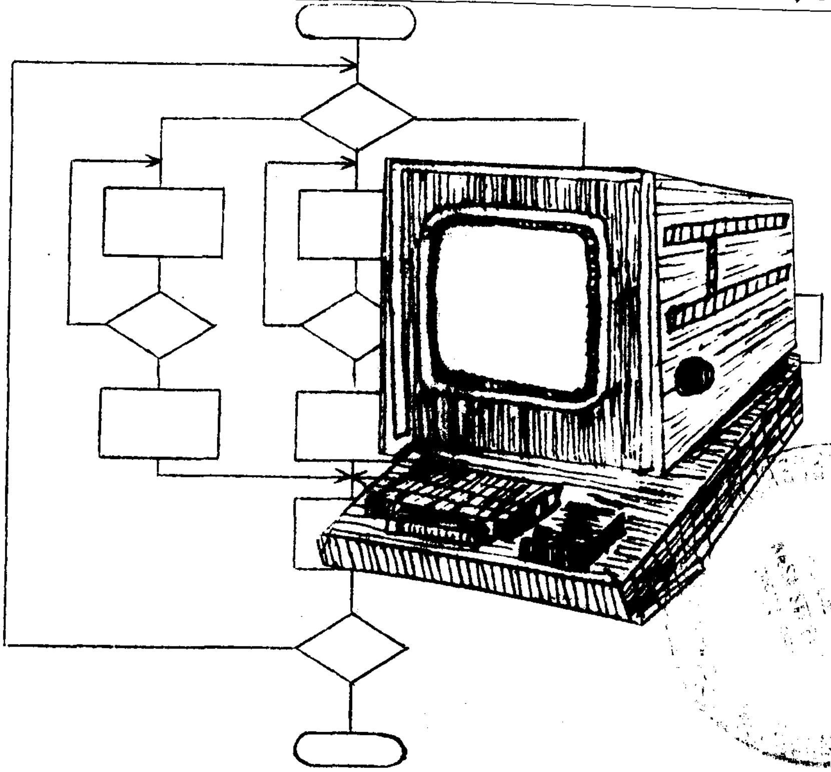
This cover is correct. Title of next page (Dynasor II ...... is correct & goes with this cover. JW

NASA

Automatic System for Computer Program Documentation

VOLUME 2



TEXAS A&M UNIVERSITY

DECEMBER 1972

DYNASOR II - A FINITE ELEMENT PROGRAM FOR THE DYNAMIC NONLINEAR ANALYSIS OF SHELLS OF REVOLUTION

Joe R. Tillerson and Walter E. Haisler

USER MANUAL

October 15, 1970

TEES-RPT-70-19

Texas A&M University

College Station, Texas

II

Volume I - N73-22129
CR-130231

APPENDIX J

SAMPLE DOCUMENTED PROGRAM

I

ABSTRACT

The DYNASOR II program is used for the DYnamic Nonlinear Analysis of Shells Of Revolution. The equations of motion of the shell are solved using Houbolt's numerical procedure. The displacements and stress resultants can be determined for both symmetrical and asymmetrical loading conditions. Asymmetrical dynamic buckling can be investigated. Solutions can be obtained for highly nonlinear problems utilizing as many as five of the harmonics generated by SAMMSOR program. A restart capability allows the user to restart the program at a specified time.

October 1972

ACKNOWLEDGEMENTS

This research was supported under Sandia Contract 82-3683, Sandia Corporation, Albuquerque, New Mexico, and NASA Grant NGL-44-001-044, Manned Spacecraft Center, Houston, Texas. Appreciation is expressed to Dr. Walter Von Riesemann of Sandia and Dr. Fred Stebbins of the Manned Spacecraft Center who served technical monitors for this research effort.

Appreciation is also expressed to the principal investigator for the research grants, Dr. James A. Stricklin, Professor, Aerospace Engineering Department, Texas A&M University, for his supervision and guidance in the development of this program.

TABLE OF CONTENTS

System Overview

J-1.5

October 1972

SOR - Shell Of Revolution

Computer Programs

A family of compatible computer codes for the analysis of the shell of revolution (SOR) structures has been developed by researchers at Texas A&M University. These analyses employ the matrix displacement method of structural analysis utilizing a curved shell element. Geometrically nonlinear static and dynamic analyses can be conducted using these codes. The important natural frequencies and mode shapes can also be determined by employing another of the codes. Efficient programming provides codes capable of performing these desired analyses in relatively small amounts of computer time.

Each of these programs has been extensively tested using problems the solutions to which have been reported by other researchers in order to establish the validity of the codes. In addition, the capabilities of the codes have been demonstrated in a number of publications by presenting solutions to problems which were unsolved by other researchers.

SAMMSOR II - Stiffness And Mass Matrices for Shells Of Revolution are generated utilizing the first member of this family. This program accepts a description of the structure in terms of the coordinates and slopes of the nodes and the properties of the elements joining the nodes. For shells with simple geometries (such as cylinders, shallow caps, hemispheres, etc.) the shell geometry can be internally generated. Utilizing the element properties, the structural stiffness and mass matrices are generated for as many as twenty harmonics and stored on magnetic tape. Each of the other SOR programs utilizes the output tape generated by SAMMSOR as input data for the respective analyses. One advantage of creating the stiffness and mass matrices in a separate program is that a variety of analyses can be performed on the same shell configuration without having to create the matrices more than once. Obviously, a variety of boundary and loading conditiions can be employed without having to create new mass and stiffness matrices for each case.

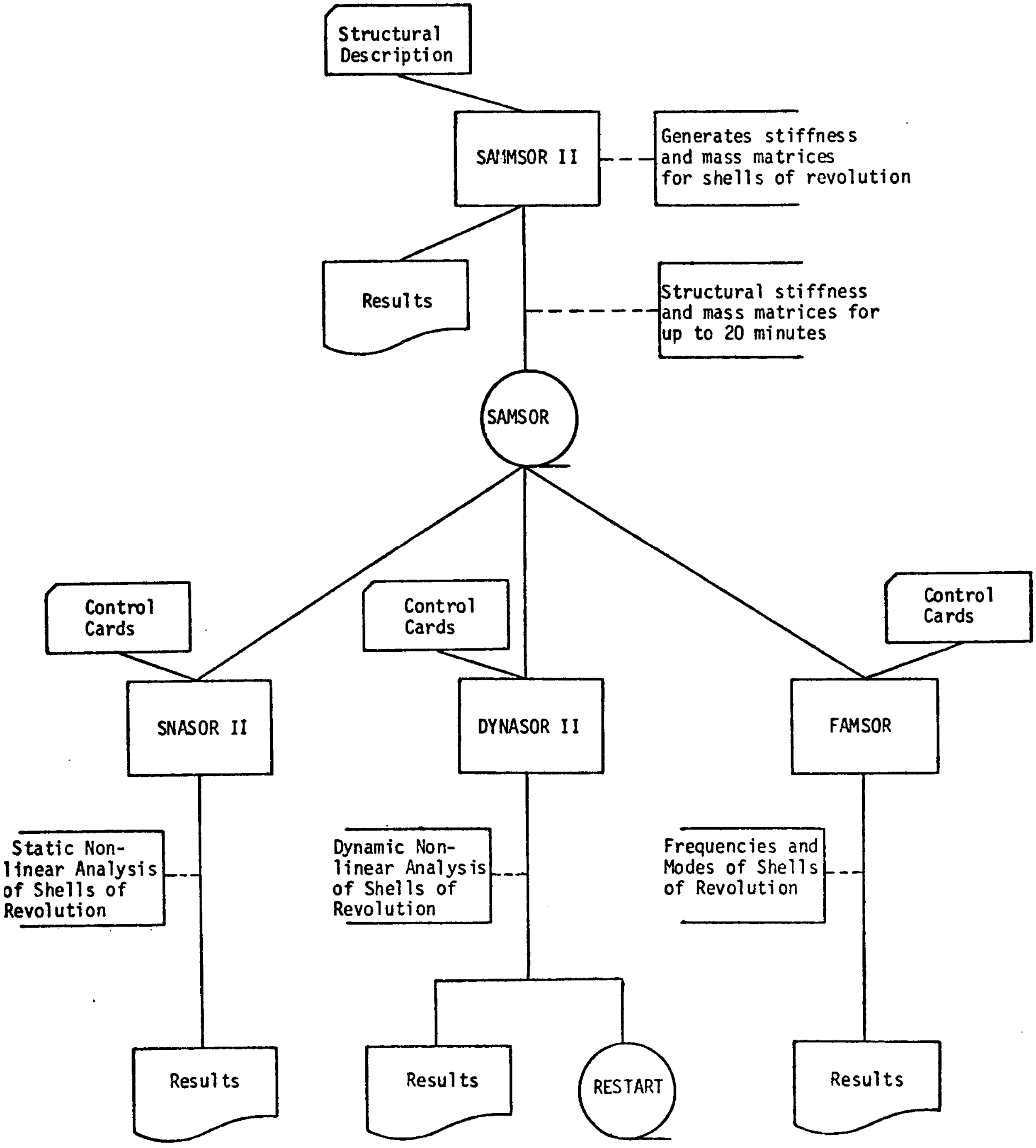
SNASOR II - The Static Nonlinear analysis of Shells Of Revolution subjected to arbitrary mechanical and thermal loading is performed using the second computer code. Utilizing the stiffness matrices generated by SAMMSOR and the loading conditions and boundary conditions input to SNASOR II, the equilibrium equations for the structure are generated. The nonlinear strain energy terms result in pseudo generalized forces (as functions of the displacements) which are combined with the applied generalized forces. The resulting set of nonlinear algebraic equilibrium equations is solved by one of several methods: Newton-Raphson

type iteration, incremental stiffness method, or a modified incremental stiffness method. In general, the Newton-Raphson procedure is the best and yields accurate results for highly nonlinear problems.

DYNASOR II - The third code is used for the DYnamic Nonlinear Analysis of Shells Of Revolution. The equations of motion of the shell are solved using Houbolt's numerical procedure with the nonlinear terms being moved to the right-hand side of the equilibrium equations and again treated as generalized loads. The displacements and stress resultants can be determined for both symmetrical and asymmetrical loading conditions. Asymmetrical dynamic buckling can be investigated using this program. Solutions can be obtained for highly nonlinear problems in reasonable periods of time on the computer utilizing as many as five of the harmonics generated in SAMMSOR. A restart capability is incorporated in this code which allows the user to restart the program at a specified time without having to expend the computer time necessary to regenerate the prior response.

FAMSOR - Frequencies And Modes for Shells Of Revolution can be determined using the fourth code. Using the stiffness matrix generated by SAMMSOR and a lumped mass representation developed from the consistent mass matrix generated by SAMMSOR, a specified number of natural frequencies (beginning with the lowest or fundamental frequency) are obtained using the inverse iteration method. The mode shapes for each of the frequencies are also obtained.

SYSTEM FLOWCHART


Structural Description
SAMMSOR II
Generates stiffness and mass matrices for shells of revolution
Results
Structural stiffness and mass matrices for up to 20 minutes
SAMSOR
Control Cards
Control Cards
Control Cards
SNASOR II
DYNASOR II
FAMSOR
Static Non-linear Analysis of Shells of Revolution
Dynamic Non-linear Analysis of Shells of Revolution
Frequencies and Modes of Shells of Revolution
Results
Results
RESTART
Results

ENVIRONMENT

The DYNASOR II program runs under OS/360 MFT or MVT and requires 220K of memory on an IBM S/360 computer. The system must also have a card reader, printer, 3 9-track tape drives and 2314 disk storage.

October 1972

INTRODUCTION

The DYNASOR II (DYnamic Nonlinear Analysis of Shells Of Revolution) code has been developed to determine the time varying response of shells of revolution to a variety of loading conditions. The code utiilizes the stiffness and mass matrices created by the SAMMSOR code for selected harmonics, generates generalized forces from a mechanical and thermal load history, and solves the resulting initial value problem. This report is a user's guide for the DYNASOR II code and is divided into four self-contained sections with an extended appendix.

The first section describes the method of analysis used to obtain the displacements, stresses, and stress resultants for the desired time increments. The formulation of the equations of motion is presented along with the numerical technique employed to obtain the solution these equations.

A section is then presented to enumerate the limitations of the code and to provide valuable guidelines to aid the user in performing the desired analyses. The limitations result partly from the procedures utilized in the method of analysis and partly from the storage capacity and programming procedures employed.

A description of the input data required by the DYNASOR II code is presented in the third section. Examples are provided in instances where the wording might, at first glance, appear to be unclear or insufficient. The limitations placed upon the input parameters are once again enumerated.

The final section contains selected example problems which are designed to illustrate the wide variety of input variations allowed by the code. A copy of the input data required for each of the cases is presented along with selected values of the output data. A thorough understanding of these example problems is mandatory if the user is to become adept at operating the code.

The extended appendix which follows the main report should prove to be extremely helpful if a thorough understanding of the program is desired. A description of the subroutines and the significant Fortran variables is supported by the presence of the subroutine call map and a flow chart of the basic operations of the code. The sections describing the restart capability and the specification of the loads should prove invaluable to users who desire to obtain optimum performance from the code. A discussion of the program output is then followed by a description of the changes necessary to modify the capacity of the code.

October 1972

SECTION I

METHOD OF ANALYSIS

Introduction

The purpose of this section is to provide theoretical documentation of the equations and procedures employed in the DYNASOR II code to perform the DYnamic Nonlinear Analysis of Shells Of Revolution. The matrix displacement method of a structural analysis is utilized. Since the documentation for the development of the stiffness and mass matrices has been adequately presented in the SAMMSOR II user's manual,[1] this section will not attempt to duplicate the previous presentation. The dynamic equations of motion are derived and the numerical techniques utilized to effect the solution of these equations are discussed.

Equations of Motion

The matrix displacement method is an energy formulation and, consequently, the equations of equilibrium for the nonlinear dynamic response are obtained from Lagrange's equation:

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_i^n}\right) + \frac{\partial U}{\partial q_i^n} = Q_i^n \tag{1}$$

where

q_i^n = generalized degree of freedom i of harmonic n

T = kinetic energy

U = internal energy (2)

Q_i^n = generalized force for degree of freedom i of harmonic n

Since the internal energy of a structure is a scalar quantity, the expression for this quantity may be separated into various parts. The formulation used in this analysis considers the internal energy as

$$U = U_L + U_{NL} - (U_L^t + U_{NL}^t) \qquad (3)$$

where the superscript, t, denotes the inclusion of thermal effects and

U_L = strain energy based upon linear strain displacement relations

U_{NL} = strain energy due to the inclusion of nonlinear contributions in the strain displacement relations

By substituting Eq. 3 into Eq. 1 and taking the nonlinear strain energy terms to the right-hand side, the equations of motion for the nonlinear dynamic analysis of shells of revolution can be written in matrix form as

$$[M^n]\{q^n\} + [K^n]\{q^n\} = \{Q^n\} + \{Q_t^n\} - \{\frac{\partial U_{NL}}{\partial q^n}\} + \{\frac{\partial U_{NL}^t}{\partial q^n}\} \qquad (4)$$

The column matrix, $\{Q_t^n\}$, of pseudo linear thermal loads is evaluated exactly from $\{\partial U_L^t/\partial q^n\}$. it should be noted that Eq. 4 is valid for any harmonic n with the coupling between the harmonics appearing on the right-hand side. In this formulation the nonlinear terms are treated as pseudo generalized forces which are applied to the structure. The obvious advantage of this formulation is that a tremendous savings in computer time can be realized since the stiffness matrix does not change as the displacements vary and must, therefore, be calculated only once. With most other formulations for geometric nonlinearities, the stiffness matrix must be updated at each time step.

Strain Displacement Relations

The DYNASOR II code utilizes the strain displacement equations given by Novozhilov[2] as restricted to shells of revolution with the additional assumption being made that the only important nonlinear contributions arise from rotations about the shell coordinate axes. The midsurface strain expressions can then be written as

$$\varepsilon_s = \hat{e}_s + \frac{1}{2}\hat{e}_{13}^{\,2}$$

$$\varepsilon_\theta = \hat{e} + \frac{1}{2}\hat{e}_{23}^{\,2} \qquad (5)$$

$$\varepsilon_{s\theta} = \hat{e}_{s\theta} + \hat{e}_{13}\hat{e}_{23}$$

The changes in curvature are those used in linear theory

$$\chi_s = -\,\partial\hat{e}_{13}/\partial s$$

$$\chi_\theta = -(1/r)(\partial\hat{e}_{23}/\partial\theta) - (1/r)\sin\phi\ \hat{e}_{13} \qquad (7)$$

$$\chi_{s\theta} = -(1/r)(\partial\hat{e}_{13}/\partial\theta) + (\sin\phi/r)\hat{e}_{23} - \partial\hat{e}_{23}/\partial s$$

Pseudo Nonlinear Forces

The nonlinear terms in this analysis are treated in the same way as the generalized forces due to external loading. The generalized forces due to the nonlinearites are evaluated for each element and are then combined at the nodes. A detailed presentation of the procedures utilized in calculating the nonlinear forces has been made in Ref.3 with an overview of the same material being provided in Ref. 4.

The pseudo forces are obtained by retaining strain energy terms containing the rotations raised to the fourth power. The retention of the fourth order terms has been shown[5] to be absolutely essential in cases where the nonlinear terms are substantial. The results presented in Ref. 6 for static shell analysis did not include the effects of the fourth order terms but results obtained after the incorporation of these terms revealed once again the necessity of retaining these contributions.

The generalized forces due to nonlinearities are evaluated using linear displacement functions in the variables u, v, and w and employing strip integration over the length of the element. The integrals around the circumference are evaluated in closed form for the particular harmonics chosen. This procedure is simpler than the one employed in Ref. 6 and permits the nonlinear forces to be evaluated without the use of secondary storage on the computer. Detailed justification for this simplified procedure has been made in Ref. 3 so these arguments will not be enumerated again. It will suffice to note that due to the exact evaluation of the integrals in the circumferential direction, it is reasonable to expect rapid convergence as the number of harmonics is increased. Examples have shown (Ref. 3) that the use of the strip integration over the length of the element produces convergence quite rapidly as the number of elements is increased.

Thermal Terms

The temperature distribution and the temperature gradients in the normal direction for an element are expanded in a Fourier series in a manner similar to that used for the displacement functions. The temperatures and temperature gradients for an element are assumed constant over each element in the meridional direction with step variationns allowed in the circumferential direction. In cases where the step variation in the circumferential direction is not considered accurate enough, the Fourier coefficients may be specified as input information.

The linear and nonlinear contributions are separated with the linear thermal loads for each harmonic being evaluated as

$$\{Q_t^n\} = \{\frac{\partial U_L^t}{\partial q^n}\} \qquad (8)$$

Employing a coordinate transformation to change to partial derivatives with respect to the generalized shell coordinates, the problem reduces to the evaluation of the partial derivatives of U_L^t with respect to the coefficients $\alpha_1, \alpha_2, \cdots \alpha_8$. These partial derivatives are presented in Eqs. 26 of Ref. 3, and the terms of $\{Q_t^n\}$ are listed in the appendix of the same report.

The nonlinear thermal loads are treated in essentially the same manner as the generalized forces due to nonlinearities are treated. Utilizing the same approximations as for the nonlinearities due to applied forces, the expression for the nonlinear thermal contribution is given by Eq. 28 of Ref. 3.

Stress Resultants

In this code, the stress resultants are determined by the use of the assumed displacement functions and finite difference relations at the mid-point of each element.

For orthotropic shells the stress resultants may be written as

$$\begin{Bmatrix} N_s \\ N_\theta \\ N_{s\theta} \\ M_s \\ M_\theta \\ M_{s\theta} \end{Bmatrix} = \begin{bmatrix} C_1 & \nu_{s\theta}C_1 & 0 & 0 & 0 & 0 \\ \nu_{\theta s}C_2 & C_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & G_1 & 0 & 0 & 0 \\ 0 & 0 & 0 & D_1 & \nu_{s\theta}D_1 & 0 \\ 0 & 0 & 0 & \nu_{\theta s}D_2 & D_2 & 0 \\ 0 & 0 & 0 & 0 & 0 & G_2 \end{bmatrix} \begin{Bmatrix} \varepsilon_s \\ \varepsilon_\theta \\ \varepsilon_{s\theta} \\ \chi_s \\ \chi_\theta \\ \chi_{s\theta} \end{Bmatrix}$$

where

$$\begin{aligned} C_1 &= E_s t/(1-\nu_{s\theta}\nu_{\theta s}) & C_2 &= E_\theta t/(1-\nu_{s\theta}\nu_{\theta s}) \\ G_1 &= Gt & G_2 &= Gt^3/12 \qquad (10) \\ D_1 &= E_s t^3/[12(1-\nu_{s\theta}\nu_{\theta s})] & D_2 &= E_\theta t^3/[12(1-\nu_{s\theta}\nu_{\theta s})] \end{aligned}$$

The shear resultants are determined approximately from the equations ofthe undeformed shell as

$$Q_s = \frac{1}{r}\left[\frac{\partial}{\partial s}(rM_s) + \frac{\partial M_{s\theta}}{\partial s} - M_\theta \sin\phi\right]$$

$$Q = \frac{1}{r}\left[\frac{\partial}{\partial s}(rM_s) + \frac{\partial M_\theta}{\partial \theta} + M_{s\theta} \sin\phi\right] \qquad (11)$$

Numerical Solution of Equations of Motion

Since a closed-form solution of Eq. 4 is generally not available, a numerical method must be used to determine the solution to the equations of motion. A finite difference procedure developed by Houbolt (Ref. 7) has been selected for use in the DYNASOR II code.

The equations of motion, Eq. 4, can be reduced to a system of equations of the form

$$[M]\{\ddot{q}\} + [K]\{q\} = \{F(t,q)\} \qquad (12)$$

The load matrix{F(t,q)} is equivalent to the right-hand side of Eq. 4. The initial displacements and velocities of the nodes must be specified and can be written as

$$q_0 = \{q\}_0 \qquad (13)$$

$$\dot{q}_0 = \{\dot{q}\}_0$$

Utilizing the Houbolt procedure, the accelerations of the nodes of the shell are approximated by a third-order backwards difference expression

$$\{\ddot{q}_{n+1}\} = \frac{1}{(\Delta t)^2}\{2q_{n+1} - 5q_n + 4q_{n-1} - q_{n-2}\} \tag{14}$$

Substitution of Eq. 14 into Eq. 12 yields the following expression which is utilized to solve for the displacements at the end of each time step, except the first one:

$$\begin{aligned}(2[M] + (\Delta t)^2[K])\{q_{n+1}\} = {} & (\Delta t)^2\{F(t,q)_{n+1}\} \\ & +[M]\{5q_n - 4q_{n-1} + q_{n-2}\}\end{aligned} \tag{15}$$

To determine the displacements at the end of the first time step, the following equation is employed

$$\begin{aligned}(6[M] + (\Delta t)^2[K])\{q_1\} = {} & (\Delta t)^2\{F(o,q_o)\} \\ & + [M]\{2(\Delta t)^2\ddot{q}_o + 6\Delta t\dot{q}_o + 6q_o\}\end{aligned} \tag{16}$$

It should be noted that the selection of the Houbolt procedure for inclusion in the code was made only after evaluating the advantages and disadvantages of a number of solution schemes (Ref. 8). The Houbolt procedure proved to be the only method capable of providing stable solutions for highly nonlinear problems while utilizing a reasonably large time increment. The significant observations made in Ref. 8 concerning Houbolt's procedure will now be presented.

It was found that double precision arithmetic is necessary if the code is utilized for highly nonlinear problems on an IBM 360/65 system (or comparable system). It is believed that if the DYNASOR II code is used on computers which have a longer word length than the 360/65 system (such as the CDC 6600) double precision arithmetic will not be necessary. Utilizing the Houbolt scheme, it has been shown that the solution converges as the number of elements is increased. Although the Houbolt procedure has been shown to be unconditionally stable for the linear problem, it has found that this is not the case with the nonlinear formulation. the damping inherent in the Houbolt procedure was noted in some instances, but the savings in computer time resulting from employing this procedure far outweighs this slight drawback. Solutions (without thhe damping) were obtained, in some instances, in one-eighth (1/8) the amount of time required by other procedures. In all cases which were run, stable, undamped solutions were obtained using larger time increments than could be used with the other methods.

Extrapolation of Forces

In order to employ Eq. 15, the loads at the end of the (n+1)th time step must be known. These loads, because of the presence of the nonlinear terms, are a function of the displacements to be calculated and therefore cannot be evaluated exactly. The right-hand side of Eq. 12 is, therefore, evaluated using a first-order Taylor's series expanded about the n-th increment:

$$\{F(t,q)_{n+1}\} = \{F(t,q)_n\} + \frac{\partial}{\partial t}\{F(t,q)_n\}\Delta t + O(\Delta t)^2 \qquad (17)$$

A second-order extrapolation process has been employed (Ref. 8), but the results indicated that the linear extrapolation procedure was more stable.

October 1972

SECTION II

USER GUIDELINES AND PROGRAM LIMITATIONS

Guidelines for the use of the DYNASOR II code along with the limitations placed upon the analysis are enumerated in this section. Some of these limitations are the result of the procedures used to program the equations while other limitations are inherent in the formulation of the equations. Since most of the limitations are minor in nature, the DYNASOR II code may be used to solve a wide variety of important shell dynamics problems.

The maximum number of elements which the program may use is fifty (50). The maximum number of harmonics which may be coupled for the analysis is five (5). It is believed that these limitations will not hinder the user in solving most problems. However, since undoubtedly some users will want to modify the program capacity, instructions for increasing or decreasing the allowable number of elements and/ or harmonics are provided in appendix 8.

In all analyses using the DYNASOR II code, the zeroth (0) harmonic must be specified as one of the input harmonics.

The coefficients of thermal expansion are assumed to be constant in the two principal directions for any given element but may vary from element to element.

The number of nodal restraints must be less than or equal to the maximum number of degrees of freedom for each harmonic (204).

The displacements of the nodes may be calculated for as many as twenty (20) angles around the circumference of the shell element.

While the displacements are calculated at every time increment, it is necessary to calculate the stresses only at time steps where a printout of the stresses is desired. The stresses and stress resultants are calculated at the middle of the elements (s-direction) for up to twenty (20) angles in the circumferential direction. The angles at which the stresses are calculated are the same as those at which the displacements are determined. The stresses on both the inner and outer surfaces are determined.

The units used in the program must be consistent with those used in the SAMMSOR code. All calculations in the versions supplied to the users of the code are given inch-pounds-seconds units.

The program accepts the mechanical and thermal load histories by accepting descriptions at discrete points in time. The difference between the times for which loads are specified must, in all cases, be greater than the value of the time increment used in solving the equations of motion. The load variation curve is approximated by assuming a linear variation of the generalized forces between the times at which the loads are specified. It may therefore be necessary to specify the loads and temperatures at a fairly large number of points in time if the loads vary rapidly with time.

If the loads and/ or temperatures propagate in any direction (moving loads), it will also be necessary to specify the loads at a fairly large number of points in time.

Pressure loadings, temperatures, and temperature gradients are assumed to be constant over the meridional length of the element but may vary in the circumferential direction. The variation in the circumferential direction (except for shear loadings) must be symmetric about the meridian corresponding to $\Theta = 0$ degrees. These loadings may be input either by specifying the values at a number of circumferential angles for each element or by specifying the values of the Fourier coefficients for each harmonic.

If the program is not being restarted, the loads and temperatures must be specied at time T1 = 0.0. Times at which loads must be specified when restarting the program are noted in Appendix 8.

One of the most important considerations in any dynamic analysis is the selection of the time increment to be used in the analysis. Several criteria have been developed for use in selecting a time increment in analyses utilizing finite difference techniques. Most of these critria require that the time increment be less than the time required for a signal to travel at the speed of sound from one difference point to the next. These criteria have been found (ref. 8) inadequate for use in this analysis. A "feel" for the selection of a time increment must be obtained by the user. To facilitate the development of this "feel" the time increments utilized in a number of problems have been carefully documented in Refs. 3 and 4. In addition, the input data for the example problems should prove helpful.

A restart capabilitty is incorporated in the code to enable the user to calculate the response from a specified point in time without having to recalculate the response prior to this time. A most valuable use of this capability arises if, after evaluation of the results of a run, it is decided to extend the calculations to observe more cycles of response. If it is desired to employ a different time increment (either smaller or larger), the user should refer to the discussion in Appendix 5. Effective use of the restart capability can result in a substantial savings of computer time. In general, the information necessary for restarting the code should be placed on tape at least every 100-400 time increments to insure that the information will be available if it is deemed desirable to restart the program.

The pseudo loads due to the nonlinearities associated with the initial displacents are neglected when calculating the response at the end of the first time step. However, when restarting the code, the initial increment utilizes both the mechanical and pseudo forces.

An extended effort has been made to check all aspects of the code. Comparisons of the response obtained using DYNASOR II with the results obtained by other researchers are presented in Ref. 3 and 4. Thesecomparisons firmly establish the validity of the code. Although the programming logic and the formulation have been thoroughly checked to insure the correctness of the code, the authors assume no responsibility for the results obtained using the code.

October 1972

SECTION III

PROGRAM INPUT

The DYNASOR II code has been written so that the code can be employed by researchers who are not familiar with the inner workings of the program. Utilizing the guidelines and adhering to the limitations presented in the previous section, it is believed that most users will find it relatively easy to employ the code.

The code is available in the FORTRAN IV language using double precision or single prescision arithmetic. This double precision version requires a storage space of about 330K bytes on IBM 360/65 system while the single precision storage space is about 200K bytes. Efforts have been made to make this code compatible with a large number of computing systems. In particular, adaption of the code for use on a CDC 6600 computer requires only minor changes.

The input data for a run consists of one card I (card types will be explained on the following pages) followed by a complete set of data (cards II-X) for each case. The set of cards II-X is the input data required to generate the response of a shell for a given number of harmonics due to a particular loading. The cards comprising the data deck for both an initial run and a restart are schematically represented in Fig. 1. The cards specifying the Fourier harmonics, the initial conditions, and the boundary conditions are omitted from the input deck when using the restart mode. If more than one case is to be run, include a set of data for each of the cases. There is no limit on the number of cases which may be included in a run. A card must be placed at the end of the data for the final case.

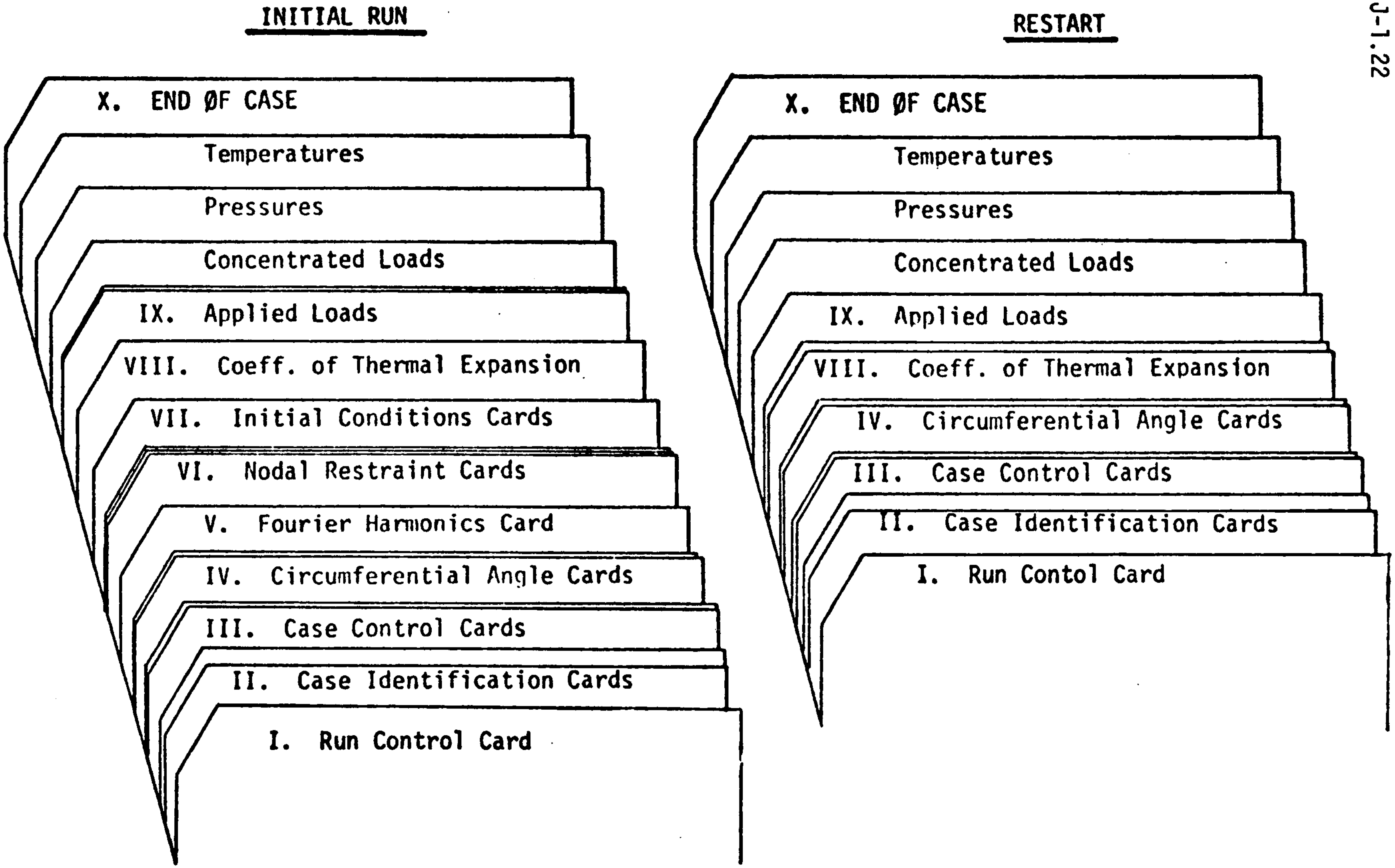

INITIAL RUN
X. END ØF CASE
Temperatures
Pressures
Concentrated Loads
IX. Applied Loads
VIII. Coeff. of Thermal Expansion
VII. Initial Conditions Cards
VI. Nodal Restraint Cards
V. Fourier Harmonics Card
IV. Circumferential Angle Cards
III. Case Control Cards
II. Case Identification Cards
I. Run Control Card
RESTART
X. END ØF CASE
Temperatures
Pressures
Concentrated Loads
IX. Applied Loads
VIII. Coeff. of Thermal Expansion
IV. Circumferential Angle Cards
III. Case Control Cards
II. Case Identification Cards
I. Run Contol Card

FIG. 1 CONSTITUTION OF DATA DECKS - INITIAL RUN AND RESTART MODES.

October 1972

I. RUN CONTROL CARD

This card is used to identify the number of cases to be run and the logical unit numbers of the scratch tapes used in the run. (ONLY ONE CARD I IS USED PER RUN.)

Card Type I Format (3I5)

Columns	Variable	Description
1-5	NCASES	The number of different data sets utilized for this run.
6-10	ND	Logical unit number of the scratch tape onto which all the data is read at the start of the run.
11-15	NS	Logical unit number of a second scratch tape used by the program.

II. CASE IDENTIFICATION CARDS

These cards allow the user to print out comments which identify the problem being run.

A. Control Card (ONE CARD II-A PER DATA SET)

Card Type II-A Format (2I5)

Columns	Variable	Description
1-5	NCARDS	Number of comment cards (TYPE II-B) which follow.
6-10	NT	Logical unit number of the tape (prepared by SAMMSOR) from which the stiffness and mass matrices, element properties, and restart information, if needed, will be read.

B. Identification Cards - The information punched on these cards is printed as output and should identify the problem being run. These comments should not duplicate those of the SAMMSOR case since the SAMMSOR comments will also appear as output. (IF NCARDS=0, OMIT CARDS II-B, OTHERWISE INCLUDE NCARDS OF TYPE II-B.)

Card Type II-B Format (20A4)

Columns	Variable	Description
1-80	COMENT	Any desired alphanumeric information may be printed on these cards.

III. CASE CONTROL CARDS

A. Control Constants - Time parameters, restart information, and other miscellaneous control constants are input on this card. (INCLUDE ONE CARD III-A PER DATA SET.)

Card Type III-A Format (2F10.0,4I5)

Columns	Variable	Description
1-10	TOTIME	The maximum time (seconds) for which the calculations are to be performed.
11-20	DELTE	Time increment (seconds) used in solving the equations of motion.
21-25	IRSTRT	Control constant which indicates if the solution is being restarted. If the solution is being restarted set IRSTRT = 1. If not, set IRSTRT = 0.
26-30	INCRST	The number of the time increment at which the solution is to be restarted. INCRST must be an integer multiple of the value of NPRNIT used in the previous run. If IRSTRT = 0, set INCRST = 0.
31-35	NCLOSE	For a closed shell (such as a spherical cap or a hemisphere) where node 1 is at the apex, set NCLOSE = 1. Radial and rotational restraints will then be applied for the zeroth harmonic to aid the numerical stability of the solution. If the shell does not fit the above description, set NCLOSE = 0.
36-40	ITELF	If thermal loads are to be applied in the program, set ITELF = 1. Otherwise, set ITELF = 0.

B. Print Control Card - The constants used to control the program output are punched on this card. (INCLUDE ONE CARD III-B PER DATA

SET.)

Card Type III-B Format (10I5)

Columns	Variable	Description
1-5	NPRNTQ	If the displacements are to be printed, set NPRNTQ = 1. If not, set NPRNTQ = 0.
6-10	IPRINT	If NPRNTQ = 1, the displacenents will be printed every IPRINT time increments beginning with the first time step. If NPRNTQ = 0, set IPRINT = 0.
11-15	NCLCST	If the stresses and stress resultants are to be calculated, set NCLCST = 1. If not, set NCLCST = 0.
16-20	NSTRSS	If NCLCST = 1, the stress and stress resultants will be calculated and printed every NSTRSS time increments beginning with the first step. If NCLCST = 0, set NSTRSS = 0.
21-25	NPRNT	If restart information is to be placed on tape, set NPRNT = 1. If not, set NPRNT = 0.
26-30	NPRNIT	If NPRNT = 1, the restart information will be written on the output tape every NPRNIT time increments. If NPRNT = 0, set NPRNIT = 0. It is suggested that relatively large values of NPRNIT be used, say 200, 400,etc., if the total number of time steps is relatively large.
31-35	NPRNTL	If a printout of the applied loads is desired, set NPRNTL = 1. Otherwise, set NPRNTL = 0.
36-40	NPRNTF	If a printout of the generalized forces is desired, set NPRNTF = 1. Otherwise, set NPRNTF = 0.

41-45	NPRNTH	If the Fourier coefficients for the temperature and temperature gradient are to be printed, set NPRNTH = 1. Otherwise, set NPRNTH = 0.
46-50	NPRNMS	If the mass and stiffness matrices are to be printed, set NPRNMS = 1. If not, set NPRNMS = 0.

IV. CIRCUMFERENTIAL ANGLE CARDS

The circumferential angles at which the displacements and stresses are to be calculated are read from these cards.

A. Control Card - (ONE CARD IV-A PER DATA SET.)

Card Type IV-A Format (I5)

Columns	Variable	Description
1-5	NTHETA	The number if circumferential angles at which the displacements and possibly stresses are to be calculated. (1 ≤ NTHETA ≤ 20)

B. Circumferential Angles - (INCLUDE 1-3 CARDS IV-B PER DATA SET DEPENDING UPON THE VALUE OF NTHETA.)

Card Type IV-B Format (8F10.0)

Columns	Variable	Description
1-10	THETA(1)	Circumferential angles at which the displacements and possible stresses will be calculated.
11-20	THETA(2)	(If it is desired to calculate the displace-
"	"	ments only along the line = 0, then include
"	"	one card IV-B and set THETA(1) = 0.0)
"	THETA(NTHETA)	

V. FOURIER HARMONICS CARD

This card provides the number of Fourier cosine harmonics to be imployed for this analysis and enumerates the specific harmonics to be used. (IF IRSTRT = 1, OMIT CARD V. OTHERWISE, INCLUDE ONE CARD V PER DATA SET.)

Card Type V Format (6I5)

Columns	Variable	Description
1-5	NH	The total number of Fourier cosine harmonics to be utilized in this analysis (1 ≤ NH ≤ 5).
6-10	IHARM(1)	Specific harmonics numbers to be imployed. NH values must be given and the zero harmonic must always be specified as one of the input harmonic numbers. The user should check to be certain that the information for each of these harmonics has been created and stored on tape by the SAMMSOR code.
11-15	IHARM(2)	
16-20	IHARM(3)	
21-25	IHARM(4)	
26-30	IHARM(5)	

Example: Consider a case where it is desired to utilize harmonics 0, 2, 3, and 4. The input data for card V would then utilize the following values:

NH = 4

IHARM(1) = 0 NOTE: IHARM(1) should always be set equal to zero.

IHARM(2) = 2

IHARM(3) = 3

IHARM(4) = 4

Columns 26-30 corresponding to IHARM(5) should be left blank for this example since only four harmonics are being run.

VI. NODAL RESTRAINT CARDS (Boundary Conditions)

The displacement constraints applied to the shell are described utilizing thes cards. (IF IRSTRT = 1, OMIT CARDS VI-A AND VI-B.)

A. Control Card - (ONE CARD VI-A PER DATA SET, UNLESS IRSTRT = 1.)

Card Type VI-A Format (I5)

Columns	Variable	Description
1-5	NODRES	Total number of displacement constraints to be applied to the shell (0 ≤ NODRES ≤ 204)

B. Boundary Conditions - (THE NUMBER OF CARDS OF TYPE VI-B MUST EQUAL NODRES, UNLESS IRSTRT = 1. IF NODRES = 0, OMIT CARDS VI-B.)

Card Type VI-B Format (2I5)

Columns	Variable	Description
1-5	NP	Number of the node where the restraint is to be applied.

6-10	NDIRCT	Key used to indicate the degree of freedom which is restrained.
		NDIRCT = 1 applies axial restraint
		NDIRCT = 2 applies circumferential restraint
		NDIRCT = 3 applies radial restraint
		NDIRCT = 4 applies rotational restraint

October 1972

VII. INITIAL CONDITIONS CARDS

The initial velocities and displacements of the nodes are specifies on these cards. (IF IRSTRT = 1, OMIT CARDS VII-Z, VII-B, AND VII-C.)

A. Control Card - Utilization of this control card greatly simplifies the specification of the initial conditions if either the initial velocities or the initial displacements, or both, are equal to zero. (ONE CARD VII-A PER DATA SET)

Card Type VII-A Format (2I5)

Columns	Variable	Description
1-5	IQN	If the initial velocities at all the nodes are zero, set IQN = 0. If not, set IQN = 1.
6-10	IQN1	If the initial displacements ar all the nodes are zero, set IQN1 = 0. If not, set IQN1 = 1.

B. Initial Velocities - The initial nodal velocities must be specified for each node of the shell for each harmonic to be run. The logic used to input the nodal velocities is essentially the same as the procedure used to specify the element properties in the SAMMSOR code. The initial velocities for each of the nodes are specifies for the first of the input harmonics, then for the second input harmonic, etc. This process is repeated until the nodal velocities for the first of the input harmonics, then for the second input harmonic, etc. This process in repeated until the nodal velocities for each harmonic have been specified. (IF IQN = 0, OMIT CARDS

VII-B.)

Card Type VII-B Format (2I5, 4F10.0)

Columns	Variable	Description
1-5	IN1	First node to which the velocities specifies on this card are applied.
6-10	IN2	Last node to which the velocities specified on this card are applied.
11-20	$\dot{q}_1$	Initial nodal velocity in the axial direction for a particular harmonic.
21-30	$\dot{q}_2$	Initial nodal velocity in the circumferential direction for a particular harmonic.
31-40	$\dot{q}_3$	Initial nodal velocity in the radial direction for a particular harmonic.
41-50	$\dot{q}_4$	Initial nodal rotational velocity in the meridional direction for a particular harmonic.

C. Initial Displacements - In identically the same manner as is utilized for the initial velocities, the initial displacements are specified for each harmonic. (IF IQN1 = 0, OMIT CARDS VII-C)

Card Type VII-C Format (2I5, 4F10.0)

Columns	Variable	Description
1-5	IN1	First node to which the displacements specified on this card are applied.
6-10	IN2	Last node to which the displacements specified on this card are applied.
11-20	q_1	Initial nodal displacement in the axial direction for a particular harmonic.
21-30	q_2	Initial nodal displacement in the circumferential direction for a particular harmonic.
31-40	q_3	Initial nodal displacement in the radial direction for a particular harmonic.
41-50	q_4	Initial nodal rotation in the meridional direction for a particular harmonic.

VIII. COEFFICIENTS OF THERMAL EXPANSION

If the thermal effects are to be included in the analysis, the coefficients of thermal expansion must be specified using these cards. These coefficients are assumed to be constant for a given element but may vary from element to element. These coefficients are read in the same manner as the element properties in the SAMMSOR code. (THE NUMBER OF CARDS VIII MUST BE ≤ NELEMS FOR ANY GIVEN DATA SET. IF ITELF = 0, OMIT CARDS VIII.)

Card Type VIII Format (2I5, 2F10.0)

Columns	Variable	Description
1-5	IELM1	Number of the first element to which the properties on this card apply.
6-10	IELM2	Number of the last element to which the properties on this card apply.
11-20	ALSI1	Coefficient of thermal expansion in the meridional direction (in/in/deg).
21-30	ALTI1	Coefficient of thermal expansion in the circumferential direction (in/in/deg).

October 1972

IX. APPLIED LOADS, TEMPERATURES, AND TEMPERATURE GRADIENTS

Since the concentrated nodal loads, distributed pressures, temperatures, and temperature gradients may vary in time; it may be necessary to specify these loads at a number of points in time. If these loads and temperatures are input at times $T1_i$ and $T1_{i+1}$, the program will calculate generalized forces due to these loads at each of the input times. A linear variation of the generalized forces is then assumed betweed the times the loads are input. As soon as the value of the time reaches $T1_{i+1}$, a new set of loads is read in at $T1_{i+2}$ and the process of calculating the generalized forces is repeated. The time increment, DELTE (CARD III-A), used in the solution of the equations of motion must be less than the difference between any too of the times at which the loads are specified. If the loads and/or temperatures propagate in and direction (moving loads), it is advisable to specify the loads at more times than is necessary if they vary in intensity only.

Ring loads can be applied at the nodes and must be input for each of the harmonics. The ring loads utilize the same sign convention employed for the shell nodal displacements.

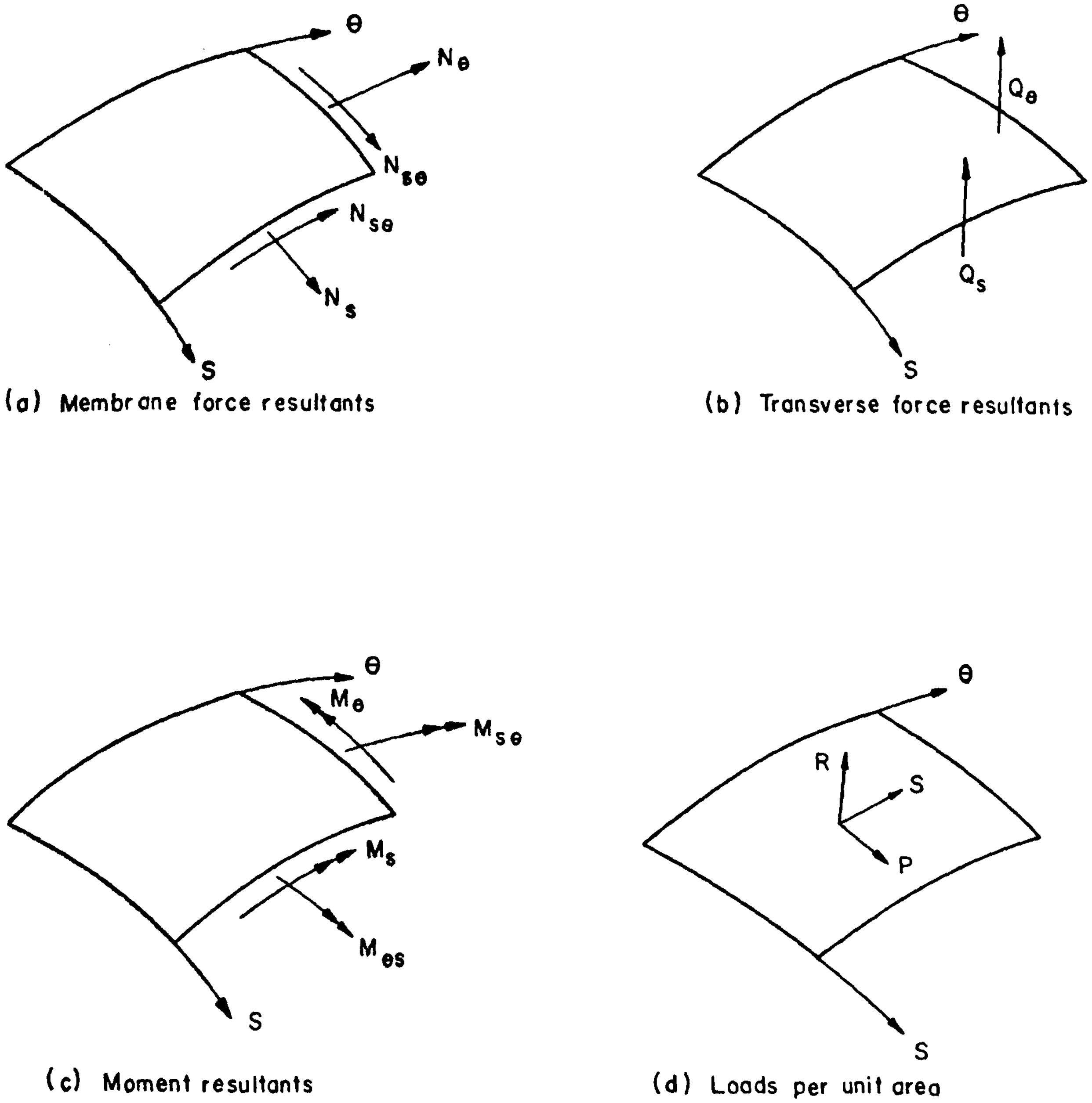
The pressure loadings, temperatures and temperature gradients are assumed constant over the meridional length of the element but variations in the circumferential direction are allowed. These loadings may be input in one of two ways. Either the Fourier coefficients can be specified for each harmonic or the values of the loads may be specified at a number of circumferential angles around the shell elements. Utilizing this second procedure a step function variation is assumed in tne circumferential direction. That is, the load is assumed constant from 0_i to $0_{i+1}$with the value of the loads being equal to those specified at 0_i. Sign conventions for the pressure loading are given in Figure 2.

A control card (Card Type IX-A) containing several key variables is used to guide the reading of the loading conditions. Proper selection of the values of these key variables results in a highly efficient procedure for specifying a wide variety of loading conditions. The key words and their meanings are explained in Figure 3.

Before attempting to input loads to the code the user is advised to study the guidelines presented in Section II, the example problems of Section II, and Appendix 6 which presents a thorough discussion of the various procedures necessary for specifying the loads.

A. Load Control Card

This control card is utilized to direct the input of the loads for a given time. This card indicates the presence or absence of concentrated



(a) Membrane force resultants

(b) Transverse force resultants

(c) Moment resultants

(d) Loads per unit area

FIG 2 POSITIVE DIRECTION OF FORCES, MOMENTS, AND LOADS ON SHELL SEGMENT

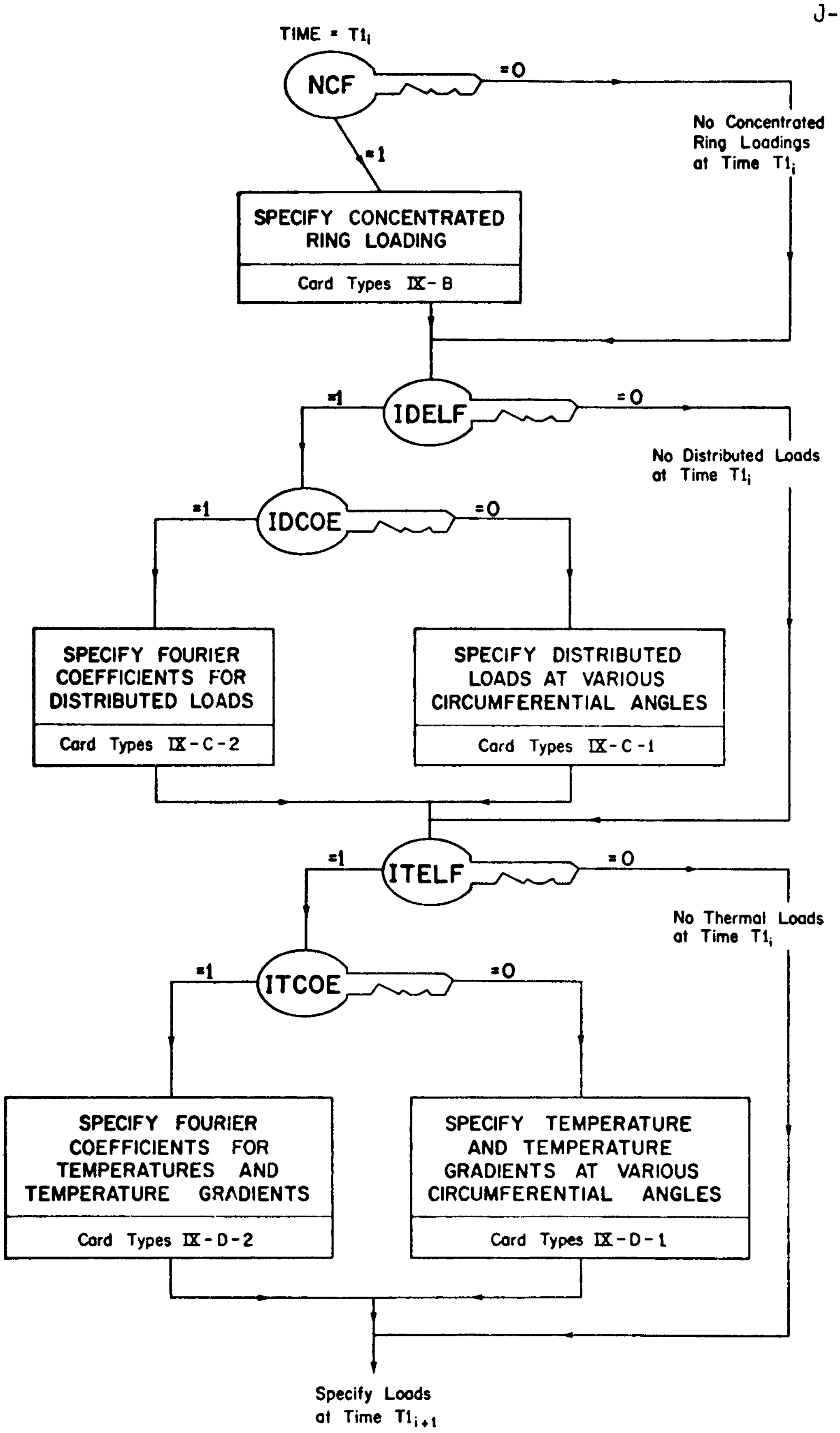

TIME = $T1_i$
NCF
=0
=1
No Concentrated Ring Loadings at Time $T1_i$
SPECIFY CONCENTRATED RING LOADING
Card Types IX-B
=1
IDELF
=0
No Distributed Loads at Time $T1_i$
=1
IDCOE
=0
SPECIFY FOURIER COEFFICIENTS FOR DISTRIBUTED LOADS
Card Types IX-C-2
SPECIFY DISTRIBUTED LOADS AT VARIOUS CIRCUMFERENTIAL ANGLES
Card Types IX-C-1
=1
ITELF
=0
No Thermal Loads at Time $T1_i$
=1
ITCOE
=0
SPECIFY FOURIER COEFFICIENTS FOR TEMPERATURES AND TEMPERATURE GRADIENTS
Card Types IX-D-2
SPECIFY TEMPERATURE AND TEMPERATURE GRADIENTS AT VARIOUS CIRCUMFERENTIAL ANGLES
Card Types IX-D-1
Specify Loads at Time $T1_{i+1}$

Fig. 3 LOAD SPECIFICATION AT TIME $T1_i$

forces and distributed pressure loadings and indicates the procedure to be utilized for creating the generalized thermal forces. (ONE CARD IX-A IS NECESSARY FOR EACH TIME AT WHICH THE LOADS ARE BEING INPUT.)

Card Type IX-A Format (F10.0, 4I5, A8)

Columns	Variable	Description
1-10	T1	The time for which the loads are being input (sec).
11-15	NCF	If concentrated ring loads are applied to the structure at time T1, set NCF = 1. If not, set NCF = 0.
16-20	IDELF	If distributed loads are to be applied to the shell at time T1, set IDELF = 1. If not, set IDELF = 0.
21-25	IDCOE	If the Fourier cosine coefficients for the distributed loadings are to be read in at time T1, set IDCOE = 1. If not, set IDCOE = 0.
26-30	ITCOE	If the Fourier cosine coefficients for the temperatures and temperature gradients are to be read in at time T1, set ITCOE = 1. If not, set ITCOE = 0.
31-38	CONSTF	If the applied loads, temperatures and temperature gradients are constant from time, T1, to the final time, TOTIME (CARD III-A), punch the word CONSTANT in columns 31-38. If these parameters are not constant, leave columns 31-38 blank.

B. Concentrated Ring Loads

The concentrated ring loads must be specified for each harmonic. (IF NCF = 0, OMIT CARDS IX-B.)

1. Control Card - This card indicates the presence or absence of concentrated ring loads for a particular harmonic. (ONE CARD IX-B-1 FOR EACH HARMONIC.)

Card Type IX-B-1 Format (I5)

Columns	Variable	Description
1-5	NCF1	If there are concentrated ring loads for this particular harmonic, set NCF1 = 1. If not, set NCF1 = 0.

2. Concentrated Ring Loads - For harmonics having ring loads associated with them, the loads are specified using these cards. (IF NCF1 = 0, OMIT CARDS IX-B-2 FOR THE HARMONIC BEING CONSIDERED.) ONE OR MORE CARDS IX-B-2 MAY BE USED, BUT NEVER UTILIZE MORE THAN 51 PER HARMONIC.

Card Type IX-B-2 Format (2I5, 4F10.0)

Columns	Variable	Description
1-5	IN1	First node to which this loading applies.
6-10	IN2	Last node to which this loading applies.
11-20	F1	Axial ring load applied at a node (lb).*
21-30	F2	Circumferential ring load applied at a node (lb).*
31-40	F3	Radial ring load applied at a node (lb).*
41-50	F4	Concentrated moment applied at a node (in-lb).*

Examples: The use of cards IX-B should become clear after considering the following examples:

1. Consider the case where a uniform tensile ring loading of 100 psi is being applied in the axial direction to the first node of a cylinder. The solution for this problem has been presented in Figure 20 of Reference 31 The thickness of the cylinder is 0.1

* The total value of the ring load for each harmonic is input, not the load per unit length of circumference. For complicated ring loads the value of the load input for each harmonic is obtained by intergrating the product of the load and the corresponding displacement function around the circumference.

inches with the radius being given as 6 inches. Consider that harmonics 0 and 2 are being run. The total ring load for the zero harmonic will be (100) x 2π(6) x (0.1) = 376.9 lb.

Five cards of type IX are required to input these loads assuming they are constant from time T1 = 0.0 to TOTIME and assuming 50 elements are used to idealize the structure.

CARD	VARIABLE	VALUES	
IX-A	T1 = 0.0	NCF = 1	IDELF = IDCOE = ITCOE = 0
IX-B	NCF1 = 1	(HARMONIC 0)	
IX-C	IN1=1 IN1=1	F1 = -376.9 F2 = F3 = F4 = 0	
IX-C	IN1 = 2 IN1 = 51	F1 = F2 = F3 = F4 = 0	
IX-B	NCF2 = 0	(HARMONIC 2)	

2. The second example considers a radial ring load of F cos0 applied to a cylinder of radius r.

Performing the integration, one obtains the radial ring load for harmonic 1 as

$$F3 = \int_0^{2\pi} (F \cos\theta) r \cos\theta d\theta$$

$$= \pi r F$$

The Fourier coefficients for the other harmonics are zero.

C. Distributed Loads - (IF IDELF = 0, OMIT CARDS IX-C)

The distributed loadings may be input in one of two ways: the Fourier coefficients may be read in for each harmonic or the loadings may be specified at a desired number of circumferential angles (≤ 37). If the second option is used, the Fourier coefficients will then be generated internally. The user should note that it is possible to input distributed loads in only one of two ways.

1. Distributed Loads - (Input at various circumferential angles) Since the choice of the displacement functions utilized in this analysis necessitate the presence of loads symmetric about the meridian $\Theta = 0$, it is necessary to specify the distributed loadings for angles from 0° --> 180°. The code then assumes that the distribution from 180° --> 360° is the mirror image of the input distribution. (IF IDCOE = 1, OMIT CARDS IX-C-1)

   a. Control Card - Utilize this card to indicate the number of angles for which the loads will be specified.

Card Type IX-C-1-a Format (3I5)

Columns	Variable	Description
1-5	IELM1	First element to be distributed loading applies.
6-10	IELM2	Last element to which this distributed loading applies.
11-15	NDP	Number of circumferential angles at which the distributed loads are to be specified ($1 \leq NDP \leq 37$). If the loadings are constant in the circumferential direction set NDP = 1.

   b. Distributed Loads at Specified Angles* This card specifies the angle at which the loads are being input and provides the values of the loads at that angle. (INCLUDE NDP CARDS OF

* The first loading must always be given for $\Theta = 0°$. The next loading is given at the angle where the load changes in value. If the load is constant with respect to Θ, only one card will be necessary to input the load. Do not input values for the loads at $\Theta = 180°$ since the load at that angle will be equal in all cases to the load input at the previous value of THETAB.

TYPE IX-C-1-b FOR EACH CARD IX-C-1-a.)

Card Type IX-C-1-b Format (4F10.0)

Columns	Variable	Description
1-10	THETB	Circumferential angle (degrees) for which this data is given.
11-20	P	Distributed load in the meridional direction (psi).
21-30	R	Distributed load in the normal direction (psi).
31-40	S	Distributed load in the circumferential direction (psi).

Example: Consider the normal pressure distribution on an element depicted in Figure 4. To input the pressure on this element requires specification of the pressures for four values of Θ.

THETB	R(I)
0.0	-Q1
30.0	-Q2
90.0	-Q3
2.0	0.0

2. Distributed Loads - (Fourier Coefficients) The Fourier coefficients for the distributed loads mey be specified using these cards. The coefficients must be specified (even though they may be zero) for each harmonic being employed in the analysis. The coefficients are specified for each harmonic of the first group of elements, then for each harmonic of the second group, etc. until the values have been input for all the elements. (IF IDCOE = 0, OMIT CARDS IX-C-2)

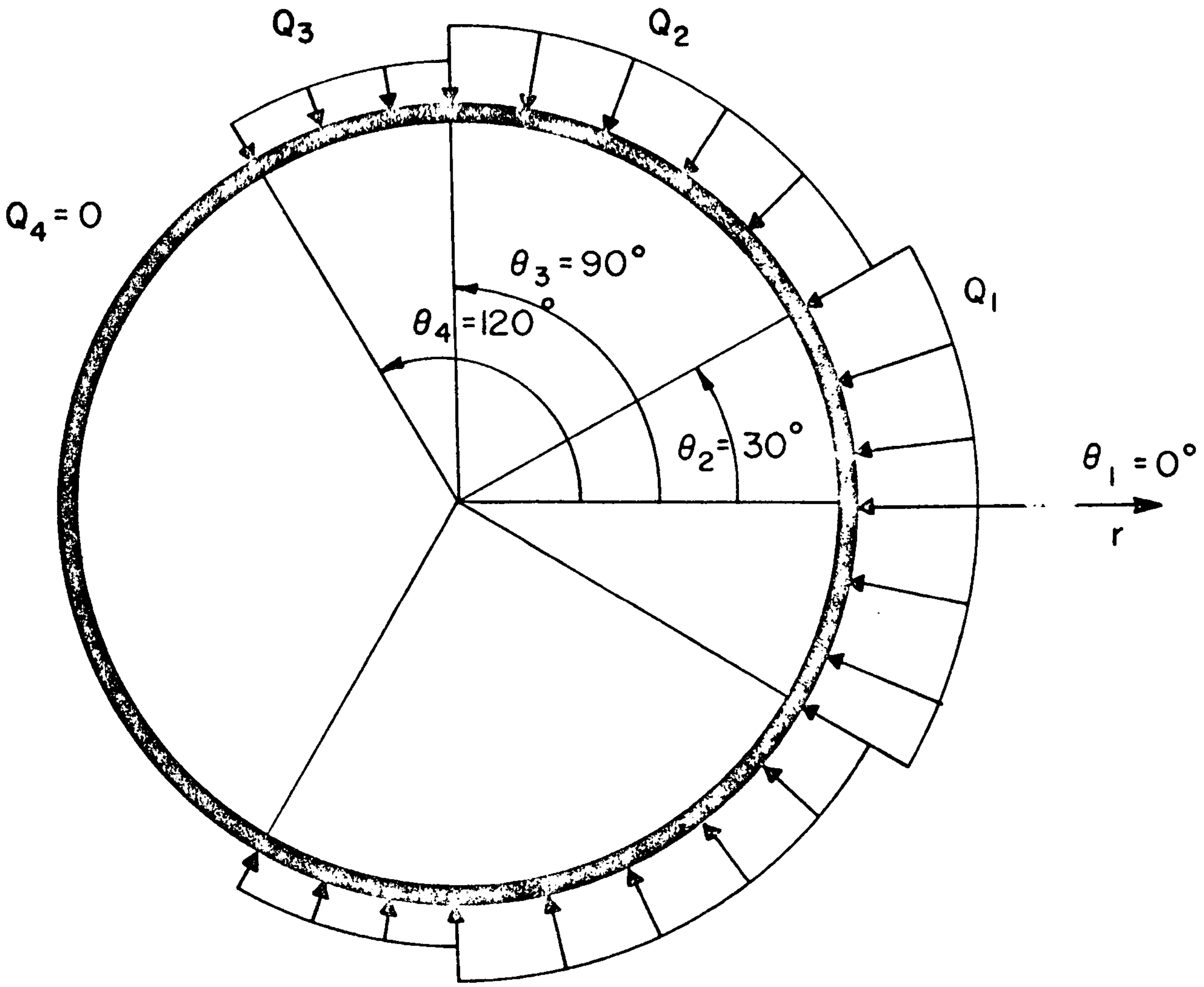


FIG 4 REPRESENTATIVE VARIATION OF DISTRIBUTED LOADS APPLIED TO A TYPICAL ELEMENT

a. Control Card

Card Type IX-C-2-a Format (2I5)

Columns	Variable	Description
1-5	IELM1	First element to which these loads apply.
6-10	IELM2	Last element to which these loads apply.

b. Fourier Coefficients - (NH CARDS OF TYPE IX-C-2-b FOR EACH CARD IX-C-2-a.)

Card Type IX-C-2-b Format (3F10.0)

Columns	Variable	Description
1-10	P	Fourier coefficient of the distributed load in the meridional direction for a particular harmonic (psi).
11-20	R	Fourier coefficient of the distributed load in the normal direction for a particular harmonic (psi).
21-30	S	Fourier coefficient of the distributed load in the circumferential direction for a particular harmonic (psi).

D. Temperature Distribution and Gradients

Essentially the same logic is employed for inputting the temperatures and gradients that was used for the specification of the distributed loads. The explanation of this procedure should therefore not need be repeated.

The temperatures are specified for the midsurface of the shell. The temperature gradients (through the thickness) are considered positive if the temperature for the outer surface is greated than the temperature on the inner surface. (IF ITELF = 0, OMIT CARDS IX-D.)

1. Temperature Distribution and Gradients - (Input at various circumferential angles)

Again, the requirement of symmetry about the meridian θ = 0, makes it necessary to specify the temperature distribution and thermal gradients only from 0° --> 180°. The temperature distribution and gradients are input on the same cards for the various angles. (IF ITCOE = 1, OMIT CARDS IX-D-1.)

a. Control Card - Utilize this card to indicate the number of angles for which the temperature and gradients will be specified.

Card Type IX-D-1-a Format (3I5)

Columns	Variable	Description
1-5	IELM1	First element to which this data applies.
6-10	IELM2	Last element to which this data applies.
11-15	NDP	Number of circumferential angles at which the temperature distribution and gradient are to BE SPECIFIED (1 ≤ NDP ≤ 37). If the temperature is constant in the circumferential direction, set NDP = 1.

b. Temperature and Temperature Gradient at Specified Angles -

This card specifies the angle at which the temperature and temperature gradient (through the thickness) is being input and provides the value of the temperature at that angle. (INCLUDE NDP CARDS OF TYPE IX-D-1b

FOR EACH CARD IX-D-1-a.)

