ı.

$$SIGH = \frac{XNTH}{2 (TFUSED)}$$
$$SIGM = \frac{XNPHI}{2 (TFUSED)}$$

8. BASE

$$P = PCR + \frac{(WHS + W) G}{144}$$
$$RØC = 0 22 \cdot RØR \left(\frac{P}{SGR}\right)^{0.588}$$
$$Z_{1}^{-} = \frac{RØF}{6}$$

where

$$Z_{3}T = \frac{RT^2 (3. + GAMF)}{16 \text{ SGF}}$$

$$TE \phi PT = \sqrt{\frac{Z_3}{Z_1}}$$

$$TCUSED = \frac{Z_3}{TFUSED}$$

$$TFUSED = \frac{Z_3}{TCUSED}$$

$$W = \frac{R \emptyset C \cdot TCUSED}{12} + ZK + Z1 \cdot TFUSED$$

•

$$WT = \frac{W \cdot \pi RT^2}{144}$$

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.

# 9. TENSØN

R3 = RC - RSC

 $R2 = RN \cdot sin (THN) + RSN (cos (BETA) - cos (THN))$ 

$$XL \phi_{GB} = \log_{e} \left[ \frac{1 + \cos (BETA)}{\sin (BETA)} \right]$$
$$C1 = \frac{2 \cdot XL \phi_{GB}}{1 - (P2)^{2}}$$

$$1 - \left(\frac{R2}{R3}\right)^2$$

$$T3 = \frac{PCR \cdot R3}{C1 \cdot SIGCYF}$$

$$YCALC = \sqrt{R_3^2 + \frac{(R_2^2 - R_3^2) \cdot \log_e \left(\frac{1 + C\emptyset ST_{41}}{SINTH}\right)}{XL\emptyset GB}}$$

$$T = \frac{R_3 T_3}{YCALC}$$

$$YDYDT = - \frac{(R2^2 - R3^2)}{SINTH \cdot 2 \cdot XL \phi GB}$$

A (I) = 
$$\frac{\text{YDYDT}}{\text{SINTH}}$$
 I = 1, 2, ... 25

$$W(I) = T A (I) I = 1, 2, ... 25$$

$$\mathbb{W}TT = \frac{2\pi \cdot \mathrm{R}OF}{1728} \int_{\mathrm{BETA}}^{\pi/2} \mathbb{W}$$

.

$$AT = \frac{2\pi}{144} \int_{BETA}^{\pi/2} A$$

10. GNRLSH

$$T3 = \frac{-(PCR)(12)}{\left[-\sin(TH3G)(DTHDY3) + \frac{A\cos(TH3G)}{Y_3}\right] \text{ SIGCYF}}$$

$$XNUM = Y(J) - Y(J - 1)$$

$$DENØM = X(J) - X(J - 1)$$

$$THETA = \tan^{-1}\left(\frac{XNUM}{DENØM}\right)$$

$$SINTH = \sin(THETA)$$

$$T = \frac{T3(Y3)^{1-A}}{y(T)^{1-A}}$$

where Y3 is the last element of the Y-array.

AFUNCT (J) = 
$$\frac{Y(J)}{SINTH}$$
  
WFUNCT (J) = T AFUNCT (J)

WTG = 
$$2\pi \cdot R \emptyset F \int_{Y(1)}^{Y_3} WFUNCT$$

$$AG = 2\pi \int_{Y(1)}^{Y_3} AFUNCT$$

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$$R3 \approx 12 \cdot Y3$$

11. <u>RING</u>

$$RR = \left(\frac{RC^3 \cdot WS1}{1.7 \cdot \pi}\right)^{1/3}$$

where,

$$WS1 = \sqrt{\frac{(2\pi)(0\ 3)\cdot T3\cdot SIGCYF}{ER \cdot RC}}$$
$$TR = \sqrt{\frac{R3 \cdot T3 \cdot SIGCYF}{0.6\pi (ER)}}$$

$$WR = \frac{\pi^2 \cdot RR \cdot TR \cdot R\emptyset RG (RC - RR)}{432}$$

$$\mathbb{W}SCST = \frac{\mathbb{W}R \cdot 144}{2\pi \cdot RSC \cdot \mathbb{W}S2}$$

where,

$$WS2 = R3 \cdot TH3 + RSC (sin (TH3) - TH3 \cdot cos (TH3))$$

.