Card Type IX-D-1-b Format (3F10.0)

Columns	Variable	Description
1-10	THETB	Circumferential angle for which this temperature and gradient are given.
11-20	P	Distributed temperature at θ = THETB (°F).
21-30	R	Temperature gradient (through the thickness) at θ = THETB (°F/in).

2. Temperature Distribution and Gradient - (Fourier Coefficients)

If the user so desires, the Fourier coefficients for the temperature distribution and gradient may be specified for each of the harmonics being used. Again, the coefficients are specified for all harmonics for the first group of elements, then for the second group, etc., until all the element coefficients have been input. (IF ITCOE = 0, OMIT CARDS IX-D-2)

a. Control Card

Card Type IX-D-2-a Format (2I5)

Columns	Variable	Description
1-5	IELM1	First element to which these properties apply.
6-10	IELM2	Last element to which these properties apply.

b. Fourier Coefficients - (NH CARDS OF TYPE IX-D-2-b FOR EACH

CARD IX-D-2-a.)

Card Type IX-D-2-b Format (2F10.0)

Columns	Variable	Description
1-10	TH1	Fourier coefficient of the temperature distribution (°F) for a particular harmonic.
11-20	DTH1	Fourier coefficient of the temperature gradient (°F/in) for a particular harmonic.

X. FINAL DATA CARD FOR A CASE

Place this card after the last card IX of each data set. This signifies the end of the input data for a case. (ONE CARD X PER DATA SET.)

Card Type X

Columns	Punch
1-11	END OF CASE

XI. FINAL DATA CARD FOR A RUN

This card must be placed after the card X of the last case to be run.

It denotes the end of the input data for a run. (ONE CARD XI PER RUN)

Card Type XI

Columns	Punch
1-10	END OF RUN ....

SECTION IV

EXAMPLE PROBLEMS

The example problems which follow were chosen to demonstrate the versatility of the code and to further acquaint the users with the procedures for inputting the data to the code. The data presented herein is typical for the problems solved by the code and demonstrates many of the input procedures.

Since the most complex portion of the input data is the specification of the loading conditions, a variety of loadings are demonstrated. Response curves are presented so the user may check his output with thhe previously obtained curves. The first two example problems utilize the shells described in example problems 1 and 2 of the SAMMSOR user's guide (Ref. 1) while the third example problem demonstrates the two procedures for specifying distributed pressure loadings.

Example Problem 1

The first example problem was chosen to demonstrate the procedure for inputting a concentrated ring load and to demonstrate the program's capability to solve highly nonlinear problems. For the forty pound load applied in this problem, the static solution shows that the nonlinear displacement is more than four times as large as the linear solution.

The shell to which the load is applied is the shallow spherical cap ($\lambda=6$) utilized in the first example problem in the SAMMSOR user's guide. The edges of the shell are assumed to be clamped. Since the loading is symmetric, the displacements and stresses will be calculated only along the line $\theta = 0$. Only the response for the zeroth harmonic will be determined. A set of input data for this case is presented in Figure 5 with the displacement response of the apex of the shell being presented in Figure 6. This response curve should allow the user to check his version of the code.

Example Problem 2

The shell described in the second example problem in the SAMMSOR user's guide is now subjected to a 50 psi internal pressure. The load-in is applied at time T1 = 0.0 and remains constant for the duration of the calculation.

Two sets of input data are provided for this example problem. The first set (Figure 7) allows the program to calculate the response for the first 300 time steps. The second set of input data (Figure 8) will

```
NCASE= 1

                                   PRINTOUT OF INPUT DATA

CARD             10        20        30        40        50        60        70        80
TYPE     12345678901234567890123456789012345678901234567890123456789012345678901234567890

 II - A      6    4
    - B  ********************************************************************************
    - B          EXAMPLE PROBLEM NO. 1               DYNASOR II USER'S MANUAL
    - B       THE SHELL DESCRIBED IN EXAMPLE PROBLEM 1 OF THE SAMMSOR USER'S GUIDE
    - B       IS SUBJECTED TO A 40 LB. APEX LOADING WITH THE SOLUTION BEING DETERMINED
    - B       FOR 400 TIME STEPS
    - B  ********************************************************************************
III - A      0.0001 .00000025    0    0    1    0
    - B      1    4    1    8    1  100    1    1    0    1
 IV - A      1
    - B         0.0
  V          1    0
 VI - A      4
    - B     31    1
    - B     31    2
    - B     31    3
    - B     31    4
VII - A      0    0
 IX - A         0.0    1    0    0    OCONSTANT
    - B - 1  1
        - 2  1    1      40.0       0.0       0.0       0.0
        - 2  2   31       0.0       0.0       0.0       0.0
  X      END OF CASE
```

Fig. 5 INPUT DATA - EXAMPLE PROBLEM 1

J-1.52

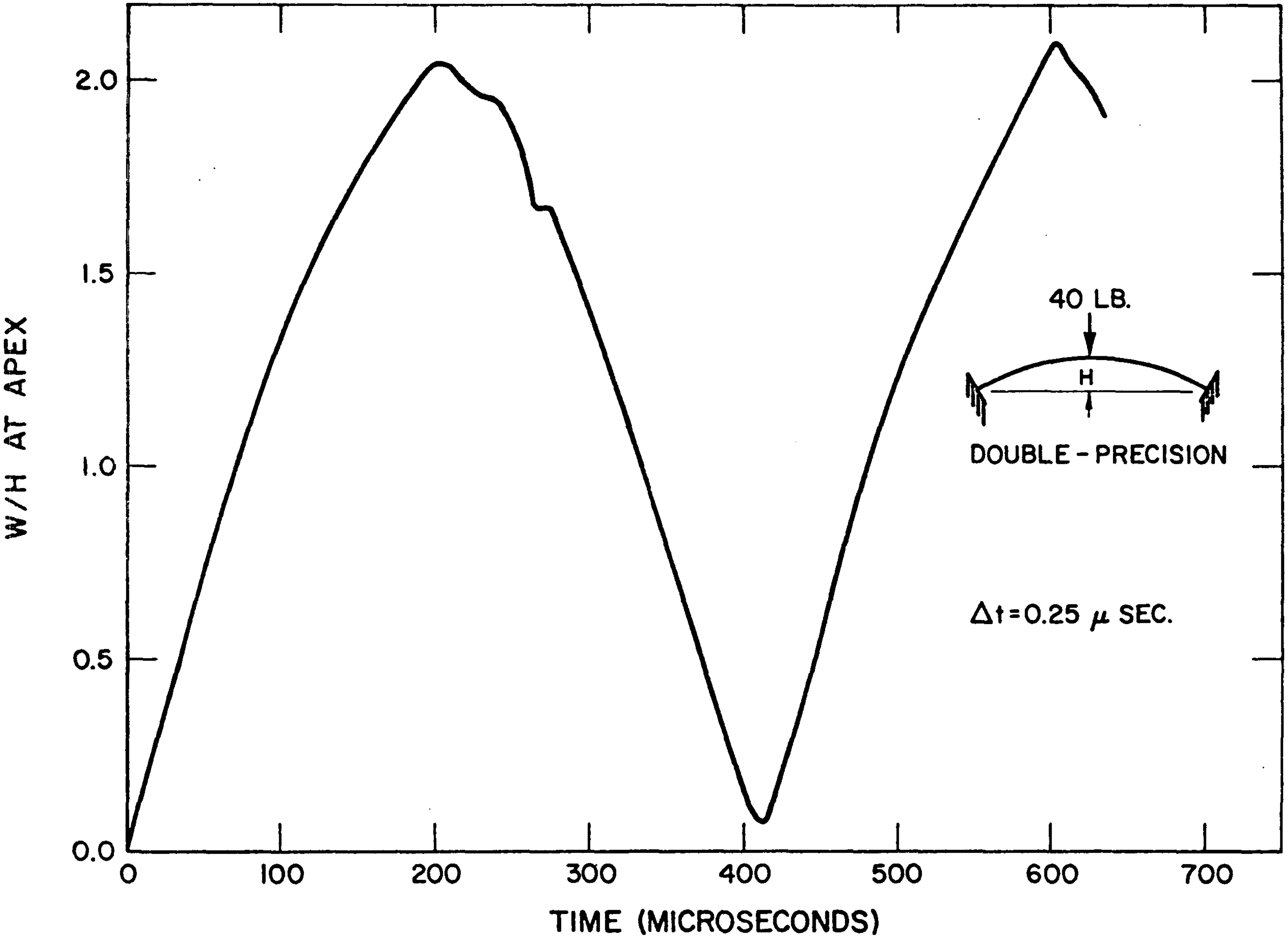
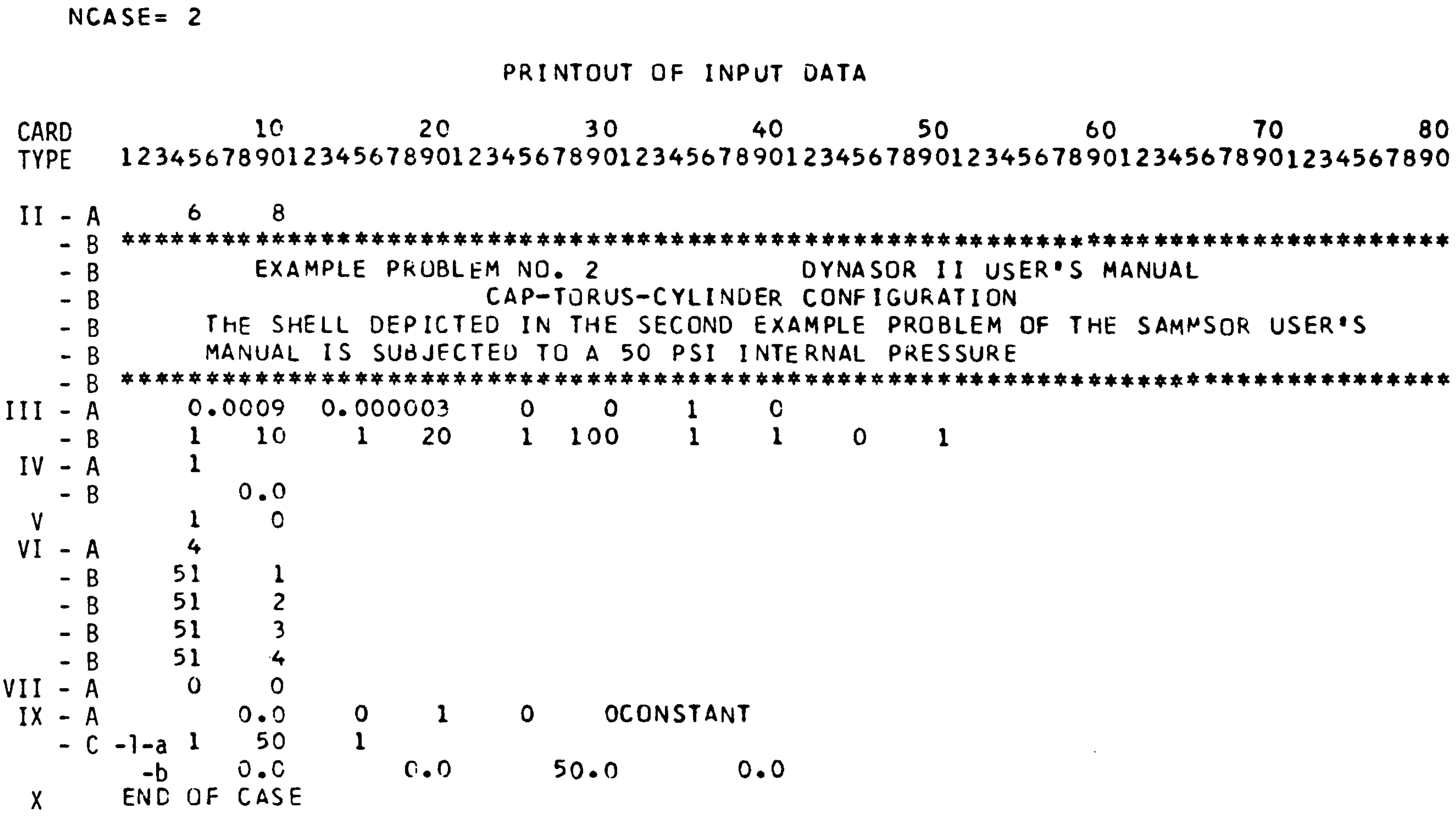
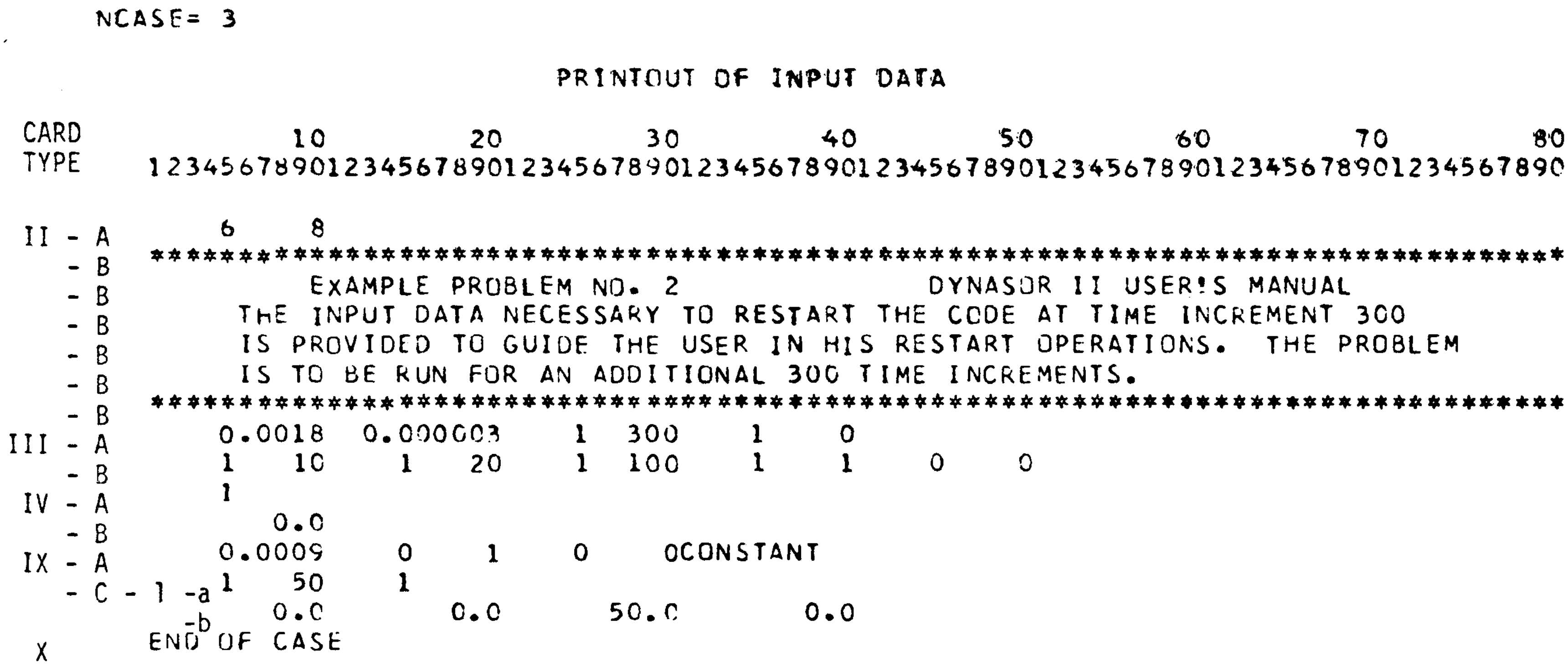


FIG. 6 APEX DISPLACEMENT RESPONSE UNDER CONCENTRATED AXIAL LOAD



```
    NCASE= 2

                               PRINTOUT OF INPUT DATA

CARD            10        20        30        40        50        60        70        80
TYPE    12345678901234567890123456789012345678901234567890123456789012345678901234567890

 II - A     6    8
    - B ********************************************************************************
    - B         EXAMPLE PROBLEM NO. 2            DYNASOR II USER'S MANUAL
    - B                       CAP-TORUS-CYLINDER CONFIGURATION
    - B      THE SHELL DEPICTED IN THE SECOND EXAMPLE PROBLEM OF THE SAMMSOR USER'S
    - B      MANUAL IS SUBJECTED TO A 50 PSI INTERNAL PRESSURE
    - B ********************************************************************************
III - A     0.0009  0.000003    0    0    1    0
    - B     1   10    1   20    1  100    1    1    0    1
 IV - A     1
    - B        0.0
  V         1    0
 VI - A     4
    - B    51    1
    - B    51    2
    - B    51    3
    - B    51    4
VII - A     0    0
 IX - A        0.0    0    1    0    0CONSTANT
   - C -1-a 1   50    1
         -b    0.0       0.0      50.0       0.0
  X     END OF CASE
```

Fig. 7 INPUT DATA - EXAMPLE PROBLEM 2



```
        NCASE= 3

                                 PRINTOUT OF INPUT DATA

 CARD             10        20        30        40        50        60        70        80
 TYPE     12345678901234567890123456789012345678901234567890123456789012345678901234567890

 II - A       6    8
    - B   ********************************************************************************
    - B            EXAMPLE PROBLEM NO. 2                DYNASOR II USER!S MANUAL
    - B        THE INPUT DATA NECESSARY TO RESTART THE CODE AT TIME INCREMENT 300
    - B        IS PROVIDED TO GUIDE THE USER IN HIS RESTART OPERATIONS.  THE PROBLEM
    - B        IS TO BE RUN FOR AN ADDITIONAL 300 TIME INCREMENTS.
    - B   ********************************************************************************
III - A       0.0018  0.000003    1  300    1    0
    - B       1   10    1   20    1  100    1    1    0    0
 IV - A       1
    - B          0.0
 IX - A       0.0009    0    1    0     0CONSTANT
    - C - 1 -a 1   50    1
           -b    0.0       0.0       50.0       0.0
 X        END OF CASE
```

Fig. 8 INPUT DATA - EXAMPLE PROBLEM 2 - RESTART MODE

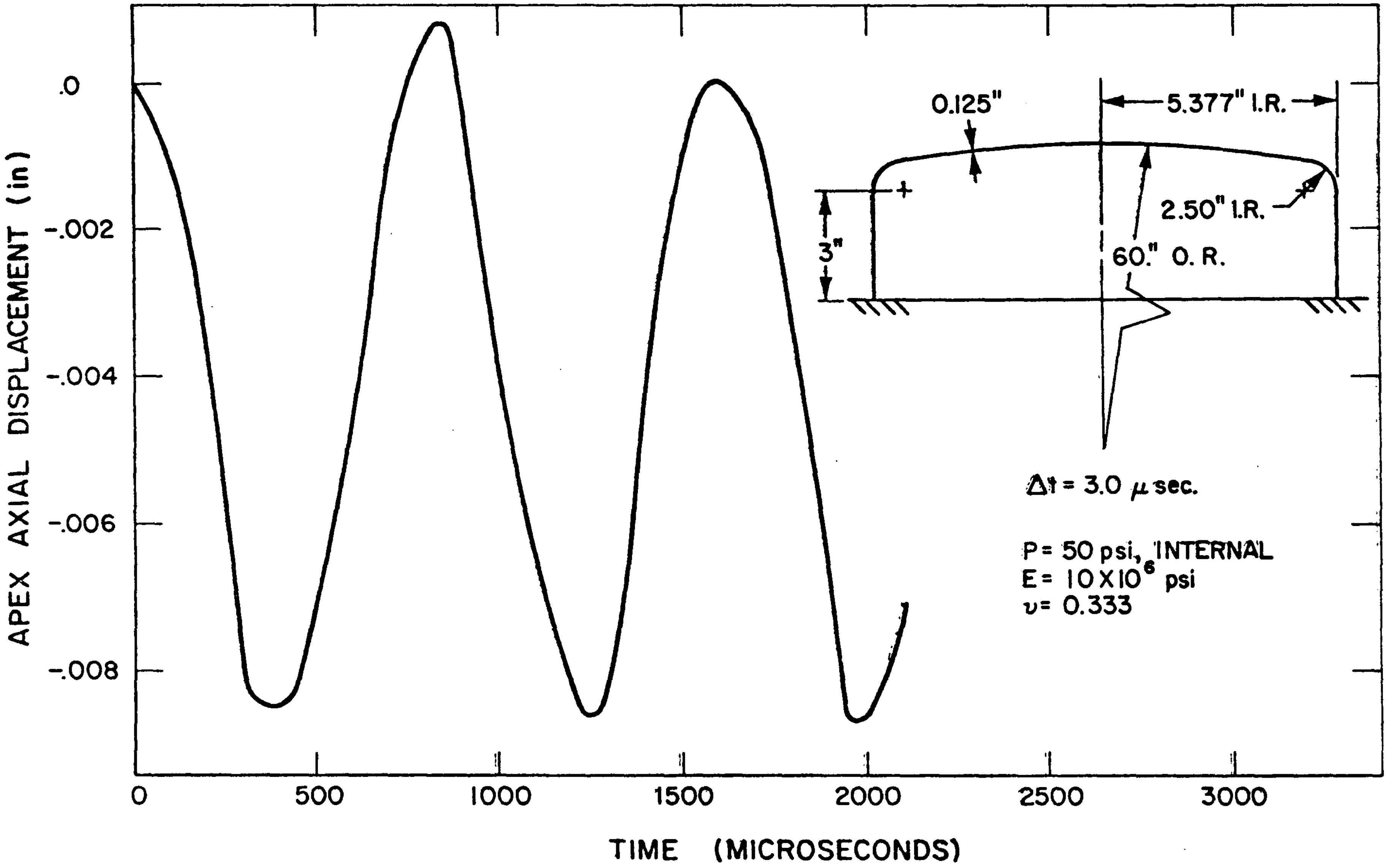


FIG. 9 DISPLACEMENT RESPONSE UNDER INTERNAL PRESSURE

restart the code at the end of the 300th time step and will then allow the program to calculate the response for an additional 300 increments.

Since this problem is only moderately nonlinear, it is interesting to note that a much larger time step can be used for this problem than was employed in the previous example problem. The displacement response obtained for this problem is presented in Figure 9.

Example Problem 3

This example problem was selected to demonstrate the procedures for inputting the distributed loadings on a shell. A cylindrical shell (figure 10) is subjected to a half cosine loading which is symmetric about the meridian = 0. This load is applied along the entire length of the shell. The pressure loading may be specified in one of two ways:

1) The Fourier coefficients may be input for each harmonic.

2) The pressure may be specified at various circumferential angles with the Fourier coefficients then being internally generated.

The first set of input data (Figure 11) utilizes the first of the above procedures and inputs the Fourier coefficients. The input data presented in Figure 12 describes the loading by specifying the value of the pressure at the various angles. The same procedure is employed to describe the temperature and temperature gradient distributions.

Considering the symmetry of the loading and the boundary conditions applied to this shell, it can easily be recognized that the displacements and stresses will be symmetric about the center of this cylindrical tube. Therefore, only one-half of the shell needs to be analyzed. The plane of symmetry is assured by applying an axial and a rotational restraint at node one (1).

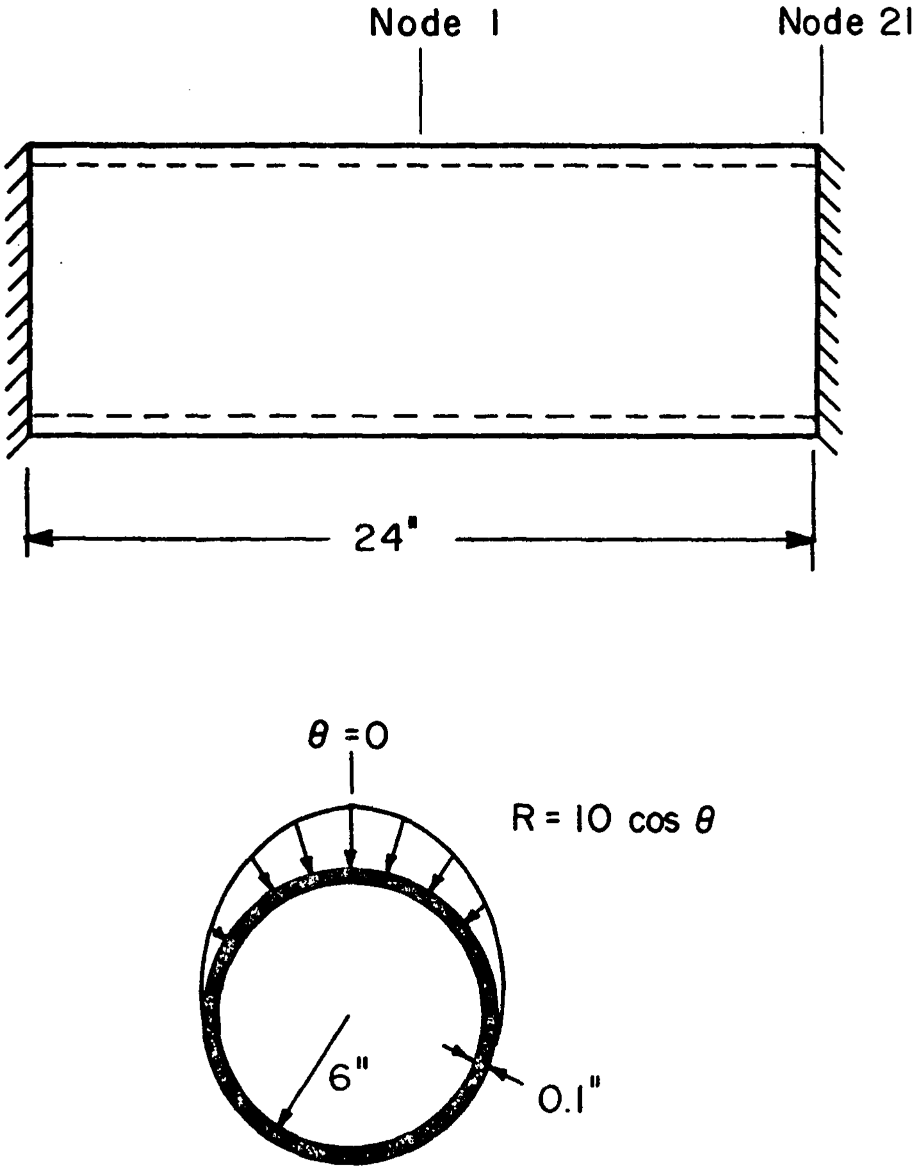


FIG 10 CYLINDRICAL SHELL SUBJECTED TO HALF COSINE PRESSURE LOADING

```
     NCASE= 5

                                              PRINTOUT OF INPUT DATA

CARD             10        20        30        40        50        60        70        80
TYPE     12345678901234567890123456789012345678901234567890123456789012345678901234567890

 II - A      6    4
    - B  ********************************************************************************
    - B           EXAMPLE PROBLEM NO. 3           DYNASOR II USER'S MANUAL
    - B       CYLINDRICAL SHELL IDEALIZED USING 30 ELEMENTS IS SUBJECTED TO A HALF COSINE
    - B       LOADING TO DEMONSTRATE THE OPTIONS FOR INPUTTING DISTRIBUTED LOADS.
    - B   ** IN THIS CASE THE PRESSURE IS SPECIFIED BY INPUTTING THE FOURIER COEFFICIENTS
    - B  ********************************************************************************
III - A      0.0005   0.00001    0    0    0    0
    - B      1    5    1   10    1   50    1    1    0    1
 IV - A      2
    - B         0.0      30.0
  V          5    0    1    2    3    4
 VI - A      6
    - B      1    1
    - B      1    4
    - B     21    1
    - B     21    2
    - B     21    3
    - B     21    4
VII - A      0    0
 IX - A         0.0    0    1    1    0CONSTANT
    - C - 2- a1  20
          - b   0.0   -3.1831       0.0
          - b   0.0   -5.0000       0.0
          - b   0.0   -2.1221       0.0
          - b   0.0    0.0000       0.0
          - b   0.0    0.4244       0.0
  X     END OF CASE
```

Fig. 11 INPUT DATA - (SET #1) - EXAMPLE PROBLEM 3

```
          NCASE= 4

                                      PRINTOUT OF INPUT DATA

CARD                 10        20        30        40        50        60        70        80
TYPE        12345678901234567890123456789012345678901234567890123456789012345678901234567890
 II - A         6    4
    - B     ********************************************************************************
    - B              EXAMPLE PROBLEM NO. 3              DYNASOR II USER'S MANUAL
    - B          CYLINDRICAL SHELL IDEALIZED USING 30 ELEMENTS IS SUBJECTED TO A HALF COSINE
    - B          LOADING TO DEMONSTRATE THE OPTIONS FOR INPUTTING DISTRIBUTED LOADS.
    - B      ** IN THIS CASE THE PRESSURE IS SPECIFIED AT VARIOUS CIRCUMFERENTIAL ANGLES **
    - B     ********************************************************************************
III - A         0.0005   0.00001    0    0    0    0
    - B         1    5    1   10    1   50    1    1    0    0
 IV - A         2
    - B            0.0      30.0
  V             5    0    1    2    3    4
 VI - A         6
    - B         1    1
    - B         1    4
    - B        21    1
    - B        21    2
    - B        21    3
    - B        21    4
VII - A         0    0
 IX - A            0.0    0    1    0    0CONSTANT
    - C - 1 - a 1   20   37
          - b      0.0       0.0  - 9.9976        0.0
          - b      2.5       0.0  - 9.9786        0.0
          - b      5.0       0.0  - 9.9406        0.0
          - b      7.5       0.0  - 9.8836        0.0
          - b     10.0       0.0  - 9.8079        0.0
          - b     12.5       0.0  - 9.7134        0.0
          - b     15.0       0.0  - 9.6005        0.0
          - b     17.5       0.0  - 9.4693        0.0
          - b     20.0       0.0  - 9.3201        0.0
          - b     22.5       0.0  - 9.1531        0.0
          - b     25.0       0.0  - 8.9687        0.0
          - b     27.5       0.0  - 8.7673        0.0
          - b     30.0       0.0  - 8.5491        0.0
          - b     32.5       0.0  - 8.3147        0.0
          - b     35.0       0.0  - 8.0644        0.0
          - b     37.5       0.0  - 7.7988        0.0
          - b     40.0       0.0  - 7.5184        0.0
          - b     42.5       0.0  - 7.2236        0.0
          - b     45.0       0.0  - 6.9151        0.0
          - b     47.5       0.0  - 6.5935        0.0
          - b     50.0       0.0  - 6.2592        0.0
          - b     52.5       0.0  - 5.9131        0.0
          - b     55.0       0.0  - 5.5557        0.0
          - b     57.5       0.0  - 5.1877        0.0
          - b     60.0       0.0  - 4.8099        0.0
          - b     62.5       0.0  - 4.4229        0.0
          - b     65.0       0.0  - 4.0275        0.0
          - b     67.5       0.0  - 3.6244        0.0
          - b     70.0       0.0  - 3.2144        0.0
          - b     72.5       0.0  - 2.7983        0.0
          - b     75.0       0.0  - 2.3769        0.0
          - b     77.5       0.0  - 1.9509        0.0
          - b     80.0       0.0  - 1.5212        0.0
          - b     82.5       0.0  - 1.0887        0.0
          - b     85.0       0.0  - 0.6540        0.0
          - b     87.5       0.0  - 0.2181        0.0
          - b     90.0       0.0    0.0000        0.0
  X           END OF CASE
```

Fig. 12 INPUT DATA - (SET #2) - EXAMPLE PROBLEM 3

REFERENCES

1. Tillerson, J. R., and Haisler, W. E., "SAMMSOR II - A Program Calculation of Stiffness and Mass Matrices of Shells of Revolution," TEES-RPT-70-18, Texas A&M University, Oct. 1970.

2. Novozhilov, V.V., Foundations of the Nonlinear Theory of Elasticity, Graylock Press, Rochester, N.Y., 1956.

3. Stricklin, J. A., Martinez, J. E., Tillerson, J. R.,Hong, J. H., and Haisler, W. E., "Nonlinear Dynamic Analysis of Shells of Revolution by Matrix Displacement Method," Sandia Corporation Contractor Report SC-CR-70-6070, Feb. 1970.

4. Stricklin, J. A., Martinez, J. E., Tillerson, J. R.,Hong, J. H., and Haisler, W. E., "Nonlinear Dynamic Analysis of Shells of Revolution by Matrix Displacement Method," AIAA/ASME 11th Structures, Structural Dynamics, and Materials Conference, Denver, Colorado, April, 1970.

5. Stricklin, J. A., and Martinez, J. E., "Dynamic Buckling of Clamped Spherical Caps Under Step Pressure Loadings," AIAA Journal, Vol. 7, No. 6, June 1969, pp. 1212-1213.

6. Stricklin, J. A., Haisler, W. E., MacDougall, H. R., and Stebbins, F. J., "Nonlinear Analysis of Shells of Revolution by the Matrix Displacement Method," AIAA Journal, Vol. 6,No. 12, Dec. 1968, pp. 2306-2312.

7. Houbolt, J. C., "A Recurrence Matrix Solution for the Dynamic Response of Elastic Aircraft,"Journal of Aeronautical Science, Vol. 17, Sept. 1950, pp. 540-550.

8. Tillerson, J. R., and Stricklin, J. A., "Numerical Methods of Integration Applied in the Nonlinear Dynamic Analysis of Shells of Revolution," TEES Report 70-23, Texas A&M University, July 1970.

Appendix 5 - Use of the Restart Option

In order for efficient use to be made of the DYNASOR II code, the user should become familiar with the option provided for restarting the program. Through effective use of this option the dynamic response studies can be completed using a minimum amount of computer time.

Use of the restart option may prove invaluable in a number of situations. Abnormal termination of the program may occur if a numerical instability is noted in the response. If this occurs, the restart option can be used with a different value of the time increment. Another important use of the restart option arises when the user is satisfied with the results previously obtained but desires to extend the response data to a further point in time. In such a case the program is restarted at the last time step for which the restart information was placed on tape. A most effective use of this option can be made when conducting dynamic stability analyses where it is desirable to evaluate the response to see if buckling has occurred. If it has not, the decision can then be made to extend the run to further points in time.

Utilizing large time steps can result in a damping effect upon the solution so it is advisable to run the problem for a couple of oscillations, check to see if the solution is significantly damped,and then run the problem for the desired number of oscillations. If an evaluation of the initial results indicates that a smaller or larger time step should be used, the restart facility might be used to keep from having to repeat the initial calculations.

The displacements, velocities, and forces should be written on tape for almost all of the cases to insure that the restart information will be available if an evaluation of the calculated response indicates that the program should be restarted. The time required to write the restart information on tape is negligible when compared with the amount of time required to obtain the total response.

If it is desirable to decrease the time increment when restarting the program, the user should exercise care in selection the increment (INRST) at which the program will be restarted. The decision to decrease the size of the time step will usually be based upon the observation that the solution has become unstable or that significant damping is present in the response. To restart the program the user must be sure that the increment (INCRST) has been selected small enough to insure that the inaccuracies created by the larger time step can be neglected.

On the other hand, if the results from a previous run indicate that it is possible to increase the size of the time stip for the remaining calculations, then care must also be taken in the selection of INCRST. For the numerical extrapolation procedure to produce accurrate sets of displacements, it is recommended that the solution be restarted on a relatively straight portion of the displacement response curve. Considering the curve presented in Figure 6, it would be recommended that the program be restarted at 500 microseconds rather than at 600 microseconds because of the extrapolation procedure being utilized (i.e. the curve is smoother at 500 microseconds).

When using the restart option, it is possible to specify different values for a number of the control constants and input parameters. The data on cards I-IV may be changed, but the same Fourier harmonics and boundary conditions must be used. It is alo required that the coefficients of thermal expansion remain the same when restarting the program. These requirements allow the user to omit card types V, VI, and VII when preparing data for restart operations. The considerations effecting the input of the loads for restart operations are presented in Appendix 6.

October 1972

Appendix 6 - Load and Temperature Input Discussion

Since the DYNASOR II program accepts time varying loading and temperature conditions, the logic required to input these conditions is of necessity more complex than the logic required to input the other parameters. A discussion of the procedures for inputting these loading conditions is contained in this section. In this appendix the term loads refers to all distributed and concentrated forces while the term temperatures refers to both the temperature and temperature gradient distributions.

If there are no loads or no temperatures, it should be noted that a proper selection of the input constants allows omission of the input cards pertaining to the missing terms. In other words, the user selects the proper values for input keys and the proper read statements are automatically skipped.

To illustrate the procedure for inputting time varying loads and tempertures the information presented in Fugure A6-1 is utilized. The load-time and temperature-time curves are approximated as a series of linear segments by specifying values of both the loads and temperatures at discrete points in time and then assuming linear variations between the times. In order to specify the loads and temperatures in Figure A6-1, it is necessary to specify both the loads and the corresponding temperatures at times $T1_1$, $T1_2$, and $T1_3$. Both the applied loads and temperatures are constant from time $T1_3$ to the selected TOTIME so the value of CONSTF should be set equal to CONSTANT at time $T1_3$. Obviously, if the loads or temperatures vary rapidly with time, it may be necessary to specify these conditions at a large number of times in order for the linear variation to be an accurate representation of the load-time and temperature-time curves.

The logic for the load and tempaerature input is now discussed for each of the two program start conditions, namely:

IRSTRT = 0 Calculation begins at time increment = 0

IRSTRT = 1 Calculation begins at time increment = INCRST

1. The loads and the temperatures must both be input at each time T1 at which the loads or temperatures vary. In other words, the loads cannot be input at one time and the temperatures at another.

2. The difference between successive times at which the loads and temperatures are input ($T1_{i+1}$ - $T1_i$) must always be

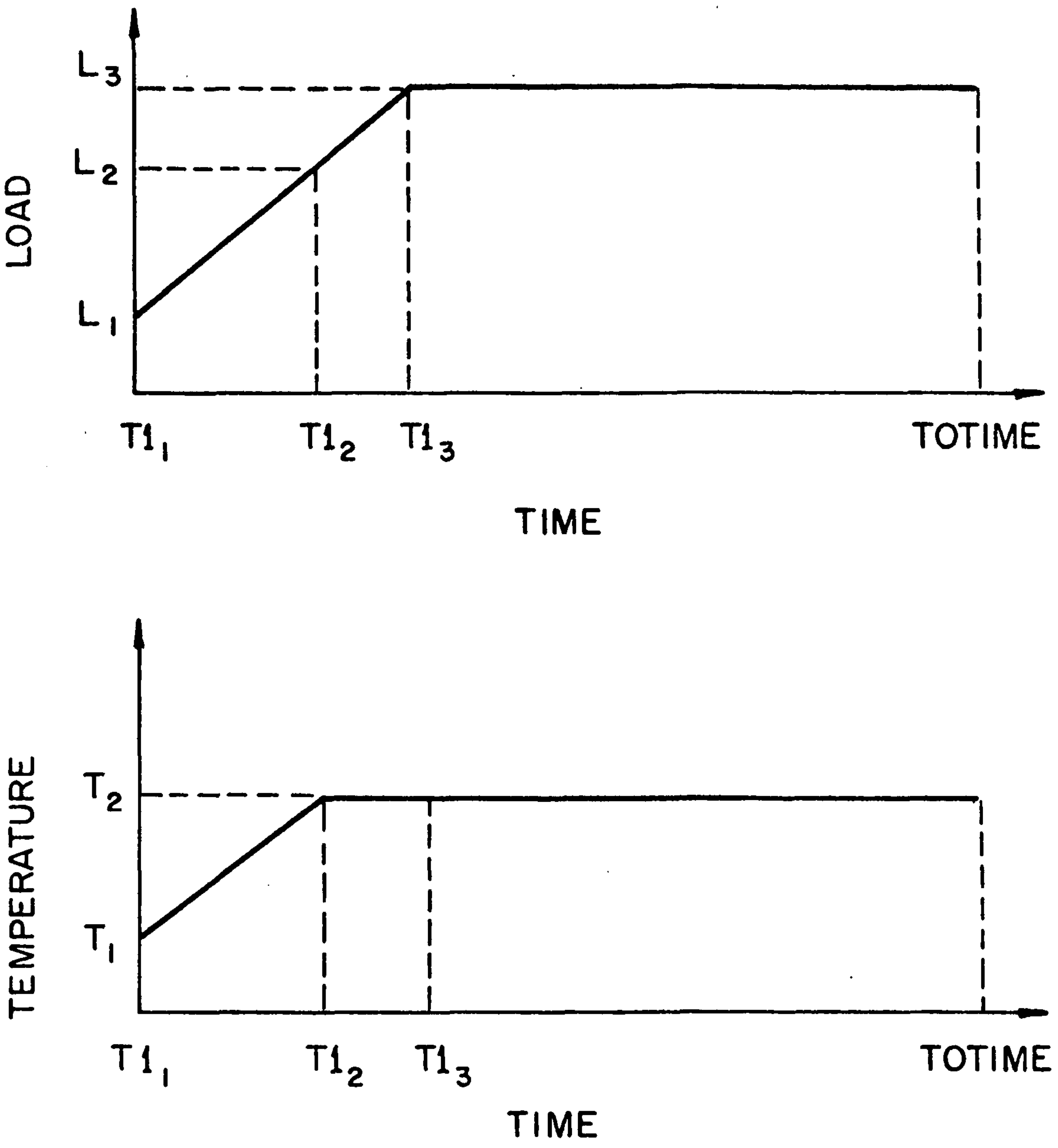


FIG A6-1 MECHANICAL AND THERMAL LOAD HISTORY FOR AN ELEMENT

greater than the time increment (DELTE) specified for solving the equations of motion.

INRART = 0

The cases which may arise when considering the loads and temperatures and the input logic required to describe these situations are as follows when the program is making an initial run on a problem:

CASE	INPUT LOGIC
1. Loads and temperatures and constant (in time) on each element. Note, however, that variations from element to element are allowed.	Input only one set of loads and temperatures. These must be specified at time T1 = 0.0 and the value of CONSTF should be read as CONSTANT.
2. Loads or temperatures (or both) vary with time.	Input, in order, the loads and temperatures at times $T1_1$ (must be equal to 0.0), $T1_2$, $T1_3$, ... until the value of T1 reaches or exceed the value of TOTIME (total time for the case.) The columns for CONSTF should be left blank.

IRSTRT = 1

The program may be restarted utilizing a new value for TOTIME which may be less than, equal to, or greater than the value which was utilized in the previous run which created and stored the restart information for use in this run. The previous value of TOTIME will be referred to as TOTIMEP. The input logic varies according to the relative values of TOTIME and TOTIMEP so each possible combination will be discussed separately.

Procedures which may not be utilized in the restart mode are:

1. If the program was originally run as case A with IRSTRT = 0, it is not possible to input loads and temperatures at any time until the value of TOTIMEP has been exceeded.

2. Consider that the program is being restarted at a time which is within the interval $T1_i$ -- $T1_{i+1}$. The loads and temperatures were input in the previous run for times $T1_i$ and $T1_{i+1}$. The first value of T1 for which the loads and temperatures may be specified in the restart mode must be greater than the time $T1_{i+1}$ which was utilized in the previous run.

Consideration will first be given to the cases where the new value of the maximum time is less than or equal to the one previously used.

TOTIME ≤ TOTIMEP

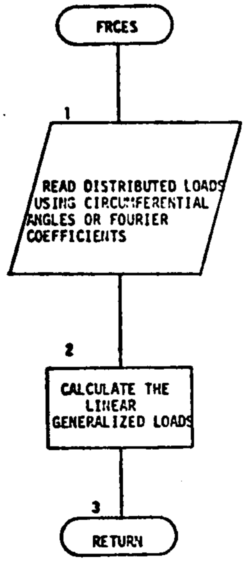
CASE	INPUT LOGIC
1. Both the loads and the temperatures are constant (in time) and are equal to the values specified for IRSTRT = 0, Case 1.	No loads or temperatures are input
2. Both the loads and temperatures are constant (in time) but are different from the values specfied for IRSTRT = 0, Case 1.	This problem is not allowed by the program. If the user desires to run this case, it is suggested that the problem be rerun beginning at time = 0.0.
3. Loads or temperatures vary with time. (This cannot be a restart of Case 1, IRSTRT = 0.)	Input loads and temperatures at times $T1_1$, $T1_2$, ... until the value $T1_n$ reaches or exceeds the value of TOTIME. The value of T1 must be greater than the value of $T1_{i+1}$ of the previous run

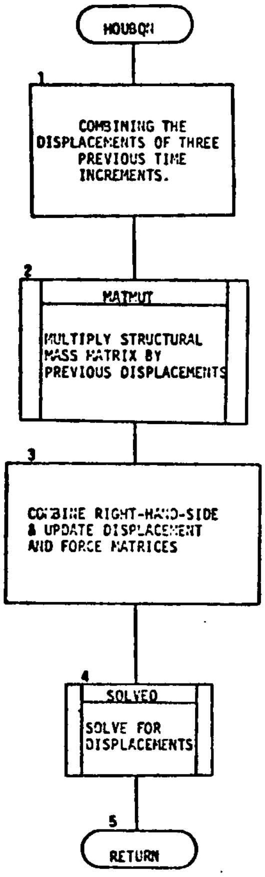
F

The possible cases which may arise if the value of TOTIME is greater than TOTIMEP are now presented. It should be noted that cases differ only slightly from those previously discussed.

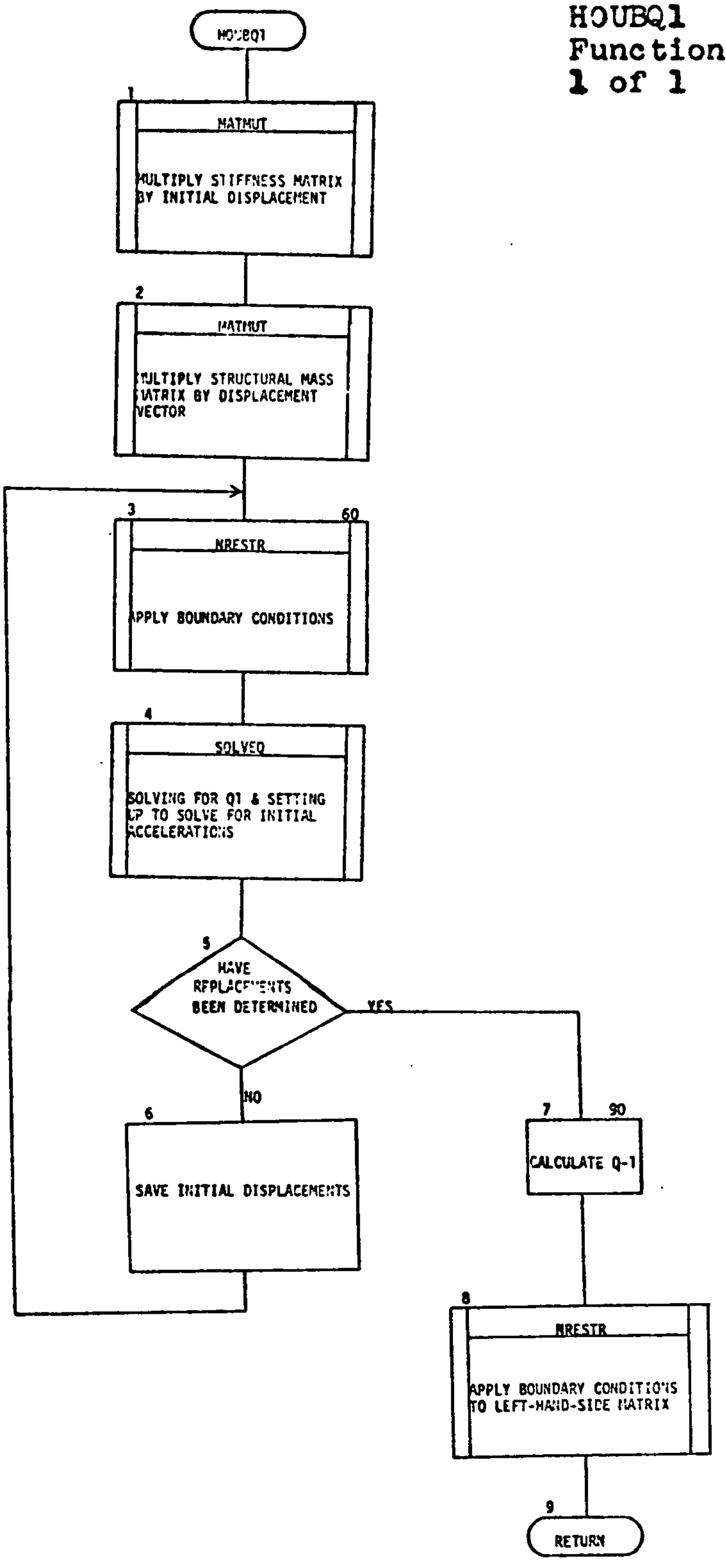
TOTIME > TOTIMEP

CASE	INPUT LOGIC
1. Both the loads and temperatures are constant (in time) and are equal to the values specified for IRSTRT = 0, Case 1.	The loads and temperatures must be input for T1 = TOTIMEP and the value of CONSTF is set as CONSTANT The specified loads and temperatures must be identical with those read for the previous run (IRSTRT = 0).
2. Both the loads and temperatures are constant (in time) but are different from the values specified for IRSTRT = 0, Case 1.	The new loads will not be applied until TOTIMEP is reached. The logic for Case 1, above, is then applied.
3. Loads at temperatures (or both) vary with time.	The loads and temperatures must be input at times $T1_1$, $T1_2$, ... until the value $T1_n$ reaches or exceeds the value of TOTIME.

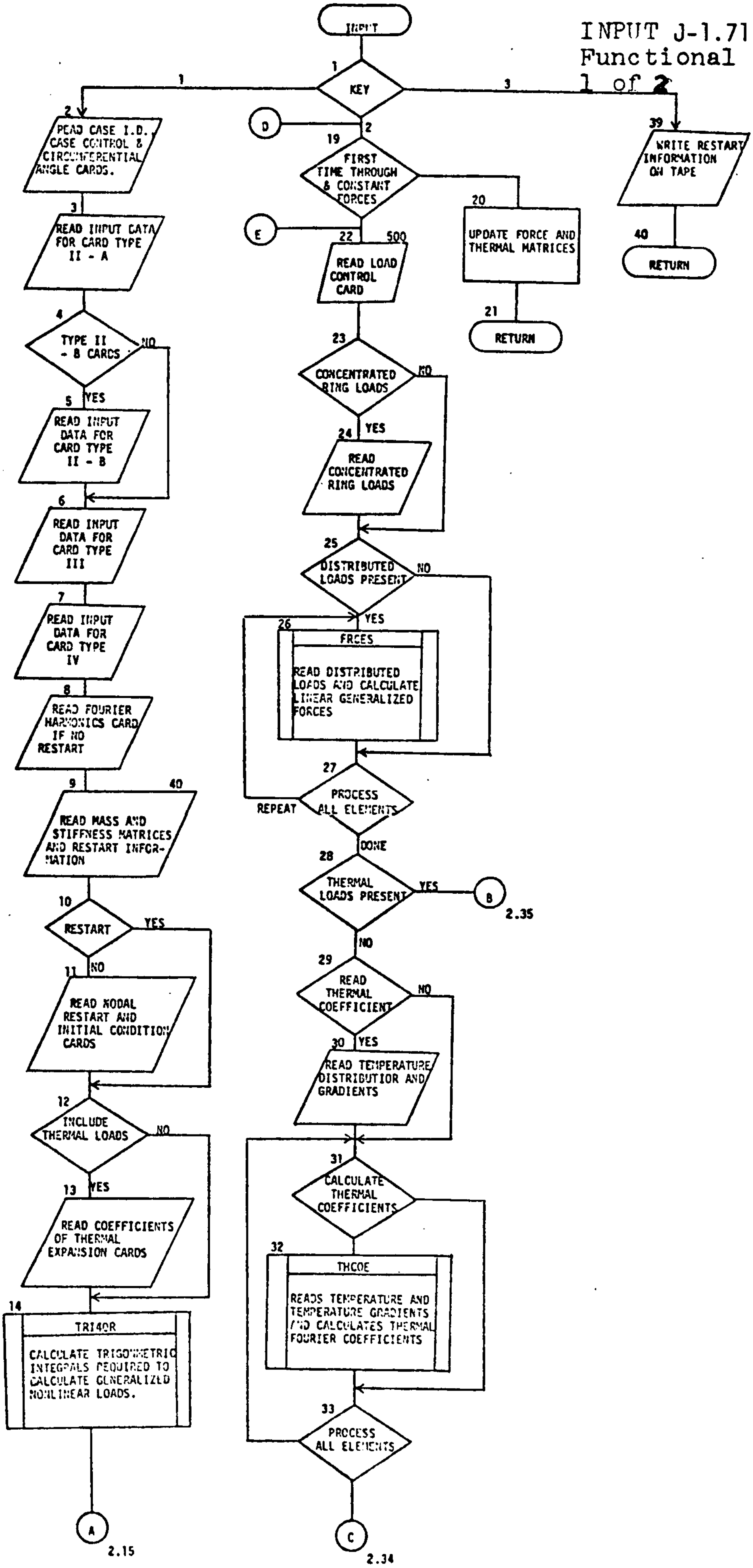

FRCES
1
READ DISTRIBUTED LOADS USING CIRCUMFERENTIAL ANGLES OR FOURIER COEFFICIENTS
2
CALCULATE THE LINEAR GENERALIZED LOADS
3
RETURN

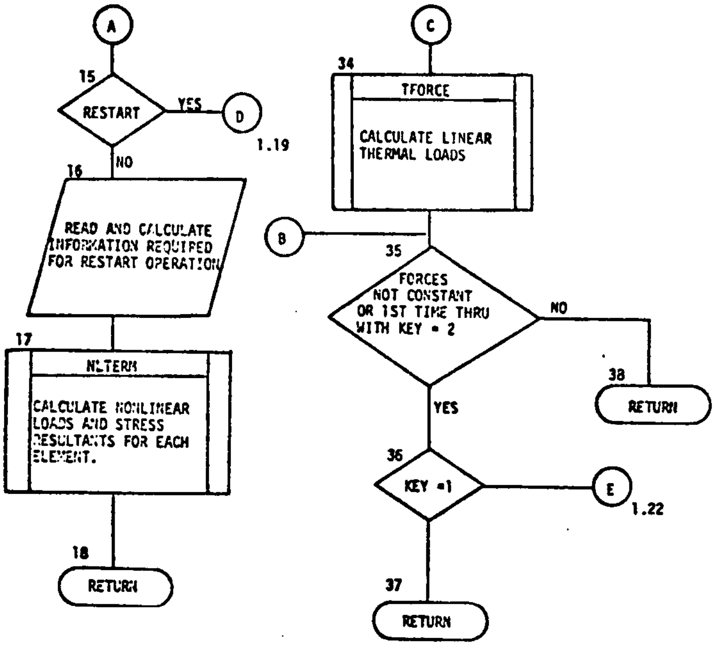

HOUBQN
1
COMBINING THE DISPLACEMENTS OF THREE PREVIOUS TIME INCREMENTS.
2
MATMUT
MULTIPLY STRUCTURAL MASS MATRIX BY PREVIOUS DISPLACEMENTS
3
COMBINE RIGHT-HAND-SIDE & UPDATE DISPLACEMENT AND FORCE MATRICES
4
SOLVEQ
SOLVE FOR DISPLACEMENTS
5
RETURN

HOUBQ1
Functional
1 of 1

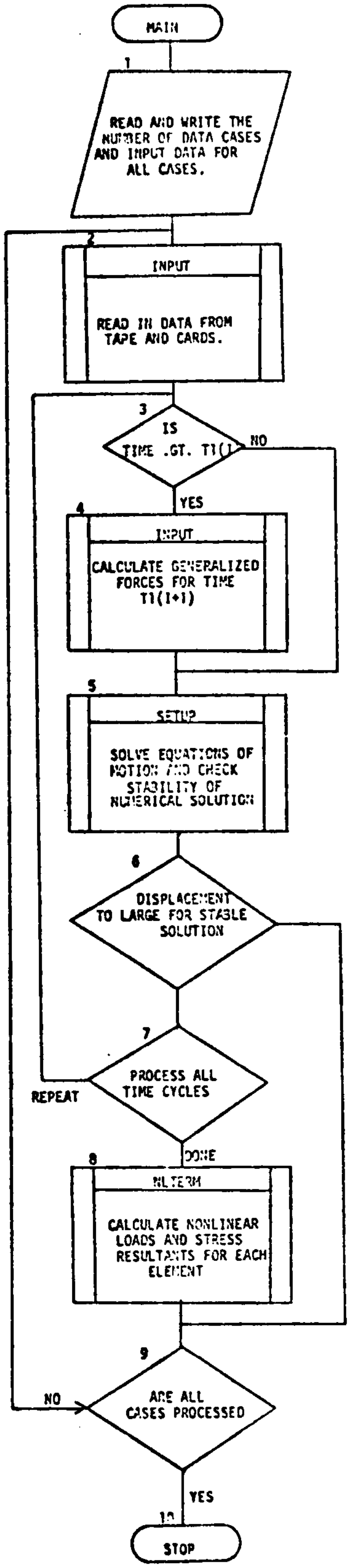

HOUBQ1
1
MATMUT
MULTIPLY STIFFNESS MATRIX BY INITIAL DISPLACEMENT
2
MATMUT
MULTIPLY STRUCTURAL MASS MATRIX BY DISPLACEMENT VECTOR
3
60
NRESTR
APPLY BOUNDARY CONDITIONS
4
SOLVEQ
SOLVING FOR Q1 & SETTING UP TO SOLVE FOR INITIAL ACCELERATIONS
5
HAVE REPLACEMENTS BEEN DETERMINED
YES
NO
6
SAVE INITIAL DISPLACEMENTS
7
90
CALCULATE Q-1
8
NRESTR
APPLY BOUNDARY CONDITIONS TO LEFT-HAND-SIDE MATRIX
9
RETURN

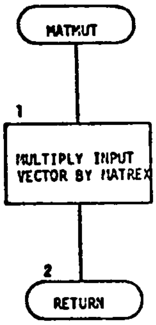
INPUT J-1.71
Functional
1 of 2

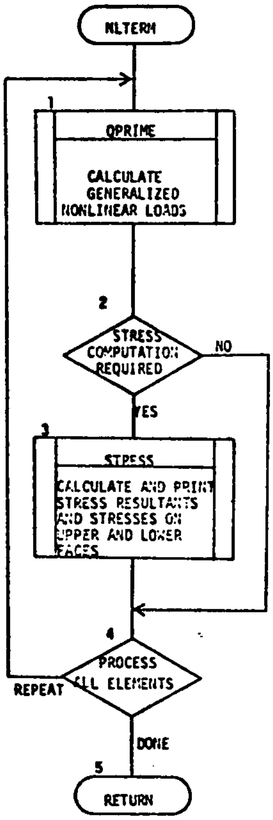

INPUT
1
KEY
1
3
2
2
READ CASE I.D., CASE CONTROL & CIRCUMFERENTIAL ANGLE CARDS.
3
READ INPUT DATA FOR CARD TYPE II - A
4
TYPE II - B CARDS
NO
YES
5
READ INPUT DATA FOR CARD TYPE II - B
6
READ INPUT DATA FOR CARD TYPE III
7
READ INPUT DATA FOR CARD TYPE IV
8
READ FOURIER HARMONICS CARD IF NO RESTART
9
40
READ MASS AND STIFFNESS MATRICES AND RESTART INFORMATION
10
RESTART
YES
11
NO
READ NODAL RESTART AND INITIAL CONDITION CARDS
12
INCLUDE THERMAL LOADS
NO
13
YES
READ COEFFICIENTS OF THERMAL EXPANSION CARDS
14
TRI40R
CALCULATE TRIGONOMETRIC INTEGRALS REQUIRED TO CALCULATE GENERALIZED NONLINEAR LOADS.
A
2.15
D
19
FIRST TIME THROUGH & CONSTANT FORCES
20
UPDATE FORCE AND THERMAL MATRICES
21
RETURN
E
22
500
READ LOAD CONTROL CARD
23
CONCENTRATED RING LOADS
NO
24
YES
READ CONCENTRATED RING LOADS
25
DISTRIBUTED LOADS PRESENT
NO
YES
26
FRCES
READ DISTRIBUTED LOADS AND CALCULATE LINEAR GENERALIZED FORCES
27
PROCESS ALL ELEMENTS
REPEAT
DONE
28
THERMAL LOADS PRESENT
YES
B
2.35
NO
29
READ THERMAL COEFFICIENT
NO
30
YES
READ TEMPERATURE DISTRIBUTIOR AND GRADIENTS
31
CALCULATE THERMAL COEFFICIENTS
32
THCOE
READS TEMPERATURE AND TEMPERATURE GRADIENTS AND CALCULATES THERMAL FOURIER COEFFICIENTS
33
PROCESS ALL ELEMENTS
C
2.34
39
WRITE RESTART INFORMATION ON TAPE
40
RETURN

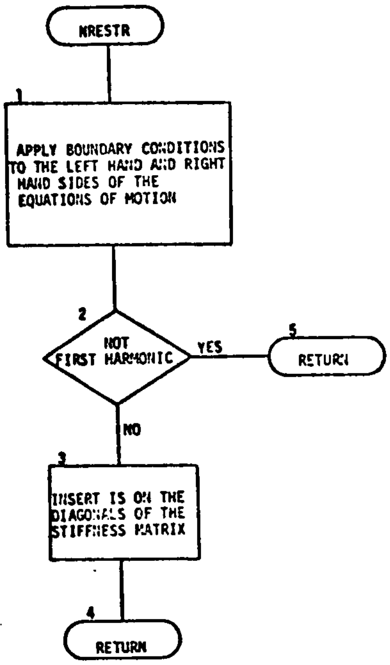

A
15
RESTART
YES
D
1.19
NO
16
READ AND CALCULATE INFORMATION REQUIRED FOR RESTART OPERATION
17
NLTERM
CALCULATE NONLINEAR LOADS AND STRESS RESULTANTS FOR EACH ELEMENT.
18
RETURN
C
34
TFORCE
CALCULATE LINEAR THERMAL LOADS
B
35
FORCES NOT CONSTANT OR 1ST TIME THRU WITH KEY = 2
NO
38
RETURN
YES
36
KEY =1
E
1.22
37
RETURN

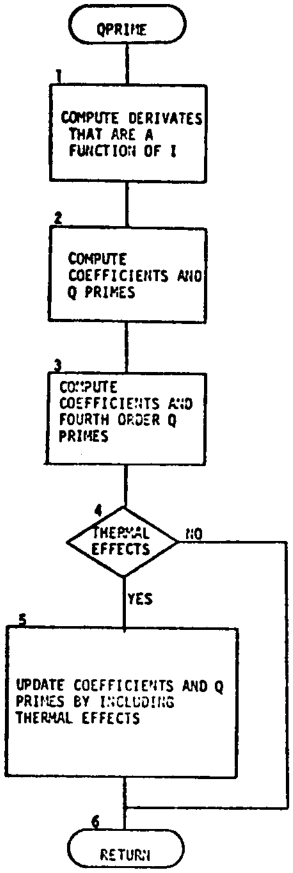
MAIN J-1.73
Functional
1 of 1


MAIN
1
READ AND WRITE THE NUMBER OF DATA CASES AND INPUT DATA FOR ALL CASES.
2
INPUT
READ IN DATA FROM TAPE AND CARDS.
3
IS TIME .GT. T1(I)
NO
YES
4
INPUT
CALCULATE GENERALIZED FORCES FOR TIME T1(I+1)
5
SETUP
SOLVE EQUATIONS OF MOTION AND CHECK STABILITY OF NUMERICAL SOLUTION
6
DISPLACEMENT TO LARGE FOR STABLE SOLUTION
7
PROCESS ALL TIME CYCLES
REPEAT
DONE
8
NLTERM
CALCULATE NONLINEAR LOADS AND STRESS RESULTANTS FOR EACH ELEMENT
9
ARE ALL CASES PROCESSED
NO
YES
10
STOP

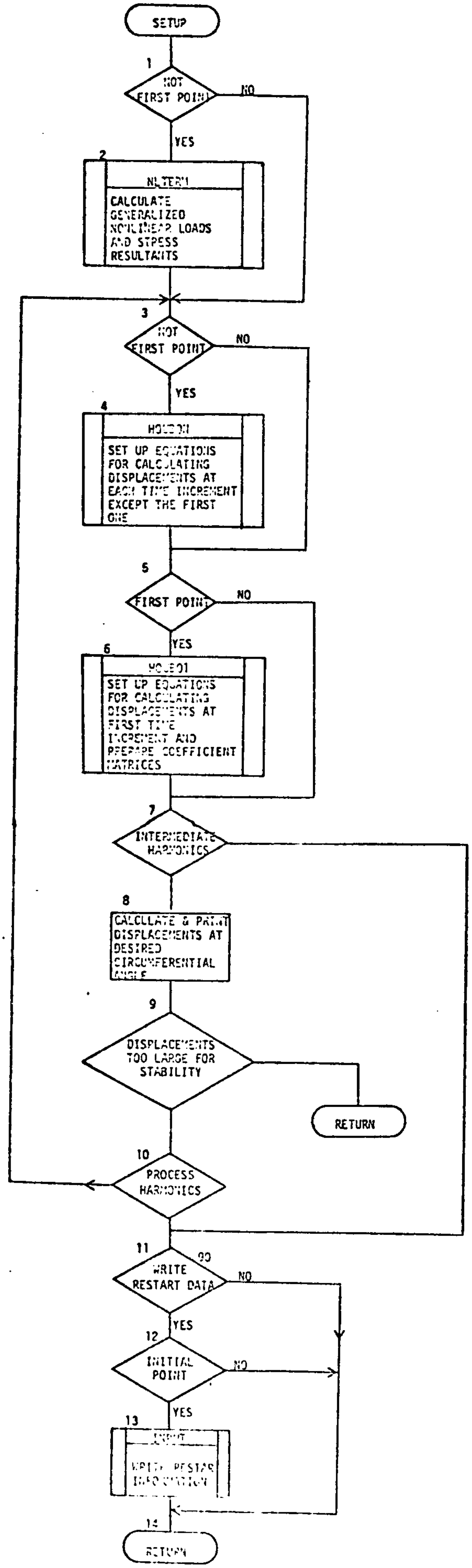

MATMUT
1
MULTIPLY INPUT VECTOR BY MATREX
2
RETURN

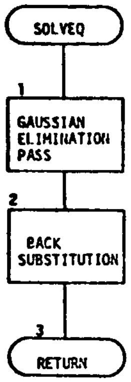

NLTERM
1
QPRIME
CALCULATE GENERALIZED NONLINEAR LOADS
2
STRESS COMPUTATION REQUIRED
NO
YES
3
STRESS
CALCULATE AND PRINT STRESS RESULTANTS AND STRESSES ON UPPER AND LOWER FACES
4
PROCESS ALL ELEMENTS
REPEAT
DONE
5
RETURN

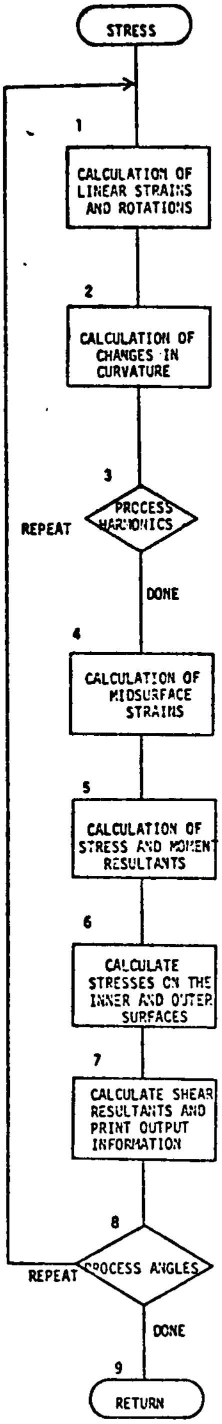

NRESTR
1
APPLY BOUNDARY CONDITIONS TO THE LEFT HAND AND RIGHT HAND SIDES OF THE EQUATIONS OF MOTION
2
NOT FIRST HARMONIC
YES
5
RETURN
NO
3
INSERT IS ON THE DIAGONALS OF THE STIFFNESS MATRIX
4
RETURN

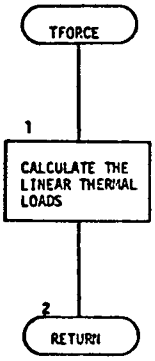

QPRIME
1
COMPUTE DERIVATES THAT ARE A FUNCTION OF I
2
COMPUTE COEFFICIENTS AND Q PRIMES
3
COMPUTE COEFFICIENTS AND FOURTH ORDER Q PRIMES
4
THERMAL EFFECTS
NO
YES
5
UPDATE COEFFICIENTS AND Q PRIMES BY INCLUDING THERMAL EFFECTS
6
RETURN

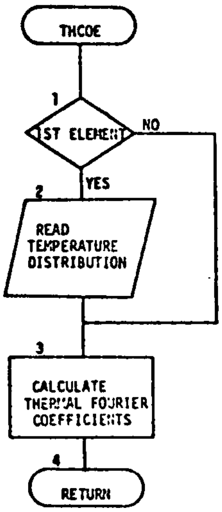
SETUP
Functional
1 of 1

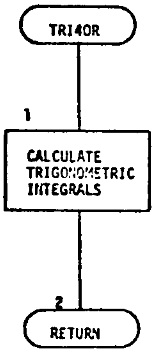

SETUP
1
NOT FIRST POINT
NO
YES
2
NLTERM
CALCULATE GENERALIZED NONLINEAR LOADS AND STRESS RESULTANTS
3
NOT FIRST POINT
NO
YES
4
HOLDON
SET UP EQUATIONS FOR CALCULATING DISPLACEMENTS AT EACH TIME INCREMENT EXCEPT THE FIRST ONE
5
FIRST POINT
NO
YES
6
MOLE01
SET UP EQUATIONS FOR CALCULATING DISPLACEMENTS AT FIRST TIME INCREMENT AND PREPARE COEFFICIENT MATRICES
7
INTERMEDIATE HARMONICS
8
CALCULATE & PRINT DISPLACEMENTS AT DESIRED CIRCUMFERENTIAL ANGLE
9
DISPLACEMENTS TOO LARGE FOR STABILITY
RETURN
10
PROCESS HARMONICS
11
90
WRITE RESTART DATA
NO
YES
12
INITIAL POINT
NO
YES
13
INPUT
WRITE RESTART INFORMATION
14
RETURN


SOLVEQ
1
GAUSSIAN
ELIMINATION
PASS
2
BACK
SUBSTITUTION
3
RETURN


STRESS
1
CALCULATION OF LINEAR STRAINS AND ROTATIONS
2
CALCULATION OF CHANGES IN CURVATURE
3
PROCESS HARMONICS
REPEAT
DONE
4
CALCULATION OF MIDSURFACE STRAINS
5
CALCULATION OF STRESS AND MOMENT RESULTANTS
6
CALCULATE STRESSES ON THE INNER AND OUTER SURFACES
7
CALCULATE SHEAR RESULTANTS AND PRINT OUTPUT INFORMATION
8
PROCESS ANGLES
REPEAT
DONE
9
RETURN


TFORCE
1
CALCULATE THE LINEAR THERMAL LOADS
2
RETURN


THCOE
1
1ST ELEMENT
NO
YES
2
READ TEMPERATURE DISTRIBUTION
3
CALCULATE THERMAL FOURIER COEFFICIENTS
4
RETURN


TRI4OR
1
CALCULATE TRIGONOMETRIC INTEGRALS
2
RETURN

DYNASOR II - A FINITE ELEMENT PROGRAM FOR THE DYNAMIC NONLINEAR ANALYSIS OF SHELLS OF REVOLUTION

Joe R. Tillerson and Walter E. Haisler

OPERATION MANUAL

October 15, 1970

TEES-RPT-70-19

Texas A&M University

College Station, Texas

J-2-1

ABSTRACT

The DYNASOR II program is used for the DYnamic Nonlinear Analysis of Shells Of Revolution. The equations of motion of the shell are solved using Houbolt's numerical procedure. The displacements and stress resultants can be determined for both symmetrical and asymmetrical loading conditions. Asymmetrical dynamic buckling can be investigated. Solutions can be obtained for highly nonlinear problems utilizing as many as five of the harmonics generated by SAMMSOR program. A restart capability allows the user to restart the program at a specified time.

TABLE OF CONTENTS

SOR - Shell Of Revolution

Computer Programs

A family of compatible computer codes for the analysis of the shell of revolution (SOR) structures has been developed by researchers at Texas A&M University. These analyses employ the matrix displacement method of structural analysis utilizing a curved shell element. Geometrically nonlinear static and dynamic analyses can be conducted using these codes. The important natural frequencies and mode shapes can also be determined by employing another of the codes. Efficient programming provides codes capable of performing these desired analyses in relatively small amounts of computer time.

Each of these programs has been extensively tested using problems the solutions to which have been reported by other researchers in order to establish the validity of the codes. In addition, the capabilities of the codes have been demonstrated in a number of publications by presenting solutions to problems which were unsolved by other researchers.

SAMMSOR II - Stiffness And Mass Matrices for Shells Of Revolution are generated utilizing the first member of this family. This program accepts a description of the structure in terms of the coordinates and slopes of the nodes and the properties of the elements joining the nodes. For shells with simple geometries (such as cylinders, shallow caps, hemispheres, etc.) the shell geometry can be internally generated. Utilizing the element properties, the structural stiffness and mass matrices are generated for as many as twenty harmonics and stored on magnetic tape. Each of the other SOR programs utilizes the output tape generated by SAMMSOR as input data for the respective analyses. One advantage of creating the stiffness and mass matrices in a separate program is that a variety of analyses can be performed on the same shell configuration without having to create the matrices more than once. Obviously, a variety of boundary and loading conditiions can be employed without having to create new mass and stiffness matrices for each case.

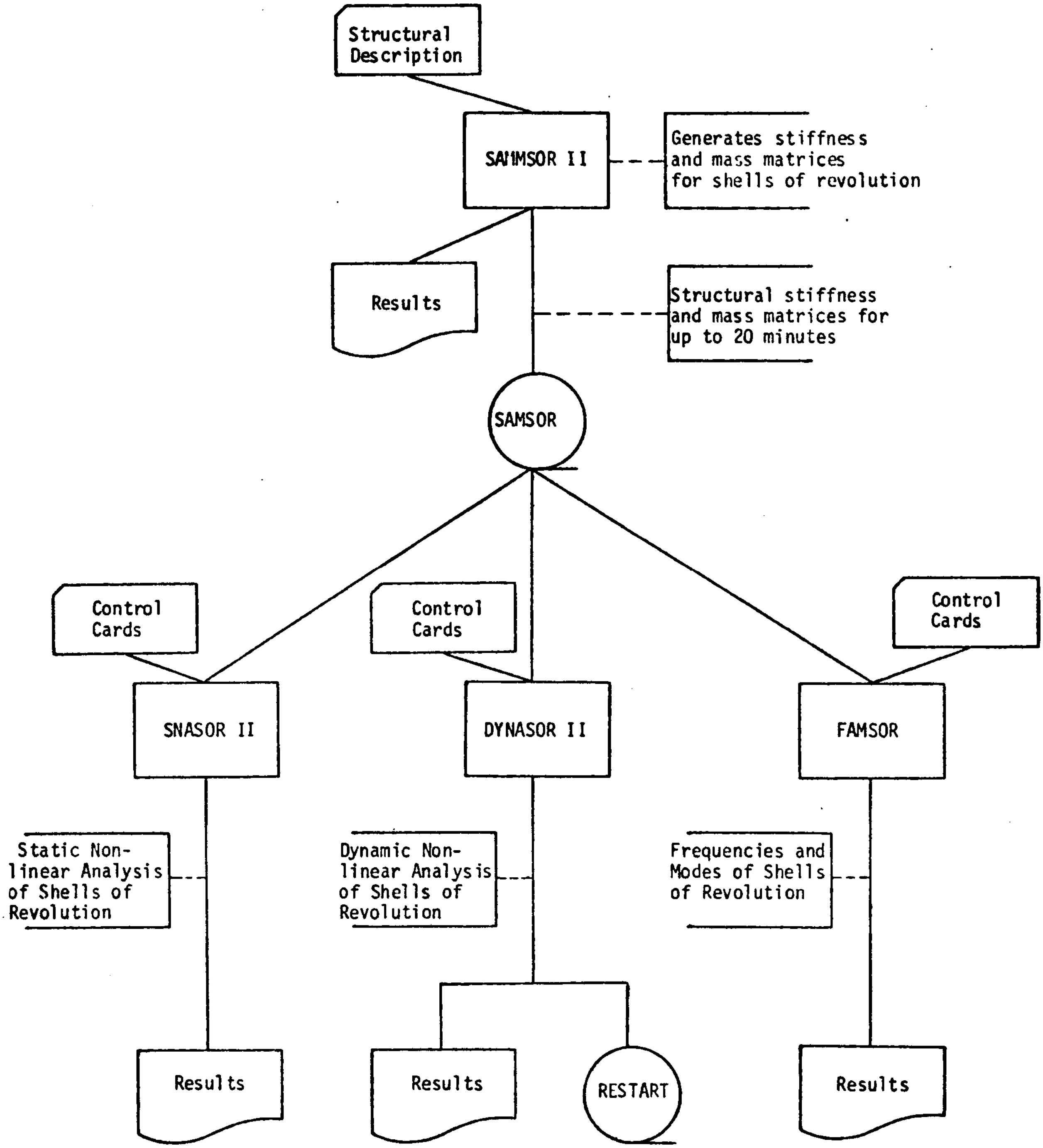
SNASOR II - The Static Nonlinear analysis of Shells Of Revolution subjected to arbitrary mechanical and thermal loading is performed using the second computer code. Utilizing the stiffness matrices generated by SAMMSOR and the loading conditions and boundary conditions input to SNASOR II, the equilibrium equations for the structure are generated. The nonlinear strain energy terms result in pseudo generalized forces (as functions of the displacements) which are combined with the applied generalized forces. The resulting set of nonlinear algebraic equilibrium equations is solved by one of several methods: Newton-Raphson

type iteration, incremental stiffness method, or a modified incremental stiffness method. In general, the Newton-Raphson procedurre is the best and yields accurate results for highly nonlinear problems.

DYNASOR II - The third code is used for the DYnamic Nonlinear Analysis of Shells Of Revolution. The equations of motion of the shell are solved using Houbolt's numerical procedure with the nonlinear terms being moved to the right-hand side of the equilibrium equations and again treated as generalized loads. The displacements and stress resultants can be determined for both symmetrical and asymmetrical loading conditions. Asymmetrical dynamic buckling can be investigated using this program. Solutions can be obtained for highly nonlinear problems in reasonable periods of time on the computer utilizing as many as five of the harmonics generated in SAMMSOR. A restart capability is incorporated in this code which allows the user to restart the program at a specified time without having to expend the computer time necessary to regenerate the prior response.

FAMSOR - Frequencies And Modes for Shells Of Revolution can be determined using the fourth code. Using the stiffness matrix generated by SAMMSOR and a lumped mass representation developed from the consistent mass matrix generated by SAMMSOR, a specified number of natural frequencies (beginning with the lowest or fundamental frequency) are obtained using the inverse iteration method. The mode shapes for each of the frequencies are also obtained.

SYSTEM FLOWCHART


Structural Description
SAMMSOR II
Generates stiffness and mass matrices for shells of revolution
Results
Structural stiffness and mass matrices for up to 20 minutes
SAMSOR
Control Cards
Control Cards
Control Cards
SNASOR II
DYNASOR II
FAMSOR
Static Non-linear Analysis of Shells of Revolution
Dynamic Non-linear Analysis of Shells of Revolution
Frequencies and Modes of Shells of Revolution
Results
Results
RESTART
Results

ENVIRONMENT

The DYNASOR II program runs under OS/360 MFT or MVT and requires 220K of memory on an IBM S/360 computer. The system must also have a card reader, printer, 3 9-track tape drives and 2314 disk storage.

SYSTEM OPERATION

A. Run Characteristics

1). Funtional description of run

(see abstract)

2). Relationship to other runs

(see system flowchart)

3). Set-up and run instructions

a. get SAMMSOR output tape

b. 2 scratch tapes

c. punch control cards

d. fill out job ticket

e. load job

4). Run frequency

when desired

5). Run prerequisites

SAMMSOR

6). Run control

none

7). Run schedule

no set schedule; run when desired or on demand

8). External procedures

none

B.

MACHINE SET UP FORM

PROG NAME DYNASOR PROG # ______ USER I.D. CODE ______
AREA Aerospace Engr. PROJECT ______ PROGRAMMER Haisler
JOB PREQ SAMMSOR REGION SIZE 110K K

DIRECT ACCESS REQUIREMENTS: none

PERMANENT

USER ASSIGNED PACK	DATA SET NAME	DDNAME	SERIAL # / CELL #	BIN #

TEMPORARY none

USER ASSIGNED PACK	DATA SET NAME	DDNAME	SERIAL # / CELL #	SPACE =

TAPE REQUIREMENTS:
#7 TRK. UNITS 0 # 9 TRK. UNITS 3

DATA SET NAME	DDNAME	LABEL TYPE	7 OR 9 TRK	DEN/ MODE	WRITE RING IN	RET PD IN DAYS	OUTPUT FROM RUN #	INPUT TO RUN #
SAMSOR	FT01F008	SL	9		no	until next	SAMSOR	DYNASOR
none	FT01F009	SL	9		yes	run	scratch	DYNASOR
none	FT01F010	SL	9		yes		scratch	DYNASOR

(FOR ADDITIONAL INFORMATION ATTACH ANOTHER SHEET)

ADDITION □ REPLACEMENT □

DATE ____ SECTION ____ PAGE ____

CARD READER REQUIREMENTS: SYSIN

DATA SET NAME	DDNAME	SOURCE	DISPOSITION

CARD PUNCH REQUIREMENTS: none

DATA SET NAME	DDNAME	POCKET #	DISPOSITION

PRINTER REQUIREMENTS: SYSPRINT

DATA SET NAME	DDNAME	PRINT TRAIN	FORM #	SETUP #	LINES PER INCH	BURST	DECOL- LATE	DISPOSITION

ADDITION □ REPLACEMENT □

DATE _____ SECTION _____ PAGE _____

C. File Information Sheet

date of last update

name: SAMSOR

system or application: DYNASOR

description of contents and use: stiffness and mass matrices for up to 20 harmonies; input to DYNASOR II program

storage medium: tape

record characteristics: Fortran output, variable length records

block characteristics: 7200 byte blocks, spanned

file activity: (approximate when necessary)

- not a permanently maintained file
- created when computing shells of revolution
- restart information written on tape by DYNASOR run.

D. Job Control Language

```
//DYNASR      JØB(_____,___,...)

/*CLASS       _

//JØBLIB      DD          DSNAME=USER.DYNASØR.JØBLIB,DISP=SHR

//DYNASØR     EXEC        PGM=DYNASØR

//FT01F005    DD          DDNAME=SYSIN

//FT01F006    DD          SYSØUT=A

//FT01F007    DD          SYSØUT=B

//FT01F008    DD          UNIT=2400,DISP=(ØLD,KEEP),DSNAME=SAMSØRIN,

//                        DCB=(RECFM=VBS,BLØCKSIZE=7200),VØL=SER=SAMSØ1

//FT01F009    DD          UNIT=2400,DISP=(NEW,DELETE),DCB=(RECFM=VBS,

//                        BLØCKSIZE=7200),VØL=SER=DYNSR1

//FT01F010    DD          UNIT=2400,DISP=(NEW,DELETE),DCB=(RECFM=VBS,

//                        BLØCKSIZE=7200),VØL=SER=DYNSR2

//SYSIN       DD          *
              .
              .
              .   CONTROL CARDS
              .
              .
/*
```

E. RUN CONTROL CARDS

Card Type I

Columns	Variable	Type
1-5	NCASES	Numeric
6-10	ND	Numeric
11-15	NS	Numeric

Card Type II-A

Columns	Variable	Type
1-5	NCARDS	Numeric
6-10	NT	Numeric

Card Type II-B

Columns	Variable	Type
1-80	COMENT	Alphanumeric

Card Type III-A

Columns	Variable	Type
1-10	TOTIME	Numeric
11-20	DELTE	Numeric
21-25	IRSTRT	Numeric
26-30	INCRST	Numeric
31-35	NCLOSE	Numeric
36-40	ITELF	Numeric

RUN CONTROL CARDS

Card Type III-B

Columns	Variable	Type
1-5	NPRNTQ	Numeric
6-10	IPRINT	Numeric
11-15	NCLCST	Numeric
16-20	NSTRSS	Numeric
21-25	NPRNT	Numeric
26-30	NPRNIT	Numeric
31-35	NPRNTL	Numeric
36-40	NPRNTF	Numeric
41-45	NPRNTH	Numeric
46-50	NPRNMS	Numeric

Card Type IV-A

Columns	Variable	Type
1-5	NTHETA	Numeric

Card Type IV-B

Columns	Variable	Type
1-10	THETA(1)	Numeric
11-20	THETA(2)	Numeric
"	"	
"	"	
"	THETA (NTHETA)	

Card Type V

Columns	Variable	Type
1-5	NH	Numeric

RUN CONTROL CARDS

Card Type V (Continued)

Columns	Variable	Type
6-10	IHARM(1)	Numeric
11-15	IHARM(2)	
16-20	IHARM(3)	
21-25	IHARM(4)	
26-30	IHARM(5)	

Card Type VI-A

Columns	Variable	Type
1-5	NODRES	Numeric

Card Type VI-B

Columns	Variable	Type
1-5	NP	Numeric
6-10	NDIRCT	Numeric

Card Type VII-A

Columns	Variable	Type
1-5	IQN	Numeric
6-10	IQN1	Numeric

Card Type VII-B

Columns	Variable	Type
1-5	IN1	Numeric
6-10	IN2	Numeric

RUN CONTROL CARDS

Card Type VII-B (Continued)

Columns	Variable	Type
11-20	$\dot{q}_1$	Numeric
21-30	$\dot{q}_2$	Numeric
31-40	$\dot{q}_3$	Numeric
41-50	$\dot{q}_4$	Numeric

Card Type VII-C

Columns	Variable	Type
1-5	IN1	Numeric
6-10	IN2	Numeric
11-20	$\dot{q}_1$	Numeric
21-30	$\dot{q}_2$	Numeric
31-40	$\dot{q}_3$	Numeric
41-50	$\dot{q}_4$	Numeric

Card Type VIII

Columns	Variable	Type
1-5	IELM1	Numeric
6-10	IELM2	Numeric
11-20	ALSI1	Numeric
21-30	ALTI1	Numeric

Card Type IX-A

Columns	Variable	Type
1-10	T1	Numeric

RUN CONTROL CARDS

Card Type IX-A (Continued)

Columns	Variable	Type
11-15	NCF	Numeric
16-20	IDELF	Numeric
21-25	IDCOE	Numeric
26-30	ITCOE	Numeric
31-38	CONSTF	Alphanumeric

Card Type IX-B-1

Columns	Variable	Type
1-5	NCF1	Numeric

Card Type IX-B-2

Columns	Variable	Type
1-5	IN1	Numeric
6-10	IN2	Numeric
11-20	F1	Numeric
21-30	F2	Numeric
31-40	F3	Numeric
41-50	F4	Numeric

Card Type IX-C-1-a

Columns	Variable	Type
1-5	IELM1	Numeric
6-10	IELM2	Numeric
11-15	NDP	Numeric

RUN CONTROL CARDS

Card Type IX-C-1-b

Columns	Variable	Type
1-10	THETB	Numeric
11-20	P	Numeric
21-30	R	Numeric
31-40	S	Numeric

Card Type IX-C-2-a

Columns	Variable	Type
1-5	IELM1	Numeric
6-10	IELM2	Numeric

Card Type IX-C-2-b

Columns	Variable	Type
1-10	P	Numeric
11-20	R	Numeric
21-30	S	Numeric

Card Type IX-D-1-a

Columns	Variable	Type
1-5	IELM1	Numeric
6-10	IELM2	Numeric
11-15	NDP	Numeric

Card Type IX-D-1-b

Columns	Variable	Type
1-10	THETB	Numeric
11-20	P	Numeric
21-30	R	Numeric

RUN CONTROL CARDS

Card Type IX-D-2-a

Columns	Variable	Type
1-5	IELM1	Numeric
6-10	IELM2	Numeric

Card Type IX-D-2-b

Columns	Variable	Type
1-10	TH1	Numeric
11-20	DTH1	Numeric

Card Type X

Columns	Punch
1-11	END OF CASE

Card Type XI

Columns	Punch
1-10	END OF RUN

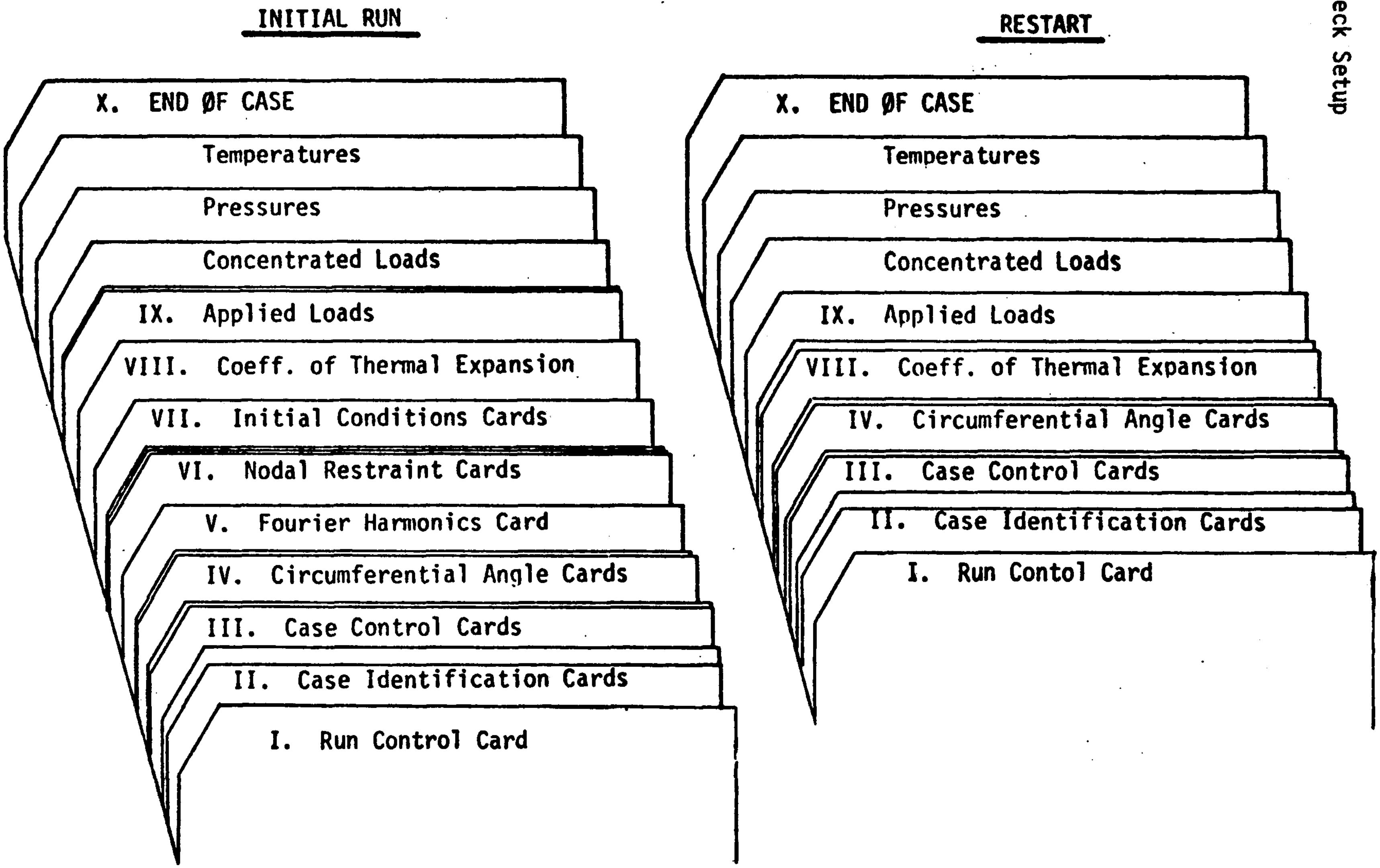
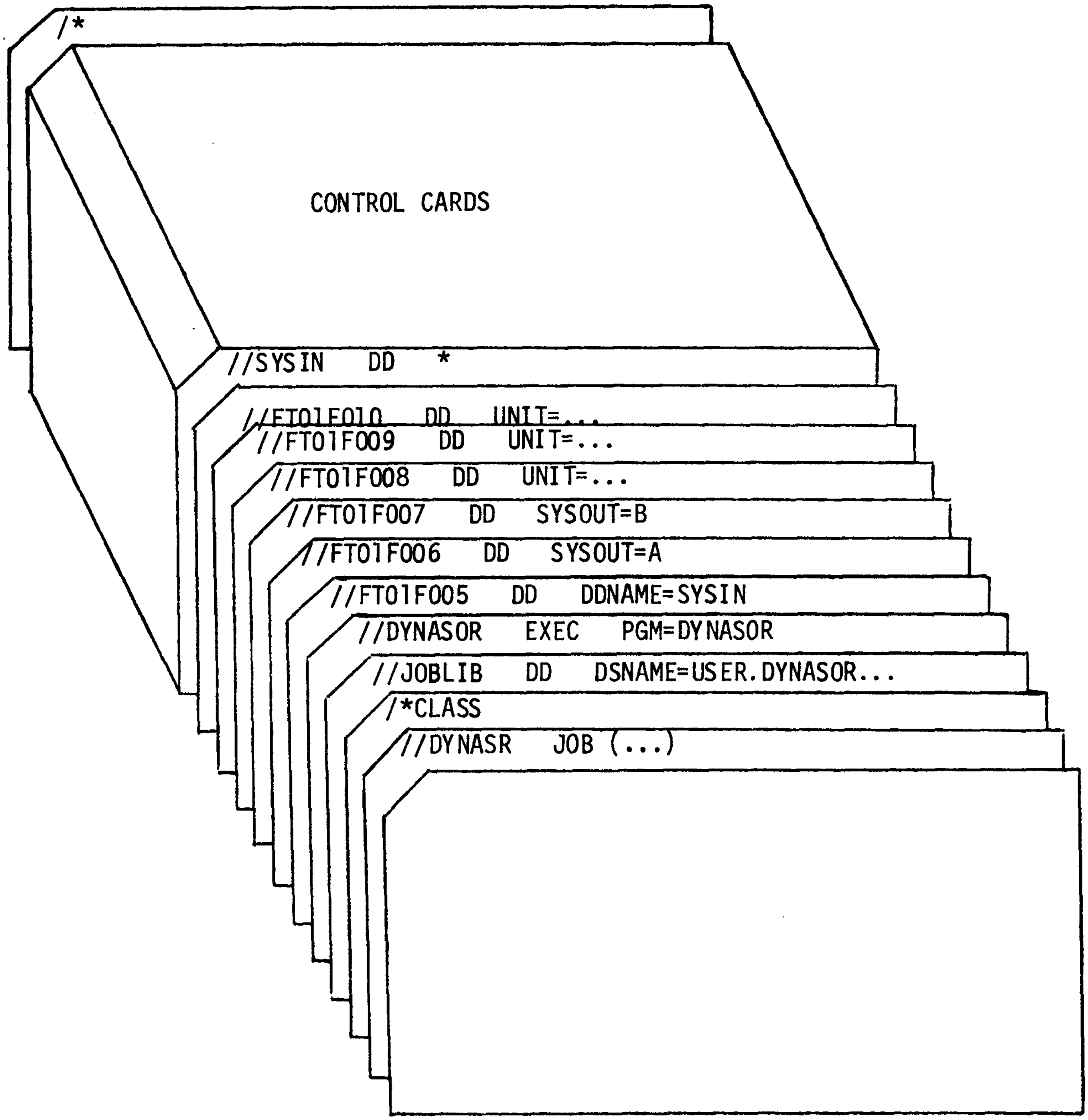

INITIAL RUN
X. END ØF CASE
Temperatures
Pressures
Concentrated Loads
IX. Applied Loads
VIII. Coeff. of Thermal Expansion
VII. Initial Conditions Cards
VI. Nodal Restraint Cards
V. Fourier Harmonics Card
IV. Circumferential Angle Cards
III. Case Control Cards
II. Case Identification Cards
I. Run Control Card
RESTART
X. END ØF CASE
Temperatures
Pressures
Concentrated Loads
IX. Applied Loads
VIII. Coeff. of Thermal Expansion
IV. Circumferential Angle Cards
III. Case Control Cards
II. Case Identification Cards
I. Run Contol Card

FIG. 1 CONSTITUTION OF DATA DECKS - INITIAL RUN AND RESTART MODES.

DECK SETUP FOR DYNASOR II



```
/*
//SYSIN     DD    *
//FT01F010    DD    UNIT=...
//FT01F009    DD    UNIT=...
//FT01F008    DD    UNIT=...
//FT01F007    DD    SYSOUT=B
//FT01F006    DD    SYSOUT=A
//FT01F005    DD    DDNAME=SYSIN
//DYNASOR    EXEC    PGM=DYNASOR
//JOBLIB    DD    DSNAME=USER.DYNASOR...
/*CLASS
//DYNASR    JOB (...)
```

G. 360 MESSAGE FORM

DATE____________________

ADDITION [] REPLACEMENT []

[] OPERATIONAL [] ADMINISTRATIVE

Jobname____________________PROGRAMMER_______________MSG ID________

MESSAGE: The number of input cases does not agree with the value of ncases input

MEANING:

ACTION:

360 MESSAGE FORM

DATE________________________

ADDITION [] REPLACEMENT []

[] OPERATIONAL [] ADMINISTRATIVE

Jobname________________________PROGRAMMER__________________MSG ID_________

MESSAGE: Restart information for time increment no., I5,/,10X, corresponding to time, F12.4, microseconds,/,2X, has been placed on tape for use in subsequent runs//

MEANING:

ACTION:

360 MESSAGE FORM

DATE____________________________

ADDITION [] REPLACEMENT []

[] OPERATIONAL [] ADMINISTRATIVE

Jobname_____________________________PROGRAMMER_____________________MSG ID__________

MESSAGE: ITAM, I5, 5X time, E 12.5 Execution terminated - displacements greater than 1.E + 4

MEANING:

ACTION:

H. CHECKPOINT, RESTART, ERROR PROCEDURES, BACKUP, AND RECOVERY PROCEDURES

Recovery Procedures:

If many computations are to be done, a backup copy of the SAMMSOR input and restart tape can be made. Otherwise, no backup is required.

Restart Procedures:

To restart DYNASOR program, set IRSTRT = 1 on control card type III-A. Use SAMMSOR input tape. Restart information was written onto this tape in the previous run.

DYNASOR II - A FINITE ELEMENT PROGRAM FOR THE DYNAMIC NONLINEAR ANALYSIS OF SHELLS OF REVOLUTION

Joe R. Tillerson and Walter E. Haisler

MAINTENANCE MANUAL

October 15, 1970

TEES-RPT-70-19

Texas A&M University

College Station, Texas

J-3-1

ABSTRACT

The DYNASOR II program is used for the DYnamic Nonlinear Analysis of Shells Of Revolution. The equations of motion of the shell are solved using Houbolt's numerical procedure. The displacements and stress resultants can be determined for both symmetrical and asymmetrical loading conditions. Asymmetrical dynamic buckling can be investigated. Solutions can be obtained for highly nonlinear problems utilizing as many as five of the harmonics generated by SAMMSOR program. A restart capability allows the user to restart the program at a specified time.

TABLE OF CONTENTS

D. INPUT

E. MAIN

F. MATMUT

G. NLTERM

H. NRESTR

I. QPRIME

J. SETUP

K. SOLVEQ

L. STRESS

M. TFORCE

SOR - Shell Of Revolution

Computer Programs

A family of compatible computer codes for the analysis of the shell of revolution (SOR) structures has been developed by researchers at Texas A&M University. These analyses employ the matrix displacement method of structural analysis utilizing a curved shell element. Geometrically nonlinear static and dynamic analyses can be conducted using these codes. The important natural frequencies and mode shapes can also be determined by employing another of the codes. Efficient programming provides codes capable of performing these desired analyses in relatively small amounts of computer time.

Each of these programs has been extensively tested using problems the solutions to which have been reported by other researchers in order to establish the validity of the codes. In addition, the capabilities of the codes have been demonstrated in a number of publications by presenting solutions to problems which were unsolved by other researchers.

SAMMSOR II - Stiffness And Mass Matrices for Shells Of Revolution are generated utilizing the first member of this family. This program accepts a description of the structure in terms of the coordinates and slopes of the nodes and the properties of the elements joining the nodes. For shells with simple geometries (such as cylinders, shallow caps, hemispheres, etc.) the shell geometry can be internally generated. Utilizing the element properties, the structural stiffness and mass matrices are generated for as many as twenty harmonics and stored on magnetic tape. Each of the other SOR programs utilizes the output tape generated by SAMMSOR as input data for the respective analyses. One advantage of creating the stiffness and mass matrices in a separate program is that a variety of analyses can be performed on the same shell configuration without having to create the matrices more than once. Obviously, a variety of boundary and loading conditiions can be employed without having to create new mass and stiffness matrices for each case.

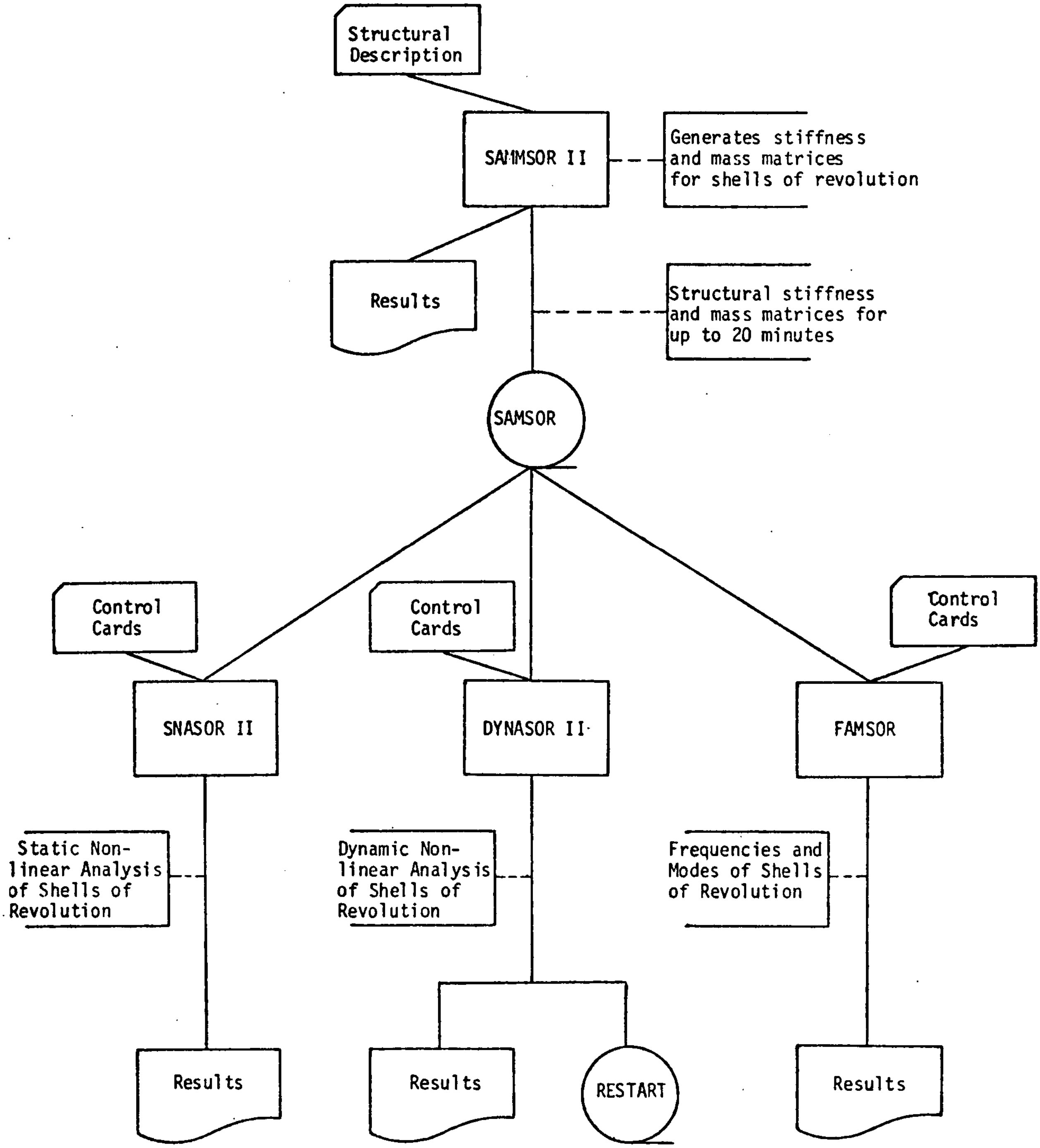
SNASOR II - The Static Nonlinear analysis of Shells Of Revolution subjected to arbitrary mechanical and thermal loading is performed using the second computer code. Utilizing the stiffness matrices generated by SAMMSOR and the loading conditions and boundary conditions input to SNASOR II, the equilibrium equations for the structure are generated. The nonlinear strain energy terms result in pseudo generalized forces (as functions of the displacements) which are combined with the applied generalized forces. The resulting set of nonlinear algebraic equilibrium equations is solved by one of several methods: Newton-Raphson

type iteration, incremental stiffness method, or a modified incremental stiffness method. In general, the Newton-Raphson procedurre is the best and yields accurate results for highly nonlinear problems.

DYNASOR II - The third code is used for the DYnamic Nonlinear Analysis of Shells Of Revolution. The equations of motion of the shell are solved using Houbolt's numerical procedure with the nonlinear terms being moved to the right-hand side of the equilibrium equations and again treated as generalized loads. The displacements and stress resultants can be determined for both symmetrical and asymmetrical loading conditions. Asymmetrical dynamic buckling can be investigated using this program. Solutions can be obtained for highly nonlinear problems in reasonable periods of time on the computer utilizing as many as five of the harmonics generated in SAMMSOR. A restart capability is incorporated in this code which allows the user to restart the program at a specified time without having to expend the computer time necessary to regenerate the prior response.

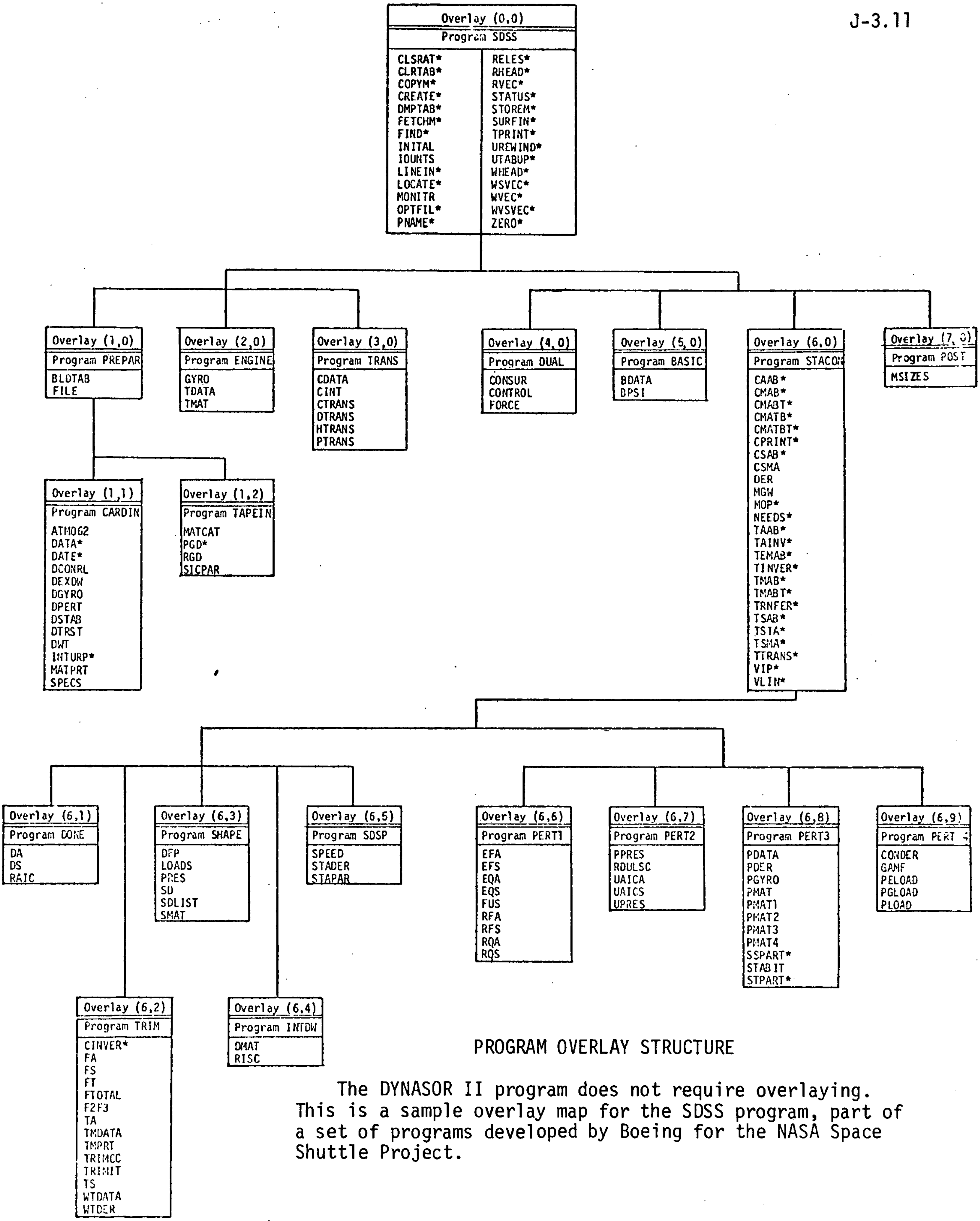
FAMSOR - Frequencies And Modes for Shells Of Revolution can be determined using the fourth code. Using the stiffness matrix generated by SAMMSOR and a lumped mass representation developed from the consistent mass matrix generated by SAMMSOR, a specified number of natural frequencies (beginning with the lowest or fundamental frequency) are obtained using the inverse iteration method. The mode shapes for each of the frequencies are also obtained.

SYSTEM FLOWCHART


Structural Description
SAMMSOR II
Generates stiffness and mass matrices for shells of revolution
Results
Structural stiffness and mass matrices for up to 20 minutes
SAMSOR
Control Cards
Control Cards
Control Cards
SNASOR II
DYNASOR II
FAMSOR
Static Non-linear Analysis of Shells of Revolution
Dynamic Non-linear Analysis of Shells of Revolution
Frequencies and Modes of Shells of Revolution
Results
Results
RESTART
Results

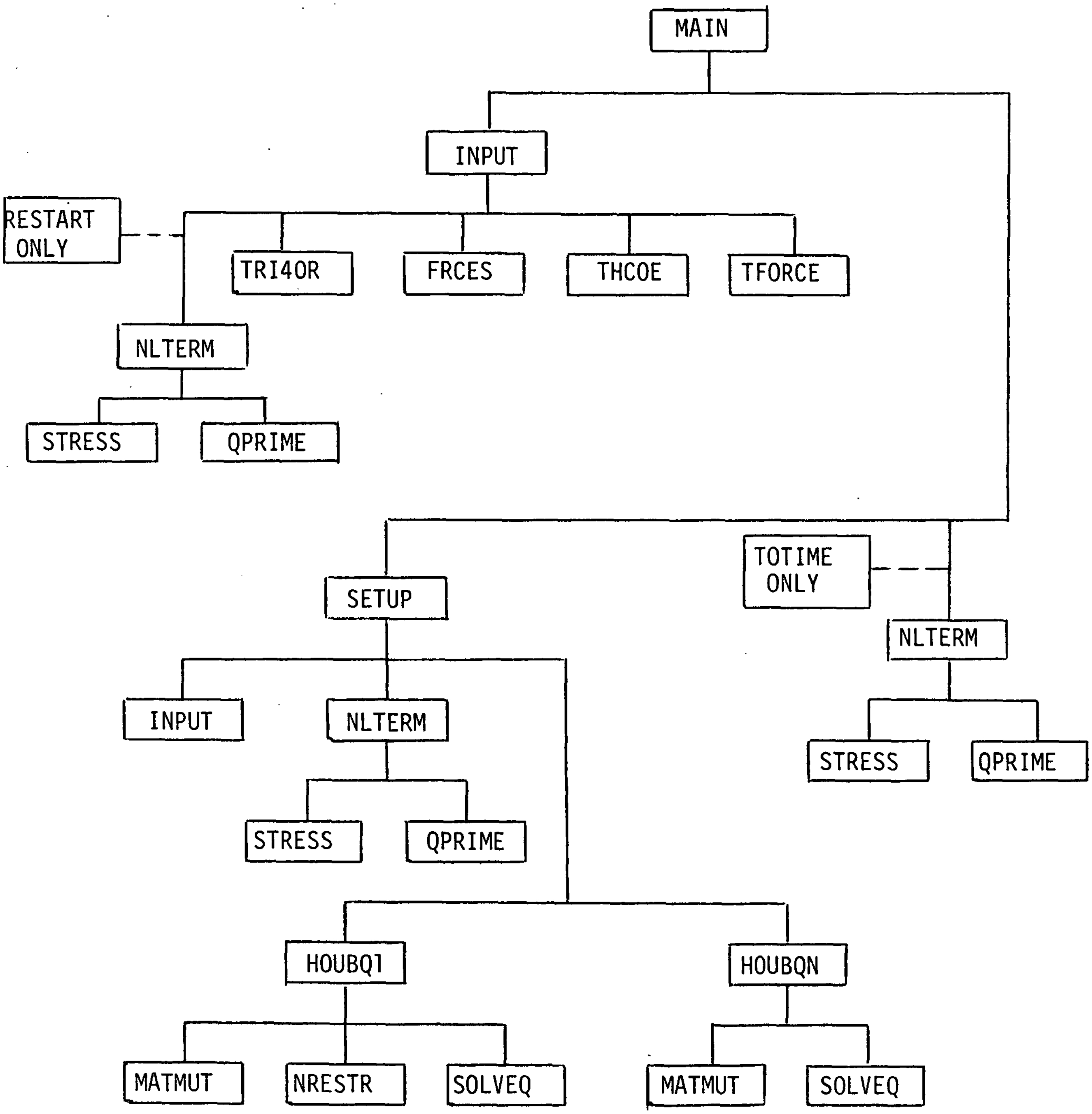
ENVIRONMENT

The DYNASOR II program runs under OS/360 MFT or MVT and requires 220K of memory on an IBM S/360 computer. The system must also have a card reader, printer, 3 9-track tape drives and 2314 disk storage.



PROGRAM OVERLAY STRUCTURE

The DYNASOR II program does not require overlaying. This is a sample overlay map for the SDSS program, part of a set of programs developed by Boeing for the NASA Space Shuttle Project.

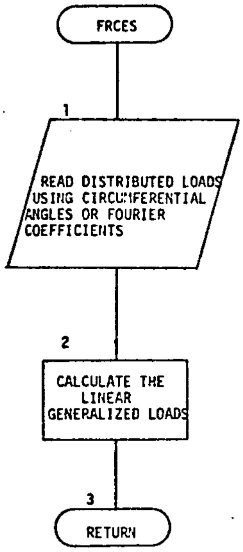


SUBROUTINE CALL DIAGRAM

```
              CE(FRCES)                                                            DYN14872
              C                                                                    DYN14874
              C     DESCRIPTION - TO READ IN THE DISTRIBUTED LOADS ON THE SHELL    DYN14876
              C            STRUCTURE. THEN, USING FITHER CIRCUMFERENTIAL OR        DYN14878
              C            FOURIER COEFFICIENTS DATA, CALCULATE THE LINEAR         DYN14880
              C            GENERALIZED LOADS.                                      DYN14882
              C                                                                    DYN14884
              C  INPUT ARGUMENTS.                                                  DYN14886
              C     IB     = FORCE ARRAY STEPPING PARAMETER, USED TO MODIFY CURRENT DYN14888
              C              BLOCK OF STORAGE FOR FORCE.                           DYN14890
              C     IELM   = NUMBER OF SHELL ELEMENTS.                             DYN14892
              C                                                                    DYN14894
              C  OUTPUT ARGUMENTS.                                                 DYN14896
              C     FORCE  = MATRIX OF GENERALIZED FORCES DUE TO EXTERNAL LOADS AND DYN14898
              C              TEMPERATURES.                                         DYN14900
              C     Q        THERMAL COEFFICIENTS USED IN CALCULATING GENERALIZED  DYN14902
              C              LINEAR LOADS DUE TO THERMAL EFFECTS.                  DYN14904
              C     QQ     = GENERALIZED LINEAR LOADS DUE TO THERMAL EFFECTS.      DYN14906
              C                                                                    DYN14908
              C  EXTERNALS.                                                        DYN14910
              C     CALLED BY                                                      DYN14912
              C              INPUT                                                 DYN14914
              C                                                                    DYN14916
 0001                SUBROUTINE FRCES (IELM,ALPHK,IB)                              DYN14918
 0002                IMPLICIT REAL*8 (A-H,O-Z)                                     DYN14920
 0003                COMMON /FRCE/ P(74),R(74),S(74),THETB(74)                     DYN14922
 0004                COMMON /CHALS/ AL(167),CHECK(8,8)                             DYN14924
 0005                COMMON /QS/ QN(1020),QN1(1020),FORCE(2040),QP(1020),QP1(1020), DYN14926
                    1        QN2(1020)                                             DYN14928
 0006                COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS, DYN14930
                    1        DT2,NPRNTL,NPRNTF,IDELF,IDCOE                         DYN14940
 0007                COMMON /HARM/ NHP,IHARM(5)                                    DYN14950
 0008                COMMON /QUES/ Q(8),QQ(8)                                      DYN14960
 0009                COMMON /TAPES/ NT,ND,NS                                       DYN14970
              C1     READ DISTRIBUTED LOADS USING CIRCUMFERENTIAL ANGLES OR FOURIER DYN14972
              C1C         COEFFICIENTS                                             DYN14974
 0010                PI=3.14159265                                                 DYN15020
 0011                IF (IELM.EQ.1) IELM2=0                                        DYN15030
 0012                IF (IELM.LE.IELM2.AND.IELM.NE.1) GO TO 40                     DYN15040
 0013                IF (IDCOE.NE.1) GO TO 10                                      DYN15050
 0014                IF (NPRNTL.EQ.1.AND.IELM.EQ.1) WRITE (6,160)                  DYN15060
              C       READ INPUT DATA FOR CARD TYPE IX - C - 2                     DYN15070
 0015                READ (ND,170) IELM1,IELM2,(P(I),R(I),S(I),I=1,NH)             DYN15080
 0016                IF (NPRNTL.EQ.1) WRITE (6,180) IELM1,IELM2,(P(I),R(I),S(I),I,I=1, DYN15090
                    1        NH)                                                   DYN15100
 0017                GO TO 40                                                      DYN15110
 0018             10 CONTINUE                                                      DYN15120
 0019                IF (NPRNTL.EQ.1.AND.IELM.EQ.1) WRITE (6,190)                  DYN15130
```

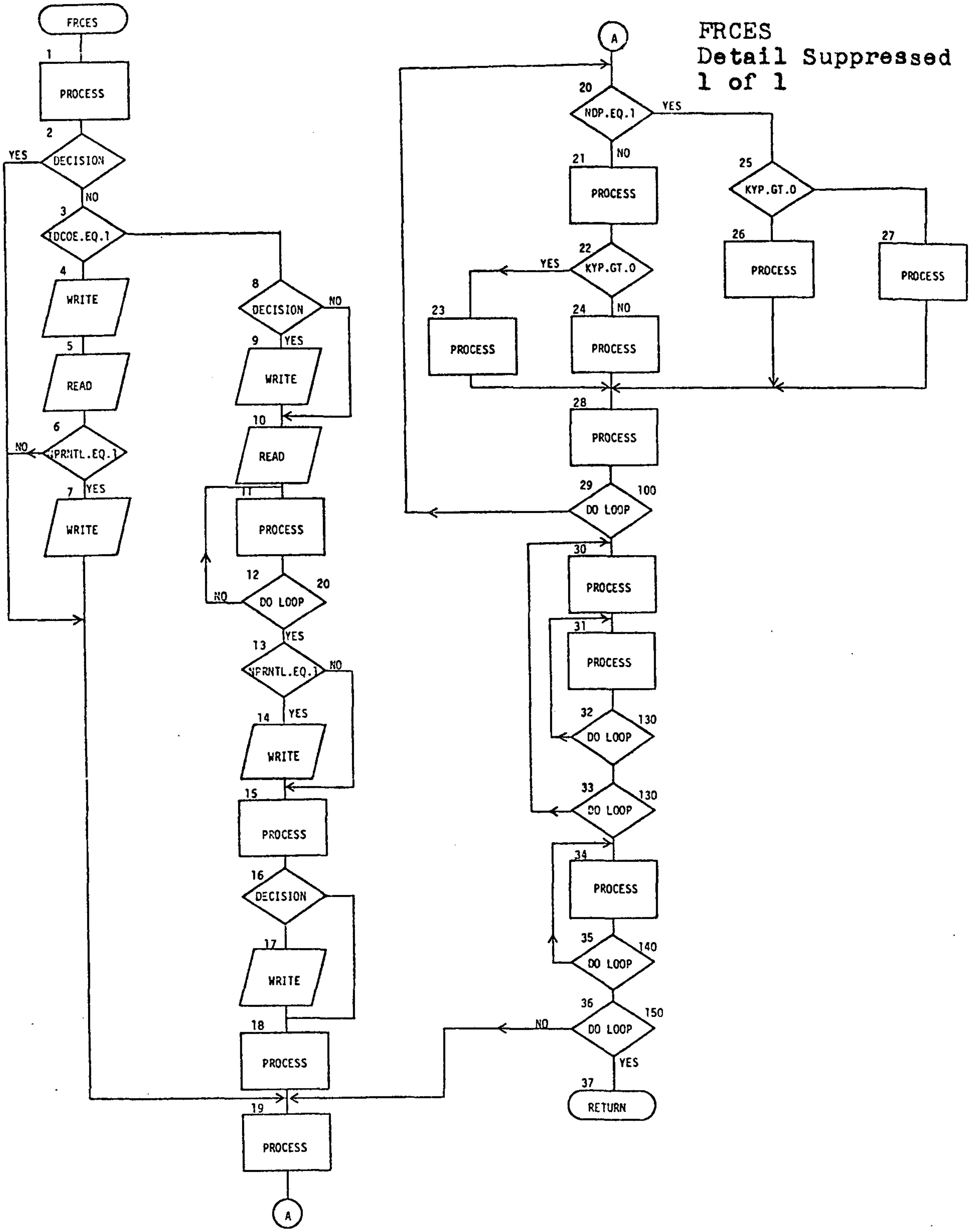
```
              C     READ DISTRIBUTED LOADS                                          DYN15140
              C                                                                     DYN15150
              C      READ INPUT DATA FOR CARD TYPE IX - C - 1                       DYN15160
 0020               READ (ND,200) IELM1,IELM2,NDP,(THETB(I),P(I),R(I),S(I),I=1,NDP) DYN15170
 0021               NDP2=2*NDP+1                                                    DYN15180
              C                                                                     DYN15188
 0022               DO 20 IF=1,NDP                                                  DYN15190
 0023                  ANG=360.0-THETB(IF)                                          DYN15200
 0024                  KEY=NDP2-IF                                                  DYN15210
 0025                  THETB(KEY)=ANG                                               DYN15220
 0026                  P(KEY)=P(IF)                                                 DYN15230
 0027                  R(KEY)=R(IF)                                                 DYN15240
 0028                  S(KEY)=S(IF)                                                 DYN15250
 0029            20 CONTINUE                                                        DYN15260
              C                                                                     DYN15263
 0030               IF (NPRNTL.EQ.1) WRITE (6,210) IELM1,IELM2,(P(I),R(I),S(I),     DYN15270
                  1          THETB(I),THETB(I+1),I=1,NDP)                           DYN15280
 0031               ND2=2*NDP                                                       DYN15290
 0032               NDPP2=NDP+2                                                     DYN15300
 0033               IF (NPRNTL.EQ.1.AND.NDP.GT.1) WRITE (6,220) (P(I),R(I),S(I),    DYN15310
                  1          THETB(I-1),THETB(I),I=NDPP2,ND2)                       DYN15320
              C                                                                     DYN15328
 0034               DO 30 IDP=1,ND2                                                 DYN15330
 0035                  THETB(IDP)=THETB(IDP)/57.2957795                             DYN15340
 0036            30 CONTINUE                                                        DYN15342
              C                                                                     DYN15345
              C1    CALCULATE THE LINEAR GENERALIZED LOADS                          DYN15347
 0037            40 CONTINUE                                                        DYN15350
              C                                                                     DYN15358
 0038               DO 150 IH=1,NH                                                  DYN15360
 0039                  KYP=IHARM(IH)                                                DYN15370
 0040                  YKP=KYP                                                      DYN15380
 0041                  IF (IDCOE.EQ.1) GO TO 110                                    DYN15390
              C                                                                     DYN15398
 0042                  DO 50 I=1,8                                                  DYN15400
 0043                     Q(I)=0.0                                                  DYN15410
 0044            50    CONTINUE                                                     DYN15412
              C                                                                     DYN15415
 0045                  NDP1=2.0*NDP-1                                               DYN15420
              C                                                                     DYN15428
 0046                  DO 100 I=1,NDP1                                              DYN15430
 0047                     IF (NDP.EQ.1) GO TO 70                                    DYN15440
 0048                     X1=THETB(I)*YKP                                           DYN15450
 0049                     X2=THETB(I+1)*YKP                                         DYN15460
 0050                     IF (KYP.GT.0) GO TO 60                                    DYN15470
 0051                     PINT=P(I)*(THETB(I+1)-THETB(I))                           DYN15480
 0052                     RINT=R(I)*(THETB(I+1)-THETB(I))                           DYN15490
 0053                     SINT=0.0                                                  DYN15500
 0054                  GO TO 90                                                   DYN15510
 0055           60     PINT=P(I)*(DSIN(X2)-DSIN(X1))/YKP                          DYN15520
 0056                  RINT=R(I)*(DSIN(X2)-DSIN(X1))/YKP                          DYN15530
 0057                  SINT=-S(I)*(DCOS(X2)-DCOS(X1))/YKP                         DYN15540
 0058                  GO TO 90                                                   DYN15550
 0059           70     IF (KYP.GT.0) GO TO 80                                     DYN15560
 0060                  PINT=2.0*PI*P(1)                                           DYN15570
 0061                  RINT=2.0*PI*R(1)                                           DYN15580
 0062                  SINT=0.0                                                   DYN15590
 0063                  GO TO 90                                                   DYN15600
 0064           80     PINT=0.0                                                   DYN15610
 0065                  RINT=0.0                                                   DYN15620
 0066                  SINT=0.0                                                   DYN15630
 0067           90     Q(1)=Q(1)+RINT*AL(1)                                       DYN15640
 0068                  Q(2)=Q(2)+RINT*AL(2)                                       DYN15650
 0069                  Q(3)=Q(3)+RINT*AL(3)                                       DYN15660
 0070                  Q(4)=Q(4)+RINT*AL(157)                                     DYN15670
 0071                  Q(5)=Q(5)+PINT*AL(1)                                       DYN15680
 0072                  Q(6)=Q(6)+PINT*AL(2)                                       DYN15690
 0073                  Q(7)=Q(7)+SINT*AL(1)                                       DYN15700
 0074                  Q(8)=Q(8)+SINT*AL(2)                                       DYN15710
 0075          100   CONTINUE                                                     DYN15712
             C                                                                    DYN15715
 0076                GO TO 120                                                    DYN15720
 0077          110   CONTINUE                                                     DYN15730
 0078                C12=1.0                                                      DYN15740
 0079                IF (KYP.EQ.0) C12=2.0                                        DYN15750
 0080                PINT=C12*PI*P(IH)                                            DYN15760
 0081                RINT=C12*PI*R(IH)                                            DYN15770
 0082                SINT=(2.0-C12)*PI*S(IH)                                      DYN15780
 0083                Q(1)=RINT*AL(1)                                              DYN15790
 0084                Q(2)=RINT*AL(2)                                              DYN15800
 0085                Q(3)=RINT*AL(3)                                              DYN15810
 0086                Q(4)=RINT*AL(157)                                            DYN15820
 0087                Q(5)=PINT*AL(1)                                              DYN15830
 0088                Q(6)=PINT*AL(2)                                              DYN15840
 0089                Q(7)=SINT*AL(1)                                              DYN15850
 0090                Q(8)=SINT*AL(2)                                              DYN15860
 0091          120   CONTINUE                                                     DYN15870
             C                                                                    DYN15878
 0092                DO 130 I=1,8                                                 DYN15880
 0093                   QQ(I)=0.0                                                 DYN15890
             C                                                                    DYN15898
 0094                   DO 130 J=1,8                                              DYN15900
 0095                      QQ(I)=QQ(I)+CHECK(J,I)*Q(J)                            DYN15910
 0096          130   CONTINUE                                                     DYN15912
             C                                                                    DYN15915
             C                                                                    DYN15918
```

```
0097                DO 140 I=1,8                                                  DYN15920
0098                   J=4*(IELM-1)+I+(IH-1)*NEQ+IB*NEQT                          DYN15930
0099                   FORCE(J)=FORCE(J)+QQ(I)                                    DYN15940
0100          140   CONTINUE                                                      DYN15942
            C                                                                     DYN15945
0101          150 CONTINUE                                                        DYN15950
            C                                                                     DYN15953
0102              RETURN                                                          DYN15960
            C                                                                     DYN15970
0103          160 FORMAT (1H1,35X,40HFOURIER COEFFICIENTS OF APPLIED PRESSURE,    DYN15980
                 1          9H LOADINGS//                                         DYN15982
                 1          20X,10HMERIDIANAL,20X,6HNORMAL,20X,10HTANGENTIAL,10X, DYN15990
                 2          12HHARMONIC NO.//)                                    DYN16000
0104          170 FORMAT (2I5/(3F10.0))                                           DYN16010
0105          180 FORMAT (/60X,11HELEMENT NO.,I3,1H-,I3,//(2X,3D28.7,15X,I2))     DYN16020
0106          190 FORMAT (1H1,51X,30HAPPLIED LOADS ON THE STRUCTURE///            DYN16030
                 1          56X,19HPRESSURE COMPONENTS//                          DYN16032
                 2          20X,10HMERIDIANAL,20X,6HNORMAL,20X,10HTANGENTIAL,11X, DYN16040
                 2          19HFROM THETA TO THETA,9H(DEGREES))                   DYN16050
0107          200 FORMAT (3I5/(4F10.0))                                           DYN16060
0108          210 FORMAT (/60X,11HELEMENT NO.,I3,1H-,I2//(2X,3F28.3,12X,2F10.3))  DYN16070
0109          220 FORMAT (2X,3F28.3,12X,2F10.3)                                   DYN16080
0110              END                                                             DYN16090
```

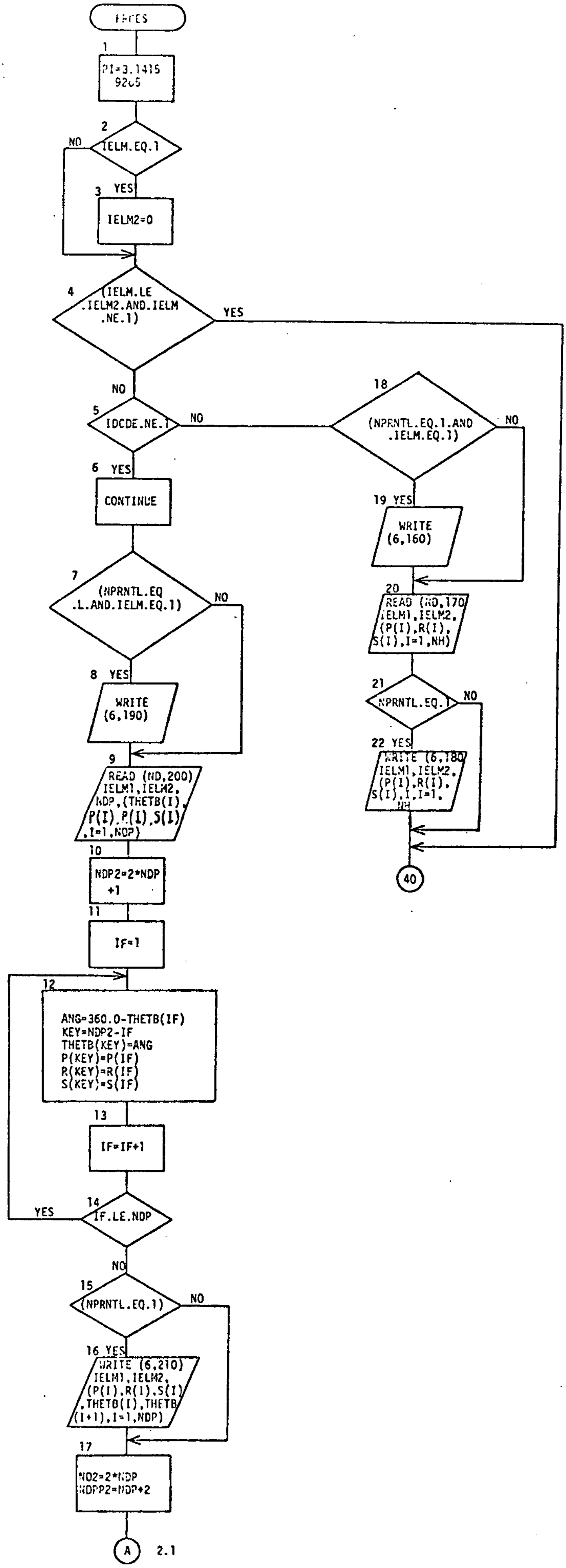

FRCES
1
READ DISTRIBUTED LOADS USING CIRCUMFERENTIAL ANGLES OR FOURIER COEFFICIENTS
2
CALCULATE THE LINEAR GENERALIZED LOADS
3
RETURN