12. HØTSTR

ENC1 = XN (23.3) + XØ (24.3) + XC (35.7) + XA (15.26)  
ENC2 = XN (49 83) + XØ (52.5) + XC (100.1) + XA (30.5) ·  

$$AW = 0.001 \left[\frac{2}{3} \text{ ENC1} - \frac{1}{6} \text{ ENC2}\right]$$
  
 $BW = -\frac{10^{-6}}{9} \left[\text{ENC1} - 0.5 \text{ ENC2}\right]$ 

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$$DELTAT = \left\{ FC \quad QCI \quad \left[ 1 - \frac{(A\dot{W} \cdot TWI + BW \quad TWI)}{HG \phi RI} \right] + FR \cdot QRI \right]$$
$$- EMISS \quad \left( \frac{TWI}{1200} \right)^{4} \left\{ \frac{1}{(WSTAR) (CP)} \right\}$$

 $T \mathbb{W} 1 = T \mathbb{W} + 460$ 

WSTAR is current weight .

TW = TW + DELTAT · DELTAU

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# V. REFERENCES

- RAD, Mars-Venus Capsule Parameter Study, I, Avco/RAD TR 64-1 JPL Contract 950626 (21 March 1964).
- Homewood, R. H., A. C. Brine, and A. E., Johnson, Buckling Instability of Monocoque Shells, The Society of Experimental Stress Analysis, Paper No. 457, presented at Washington, D. C. (20 to 22 May 1959).
- Von Kloppel, K., and O. Jungbluth, Beitrag zum Durchschlag Problem dunnwandiger Kugelschalen, Der Stahlbau 22, pp. 121 through 130 (errata p. 288) Berlin, Springer (1935).
- Kaplan, A., and Y. C. Fung, A Nonlinear Theory of Bending and Buckling of Thin Elastic Shallow Spherical Shells, NACS-TN-3212 (August 1954).
- Serpico, J C., Elastic Stability of Orthotropic Conical and Cylindrical Shells Subjected to Axisymmetric Loading Conditions, AIAA Journal 1, No. 1 (1963).
- Anderson, M. S., J. C. Robinson, H. G. Bush, and R. W. Fralich, A Tension Shell Structure for Application to Entry Vehicles, NASA TN D-2675 (March 1965).
- Timoshenko, S P., and J. M. Gere, <u>Theory of Elastic Stability</u>, McGraw Hill Book Co., Second Edition (1961), pp. 313 through 318.
- Gerard, G., and H. Becker, Handbook of Structural Stability, Part III-Buckling of Curved Plates and Shells, NACA TN 3783 (August 1957).
- Weigarten, V.I., and P. Seide, Elastic Stability of Thin-Walled Cylindrical and Conical Shells Under Combined External Pressure and Axial Compression, AIAA Journal, 3, No. 5, pp. 913 through 920 (May 1965).
- Weigarten, V. I., E. F. Morgan, and P. Seide, Final Report on Development of Design Criteria for Elastic Stability of Thin Shell Structures, STL/TR-60-0000-19425 (December 1960).

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SPECIAL SUBROUTINES

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# I GENERAL PURPOSE SUBROUTINES

# A ARTLU

1 Purpose

The purpose of subroutine ARTLU is to perform a linear interpolation within  $N \leq 10$  dependent variable tables Y1TBL, Y2TBL, , corresponding to a monotonically increasing independent variable table XTBL.

### 2. Calling Sequence

| N<br>X | number of dependent variable tables ( $N \le 10$ ).<br>independent argument (X must not be larger than the last<br>element of XTBL). |
|--------|--------------------------------------------------------------------------------------------------------------------------------------|
| XTBL   | table of independent variable (maximum of 1000 elements).                                                                            |
| Yl     | dependent argument.                                                                                                                  |
| YITBL  | table of dependent variable, with elements corresponding to those in XTBL.                                                           |
| Y2     | dependent argument.                                                                                                                  |
| Y2TBL  | table of dependent variable, with elements corresponding to those in XTBL.                                                           |

### 3 Method

Within the DO 11 loop the index I is increased until XTBL(I), the last value of XTBL smaller than the argument X has been found  $\mathcal{P}$  is then defined as (X-XTBL(I)) /(XTBL(I+1)-XTBL(I)). The computed G $\mathcal{O}$  T $\mathcal{O}$  ensures that N values of the dependent variable will be computed between Statements N and 1 For each i,  $1 \leq i \leq N$ ,

 $Yi = YiTBL(I) + P * (YiTBL(I+1) - Y_1TBL(I)).$ 

If X is smaller than the first element of XTBL, automatic linear extrapolation is performed from the first two elements of the tables. If X is larger than the last element of XTBL an unpredictable error will result, although a value of I > 1000 would produce an error message written according to F $\phi$ RMAT Statement 30.

# B. AR2TLU

### 1. Purpose

The purpose of Subroutine AR2TLU is to perform an interpolation within a two-dimensional table ZTBL the elements of which correspond to the entries in two one-dimensional monotonically increasing tables XTBL and YTBL.

2 Calling Sequence

| NX   | number of values in XTBL.                             |
|------|-------------------------------------------------------|
| NY   | number of values in YTBL.                             |
| x    | independent argument.                                 |
| XTBL | table of independent variable.                        |
| Y    | independent argument                                  |
| YTBL | table of independent variable                         |
| Z    | dependent argument                                    |
| ZTBL | table of dependent variable (with dimension (NX, NY)) |

### 3 Method

The DØ 5 loop searches XTBL for XTBL(I), the first element greater than or equal to X If there is no such XTBL(I), an error message 1s written, ICHK is set to 1, and a return to the calling routine is executed

Similarly, the DØ 15 loop searches YTBL for YTBL(J), the first element greater than or equal to Y If there is no such YTBL(J), an error message is written, ICHK is set to 1, and a return to the calling routine is executed

If there is no error return, Z is computed starting at Statement 20 according to the following formula:

where,

Pl = (X - XTBL(I-1))/(XTBL(I) - XTBL(I-1)) P2 = (Y - YTBL(J-1))/(YTBL(J) - YTBL(J-1)) P3 = P1 \* P2.

Return is then made to the calling routine

# C. ARSIMP

### 1 Purpose

The purpose of Subroutine ARSIMP is to integrate by Simpson's Rule an array YARRAY of N points tabulated at an equally-spaced interval of the independent variable.

### 2 Method

The calling sequence is

CALL ARSIMP (N, DELTAX, YARRAY, ANSWER)

where,

| N      | number of points to be integrated (N must be odd )     |
|--------|--------------------------------------------------------|
| DELTAX | interval of independent variable at which array points |
|        | were tabulated                                         |
| YARRAY | array of points to be integrated                       |
| ANSWER | result of integration                                  |

The Simpson's Rule algorithm is applied in a  $D\emptyset$  loop

# D. ADAMS4

#### 1 Purpose

The purpose of Subroutine ADAMS4 is to integrate a set of N first order differential equations by a predictor-corrector method

2 Method

ADAMS4 is a slightly modified version of Subroutine ADM4RK The differences between the two routines are as follows:

a. The calling sequence for ADAMS4 is

CALL ADAMS4 (NZ, ZDEL, VALUE, DERN, UPBND, DNBND, FACTØR, FREQ, HLIMIT, LZ, ZXINDE, DELMIT, DEREQ, PAR, NPAR)

All but the last three arguments are defined identically as those in ADM4RK The arguments DEREQ, PAR, and NPAR were

added to the list They have the following meanings

- DEREQ name of subroutine defining derivatives (The name can now be arbitrary but must appear in an external statement in the calling program )
- PAR array of parameters appearing in the derivative calculations (In ADM4RK, information is generally transmitted to DEREQ through CØMMØN )
- NPAR number of elements in the array PAR
- b. Within ADAMS4 the calling sequence for DEREQ is

CALL DEREQ (NZ, VALUE, XINDEP, DERN, LZ, PAR, NPAR)

The three elements added to the list NZ, PAR, and NPAR, have the same meaning here as in the ADAMS4 calling sequence.

c After the 3 CALL DEREQ statements within ADAMS4, the controlling parameter L is tested in an IF statement. If  $L \ge 6$ , immediate return is made to the calling program This allows L to be reset within DEREQ to indicate an error condition which the main program may act upon

The original writeup of ADM4RK has been included in this section of the manual.

# E. ADM4RK<sup>1</sup>

### 1. Purpose

To allow integration of N differential equations by a predictor-corrector method which will alter the delta of integration so that the required accuracy is maintained.