J-3.18

FRCES
Detail Suppressed
1 of 1

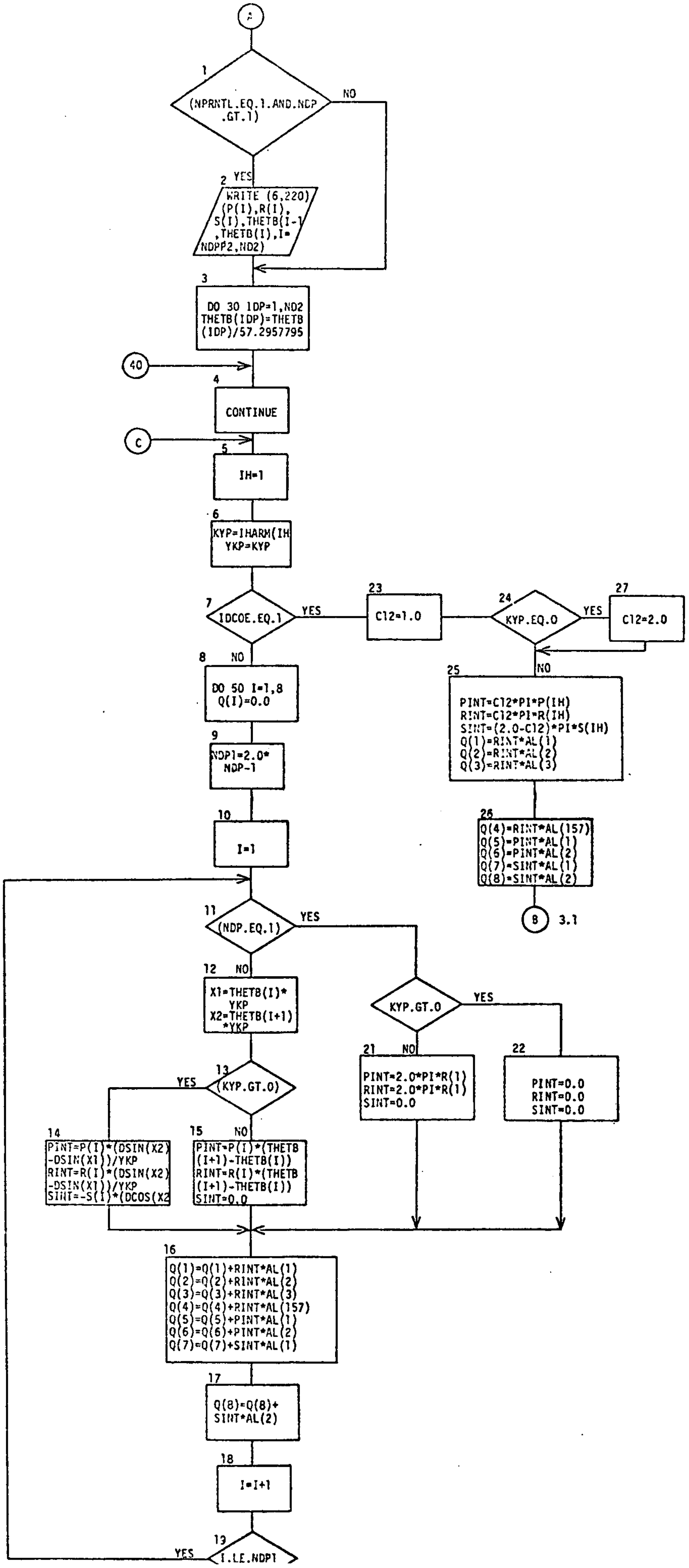


FRCES J-3.19
Detail
1 of 3

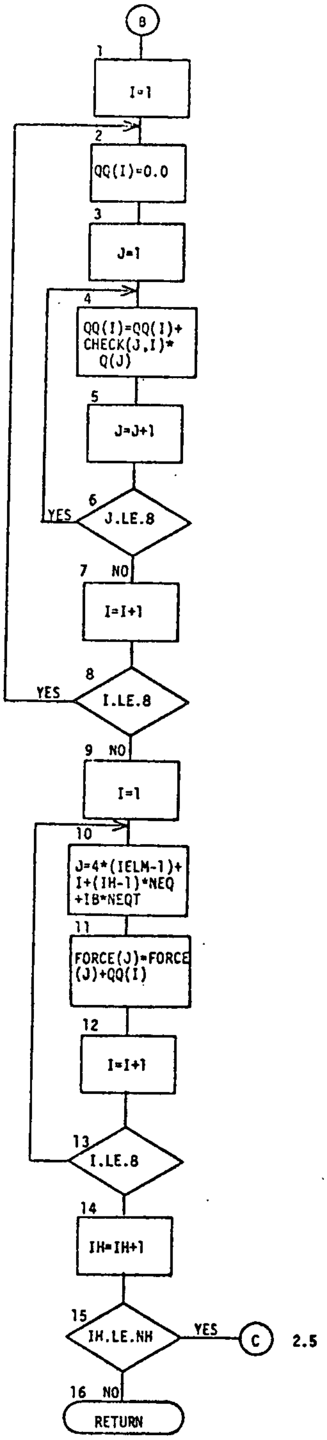


J-3.20

FRCES
Detail
2 of 3

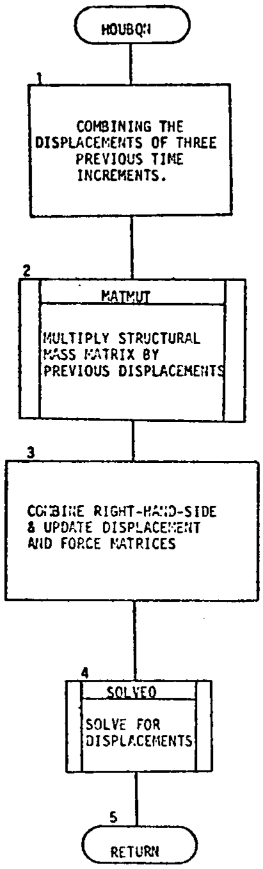


FRCES
Detail
3 of 3

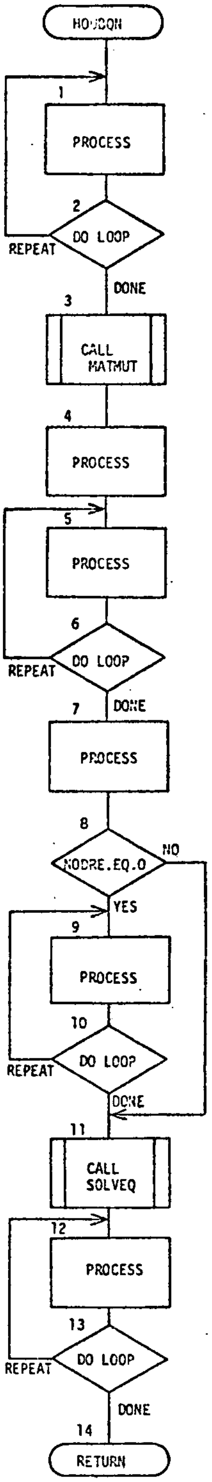


```
            CE(HOUBQN)                                                              DYN09772
            C                                                                       DYN09774
            C      DESCRIPTION - TO SET UP AND CONTROL THE SOLUTION OF THE          DYN09776
            C      EQUATIONS OF MOTICN FOR EACH TIME STEP EXCEPT THE FIRST ONE.     DYN09778
            C                                                                       DYN09780
            C  INPUT ARGUMENTS.                                                     DYN09782
            C      FORCE  = MATRIX OF GENERALIZED FORCES DUE TO EXTERNAL LOADS AND  DYN09784
            C               TEMPERATURES.                                           DYN09786
            C      IH     = HARMONIC KEY.                                           DYN09788
            C      KY     = RESTART KEY.                                            DYN09790
            C      QN     = DISPLACEMENTS AT TIME INCREMENT (N-1) UP TO STATEMENT 20 DYN09792
            C               AFTER STATEMENT 30 THIS MATRIX HAS BEEN CHANGED TO      DYN09794
            C               THE DISPLACEMENTS AT TIME STEP (N).                     DYN09796
            C      QN1    = DISPLACEMENTS AT TIME INCREMENT (N-2) BEFORE STATEMENT 10DYN09798
            C               AND AT TIME INCREMENT (N-1) AFTER STATEMENT 20.         DYN09800
            C      QP     = Q - PARTIAL DERIVATIVE OF U-NL WITH RESPECT TO LOWER    DYN09802
            C               CASE Q AT TIME STEP (N-1).                              DYN09804
            C      QP1    = Q - PARTIAL DERIVATIVE OF U-NL WITH RESPECT TO LOWER CASEDYN09806
            C               Q AT TIME STEP (N-2).                                   DYN09808
            C                                                                       DYN09810
            C  OUTPUT ARGUMENTS.                                                    DYN09812
            C      QLOAD  = RIGHT-HAND SIDE OF THE DYNAMIC EQUATIONS OF MOTION      DYN09814
            C               BEFORE CALLING SOLVEQ.                                  DYN09816
            C      QN     = DISPLACEMENTS AT TIME INCREMENT (N-1) UP TO STATEMENT 20 DYN09818
            C               AFTER STATEMENT 30 THIS MATRIX HAS BEEN CHANGED TO      DYN09820
            C               THE DISPLACEMENTS AT TIME STEP (N).                     DYN09822
            C      QN1    = DISPLACEMENTS AT TIME INCREMENT (N-2) BEFORE STATEMENT 10DYN09824
            C               AND AT TIME INCREMENT (N-1) AFTER STATEMENT 20.         DYN09826
            C      QN2    = DISPLACEMENTS AT TIME INCREMENT (N-3) BEFORE STATEMENT 10DYN09828
            C               AND AT TIME STEP (N-2) AFTER STATEMENT 20.              DYN09830
            C      QP1    = Q - PARTIAL DERIVATIVE OF U-NL WITH RESPECT TO LOWER CASEDYN09832
            C               Q AT TIME STEP (N-2).                                   DYN09834
            C                                                                       DYN09836
            C  EXTERNALS.                                                           DYN09838
            C      CALLED BY                                                        DYN09840
            C               SETUP                                                   DYN09842
            C      CALLS                                                            DYN09844
            C               MATMUT                                                  DYN09846
            C               SOLVEQ                                                  DYN09848
            C                                                                       DYN09850
 0001              SUBROUTINE HOUBQN (KY,IH)                                        DYN09852
 0002              IMPLICIT REAL*8 (A-H,O-Z)                                        DYN09854
 0003              COMMON /SLVEEQ/ XN(6550),QLOAD(204)                              DYN09856
 0004              COMMON /QS/ QN(1020),QN1(1020),FORCE(2040),QP(1020),QP1(1020),   DYN09858
                 1          QN2(1020)                                               DYN09860
 0005              COMMON /RSTRNT/ NODRES,NCLOSE,LK(204)                            DYN09862
 0006              COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS, DYN09864
                 1          DT2,NPRNTL,NPRNTF,IDELF,IDCOE                           DYN09866
```

```
0007                COMMON /PS/ XP(6550)                                             DYN09868
0008                COMMON /TMFT/ TOTIME,DELTE,TIME,TO,T1                            DYN09870
              C1    COMBINING THE DISPLACEMENTS OF THREE PREVIOUS TIME INCREMENTS    DYN09872
              C                                                                      DYN09918
0009                DO 10 I=1,NEQ                                                    DYN09920
0010                   NPI=N+I                                                       DYN09930
0011                   QN2(NPI)=5.*QN(NPI)-4.*QN1(NPI)+QN2(NPI)                      DYN09940
0012             10 CONTINUE                                                         DYN09950
              C                                                                      DYN09953
              C1    MULTIPLY STRUCTURAL MASS MATRIX BY PREVIOUS DISPLACEMENTS        DYN09955
0013                CALL MATMUT (IH,QN2,XP,QLOAD,NEQ)                                DYN09960
              C1    COMBINE RIGHT-HAND-SIDE & UPDATE DISPLACEMENT AND FORCE MATRICES DYN09962
0014                T3=(TIME-TO)/(T1-TO)                                             DYN09980
              C                                                                      DYN09988
0015                DO 20 I=1,NEQ                                                    DYN09990
0016                   NPI=N+I                                                       DYN10000
0017                   QSS=2.0*QP(NPI)-QP1(NPI)+FORCE(NPI)+T3*(FORCE(NPI+NEQT)-      DYN10010
                  1             FORCE(NPI))                                          DYN10012
0018                   QLOAD(I)=QLOAD(I)+DT2*QSS                                     DYN10030
0019                   QN2(NPI)=QN1(NPI)                                             DYN10040
0020                   QN1(NPI)=QN(NPI)                                              DYN10050
0021                   QP1(NPI)=QP(NPI)                                              DYN10060
0022             20 CONTINUE                                                         DYN10070
              C                                                                      DYN10073
              C1    APPLY BOUNDARY CONDITIONS TO RIGHT-HAND-SIDE                     DYN10075
0023                NODRE=NODRES                                                     DYN10090
0024                IF (NCLOSE.EQ.1.AND.KY.EQ.0) NODRE=NODRE+2                       DYN10100
0025                IF (NODRE.EQ.0) GO TO 40                                         DYN10110
              C                                                                      DYN10118
0026                DO 30 I=1,NODRE                                                  DYN10120
0027                   IEQ=LK(I)                                                     DYN10130
0028                   QLOAD(IEQ)=0.0                                                DYN10140
0029             30 CONTINUE                                                         DYN10150
              C                                                                      DYN10153
0030             40 CONTINUE                                                         DYN10160
              C1    SOLVE FOR DISPLACEMENTS                                          DYN10162
0031                CALL SOLVEQ (IH)                                                 DYN10180
              C                                                                      DYN10188
0032                DO 50 I=1,NEQ                                                    DYN10190
0033                   NPI=N+I                                                       DYN10200
0034                   QN(NPI)=QLOAD(I)                                              DYN10210
0035             50 CONTINUE                                                         DYN10220
              C                                                                      DYN10223
0036                RETURN                                                           DYN10230
0037                END                                                              DYN10240
```

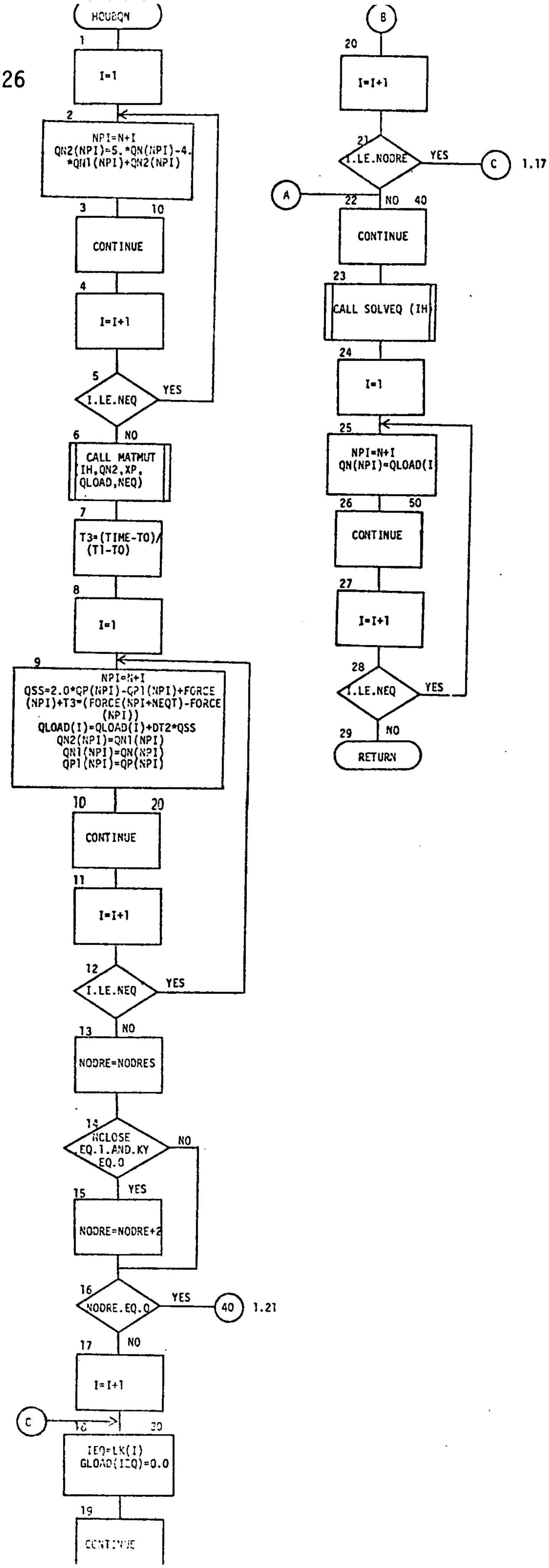

HOUBQN
1
COMBINING THE DISPLACEMENTS OF THREE PREVIOUS TIME INCREMENTS.
2
MATMUT
MULTIPLY STRUCTURAL MASS MATRIX BY PREVIOUS DISPLACEMENTS
3
COMBINE RIGHT-HAND-SIDE & UPDATE DISPLACEMENT AND FORCE MATRICES
4
SOLVEQ
SOLVE FOR DISPLACEMENTS
5
RETURN

HOUBQN J-3.25
Detail Suppressed
1 of 1



J-3.26

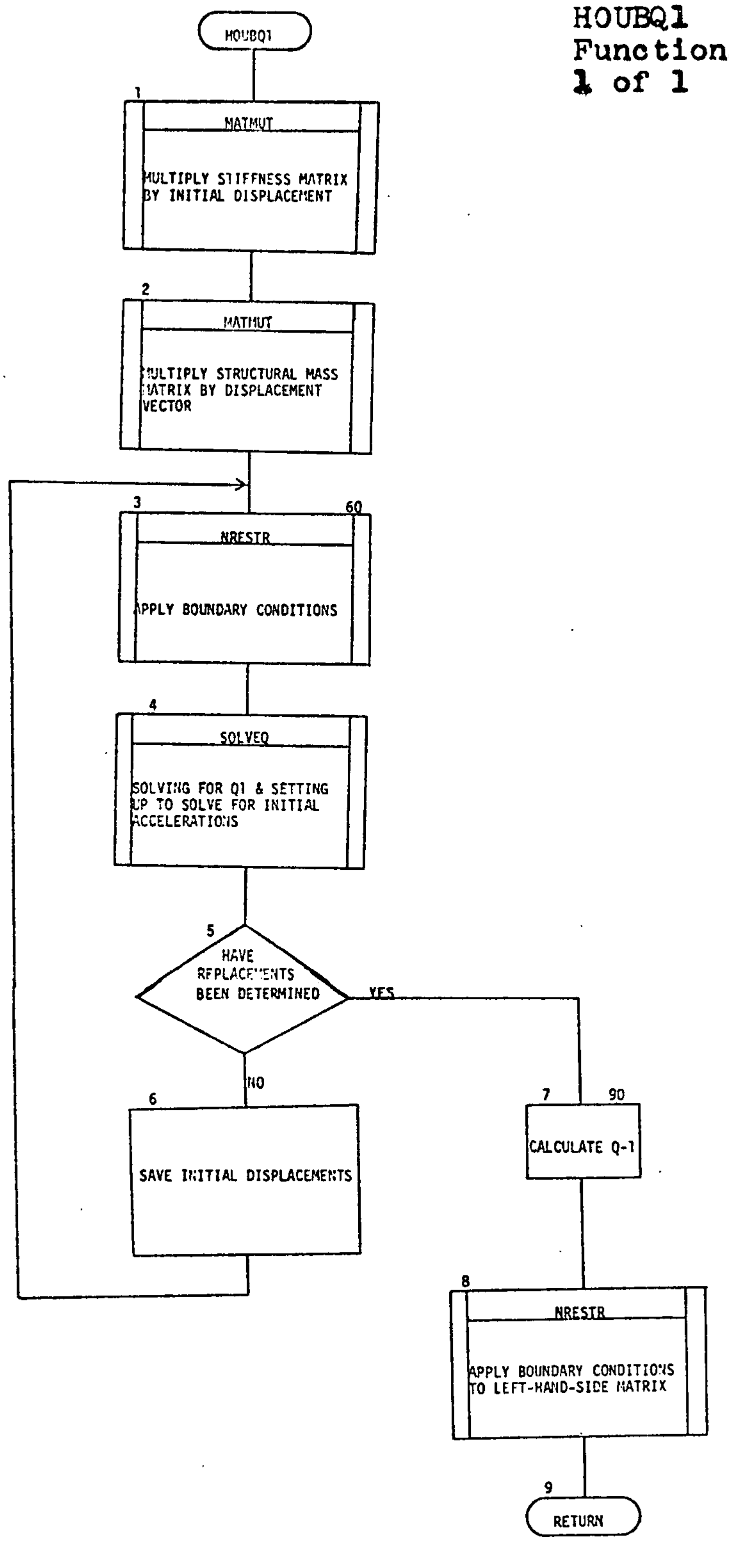
HOUBQN
Detail
1 of 1



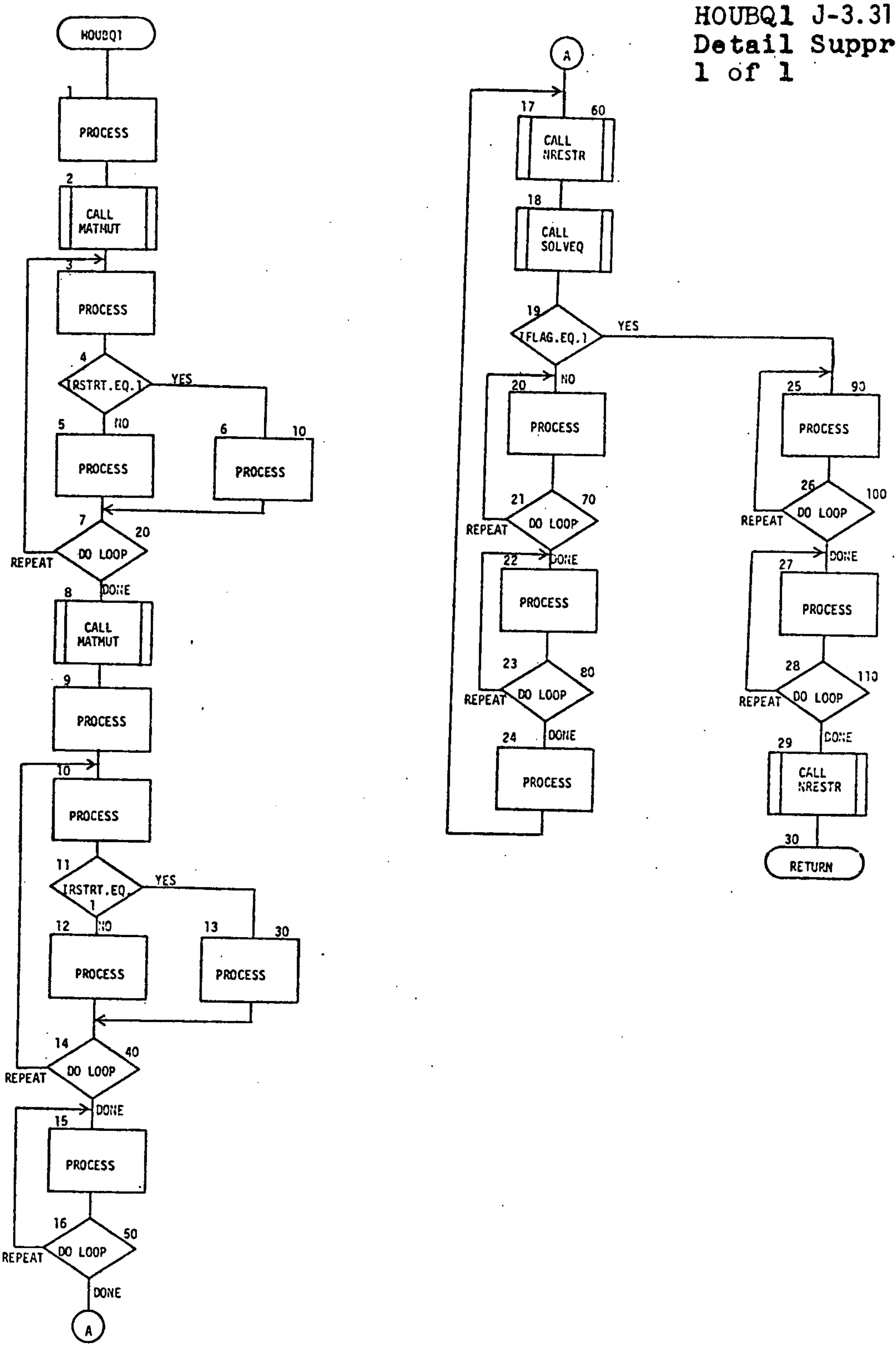
```
              CE(HOUBQ1)                                                        DYN08962
              C                                                                 DYN08964
              C     DESCRIPTION - TO CALCULATE THE DISPLACEMENTS AT THE END     DYN08966
              C            OF THE FIRST TIME STEP ONLY AND SET UP THE COEFFICIENT DYN08968
              C            MATRICES FOR USE IN SUBSEQUENT STEPS.                DYN08970
              C                                                                 DYN08972
              C  INPUT ARGUMENTS.                                               DYN08974
              C     DELTE  = TIME INCREMENT USED IN SOLVING THE EQUATIONS OF MOTION  DYN08976
              C              OF THE SHELL.                                      DYN08978
              C     DT2    = THE SQUARE OF THE TIME INCREMENT.                  DYN08980
              C     FORCE  = MATRIX OF GENERALIZED FORCES DUE TO EXTERNAL LOADS AND  DYN08982
              C              TEMPERATURES.                                      DYN08984
              C     IH     = HARMONIC KEY.                                      DYN08986
              C     IRSTRT = INPUT CONSTANT WHICH INDICATES IF THE PROGRAM IS BEING  DYN08988
              C              RESTARTED.                                         DYN08990
              C     KY     = RESTART KEY.                                       DYN08992
              C     QN     = DISPLACEMENTS AT TIME INCREMENT (N-1) UP TO STATEMENT 20 DYN08994
              C              AFTER STATEMENT 30 THIS MATRIX HAS BEEN CHANGED TO DYN08996
              C              THE DISPLACEMENTS AT TIME STEP (N).                DYN08998
              C     TIME   = CURRENT TIME.                                      DYN09000
              C     TO     = INITIAL TIME.                                      DYN09002
              C     T1     = STOP TIME.                                         DYN09004
              C     XN     = STRUCTURAL STIFFNESS MATRIX AS READ FROM INPUT TAPE.  DYN09006
              C              AFTER THE FIRST TIME STEP, THIS MATRIX IS REPLACED BY A  DYN09008
              C              COMBINATION OF THE MASS AND STIFFNESS MATRICES.    DYN09010
              C                                                                 DYN09012
              C  EXTERNALS.                                                     DYN09014
              C     CALLED BY                                                   DYN09016
              C              SETUP                                              DYN09018
              C     CALLS                                                       DYN09020
              C              MATMUT                                             DYN09022
              C              NRESTR                                             DYN09024
              C              SOLVEQ                                             DYN09026
              C                                                                 DYN09028
 0001               SUBROUTINE HOUBQ1 (KY,IH)                                   DYN09030
 0002               IMPLICIT REAL*8 (A-H,O-Z)                                   DYN09032
 0003               COMMON /SLVEEQ/ XN(6550),QLOAD(204)                         DYN09034
 0004               COMMON /QS/ QN(1020),QN1(1020),FORCE(2040),QP(1020),QP1(1020),  DYN09036
                   1         QN2(1020)                                          DYN09038
 0005               COMMON /RSTRNT/ NCORES,NCLOSE,LK(204)                       DYN09040
 0006               COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS,  DYN09042
                   1         DT2,NPRNTL,NPRNTF,IDELF,IDCOE                      DYN09044
 0007               COMMON /PS/ XP(6550)                                        DYN09046
 0008               COMMON /TMFT/ TOTIME,DELTE,TIME,TO,T1                       DYN09050
 0009               COMMON /RESTRT/ IRSTRT,NPRNT,NPRNIT,ITP,TIMEP,DELTEP        DYN09060
 0010               DIMENSION QLOAD1(1020)                                      DYN09070
              C                                                                 DYN09080
 0011               IFLAG=0                                                     DYN09130
 0012                T3=(TIME-T0)/(T1-T0)                                                DYNO9140
 0013                T3M1=(TIME-DELTE-T0)/(T1-T0)                                        DYNC9150
            C1       MULTIPLY STIFFNESS MATRIX BY INITIAL DISPLACEMENT                   DYNO9152
 0014                CALL MATMUT (IH,QN1,XN,QLOAD1,NEQ)                                  DYNO9170
            C                                                                            DYNO9178
 0015                DO 20 I=1,NEQ                                                       DYNO9180
 0016                   NPI=N+I                                                          DYNO9190
 0017                   QN(NPI)=QN1(NPI)+DELTE*QN(NPI)                                   DYNO9200
 0018                   IF (IRSTRT.EQ.1) GO TO 10                                        DYNC9210
 0019                   QLOAD1(I)=FORCE(NPI)-QLOAD1(I)                                   DYNO9220
 0020                   GO TO 20                                                         DYNO9230
 0021             10    QLOAD1(I)=QP1(NPI)-QLOAD1(I)+FORCE(NPI)+T3M1*(FORCE(NPI+NEQT)-   DYNC9240
                   1             FORCE(NPI))                                             DYNO9250
 0022             20 CONTINUE                                                            DYNC9260
            C                                                                            DYNO9263
            C1       MULTIPLY STRUCTURAL MASS MATRIX BY DISPLACEMENT VECTOR              DYNC9265
 0023                CALL MATMUT (IH,QN,XP,QLOAD,NEQ)                                    DYNC9280
 0024                TDT2=2*DT2                                                          DYNO9290
            C                                                                            DYNO9298
 0025                DO 40 I=1,NEQ                                                       DYNO9300
 0026                   NPI=N+I                                                          DYNO9310
 0027                   IF (IRSTRT.EQ.1) GO TO 30                                        DYNC9320
 0028                   QLOAD(I)=6.*QLOAD(I)+DT2*FORCE(NPI)+TDT2*QLOAD1(I)               DYNC9330
 0029                   GO TO 40                                                         DYNC9340
 0030             30    QLOAD(I)=6.*QLOAD(I)+DT2*QP(NPI)+TDT2*QLOAD1(I)+DT2*             DYNO9350
                   1             (FORCE(NPI)+T3*(FORCE(NPI+NEQT)-FORCE(NPI)))            DYNO9360
 0031             40 CONTINUE                                                            DYNC9370
            C                                                                            DYNO9373
            C                                                                            DYNO9378
 0032                DO 50 I=1,NSIZE                                                     DYNO9380
 0033                   NNPI=NN+I                                                        DYNO9390
 0034                   XN(NNPI)=DT2*XN(NNPI)+6.*XP(NNPI)                                DYNC9400
 0035             50 CONTINUE                                                            DYNC9410
            C                                                                            DYNC9413
            C1       APPLY BOUNDARY CONDITIONS                                           DYNO9415
 0036             60 CALL NRESTR (KY)                                                    DYNC9430
            C1       SOLVING FOR Q1 & SETTING UP TO SOLVE FOR INITIAL ACCELERATIONS      DYNO9432
 0037                CALL SOLVEQ (IH)                                                    DYNC9450
            C1       HAVE DISPLACEMENTS BEEN DETERMINED//YES(90)                         DYNO9452
 0038                IF (IFLAG.EQ.1) GO TO 90                                            DYNO9460
            C1       SAVE INITIAL DISPLACEMENTS                                          DYNO9462
            C                                                                            DYNC9468
 0039                DO 70 I=1,NEQ                                                       DYNC9470
 0040                   NPI=N+I                                                          DYN39480
 0041                   QN(NPI)=QLOAD(I)                                                 DYNO9490
 0042                   QLOAD(I)=QLOAD1(I)                                               DYNO9500
 0043             70 CONTINUE                                                            DYNO9510
            C                                                                            DYNO9513
```

```
             C                                                                      DYN09518
 0044                 DO 80 I=1,NSIZE                                               DYN09520
 0045                    NNPI=NN+I                                                  DYN09530
 0046                    XKEEP=XN(NNPI)                                             DYN09540
 0047                    XN(NNPI)=XP(NNPI)                                          DYN09550
 0048                    XP(NNPI)=XKEEP                                             DYN09560
 0049              80 CONTINUE                                                      DYN09570
             C                                                                      DYN09573
 0050                 IFLAG=1                                                       DYN09590
 0051                 GO TO 60                                                      DYN09600
 0052              90 CONTINUE                                                      DYN09610
             C1       CALCULATE Q-1                                                 DYN09612
             C                                                                      DYN09628
 0053                 DO 100 I=1,NEQ                                                DYN09630
 0054                    NPI=N+I                                                    DYN09640
 0055                    QN2(NPI)=DT2*QLOAD(I)+2*QN1(NPI)-QN(NPI)                   DYN09650
 0056             100 CONTINUE                                                      DYN09660
             C                                                                      DYN09663
             C                                                                      DYN09668
 0057                 DO 110 I=1,NSIZE                                              DYN09670
 0058                    NNPI=NN+I                                                  DYN09680
 0059                    XKEEP=XN(NNPI)                                             DYN09690
 0060                    XN(NNPI)=XP(NNPI)-4.*XN(NNPI)                              DYN09700
 0061                    XP(NNPI)=XKEEP                                             DYN09710
 0062             110 CONTINUE                                                      DYN09720
             C                                                                      DYN09723
             C1       APPLY BOUNDARY CONDITIONS TO LEFT-HAND-SIDE MATRIX            DYN09725
 0063                 CALL NRESTR (KY)                                              DYN09740
 0064                 RETURN                                                        DYN09750
 0065                 END                                                           DYN09760
```

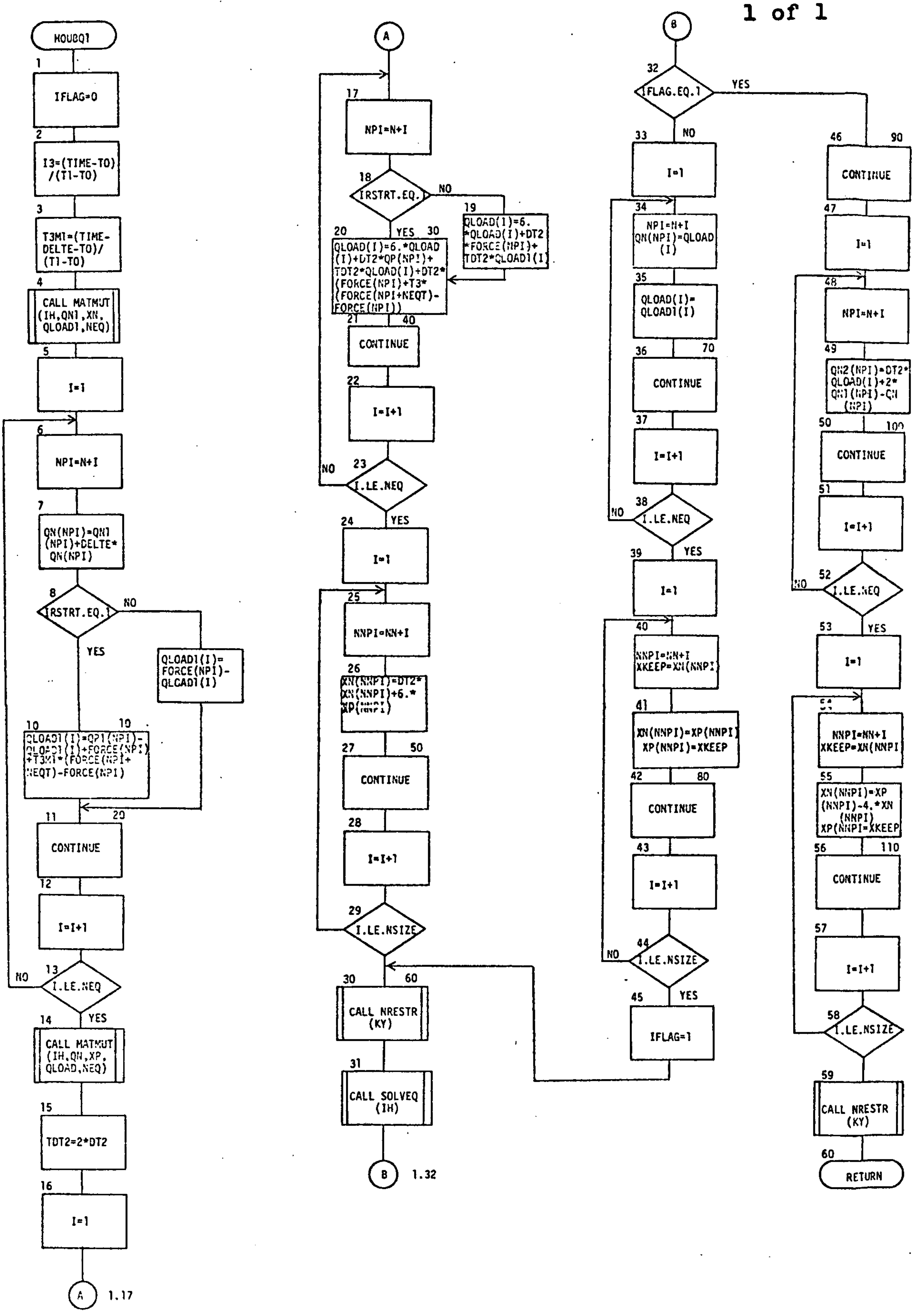
HOUBQ1
Functional
1 of 1


HOUBQ1
1
MATMUT
MULTIPLY STIFFNESS MATRIX BY INITIAL DISPLACEMENT
2
MATMUT
MULTIPLY STRUCTURAL MASS MATRIX BY DISPLACEMENT VECTOR
3
60
NRESTR
APPLY BOUNDARY CONDITIONS
4
SOLVEQ
SOLVING FOR Q1 & SETTING UP TO SOLVE FOR INITIAL ACCELERATIONS
5
HAVE REPLACEMENTS BEEN DETERMINED
YES
NO
6
SAVE INITIAL DISPLACEMENTS
7
90
CALCULATE Q-1
8
NRESTR
APPLY BOUNDARY CONDITIONS TO LEFT-HAND-SIDE MATRIX
9
RETURN

HOUBQ1 J-3.31
Detail Suppressed
1 of 1



HOUBQ1
Detail
1 of 1



```
      CE(INPUT)                                                         DYN00912
C                                                                       DYN00914
C     DESCRIPTION - TO PERFORM THE MAJOR INPUT FUNCTIONS FOR THE        DYN00916
C            DYNASOR PROGRAM. IT READS ALL CASE CONTROL PARAMETERS      DYN00918
C            AND ALL DATA CARD TYPES. SOME DATA REFINEMENT              DYN00920
C            FUNCTIONS, SUCH AS CALCULATION OF THE TRIGONOMETRIC        DYN00922
C            INTEGRALS REQUIRED TO CALCULATE THE GENERALIZED            DYN00924
C            NONLINEAR LOADS, ARE PERFORMED. THE FOLLOWING              DYN00926
C            QUANTITIES CAN BE READ IN - FOURIER HARMONICS,             DYN00928
C            MASS AND STIFFNESS MATRICES, NODAL RESTRAINTS,             DYN00930
C            INITIAL CONDITIONS, SHELL STRUCTURAL DATA, THERMAL         DYN00932
C            LOADS, THERMAL EXPANSION COEFFICIENTS, CONCENTRATED        DYN00934
C            RING LOADS, TEMPERATURE DISTRIBUTIONS AND GRADIENTS.       DYN00936
C                                                                       DYN00938
C  INPUT ARGUMENTS.                                                     DYN00940
C     KEY     = FLAG GOVERNING  =1) DATA INPUT FROM TAPE AND CARDS      DYN00942
C                               =2) BYPASSING DATA INPUT DURING RESTART DYN00944
C                               =3) PERIODIC OUTPUT OF RESTART DATA TO  DYN00946
C                                   TAPE.                               DYN00948
C                                                                       DYN00950
C  OUTPUT ARGUMENTS.                                                    DYN00952
C     ALS     = MATRIX OF COEFFICIENTS OF THERMAL EXPANSION IN THE      DYN00954
C               MERIDIANAL DIRECTION FOR THE ELEMENTS.                  DYN00956
C     ALT     = MATRIX OF COEFFICIENTS OF THERMAL EXPANSION IN THE      DYN00958
C               CIRCUMFERENTIAL DIRECTION FOR THE ELEMENTS.             DYN00960
C     COSM    = MATRIX WHOSE ELEMENTS ARE THE COSINE OF PHI AT THE      DYN00962
C               MIDDLE OF EACH ELEMENT.                                 DYN00964
C     DTH     = MATRIX OF FOURIER COEFFICIENTS FOR THE CIRCUMFERENTIAL  DYN00966
C               TEMPERATURE GRADIENT DISTRIBUTION.                      DYN00968
C     FORCE   = MATRIX OF GENERALIZED FORCES DUE TO EXTERNAL LOADS AND  DYN00970
C               TEMPERATURES.                                           DYN00972
C     LK      = MATRIX INDICATING THE NODAL RESTRAINTS WHICH ARE APPLIED DYN00974
C               ON THE SHELL.                                           DYN00976
C     NEQ     = NUMBER OF EQUILIBRIUM EQUATIONS PER HARMONIC.           DYN00978
C     NEQT    = TOTAL NUMBER OF EQUILIBRIUM EQUATIONS FOR ALL HARMONICS. DYN00980
C     NHNS      LENGTH OF STRUCTURAL STIFFNESS OR MASS MATRIX FOR ALL   DYN00982
C               HARMONICS STORED IN VECTOR FORM.                        DYN00984
C     NNODES = TOTAL NUMBER OF NODES, EQUAL TO (NELEMS + 1).            DYN00986
C     NSIZE   = THE NUMBER OF TERMS IN THE STRUCTURAL STIFFNESS OR MASS DYN00988
C               MATRIX (IN VECTOR FORM) FOR A PARTICULAR HARMONIC.      DYN00990
C     QN      = INITIAL NODAL VELOCITIES.                               DYN00992
C     QN1     = DISPLACEMENTS AT TIME INCREMENT (N-2) BEFORE STATEMENT 10DYN00994
C               AND AT TIME INCREMENT (N-1) AFTER STATEMENT 20.         DYN00996
C     QP      = Q - PARTIAL DERIVATIVE OF U-NL WITH RESPECT TO LOWER    DYN00998
C               CASE Q AT TIME STEP (N-1).                              DYN01000
C     QP1     = Q - PARTIAL DERIVATIVE OF U-NL WITH RESPECT TO LOWER CASEDYN01002
C               Q AT TIME STEP (N-2).                                   DYN01004
C     SINM    = SINE OF PHI AT THE MIDDLE OF THE ELEMENTS.              DYN01006
```

```
                C      TH      = MATRIX WHOSE ELEMENTS ARE THE FOURIER COEFFICIENTS       DYN01008
                C                OF THE CIRCUMFERENTIAL TEMPERATURE DISTRIBUTION.         DYN01010
                C      TO      = INITIAL TIME.                                            DYN01012
                C      T1      = STOP TIME.                                               DYN01014
                C                                                                         DYN01016
                C  EXTERNALS.                                                             DYN01018
                C      CALLED BY                                                          DYN01020
                C                MAIN                                                     DYN01022
                C                SETUP                                                    DYN01024
                C      CALLS                                                              DYN01026
                C                TRI4OR                                                   DYN01028
                C                NLTERM                                                   DYN01030
                C                FRCES                                                    DYN01032
                C                THCOE                                                    DYN01034
                C                TFORCE                                                   DYN01036
                C                                                                         DYN01038
 0001                  SUBROUTINE INPUT (KEY)                                             DYN01040
 0002                  IMPLICIT REAL*8 (A-H,O-Z)                                          DYN01042
 0003                  COMMON /CHALS/ AL(167),CHECK(8,8)                                  DYN01044
 0004                  COMMON /SLVEEQ/ XN(6550),QLOAD(204)                                DYN01046
 0005                  COMMON /QS/ QN(1020),QN1(1020),FORCE(2040),QP(1020),QP1(1020),     DYN01048
                     1          QN2(1020)                                                 DYN01050
 0006                  COMMON /RSTRNT/ NODRES,NCLOSE,LK(204)                              DYN01052
 0007                  COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS,   DYN01054
                     1          DT2,NPRNTL,NPRNTF,IDELF,IDCOE                             DYN01056
 0008                  COMMON /PS/ XP(6550)                                               DYN01058
 0009                  COMMON /TMFT/ TOTIME,DELTE,TIME,TO,T1                              DYN01060
 0010                  COMMON /GEOM/ FNU1(50),FNU2(50),E1(50),E2(50),G(50),T(50),         DYN01062
                     1          SINE(51),COSINE(51),SINM(50),COSM(50),R(50),PH(50),       DYN01064
                     1          PHP(50),ARCL(50)                                          DYN01066
 0011                  COMMON /THETAS/ THETA(20),NTHETA,NCLCST,NSTRSS                     DYN01068
 0012                  COMMON /PRINT/ IPRINT,NOIT,LL                                      DYN01070
 0013                  COMMON /HARM/ NHP,IHARM(5)                                         DYN01072
 0014                  COMMON /RESTRT/ IRSTRT,NPRNT,NPRNIT,ITP,TIMEP,DELTEP               DYN01074
 0015                  COMMON /THER/ TH(50,5,2),DTH(50,5,2),ALS(50),ALT(50)               DYN01080
 0016                  COMMON /THCON/ ITELF,ITCOE,NPRNTH                                  DYN01090
 0017                  COMMON /CYCLE/ ITAM                                                DYN01100
 0018                  COMMON /TAPES/ NT,ND,NS                                            DYN01110
 0019                  COMMON /RZ/ RO(51),Z(51)                                           DYN01120
 0020                  DIMENSION COMENT(20), JUNK(20), TH1(5), DTH1(5)                    DYN01130
 0021                  DIMENSION DUM(1310)                                                DYN01140
 0022                  EQUIVALENCE (DUM(1),XN(1)), (XN(1),COMENT(1))                      DYN01150
 0023                  DOUBLE PRECISION CONSTN,CONSTF,CONST1                              DYN01160
 0024                  DATA CONSTN/8HCONSTANT/,CONST1/8H        /                         DYN01170
                C1     KEY//1(10),2(430),3(710)                                           DYN01172
 0025                  GO TO (10,430,710), KEY                                            DYN01180
                C1     READ CASE I.D., CASE CONTROL, AND CIRCUMFERENTIAL ANGLE CARDS      DYN01182
 0026               10 CONTINUE                                                           DYN01190
 0027                CONSTF=CONST1                                                       DYN01200
 0028                WRITE (6,730)                                                       DYN01210
              C2     READ INPUT DATA FOR CARD TYPE II - A                                DYN01212
 0029                READ (ND,740) NCARDS,NT                                             DYN01230
              C2     TYPE II-B CARDS LEFT//NO(30)                                        DYN01232
 0030                IF (NCARDS.EQ.0) GO TO 30                                           DYN01240
              C                                                                          DYN01248
 0031                DO 20 I=1,NCARDS                                                    DYN01250
              C2     READ INPUT DATA FOR CARD TYPE II - B                                DYN01252
 0032                   READ (ND,750) (COMENT(J),J=1,20)                                 DYN01270
 0033                   WRITE (6,800) (COMENT(J),J=1,20)                                 DYN01280
 0034             20 CONTINUE                                                            DYN01282
              C                                                                          DYN01285
 0035             30 CONTINUE                                                            DYN01290
              C2     READ INPUT DATA FOR CARD TYPE III                                   DYN01292
 0036                READ (ND,760) TOTIME,DELTE,IRSTRT,INCRST,NCLOSE,ITELF,NPRNTQ,       DYN01320
                    1         IPRINT,NCLCST,NSTRSS,NPRNT,NPRNIT,NPRNTL,NPRNTF,NPRNTH,    DYN01322
                    1         NPRNMS                                                     DYN01330
              C2     READ INPUT DATA FOR CARD TYPE IV                                    DYN01332
 0037                READ (ND,770) NTHETA,(THETA(I),I=1,NTHETA)                          DYN01340
 0038                NOIT=1                                                              DYN01350
              C1     READ FOURIER HARMONICS CARD IF NO RESTART                           DYN01352
 0039                IF (IRSTRT.EQ.0) READ (ND,780) NH,(IHARM(I),I=1,NH)                 DYN01370
 0040                KEYRS=0                                                             DYN01380
 0041                IF (IRSTRT.EQ.1) KEYRS=1                                            DYN01390
 0042             40 CONTINUE                                                            DYN01400
              C2     READ INFORMATION AND SHELL DESCRIPTION FROM INPUT TAPE              DYN01402
 0043                REWIND NT                                                           DYN01440
 0044                READ (NT) NCARDS,JUNK                                               DYN01450
 0045                IF (NCARDS.EQ.0) GO TO 60                                           DYN01460
 0046                WRITE (6,790)                                                       DYN01470
              C                                                                          DYN01478
 0047                DO 50 K=1,NCARDS                                                    DYN01480
 0048                   READ (NT) (COMENT(J),J=1,20)                                     DYN01490
 0049                   IF (KEYRS.EQ.1) GO TO 50                                         DYN01500
 0050                   WRITE (6,800) (COMENT(J),J=1,20)                                 DYN01510
 0051             50 CONTINUE                                                            DYN01520
              C                                                                          DYN01523
 0052             60 READ (NT) NHP,NELEMS,JUNK                                           DYN01530
 0053                IF (KEYRS.EQ.0) GO TO 110                                           DYN01540
              C2     READ ADDITIONAL INFORMATION FROM INPUT TAPE FOR RESTART OPERATION DYN01542
              C                                                                          DYN01578
 0054                DO 70 K=1,NELEMS                                                    DYN01580
 0055                   READ (NT) (DUM(I),I=1,230)                                       DYN01590
 0056             70 CONTINUE                                                            DYN01592
              C                                                                          DYN01595
 0057                J=6*NELEMS                                                          DYN01600
 0058                READ (NT) (DUM(I),I=1,J)                                            DYN01610
```

```
            C                                                                       DYN01618
0059              DO 90 K=1,NELEMS                                                  DYN01620
0060                 IF (K.EQ.NELEMS) GO TO 80                                      DYN01630
0061                 READ (NT) (DUM(I),I=1,6)                                       DYN01640
0062                 GO TO 90                                                       DYN01650
0063           80    READ (NT) (DUM(I),I=1,8)                                       DYN01660
0064           90 CONTINUE                                                          DYN01670
            C                                                                       DYN01673
0065              J=2*(NELEMS+1)                                                    DYN01680
0066              READ (NT) (DUM(I),I=1,J)                                          DYN01690
0067              J=2*NHP                                                           DYN01700
0068              NSIZE=10+26*NELEMS                                                DYN01710
            C                                                                       DYN01718
0069              DO 100 K=1,J                                                      DYN01720
0070                 READ (NT) (DUM(I),I=1,NSIZE)                                   DYN01730
0071          100 CONTINUE                                                          DYN01732
            C                                                                       DYN01735
0072              READ (NT) NH,(IHARM(I),I=1,NH),JUNK                               DYN01740
0073              KEYRS=0                                                           DYN01750
0074              GO TO 40                                                          DYN01760
0075          110 CONTINUE                                                          DYN01770
0076              WRITE (6,810) TOTIME,DELTE,IRSTRT,INCRST,NPRNT,NPRNIT,NPRNTQ,     DYN01780
                 1         IPRINT,NCLCST,NSTRSS,NPRNTL,NPRNTF,NPRNTH,NT,NS,ND,      DYN01790
                 2         NCLOSE,ITELF,NELEMS,NPRNMS,NH,(IHARM(I),I=1,NH)          DYN01800
0077              WRITE (6,820) NTHETA,(THETA(I),I=1,NTHETA)                        DYN01810
            C                                                                       DYN01820
            C2    READ IN QN1     INITIAL DISPLACEMENTS  Q0                         DYN01822
            C2C           QN      INITIAL VELOCITIES     Q0DOT                      DYN01824
            C2C           XN      STIFFNESS MATRIX       K                          DYN01826
            C2C           XP      MASS MATRIX            M                          DYN01828
            C2C           FORCE LOADS                                               DYN01830
            C2C           NODRES NUMBER OF NODAL RESTRAINTS                         DYN01832
            C2C           LK      LOCATION OF RESTRAINTS                            DYN01834
            C                                                                       DYN01900
0078              PI=3.14159                                                        DYN01910
0079              RAD=PI/180.                                                       DYN01920
            C                                                                       DYN01928
0080              DO 120 I=1,NTHETA                                                 DYN01930
0081                 THETA(I)=THETA(I)*RAD                                          DYN01940
0082          120 CONTINUE                                                          DYN01950
            C                                                                       DYN01953
0083              NNODES=NELEMS+1                                                   DYN01960
0084              NEQ=4*NNODES                                                      DYN01970
0085              NEQT=NH*NEQ                                                       DYN01980
0086              NSIZE=10+26*NELEMS                                                DYN01990
0087              NHNS=NH*NSIZE                                                     DYN02000
0088              DT2=DELTE**2                                                      DYN02010
            C                                                                       DYN02018
```

```
 0089              DO 130 I=1,NEQT                                                 DYN02020
 0090                 QN(I)=0.0                                                    DYN02030
 0091                 QN1(I)=0.0                                                   DYN02040
 0092          130 CONTINUE                                                        DYN02050
             C                                                                     DYN02053
             C1    RESTART//YES(250)                                               DYN02055
 0093              IF (IRSTRT.EQ.1) GO TO 250                                      DYN02060
             C1    READ NODAL RESTRAINT AND INITIAL CONDITIONS CARDS.              DYN02062
             C      READ INPUT DATA FOR CARD TYPE VI - A                           DYN02100
 0094              READ (ND,780) NODRES                                            DYN02110
 0095              WRITE (6,830) NODRES                                            DYN02120
 0096              IF (NODRES.EQ.0) GO TO 150                                      DYN02130
             C                                                                     DYN02138
 0097              DO 140 I=1,NODRES                                               DYN02140
             C        READ INPUT DATA FOR CARD TYPE VI - B                         DYN02150
 0098                 READ (ND,780) NP,NDIRCT                                      DYN02160
 0099                 WRITE (6,840) NP,NDIRCT                                      DYN02170
 0100                 LK(I)=4*(NP-1)+NDIRCT                                        DYN02180
 0101          140 CONTINUE                                                        DYN02182
             C                                                                     DYN02185
 0102          150 LK(NODRES+1)=3                                                  DYN02190
 0103              LK(NODRES+2)=4                                                  DYN02200
             C2    READ AND PRINT INITIAL VELOCITIES AND DISPLACEMENTS             DYN02202
             C      READ INPUT DATA FOR CARD TYPE VII - A                          DYN02240
 0104              READ (ND,780) IQN,IQN1                                          DYN02250
 0105              IF (IQN.EQ.0) GO TO 190                                         DYN02260
             C                                                                     DYN02268
 0106              DO 180 IH=1,NH                                                  DYN02270
 0107                 N=NEQ*(IH-1)                                                 DYN02280
             C2       READ INPUT DATA FOR CARD TYPE VII - B                        DYN02282
 0108          160    READ (ND,850) IN1,IN2,Q1,Q2,Q3,Q4                            DYN02300
             C                                                                     DYN02308
 0109                 DO 170 INODE=IN1,IN2                                         DYN02310
 0110                    IFLAG=4*(INODE-1)+N                                       DYN02320
 0111                    QN(IFLAG+1)=Q1                                            DYN02330
 0112                    QN(IFLAG+2)=Q2                                            DYN02340
 0113                    QN(IFLAG+3)=Q3                                            DYN02350
 0114                    QN(IFLAG+4)=Q4                                            DYN02360
 0115          170    CONTINUE                                                     DYN02362
             C                                                                     DYN02365
 0116                 IF (IN2.NE.NNODES) GO TO 160                                 DYN02370
 0117          180 CONTINUE                                                        DYN02380
             C                                                                     DYN02383
 0118          190 CONTINUE                                                        DYN02390
 0119              IF (IQN1.EQ.0) GO TO 230                                        DYN02400
             C                                                                     DYN02408
 0120              DO 220 IH=1,NH                                                  DYN02410
 0121                 N=NEQ*(IH-1)                                                 DYN02420
```

```
           C2        READ INPUT DATA FOR CARD TYPE VII - C                        DYN02422
 0122         200    READ (ND,850) IN1,IN2,Q1,Q2,Q3,Q4                            DYN0244C
           C                                                                      DYN02448
 0123                DO 210 INODE=IN1,IN2                                         DYN02450
 0124                   IFLAG=4*(INODE-1)+N                                       DYNC2460
 0125                   QN1(IFLAG+1)=Q1                                           DYN02470
 0126                   QN1(IFLAG+2)=Q2                                           DYN02480
 0127                   QN1(IFLAG+3)=Q3                                           DYN02490
 0128                   QN1(IFLAG+4)=Q4                                           DYN02500
 0129         210    CONTINUE                                                     DYN02502
           C                                                                      DYN02505
 0130                IF (IN2.NE.NNODES) GO TO 200                                 DYN02510
 0131         220 CONTINUE                                                        DYN02520
           C                                                                      DYN02523
 0132         230 CONTINUE                                                        DYN02530
 0133             WRITE (6,860)                                                   DYN02540
           C                                                                      DYN02548
 0134             DO 240 I=1,NH                                                   DYN02550
 0135                IQ=NEQ*(I-1)                                                 DYN02560
           C                                                                      DYN02568
 0136                DO 240 II=1,NNODES                                           DYN02570
 0137                   IX=4*(II-1)                                               DYN02580
 0138                   WRITE (6,870) II,IHARM(I),QN(IQ+IX+1),QN(IQ+IX+2),        DYN0259C
               1                 QN(IQ+IX+3),QN(IQ+IX+4),QN1(IQ+IX+1),QN1(IQ+IX+2), DYN02600
               1                 QN1(IQ+IX+3),QN1(IQ+IX+4)                        DYN02601
 0139         240 CONTINUE                                                        DYN02610
           C                                                                      DYN02613
 0140         250 CONTINUE                                                        DYN02620
 0141             REWIND NS                                                       DYN02630
           C2     READ STRUCTURAL DATA FOR SHELL                                  DYN02632
           C                                                                      DYN02638
 0142             DO 260 II=1,NELEMS                                              DYNC2640
 0143                READ (NT) ((CHECK(I,J),I=1,8),J=1,8),(AL(I),I=1,166)         DYN02650
 0144                WRITE (NS) ((CHECK(I,J),I=1,8),J=1,8),(AL(I),I=1,166)        DYN02660
 0145         260 CONTINUE                                                        DYN02670
           C                                                                      DYN02673
 0146             READ (NT) (FNU1(I),I=1,NELEMS),(FNU2(I),I=1,NELEMS),(E1(I),I=1, DYN02680
               1           NELEMS),(E2(I),I=1,NELEMS),(G(I),I=1,NELEMS),(T(I),I=1, DYN02690
               1           NELEMS)                                                DYN02692
           C                                                                      DYN02698
 0147             DO 280 I=1,NELEMS                                               DYN02700
 0148                IF (I.EQ.NELEMS) GO TO 270                                   DYN02710
 0149                READ (NT) R(I),PH(I),PHP(I),ARCL(I),SINE(I),COSINE(I)        DYN02720
 0150                GO TO 280                                                    DYN02730
 0151         270    READ (NT) R(I),PH(I),PHP(I),ARCL(I),SINE(I),COSINE(I),       DYN02740
              1              SINE(I+1),COSINE(I+1)                                DYN02750
 0152         280 CONTINUE                                                        DYN0276C
           C                                                                      DYN02763
 0153               READ (NT) (RO(I),I=1,NNODES),(Z(I),I=1,NNODES)                 DYNO2770
            C                                                                      DYNO2778
 0154               DO 290 I=1,NELEMS                                              DYNO2780
 0155                  COSM(I)=DCOS(PH(I))                                         DYNO2790
 0156                  SINM(I)=DSIN(PH(I))                                         DYNO2800
 0157           290 CONTINUE                                                       DYNO2810
            C1      INCLUDE THERMAL LOADS//NO(320)                                 DYNO2815
            C                                                                      DYNO2817
 0158               IF (ITELF.NE.1) GO TO 320                                      DYNO2820
            C1      READ COEFFICIENTS OF THERMAL EXPANSION CARDS                   DYNO2822
            C2      READ INPUT DATA FOR CARD TYPE VIII                             DYNO2824
 0159           300 READ (ND,880) IELM1,IELM2,ALSI1,ALTI1                          DYNO2870
            C                                                                      DYNO2878
 0160               DO 310 IELM=IELM1,IELM2                                        DYNO2880
 0161                  ALS(IELM)=ALSI1                                             DYNO2890
 0162                  ALT(IELM)=ALTI1                                             DYNO2900
 0163           310 CONTINUE                                                       DYNO2902
            C                                                                      DYNO2905
 0164               IF (IELM2.NE.NELEMS) GO TO 300                                 DYNO2910
 0165               GO TO 340                                                      DYNO2920
            C                                                                      DYNO2928
 0166           320 DO 330 IELM=1,NELEMS                                           DYNO2930
 0167                  ALS(IELM)=0.0                                               DYNO2940
 0168                  ALT(IELM)=0.0                                               DYNO2950
 0169           330 CONTINUE                                                       DYNO2960
            C                                                                      DYNO2963
 0170           340 CONTINUE                                                       DYNO2970
            C2      PRINT ELEMENT PROPERTIES AND DESIRED STIFFNESS AND MASS MATRICES DYNO2972
 0171               WRITE (6,890)                                                  DYNO3010
 0172               WRITE (6,900) (I,ALS(I),ALT(I),E1(I),E2(I),FNU1(I),FNU2(I),G(I), DYNO3020
                   1         R(I),T(I),ARCL(I),PH(I),PHP(I),I=1,NELEMS)            DYNO3030
            C                                                                      DYNO3038
 0173               DO 370 IH=1,NHP                                                DYNO3040
            C                                                                      DYNO3048
 0174                  DO 350 JH=1,NH                                              DYNO3050
 0175                     IF (IH-1.EQ.IHARM(JH)) GO TO 360                         DYNO3060
 0176           350    CONTINUE                                                    DYNO3070
            C                                                                      DYNO3073
 0177                  READ (NT) (FORCE(I),I=1,NSIZE)                              DYNO3080
 0178                  READ (NT) (FORCE(I),I=1,NSIZE)                              DYNO3090
 0179                  GO TO 370                                                   DYNO3100
 0180           360    CONTINUE                                                    DYNO3110
 0181                  NN=NSIZE*(JH-1)                                             DYNO3120
 0182                  READ (NT) (XN(I+NN),I=1,NSIZE)                              DYNO3130
 0183                  READ (NT) (XP(I+NN),I=1,NSIZE)                              DYNO3140
 0184                  IF (NPRNMS.EQ.0) GO TO 370                                  DYNO3150
 0185                  WRITE (6,910) IHARM(JH)                                     DYNO3160
 0186                  WRITE (6,920) (XN(I+NN),I=1,NSIZE)                          DYNO3170
 0187                WRITE (6,930) IHARM(JH)                                      DYNO3180
 0188                WRITE (6,920) (XP(I+NN),I=1,NSIZE)                           DYNO3190
 0189          370 CONTINUE                                                       DYNO3200
             C                                                                    DYNO3203
             C1     CALCULATE TRIGONOMETRIC INTEGRALS REQUIRED TO CALCULATE       DYNO3205
             C1C         GENERALIZED NONLINEAR LOADS                              DYNO3207
 0190               CALL TRI4OR                                                   DYNO3210
             C1     RESTART//NO(400)                                              DYNO3212
 0191               IF (IRSTRT.EQ.0) GO TO 400                                    DYNO3220
             C1     READ AND CALCULATE INFORMATION REQUIRED FOR RESTART OPERATION DYNO3222
 0192               NTF=2*NEQT                                                    DYNO3260
 0193          380 READ (NT) NH,(IHARM(I),I=1,NH),JUNK                            DYNO3270
 0194               READ (NT) ITP,TIMEP,DELTEP,TO,T1,NODRES,(LK(I),I=1,NODRES),   DYNO3280
                  1          (FORCE(I),I=1,NTF)                                   DYNO3290
 0195               READ (NT) (((TH(IELM,IH,IBP1),IELM=1,NELEMS),IH=1,NH),IBP1=1,2), DYNO3300
                  1          (((DTH(IELM,IH,IBP1),IELM=1,NELEMS),IH=1,NH),IBP1=1,2)  DYNO3310
 0196               READ (NT) (QP1(I),I=1,NEQT),(QN(I),I=1,NEQT),(QN1(I),I=1,NEQT)   DYNO3320
 0197               LK(NODRES+1)=3                                                DYNO3330
 0198               LK(NODRES+2)=4                                                DYNO3340
 0199               IF (ITP.NE.INCRST) GO TO 380                                  DYNO3350
             C1     CALCULATE NONLINEAR LOADS AND STRESS RESULTANTS FOR EACH ELEMENT DYNO3352
 0200               CALL NLTERM (0)                                               DYNO3360
             C                                                                    DYNO3368
 0201               DO 390 I=1,NEQT                                               DYNO3370
 0202                  XKEEP=QN(I)                                                DYNO3380
 0203                  QN(I)=QN1(I)                                               DYNO3390
 0204                  QN1(I)=XKEEP                                               DYNO3400
 0205                  XKEEP=QP1(I)                                               DYNO3410
 0206                  QP1(I)=QP(I)                                               DYNO3420
 0207                  QP(I)=QP(I)+(DELTE/DELTEP)*(QP(I)-XKEEP)                   DYNO3430
 0208          390 CONTINUE                                                       DYNO3432
             C                                                                    DYNO3435
             C         QP  -  GENERALIZED FORCES AT N+1 TH INCREMENT              DYNO3450
             C         QP1 -  GENERALIZED FORCES AT  N  TH INCREMENT              DYNO3460
             C         QN  -  GENERALIZED NODAL VELOCITIES AT N TH INCREMENT      DYNO3470
             C         QN1 -  GENERALIZED NODAL DISP.      AT N TH INCREMENT      DYNO3480
             C                                                                    DYNO3482
 0209               TPRNT=TIMEP*1000000.                                          DYNO3500
 0210               WRITE (6,940) ITP,TPRNT,DELTEP                                DYNO3510
 0211               RETURN                                                        DYNO3520
 0212          400 CONTINUE                                                       DYNO3530
             C2     INITIALIZE FORCE AND THERMAL MATRICES                         DYNO3532
             C                                                                    DYNO3568
 0213               DO 410 I=1,NEQT                                               DYNO3570
 0214                  FORCE(I)=0.0                                               DYNO3580
 0215                  FORCE(I+NEQT)=0.0                                          DYNO3590
 0216          410 CONTINUE                                                       DYNO3600
             C                                                                    DYNO3603
             C                                                                    DYN03608
 0217              DO 420 I=1,NELEMS                                              DYN03610
             C                                                                    DYN03618
 0218                 DO 420 J=1,NH                                               DYN03620
 0219                    TH(I,J,1)=0.0                                            DYN03630
 0220                    TH(I,J,2)=0.0                                            DYN03640
 0221                    DTH(I,J,1)=0.0                                           DYN03650
 0222                    DTH(I,J,2)=0.0                                           DYN03660
 0223          420 CONTINUE                                                       DYN03670
             C                                                                    DYN03673
             C1    FIRST TIME THROUGH AND CONSTANT FORCES//NO(440)                DYN03675
 0224          430 IF (CONSTF.EQ.CONSTN.AND.KEY.NE.1) GO TO 440                   DYN03710
 0225              GO TO 470                                                      DYN03720
             C1    UPDATE FORCE AND THERMAL MATRICES                              DYN03722
             C                                                                    DYN03728
 0226          440 DO 450 I=1,NEQT                                                DYN03730
 0227                 FORCE(I)=FORCE(I+NEQT)                                      DYN03740
 0228          450 CONTINUE                                                       DYN03742
             C                                                                    DYN03745
             C                                                                    DYN03748
 0229              DO 460 I=1,NELEMS                                              DYN03750
             C                                                                    DYN03758
 0230                 DO 460 J=1,NH                                               DYN03760
 0231                    TH(I,J,1)=TH(I,J,2)                                      DYN03770
 0232                    DTH(I,J,1)=DTH(I,J,2)                                    DYN03780
 0233          460 CONTINUE                                                       DYN03782
             C                                                                    DYNC3785
 0234              T0=T1                                                          DYN03790
 0235              T1=TOTIME                                                      DYN03800
 0236              RETURN                                                         DYN03810
 0237          470 CONTINUE                                                       DYN03820
             C                                                                    DYN03828
 0238              DO 480 I=1,NEQT                                                DYN03830
 0239                 FORCE(I)=FORCE(I+NEQT)                                      DYN03840
 0240                 FORCE(I+NEQT)=0.0                                           DYN03850
 0241          480 CONTINUE                                                       DYN03860
             C                                                                    DYN03863
             C                                                                    DYN03868
 0242              DO 490 I=1,NELEMS                                              DYN03870
             C                                                                    DYN03878
 0243                 DO 490 J=1,NH                                               DYN03880
 0244                    TH(I,J,1)=TH(I,J,2)                                      DYN03890
 0245                    DTH(I,J,1)=DTH(I,J,2)                                    DYN03900
 0246                    TH(I,J,2)=0.0                                            DYN03910
 0247                    DTH(I,J,2)=0.0                                           DYN03920
 0248          490 CONTINUE                                                       DYN03930
             C                                                                    DYN03933
 0249              IB=0                                                           DYN03940
 0250               IF (KEY.EQ.2) IB=1                                                    DYN03950
 0251               IF (IB.EQ.1) TO=T1                                                    DYN03960
              C1    READ LOAD CONTROL CARD                                                DYN03962
 0252           500 READ (ND,950) T1,NCF,IDELF,IDCOE,ITCOE,CONSTF                         DYN03980
 0253               TIM=T1                                                                DYN03990
 0254               IF (CONSTF.EQ.CONSTN.AND.IB.EQ.0) T1=TOTIME                           DYN04000
 0255               IF (NPRNTL.EQ.0.AND.NPRNTF.EQ.0) GO TO 510                            DYN04010
              C2    PRINT LOADING DESCRIPTION                                             DYN04012
 0256               TPRNT=TIM*1000000.                                                    DYN04050
 0257               WRITE (6,960) TPRNT,CONSTF                                            DYN04060
              C1    CONCENTRATED RING LOADS//NO(550)                                      DYN04062
 0258           510 IF (NCF.EQ.0) GO TO 550                                               DYN04070
              C1    READ CONCENTRATED RING LOADS                                          DYN04072
              C                                                                           DYN04078
 0259               DO 540 IH=1,NH                                                        DYN04080
 0260                  IH1=IH-1                                                           DYN04090
              C        READ INPUT DATA FOR CARD TYPE IX - B - 1                           DYN04100
 0261                  READ (ND,970) NCF1                                                 DYN04110
 0262                  IF (NCF1.EQ.0) GO TO 540                                           DYN04120
 0263                  IF (NPRNTL.EQ.0) GO TO 520                                         DYN04130
 0264                  WRITE (6,980) IHARM(IH)                                            DYN04140
              C        READ INPUT DATA FOR CARD TYPE IX - B - 2                           DYN04150
 0265           520    READ (ND,970) IN1,IN2,F1,F2,F3,F4                                  DYN04160
              C                                                                           DYN04168
 0266                  DO 530 IN=IN1,IN2                                                  DYN04170
 0267                     K=4*IN+NEQ*IH1+IB*NEQT                                          DYN04180
 0268                     FORCE(K-3)=F1                                                   DYN04190
 0269                     FORCE(K-2)=F2                                                   DYN04200
 0270                     FORCE(K-1)=F3                                                   DYN04210
 0271                     FORCE(K)=F4                                                     DYN04220
 0272                     IF (NPRNTL.EQ.1) WRITE (6,990) IN,F1,F2,F3,F4                   DYN04230
 0273           530    CONTINUE                                                           DYN04240
              C                                                                           DYN04243
 0274                  IF (IN2.NE.NNODES) GO TO 520                                       DYN04250
 0275           540 CONTINUE                                                              DYN04260
              C                                                                           DYN04263
 0276           550 CONTINUE                                                              DYN04270
              C1    DISTRIBUTED LOADS PRESENT//NO(570)                                    DYN04272
 0277               IF (IDELF.NE.1) GO TO 570                                             DYN04280
 0278               REWIND NS                                                             DYN04290
              C1DO  PROCESS ALL ELEMENTS                                                  DYN04292
              C                                                                           DYN04298
 0279               DO 560 IELM=1,NELEMS                                                  DYN04300
 0280                  READ (NS) ((CHECK(I,J),I=1,8),J=1,8),(AL(I),I=1,166)               DYN04310
              C1       READ DISTRIBUTED LOADS AND CALCULATE LINEAR GENERALIZED FORCES DYN04312
 0281                  CALL FRCES (IELM,ALPHK,IB)                                         DYN04320
 0282           560 CONTINUE                                                              DYN04330
              C                                                                           DYN04333
```

```
               C1     THERMAL LOADS PRESENT//NO(650)                                        DYN04335
 0283             570 IF (ITELF.EQ.0) GO TO 650                                             DYN04340
 0284                 REWIND NS                                                             DYN04380
 0285                 IBP1=IB+1                                                             DYN04390
               C1     READ THERMAL COEFICIENTS//NO(600)                                     DYN04392
 0286                 IF (ITCOE.EQ.0) GO TO 600                                             DYN04400
               C1     READ TEMPERATURE DISTRIBUTIONS AND GRADIENTS                          DYN04402
 0287             580 READ (ND,1000) IELM1,IELM2,(TH1(IH),DTH1(IH),IH=1,NH)                 DYN04420
               C                                                                            DYN04428
 0288                 DO 590 IELM=IELM1,IELM2                                               DYN04430
               C                                                                            DYN04438
 0289                    DO 590 IH=1,NH                                                     DYN04440
 0290                       DTH(IELM,IH,IBP1)=DTH1(IH)                                      DYN04450
 0291                       TH(IELM,IH,IBP1)=TH1(IH)                                        DYN04460
 0292             590 CONTINUE                                                              DYN04462
               C                                                                            DYN04465
 0293                 IF (IELM2.NE.NELEMS) GO TO 580                                        DYN04470
               C1DO   PROCESS ALL ELEMENTS                                                  DYN04472
               C                                                                            DYN04478
 0294             600 DO 620 IELM=1,NELEMS                                                  DYN04480
 0295                    READ (NS) ((CHECK(I,J),I=1,8),J=1,8),(AL(I),I=1,166)               DYN04490
               C1        CALCULATE THERMAL COEFFICIENTS//NO(610)                            DYN04492
 0296                    IF (ITCOE.EQ.1) GO TO 610                                          DYN04500
               C1        READS TEMPERATURE AND TEMPERATURE GRADIENTS AND CALCULATES         DYN04502
               C1C                THERMAL FOURIER COEFFICIENTS                              DYN04504
 0297                    CALL THCOE (IELM,IB)                                               DYN04510
               C1        CALCULATES LINEAR THERMAL LOADS                                    DYN04512
 0298             610    CALL TFORCE (IELM,IB)                                              DYN04520
 0299             620 CONTINUE                                                              DYN04530
               C                                                                            DYN04533
 0300                 IF (NPRNTH.EQ.0) GO TO 640                                            DYN04540
               C                                                                            DYN04548
 0301                 DO 630 IH=1,NH                                                        DYN04550
 0302                    WRITE (6,1010) IHARM(IH)                                           DYN04560
               C                                                                            DYN04568
 0303                    DO 630 IELM=1,NELEMS                                               DYN04570
 0304                       WRITE (6,1020) IELM,TH(IELM,IH,IBP1),DTH(IELM,IH,IBP1)          DYN04580
 0305             630 CONTINUE                                                              DYN04582
               C                                                                            DYN04585
 0306             640 CONTINUE                                                              DYN04590
 0307             650 IF (NPRNTF.EQ.0) GO TO 670                                            DYN04600
               C2     PRINT GENERALIZED FORCES FOR EACH HARMONIC                            DYN04602
               C                                                                            DYN04638
 0308                 DO 660 IH=1,NH                                                        DYN04640
 0309                    KK=NEQ*(IH-1)+IB*NEQT                                              DYN04650
 0310                    KYP=IHARM(IH)                                                      DYN04660
 0311                    WRITE (6,1030) KYP                                                 DYN04670
               C                                                                            DYN04678
```

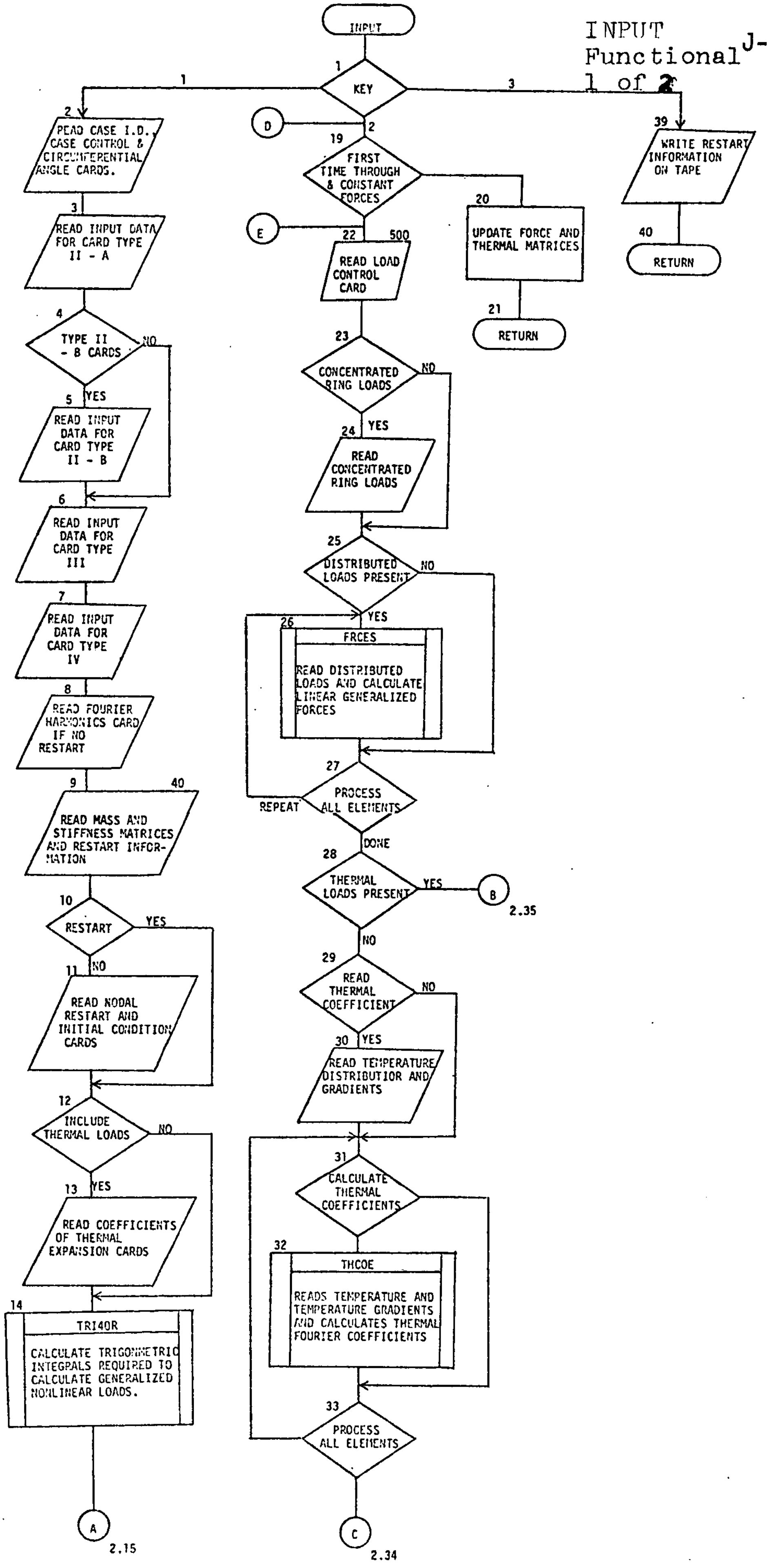
```
0312             DO 660 I=1,NNODES                                                   DYN04680
0313                K=KK+4*(I-1)                                                     DYN04690
0314                WRITE (6,1040) I,FORCE(K+1),FORCE(K+2),FORCE(K+3),FORCE(K+4)DYN04700
0315         660 CONTINUE                                                            DYN04702
           C                                                                         DYN04705
0316         670 CONTINUE                                                            DYN04710
           C1       FORCES NOT CONSTANT OR FIRST TIME THROUGH WITH KEY=2//YES(700)    DYN04712
0317             IF (CONSTF.NE.CONSTN.OR.IB.EQ.1) GO TO 70C                           DYN04720
           C                                                                         DYN04728
0318             DO 680 I=1,NEQT                                                     DYN04730
0319                FORCE(I+NEQT)=FORCE(I)                                           DYN04740
0320         680 CONTINUE                                                            DYN04742
           C                                                                         DYN04745
           C                                                                         DYN04748
0321             DO 690 I=1,NELEMS                                                   DYN(4750
           C                                                                         DYN04758
0322                DO 690 J=1,NH                                                    DYN04760
0323                   TH(I,J,2)=TH(I,J,1)                                           DYN04770
0324                   DTH(I,J,2)=DTH(I,J,1)                                         DYN04780
0325         690 CONTINUE                                                            DYN04790
           C                                                                         DYN04793
0326             RETURN                                                              DYNC4800
0327         700 CONTINUE                                                            DYN04810
0328             IB=IB+1                                                             DYN04820
           C1       KEY = 1 //YES(500)                                                DYN04822
0329             IF (IB.EQ.1) GO TO 500                                              DYN04830
0330             RETURN                                                              DYN04840
           C1       WRITE RESTART INFORMATION ON TAPE                                 DYN04842
0331         710 CONTINUE                                                            DYNC4880
0332             NTF=2*NEQT                                                          DYN04890
0333             WRITE (NT) NH,(IHARM(I),I=1,NH),JUNK                                DYN04900
0334             WRITE (NT) ITAM,TIME,DELTE,TC,T1,NODRES,(LK(I),I=1,NODRES),          DYN04910
               1          (FORCE(I),I=1,NTF)                                          DYN04920
0335             WRITE (NT) (((TH(IELM,IH,IBP1),IELM=1,NELEMS),IH=1,NH),IBP1=1,2),    DYN04930
               1          (((DTH(IELM,IH,IBP1),IELM=1,NELFMS),IH=1,NH),IBP1=1,2)      DYNC4940
0336             QDC3=1.0/(2.0*DELTE)                                                DYN04950
0337             QDC2=4.0*QDC3                                                       DYNC4960
0338             QDC1=3.0*QDC3                                                       DYNC4970
           C                                                                         DYN04978
0339             DO 720 I=1,NEQT                                                     DYN04980
0340                QP(I)=QDC1*QN(I)-QDC2*QN1(I)+QDC3*QN2(I)                          DYNC4990
0341         720 CONTINUE                                                            DYN04992
           C                                                                         DYN04995
0342             WRITE (NT) (QP1(I),I=1,NEQT),(QN(I),I=1,NEQT),(QP(I),I=1,NEQT)       DYN05000
0343             TPRNT=TIME*10000C0.                                                 DYN05010
0344             WRITE (6,1050) ITAM,TPRNT                                           DYN05020
0345             RETURN                                                              DYN05030
           C                                                                         DYN05040
```

```
0346             730 FORMAT (1H1,38X,44HDYNASOR-II  -  DYNAMIC NONLINEAR ANALYSIS OF,  DYN05050
                    1           21H SHELLS OF REVOLUTION//)                              DYN05060
0347             740 FORMAT (2I5)                                                         DYN05070
0348             750 FORMAT (20A4)                                                        DYN05080
0349             760 FORMAT (2F10.0,4I5,/,10I5)                                           DYN05090
0350             770 FORMAT (I5,/,(8F10.0))                                               DYN05100
0351             780 FORMAT (16I5)                                                        DYN05110
0352             790 FORMAT (///,2X,46H**SHELL IDENTIFICATION COMMENTS FROM SAMMSOR**) DYN05120
0353             800 FORMAT (/5X,20A4)                                                    DYN05130
0354             810 FORMAT (1H1,50X,33HCONTROL  CONSTANTS  AND  COMMENTS///              DYN05140
                    1           35X,8HTOTIME =,F12.9,22X,7HDELTE =,F13.9/                DYN05142
                    1           35X,8HIRSTRT =,I12,22X,8HINCRST =,I12/                    DYNC5144
                    2           35X,7HNPRNT =,I13,22X,8HNPRNIT =,I12/                     DYN05146
                    2           35X,8HNPRNTQ =,I12,22X,8HIPRINT =,I12/                    DYN05148
                    3           35X,8HNCLCST =,I12,22X,8HNSTRSS =,I12/                    DYN05150
                    3           35X,8HNPRNTL =,I12,22X,8HNPRNTF =,I12/                    DYN05152
                    4           35X,8HNPRNTH =,I12,22X,4HNT =,I16/                        DYN05154
                    4           35X,4HNS =,I16,22X,4HND =,I16,/                           DYN05156
                    5           35X,8HNCLOSE =,I12,22X,7HITELF =,I13/                     DYN05158
                    5           35X,8HNELEMS =,I12,22X,8HNPRNMS =,I12/                    DYN05160
                    6           35X,4HNH =,I16/                                           DYN05162
                    6           35X,7HIHARM =,5I11//)                                     DYN05164
0355             820 FORMAT (35X,8HNTHETA =,I12,/35X,7HTHETA =,5F10.2,(/,42X,5F10.2))  DYNC5210
0356             830 FORMAT (/////50X,29HNUMBER OF NODAL RESTRAINTS ISI5//              DYN05220
                    1           52X,9HDIRECTION,12X,7HAPPLIES,//                          DYN05222
                    1           57X,1H1,10X,15HAXIAL RESTRAINT/                           DYN05230
                    2           57X,1H2,10X,20HTANGENTIAL RESTRAINT,/,                    DYN05232
                    2           57X,1H3,10X,16HRADIAL RESTRAINT/                          DYN05240
                    3           57X,1H4,10X,17HANGULAR RESTRAINT,//                       DYN05242
                    4           58X,15HNODE  DIPECTION/)                                  DYN05250
0357             840 FORMAT (58X,I3,7X,I1)                                                DYN05260
0358             850 FORMAT (2I5,4F10.C)                                                  DYN05270
0359             860 FORMAT (1H1,7X,7HINITIAL,29X,10HVELOCITIES,22X,3HAND,19X,           DYN05280
                    1           13HDISPLACEMENTS//                                        DYN05290
                    1           4X,14HNODE  HARMONIC,2(30H   AXIAL       TANGENTIAL     ,DYNC5300
                    2           26H RADIAL         ANGULAR      )//)                      DYN05310
0360             870 FORMAT (5X,I2,6X,I2,3X,8D14.4)                                       DYN05320
0361             880 FORMAT (2I5,2F10.C)                                                  DYN05330
0362             890 FORMAT (1H1,45X,41HELEMENT ELASTIC AND GEOMETRIC PROPERTIES,///    DYN05340
                    1           48H ELEMENT ALPHA--S  ALPHA--T      E1         E2     ,  DYNC5342
                    1           11H FNU1  FNU2,7X,1HG,11X,1HR,11X,1HT,9X,4HARCL,9X,2HPH, DYN05350
                    2           10X,3HPHP//)                                              DYN05360
0363             900 FORMAT (3X,I2,2X,4D10.2,2F6.3,6D12.4)                                DYN05370
0364             910 FORMAT (1H1,38X,15HHARMONIC NUMBER,I5,                               DYNC5380
                    1           37H   HAS THE FOLLOWING STIFFNESS MATRIX//)               DYN05390
0365             920 FORMAT (2X,D16.8,/,2X,2D16.8,/,2X,3D16.8,/,2X,4D16.8,/,2X,5D16.8,/DYN05400
                    1           2X,6D16.8,/,2X,7D16.8,/,2X,8D16.8,/                       DYN05410
                    1           (2X,5D16.8,/2X,6D16.8/2X,7D16.8/2X,8D16.8/))              DYNC5420
```

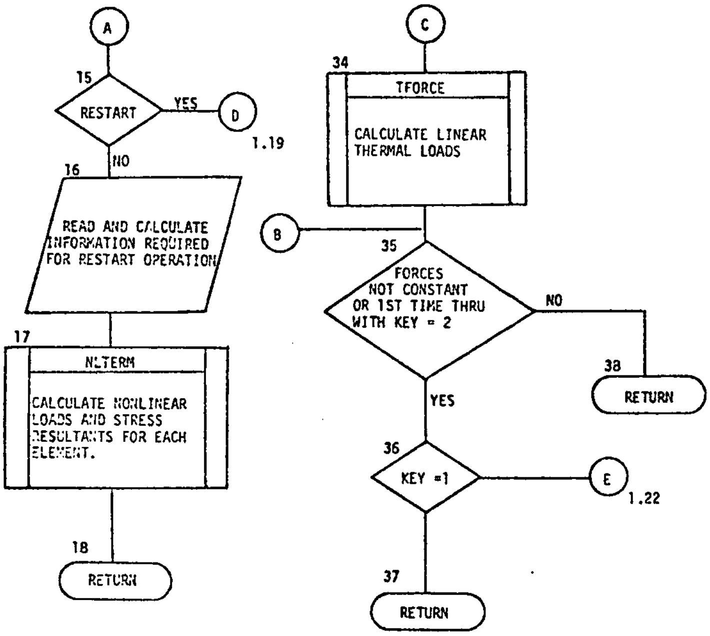
```
 0366           930 FORMAT (1H1,38X,15HHARMONIC NUMBER,I5,                               DYNO5430
                  1          32H   HAS THE FOLLOWING MASS MATRIX//)                      DYNO5440
 0367           940 FORMAT (1H1//////5X,41HTHIS SOLUTION STARTS AFTER TIME INCREMENT,  DYNO5450
                  1          4H NO.,I5,19H WHERE  THE TIME WAS,F12.4,13H MICROSECONDS,/DYNO5460
                  1          5X,27H AND THE TIME  INCREMENT WAS,D12.5//////)            DYNO5470
 0368           950 FORMAT (F10.0,4I5,A8)                                               DYNO5480
 0369           960 FORMAT (40H1FOLLOWING IS LOAD DESCRIPTION AT TIME =,F12.4,          DYNO5490
                  1          13H MICRCSECONDS,5X,A8)                                     DYNO5500
 0370           970 FORMAT (2I5,4F10.0)                                                 DYNO5510
 0371           980 FORMAT (///20X,30HCONCENTRATED FORCES  HARMONIC ,I5//              DYNO5520
                  1          6X,8HNODE NO.,6X,5HAXIAL,10X,10HTANGENTIAL,10X,6HRADIAL,  DYNO5530
                  1          7HANGULAR/)                                                 DYNO5532
 0372           990 FORMAT (I10,4D20.8)                                                 DYNO5540
 0373          1000 FORMAT (2I5,/,(2F10.0))                                              DYNO5550
 0374          1010 FORMAT (1H1,25X,39HTEMPERATURE COEFFICIENTS, HARMONIC NO. I3//      DYNO5560
                  1          10X,11HELEMENT NO.,17X,12HTEMP. COEFF.,12X,                DYNO5570
                  1          18HTEMP. GRAD. COEFF.///)                                   DYNO5572
 0375          1020 FORMAT (I20,2D30.5)                                                  DYNO5580
 0376          1030 FORMAT (1H1,25X,32HGENERALIZED FORCES, HARMONIC NO.,I3,//           DYNO5590
                  1          6X,8HNODE NO.,6X,5HAXIAL,13X,10HTANGENTIAL,11X,6HRADIAL,  DYNO5600
                  1          13X,7HANGULAR///)                                           DYNO5602
 0377          1040 FORMAT (I9,4D19.8)                                                   DYNO5610
 0378          1050 FORMAT (1H1//////5X,42HRESTART INFORMATION FOR TIME INCREMENT NO.,DYNO5620
                  1          I5/                                                         DYNO5622
                  1          10X,22H CORRESPONDING TO TIME,F12.4,13H MICROSECONDS,/     DYNO5630
                  2          2X,46H HAS BEEN PLACED ON TAPE FOR USE IN SUBSEQUENT,      DYNO5640
                  2          5H RUNS//)                                                  DYNO5642
 0379                END                                                                 DYNO5650
```

INPUT
Functional
1 of 2

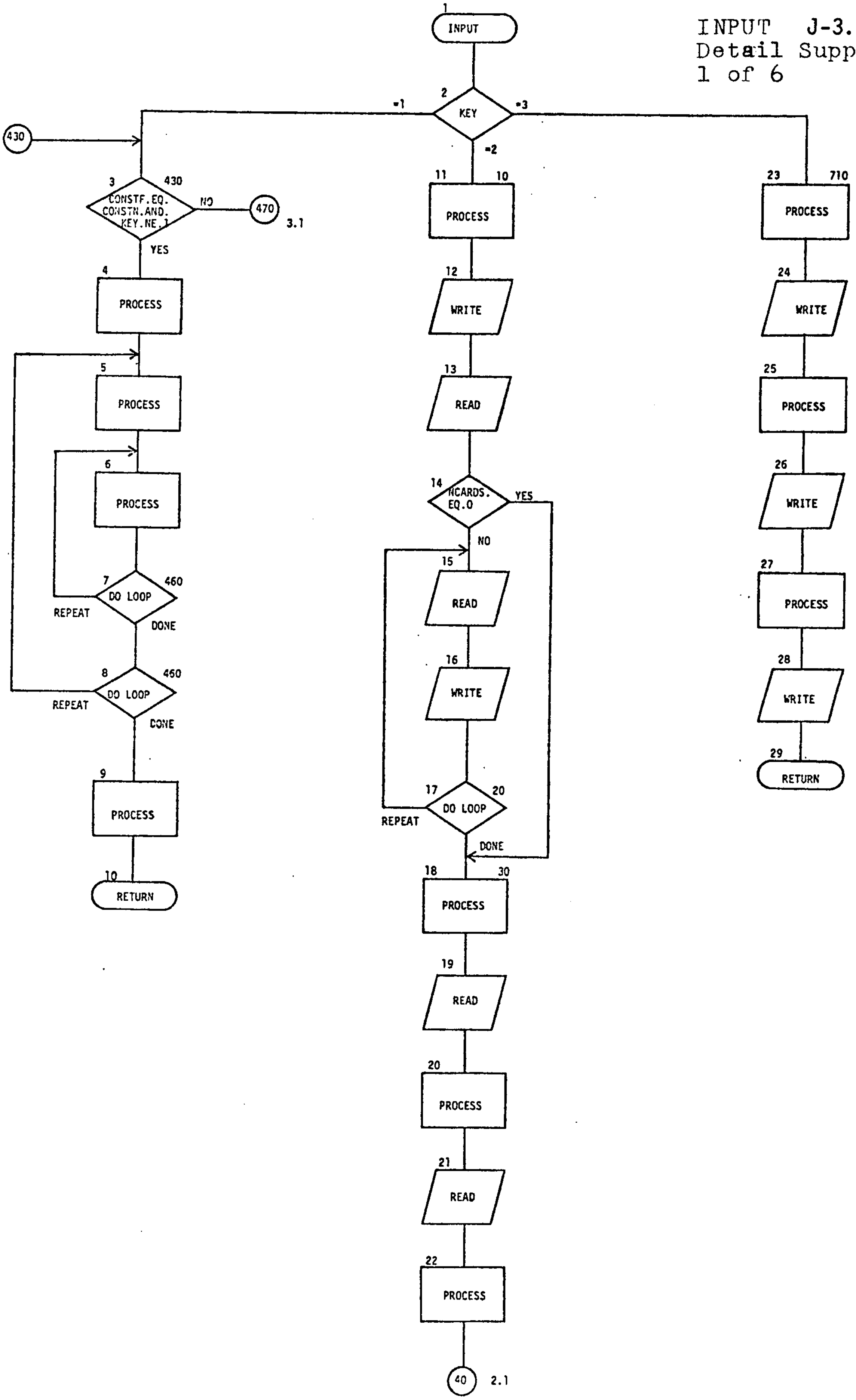
J-3.47



INPUT
1
KEY
1
2
3
2
PEAD CASE I.D., CASE CONTROL & CIRCUMFERENTIAL ANGLE CARDS.
3
READ INPUT DATA FOR CARD TYPE II - A
4
TYPE II - B CARDS
NO
YES
5
READ INPUT DATA FOR CARD TYPE II - B
6
READ INPUT DATA FOR CARD TYPE III
7
READ INPUT DATA FOR CARD TYPE IV
8
READ FOURIER HARMONICS CARD IF NO RESTART
9
40
READ MASS AND STIFFNESS MATRICES AND RESTART INFORMATION
10
RESTART
YES
NO
11
READ NODAL RESTART AND INITIAL CONDITION CARDS
12
INCLUDE THERMAL LOADS
NO
YES
13
READ COEFFICIENTS OF THERMAL EXPANSION CARDS
14
TRI40R
CALCULATE TRIGONOMETRIC INTEGRALS REQUIRED TO CALCULATE GENERALIZED NONLINEAR LOADS.
A
2.15
D
19
FIRST TIME THROUGH & CONSTANT FORCES
20
UPDATE FORCE AND THERMAL MATRICES
21
RETURN
E
22
500
READ LOAD CONTROL CARD
23
CONCENTRATED RING LOADS
NO
YES
24
READ CONCENTRATED RING LOADS
25
DISTRIBUTED LOADS PRESENT
NO
YES
26
FRCES
READ DISTRIBUTED LOADS AND CALCULATE LINEAR GENERALIZED FORCES
27
PROCESS ALL ELEMENTS
REPEAT
DONE
28
THERMAL LOADS PRESENT
YES
B
2.35
NO
29
READ THERMAL COEFFICIENT
NO
YES
30
READ TEMPERATURE DISTRIBUTIOR AND GRADIENTS
31
CALCULATE THERMAL COEFFICIENTS
32
THCOE
READS TEMPERATURE AND TEMPERATURE GRADIENTS AND CALCULATES THERMAL FOURIER COEFFICIENTS
33
PROCESS ALL ELEMENTS
C
2.34
39
WRITE RESTART INFORMATION ON TAPE
40
RETURN

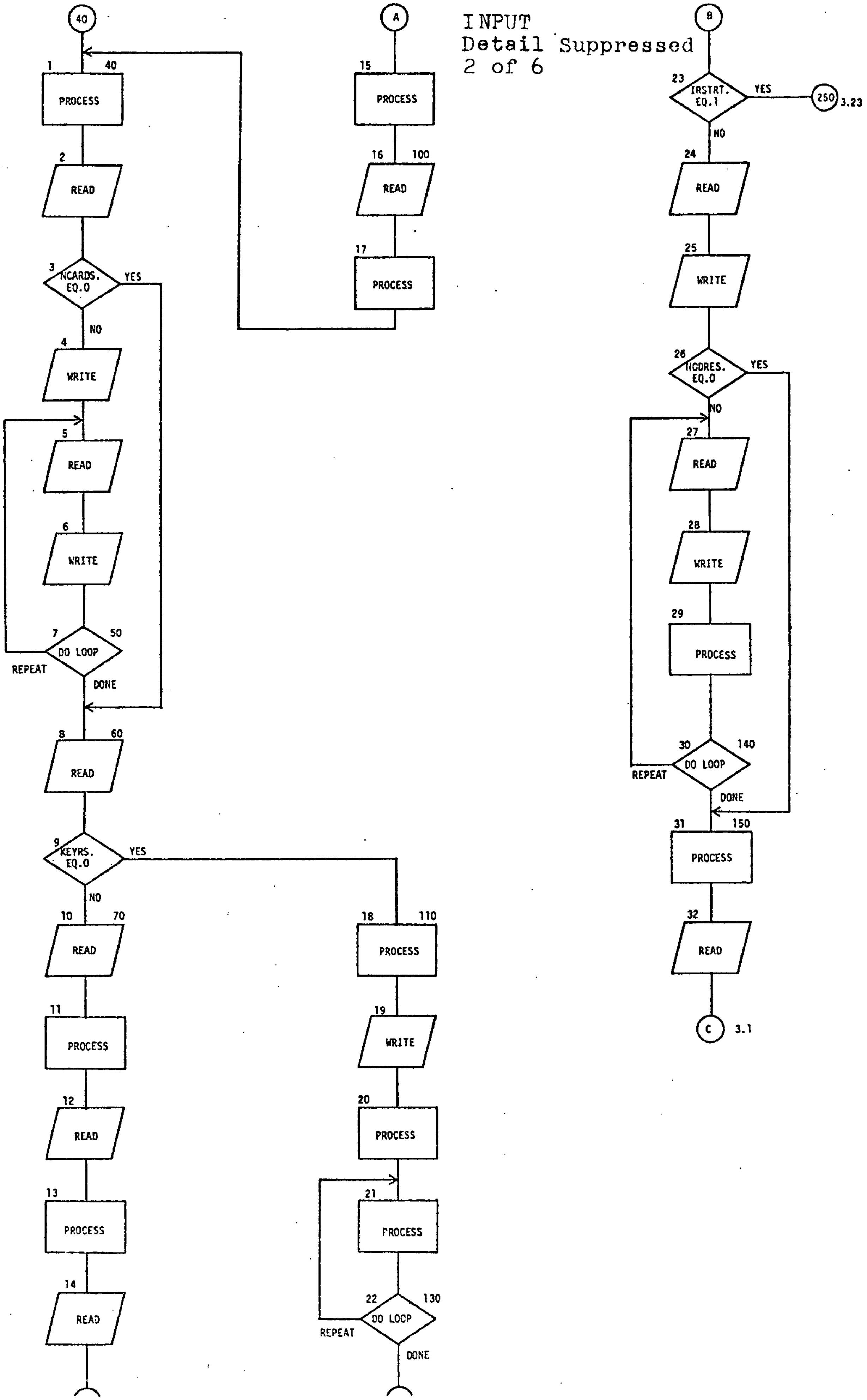

A
15
RESTART
YES
D
1.19
NO
16
READ AND CALCULATE INFORMATION REQUIRED FOR RESTART OPERATION
17
NLTERM
CALCULATE NONLINEAR LOADS AND STRESS RESULTANTS FOR EACH ELEMENT.
18
RETURN
C
34
TFORCE
CALCULATE LINEAR THERMAL LOADS
B
35
FORCES NOT CONSTANT OR 1ST TIME THRU WITH KEY = 2
NO
38
RETURN
YES
36
KEY =1
E
1.22
37
RETURN

INPUT J-3.49
Detail Suppressed
1 of 6

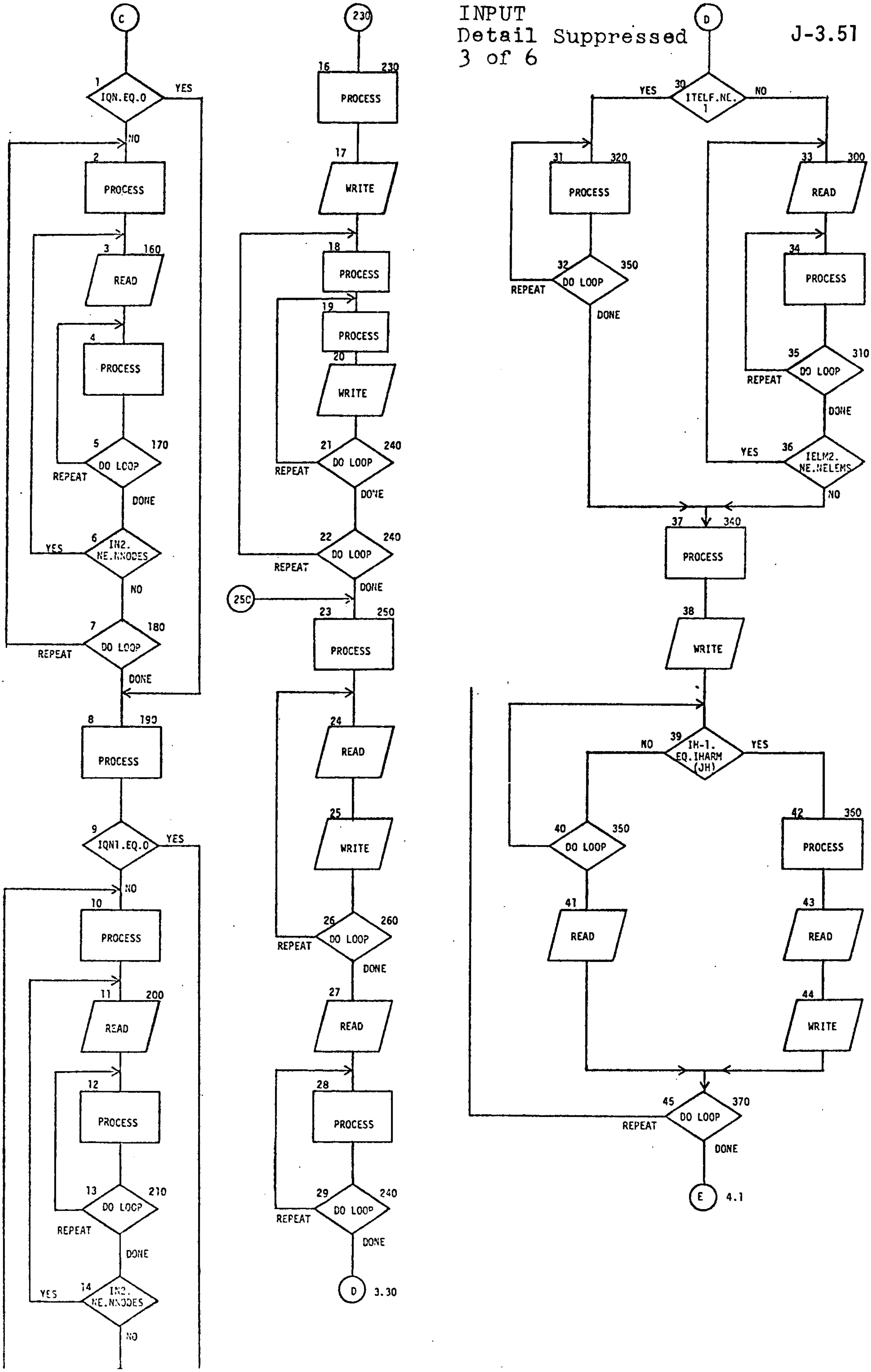


J-3.50

INPUT
Detail Suppressed
2 of 6



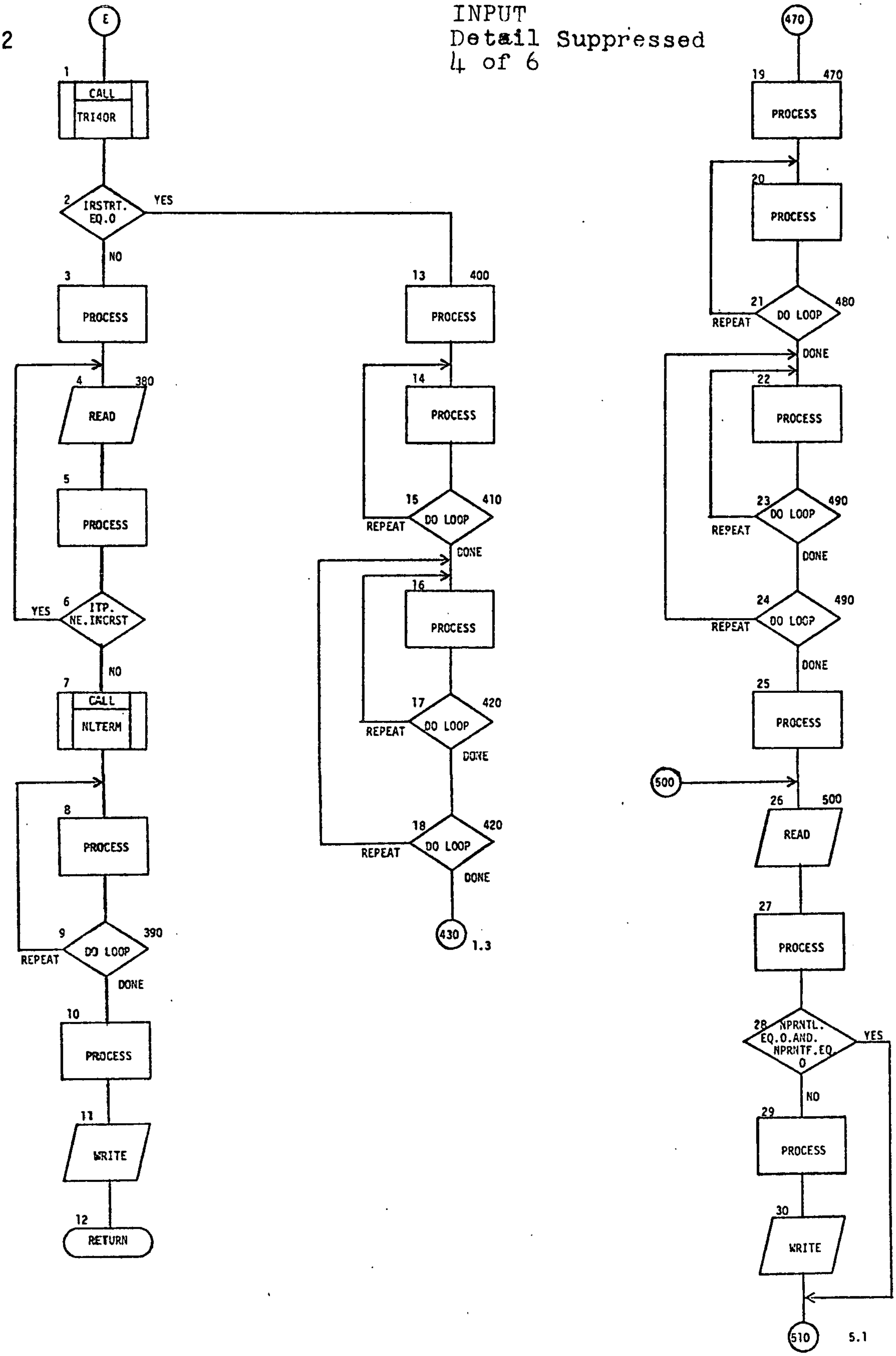
INPUT
Detail Suppressed
3 of 6



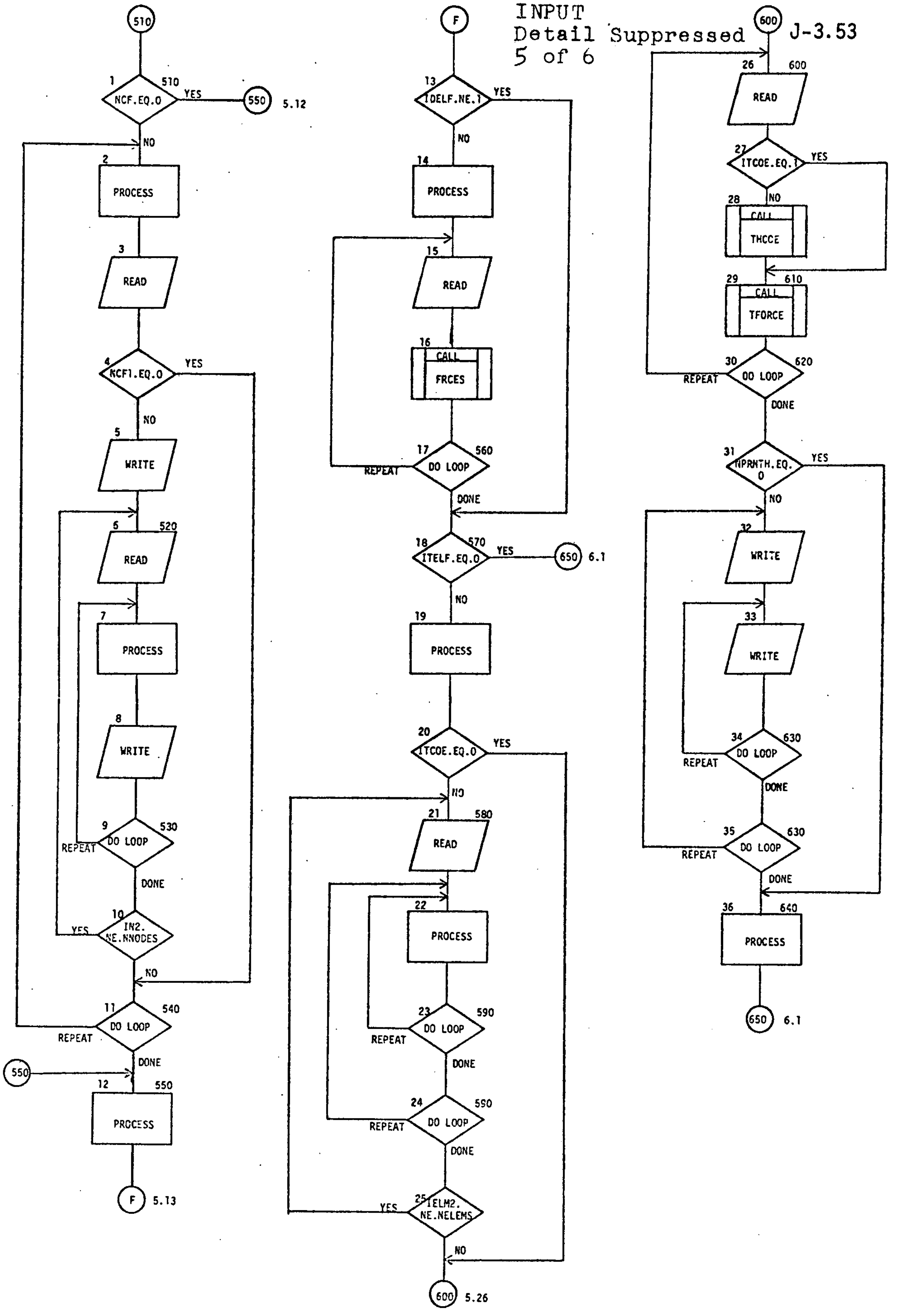
F

J-3.52

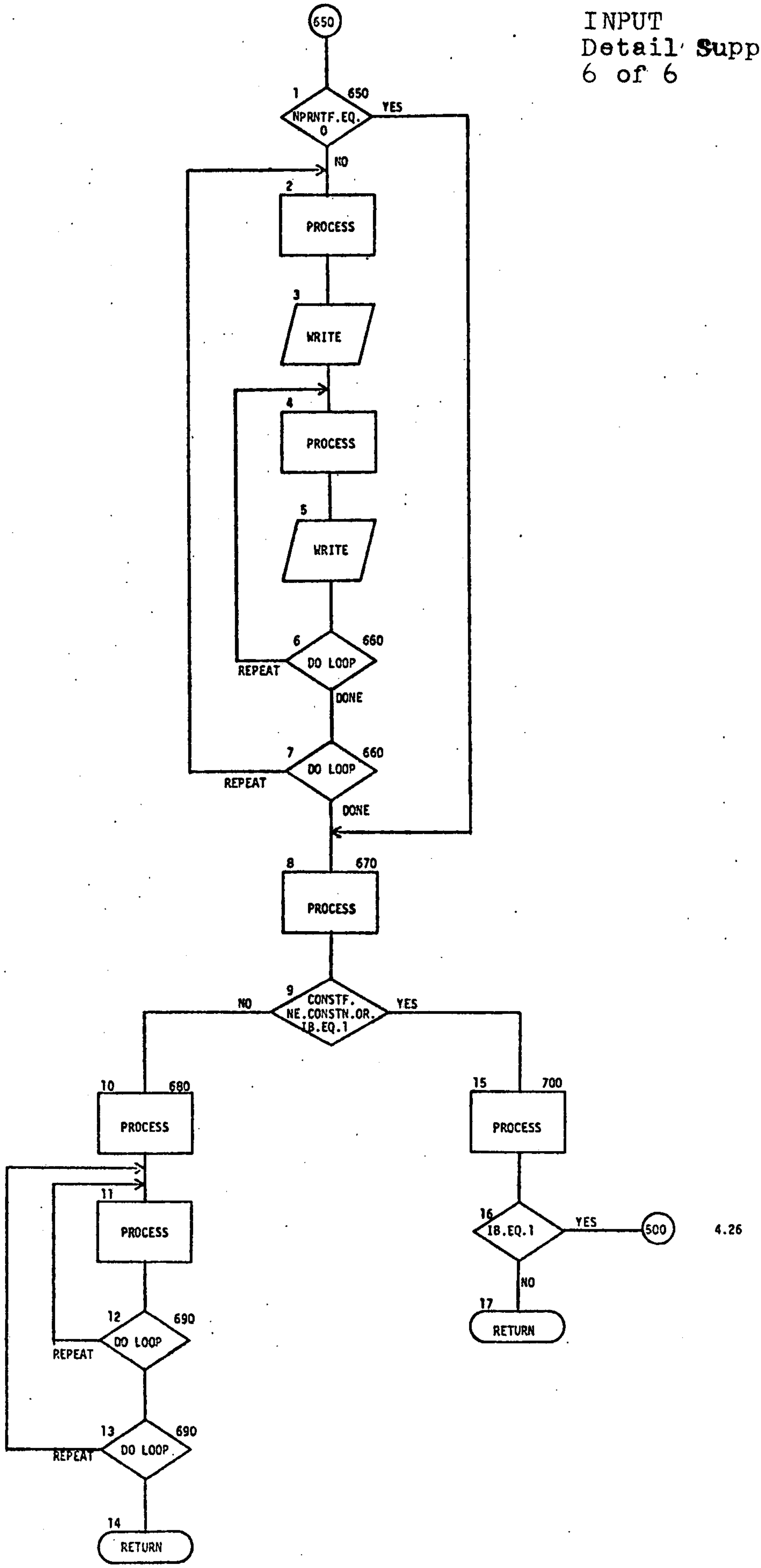
INPUT
Detail Suppressed
4 of 6

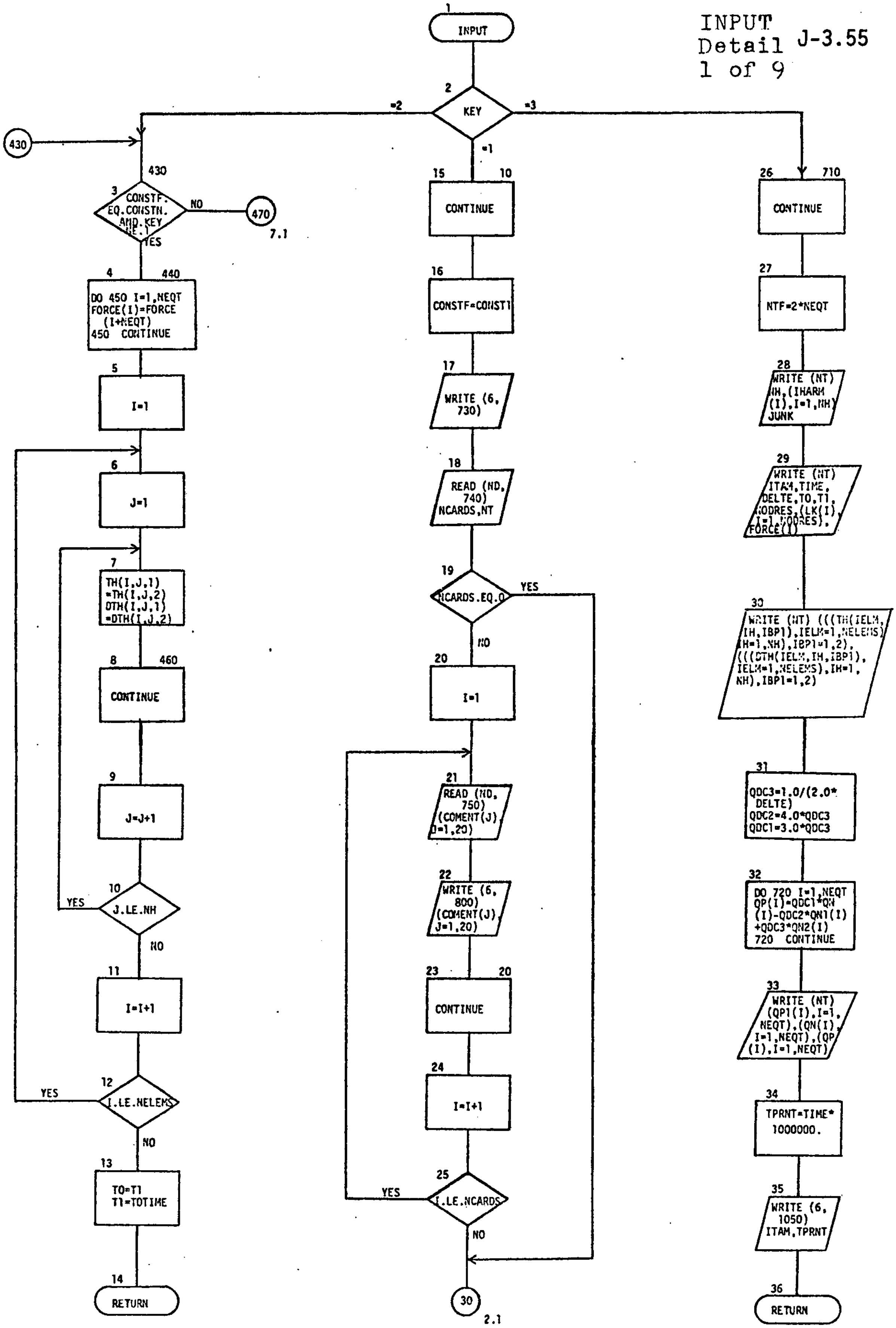


INPUT
Detail Suppressed
5 of 6



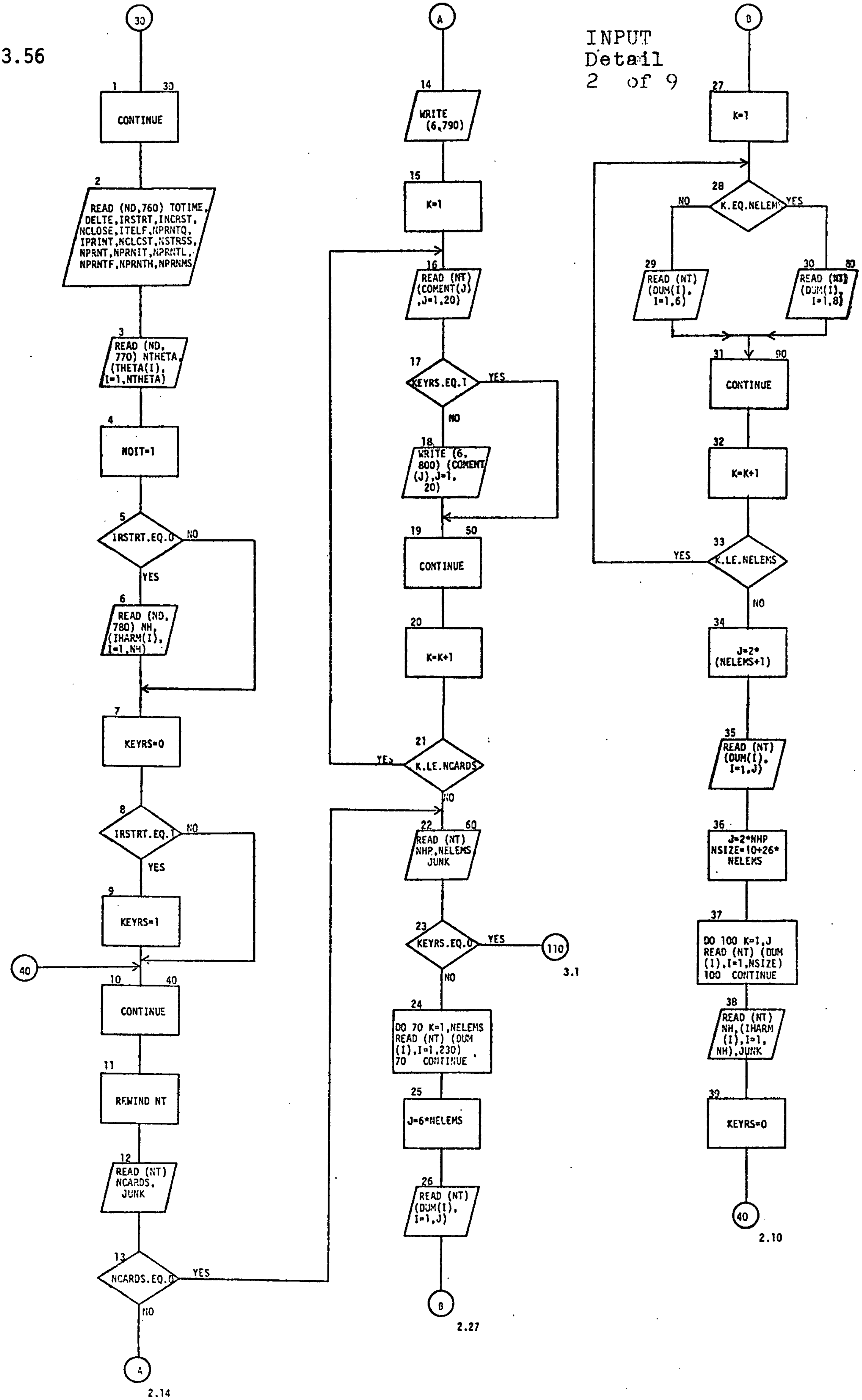
INPUT
Detail Suppressed
6 of 6



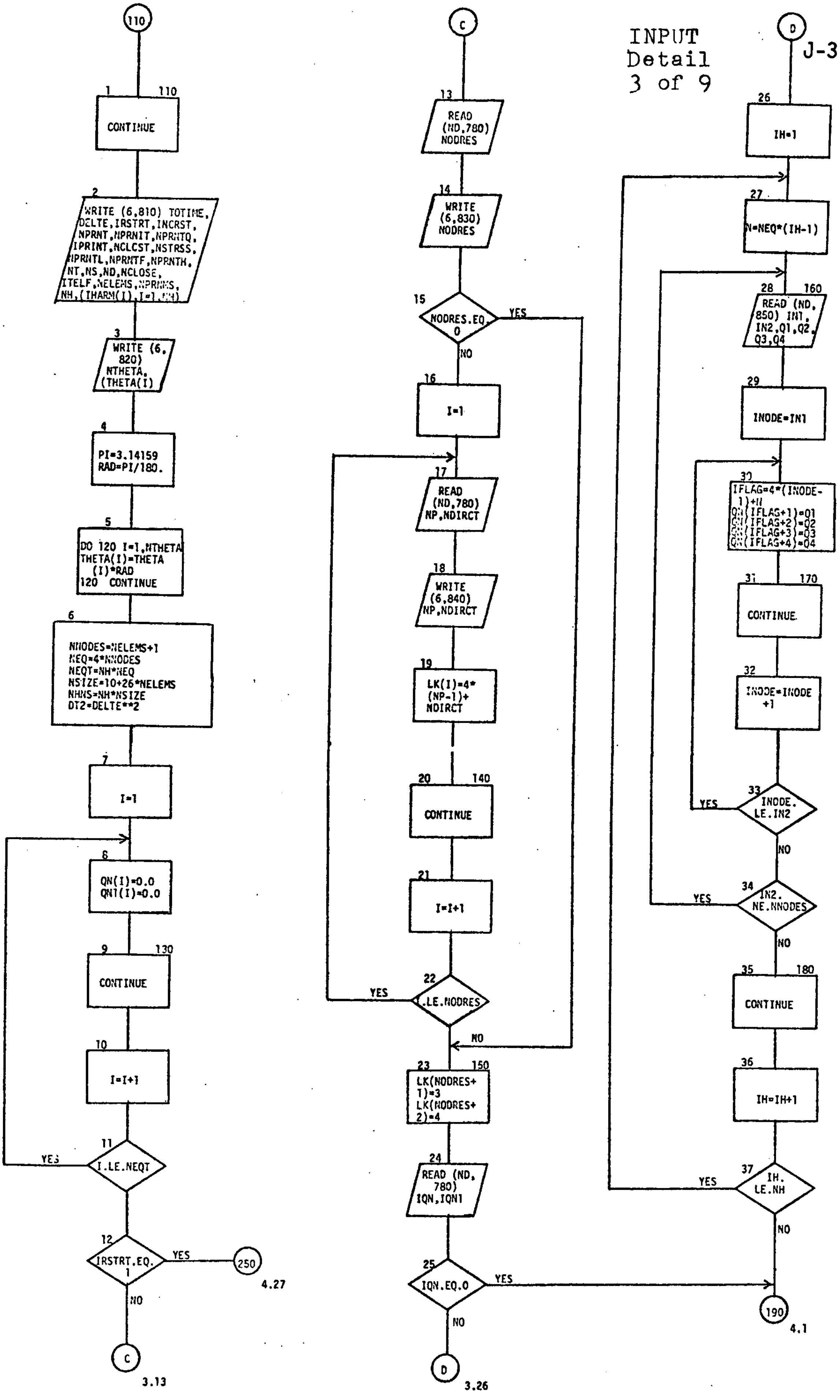

1
INPUT
2
KEY
=2
=1
=3
430
430
3
CONSTF.
EQ.CONSTN.
AND.KEY
NE.1
NO
470
7.1
YES
4
440
DO 450 I=1,NEQT
FORCE(I)=FORCE
(I+NEQT)
450 CONTINUE
5
I=1
6
J=1
7
TH(I,J,1)
=TH(I,J,2)
DTH(I,J,1)
=DTH(I,J,2)
8
460
CONTINUE
9
J=J+1
10
YES
J.LE.NH
NO
11
I=I+1
12
YES
I.LE.NELEMS
NO
13
TO=T1
T1=TOTIME
14
RETURN
15
10
CONTINUE
16
CONSTF=CONST1
17
WRITE (6,
730)
18
READ (ND,
740)
NCARDS,NT
19
NCARDS.EQ.0
YES
NO
20
I=1
21
READ (ND,
750)
(COMENT(J),
J=1,20)
22
WRITE (6,
800)
(COMENT(J),
J=1,20)
23
20
CONTINUE
24
I=I+1
25
YES
I.LE.NCARDS
NO
30
2.1
26
710
CONTINUE
27
NTF=2*NEQT
28
WRITE (NT)
NH,(IHARM
(I),I=1,NH)
JUNK
29
WRITE (NT)
ITAM,TIME,
DELTE,TO,T1,
NODRES,(LK(I),
I=1,NODRES),
FORCE(I)
30
WRITE (NT) (((TH(IELM,
IH,IBP1),IELM=1,NELEMS)
IH=1,NH),IBP1=1,2),
(((DTH(IELM,IH,IBP1),
IELM=1,NELEMS),IH=1,
NH),IBP1=1,2)
31
QDC3=1.0/(2.0*
DELTE)
QDC2=4.0*QDC3
QDC1=3.0*QDC3
32
DO 720 I=1,NEQT
QP(I)=QDC1*QN
(I)-QDC2*QN1(I)
+QDC3*QN2(I)
720 CONTINUE
33
WRITE (NT)
(QP1(I),I=1,
NEQT),(QN(I),
I=1,NEQT),(QP
(I),I=1,NEQT)
34
TPRNT=TIME*
1000000.
35
WRITE (6,
1050)
ITAM,TPRNT
36
RETURN

J-3.56

INPUT
Detail
2 of 9

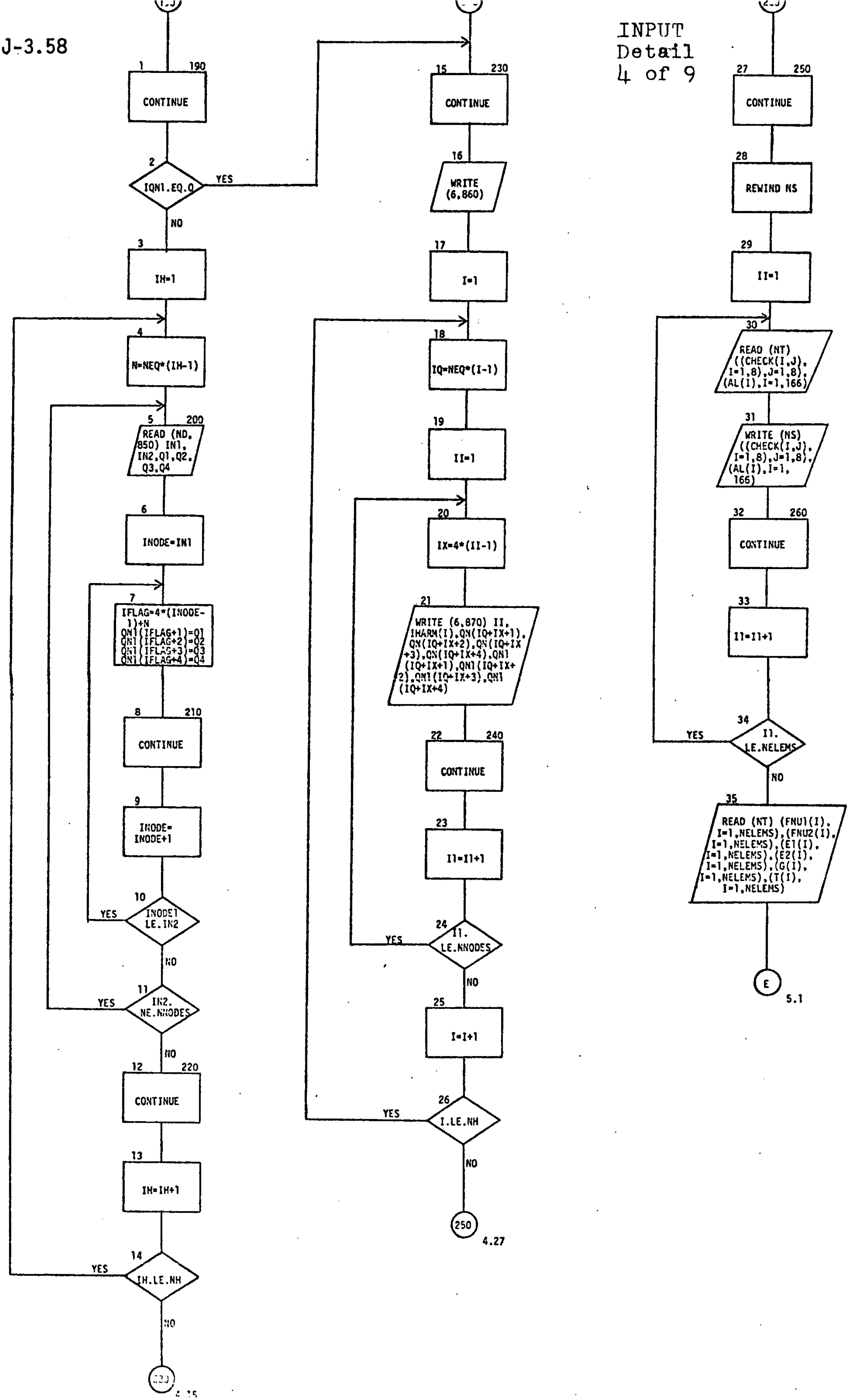

30
1 30
CONTINUE
2
READ (ND,760) TOTIME, DELTE,IRSTRT,INCRST, NCLOSE,ITELF,NPRNTQ, IPRINT,NCLCST,NSTRSS, NPRNT,NPRNIT,NPRNTL, NPRNTF,NPRNTH,NPRNMS
3
READ (ND, 770) NTHETA, (THETA(I), I=1,NTHETA)
4
NOIT=1
5
IRSTRT.EQ.0
NO
YES
6
READ (ND, 780) NH, (IHARM(I), I=1,NH)
7
KEYRS=0
8
IRSTRT.EQ.1
NO
YES
9
KEYRS=1
40
10 40
CONTINUE
11
REWIND NT
12
READ (NT) NCARDS, JUNK
13
NCARDS.EQ.0
YES
NO
A
2.14
A
14
WRITE (6,790)
15
K=1
16
READ (NT) (COMENT(J) ,J=1,20)
17
KEYRS.EQ.1
YES
NO
18
WRITE (6, 800) (COMENT (J),J=1, 20)
19 50
CONTINUE
20
K=K+1
21
K.LE.NCARDS
YES
NO
22 60
READ (NT) NHP,NELEMS JUNK
23
KEYRS.EQ.0
YES
110
3.1
NO
24
DO 70 K=1,NELEMS
READ (NT) (DUM (I),I=1,230)
70 CONTINUE
25
J=6*NELEMS
26
READ (NT) (DUM(I), I=1,J)
B
2.27
B
27
K=1
28
K.EQ.NELEMS
NO
YES
29
READ (NT) (DUM(I), I=1,6)
30 80
READ (NT) (DUM(I), I=1,8)
31 90
CONTINUE
32
K=K+1
33
K.LE.NELEMS
YES
NO
34
J=2* (NELEMS+1)
35
READ (NT) (DUM(I), I=1,J)
36
J=2*NHP
NSIZE=10+26* NELEMS
37
DO 100 K=1,J
READ (NT) (DUM (I),I=1,NSIZE)
100 CONTINUE
38
READ (NT) NH,(IHARM (I),I=1, NH),JUNK
39
KEYRS=0
40
2.10