<sup>&</sup>lt;sup>1</sup> Sova, C., Avco Programmer's Handbook, No. F2-70, IBM 7094 (11 March 1965)

2. Usage

CALL ADM4RK (N, DEL, VALUE, DERN, UPBND, DNBND, FACTØR, FREQ, HLIMIT, L, XINDEP, DELMIT)

- where,
- N The number of equations to be integrated.
- DEL The delta of integration.
- VALUE The array of N integrated values.
- DERN The array of N derivative values.
- FREQ The value which indicates the interval at which the user would like to return to the calling program
- HLIMIT The value which specifies the upper limit of integration When this value is reached, return is made to the calling program.
- L: The control parameter:
  - = 1 Indicates initial pass. Must be set by user who desires FREQ and HLIMIT testing.
  - = 2 Indicates that a FREQ interval has been reached.
  - = 3 Indicates that HLIMIT has been reached.
  - = 4 Indicates that HLIMIT and FREQ interval has been reached, simultaneously.
  - = -5 Indicates that return to the calling program is to be made after each successful integration step. This will be set to +5 during the initial pass. No tests are made for FREQ or HLIMIT.
  - = 6 Indicates that the integration interval is less than DELMIT.

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- 5 -

- XINDEP The value of the independent variable.
- UPBND The upper bound on the absolute difference that is allowed between the extrapolated and interpolated values. If this bound is exceeded by this difference, the delta of integration is reduced and integration is retried.
- DNBND The lower bound on the absolute difference between the extrapolated and interpolated values. If this bound exceeds this difference, the delta of integration is increased and integration is carried on.
- FACTØR. The percentage by which the delta of integration is increased or decreased in the above. This must be less than 1.
- DELMIT The value below which we do not wish to reduce the delta of integration. If this is not specified (i.e., = 0), it will be set to the initially specified delta of integration divided by 1000.0.

In addition, the user must supply a subroutine having the following specifications:

a. Calling sequence CALL DEREQ (A, B, C, I)

where,

- A The array of N integrated values
- B The value of the independent variable
- C The array of N derivative values
- I Corresponds to L in the explanation above.
- b. Use

This routine should evaluate the N differential equations given the N integrated values at the value of the independent variable B  $\,$ 

c. Restriction

The values of the integrated variables, if used in this routine should be picked up from the argument A and B above only and not from XINDEP and VALUE which were previously defined. Also nothing should be stored into A and B.

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3. Sample of Use

Given:  $\frac{d^2 y}{dx^2} = x$  where  $y_0 = 0$ ,  $\frac{dy_0}{dx} = 0$ 

evaluate y from 0 to x = 100 and print the values of y at x = 0, 2, 4, 6, ...100. Starting with an initial  $\Delta x$  of 0.005 and increase or decrease the  $\Delta x$ by 30 percent if the difference between the extrapolated and interpolated values do not fall between certain given bounds.

DEREQ (D, X, LT, L) DIMENSION D(7), DT (8). DT(1) = D(2)DT(2) = xRETURN END DIMENSION D (2), DT (2), UPBND (2), DNBND (2) L = l or L = -5DELTAX = 0.005X = 0.0D(1) = 0.0D(2) = 0.0UPBND (1) = 1.0E - 5DNBND (1) = 1.0E - 6UPBND (2) = 0.5E - 5DNBND (2) = 0.5E - 6

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1 CONTINUE

CALL ADM4RK (2, DELTAX= D= DT= UPBND= 0.3, 2.0, 100.0, L, X, 1.0E-7)

WRITE ØUTPUT TAPE 5, 2, X, D (1)

2 FØRMAT (1P2E20.5)

GØ TØ (1, 1, 3, 3, 4, 5), L

- 3 STØP 77777
- 4 IF (X 100.0) 1, 3, 3
- 5 CALL MESSAG (24H DEL X IS  $T\phi\phi$  SMALL, 3)

STØP 77776 END

- F. PØLRØT
  - 1. Purpose

The purpose of Subroutine PØLRØT is to calculate the roots of a polynomial

2. Method

The calling sequence is

CALL PØLRØT (N, A, R, C)

- degree of polynomial. Maximum of 20 Ν
- coefficients of polynomial (Note that A(1) is the А coefficient of  $X^n$  )
- roots of polynomial R is dimensioned (2, N) where R(1, J) R is the real, R(2, J) is the imaginary part of the J<sup>th</sup> root convergence factor, (C =  $10^{-5}$  is satisfactory in most cases )
- С

Newton-Raphson iteration is used Therefore, if f(x) is the polynomial and if f' (r)  $\rightarrow 0$ , the method will not converge. Moreover, the constant term of the polynomial cannot be 0.

(PØLRØT calls PØLRT1 )

# G. CØMDIV

1. Purpose

The purpose of Subroutine C $\emptyset$ MDIV is to evaluate E +  $\iota$ F = (A + $\iota$ B)/(C +  $\iota$ D) when A, B, C, D are given

,

2. Method

The calling sequence is

CALL CØMDIV (A, B, C, D, E, F)

The routine calculates

G = C \* C + D \* D E = (A \* C + B \* D)/GF = (B \* C - A \* D)/G

### H. ATANQR

1 Purpose

The purpose of function ATANQR(W, H) is to calculate the arctangent of W/H where W and H are floating point numbers, and to return the result either in radians or degrees The convention to be observed is that

0 
$$\leq$$
 AT ANQR (W, H)  $< \begin{cases} 2 \pi \\ 360 \text{ degrees} \end{cases}$ 

2. Method

ATANQR is a multiple entry function with entry points ATANQ and ATANQD  $% \left( {{{\rm{ATANQ}}}} \right)$ 

If ATANQR (W, H) or ATANQ (W, H) is referenced, D is set to 1, and X is defined as ATAN2(W, H), where ATAN2 is the FØRTRAN IV library function IF X < 0, it is reset to X + 2  $\pi$  Then ATANQR is defined as X/D.

If ATANQD(W, H) is referenced, D is set to 0 017453293, and the remaining computations are carried out as before.

### I ASINR

### 1 Purpose

The purpose of function ASINR(W) is to calculate the arc-sine of a floating point number W and to return the result either in radians or degrees. The convention to be observed is

$$0 \leq \text{ASINR (W)} \leq \begin{cases} \pi/2 \\ 90 \text{ degrees} \end{cases}$$

or,

$$\begin{cases} 3\pi/2 \\ 270 \text{ degrees} \end{cases} \leq \text{ASINR(W)} \leq \begin{cases} 2\pi \\ 360 \text{ degrees} \end{cases}$$

2. Method

ASINR is a multiple entry function with entry points ASIN and ASIND.

If ASINR(W) or ASIN(W) is referenced, D is set to 1., WS is defined as 1 - W \* W, and ASINR is computed as

ASINR = ATANQR (W, SQRT(WS))/D

If ASIND(W) is referenced, D is set to 0 017453293, and the remaining computations are carried out as before

- J. ACØSR
  - 1. Purpose

The purpose of function ACOSR(W) is to calculate the arc-cosine of a floating point number W and to return the result either in radians or degrees The convention to be observed is

 $0 \leq AC\phi SR(W) \leq \begin{cases} \pi \\ 180 \text{ degrees} \end{cases}$ 

2 Method

AC $\phi$ SR 1s a multiple entry function with entry points AC $\phi$ S and AC $\phi$ SD

If  $AC\phi SR(W)$  or  $AC\phi S(W)$  is referenced, D is set to 1 , WS is defined as 1 - W \* W, and  $AC\phi SR$  is computed as

 $AC\phi SR = ATANQR (SQRT(WS), W)/D$ 

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If ACØSD(W) is referenced, D is set to 0 017453293, and the remaining computations are carried out as before

# K. AICRT3<sup>1</sup>

# 1. Purpose

AICRT3 is a general-purpose subroutine for the displaying of output data in graphical form

# 2. Method

From the user's viewpoint, the version of AICRT3 to be used with  $F \phi RTRAN$  IV programs operates in the same manner as the

FORTRAN II version Therefore, although no new writeup was issued for FORTRAN IV, the following original writeup still described the subroutine usage, if the reader makes allowances for the standard differences between the two systems 9 (e.g., FORTRAN IV arrays being stored forward in core):

- a. Log x Log
- b. Log x Linear
- c. Linear x Log
- d. Linear x Linear.

Along with these types of graphs, AICRT3 has the ability of plotting multifunction graphs. If this feature of the code is used, one must obtain separately the upper and lower limits of the functions. One must then supply the upper and lower limits to the subroutine by use of the override feature, or first plot the curve which has both the maximum value of all functions being plotted and also the minimum value of all functions. If the override feature is used, the arguments supplied are unaltered. If the override feature is not used, the upper and lower limits are determined by the code and returned to the user via the arguments. Therefore, the programmer must not place a variable or constant for said arguments that are to be used again at their original values, since they will be changed by this subroutine. The override feature also will give the user the ability for a standard size grid for multiple case plotting.