INPUT
Detail
3 of 9

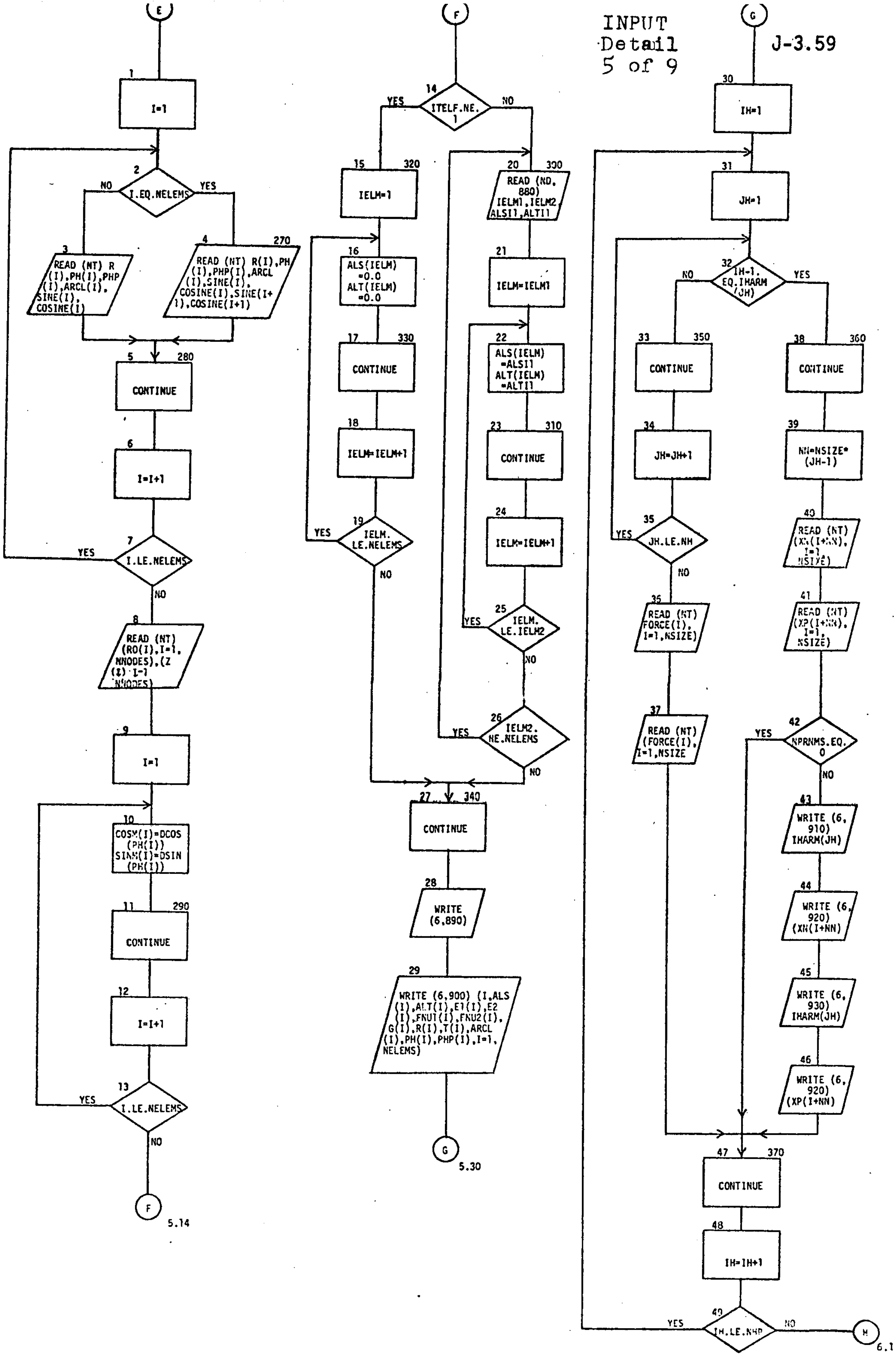


J-3.58

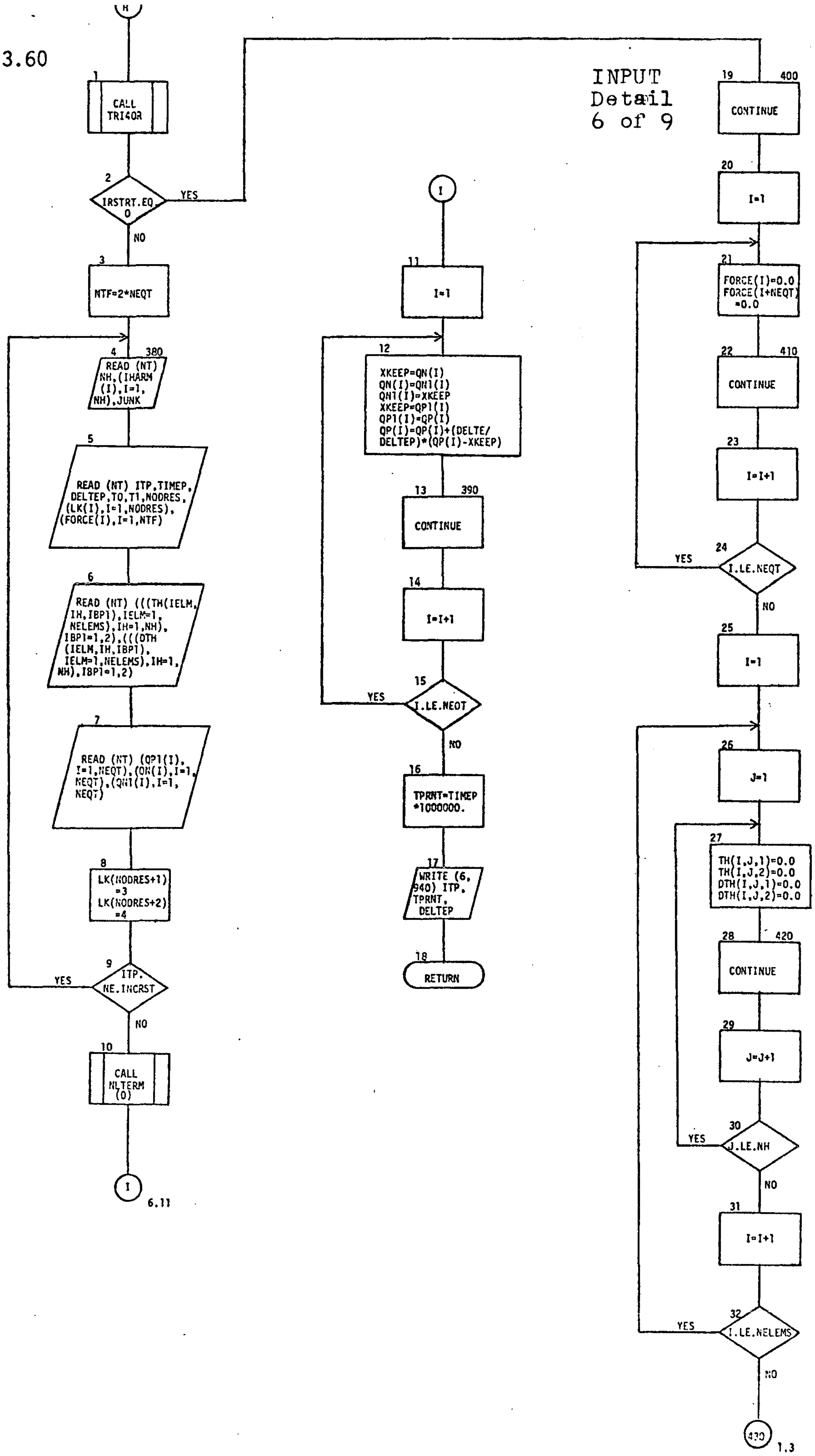
INPUT
Detail
4 of 9



INPUT
Detail
5 of 9

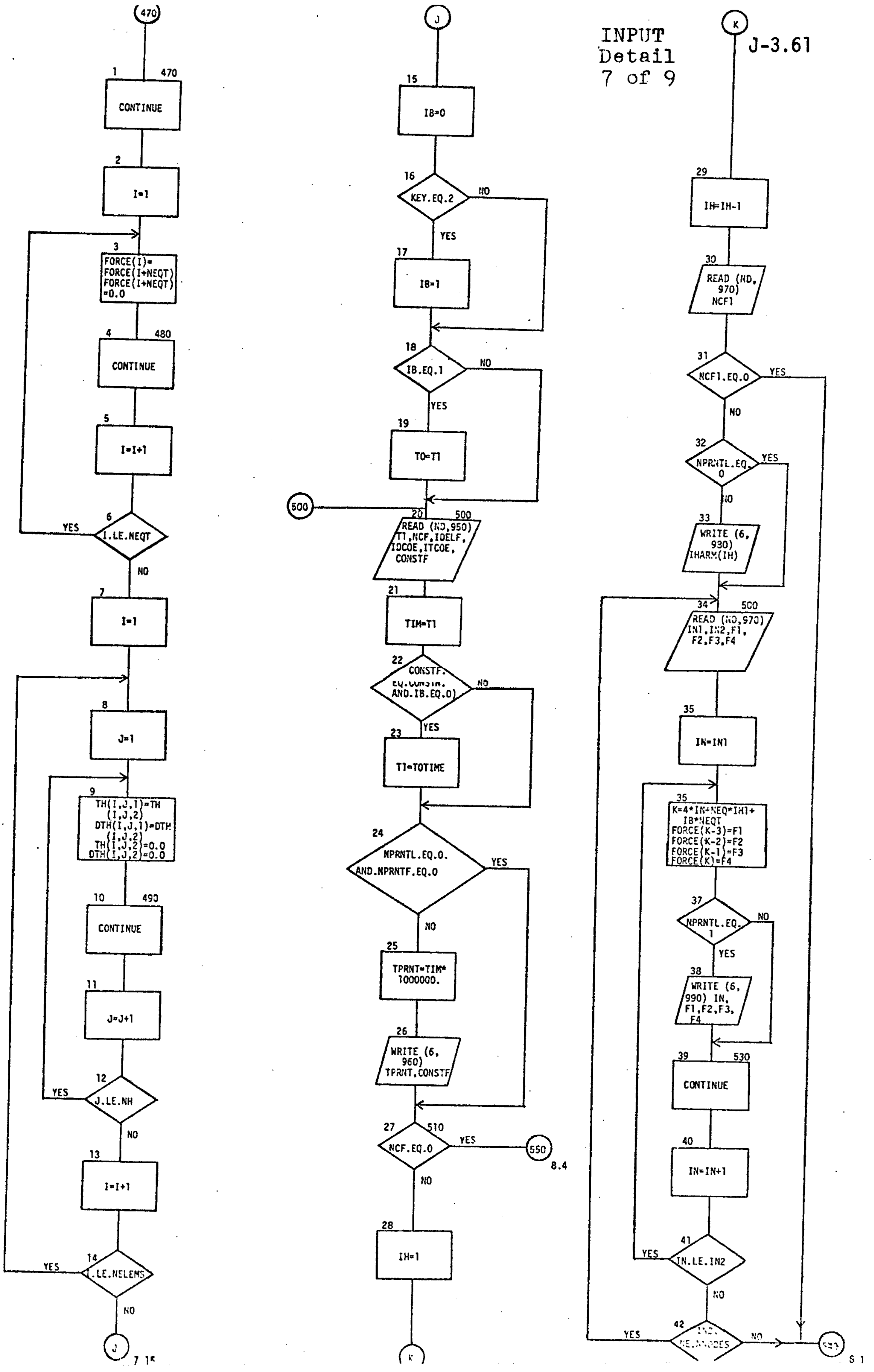


INPUT
Detail
6 of 9

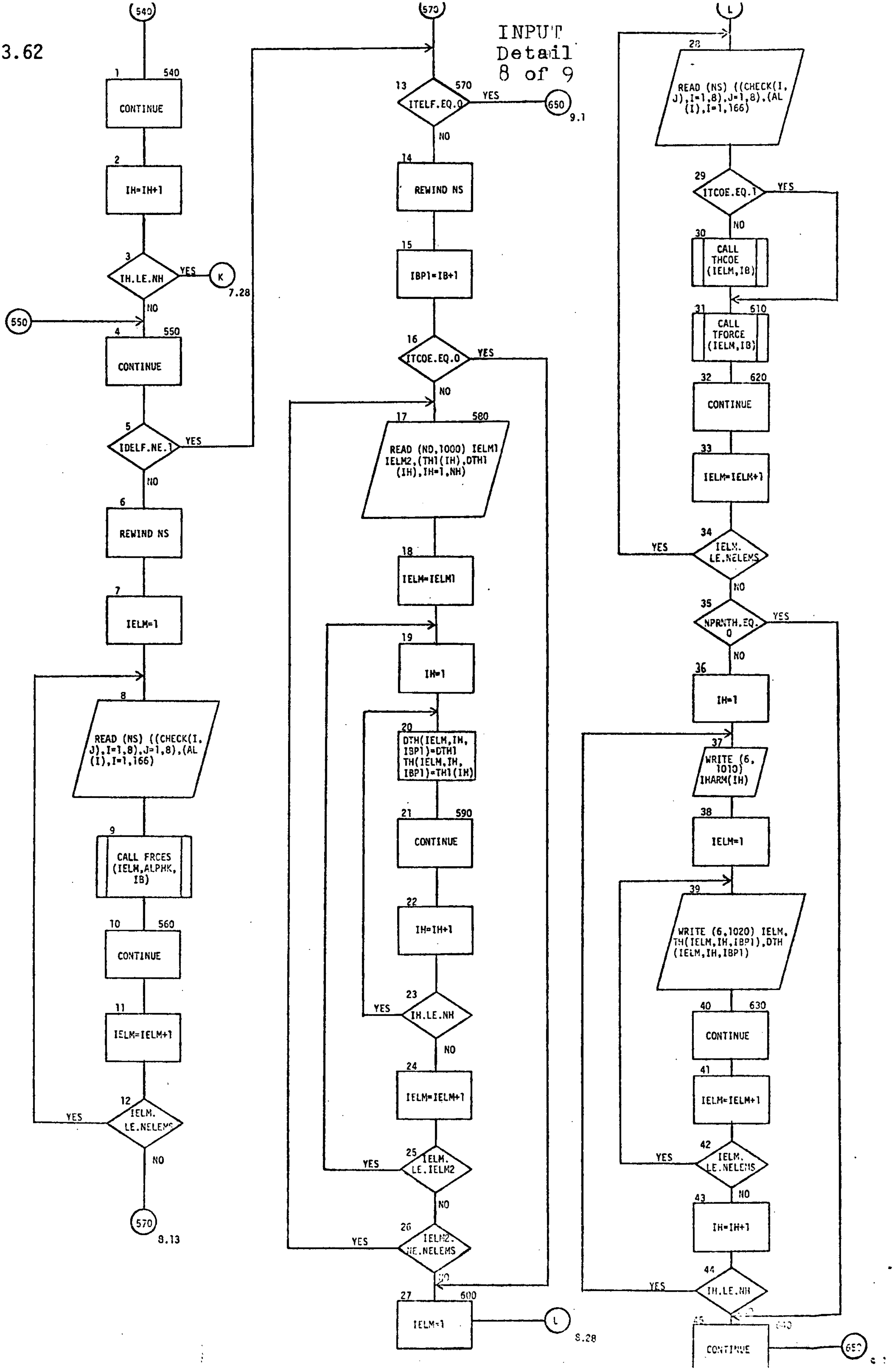


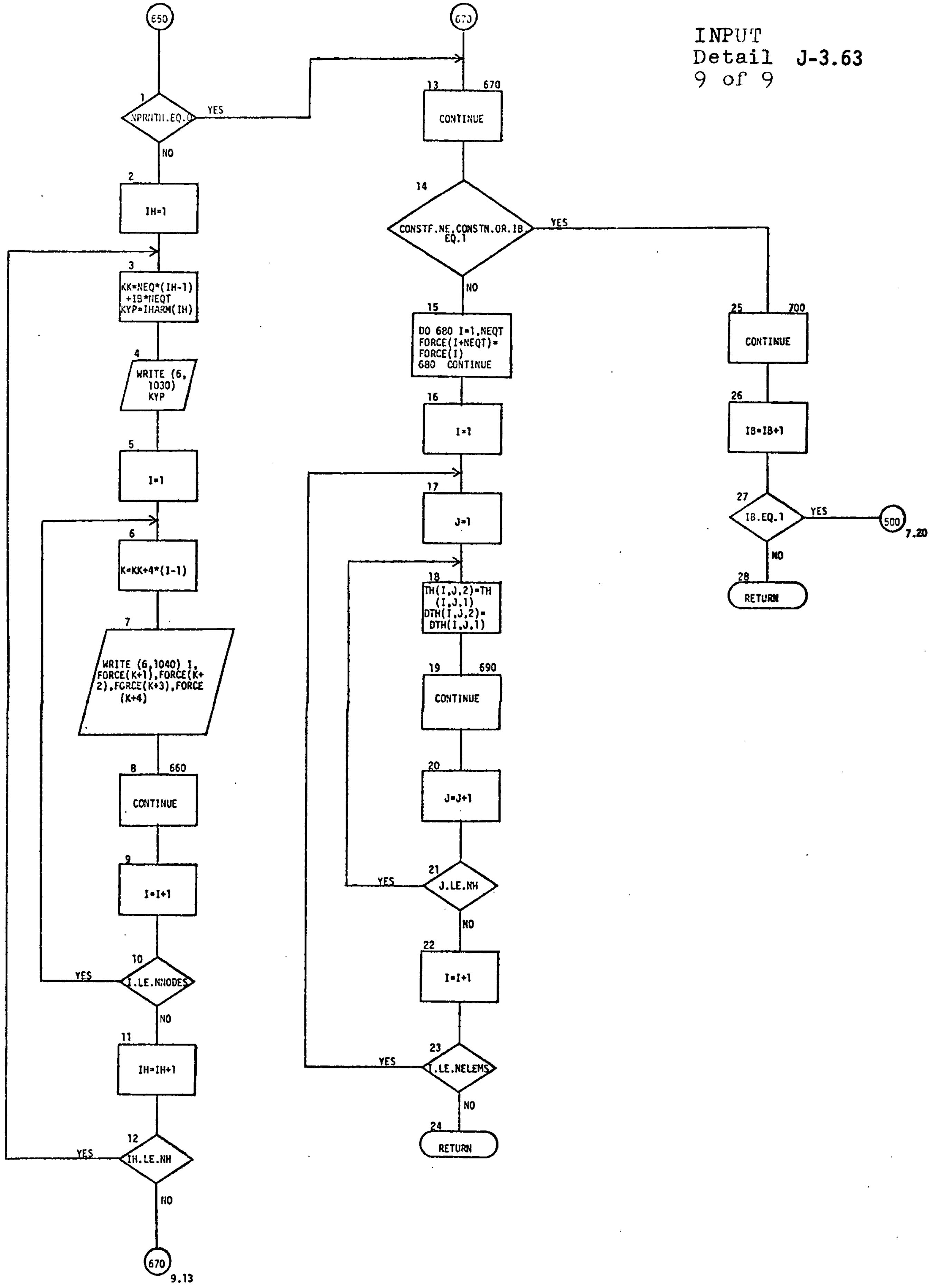
INPUT
Detail
7 of 9

J-3.61



INPUT Detail 8 of 9

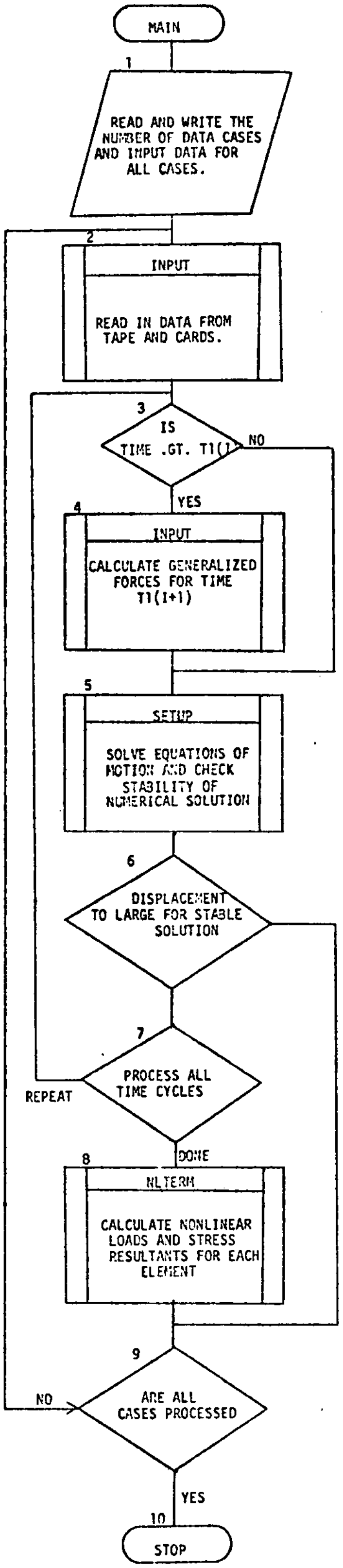



650
1
NPRNTH.EQ.0
YES
NO
2
IH=1
3
KK=NEQ*(IH-1)
+IB*NEQT
KYP=IHARM(IH)
4
WRITE (6,
1030)
KYP
5
I=1
6
K=KK+4*(I-1)
7
WRITE (6,1040) I,
FORCE(K+1),FORCE(K+
2),FORCE(K+3),FORCE
(K+4)
8
660
CONTINUE
9
I=I+1
10
I.LE.NNODES
YES
NO
11
IH=IH+1
12
IH.LE.NH
YES
NO
670
9.13
670
13
670
CONTINUE
14
CONSTF.NE.CONSTN.OR.IB.
EQ.1
YES
NO
15
DO 680 I=1,NEQT
FORCE(I+NEQT)=
FORCE(I)
680 CONTINUE
16
I=1
17
J=1
18
TH(I,J,2)=TH
(I,J,1)
DTH(I,J,2)=
DTH(I,J,1)
19
690
CONTINUE
20
J=J+1
21
J.LE.NH
YES
NO
22
I=I+1
23
I.LE.NELEMS
YES
NO
24
RETURN
25
700
CONTINUE
26
IB=IB+1
27
IB.EQ.1
YES
500
7.20
NO
28
RETURN

```
              C        DYNASOR II  *****   VERSION 6   *****   DOUBLE PRECISION   ****DYN00010
              CE(MAIN)                                                               DYN00012
              C                                                                      DYN00014
              C     DESCRIPTION - TO CONTROL PROGRAM FLOW. IT PERFORMS THE           DYN00016
              C            INPUT/OUTPUT FUNCTIONS FOR CASE DATA. PROCESSING          DYN00018
              C            IS CONTROLLED BY INCREMENTING THE INDEPENDENT             DYN00020
              C            VARIABLE, TIME, WHOSE INDIVIDUAL VALUES ARE USED          DYN00022
              C            TO SUPPLY THE SHELL DISPLACEMENTS THROUGH INTEGRATION     DYN00024
              C            OF THE EQUATIONS OF MOTION. THE NONLINEAR LOADS           DYN00026
              C            AND STRESS RESULTANTS FOR THE SHELL ARE ALSO CALCULATED.  DYN00028
              C                                                                      DYN00030
              C  INPUT ARGUMENTS.                                                    DYN00032
              C     LARGE  = CONSTANT WHICH CONTROLS TERMINATION OF THE PROBLEM      DYN00034
              C              IF DISPLACEMENTS BECOME EXCESSIVE.                      DYN00036
              C     NEQT   = TOTAL NUMBER OF EQUILIBRIUM EQUATIONS FOR ALL HARMONICS. DYN00038
              C                                                                      DYN00040
              C  EXTERNALS.                                                          DYN00042
              C     CALLS                                                            DYN00044
              C              INPUT                                                   DYN00046
              C              NLTERM                                                  DYN00048
              C              SETUP                                                   DYN00050
              C                                                                      DYN00052
0001                IMPLICIT REAL*8 (A-H,O-Z)                                        DYN00054
0002                COMMON /QS/ QN(1020),QN1(1020),FORCE(2040),QP(1020),QP1(1020),    DYN00056
                   1         QN2(1020)                                               DYN00058
0003                COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS,  DYN00060
                   1         DT2,NPRNTL,NPRNTF,IDELF,IDCOE                           DYN00062
0004                COMMON /TMFT/ TOTIME,DELTE,TIME,TO,T1                            DYN00070
0005                COMMON /PRINT/ IPRINT,NOIT,LL                                    DYN00080
0006                COMMON /HARM/ NHP,IHARM(5)                                       DYN00090
0007                COMMON /RESTRT/ IRSTRT,NPRNT,NPRNIT,ITP,TIMEP,DELTEP             DYN00100
0008                COMMON /CYCLE/ ITAM                                              DYN00110
0009                COMMON /TAPES/ NT,ND,NS                                          DYN00120
0010                DIMENSION CARD(20)                                               DYN00130
0011                EQUIVALENCE (QN(1),CARD(1))                                      DYN00140
0012                DATA TEST/4HEND /                                                DYN00150
              C                                                                      DYN00152
              C1 (IO) READ AND WRITE THE NUMBER OF DATA CASES AND INPUT DATA FOR ALL DYN00154
              C1C        CASES                                                       DYN00156
              C                                                                      DYN00158
              C      READ INPUT DATA FOR CARD TYPE I                                 DYN00190
0013                READ (5,110) NCASES,ND,NS                                        DYN00200
0014                WRITE (6,120) NCASES                                             DYN00210
0015                NCASE=0                                                          DYN00220
              C2    READ AND WRITE INPUT DATA FOR ALL CASES                          DYN00230
0016                REWIND ND                                                        DYN00260
0017             10 NCARD=0                                                          DYN00270
0018                NCASE=NCASE+1                                                    DYN00280
```

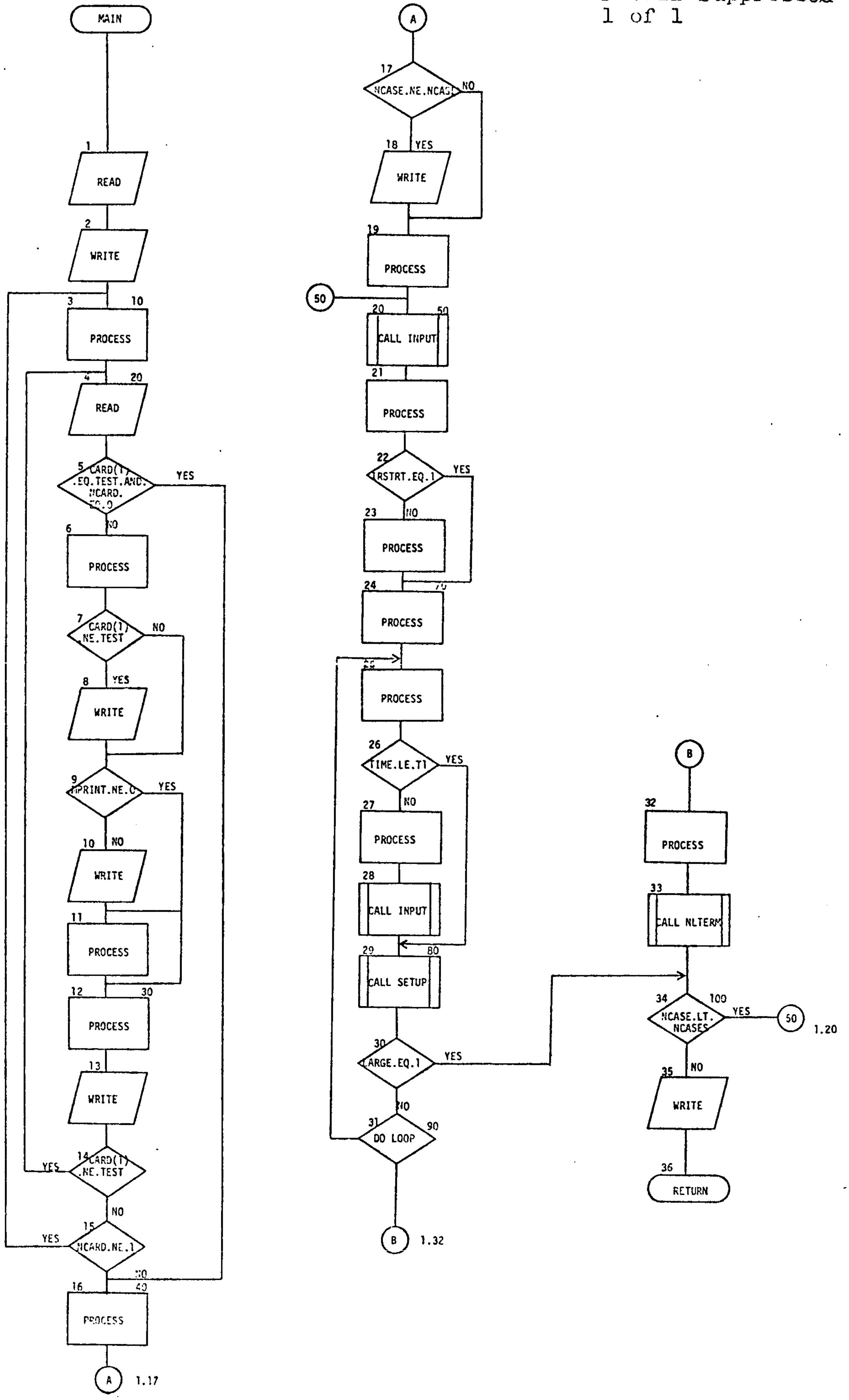
```
              MPRINT=0                                                          DYN00290
           20 READ (5,130) CARD                                                 DYN00300
              IF (CARD(1).EQ.TEST.AND.NCARD.EQ.0) GO TO 40                      DYN00310
              NCARD=NCARD+1                                                     DYN00320
              IF (CARD(1).NE.TEST) WRITE (ND,130) CARD                          DYN00330
              IF (MPRINT.NE.0) GO TO 30                                         DYN00340
              WRITE (6,140) NCASE                                               DYN00350
              WRITE (6,150)                                                     DYN00360
              MPRINT=5000                                                       DYN00370
           30 MPRINT=MPRINT-1                                                   DYN00380
              WRITE (6,160) CARD                                                DYN00390
              IF (CARD(1).NE.TEST) GO TO 20                                     DYN00400
              IF (NCARD.NE.1) GO TO 10                                          DYN00410
           40 NCASE=NCASE-1                                                     DYN00420
              IF (NCASE.NE.NCASES) WRITE (6,170)                                DYN00430
              REWIND ND                                                         DYN00440
              NCASE=0                                                           DYN00460
        C                                                                       DYN00462
           50 CALL INPUT (1)                                                    DYN00470
              NCASE=NCASE+1                                                     DYN00480
              LARGE=0                                                           DYN00490
        C                                                                       DYN00492
        C2    IS THIS A PROGRAM RESTART //YES(70)                               DYN00494
              IF (IRSTRT.EQ.1) GO TO 70                                         DYN00500
        C                                                                       DYN00508
              DO 60 I=1,NEQT                                                    DYN00510
                 QP1(I)=0.0                                                     DYN00520
           60 CONTINUE                                                          DYN00530
        C                                                                       DYN00533
        C2    BEGIN TIME INCREMENTS                                             DYN00535
              ITP=0                                                             DYN00550
              TIMEP=0.0                                                         DYN00560
              T0=0.0                                                            DYN00570
           70 KKP2=ITP+(TOTIME-TIMEP+DELTE*.001)/DELTE                          DYN00580
              NOIT=KKP2                                                         DYN00590
              LL=1                                                              DYN00600
              IF (IRSTRT.EQ.1) LL=ITP+1                                         DYN00610
        C1DO  PROCESS ALL TIME CYCLES                                           DYN00612
        C                                                                       DYN00618
              DO 90 ITAM=LL,KKP2                                                DYN00620
                 TIME=TIMEP+(ITAM-ITP)*DELTE                                    DYN00630
        C1IF     TIME .GT. T1(I)//NO(80)                                        DYN00632
                 IF (TIME.LE.T1) GO TO 80                                       DYN00640
                 IF (ITAM.EQ.KKP2) GO TO 80                                     DYN00650
                 T0=T1                                                          DYN00660
        C1       CALCULATE GENERALIZED FORCES FOR TIME T1(I+1)                  DYN00662
                 CALL INPUT (2)                                                 DYN00670
           80    CONTINUE                                                       DYN00680
```

```
               C1         SOLVE EQUATIONS OF MOTION AND CHECK STABILITY OF NUMERICAL      DYN00682
               C1C   -               SOLUTION.                                            DYN00684
 0057                     CALL SETUP (ITAM,TIME,LARGE)                                    DYN00690
               C1         DISPLACEMENT TOO LARGE FOR STABLE SOLUTION//YES(100)            DYN00692
 0058                     IF (LARGE.EQ.1) GO TO 100                                       DYN00700
 0059                 90 CONTINUE                                                         DYN00710
               C                                                                          DYN00713
 0060                   ITAM=KKP2+1                                                       DYN00720
 0061                   TIME=TIME+DELTE                                                   DYN00730
               C1       CALCULATE NONLINEAR LOADS AND STRESS RESULTANTS FOR EACH ELEMENT  DYN00732
 0062                   CALL NLTERM (ITAM)                                                DYN00740
               C1       ARE ALL CASES PROCESSED//NO(50)                                   DYN00742
 0063              100 IF (NCASE.LT.NCASES) GO TO 50                                      DYN00750
 0064                   WRITE (6,180)                                                     DYN00760
 0065                   STOP                                                              DYN00770
               C                                                                          DYN00780
 0066              110 FORMAT (3I5)                                                       DYN00790
 0067              120 FORMAT (1H1,///,30X,31HTHE NUMBER OF CASES TO BE RUN =,I5)         DYN00800
 0068              130 FORMAT (20A4)                                                      DYN00810
 0069              140 FORMAT (//8H1 NCASE=,I1//,28X,22HPRINTOUT OF INPUT DATA,/)         DYN00820
 0070              150 FORMAT (13X,2H10,8X,2H20,8X,2H30,8X,2H40,8X,2H50,8X,2H60,8X,2H70,  DYN00830
                     1         8X,2H80/                                                   DYN00840
                     1         5X,8(10H1234567890)/)                                      DYN00850
 0071              160 FORMAT (5X,20A4)                                                   DYN00860
 0072              170 FORMAT (50H THE NUMBER OF INPUT CASES DOES NOT AGREE WITH THE,     DYN00870
                     1         22H VALUE OF NCASES INPUT)                                 DYN00880
 0073              180 FORMAT (1H1//10X,18HALL DATA PROCESSED//10X,11H . . . STOP)        DYN00890
 0074                   END                                                               DYN00900
```

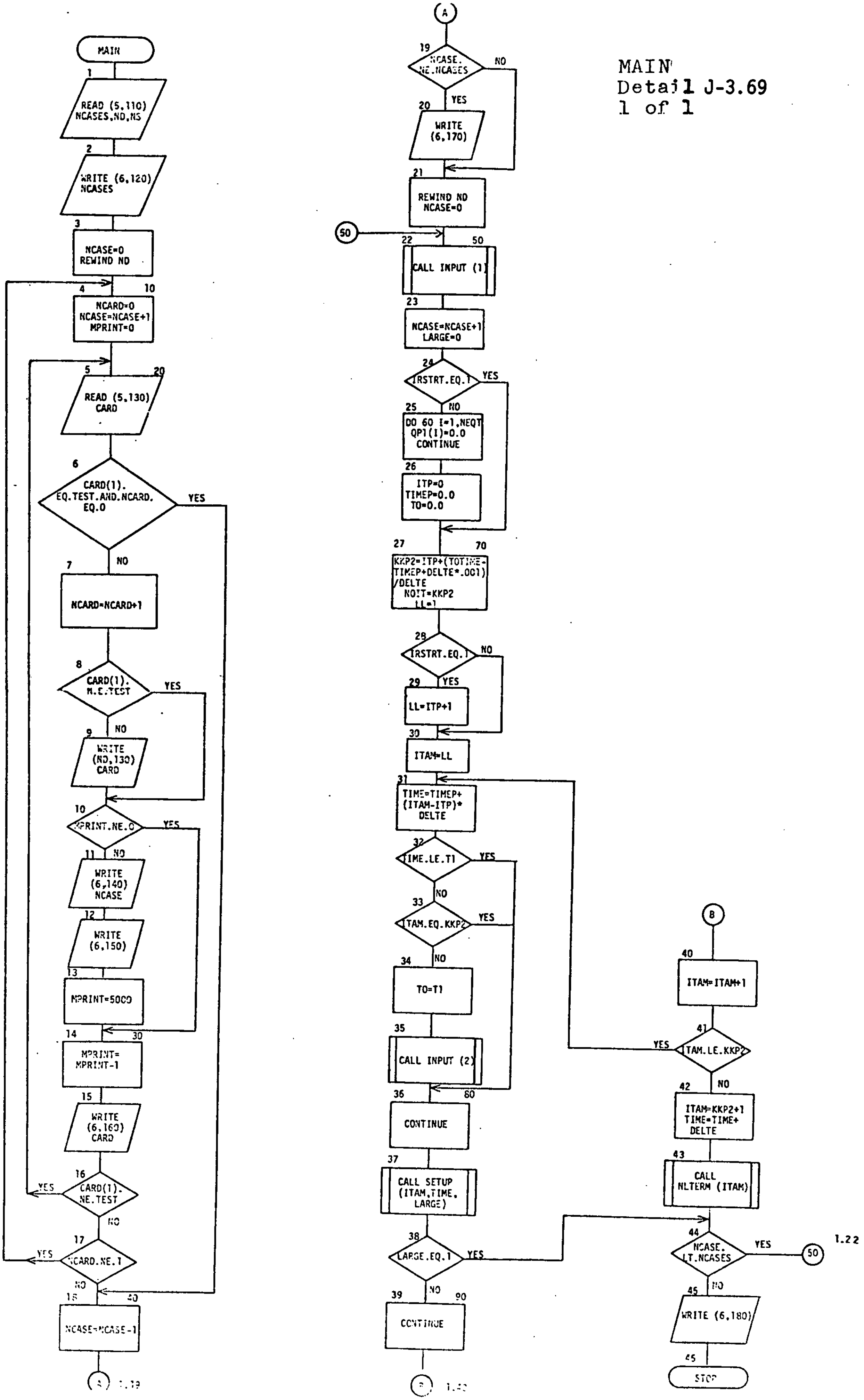

MAIN
1
READ AND WRITE THE NUMBER OF DATA CASES AND INPUT DATA FOR ALL CASES.
2
INPUT
READ IN DATA FROM TAPE AND CARDS.
3
IS TIME .GT. T1(I)
NO
YES
4
INPUT
CALCULATE GENERALIZED FORCES FOR TIME T1(I+1)
5
SETUP
SOLVE EQUATIONS OF MOTION AND CHECK STABILITY OF NUMERICAL SOLUTION
6
DISPLACEMENT TO LARGE FOR STABLE SOLUTION
7
PROCESS ALL TIME CYCLES
REPEAT
DONE
8
NLTERM
CALCULATE NONLINEAR LOADS AND STRESS RESULTANTS FOR EACH ELEMENT
9
ARE ALL CASES PROCESSED
NO
YES
10
STOP

J-3.68

MAIN
Detail Suppressed
1 of 1

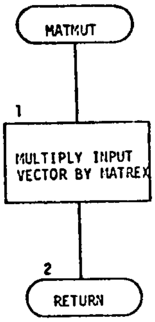


MAIN
Detail J-3.69
1 of 1

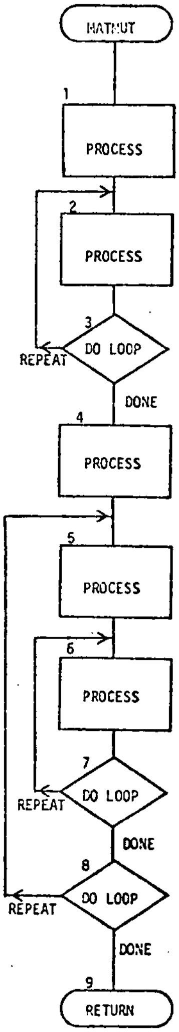


```
               CE(MATMUT)                                                         DYN10852
               C                                                                  DYN10854
               C     DESCRIPTION - TO MULTIPLY AN INPUT VECTOR BY THE STIFFNESS MATRIX DYN10856
               C                                                                  DYN10858
               C INPUT ARGUMENTS.                                                 DYN10860
               C     FORCE  = MATRIX OF GENERALIZED FORCES DUE TO EXTERNAL LOADS AND  DYN10862
               C              TEMPERATURES.                                       DYN10864
               C     IH     = HARMONIC KEY.                                       DYN10866
               C     IID    = VECTOR RANK IN MATMUT.                              DYN10868
               C     STIFM  = STIFFNESS MATRIX.                                   DYN10870
               C                                                                  DYN10872
               C EXTERNALS.                                                       DYN10874
               C     CALLED BY                                                    DYN10876
               C              HOUBQ1                                              DYN10878
               C              HOUBQN                                              DYN10880
               C                                                                  DYN10882
 0001                SUBROUTINE MATMUT (IH,FORCE,STIFM,A,IID)                     DYN10884
 0002                IMPLICIT REAL*8 (A-H,O-Z)                                    DYN10886
 0003                DIMENSION A(204), STIFM(6550), FORCE(1020)                   DYN10888
               C1    MULTIPLY INPUT VECTOR BY MATRIX                              DYN10890
               C                                                                  DYN10938
 0004                DO 10 I=1,IID                                                DYN10940
 0005                   A(I)=0.0                                                  DYN10950
 0006             10 CONTINUE                                                     DYN10952
               C                                                                  DYN10955
 0007                NN=IID/4                                                     DYN10960
 0008                NT=26*(NN-1)+10                                              DYN10970
 0009                NK=NT*(IH-1)                                                 DYN10980
 0010                NF=IID*(IH-1)                                                DYN10990
 0011                NA=NK                                                        DYN11000
               C                                                                  DYN11008
 0012                DO 20 J=1,4                                                  DYN11010
               C                                                                  DYN11018
 0013                   DO 20 I=1,J                                               DYN11020
 0014                      NA=NA+1                                                DYN11030
 0015                      A(I)=A(I)+STIFM(NA)*FORCE(NF+J)                        DYN11040
 0016             20 CONTINUE                                                     DYN11042
               C                                                                  DYN11045
 0017                A(2)=A(2)+STIFM(NK+2)*FORCE(NF+1)                            DYN11050
 0018                A(3)=A(3)+STIFM(NK+4)*FORCE(NF+1)+STIFM(NK+5)*FORCE(NF+2)    DYN11060
 0019                A(4)=A(4)+STIFM(NK+7)*FORCE(NF+1)+STIFM(NK+8)*FORCE(NF+2)+   DYN11070
                  1            STIFM(NK+9)*FORCE(NF+3)                            DYN11080
 0020                NKK=NK+10                                                    DYN11090
 0021                NM1=NN-1                                                     DYN11100
               C                                                                  DYN11108
 0022                DO 40 I=1,NM1                                                DYN11110
 0023                   NI=4*(I-1)                                                DYN11120
 0024                   NFF=NF+NI                                                 DYN11130
```

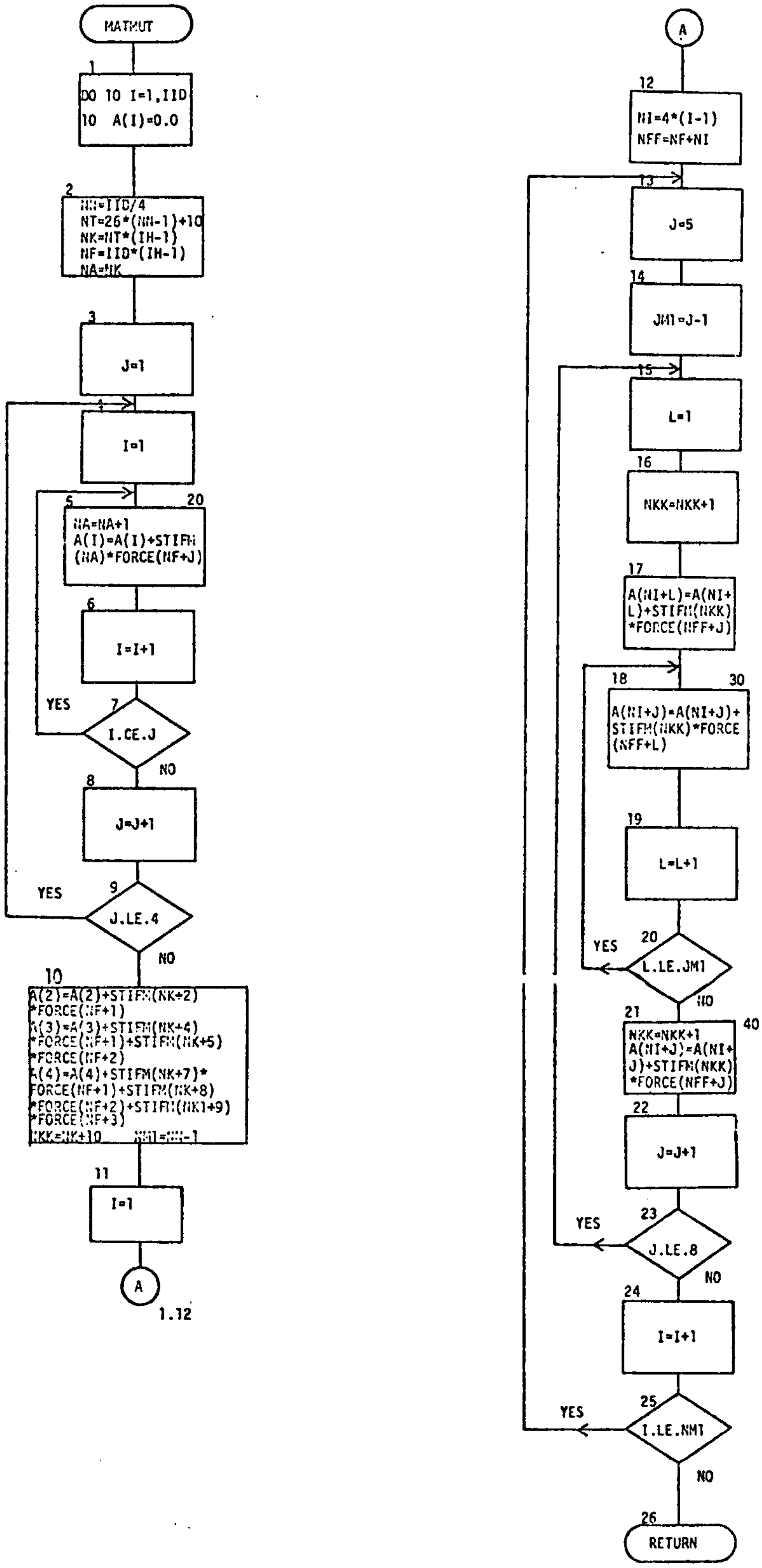
```
             C                                                                        DYN11138
 0025                 DO 40 J=5,8                                                     DYN11140
 0026                    JM1=J-1                                                      DYN11150
             C                                                                        DYN11158
 0027                    DO 30 L=1,JM1                                                DYN11160
 0028                       NKK=NKK+1                                                 DYN11170
 0029                       A(NI+L)=A(NI+L)+STIFM(NKK)*FORCE(NFF+J)                   DYN11180
 0030                       A(NI+J)=A(NI+J)+STIFM(NKK)*FORCE(NFF+L)                   DYN11190
 0031           30       CONTINUE                                                     DYN11192
             C                                                                        DYN11195
 0032                    NKK=NKK+1                                                    DYN11200
 0033                    A(NI+J)=A(NI+J)+STIFM(NKK)*FORCE(NFF+J)                      DYN11210
 0034           40 CONTINUE                                                           DYN11212
             C                                                                        DYN11215
 0035              RETURN                                                             DYN11220
 0036              END                                                                DYN11230
```


MATMUT
1
MULTIPLY INPUT VECTOR BY MATREX
2
RETURN

MATMUT J-3.73
Detail Suppressed
1 of 1

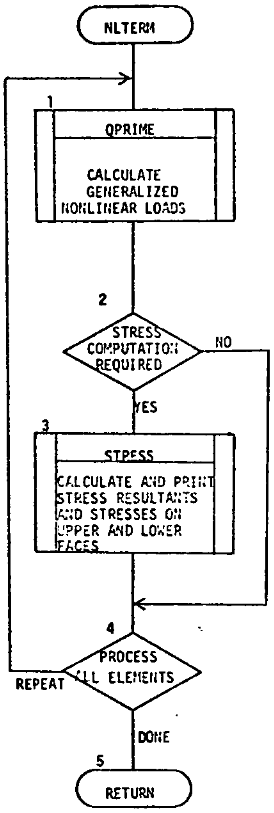


MATMUT
Detail
1 of 1

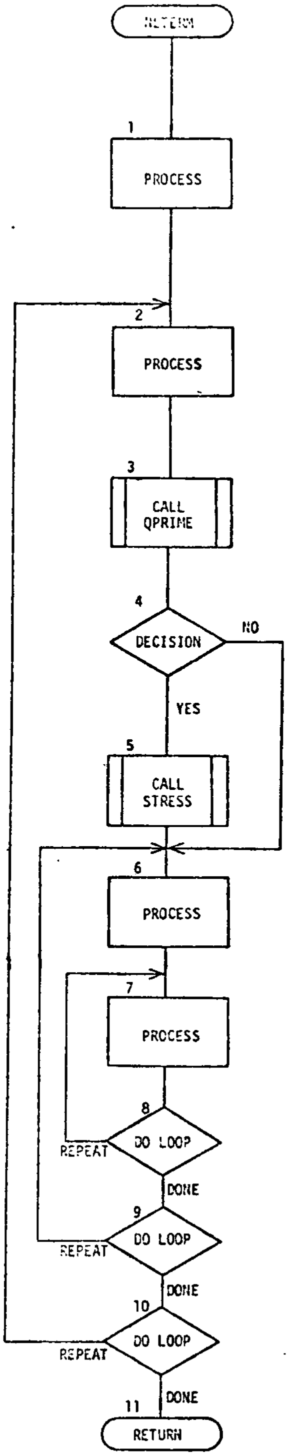


```
              CE(NLTERM)                                                            DYN06532
              C                                                                     DYN06534
              C     DESCRIPTION - TO PROCESS ALL ELEMENTS TO OBTAIN THE             DYN06536
              C            GENERALIZED NONLINEAR LOADS. IF STRESS COMPUTATIONS      DYN06538
              C            ARE REQUIRED, THEN THE STRESS RESULTANTS AND STRESSES    DYN06540
              C            ON THE UPPER AND LOWER SHELL SURFACES ARE COMPUTED       DYN06542
              C            AND PRINTED OUT.                                         DYN06544
              C                                                                     DYN06546
              C  INPUT ARGUMENTS.                                                   DYN06548
              C     E1      = MATRIX CONTAINING THE YOUNG'S MODULUS IN THE MERIDIANAL  DYN06550
              C               DIRECTION FOR EACH HARMONIC.                          DYN06552
              C     E2      = MATRIX CONTAINING THE YOUNG'S MODULUS IN CIRCUMFERENTIAL DYN06554
              C               DIRECTION FOR EACH ELEMENT.                           DYN06556
              C     FNU1    = MATRIX CONTAINING THE VALUES OF POISSON'S RATIO FOR   DYN06558
              C               EACH ELEMENT.                                         DYN06560
              C     FNU2    = MATRIX CONTAINING THE VALUES OF POISSON'S RATION FOR EACHDYN06562
              C               ELEMENT.                                              DYN06564
              C     G       = SHEAR MODULUS, G (FOR AN ISOTROPIC MATERIAL           DYN06566
              C               G = (E/2)*(1 + NU)).                                  DYN06568
              C     QPR     = - PARTIAL DERIVATIVE OF U-NL WITH RESPECT TO LOWER CASE QDYN06570
              C     T       = MATRIX OF ELEMENT THICKNESSES.                        DYN06572
              C                                                                     DYN06574
              C  OUTPUT ARGUMENTS.                                                  DYN06576
              C     QP      = Q - PARTIAL DERIVATIVE OF U-NL WITH RESPECT TO LOWER  DYN06578
              C               CASE Q AT TIME STEP (N-1).                            DYN06580
              C                                                                     DYN06582
              C  EXTERNALS.                                                         DYN06584
              C     CALLED BY                                                       DYN06586
              C               MAIN                                                  DYN06588
              C               INPUT                                                 DYN06590
              C               SETUP                                                 DYN06592
              C     CALLS                                                           DYN06594
              C               QPRIME                                                DYN06596
              C               STRESS                                                DYN06598
              C                                                                     DYN06600
0001                SUBROUTINE NLTERM (ITAM)                                        DYN06602
0002                IMPLICIT REAL*8 (A-H,O-Z)                                       DYN06604
0003                COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS,  DYN06606
                   1          DT2,NPRNTL,NPRNTF,IDELF,IDCOE                         DYN06608
0004                COMMON /TMET/ TOTIME,DELTE,TIME,T0,T1                           DYN06610
0005                COMMON /QS/ QN(1020),QN1(1020),FORCE(2040),QP(1020),QP1(1020),  DYN06612
                   1          QN2(1020)                                             DYN06614
0006                COMMON /GEOM/ FNU1(50),FNU2(50),E1(50),E2(50),G(50),T(50),      DYN06616
                   1          SINE(51),COSINE(51),SINM(50),COSM(50),R(50),PH(50),   DYN06618
                   1          PHP(50),ARCL(50)                                      DYN06619
0007                COMMON /EES/ ES(5),ET(5),EST(5),E13(5),E23(5)                   DYN06620
0008                COMMON /NLTRMS/ QPR(8,5)                                        DYN06630
0009                COMMON /GCD/ CC1,CC2,DD1,DD2,GG1,GG2                            DYN06640
```

```
 0010            COMMON /THETAS/ THETA(20),NTHETA,NCLCST,NSTRSS                       DYN06650
 0011            COMMON /PRINT/ IPRINT,NOIT,LL                                        DYN06660
           C                                                                          DYNC6670
           C        CALCULATION OF NONLINEAR TERMS                                    DYN06680
           C                                                                          DYN06690
           C     THE MIDSURFACE STRAINS AND ROTATIONS AND NONLINEAR TERMS             DYN06700
           C     ARE BASED ON A CONICAL FRUSTUM ELEMENT.  THIS IS THE ONLY PLACE A DYN06710
           C     CONICAL FRUSTUM ELEMENT IS USED.                                     DYN06720
           C                                                                          DYN06728
 0012            DO 10 I=1,NEQT                                                       DYN06730
 0013               QP(I)=0.0                                                         DYN06740
 0014         10 CONTINUE                                                             DYNC6750
           C                                                                          DYN06753
           C1DO  PROCESS ALL ELEMENTS                                                 DYN06755
           C                                                                          DYN06758
 0015            DO 40 I1=1,NELEMS                                                    DYN06760
 0016               FN=1.-FNU1(I1)*FNU2(I1)                                           DYN06770
 0017               CC1=E1(I1)*T(I1)/FN                                               DYNC6780
 0018               CC2=E2(I1)*T(I1)/FN                                               DYN06790
 0019               GG1=G(I1)*T(I1)                                                   DYN06800
 0020               GG2=G(I1)*T(I1)**3/12.                                            DYNC6810
 0021               DD1=E1(I1)*T(I1)**3/(12.*FN)                                      DYN06820
 0022               DD2=E2(I1)*T(I1)**3/(12.*FN)                                      DYNC6830
           C                                                                          DYN06840
           C        FORM QPRIMES                                                      DYN06850
           C                                                                          DYNC6860
           C1       CALCULATE GENERALIZED NONLINEAR LOADS                             DYN06862
 0023               CALL QPRIME (I1)                                                  DYNC6870
           C                                                                          DYN06880
           C        FORM STRESS RESULTANTS                                            DYNC6890
           C                                                                          DYN06900
 0024               IF (NSTRSS.EQ.0) GO TO 20                                         DYNC6910
           C1IF     STRESS COMPUTATION REQUIRED .THEN. CALCULATE AND PRINT STRESS     DYNC6912
           C1C               RESULTANTS AND STRESSES ON UPPER AND LOWER FACES         DYN06914
 0025            IF (((ITAM-(ITAM/(NSTRSS))*(NSTRSS)).EQ.1                            DYN06920
                1          .OR.ITAM.EQ.2                                              DYN06922
                1          .OR.ITAM.EQ.NOIT+1                                         DYN06924
                1          .OR.NSTRSS.EQ.1)                                           DYN06926
                1             .AND.NCLCST.EQ.1)                                       DYNC6928
                1                       CALL STRESS (I1,ITAM)                         DYNC6930
 0026         20    CONTINUE                                                          DYN06940
           C                                                                          DYN06948
 0027               DO 30 II=1,NH                                                     DYNC6950
 0028                  KA=NEQ*(II-1)+4*(I1-1)                                         DYNC6960
           C                                                                          DYNC6968
 0029                  DO 30 JJ=1,4                                                   DYNC6970
 0030                     KK=KA+JJ                                                    DYNC6980
 0031                     QP(KK)=QP(KK)-QPR(JJ,II)                                    DYN06990
 0032                      QP(KK+4)=-QPR(JJ+4,II)                           DYN07000
 0033             30    CONTINUE                                            DYN07010
            C                                                               DYN07013
 0034             40 CONTINUE                                               DYNC7020
            C                                                               DYNC7023
 0035                RETURN                                                 DYN07030
 0036                END                                                    DYN07040
```

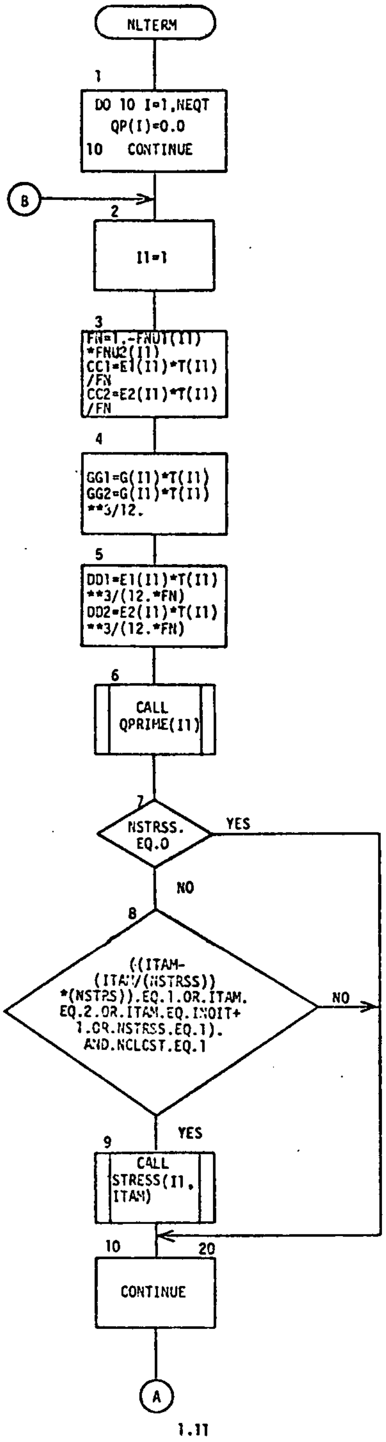

NLTERM
1
QPRIME
CALCULATE GENERALIZED NONLINEAR LOADS
2
STRESS COMPUTATION REQUIRED
NO
YES
3
STPESS
CALCULATE AND PRINT STRESS RESULTANTS AND STRESSES ON UPPER AND LOWER FACES
4
PROCESS ALL ELEMENTS
REPEAT
DONE
5
RETURN

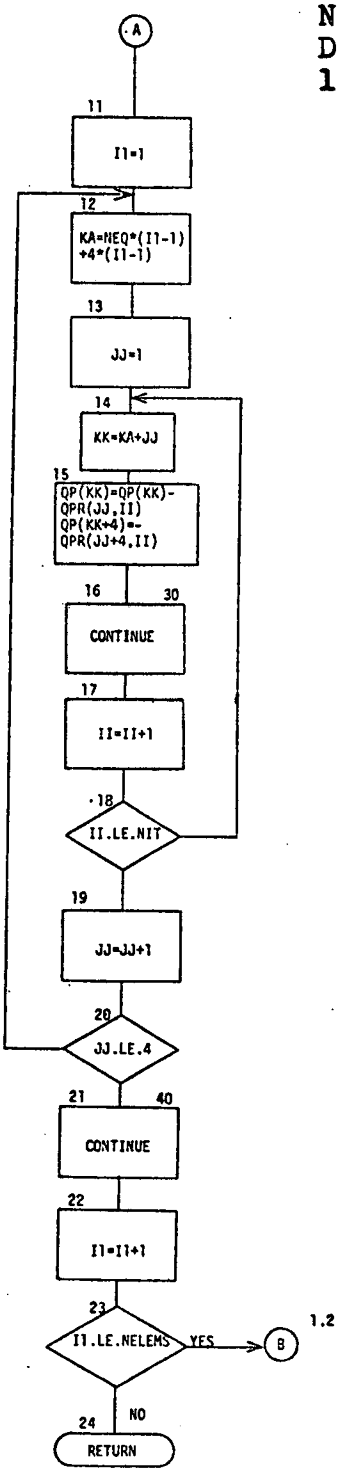
NLTERM J-3.79
Detail Suppressed
1 of 1



C3

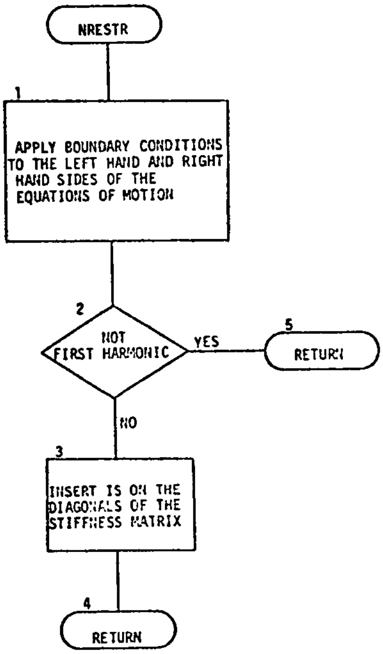
NLTERM
Detail
1 of 1



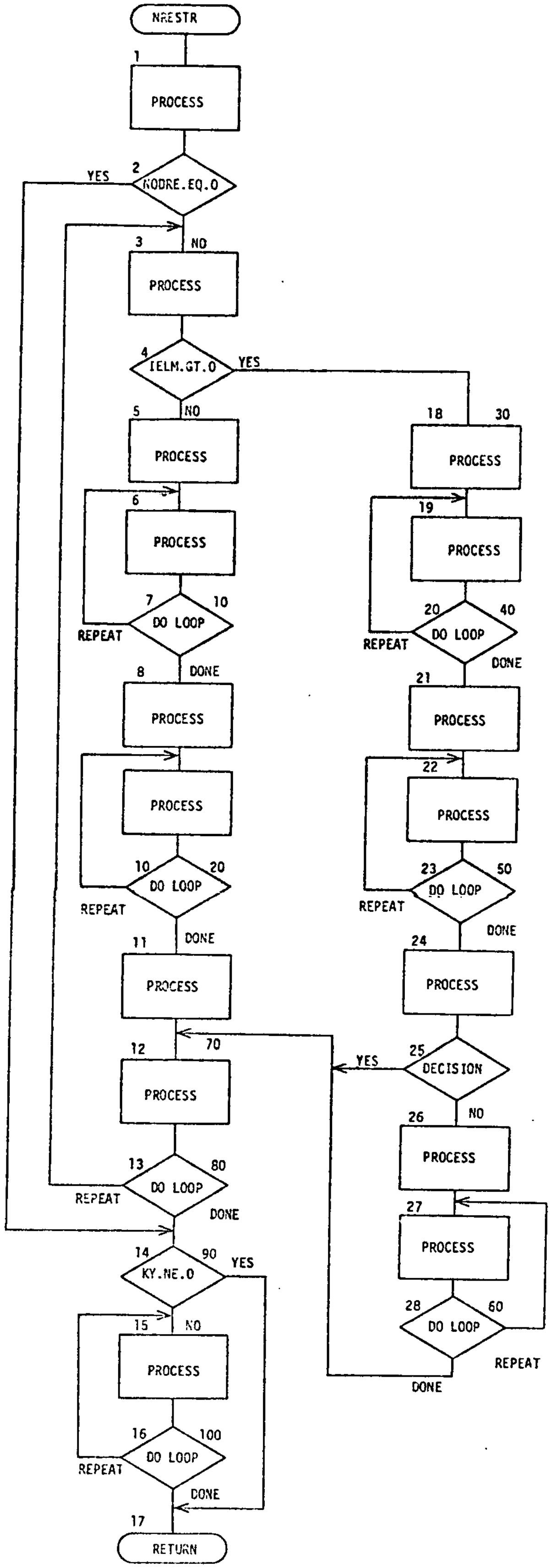


```
                CE(NRESTR)                                                          DYN10252
                C                                                                   DYN10254
                C     DESCRIPTION - TO APPLY THE DESIRED BOUNDARY CONDITIONS TO     DYN10256
                C            THE LEFT SIDE OF THE EQUATIONS OF MOTION. INSERT       DYN10258
                C            ONES ON THE DIAGONAL OF THE STIFFNESS MATRIX FOR       DYN10260
                C            THE FIRST HARMONIC ONLY.                               DYN10262
                C                                                                   DYN10264
                C  INPUT ARGUMENTS.                                                 DYN10266
                C     KY      = RESTART KEY.                                        DYN10268
                C     LK      = MATRIX INDICATING THE NODAL RESTPAINTS WHICH ARE APPLIED DYN10270
                C               ON THE SHELL.                                       DYN10272
                C     NCLOSE = CONSTANT USED TO INDICATE THE PRESENCE OF A SINGULARITY  DYN10274
                C               AT THE FIRST NODE OF A CLOSED SHELL.                DYN10276
                C     NN      = STORAGE BLOCK INDICATOR FLAG FOR STIFFNESS AND MASS  DYN10278
                C               MATRICES.                                           DYN10280
                C     NODRES = NUMBER OF DOSPLACEMENT CONSTRAINTS APPLIED TO THE SHELL. DYN10282
                C                                                                   DYN10284
                C  OUTPUT ARGUMENTS.                                                DYN10286
                C     FORCE  = MATRIX OF GENERALIZED FORCES DUE TO EXTERNAL LOADS AND  DYN10288
                C               TEMPERATURES.                                       DYN10290
                C     STIFM  = STIFFNESS MATRIX.                                    DYN10292
                C                                                                   DYN10294
                C  EXTERNALS.                                                       DYN10296
                C     CALLED BY                                                     DYN10298
                C               HOUBQ1                                              DYN10300
                C                                                                   DYN10302
 0001                 SUBROUTINE NRESTR (KY)                                        DYN10304
 0002                 IMPLICIT REAL*8 (A-H,O-Z)                                     DYN10306
 0003                 COMMON /SLVEEQ/ STIFM(6550),FORCE(204)                        DYN10308
 0004                 COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS,  DYN10310
                    1          DT2,NPRNTL,NPRNTF,IDELF,IDCOE                        DYN10312
 0005                 COMMON /RSTRNT/ NODRES,NCLOSE,LK(204)                         DYN10314
                C1    APPLY BOUNDARY CONDITIONS TO THE LEFT HAND AND RIGHT HAND SIDES  DYN10316
                C1C        OF THE EQUATIONS OF MOTION                               DYN10318
 0006                 NODRE=NODRES                                                  DYN10350
 0007                 IF (KY.EQ.0.AND.NCLOSE.EQ.1) NODRE=NODRE+2                    DYN10360
 0008                 IF (NODRE.EQ.0) GO TO 90                                      DYN10370
                C                                                                   DYN10378
 0009                 DO 80 L=1,NODRE                                               DYN10380
 0010                    NEQ=LK(L)                                                  DYN10390
 0011                    IELM=(NEQ-1)/4                                             DYN10400
 0012                    IF (IELM.GT.0) GO TO 30                                    DYN10410
 0013                    I=NEQ                                                      DYN10420
                C                                                                   DYN10428
 0014                    DO 10 J=1,NFQ                                              DYN10430
 0015                       K=(I*I-I)/2+J+NN                                        DYN10440
 0016                       STIFM(K)=0.0                                            DYN10450
 0017          10        CONTINUE                                                   DYN10452
```

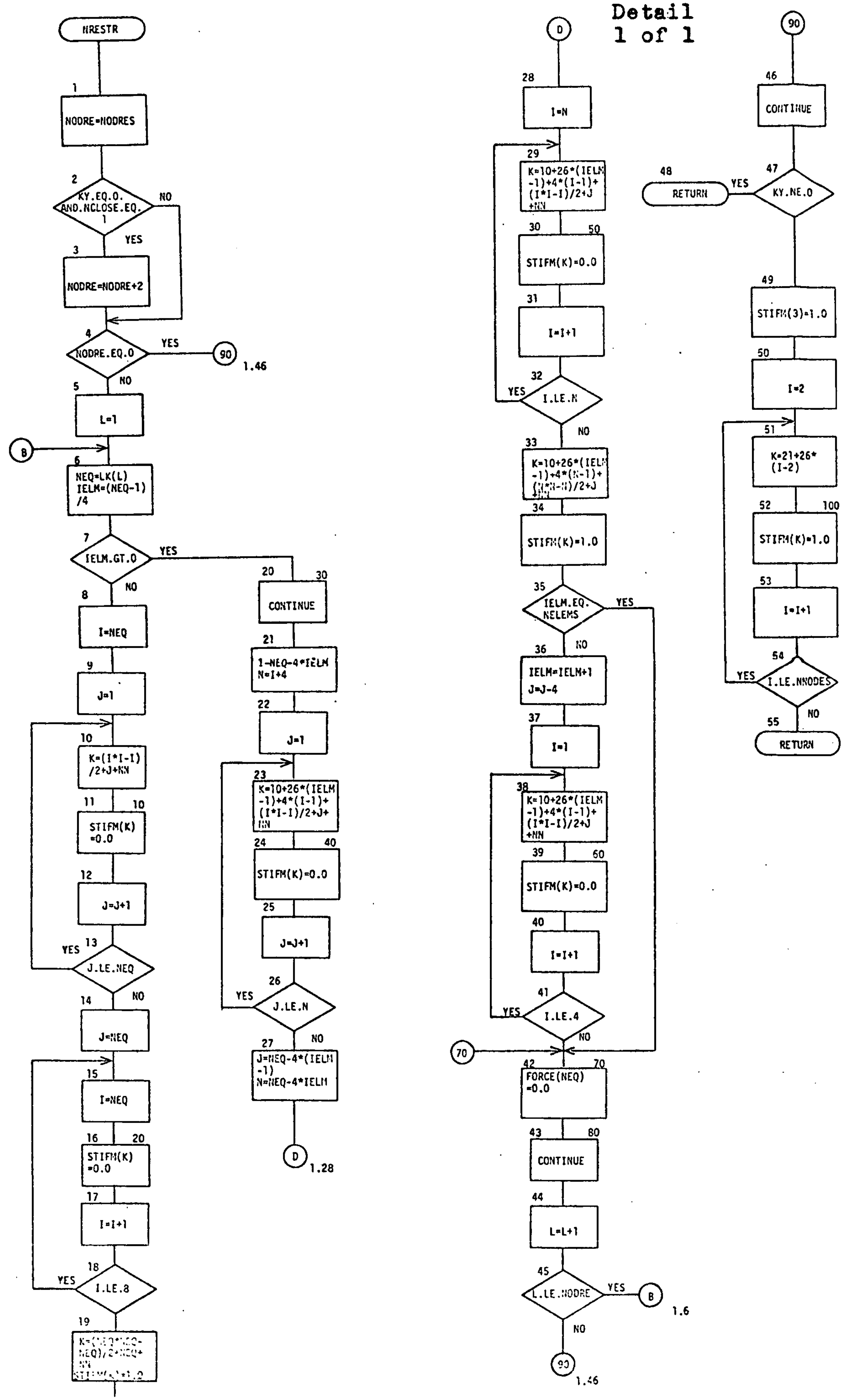
```
             C                                                                          DYN10455
 0018                  J=NEQ                                                            DYN10460
             C                                                                          DYN10468
 0019                  DO 20 I=NEQ,8                                                    DYN10470
 0020                     K=(I*I-I)/2+J+NN                                              DYN10480
 0021                     STIFM(K)=0.0                                                  DYN10490
 0022              20  CONTINUE                                                         DYN10492
             C                                                                          DYN10495
 0023                  K=(NEQ*NEQ-NEQ)/2+NEQ+NN                                         DYN10500
 0024                  STIFM(K)=1.0                                                     DYN10510
 0025                  GO TO 70                                                         DYN10520
 0026              30  CONTINUE                                                         DYN10530
 0027                  I=NEQ-4*IELM                                                     DYN10540
 0028                  N=I+4                                                            DYN10550
             C                                                                          DYN10558
 0029                  DO 40 J=1,N                                                      DYN10560
 0030                     K=10+26*(IELM-1)+4*(I-1)+(I*I-I)/2+J+NN                       DYN10570
 0031                     STIFM(K)=0.0                                                  DYN10580
 0032              40  CONTINUE                                                         DYN10582
             C                                                                          DYN10585
 0033                  J=NEQ-4*(IELM-1)                                                 DYN10590
 0034                  N=NEQ-4*IELM                                                     DYN10600
             C                                                                          DYN10608
 0035                  DO 50 I=N,4                                                      DYN10610
 0036                     K=10+26*(IELM-1)+4*(I-1)+(I*I-I)/2+J+NN                       DYN10620
 0037                     STIFM(K)=0.0                                                  DYN10630
 0038              50  CONTINUE                                                         DYN10632
             C                                                                          DYN10635
 0039                  K=10+26*(IELM-1)+4*(N-1)+(N*N-N)/2+J+NN                          DYN10640
 0040                  STIFM(K)=1.0                                                     DYN10650
 0041                  IF (IELM.EQ.NELEMS) GO TO 70                                     DYN10660
 0042                  IELM=IELM+1                                                      DYN10670
 0043                  J=J-4                                                            DYN10680
             C                                                                          DYN10688
 0044                  DO 60 I=1,4                                                      DYN10690
 0045                     K=10+26*(IELM-1)+4*(I-1)+(I*I-I)/2+J+NN                       DYN10700
 0046                     STIFM(K)=0.0                                                  DYN10710
 0047              60  CONTINUE                                                         DYN10712
             C                                                                          DYN10715
 0048              70  FORCE(NEQ)=0.0                                                   DYN10720
 0049              80 CONTINUE                                                          DYN10730
             C                                                                          DYN10733
 0050              90 CONTINUE                                                          DYN10740
             C1     IF NOT FIRST HARMONIC .THEN. RETURN                                 DYN10742
 0051               IF (KY.NE.0) RETURN                                                 DYN10780
             C1     INSERT ONES ON THE DIAGONALS OF THE STIFFNESS MATRIX                DYN10782
 0052               STIFM(3)=1.0                                                        DYN10790
             C                                                                          DYN10798
 0053            DO 100 I=2,NNODES                                                        DYN10800
 0054               K=21+26*(I-2)                                                         DYN10810
 0055               STIFM(K)=1.0                                                          DYN10820
 0056        100 CONTINUE                                                                 DYN10822
           C                                                                              DYN10825
 0057            RETURN                                                                   DYN10830
 0058            END                                                                      DYN10840
```