<sup>1</sup> Hoffman, M, General Code for Display of Digital Data, Applied Mathematics, Atomic International, Naa, Inc., Canoga Park, California(8January 1963), published and distributed under bylaws of UAIDE

3. Üse

The method one uses to obtain the above named plot is as follows:

a. On the EDPM Job Request, deck set up instructions; request subject deck first before data

b. In your program deck for each plot, use the following calling sequence:

CALL AICRT 3 (KX, KY, X, Y, NP, ND, NV, NS, NC, T, A,  $\phi$ , NF, NG, DCX, DCY, NX $\phi$ , XL, XU, NY $\phi$ , YL, YU) \*

c. This routine should not be used to plot a point at a time.

# 4 Input Data Description

The inputs for this program are the arguments of the calling sequence in Section 5. They are as follows:

| КX | 0 for linear display in X<br>l for log display in X                                                         |
|----|-------------------------------------------------------------------------------------------------------------|
| КҮ | 0 for linear display in Y<br>l for log display in Y                                                         |
| х  | First location of storage for values of X                                                                   |
| Y  | First location of storage for values of Y                                                                   |
| NP | Number of points in X and Y array to be plotted                                                             |
| ND | Interval at which points will be displayed, e.g.,<br>every point = 1, every 10th point = 10                 |
| NV | 2 if one wishes to join points plotted with a straight line l if not $% \mathcal{L}_{\mathcal{L}}^{(n)}(x)$ |

\* The arguments for this calling sequence will be explained in the next section

| NS       | 2 if the data is to be sorted as a function of X<br>1 if the data is not to be sorted (This is to enable the<br>connecting of points by vectors.)                               |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NC       | Character representation of point to be plotted                                                                                                                                 |
| T**      | A nine word title to be displayed at the top of the graph                                                                                                                       |
| A**      | A nine word abscissa title                                                                                                                                                      |
| Ø**      | A nine word ordinate title                                                                                                                                                      |
| NF       | l 1f new frame 1s required<br>2 1f overlay 1s required                                                                                                                          |
| NG       | l non-log labeling determined by code<br>If any X meets the following condition,                                                                                                |
|          | $ X  \ge 10^{6}$<br>or if all X are in the range $-10^{5} < X < 10^{5}$ the<br>labeling would automatically be E-label notation.<br>-2 non-log labeling always E-label notation |
| DCX, DCY | Governs the coarseness of the X and Y linear meshes.<br>(See Section V - Special Features.)                                                                                     |
| NXØ      | 2 override search for X-upper and X-lower.<br>l let routine determine-X-upper and X-lower (See section<br>E - Special Features.)                                                |
| XL       | X-lower, if needed (NX $\phi$ = 2)                                                                                                                                              |
| XU       | X-upper, if needed (NX $\phi$ = 2)                                                                                                                                              |
| NYØ      | 2 override search for Y-upper and Y-lower<br>l let routine determine Y-upper and Y-lower                                                                                        |
| YL       | Y-lower, if needed (NY $\phi$ = 2)                                                                                                                                              |
| YU       | Y-upper, if needed (NY $\phi$ = 2).                                                                                                                                             |

\*\*Must be stored in FORTRAN order (backwards in core) or read into core using the A conversion

.

### 5. Special Features

It should be noted that 16.0 is the recommended value for DCX and DCY. If it is necessary to have more grid lines, all one has to do is decrease the value of DCX and DCY. If one wants fewer lines, increase the value of DCX and DCY. Another note of special interest is that the entire array of X and Y that are being plotted must be in core at the time of execution of this routine.

The feature of sorting the functions before plotting has one drawback; viz., after the functions have been sorted, the original order is totally destroyed. This feature should not be used unless the plotting of the data is the last function of the code or order of the data is of no importance.

If (XU/XL - 1) < 0.0001, or if XU = XL = 0, no graph will be drawn as the function is or is almost constant (similarly for YU and YL).

The titles used should be centered in the 48-character array to ensure centering of the titles on the graph. The abscissa and ordinate title can be as large as 54 characters.

If one uses the upper and lower limit search provided by AICRT3, care should be exercised in the definition of the variable or constant used for XL, XU, YL, or YU as they will be changed by the subroutine.

NG is used to permit a floating point notation labeling of linear plots. This is provided because the maximum fixed point number that can be used is 999999, and the smallest greater than zero 0.000001, similarly for negative values. To provide meaningful labeling of data outside this range, the floating point notation has been made available.

A very important factor is assigning X and Y arguments is to make sure you only have a singly subscripted array for each.

The limit of the number of cycles in log plotting is 10. Do not try to plot more than a  $10 \times 10 \log x \log plot$ .

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