NRESTR
1
APPLY BOUNDARY CONDITIONS TO THE LEFT HAND AND RIGHT HAND SIDES OF THE EQUATIONS OF MOTION
2
NOT FIRST HARMONIC
YES
5
RETURN
NO
3
INSERT 1S ON THE DIAGONALS OF THE STIFFNESS MATRIX
4
RETURN

NRESTR J-3.85
Detail Suppressed
1 of 1



NRESTR
Detail
1 of 1



```
      CE(QPRIME)                                                        DYN07052
      C                                                                 DYN07054
      C    DESCRIPTION - TO COMPUTE THE GENERALIZED NONLINEAR LOADS.    DYN07056
      C            FOURIER COEFFICIENTS AND Q-PRIMES ARE COMPUTED. IF   DYN07058
      C            NECESSARY, COEFFICIENTS AND Q-PRIMES ARE UPDATED     DYN07060
      C            BY INCLUDING THERMAL EFFECTS.                        DYN07062
      C                                                                 DYN07064
      C INPUT ARGUMENTS.                                                DYN07066
      C    CCC     = MATRIX CONTAINING INTEGRALS FROM 0 TO 2*PI OF      DYN07068
      C              COS(I*THETA) * COS(J*THETA) * COS(K*THETA) * DTHETA.  DYN07070
      C    CC1     = YOUNG'S MODULUS TIMES SHELL THICKNESS, NORMALIZED WITH   DYN07072
      C              RESPECT TO POISSON RATIOS (MERIDIANAL DIRECTION).  DYN07074
      C    CC2     = YOUNG'S MODULUS TIMES SHELL THICKNESS, NORMALIZED WITH   DYN07076
      C              RESPECT TO POISSON RATIOS (CIRCUMFERENTIAL DIRECTION).   DYN07078
      C    CSS     = MATRIX CONTAINING INTEGRALS FROM 0 TO 2*PI OF      DYN07080
      C              COS(I*THETA) * SIN(J*THETA) * SIN(K*THETA) * DTHETA.  DYN07082
      C    E13     = MATRIX OF NONLINEAR STRAINS USED IN THE CALCULATION OF   DYN07084
      C              EACH HARMONIC.                                     DYN07086
      C    E23     = MATRIX OF NONLINEAR STRAINS USED IN THE CALCULATION OF   DYN07088
      C              EACH HARMONIC.                                     DYN07090
      C    FNU1    = MATRIX CONTAINING THE VALUES OF POISSON'S RATIO FOR   DYN07092
      C              EACH ELEMENT.                                      DYN07094
      C    GG1     = SHEAR MODULUS TIMES SHELL THICKNESS (MERIDIANAL    DYN07096
      C              DIRECTION).                                        DYN07098
      C    IHARM   = MATRIX OF HARMONIC NUMBERS FOR WHICH DISPLACEMENTS  DYN07100
      C              AND/OR STRESSES WILL BE CALCULATED.                DYN07102
      C    QN      = DISPLACEMENTS AT TIME INCREMENT (N-1) UP TO STATEMENT 20 DYN07104
      C              AFTER STATEMENT 30 THIS MATRIX HAS BEEN CHANGED TO  DYN07106
      C              THE DISPLACEMENTS AT TIME STEP (N).                DYN07108
      C    RO      = RADIAL DISTANCE OF ELEMENT FROM ORIGIN.            DYN07110
      C    SSC     = MATRIX CONTAINING INTEGRALS FROM 0 TO 2*PI OF      DYN07112
      C              SIN(I*THETA) * SIN(J*THETA) * COS(K*THETA) * DTHETA.  DYN07114
      C    Z       = Z-DISTANCE OF ELEMENT FROM ORIGIN.                 DYN07116
      C                                                                 DYN07118
      C OUTPUT ARGUMENTS.                                               DYN07120
      C    ES      = MATRIX OF THE LINEAR STRAINS, USED IN THE CALCULATION   DYN07122
      C              OF EACH HARMONIC.                                  DYN07124
      C    EST     = MATRIX OF THE LINEAR STRAINS, USED IN THE CALCULATION   DYN07126
      C              OF EACH HARMONIC.                                  DYN07128
      C    ET      = MATRIX OF THE LINEAR STRAINS, USED IN THE CALCULATION OF DYN07130
      C              EACH HARMONIC.                                     DYN07132
      C    E13     = MATRIX OF NONLINEAR STRAINS USED IN THE CALCULATION OF   DYN07134
      C              EACH HARMONIC.                                     DYN07136
      C    E23     = MATRIX OF NONLINEAR STRAINS USED IN THE CALCULATION OF   DYN07138
      C              EACH HARMONIC.                                     DYN07140
      C    QPR     = - PARTIAL DERIVATIVE OF U-NL WITH RESPECT TO LOWER CASE QDYN07142
      C                                                                 DYN07144
      C EXTERNALS.                                                      DYN07146
```

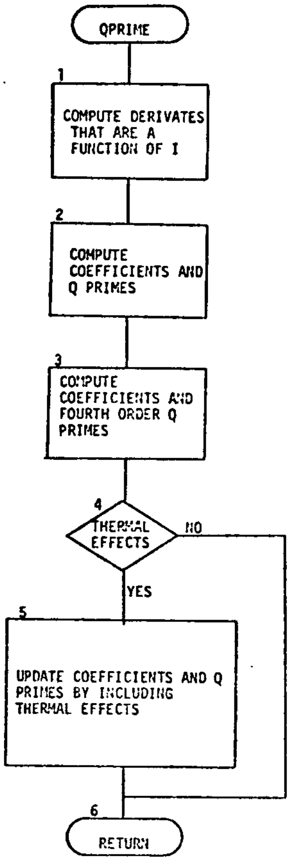
```
             C      CALLED BY                                                      DYNO7148
             C               NLTERM                                                DYNO7150
             C                                                                     DYNC7152
 0001               SUBROUTINE QPRIME (I1)                                         DYNO7154
 0002               IMPLICIT REAL*8 (A-H,O-Z)                                      DYNO7156
 0003               COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS,  DYNO7158
                   1         DT2,NPRNTL,NPRNTF,IDELF,IDCOE                         DYNO7160
 0004               COMMON /CS/ CCC(125),SSC(125),CSS(125)                         DYNO7162
 0005               COMMON /CS4/ CCCC(625),SSSS(625),SSCC(625),SCCS(625)           DYNO7164
 0006               COMMON /EES/ ES(5),ET(5),EST(5),E13(5),E23(5)                  DYNO7166
 0007               COMMON /NLTRMS/ QPR(8,5)                                       DYNO7168
 0008               COMMON /GEOM/ FNU1(50),FNU2(50),E1(50),E2(50),G(50),T(50),     DYNO7170
                   1         SINE(51),COSINE(51),SINM(50),COSM(50),R(50),PH(50),   DYNO7172
                   1         PHP(50),ARCL(50)                                      DYNO7174
 0009               COMMON /GCD/ CC1,CC2,DD1,DD2,GG1,GG2                           DYNO7176
 0010               COMMON /HARM/ NHP,IHARM(5)                                     DYNO7178
 0011               COMMON /THER/ TH(50,5,2),DTH(50,5,2),ALS(50),ALT(50)           DYNO7180
 0012               COMMON /THCON/ ITELF,ITCOE,NPRNTH                              DYNO7182
 0013               COMMON /TMFT/ TOTIME,DELTE,TIME,TO,T1                          DYNO7190
 0014               COMMON /QS/ QN(1020),QN1(1020),FORCE(2040),QP(1020),QP1(1020),  DYNO7200
                   1         QN2(1020)                                             DYNC7210
 0015               COMMON /RZ/ RO(51),Z(51)                                       DYNO7220
 0016               DIMENSION E23Q1(5), E23Q3(5), E23Q5(5), E23Q7(5), ESTQ1(5),    DYNO7230
                   1         ESTQ3(5), ESTQ5(5), ESTQ7(5), ETQ2(5), ETQ6(5)        DYNO7240
             C      CALCULATE GENERALIZED NONLINEAR LOADS                          DYNO7260
             C       COMPUTE OFTEN USED QUANTITIES                                 DYNO7280
 0017               J1=I1                                                          DYNO7290
 0018               J11=I1+1                                                       DYNO7300
 0019               DRO=RO(J11)-RO(J1)                                             DYNO7310
 0020               DZ=Z(J11)-Z(J1)                                                DYNO7320
 0021               ARL=DSQRT(DRO*DRO+DZ*DZ)                                       DYNO7330
 0022               SIPH=DRO/ARL                                                   DYNO7340
 0023               COPH=DZ/ARL                                                    DYNO7350
 0024               RM=(RO(J1)+RO(J11))/2.0                                        DYNC7360
 0025               R2I=1.0/(2.0*RM)                                               DYNO7370
 0026               ARCLI=1.0/ARL                                                  DYNO7380
             C       COMPUTE DERIVATES INDEPENDENT OF I                            DYNO7390
 0027               ETQ3=R2I                                                       DYNO7400
 0028               ETQ7=R2I                                                       DYNO7410
 0029               E23Q2=-R2I*COPH                                                DYNO7420
 0030               E23Q6=E23Q2                                                    DYNO7430
 0031               E13Q1=ARCLI*SIPH                                               DYNO7440
 0032               E13Q3=-ARCLI*COPH                                              DYNO7450
 0033               E13Q5=-ARCLI*SIPH                                              DYNO7460
 0034               E13Q7=ARCLI*COPH                                               DYNO7470
 0035               ESTQ2=-SIPH*R2I-ARCLI                                          DYNO7480
 0036               ESTQ6=-SIPH*R2I+ARCLI                                          DYNO7490
 0037               ESQ1=E13Q3                                                     DYNC7500
```

```
0038               ESQ3=-E13Q1                                                      DYNO7510
0039               ESQ5=E13Q7                                                       DYNO7520
0040               ESQ7=-E13Q5                                                      DYNO7530
            C1     COMPUTE DERIVATES THAT ARE A FUNCTION OF I                       DYNO7532
0041               CO2R=COPH*R2I                                                    DYNO7550
0042               SL2R=SIPH*R2I                                                    DYNO7560
0043               CL2R=COPH*R2I                                                    DYNO7570
0044               SO2R=SIPH*R2I                                                    DYNO7580
            C                                                                       DYNO7588
0045               DO 10 IH=1,NH                                                    DYNO7590
0046                  K=IHARM(IH)                                                   DYNO7600
0047                  XK=K                                                          DYNO7610
0048                  E23Q1(IH)=SO2R*XK                                             DYNO7620
0049                  E23Q3(IH)=-CO2R*XK                                            DYNO7630
0050                  E23Q5(IH)=SL2R*XK                                             DYNO7640
0051                  E23Q7(IH)=-CL2R*XK                                            DYNO7650
0052                  ESTQ1(IH)=E23Q3(IH)                                           DYNO7660
0053                  ESTQ3(IH)=-E23Q1(IH)                                          DYNO7670
0054                  ESTQ5(IH)=E23Q7(IH)                                           DYNO7680
0055                  ESTQ7(IH)=-E23Q5(IH)                                          DYNO7690
0056                  ETQ2(IH)=R2I*XK                                               DYNO7700
0057                  ETQ6(IH)=ETQ2(IH)                                             DYNO7710
            C         COMPUTE ET, ES, EST, E13, E23                                 DYNO7720
0058                  KK=NEQ*(IH-1)+4*(I1-1)                                        DYNO7730
0059                  KK1=KK+1                                                      DYNO7740
0060                  KK2=KK+2                                                      DYNO7750
0061                  KK3=KK+3                                                      DYNO7760
0062                  KK5=KK+5                                                      DYNO7770
0063                  KK6=KK+6                                                      DYNO7780
0064                  KK7=KK+7                                                      DYNO7790
0065                  ET(IH)=+ETQ2(IH)*QN(KK2)+ETQ3*QN(KK3)+ETQ6(IH)*QN(KK6)+ETQ7*  DYNO7800
                 1             QN(KK7)                                              DYNO7810
0066                  ES(IH)=ESQ1*QN(KK1)+ESQ3*QN(KK3)+ESQ5*QN(KK5)+ESQ7*QN(KK7)    DYNO7820
0067                  EST(IH)=ESTQ1(IH)*QN(KK1)+ESTQ2*QN(KK2)+ESTQ3(IH)*QN(KK3)+    DYNO7830
                 1             ESTQ5(IH)*QN(KK5)+ESTQ6*QN(KK6)+FSTQ7(IH)*QN(KK7)    DYNO7840
0068                  E13(IH)=E13Q1*QN(KK1)+E13Q3*QN(KK3)+E13Q5*QN(KK5)+E13Q7*QN(KK7)DYNO7850
0069                  E23(IH)=E23Q1(IH)*QN(KK1)+E23Q2*QN(KK2)+E23Q3(IH)*QN(KK3)+    DYNO7860
                 1             E23Q5(IH)*QN(KK5)+E23Q6*QN(KK6)+E23Q7(IH)*QN(KK7)    DYNO7870
0070            10 CONTINUE                                                         DYNO7880
            C                                                                       DYNO7883
0071               ITH=0                                                            DYNO7890
0072               RSL=RM*ARL/2.0                                                   DYNO7900
            C1     COMPUTE COEFFICIENTS AND Q-PRIMES                                DYNO7902
            C                                                                       DYNO7908
0073               DO 40 M=1,NH                                                     DYNO7910
0074                  CES=0.0                                                       DYNO7920
0075                  CET=0.0                                                       DYNO7930
0076                  CEST=0.0                                                      DYNO7940
```

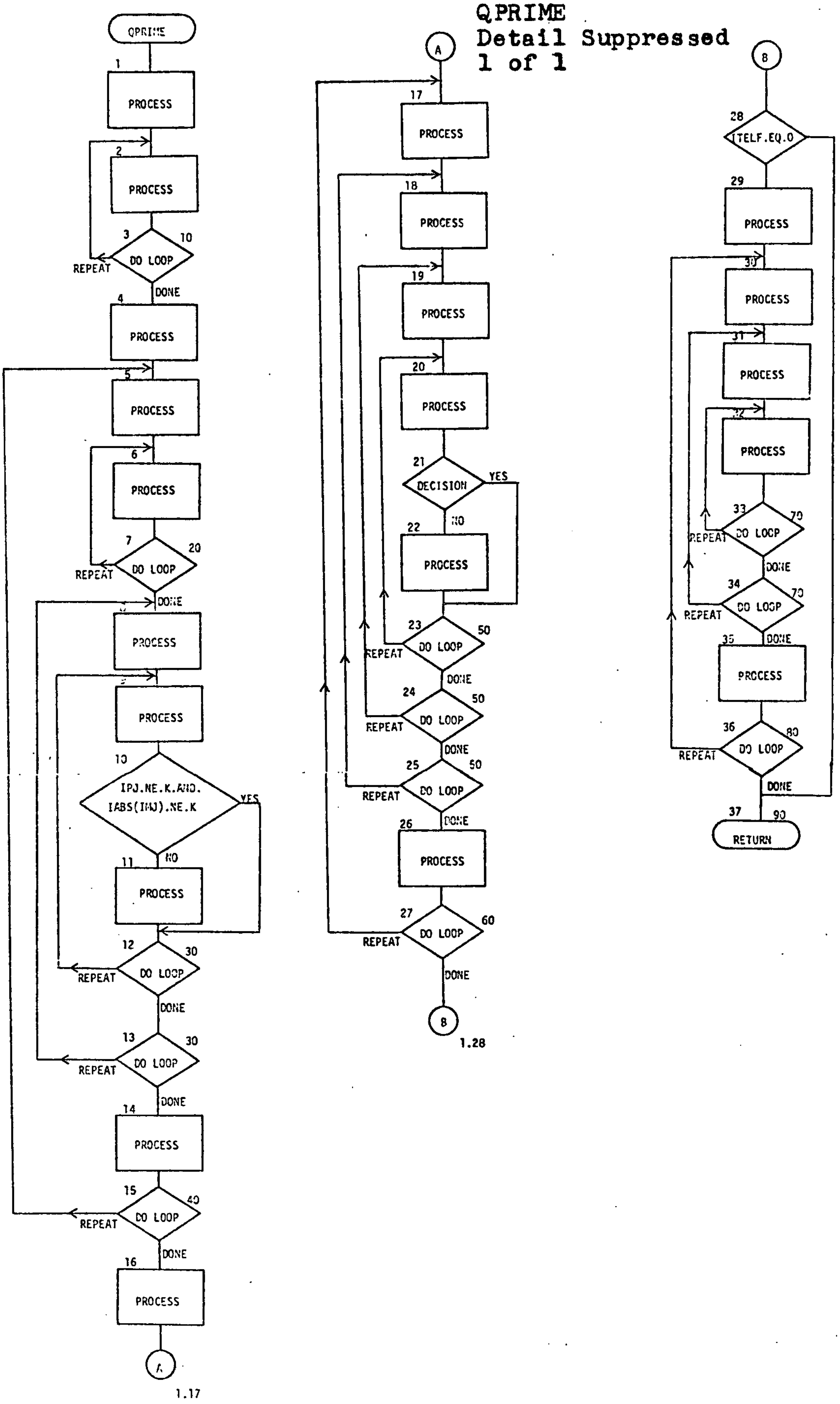
```
0077                 CE13=0.0                                                      DYN07950
0078                 CE23=0.0                                                      DYN07960
0079                 K=IHARM(M)                                                    DYN07970
            C                                                                      DYN07978
0080                 DO 20 I=1,8                                                   DYN07980
0081                    QPR(I,M)=0.0                                               DYN07990
0082           20    CONTINUE                                                      DYN08000
            C                                                                      DYN08003
            C                                                                      DYN08008
0083                 DO 30 I=1,NH                                                  DYN08010
0084                    II=IHARM(I)                                                DYN08020
            C                                                                      DYN08028
0085                    DO 30 J=1,NH                                               DYN08030
0086                       JJ=IHARM(J)                                             DYN08040
0087                       IPJ=II+JJ                                               DYN08050
0088                       IMJ=II-JJ                                               DYN08060
0089                       IF (IPJ.NE.K.AND.IABS(IMJ).NE.K) GO TO 30               DYN08070
0090                       ITH=ITH+1                                               DYN08080
            C              COMPUTE COEFFICIENTS                                    DYN08082
0091                       CES=CC1*(CCC(ITH)*E13(I)*E13(J)+FNU1(I1)*SSC(ITH)*E23(I)*DYN08100
                 1                  E23(J))+CES                                    DYN08110
0092                       CET=SSC(ITH)*CC2*E23(I)*E23(J)+FNU1(I1)*CC1*CCC(ITH)*   DYN08120
                 1                  E13(I)*E13(J)+CET                              DYN08130
0093                       CEST=2.0*GG1*CSS(ITH)*E13(J)*E23(I)+CEST                DYN08140
0094                       CE13=2.0*CC1*CCC(ITH)*E13(I)*(ES(J)+FNU1(I1)*ET(J))+2.0* DYN08150
                 1                  GG1*SSC(ITH)*EST(I)*E23(J)+CE13                DYN08152
0095                       CE23=2.0*CSS(ITH)*(E23(I)*(CC2*ET(J)+FNU1(I1)*CC1*ES(J))+DYN08170
                 1                  GG1*E13(J)*EST(I))+CE23                        DYN08180
0096           30    CONTINUE                                                      DYN08190
            C                                                                      DYN08193
            C      COMPUTE Q PRIMES                                                DYN08200
0097                 QPR(1,M)=(CE13*E13Q1+CES*ESQ1+CEST*ESTQ1(M)+CE23*E23Q1(M))*RSL+DYN08210
                 1            QPR(1,M)                                             DYN08220
0098                 QPR(2,M)=(CE23*E23Q2+CEST*ESTQ2+CET*ETQ2(M))*RSL+QPR(2,M)     DYN08230
0099                 QPR(3,M)=(CE13*E13Q3+CET*ETQ3+CES*ESQ3+CE23*E23Q3(M)+CEST*    DYN08240
                 1            ESTQ3(M))*RSL+QPR(3,M)                               DYN08250
0100                 QPR(5,M)=(CE13*E13Q5+CES*ESQ5+CE23*E23Q5(M)+CEST*ESTQ5(M))*RSL+DYN08260
                 1            QPR(5,M)                                             DYN08270
0101                 QPR(6,M)=(CET*ETQ6(M)+CE23*E23Q6+CEST*ESTQ6)*RSL+QPR(6,M)     DYN08280
0102                 QPR(7,M)=(CE13*E13Q7+CET*ETQ7+CES*ESQ7+CE23*E23Q7(M)+CEST*    DYN08290
                 1            ESTQ7(M))*RSL+QPR(7,M)                               DYN08300
0103           40 CONTINUE                                                         DYN08310
            C                                                                      DYN08313
0104              IFO=0                                                            DYN08320
            C                                                                      DYN08328
0105              DO 60 L=1,NH                                                     DYN08330
0106                 CE413=0.0                                                     DYN08340
0107                 CE423=0.0                                                     DYN08350
```

```
0108                  LL=IHARM(L)                                               DYN08360
        C                                                                       DYN08368
0109                  DO 50 I=1,NH                                              DYN08370
0110                    II=IHARM(I)                                             DYN08380
        C                                                                       DYN08388
0111                    DO 50 J=1,NH                                            DYN08390
0112                      JJ=IHARM(J)                                           DYN08400
0113                      IPJ=II+JJ                                             DYN08410
0114                      IMJ=IABS(II-JJ)                                       DYN08420
        C                                                                       DYN08428
0115                      DO 50 K=1,NH                                          DYN08430
0116                        KK=IHARM(K)                                         DYN08440
0117                        KPL=KK+LL                                           DYN08450
0118                        KML=IABS(KK-LL)                                     DYN08460
0119                        IF (IPJ.NE.KPL.AND.IPJ.NE.KML.AND.IMJ.              DYN08470
           1                      NE.KPL.AND.IMJ.NE.KML) GO TO 50               DYN08480
0120                        IFO=IFO+1                                           DYN08490
        C1                  COMPUTE COEFFICIENTS AND FOURTH ORDER Q-PRIMES      DYN08492
0121                        FOR=(FNU1(I1)*CC1+2.0*GG1)*E23(I)*E13(K)            DYN08510
0122                        CE413=CC1*E13(I)*E13(J)*E13(K)*CCCC(IFO)+FOR*E23(J)*  DYN08520
           1                      SSCC(IFO)+CE413                               DYN08530
0123                        CE423=CC2*E23(I)*E23(J)*E23(K)*SSSS(IFO)+FOR*E13(J)*  DYN08540
           1                      SCCS(IFO)+CE423                               DYN08550
0124          50      CONTINUE                                                  DYN08560
        C                                                                       DYN08563
0125                  QPR(1,L)=QPR(1,L)+RSL*(CE413*E13Q1+CE423*E23Q1(L))        DYN08580
0126                  QPR(2,L)=QPR(2,L)+RSL*(CE423*E23Q2)                       DYN08590
0127                  QPR(3,L)=QPR(3,L)+RSL*(CE413*E13Q3+CE423*E23Q3(L))        DYN08600
0128                  QPR(5,L)=QPR(5,L)+RSL*(CE413*E13Q5+CE423*E23Q5(L))        DYN08610
0129                  QPR(6,L)=QPR(6,L)+RSL*(CE423*E23Q6)                       DYN08620
0130                  QPR(7,L)=QPR(7,L)+RSL*(CE413*E13Q7+CE423*E23Q7(L))        DYN08630
0131          60 CONTINUE                                                       DYN08640
        C                                                                       DYNC8643
        C1      THERMAL EFFECTS//NO(90)                                         DYN08645
0132            IF (ITELF.EQ.0) GO TO 90                                        DYN08650
        C1      UPDATE COEFFICIENTS AND Q-PRIMES BY INCLUDING THERMAL DFFECTS   DYN08652
0133            ITH=0                                                           DYN08660
0134            RL=RM*ARL                                                       DYN08670
        C                                                                       DYN08678
0135            DO 80 M=1,NH                                                    DYN08680
0136              CE13=0.0                                                      DYN08690
0137              CE23=0.0                                                      DYN08700
0138              K=IHARM(M)                                                    DYN08710
        C                                                                       DYN08718
0139              DO 70 I=1,NH                                                  DYN08720
0140                II=IHARM(I)                                                 DYN08730
        C                                                                       DYN08738
0141                DO 70 J=1,NH                                                DYN08740
```

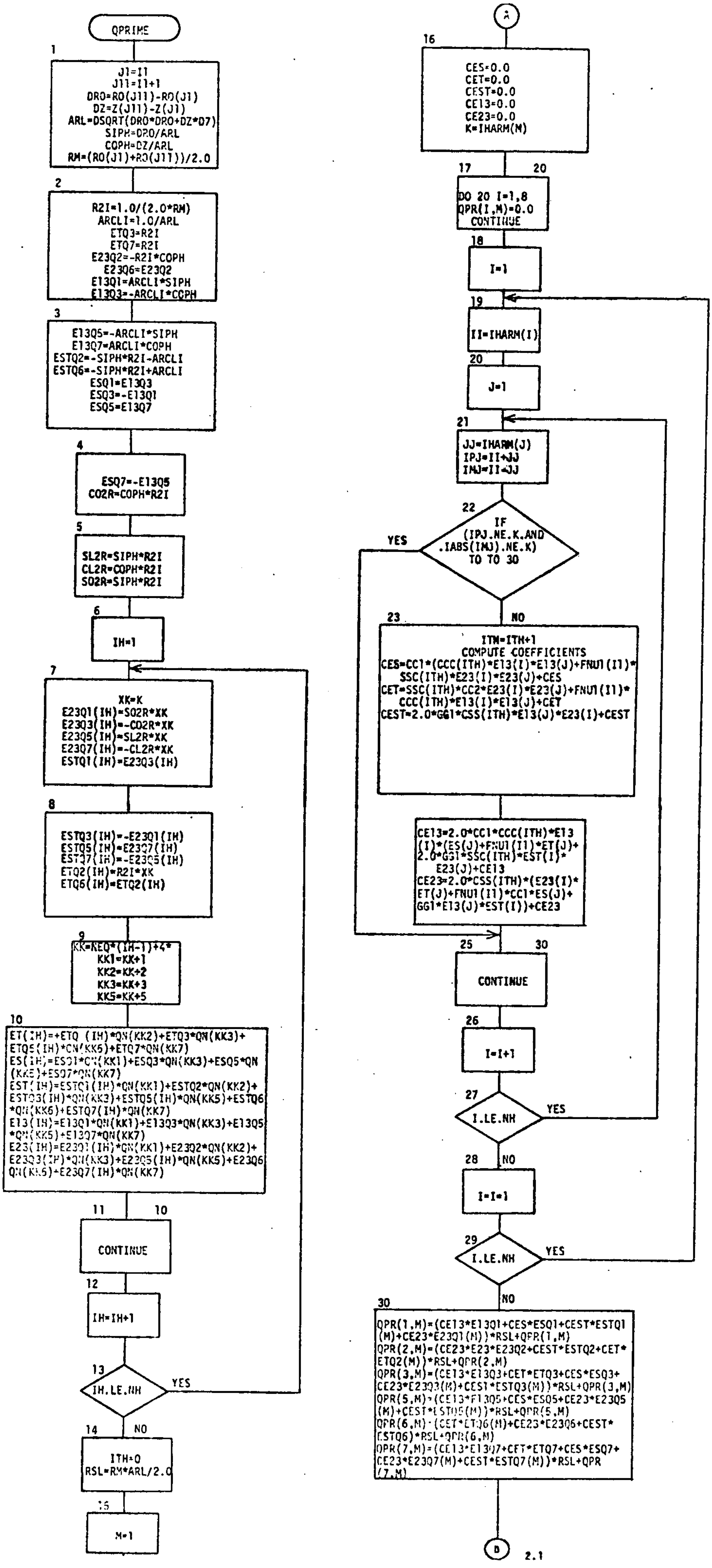
```
 0142                      JJ=IHARM(J)                                              DYN08750
 0143                      IPJ=II+JJ                                                DYN08760
 0144                      IMJ=II-JJ                                                DYN08770
 0145                      IF (IPJ.NE.K.AND.IABS(IMJ).NE.K) GO TO 70                DYN08780
 0146                      THT=TH(I1,J,1)+(TH(I1,J,2)-TH(I1,J,1))*(TIME-T0)/(T1-T0) DYN08790
 0147                      ITH=ITH+1                                                DYN08800
             C             COMPUTE COEFFICIENTS                                     DYN08810
 0148                      CE13=-CC1*(ALS(I1)+FNU1(I1)*ALT(I1))*THT*CCC(ITH)*E13(I)+DYN08820
                 1               CE13                                               DYN08822
 0149                      CE23=-CC2*(ALT(I1)+FNU2(I1)*ALS(I1))*THT*CSS(ITH)*E23(I)+DYN08830
                 1               CE23                                               DYN08832
 0150               70     CONTINUE                                                 DYN08840
             C                                                                      DYN08843
             C             COMPUTE Q PRIMES                                         DYN08850
 0151                  QPR(1,M)=QPR(1,M)+(CE13*E13Q1+CE23*E23Q1(M))*RL              DYN08860
 0152                  QPR(2,M)=QPR(2,M)+CE23*E23Q2*RL                              DYN08870
 0153                  QPR(3,M)=QPR(3,M)+(CE13*E13Q3+CE23*E23Q3(M))*RL              DYN08880
 0154                  QPR(5,M)=QPR(5,M)+(CE13*E13Q5+CE23*E23Q5(M))*RL              DYN08890
 0155                  QPR(6,M)=QPR(6,M)+CE23*E23Q6*RL                              DYN08900
 0156                  QPR(7,M)=QPR(7,M)+(CE13*E13Q7+CE23*E23Q7(M))*RL              DYN08910
 0157               80 CONTINUE                                                     DYN08920
             C                                                                      DYN08923
 0158               90 CONTINUE                                                     DYN08930
 0159                  RETURN                                                       DYN08940
 0160                  END                                                          DYN08950
```


QPRIME
1
COMPUTE DERIVATES THAT ARE A FUNCTION OF I
2
COMPUTE COEFFICIENTS AND Q PRIMES
3
COMPUTE COEFFICIENTS AND FOURTH ORDER Q PRIMES
4
THERMAL EFFECTS
NO
YES
5
UPDATE COEFFICIENTS AND Q PRIMES BY INCLUDING THERMAL EFFECTS
6
RETURN

QPRIME
Detail Suppressed
1 of 1



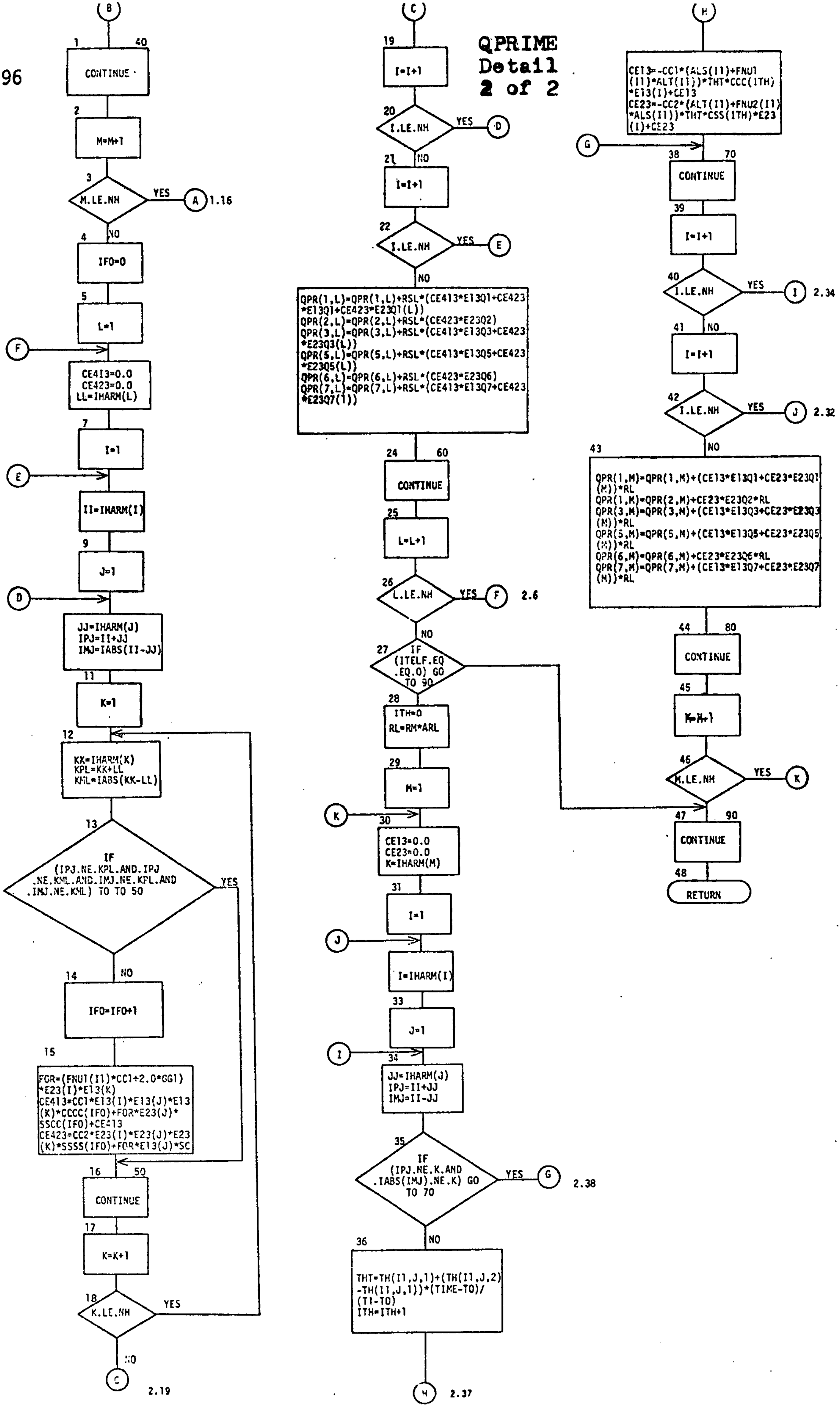
QPRIME J-3.95
Detail
1 of 2



```
QPRIME

1
J1=I1
J11=I1+1
DRO=RO(J11)-RO(J1)
DZ=Z(J11)-Z(J1)
ARL=DSQRT(DRO*DRO+DZ*D7)
SIPH=DRO/ARL
COPH=DZ/ARL
RM=(RO(J1)+RO(J11))/2.0

2
R2I=1.0/(2.0*RM)
ARCLI=1.0/ARL
ETQ3=R2I
ETQ7=R2I
E23Q2=-R2I*COPH
E23Q6=E23Q2
E13Q1=ARCLI*SIPH
E13Q3=-ARCLI*CCPH

3
E13Q5=-ARCLI*SIPH
E13Q7=ARCLI*COPH
ESTQ2=-SIPH*R2I-ARCLI
ESTQ6=-SIPH*R2I+ARCLI
ESQ1=E13Q3
ESQ3=-E13Q1
ESQ5=E13Q7

4
ESQ7=-E13Q5
CO2R=COPH*R2I

5
SL2R=SIPH*R2I
CL2R=COPH*R2I
SO2R=SIPH*R2I

6
IH=1

7
XK=K
E23Q1(IH)=SO2R*XK
E23Q3(IH)=-CO2R*XK
E23Q5(IH)=SL2R*XK
E23Q7(IH)=-CL2R*XK
ESTQ1(IH)=E23Q3(IH)

8
ESTQ3(IH)=-E23Q1(IH)
ESTQ5(IH)=E23Q7(IH)
ESTQ7(IH)=-E23Q5(IH)
ETQ2(IH)=R2I*XK
ETQ6(IH)=ETQ2(IH)

9
KK=NEQ*(IH-1)+4*
KK1=KK+1
KK2=KK+2
KK3=KK+3
KK5=KK+5

10
ET(IH)=+ETQ (IH)*QN(KK2)+ETQ3*QN(KK3)+
ETQ5(IH)*CN(KK5)+ETQ7*QN(KK7)
ES(IH)=ESQ1*CN(KK1)+ESQ3*QN(KK3)+ESQ5*QN
(KKE)+ESQ7*QN(KK7)
EST(IH)=ESTQ1(IH)*QN(KK1)+ESTQ2*QN(KK2)+
ESTQ3(IH)*QN(KK3)+ESTQ5(IH)*QN(KK5)+ESTQ6
*QN(KK6)+ESTQ7(IH)*QN(KK7)
E13(IH)=E13Q1*QN(KK1)+E13Q3*QN(KK3)+E13Q5
*QN(KK5)+E13Q7*QN(KK7)
E23(IH)=E23Q1(IH)*QN(KK1)+E23Q2*QN(KK2)+
E23Q3(IP)*QN(KK3)+E23Q5(IH)*QN(KK5)+E23Q6
QN(KK5)+E23Q7(IH)*QN(KK7)

11 10
CONTINUE

12
IH=IH+1

13
IH.LE.NH

14
ITH=0
RSL=RM*ARL/2.0

15
M=1

16
CES=0.0
CET=0.0
CEST=0.0
CE13=0.0
CE23=0.0
K=IHARM(M)

17 20
DO 20 I=1,8
QPR(I,M)=0.0
CONTINUE

18
I=1

19
II=IHARM(I)

20
J=1

21
JJ=IHARM(J)
IPJ=II+JJ
IMJ=II-JJ

22
IF
(IPJ.NE.K.AND
.IABS(IMJ).NE.K)
TO TO 30

23
ITM=ITH+1
COMPUTE COEFFICIENTS
CES=CC1*(CCC(ITH)*E13(I)*E13(J)+FNU1(I1)*
   SSC(ITH)*E23(I)*E23(J)+CES
CET=SSC(ITH)*CC2*E23(I)*E23(J)+FNU1(I1)*
   CCC(ITH)*E13(I)*E13(J)+CET
CEST=2.0*GG1*CSS(ITH)*E13(J)*E23(I)+CEST

CE13=2.0*CC1*CCC(ITH)*E13
(I)*(ES(J)+FNU1(I1)*ET(J)+
2.0*GG1*SSC(ITH)*EST(I)*
   E23(J)+CE13
CE23=2.0*CSS(ITH)*(E23(I)*
ET(J)+FNU1(I1)*CC1*ES(J)+
GG1*E13(J)*EST(I))+CE23

25 30
CONTINUE

26
I=I+1

27
I.LE.NH

28
I=I+1

29
I.LE.NH

30
QPR(1,M)=(CE13*E13Q1+CES*ESQ1+CEST*ESTQ1
(M)+CE23*E23Q1(M))*RSL+QPR(1,M)
QPR(2,M)=(CE23*E23*E23Q2+CEST*ESTQ2+CET*
ETQ2(M))*RSL+QPR(2,M)
QPR(3,M)=(CE13*E13Q3+CET*ETQ3+CES*ESQ3+
CE23*E23Q3(M)+CEST*ESTQ3(M))*RSL+QPR(3,M)
QPR(5,M)=(CE13*F13Q5+CES*ESQ5+CE23*E23Q5
(M)+CEST*ESTQ5(M))*RSL+QPR(5,M)
QPR(6,M)-(CET*ETQ6(M)+CE23*E23Q6+CEST*
ESTQ6)*RSL+QPR(6,M)
QPR(7,M)=(CE13*E13Q7+CFT*ETQ7+CES*ESQ7+
CE23*E23Q7(M)+CEST*ESTQ7(M))*RSL+QPR
(7,M)
```

J-3.96

QPRIME Detail 2 of 2



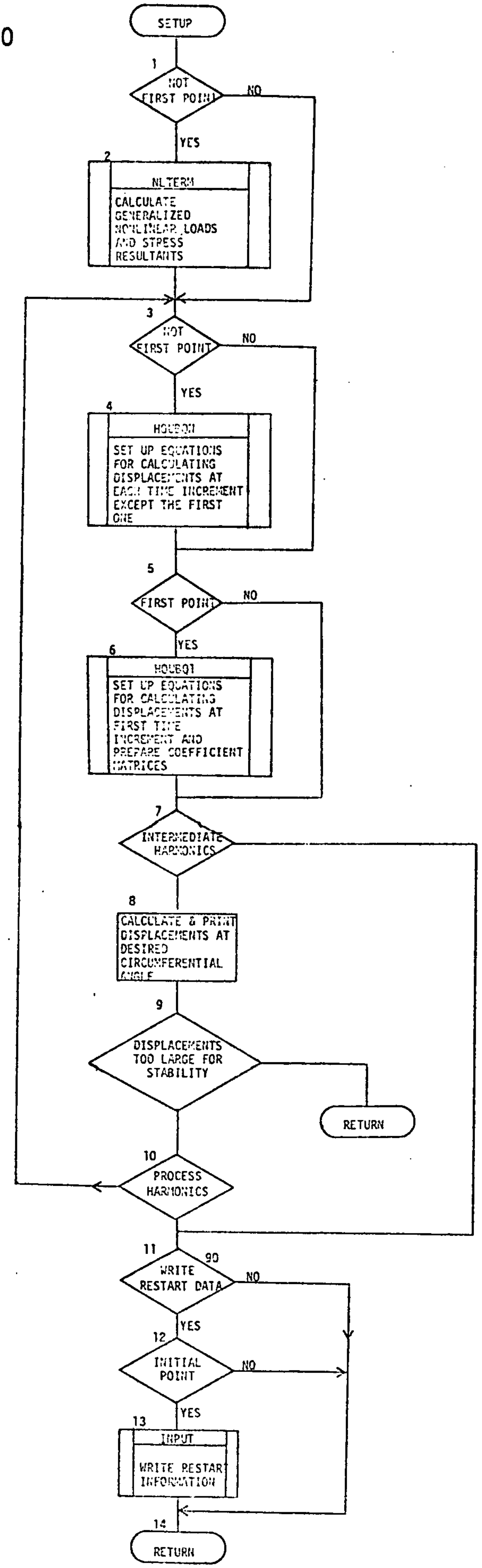
```
              CE(SETUP)                                                           DYN05662
              C                                                                   DYN05664
              C     DESCRIPTION - TO OBTAIN THE SHELL DISPLACEMENTS BY SOLVING    DYN05666
              C            THE EQUATIONS OF MOTION. THESE DISPLACEMENTS ARE       DYN05668
              C            CHECKED IN MAGNITUDE FOR BEING TOO LARGE TO ALLOW      DYN05670
              C            STABLE SOLUTIONS. THE AXIAL DISPLACEMENT OF THE SECOND DYN05672
              C            NODE IS CHECKED.                                       DYN05674
              C                                                                   DYN05676
              C  INPUT ARGUMENTS.                                                 DYN05678
              C     NH      = TOTAL NUMBER OF HARMONICS USED IN THE DYNAMIC ANALYSIS. DYN05680
              C     QN      = DISPLACEMENTS AT TIME INCREMENT (N-1) UP TO STATEMENT 20 DYN05682
              C               AFTER STATEMENT 30 THIS MATRIX HAS BEEN CHANGED TO  DYN05684
              C               THE DISPLACEMENTS AT TIME STEP (N).                 DYN05686
              C     THETA   = MATRIX CONTAINING CIRCUMFERENTIAL ANGLES AT WHICH   DYN05688
              C               STRESSES AND/OR DISPLACEMENTS ARE TO BE CALCULATED. DYN05690
              C                                                                   DYN05692
              C  OUTPUT ARGUMENTS.                                                DYN05694
              C     LARGE   = CONSTANT WHICH CONTROLS TERMINATION OF THE PROBLEM  DYN05696
              C               IF DISPLACEMENTS BECOME EXCESSIVE.                  DYN05698
              C     QLOAD   = RIGHT-HAND SIDE OF THE DYNAMIC EQUATIONS OF MOTION  DYN05700
              C               BEFORE CALLING SOLVEQ.                              DYN05702
              C                                                                   DYN05704
              C  EXTERNALS.                                                       DYN05706
              C     CALLED BY                                                     DYN05708
              C               MAIN                                                DYN05710
              C     CALLS                                                         DYN05712
              C               NLTERM                                              DYN05714
              C               HOUBQN                                              DYN05716
              C               HOUBQ1                                              DYN05718
              C               INPUT                                               DYN05720
              C                                                                   DYN05722
0001                SUBROUTINE SETUP (ITAM,TIME,LARGE)                            DYN05724
0002                IMPLICIT REAL*8 (A-H,O-Z)                                     DYN05726
0003                COMMON /SLVEEQ/ XN(6550),QLOAD(204)                           DYN05728
0004                COMMON /QS/ QN(1020),QN1(1020),FORCE(2040),QP(1020),QP1(1020), DYN05730
                  1           QN2(1020)                                           DYN05732
0005                COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS, DYN05734
                  1           DT2,NPRNTL,NPRNTF,IDELF,IDCOE                       DYN05736
0006                COMMON /GCD/ CC1,CC2,DD1,DD2,GG1,GG2                          DYN05738
0007                COMMON /THETAS/ THETA(20),NTHETA,NCLCST,NSTRSS                DYN05740
0008                COMMON /PRINT/ IPRINT,NOIT,LL                                 DYN05750
0009                COMMON /HARM/ NHP,IHARM(5)                                    DYN05760
0010                COMMON /RESTRT/ IRSTRT,NPRNT,NPRNIT,ITP,TIMEP,DELTEP          DYN05770
              C1IF  NOT FIRST POINT .THEN. CALCULATE GENERALIZED NONLINEAR LOADS AND DYN05772
              C1C          STRESS RESULTANTS                                      DYN05774
0011                IF (ITAM.NE.LL) CALL NLTERM (ITAM)                            DYN05820
              C1DO  PROCESS HARMONICS                                             DYN05822
              C                                                                   DYN05828
```

```
 0012              DO 90 IH=1,NH                                                     DYN05830
 0013                 KY=IHARM(IH)                                                   DYN05840
 0014                 NN=NSIZE*(IH-1)                                                DYN05850
 0015                 N=NEQ*(IH-1)                                                   DYN05860
            C1IF      NOT FIRST POINT .THEN. SET UP EQUATIONS FOR CALCULATING        DYN05862
            C1C                DISPLACEMENTS AT EACH TIME INCREMENT EXCEPT THE FIRST DYN05864
 0016                 IF (ITAM.NE.LL) CALL HOUBQN (KY,IH)                            DYN05870
            C1IF      FIRST POINT .THEN. SET UP EQUATIONS FOR CALCULATING DISPLACE-  DYN05872
            C1C                MENTS AT FIRST TIME INCREMENT AND PREPARE COEFFICIENT DYN05874
            C1C                MATRICES                                              DYN05876
 0017                 IF (ITAM.EQ.LL) CALL HOUBQ1 (KY,IH)                            DYN05880
 0018                 IT=ITAM-(ITAM/IPRINT)*IPRINT                                   DYN05890
 0019                 IF (ITAM.EQ.NOIT) GO TO 10                                     DYN05900
            C1        FIRST TIME THRU WITH PRINT REQUIREMENTS//NO(90)                DYN05902
 0020                 IF (IT.NE.0.AND.ITAM.NE.1) GO TO 90                            DYN05910
 0021          10     IF (NPRNTQ.EQ.0) GO TO 90                                      DYN05920
 0022                 TPRNT=TIME*1000000.                                            DYN05930
 0023                 WRITE (6,110) ITAM,TPRNT                                       DYN05940
 0024                 WRITE (6,120) KY                                               DYN05950
            C                                                                        DYN05958
 0025                 DO 20 I=1,NNODES                                               DYN05960
 0026                    K=4*(I-1)+N                                                 DYN05970
 0027                    WRITE (6,130) I,(QN(K+J),J=1,4)                             DYN05980
 0028          20     CONTINUE                                                       DYN05990
            C                                                                        DYN05993
            C1        INTERMEDIATE HARMONIC//YES(80)                                 DYN05995
 0029                 IF (IH.NE.NH) GO TO 80                                         DYN06000
 0030                 IF (NH.EQ.1) GO TO 80                                          DYN06010
            C1        CALCULATE AND PRINT DISPLACEMENTS AT DESIRED CIRCUMFERENTIAL   DYN06012
            C1C                ANGLE                                                 DYN06014
            C                                                                        DYN06048
 0031                 DO 70 IT=1,NTHETA                                              DYN06050
            C                                                                        DYN06058
 0032                    DO 30 I=1,NEQ                                               DYN06060
 0033                       QLOAD(I)=0.0                                             DYN06070
 0034          30        CONTINUE                                                    DYN06072
            C                                                                        DYN06075
            C                                                                        DYN06078
 0035                    DO 50 JH=1,NH                                               DYN06080
 0036                       N=NEQ*(JH-1)                                             DYN06090
 0037                       XIH1=IHARM(JH)                                           DYN06100
 0038                       SN=DSIN(XIH1*THETA(IT))                                  DYN06110
 0039                       CS=DCOS(XIH1*THETA(IT))                                  DYN06120
            C                                                                        DYN06128
 0040                       DO 50 I1=1,NNODES                                        DYN06130
 0041                          K=4*(I1-1)                                            DYN06140
 0042                          NPK=N+K                                               DYN06150
            C                                                                        DYN06158
```

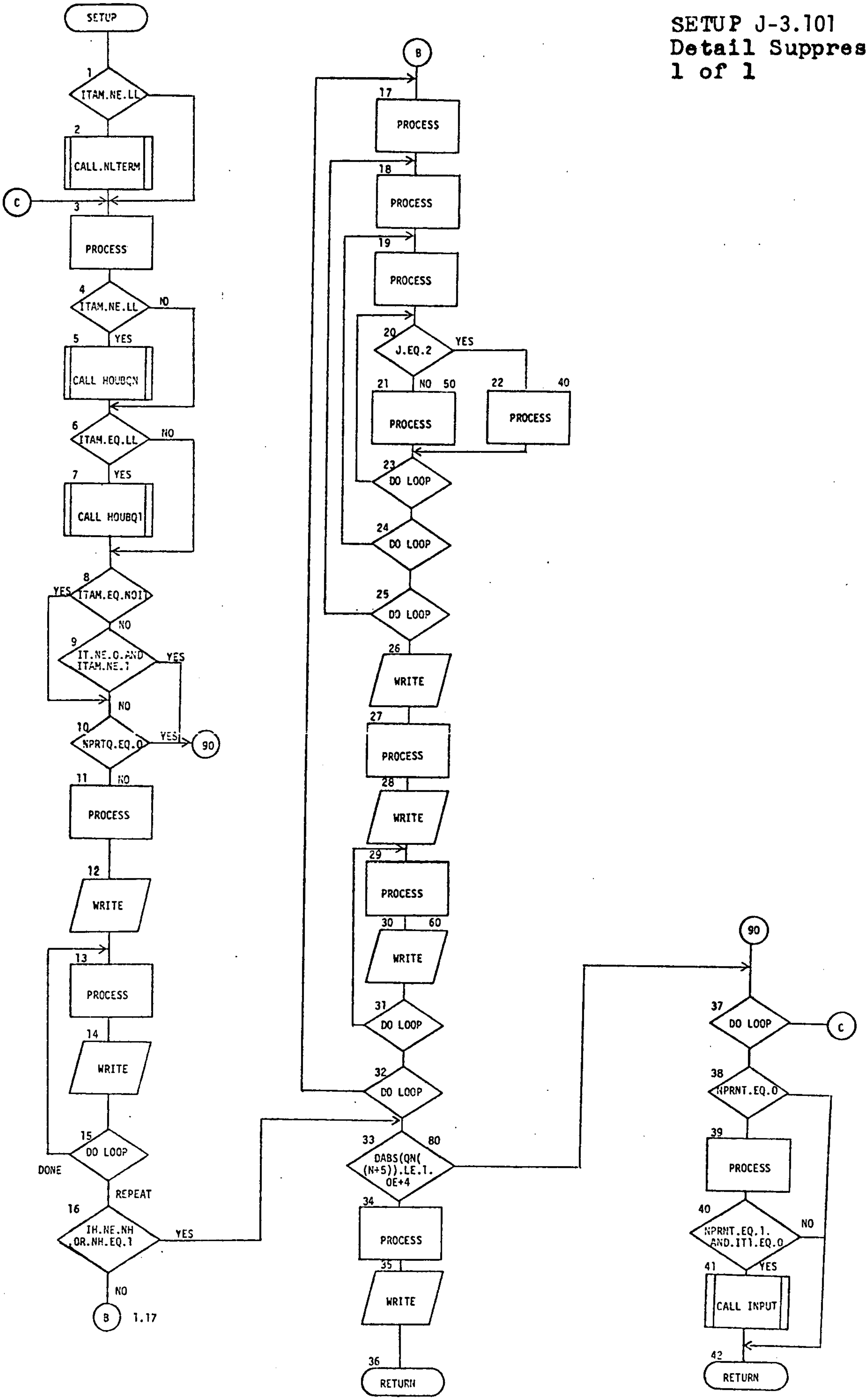
```
                  DO 50 J=1,4                                           DYN06160
                     IF (J.EQ.2) GO TO 40                               DYN06170
                     QLOAD(K+J)=QLOAD(K+J)+QN(NPK+J)*CS                 DYN06180
                     GO TO 50                                           DYN06190
   40                QLOAD(K+J)=QLOAD(K+J)+QN(NPK+J)*SN                 DYN06200
   50       CONTINUE                                                    DYN06210
C                                                                       DYN06213
            WRITE (6,110) ITAM,TPRNT                                    DYN06220
            THETA1=THETA(IT)*180./3.14159                               DYN06230
            WRITE (6,140) THETA1                                        DYN06240
C                                                                       DYN06248
            DO 60 I=1,NNODES                                            DYN06250
               K=4*(I-1)                                                DYN06260
               WRITE (6,130) I,(QLOAD(K+J),J=1,4)                       DYN06270
   60       CONTINUE                                                    DYN06272
C                                                                       DYN06275
   70    CONTINUE                                                       DYN06280
C                                                                       DYN06283
C1       DISPLACEMENTS TOO LARGE FOR STABILITY//NO(90)                  DYN06285
   80    IF (DABS(QN(N+5)).LE.1.0E+4) GO TO 90                          DYN06330
         LARGE=1                                                        DYN06340
         WRITE (6,150) ITAM,TIME                                        DYN06350
         RETURN                                                         DYN06360
   90 CONTINUE                                                          DYN06370
C                                                                       DYN06373
C1    WRITE RESTART DATA//NO(100)                                       DYN06375
      IF (NPRNT.EQ.0) GO TO 100                                         DYN06380
      IT1=ITAM-(ITAM/NPRNIT)*NPRNIT                                     DYN06390
      IF (NPRNT.EQ.1.AND.IT1.EQ.0) CALL INPUT (3)                       DYN06400
  100 RETURN                                                            DYN06410
C                                                                       DYN06420
  110 FORMAT (1H1,30X,6HITAM =,I5,5X,6HTIME =,F12.4,13H MICROSECONDS//) DYN06430
  120 FORMAT (36X,22HDISPLACEMENTS OF NODES/38X,9HHARMONIC ,I5//        DYN06440
     1        6X,8HNODE NO.,6X,5HAXIAL,13X,10HTANGENTIAL,11X,6HRADIAL,  DYN06450
     1        13X,7HANGULAR//)                                          DYN06452
  130 FORMAT (I10,4D20.8)                                               DYN06460
  140 FORMAT (25X,34HDISPLACEMENTS OF NODES AT THETA = ,F8.3,           DYN06470
     1        9H  DEGREES/38X,13HALL HARMONICS/                         DYN06480
     1        2X,8HNODE NO.,9X,5HAXIAL,12X,10HTANGENTIAL,12X,6HRADIAL,  DYN06490
     1        13X,7HANGULAR//)                                          DYN06492
  150 FORMAT (1H1,5X,4HITAM,I5,5X,4HTIME,E12.5//                        DYN06500
     1        6X,22HEXECUTION TERMINATED -,                             DYN06510
     1        33H DISPLACEMENTS GREATER THAN 1.E+4)                     DYN06512
      END                                                               DYN06520
```

J-3.100

SETUP
Functional
1 of 1

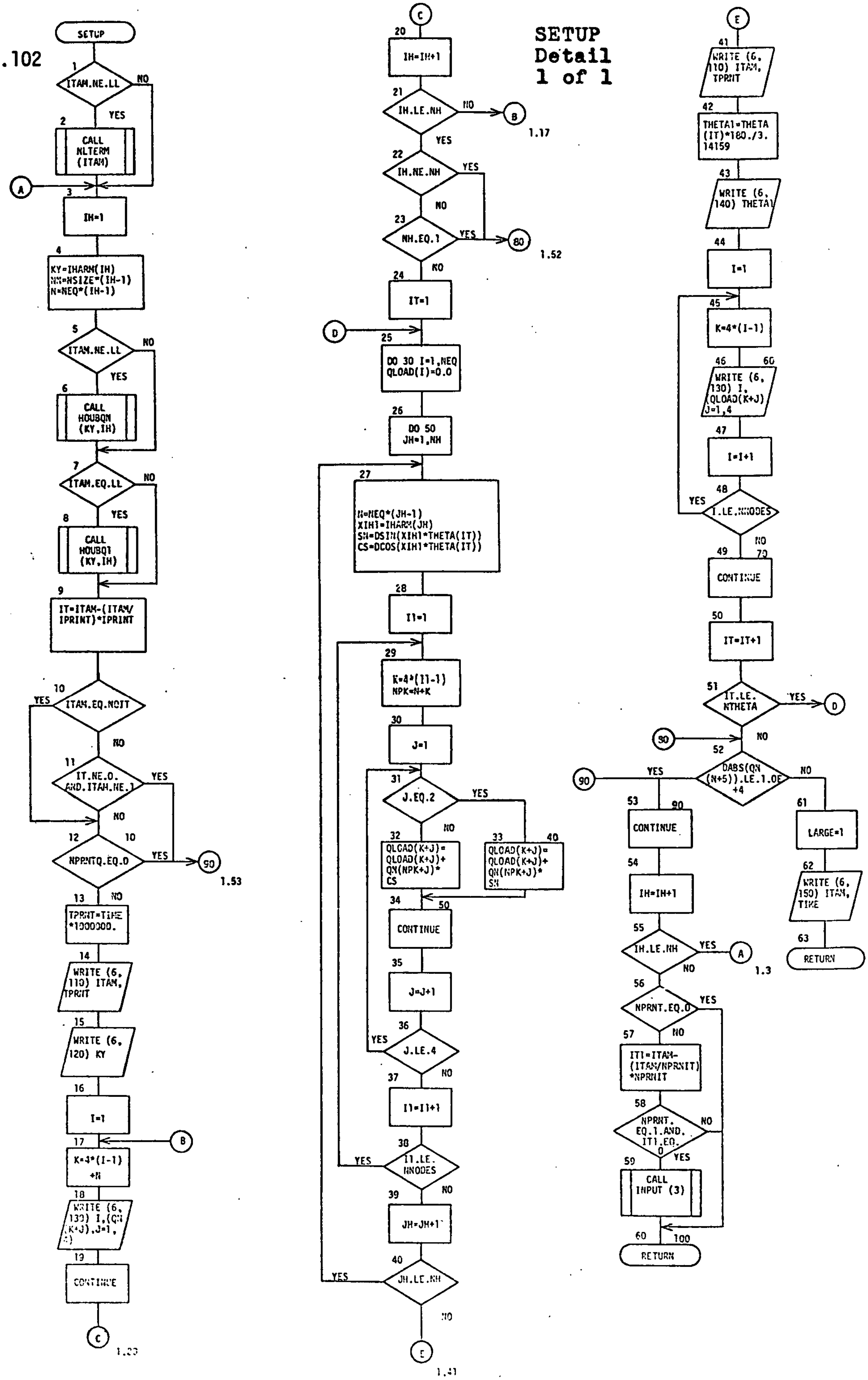

SETUP
1
NOT FIRST POINT
NO
YES
2
NLTERM
CALCULATE GENERALIZED NONLINEAR LOADS AND STRESS RESULTANTS
3
NOT FIRST POINT
NO
YES
4
HQUEQN
SET UP EQUATIONS FOR CALCULATING DISPLACEMENTS AT EACH TIME INCREMENT EXCEPT THE FIRST ONE
5
FIRST POINT
NO
YES
6
HQUEQ1
SET UP EQUATIONS FOR CALCULATING DISPLACEMENTS AT FIRST TIME INCREMENT AND PREPARE COEFFICIENT MATRICES
7
INTERMEDIATE HARMONICS
8
CALCULATE & PRINT DISPLACEMENTS AT DESIRED CIRCUMFERENTIAL ANGLE
9
DISPLACEMENTS TOO LARGE FOR STABILITY
RETURN
10
PROCESS HARMONICS
11
90
WRITE RESTART DATA
NO
YES
12
INITIAL POINT
NO
YES
13
INPUT
WRITE RESTART INFORMATION
14
RETURN

SETUP J-3.101
Detail Suppressed
1 of 1



J-3.102

SETUP Detail 1 of 1



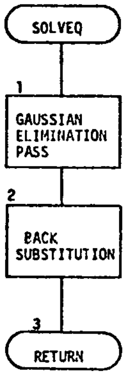
```
            CE(SOLVEQ)                                                             DYN11242
            C                                                                      DYN11244
            C     DESCRIPTION - TO SOLVE THE SET OF SIMULTANEOUS LINEAR            DYN11246
            C            EQUATIONS USING A MODIFIED GAUSS ELIMINATION TECHNIQUE    DYN11248
            C            WHICH TAKES INTO ACCOUNT DIAGONAL SYMMETRY OF THE         DYN11250
            C            SYSTEM. THIS ROUTINE WILL ACCEPT ONLY SPECIAL BANDED      DYN11252
            C            MATRICES (I.E., FORMED BY OVERLAPPING SUBMATRICES).       DYN11254
            C            ELEMENTS OF THE UPPER BAND ARE STORED IN A 1-DIMENSIONAL  DYN11256
            C            ARRAY BY COLUMNS. ALL ZEROS THAT FALL OUTSIDE OF          DYN11258
            C            THE SUB-MATRICES ARE SUPPRESSED.                          DYN11260
            C                                                                      DYN11262
            C  INPUT ARGUMENTS.                                                    DYN11264
            C     IH      = HARMONIC KEY.                                          DYN11266
            C                                                                      DYN11268
            C  OUTPUT ARGUMENTS.                                                   DYN11270
            C     SPR     = ALIAS FOR QLOAD.                                       DYN11272
            C                                                                      DYN11274
            C  EXTERNALS.                                                          DYN11276
            C     CALLED BY                                                        DYN11278
            C              HOUBQ1                                                  DYN11280
            C              HOUBQN                                                  DYN11282
            C                                                                      DYN11284
0001              SUBROUTINE SOLVEQ (IH)                                           DYN11286
0002              IMPLICIT REAL*8 (A-H,O-Z)                                        DYN11288
0003              COMMON /SLVEEQ/ SPA(6550),SPR(204)                               DYN11290
0004              COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS, DYN11292
                 1        DT2,NPRNTL,NPRNTF,IDELF,IDCOE                            DYN11294
0005              COMMON /PRINT/ IPRINT,NOIT,LL                                    DYN11296
0006              COMMON /CYCLF/ ITAM                                              DYN11300
0007              DIMENSION A(1310), R(204)                                        DYN11310
            C1    GAUSSIAN ELIMINATION PASS                                        DYN11312
            C                                                                      DYN11388
0008              DO 10 I=1,NSIZE                                                  DYN11390
0009                 NNPI=NN+I                                                     DYN11400
0010                 A(I)=SPA(NNPI)                                                DYN11410
0011            10 CONTINUE                                                        DYN11412
            C                                                                      DYN11415
            C                                                                      DYN11418
0012              DO 20 I=1,NEQ                                                    DYN11420
0013                  R(I)=SPR(I)                                                  DYN11430
0014            20 CONTINUE                                                        DYN11432
            C                                                                      DYN11435
0015              IF (ITAM.GT.(LL+1)) GO TO 100                                    DYN11440
0016              KEY=2                                                            DYN11450
0017              A(2)=A(2)/A(1)                                                   DYN11460
0018              A(3)=A(3)-A(2)*A(2)*A(1)                                         DYN11470
0019              A(5)=A(5)-A(4)*A(2)                                              DYN11480
0020              A(8)=A(8)-A(7)*A(2)                                              DYN11490
```

```
      A(4)=A(4)/A(1)                                                    DYN11500
      A(5)=A(5)/A(3)                                                    DYN11510
      A(6)=A(6)-A(4)*A(4)*A(1)-A(5)*A(5)*A(3)                           DYN11520
      A(9)=A(9)-A(7)*A(4)-A(8)*A(5)                                     DYN11530
      A(7)=A(7)/A(1)                                                    DYN11540
      A(8)=A(8)/A(3)                                                    DYN11550
      A(9)=A(9)/A(6)                                                    DYN11560
      A(10)=A(10)-A(7)*A(7)*A(1)-A(8)*A(8)*A(3)-A(9)*A(9)*A(6)          DYN11570
      R(2)=R(2)-R(1)*A(2)                                               DYN11580
      R(3)=R(3)-R(1)*A(4)-R(2)*A(5)                                     DYN11590
      R(4)=R(4)-R(1)*A(7)-R(2)*A(8)-R(3)*A(9)                           DYN11600
C                                                                       DYN11608
      DO 90 K=1,NELEMS                                                  DYN11610
         I=11+(K-1)*26                                                  DYN11620
         J=5+(K-1)*4                                                    DYN11630
         GO TO (40,30), KEY                                             DYN11640
   30    AM10=A(I-10)                                                   DYN11650
         AM9=A(I-9)                                                     DYN11660
         AM8=A(I-8)                                                     DYN11670
         AM7=A(I-7)                                                     DYN11680
         AM6=A(I-6)                                                     DYN11690
         AM5=A(I-5)                                                     DYN11700
         GO TO 50                                                       DYN11710
   40    AM10=A(I-22)                                                   DYN11720
         AM9=A(I-17)                                                    DYN11730
         AM8=A(I-16)                                                    DYN11740
         AM7=A(I-11)                                                    DYN11750
         AM6=A(I-10)                                                    DYN11760
         AM5=A(I-9)                                                     DYN11770
   50    AM4=A(I-4)                                                     DYN11780
         AM3=A(I-3)                                                     DYN11790
         AM2=A(I-2)                                                     DYN11800
         AM1=A(I-1)                                                     DYN11810
         A0=A(I)                                                        DYN11820
         A1=A(I+1)                                                      DYN11830
         A2=A(I+2)                                                      DYN11840
         A3=A(I+3)                                                      DYN11850
         A4=A(I+4)                                                      DYN11860
         A5=A(I+5)                                                      DYN11870
         A6=A(I+6)                                                      DYN11880
         A7=A(I+7)                                                      DYN11890
         A8=A(I+8)                                                      DYN11900
         A9=A(I+9)                                                      DYN11910
         A10=A(I+10)                                                    DYN11920
         A11=A(I+11)                                                    DYN11930
         A12=A(I+12)                                                    DYN11940
         A13=A(I+13)                                                    DYN11950
         A14=A(I+14)                                                    DYN11960
```

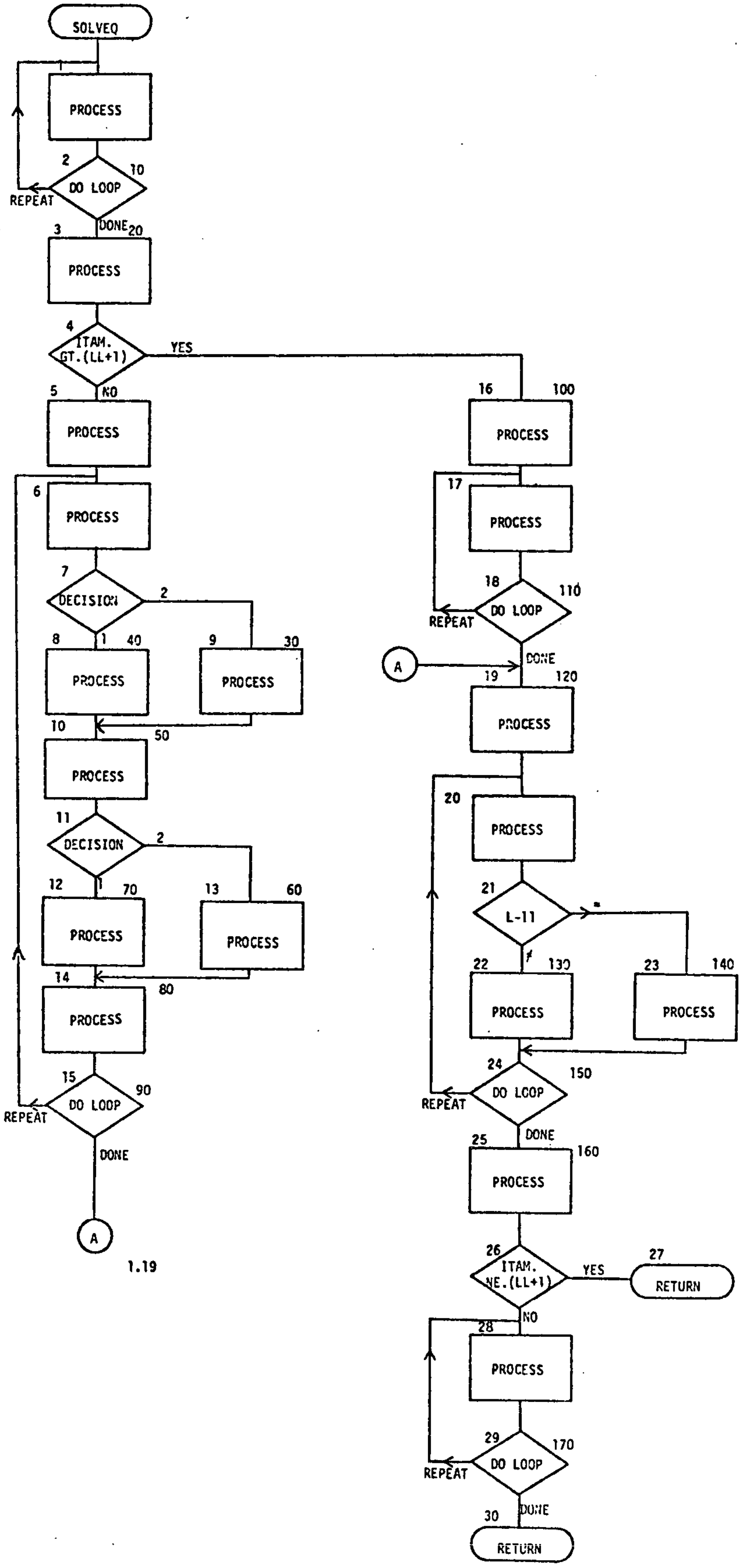
```
 0068                  A15=A(I+15)                                                       DYN11970
 0069                  A16=A(I+16)                                                       DYN11980
 0070                  A17=A(I+17)                                                       DYN11990
 0071                  A18=A(I+18)                                                       DYN12000
 0072                  A19=A(I+19)                                                       DYN12010
 0073                  A20=A(I+20)                                                       DYN12020
 0074                  A21=A(I+21)                                                       DYN12030
 0075                  A22=A(I+22)                                                       DYN12040
 0076                  A23=A(I+23)                                                       DYN12050
 0077                  A24=A(I+24)                                                       DYN12060
 0078                  A25=A(I+25)                                                       DYN12070
 0079                  A1=A1-A0*AM9                                                      DYN12080
 0080                  A6=A6-A5*AM9                                                      DYN12090
 0081                  A12=A12-A11*AM9                                                   DYN12100
 0082                  A19=A19-A18*AM9                                                   DYN12110
 0083                  A2=A2-A0*AM7-A1*AM6                                               DYN12120
 0084                  A7=A7-A5*AM7-A6*AM6                                               DYN12130
 0085                  A13=A13-A11*AM7-A12*AM6                                           DYN12140
 0086                  A20=A20-A18*AM7-A19*AM6                                           DYN12150
 0087                  A3=A3-A0*AM4-A1*AM3-A2*AM2                                        DYN12160
 0088                  A8=A8-A5*AM4-A6*AM3-A7*AM2                                        DYN12170
 0089                  A14=A14-A11*AM4-A12*AM3-A13*AM2                                   DYN12180
 0090                  A21=A21-A18*AM4-A19*AM3-A20*AM2                                   DYN12190
 0091                  A0=A0/AM10                                                        DYN12200
 0092                  A1=A1/AM8                                                         DYN12210
 0093                  A2=A2/AM5                                                         DYN12220
 0094                  A4=A4-A0*A0*AM10-A1*A1*AM8-A2*A2*AM5-A3*A3*AM1                    DYN12230
 0095                  A9=A9-A5*A0-A6*A1-A7*A2-A8*A3                                     DYN12240
 0096                  A15=A15-A11*A0-A12*A1-A13*A2-A14*A3                               DYN12250
 0097                  A22=A22-A18*A0-A19*A1-A20*A2-A21*A3                               DYN12260
 0098                  R(J)=R(J)-R(J-4)*A0-R(J-3)*A1-R(J-2)*A2-R(J-1)*A3                 DYN12270
 0099                  A5=A5/AM10                                                        DYN12280
 0100                  A6=A6/AM8                                                         DYN12290
 0101                  A7=A7/AM5                                                         DYN12300
 0102                  A8=A8/AM1                                                         DYN12310
 0103                  A9=A9/A4                                                          DYN12320
 0104                  A10=A10-A5*A5*AM10-A6*A6*AM8-A7*A7*AM5-A8*A8*AM1-A9*A9*A4         DYN12330
 0105                  A16=A16-A5*A11-A6*A12-A7*A13-A8*A14-A9*A15                        DYN12340
 0106                  A23=A23-A5*A18-A6*A19-A7*A20-A8*A21-A9*A22                        DYN12350
 0107                  R(J+1)=R(J+1)-R(J-4)*A5-R(J-3)*A6-R(J-2)*A7-R(J-1)*A8-R(J)*A9     DYN12360
 0108                  A11=A11/AM10                                                      DYN12370
 0109                  A12=A12/AM8                                                       DYN12380
 0110                  A13=A13/AM5                                                       DYN12390
 0111                  A14=A14/AM1                                                       DYN12400
 0112                  A15=A15/A4                                                        DYN12410
 0113                  A16=A16/A10                                                       DYN12420
 0114                  A17=A17-A11*A11*AM10-A12*A12*AM8-A13*A13*AM5-A14*A14*AM1-A15*     DYN12430
                1           A15*A4-A16*A16*A10                                           DYN12440
 0115                 A24=A24-A11*A18-A12*A19-A13*A20-A14*A21-A15*A22-A16*A23          DYN12450
 0116                 R(J+2)=R(J+2)-R(J-4)*A11-R(J-3)*A12-R(J-2)*A13-R(J-1)*A14-R(J)*DYN12460
                1          A15-R(J+1)*A16                                              DYN12470
 0117                 A18=A18/AM10                                                     DYN12480
 0118                 A19=A19/AM8                                                      DYN12490
 0119                 A20=A20/AM5                                                      DYN12500
 0120                 A21=A21/AM1                                                      DYN12510
 0121                 A22=A22/A4                                                       DYN12520
 0122                 A23=A23/A10                                                      DYN12530
 0123                 A24=A24/A17                                                      DYN12540
 0124                 A25=A25-A18*A18*AM10-A19*A19*AM8-A20*A20*AM5-A21*A21*AM1-A22*    DYN12550
                1          A22*A4-A23*A23*A10-A24*A24*A17                              DYN12560
 0125                 R(J+3)=R(J+3)-R(J-4)*A18-R(J-3)*A19-R(J-2)*A20-R(J-1)*A21-R(J)*DYN12570
                1          A22-R(J+1)*A23-R(J+2)*A24                                   DYN12580
 0126                 GO TO (70,60), KEY                                               DYN12590
 0127          60     A(I-10)=AM10                                                     DYN12600
 0128                 A(I-9)=AM9                                                       DYN12610
 0129                 A(I-8)=AM8                                                       DYN12620
 0130                 A(I-7)=AM7                                                       DYN12630
 0131                 A(I-6)=AM6                                                       DYN12640
 0132                 A(I-5)=AM5                                                       DYN12650
 0133                 KEY=1                                                            DYN12660
 0134                 GO TO 80                                                         DYN12670
 0135          70     A(I-22)=AM10                                                     DYN12680
 0136                 A(I-17)=AM9                                                      DYN12690
 0137                 A(I-16)=AM8                                                      DYN12700
 0138                 A(I-11)=AM7                                                      DYN12710
 0139                 A(I-10)=AM6                                                      DYN12720
 0140                 A(I-9)=AM5                                                       DYN12730
 0141          80     A(I-4)=AM4                                                       DYN12740
 0142                 A(I-3)=AM3                                                       DYN12750
 0143                 A(I-2)=AM2                                                       DYN12760
 0144                 A(I-1)=AM1                                                       DYN12770
 0145                 A(I)=A0                                                          DYN12780
 0146                 A(I+1)=A1                                                        DYN12790
 0147                 A(I+2)=A2                                                        DYN12800
 0148                 A(I+3)=A3                                                        DYN12810
 0149                 A(I+4)=A4                                                        DYN12820
 0150                 A(I+5)=A5                                                        DYN12830
 0151                 A(I+6)=A6                                                        DYN12840
 0152                 A(I+7)=A7                                                        DYN12850
 0153                 A(I+8)=A8                                                        DYN12860
 0154                 A(I+9)=A9                                                        DYN12870
 0155                 A(I+10)=A10                                                      DYN12880
 0156                 A(I+11)=A11                                                      DYN12890
 0157                 A(I+12)=A12                                                      DYN12900
 0158                 A(I+13)=A13                                                      DYN12910
 0159                 A(I+14)=A14                                                      DYN12920
```

```
            A(I+15)=A15                                                 DYN12930
            A(I+16)=A16                                                 DYN12940
            A(I+17)=A17                                                 DYN12950
            A(I+18)=A18                                                 DYN12960
            A(I+19)=A19                                                 DYN12970
            A(I+20)=A20                                                 DYN12980
            A(I+21)=A21                                                 DYN12990
            A(I+22)=A22                                                 DYN13000
            A(I+23)=A23                                                 DYN13010
            A(I+24)=A24                                                 DYN13020
            A(I+25)=A25                                                 DYN13030
   90 CONTINUE                                                          DYN13032
C                                                                       DYN13035
      GO TO 120                                                         DYN13040
  100 CONTINUE                                                          DYN13050
      R(2)=R(2)-R(1)*A(2)                                               DYN13060
      R(3)=R(3)-R(1)*A(4)-R(2)*A(5)                                     DYN13070
      R(4)=R(4)-R(1)*A(7)-R(2)*A(8)-R(3)*A(9)                           DYN13080
C                                                                       DYN13088
      DO 110 K=1,NELEMS                                                 DYN13090
         N=4*(K+1)-3                                                    DYN13100
         L=26*K-15                                                      DYN13110
         R(N)=R(N)-R(N-4)*A(L)-R(N-3)*A(L+1)-R(N-2)*A(L+2)-R(N-1)*A(L+3)DYN13120
         R(N+1)=R(N+1)-R(N-4)*A(L+5)-R(N-3)*A(L+6)-R(N-2)*A(L+7)-       DYN13130
     1              R(N-1)*A(L+8)-R(N)*A(L+9)                           DYN13132
         R(N+2)=R(N+2)-R(N-4)*A(L+11)-R(N-3)*A(L+12)-R(N-2)*A(L+13)-    DYN13134
     1              R(N-1)*A(L+14)-R(N)*A(L+15)-R(N+1)*A(L+16)          DYN13136
         R(N+3)=R(N+3)-R(N-4)*A(L+18)-R(N-3)*A(L+19)-R(N-2)*A(L+20)-    DYN13138
     1              R(N-1)*A(L+21)-R(N)*A(L+22)-R(N+1)*A(L+23)-R(N+2)*  DYN13140
     1              A(L+24)                                             DYN13142
  110 CONTINUE                                                          DYN13190
C                                                                       DYN13193
  120 CONTINUE                                                          DYN13200
C1    BACK SUBSTITUTIONS                                                DYN13202
      N=26*NELEMS+10                                                    DYN13220
      M=(NELEMS+1)*4                                                    DYN13230
      R(M)=R(M)/A(N)                                                    DYN13240
      R(M-1)=R(M-1)/A(N-8)-R(M)*A(N-1)                                  DYN13250
      R(M-2)=R(M-2)/A(N-15)-R(M-1)*A(N-9)-R(M)*A(N-2)                   DYN13260
      R(M-3)=R(M-3)/A(N-21)-R(M-2)*A(N-16)-R(M-1)*A(N-10)-R(M)*A(N-3)   DYN13270
C                                                                       DYN13278
      DO 150 K=1,NELEMS                                                 DYN13280
         L=26*(NELEMS+1-K)-15                                           DYN13290
         N=4*(NELEMS+1-K)-3                                             DYN13300
         IF (L-11) 130,140,130                                          DYN13310
  130    R(N+3)=R(N+3)/A(L-1)-R(N+4)*A(L+3)-R(N+5)*A(L+8)-R(N+6)*       DYN13320
     1              A(L+14)-R(N+7)*A(L+21)                              DYN13330
         R(N+2)=R(N+2)/A(L-9)-R(N+3)*A(L-2)-R(N+4)*A(L+2)-R(N+5)*       DYN13340
```

```
                  1            A(L+7)-R(N+6)*A(L+13)-R(N+7)*A(L+20)                  DYN13350
 0198                 R(N+1)=R(N+1)/A(L-16)-R(N+2)*A(L-10)-R(N+3)*A(L-3)-R(N+4)*     DYN13360
                  1            A(L+1)-R(N+5)*A(L+6)-R(N+6)*A(L+12)-R(N+7)*A(L+19)    DYN13370
 0199                 R(N)=R(N)/A(L-22)-R(N+1)*A(L-17)-R(N+2)*A(L-11)-R(N+3)*A(L-4)- DYN13380
                  1            R(N+4)*A(L)-R(N+5)*A(L+5)-R(N+6)*A(L+11)-R(N+7)*      DYN13390
                  1            A(L+18)                                               DYN13391
 0200                 GO TO 150                                                      DYN13400
 0201          140    R(N+3)=R(N+3)/A(L-1)-R(N+4)*A(L+3)-R(N+5)*A(L+8)-R(N+6)*       DYN13410
                  1            A(L+14)-R(N+7)*A(L+21)                                DYN13420
 0202                 R(N+2)=R(N+2)/A(L-5)-R(N+3)*A(L-2)-R(N+4)*A(L+2)-R(N+5)*A(L+7)-DYN13430
                  1            R(N+6)*A(L+13)-R(N+7)*A(L+20)                         DYN13440
 0203                 R(N+1)=R(N+1)/A(L-8)-R(N+2)*A(L-6)-R(N+3)*A(L-3)-R(N+4)*A(L+1)-DYN13450
                  1            R(N+5)*A(L+6)-R(N+6)*A(L+12)-R(N+7)*A(L+19)           DYN13460
 0204                 R(N)=R(N)/A(L-10)-R(N+1)*A(L-9)-R(N+2)*A(L-7)-R(N+3)*A(L-4)-   DYN13470
                  1            R(N+4)*A(L)-R(N+5)*A(L+5)-R(N+6)*A(L+11)-R(N+7)*      DYN13480
                  1            A(L+18)                                               DYN13481
 0205          150 CONTINUE                                                          DYN13490
             C                                                                       DYN13493
             C                                                                       DYN13498
 0206              DO 160 I=1,NEQ                                                    DYN13500
 0207                 SPR(I)=R(I)                                                    DYN13510
 0208          160 CONTINUE                                                          DYN13512
             C                                                                       DYN13515
 0209              IF (ITAM.NE.(LL+1)) RETURN                                        DYN13520
             C                                                                       DYN13528
 0210              DO 170 I=1,NSIZE                                                  DYN13530
 0211                 NNPI=NN+I                                                      DYN13540
 0212                 SPA(NNPI)=A(I)                                                 DYN13550
 0213          170 CONTINUE                                                          DYN13552
             C                                                                       DYN13555
 0214              RETURN                                                            DYN13560
 0215              END                                                               DYN13570
```


SOLVEQ
1
GAUSSIAN ELIMINATION PASS
2
BACK SUBSTITUTION
3
RETURN

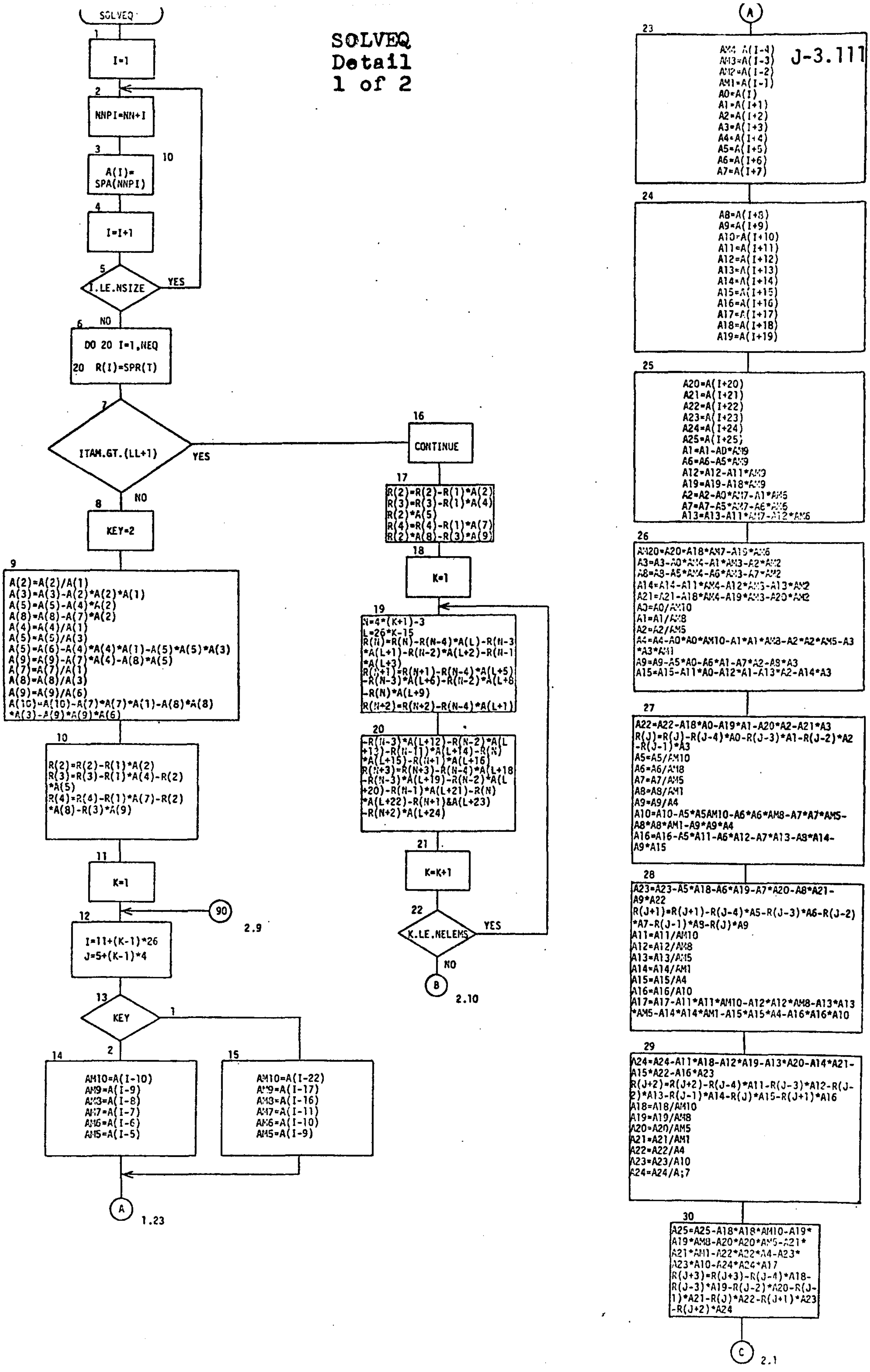
SOLVEQ
Detail Suppressed
1 of 1



1.19

SOLVEQ Detail 1 of 2

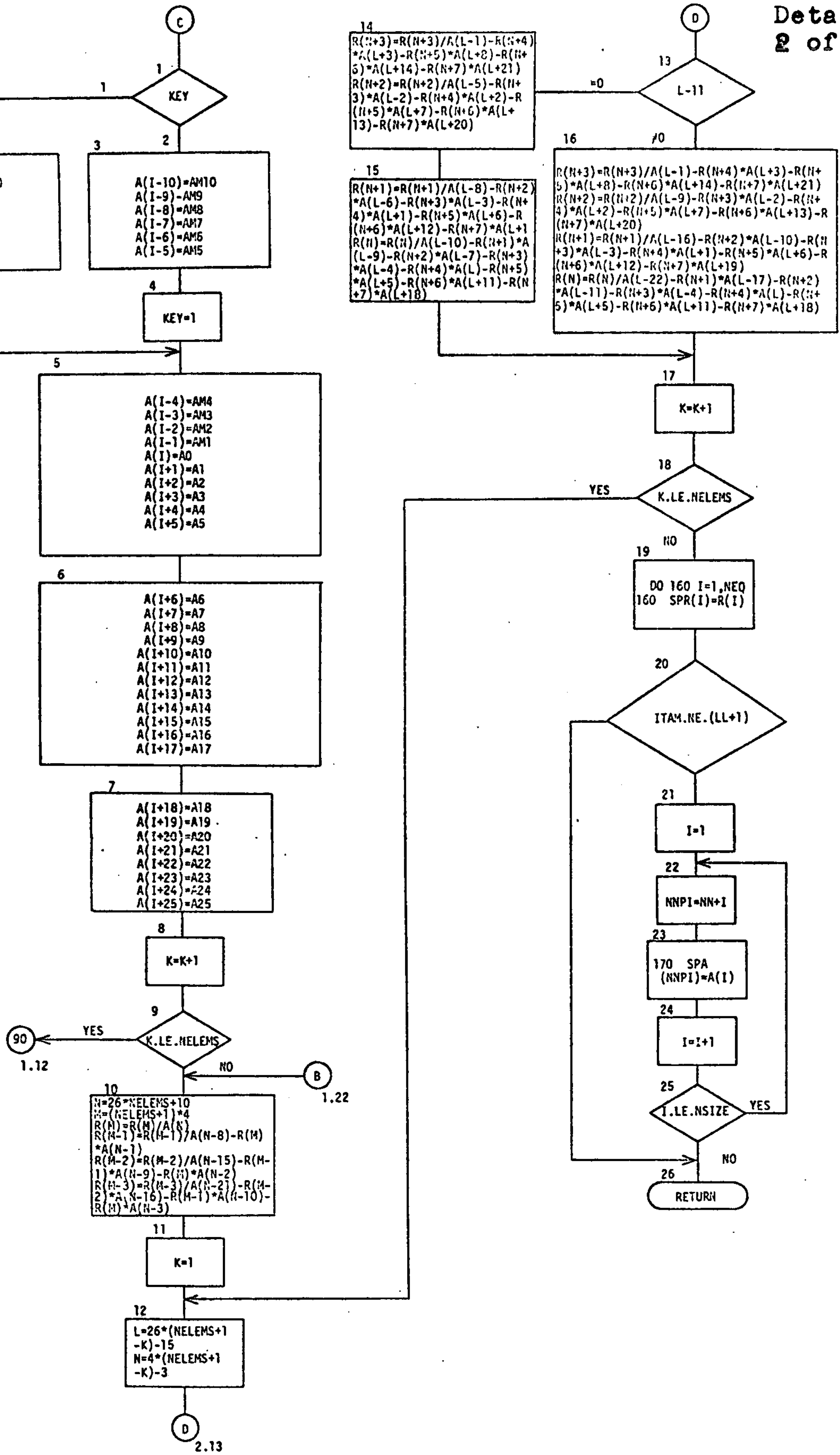
J-3.111



```
1   I=1
2   NNPI=NN+I
3   A(I)=
    SPA(NNPI)        10
4   I=I+1
5   I.LE.NSIZE
6   DO 20 I=1,NEQ
    20  R(I)=SPR(T)
7   ITAM.GT.(LL+1)
8   KEY=2
9   A(2)=A(2)/A(1)
    A(3)=A(3)-A(2)*A(2)*A(1)
    A(5)=A(5)-A(4)*A(2)
    A(8)=A(8)-A(7)*A(2)
    A(4)=A(4)/A(1)
    A(5)=A(5)/A(3)
    A(5)=A(6)-A(4)*A(4)*A(1)-A(5)*A(5)*A(3)
    A(9)=A(9)-A(7)*A(4)-A(8)*A(5)
    A(7)=A(7)/A(1)
    A(8)=A(8)/A(3)
    A(9)=A(9)/A(6)
    A(10)=A(10)-A(7)*A(7)*A(1)-A(8)*A(8)
    *A(3)-A(9)*A(9)*A(6)
10  R(2)=R(2)-R(1)*A(2)
    R(3)=R(3)-R(1)*A(4)-R(2)
    *A(5)
    R(4)=R(4)-R(1)*A(7)-R(2)
    *A(8)-R(3)*A(9)
11  K=1
12  I=11+(K-1)*26
    J=5+(K-1)*4
13  KEY
14  AM10=A(I-10)
    AM9=A(I-9)
    AM8=A(I-8)
    AM7=A(I-7)
    AM6=A(I-6)
    AM5=A(I-5)
15  AM10=A(I-22)
    AM9=A(I-17)
    AM8=A(I-16)
    AM7=A(I-11)
    AM6=A(I-10)
    AM5=A(I-9)
16  CONTINUE
17  R(2)=R(2)-R(1)*A(2)
    R(3)=R(3)-R(1)*A(4)
    R(2)*A(5)
    R(4)=R(4)-R(1)*A(7)
    R(2)*A(8)-R(3)*A(9)
18  K=1
19  N=4*(K+1)-3
    L=26*K-15
    R(N)=R(N)-R(N-4)*A(L)-R(N-3
    *A(L+1)-R(N-2)*A(L+2)-R(N-1
    *A(L+3)
    R(N+1)=R(N+1)-R(N-4)*A(L+5)
    -R(N-3)*A(L+6)-R(N-2)*A(L+8
    -R(N)*A(L+9)
    R(N+2)=R(N+2)-R(N-4)*A(L+1)
20  -R(N-3)*A(L+12)-R(N-2)*A(L
    +13)-R(N-11)*A(L+14)-R(N)
    *A(L+15)-R(N+1)*A(L+16)
    R(N+3)=R(N+3)-R(N-4)*A(L+18
    -R(N-3)*A(L+19)-R(N-2)*A(L
    +20)-R(N-1)*A(L+21)-R(N)
    *A(L+22)-R(N+1)&A(L+23)
    -R(N+2)*A(L+24)
21  K=K+1
22  K.LE.NELEMS
23  AM4 A(I-4)
    AM3=A(I-3)
    AM2=A(I-2)
    AM1=A(I-1)
    A0=A(I)
    A1=A(I+1)
    A2=A(I+2)
    A3=A(I+3)
    A4=A(I+4)
    A5=A(I+5)
    A6=A(I+6)
    A7=A(I+7)
24  A8=A(I+8)
    A9=A(I+9)
    A10=A(I+10)
    A11=A(I+11)
    A12=A(I+12)
    A13=A(I+13)
    A14=A(I+14)
    A15=A(I+15)
    A16=A(I+16)
    A17=A(I+17)
    A18=A(I+18)
    A19=A(I+19)
25  A20=A(I+20)
    A21=A(I+21)
    A22=A(I+22)
    A23=A(I+23)
    A24=A(I+24)
    A25=A(I+25;
    A1=A1-AD*AM9
    A6=A6-A5*AM9
    A12=A12-A11*AM9
    A19=A19-A18*AM9
    A2=A2-A0*AM7-A1*AM5
    A7=A7-A5*AM7-A6*AM6
    A13=A13-A11*AM7-A12*AM6
26  AM20=A20=A18*AM7-A19*AM6
    A3=A3-A0*AM4-A1*AM3-A2*AM2
    A8=A8-A5*AM4-A6*AM3-A7*AM2
    A14=A14-A11*AM4-A12*AM3-A13*AM2
    A21=A21-A18*AM4-A19*AM3-A20*AM2
    A0=A0/AM10
    A1=A1/AM8
    A2=A2/AM5
    A4=A4-A0*A0*AM10-A1*A1*AM8-A2*A2*AM5-A3
    *A3*AM1
    A9=A9-A5*A0-A6*A1-A7*A2-A8*A3
    A15=A15-A11*A0-A12*A1-A13*A2-A14*A3
27  A22=A22-A18*A0-A19*A1-A20*A2-A21*A3
    R(J)=R(J)-R(J-4)*A0-R(J-3)*A1-R(J-2)*A2
    -R(J-1)*A3
    A5=A5/AM10
    A6=A6/AM8
    A7=A7/AM5
    A8=A8/AM1
    A9=A9/A4
    A10=A10-A5*A5AM10-A6*A6*AM8-A7*A7*AM5-
    A8*A8*AM1-A9*A9*A4
    A16=A16-A5*A11-A6*A12-A7*A13-A8*A14-
    A9*A15
28  A23=A23-A5*A18-A6*A19-A7*A20-A8*A21-
    A9*A22
    R(J+1)=R(J+1)-R(J-4)*A5-R(J-3)*A6-R(J-2)
    *A7-R(J-1)*A8-R(J)*A9
    A11=A11/AM10
    A12=A12/AM8
    A13=A13/AM5
    A14=A14/AM1
    A15=A15/A4
    A16=A16/A10
    A17=A17-A11*A11*AM10-A12*A12*AM8-A13*A13
    *AM5-A14*A14*AM1-A15*A15*A4-A16*A16*A10
29  A24=A24-A11*A18-A12*A19-A13*A20-A14*A21-
    A15*A22-A16*A23
    R(J+2)=R(J+2)-R(J-4)*A11-R(J-3)*A12-R(J-
    2)*A13-R(J-1)*A14-R(J)*A15-R(J+1)*A16
    A18=A18/AM10
    A19=A19/AM8
    A20=A20/AM5
    A21=A21/AM1
    A22=A22/A4
    A23=A23/A10
    A24=A24/A;7
30  A25=A25-A18*A18*AM10-A19*
    A19*AM8-A20*A20*AM5-A21*
    A21*AM1-A22*A22*A4-A23*
    A23*A10-A24*A24*A17
    R(J+3)=R(J+3)-R(J-4)*A18-
    R(J-3)*A19-R(J-2)*A20-R(J-
    1)*A21-R(J)*A22-R(J+1)*A23
    -R(J+2)*A24
```

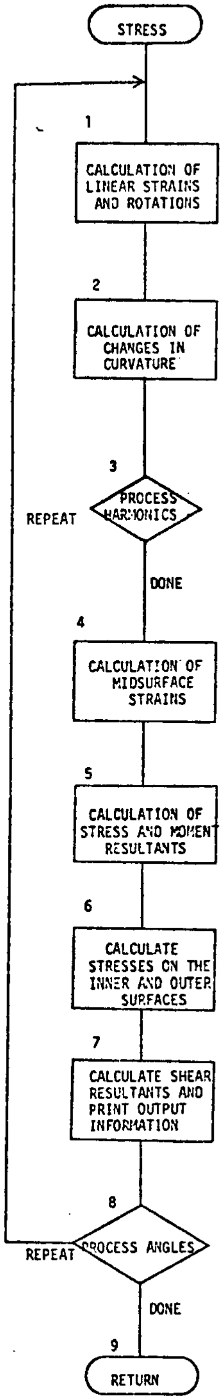
SOLVEQ
Detail
2 of 2

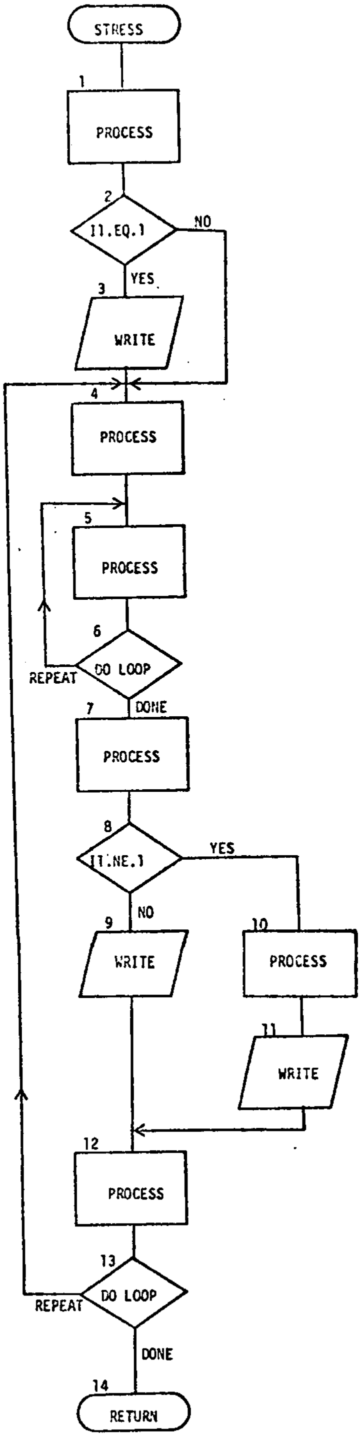
J-3.112



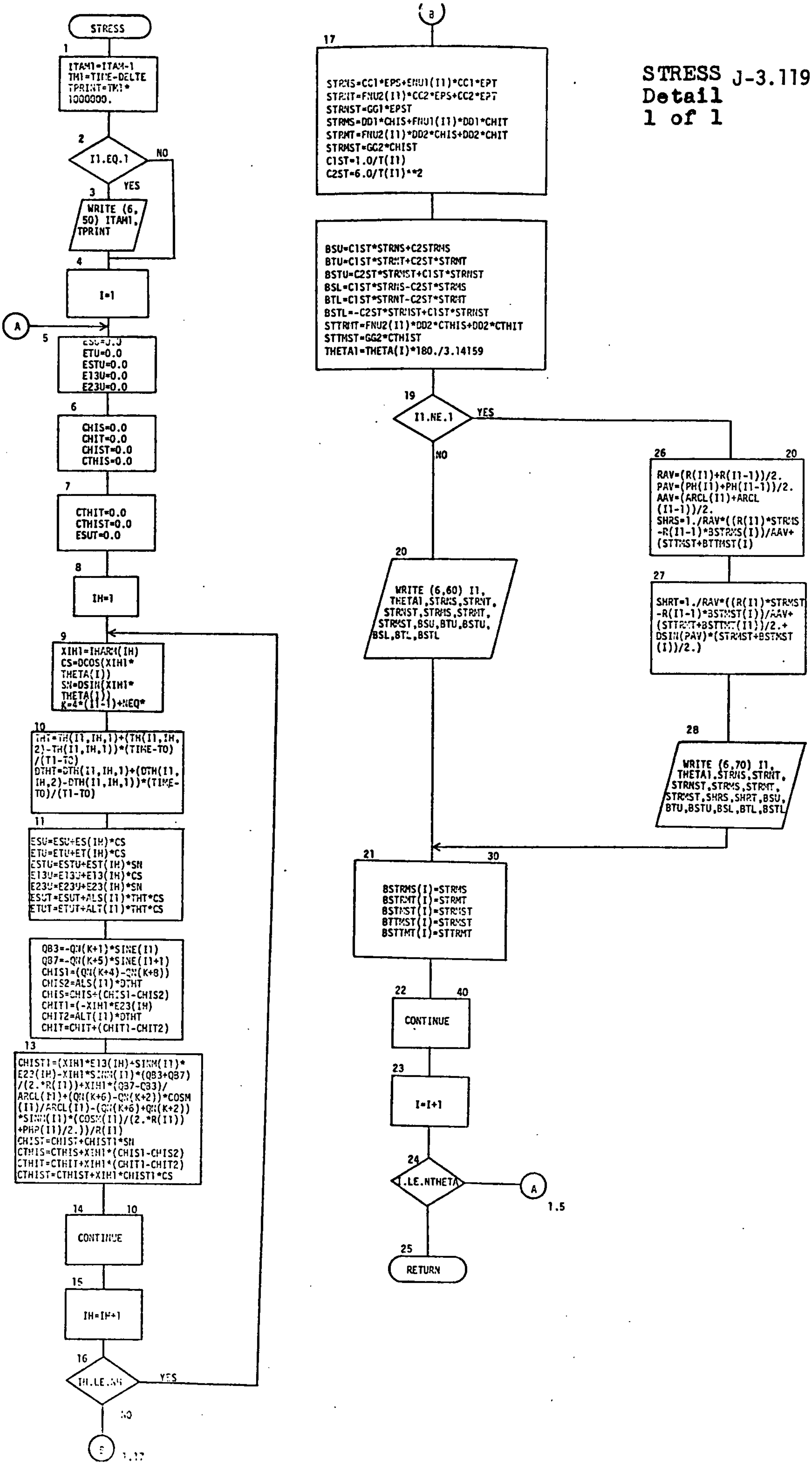
```
              CE(STRESS)                                                          DYN13582
              C                                                                   DYN13584
              C     DESCRIPTION - TO CALCULATE THE MIDSURFACE STRESSES AND        DYN13586
              C            STRESS RESULTANTS ON THE UPPER AND LOWER SHELL SURFACES.  DYN13588
              C                                                                   DYN13590
              C  INPUT ARGUMENTS.                                                 DYN13592
              C     DTH    = MATRIX OF FOURIER COEFFICIENTS FOR THE CIRCUMFERENTIAL  DYN13594
              C              TEMPERATURE GRADIENT DISTRIBUTION.                   DYN13596
              C     IHARM  = MATRIX OF HARMONIC NUMBERS FOR WHICH DISPLACEMENTS   DYN13598
              C              AND/OR STRESSES WILL BE CALCULATED.                  DYN13600
              C     ITAM   = NUMBER OF TIME CYCLE.                                DYN13602
              C     I1     = PRINT FLAG FOR STRESSES.                             DYN13604
              C     NH     = TOTAL NUMBER OF HARMONICS USED IN THE DYNAMIC ANALYSIS.  DYN13606
              C     NTHETA = THE NUMBER OF CIRCUMFERENTIAL ANGLES AT WHICH DISPLACE-  DYN13608
              C              MENTS AND/OR STRESSES ARE TO BE CALCULATED.          DYN13610
              C     TH     = MATRIX WHOSE ELEMENTS ARE THE FOURIER COEFFICIENTS   DYN13612
              C              OF THE CIRCUMFERENTIAL TEMPERATURE DISTRIBUTION.     DYN13614
              C     THETA  = MATRIX CONTAINING CIRCUMFERENTIAL ANGLES AT WHICH    DYN13616
              C              STRESSES AND/OR DISPLACEMENTS ARE TO BE CALCULATED.  DYN13618
              C                                                                   DYN13620
              C  EXTERNALS.                                                       DYN13622
              C     CALLED BY                                                     DYN13624
              C              NLTERM                                               DYN13626
              C                                                                   DYN13628
 0001               SUBROUTINE STRESS (I1,ITAM)                                   DYN13630
 0002               IMPLICIT REAL*8 (A-H,O-Z)                                     DYN13632
 0003               COMMON /EES/ ES(5),ET(5),EST(5),E13(5),E23(5)                 DYN13634
 0004               COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS,  DYN13636
                   1          DT2,NPRNTL,NPRNTF,IDELF,IDCOE                       DYN13638
 0005               COMMON /THETAS/ THETA(20),NTHETA,NCLCST,NSTRSS                DYN13640
 0006               COMMON /GEOM/ FNU1(50),FNU2(50),E1(50),E2(50),G(50),T(50),    DYN13642
                   1          SINE(51),COSINE(51),SINM(50),COSM(50),R(50),PH(50),  DYN13650
                   1          PHP(50),ARCL(50)                                    DYN13652
 0007               COMMON /GCD/ CC1,CC2,DD1,DD2,GG1,GG2                          DYN13660
 0008               COMMON /HARM/ NHP,IHARM(5)                                    DYN13670
 0009               COMMON /TMFT/ TOTIME,DELTE,TIME,TO,T1                         DYN13680
 0010               COMMON /QS/ QN(1020),QN1(1020),FORCE(2040),QP(1020),QP1(1020),  DYN13690
                   1          QN2(1020)                                           DYN13700
 0011               COMMON /THER/ TH(50,5,2),DTH(50,5,2),ALS(50),ALT(50)          DYN13710
 0012               DIMENSION BSTRMS(20), BSTRMT(20), BSTMST(20), BTTMST(20),     DYN13720
                   1          BSTTMT(20)                                          DYN13730
 0013               ITAM1=ITAM-1                                                  DYN13780
 0014               TM1=TIME-DELTE                                                DYN13790
 0015               TPRINT=TM1*1000000.                                           DYN13800
 0016               IF (I1.EQ.1) WRITE (6,50) ITAM1,TPRINT                        DYN13810
              C100  PROCESS ANGLES                                                DYN13812
              C                                                                   DYN13818
 0017               DO 40 I=1,NTHETA                                              DYN13820
 0018                 ESU=0.0                                                   DYN13830
 0019                 ETU=0.0                                                   DYN13840
 0020                 ESTU=0.0                                                  DYN13850
 0021                 E13U=0.0                                                  DYN13860
 0022                 E23U=0.0                                                  DYN13870
 0023                 CHIS=0.0                                                  DYN13880
 0024                 CHIT=0.0                                                  DYN13890
 0025                 CHIST=0.0                                                 DYN13900
 0026                 CTHIS=0.0                                                 DYN13910
 0027                 CTHIT=0.0                                                 DYN13920
 0028                 CTHIST=0.0                                                DYN13930
 0029                 ESUT=0.0                                                  DYN13940
            C1DO      PROCESS HARMONICS                                         DYN13950
            C                                                                   DYN13958
 0030                 DO 10 IH=1,NH                                             DYN13960
 0031                    XIH1=IHARM(IH)                                         DYN13970
 0032                    CS=DCOS(XIH1*THETA(I))                                 DYN13980
 0033                    SN=DSIN(XIH1*THETA(I))                                 DYN13990
 0034                    K=4*(I1-1)+NEQ*(IH-1)                                  DYN14000
 0035                    THT=TH(I1,IH,1)+(TH(I1,IH,2)-TH(I1,IH,1))*(TIME-TO)/(T1-TO) DYN14010
 0036                    DTHT=DTH(I1,IH,1)+(DTH(I1,IH,2)-DTH(I1,IH,1))*(TIME-TO)/(T1-DYN14020
                 1             TO)                                              DYN14021
            C1           CALCULATION OF LINEAR STRAINS AND ROTATIONS            DYN14023
 0037                    ESU=ESU+ES(IH)*CS                                      DYN14040
 0038                    ETU=ETU+ET(IH)*CS                                      DYN14050
 0039                    ESTU=ESTU+EST(IH)*SN                                   DYN14060
 0040                    E13U=E13U+E13(IH)*CS                                   DYN14070
 0041                    E23U=E23U+E23(IH)*SN                                   DYN14080
 0042                    ESUT=ESUT+ALS(I1)*THT*CS                               DYN14090
 0043                    ETUT=ETUT+ALT(I1)*THT*CS                               DYN14100
            C1           CALCULATION OF CHANGES IN CURVATURE                    DYN14102
 0044                    QB3=-QN(K+1)*SINE(I1)+QN(K+3)*COSINE(I1)               DYN14120
 0045                    QB7=-QN(K+5)*SINE(I1+1)+QN(K+7)*COSINE(I1+1)           DYN14130
 0046                    CHIS1=(QN(K+4)-QN(K+8))/ARCL(I1)                       DYN14140
 0047                    CHIS2=ALS(I1)*DTHT                                     DYN14150
 0048                    CHIS=CHIS+(CHIS1-CHIS2)*CS                             DYN14160
 0049                    CHIT1=(-XIH1*E23(IH)-SINM(I1)*E13(IH))/R(I1)           DYN14170
 0050                    CHIT2=ALT(I1)*DTHT                                     DYN14180
 0051                    CHIT=CHIT+(CHIT1-CHIT2)*CS                             DYN14190
 0052                    CHIST1=(XIH1*E13(IH)+SINM(I1)*E23(IH)-XIH1*SINM(I1)*(QB3+  DYN14200
                 1                QB7)/(2.*R(I1))+XIH1*(QB7-QB3)/ARCL(I1)+(QN(K+6)-  DYN14210
                 2                QN(K+2))*COSM(I1)/ARCL(I1)-(QN(K+6)+QN(K+2))*      DYN14220
                 3                SINM(I1)*(COSM(I1)/(2.*R(I1))+PHP(I1)/2.))/R(I1)   DYN14230
 0053                    CHIST=CHIST+CHIST1*SN                                  DYN14240
 0054                    CTHIS=CTHIS+XIH1*(CHIS1-CHIS2)*(-SN)                   DYN14250
 0055                    CTHIT=CTHIT+XIH1*(CHIT1-CHIT2)*(-SN)                   DYN14260
 0056                    CTHIST=CTHIST+XIH1*CHIST1*CS                           DYN14270
 0057             10  CONTINUE                                                  DYN14280
```

```
              C                                                                  DYN14283
              C1       CALCULATION OF MIDSURFACE STRAINS                         DYN14285
 0058                  EPS=ESU+.5*E13U**2-ESUT                                   DYN14300
 0059                  EPT=ETU+.5*E23U**2-ETUT                                   DYN14310
 0060                  EPST=ESTU+E13U*E23U                                       DYN14320
              C1       CALCULATION OF STRESS AND MOMENT RESULTANTS               DYN14322
 0061                  STRNS=CC1*EPS+FNU1(I1)*CC1*EPT                            DYN14340
 0062                  STRNT=FNU2(I1)*CC2*EPS+CC2*EPT                            DYN14350
 0063                  STRNST=GG1*EPST                                           DYN14360
 0064                  STRMS=DD1*CHIS+FNU1(I1)*DD1*CHIT                          DYN14370
 0065                  STRMT=FNU2(I1)*DD2*CHIS+DD2*CHIT                          DYN14380
 0066                  STRMST=GG2*CHIST                                          DYN14390
              C1       CALCULATE STRESSES ON THE INNER AND OUTER SURFACES        DYN14392
 0067                  C1ST=1.0/T(I1)                                            DYN14410
 0068                  C2ST=6.0/T(I1)**2                                         DYN14420
 0069                  BSU=C1ST*STRNS+C2ST*STRMS                                 DYN14430
 0070                  BTU=C1ST*STRNT+C2ST*STRMT                                 DYN14440
 0071                  BSTU=C2ST*STRMST+C1ST*STRNST                              DYN14450
 0072                  BSL=C1ST*STRNS-C2ST*STRMS                                 DYN14460
 0073                  BTL=C1ST*STRNT-C2ST*STRMT                                 DYN14470
 0074                  BSTL=-C2ST*STRMST+C1ST*STRNST                             DYN14480
              C1       CALCULATE SHEAR RESULTANTS AND PRINT OUTPUT INFORMATION   DYN14482
 0075                  STTRMT=FNU2(I1)*DD2*CTHIS+DD2*CTHIT                       DYN14500
 0076                  STTMST=GG2*CTHIST                                         DYN14510
 0077                  THETA1=THETA(I)*180./3.14159                              DYN14520
 0078                  IF (I1.NE.1) GO TO 20                                     DYN14530
 0079                  WRITE (6,60) I1,THETA1,STRNS,STRNT,STRNST,STRMS,STRMT,STRMST, DYN14540
                   1          BSU,BTU,BSTU,BSL,BTL,BSTL                          DYN14550
 0080                  GO TO 30                                                  DYN14560
 0081              20  RAV=(R(I1)+R(I1-1))/2.                                    DYN14570
 0082                  PAV=(PH(I1)+PH(I1-1))/2.                                  DYN14580
 0083                  AAV=(ARCL(I1)+ARCL(I1-1))/2.                              DYN14590
 0084                  SHRS=1./RAV*((R(I1)*STRMS-R(I1-1)*BSTRMS(I))/AAV+(STTMST+ DYN14600
                   1          BTTMST(I))/2.-DSIN(PAV)*(STRMT+BSTRMT(I))/2.)      DYN14610
 0085                  SHRT=1./RAV*((R(I1)*STRMST-R(I1-1)*BSTMST(I))/AAV+(STTRMT+ DYN14620
                   1          BSTTMT(I))/2.+DSIN(PAV)*(STRMST+BSTMST(I))/2.)     DYN14630
 0086                  WRITE (6,70) I1,THETA1,STRNS,STRNT,STRNST,STRMS,STRMT,STRMST, DYN14640
                   1          SHRS,SHRT,BSU,BTU,BSTU,BSL,BTL,BSTL                DYN14650
 0087              30  BSTRMS(I)=STRMS                                           DYN14660
 0088                  BSTRMT(I)=STRMT                                           DYN14670
 0089                  BSTMST(I)=STRMST                                          DYN14680
 0090                  BTTMST(I)=STTMST                                          DYN14690
 0091                  BSTTMT(I)=STTRMT                                          DYN14700
 0092              40 CONTINUE                                                   DYN14710
              C                                                                  DYN14713
 0093                 RETURN                                                     DYN14720
              C                                                                  DYN14730
 0094              50 FORMAT (1H1,3X,6HITAM =,I5,3X,6HTIME =,F12.4,13H MICROSECONDS,// DYN14740
               1       47X,33HSTRESSES  AND  STRESS  RESULTANTS,/              DYN14750
               2       25X,17HFORCE  RESULTANTS,31X,18HMOMFNT  RESULTANTS,18X,  DYN14760
               2       17HSHEAR  RESULTANTS/                                   DYN14770
               2       19X,4HN(S),11X,4HN(T),11X,5HN(ST),10X,4HM(S),11X,4HM(T), DYN14780
               2       11X,5HM(ST),10X,4HQ(S),11X,4HQ(T)//12H ELEM  THETA,/     DYN14790
               3       53H  NO   (DEG)   *****     OUTER  SURFACE  STRESSES    ,DYN14800
               3       51H   ******       INNER  SURFACE  STRESSES      *****,/ DYN14810
               4       15X,41H* SIGMA(S)       SIGMA(T)        SIGMA(ST),       DYN14820
               4       47H      SIGMA(S)       SIGMA(T)        SIGMA(ST) */)    DYN14822
 0095         60 FORMAT (I4,F8.2,6(1PD15.4),30H       XXXX         XXXX    ,/    DYN14830
               1       12H STRESSES **,6(1PD15.4))                              DYN14840
 0096         70 FORMAT (I4,F8.2,8(1PD15.4),/,12H STRESSES **,6(1PD15.4))        DYN14850
 )097            END                                                            DYN14860
```


STRESS
1
CALCULATION OF LINEAR STRAINS AND ROTATIONS
2
CALCULATION OF CHANGES IN CURVATURE
3
PROCESS HARMONICS
REPEAT
DONE
4
CALCULATION OF MIDSURFACE STRAINS
5
CALCULATION OF STRESS AND MOMENT RESULTANTS
6
CALCULATE STRESSES ON THE INNER AND OUTER SURFACES
7
CALCULATE SHEAR RESULTANTS AND PRINT OUTPUT INFORMATION
8
PROCESS ANGLES
REPEAT
DONE
9
RETURN

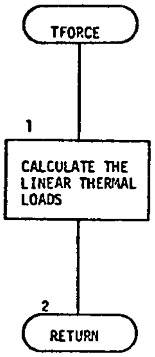

STRESS
1
PROCESS
2
I1.EQ.1
NO
YES
3
WRITE
4
PROCESS
5
PROCESS
6
DO LOOP
REPEAT
DONE
7
PROCESS
8
I1.NE.1
YES
NO
9
WRITE
10
PROCESS
11
WRITE
12
PROCESS
13
DO LOOP
REPEAT
DONE
14
RETURN

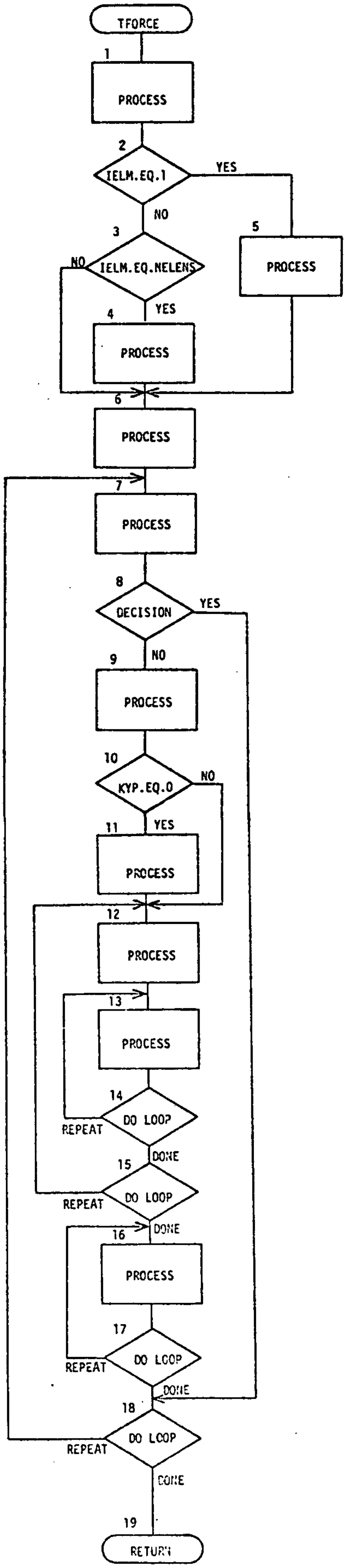
STRESS J-3.119
Detail
1 of 1

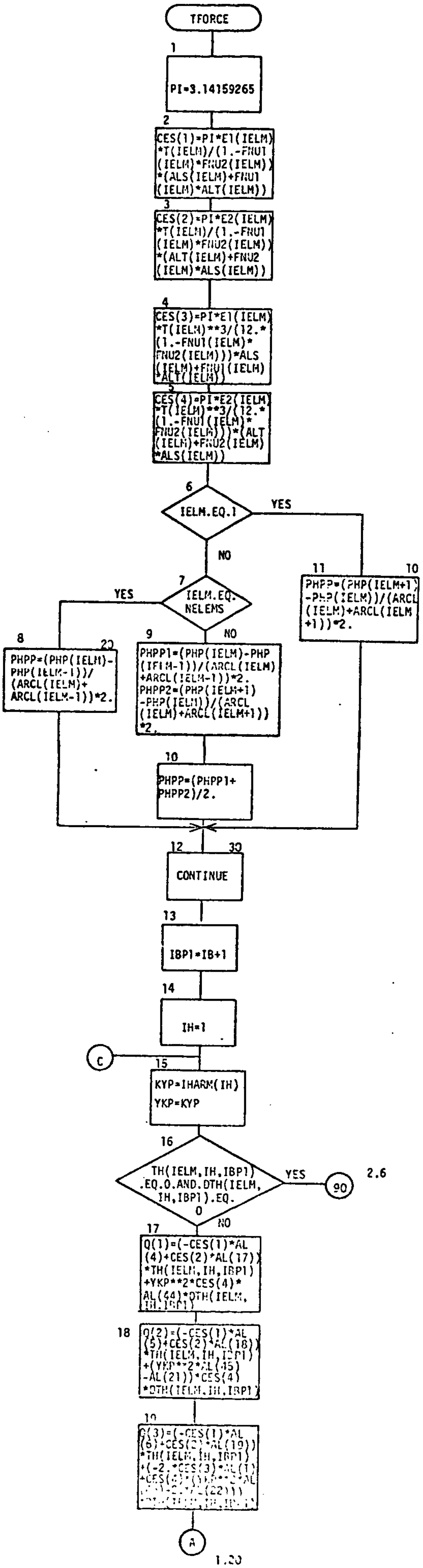


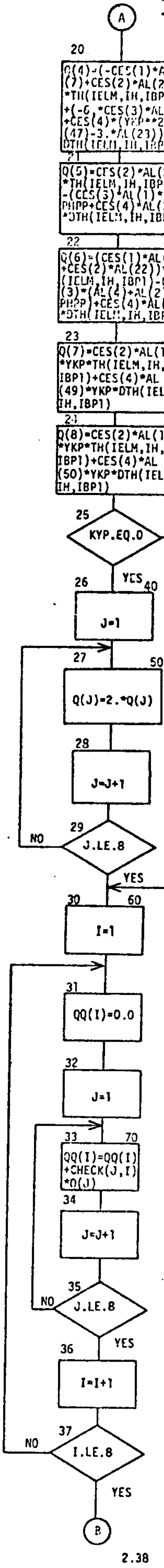
```
                 CE(TFORCE)                                                           DYN16852
                 C                                                                    DYN16854
                 C      DESCRIPTION - TO CALCULATE THE LINEAR THERMAL LOADS ON        DYN16856
                 C             THE SHELL STRUCTURE.                                   DYN16858
                 C                                                                    DYN16860
                 C  INPUT ARGUMENTS.                                                  DYN16862
                 C      ARCL    = MATRIX OF THE ARC LENGTHS OF THE ELEMENTS (S-DIRECTION). DYN16864
                 C      IB      = FORCE ARRAY STEPPING PARAMETER, USED TO MODIFY CURRENT   DYN16866
                 C                BLOCK OF STORAGE FOR FORCE.                         DYN16868
                 C      IELM    = NUMBER OF SHELL ELEMENTS.                           DYN16870
                 C      IHARM   = MATRIX OF HARMONIC NUMBERS FOR WHICH DISPLACEMENTS  DYN16872
                 C                AND/OR STRESSES WILL BE CALCULATED.                 DYN16874
                 C      NELEMS = TOTAL NUMBER OF ELEMENTS USED TO IDEALIZE THE STRUCTURE. DYN16876
                 C      NH      = TOTAL NUMBER OF HARMONICS USED IN THE DYNAMIC ANALYSIS.  DYN16878
                 C      PHP     = DPHI/DS AT THE MIDDLE OF AN ELEMENT.                DYN16880
                 C      TH      = MATRIX WHOSE ELEMENTS ARE THE FOURIER COEFFICIENTS  DYN16882
                 C                OF THE CIRCUMFERENTIAL TEMPERATURE DISTRIBUTION.    DYN16884
                 C                                                                    DYN16886
                 C  OUTPUT ARGUMENTS.                                                 DYN16888
                 C      FORCE   = MATRIX OF GENERALIZED FORCES DUE TO EXTERNAL LOADS AND   DYN16890
                 C                TEMPERATURES.                                       DYN16892
                 C      Q         THERMAL COEFFICIENTS USED IN CALCULATING GENERALIZED     DYN16894
                 C                LINEAR LOADS DUE TO THERMAL EFFECTS.                DYN16896
                 C      QQ      = GENERALIZED LINEAR LOADS DUE TO THERMAL EFFECTS.    DYN16898
                 C                                                                    DYN16900
                 C  EXTERNALS.                                                        DYN16902
                 C      CALLED BY                                                     DYN16904
                 C                INPUT                                               DYN16906
                 C                                                                    DYN16908
 0001                   SUBROUTINE TFORCE (IELM,IB)                                   DYN16910
 0002                   IMPLICIT REAL*8 (A-H,O-Z)                                     DYN16912
 0003                   COMMON /GEOM/ FNU1(50),FNU2(50),E1(50),E2(50),G(50),T(50),    DYN16914
                      1          SINE(51),COSINE(51),SINM(50),COSM(50),R(50),PH(50),  DYN16916
                      1          PHP(50),ARCL(50)                                     DYN16918
 0004                   COMMON /THER/ TH(50,5,2),DTH(50,5,2),ALS(50),ALT(50)          DYN16920
 0005                   COMMON /HARM/ NHP,IHARM(5)                                    DYN16922
 0006                   COMMON /CHALS/ AL(167),CHECK(6,8)                             DYN16924
 0007                   COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS,  DYN16928
                      1          DT2,NPRNTL,NPRNTF,IDELF,IDCDE                        DYN16930
 0008                   COMMON /QS/ QN(1020),QN1(1020),FORCE(2040),QP(1020),QP1(1020),    DYN16940
                      1          QN2(1020)                                            DYN16950
 0009                   COMMON /QUES/ Q(8),QQ(8)                                      DYN16960
 0010                   DIMENSION CES(4)                                              DYN16970
                 C1     LINEAR THERMAL LOADS                                          DYN16972
 0011                   PI=3.14159265                                                 DYN17010
 0012                   CES(1)=PI*E1(IELM)*T(IELM)/(1.-FNU1(IELM)*FNU2(IELM))*(ALS(IELM)+ DYN17020
                      1          FNU1(IELM)*ALT(IELM))                                DYN17030
 0013                   CES(2)=PI*E2(IELM)*T(IELM)/(1.-FNU1(IELM)*FNU2(IELM))*(ALT(IELM)+ DYN17040
                 1          FNU2(IELM)*ALS(IELM))                                DYN17050
 0014             CES(3)=PI*E1(IELM)*T(IELM)**3/(12.*(1.-FNU1(IELM)*FNU2(IELM)))*   DYN17060
                 1          (ALS(IELM)+FNU1(IELM)*ALT(IELM))                     DYN17070
 0015             CES(4)=PI*E2(IELM)*T(IELM)**3/(12.*(1.-FNU1(IELM)*FNU2(IELM)))*   DYN17080
                 1          (ALT(IELM)+FNU2(IELM)*ALS(IELM))                     DYN17090
             C                                                                  DYN17100
             C      CALCULATE PHPP(IELM)                                        DYN17110
             C                                                                  DYN17120
 0016              IF (IELM.EQ.1) GO TO 10                                      DYN17130
 0017              IF (IELM.EQ.NELEMS) GO TO 20                                 DYN17140
 0018              PHPP1=(PHP(IELM)-PHP(IELM-1))/(ARCL(IELM)+ARCL(IELM-1))*2.   DYN17150
 0019              PHPP2=(PHP(IELM+1)-PHP(IELM))/(ARCL(IELM)+ARCL(IELM+1))*2.   DYN17160
 0020              PHPP=(PHPP1+PHPP2)/2.                                        DYN17170
 0021              GO TO 30                                                     DYN17180
 0022           10 PHPP=(PHP(IELM+1)-PHP(IELM))/(ARCL(IELM)+ARCL(IELM+1))*2.    DYN17190
 0023              GO TO 30                                                     DYN17200
 0024           20 PHPP=(PHP(IELM)-PHP(IELM-1))/(ARCL(IELM)+ARCL(IELM-1))*2.    DYN17210
 0025           30 CONTINUE                                                     DYN17220
 0026              IBP1=IB+1                                                    DYN17230
             C                                                                  DYN17238
 0027              DO 90 IH=1,NH                                                DYN17240
 0028                 KYP=IHARM(IH)                                             DYN17250
 0029                 YKP=KYP                                                   DYN17260
 0030                 IF (TH(IELM,IH,IBP1).EQ.0.AND.DTH(IELM,IH,IBP1).EQ.0) GO TO 90 DYN17270
 0031                 Q(1)=(-CES(1)*AL(4)+CES(2)*AL(17))*TH(IELM,IH,IBP1)+YKP**2*    DYN17280
                 1          CES(4)*AL(44)*DTH(IELM,IH,IBP1)                      DYN17290
 0032                 Q(2)=(-CES(1)*AL(5)+CES(2)*AL(18))*TH(IELM,IH,IBP1)+(YKP**2*   DYN17300
                 1          AL(45)-AL(21))*CES(4)*DTH(IELM,IH,IBP1)              DYN17310
 0033                 Q(3)=(-CES(1)*AL(6)+CES(2)*AL(19))*TH(IELM,IH,IBP1)+(-2.*      DYN17320
                 1          CES(3)*AL(1)+CES(4)*(YKP**2*AL(46)-2.*AL(22)))*      DYN17330
                 1          DTH(IELM,IH,IBP1)                                    DYN17331
 0034                 Q(4)=(-CES(1)*AL(7)+CES(2)*AL(20))*TH(IELM,IH,IBP1)+(-6.*      DYN17340
                 1          CES(3)*AL(2)+CES(4)*(YKP**2*AL(47)-3.*AL(23)))*      DYN17350
                 1          DTH(IELM,IH,IBP1)                                    DYN17351
 0035                 Q(5)=CES(2)*AL(21)*TH(IELM,IH,IBP1)-(CES(3)*AL(1)*PHPP+CES(4)* DYN17360
                 1          AL(37))*DTH(IELM,IH,IBP1)                            DYN17370
 0036                 Q(6)=(CES(1)*AL(1)+CES(2)*AL(22))*TH(IELM,IH,IBP1)-(CES(3)*    DYN17380
                 1          (AL(4)+AL(2)*PHPP)+CES(4)*AL(38))*DTH(IELM,IH,IBP1)  DYN17390
 0037                 Q(7)=CES(2)*AL(15)*YKP*TH(IELM,IH,IBP1)+CES(4)*AL(49)*YKP*     DYN17400
                 1          DTH(IELM,IH,IBP1)                                    DYN17410
 0038                 Q(8)=CES(2)*AL(16)*YKP*TH(IELM,IH,IBP1)+CES(4)*AL(50)*YKP*     DYN17420
                 1          DTH(IELM,IH,IBP1)                                    DYN17430
 0039                 IF (KYP.EQ.0) GO TO 40                                    DYN17440
 0040                 GO TO 60                                                  DYN17450
             C                                                                  DYN17458
 0041           40    DO 50 J=1,8                                               DYN17460
 0042                    Q(J)=2.*Q(J)                                           DYN17470
 0043           50    CONTINUE                                                  DYN17472
```

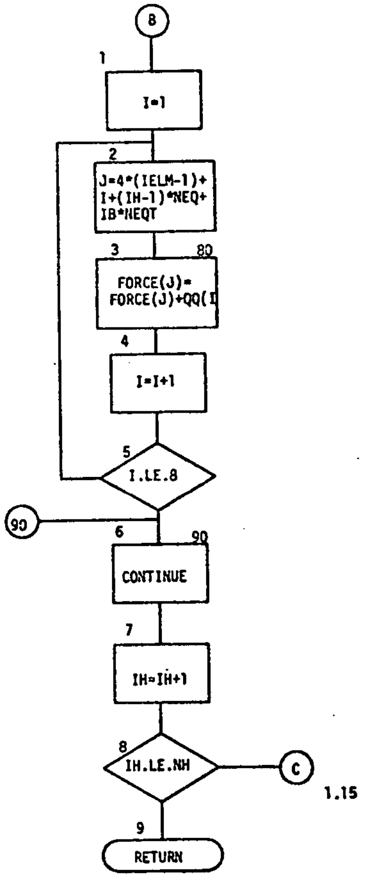
```
              C                                                                 DYN17475
              C                                                                 DYN17478
 0044            60    DO 70 I=1,8                                              DYN17480
 0045                     QQ(I)=0.0                                             DYN17490
              C                                                                 DYN17498
 0046                     DO 70 J=1,8                                           DYN17500
 0047                        QQ(I)=QQ(I)+CHECK(J,I)*Q(J)                        DYN17510
 0048            70    CONTINUE                                                 DYN17512
              C                                                                 DYN17515
              C                                                                 DYN17518
 0049                  DO 80 I=1,8                                              DYN17520
 0050                     J=4*(IELM-1)+I+(IH-1)*NEQ+IB*NEQT                     DYN17530
 0051                     FORCE(J)=FORCE(J)+QQ(I)                               DYN17540
 0052            80    CONTINUE                                                 DYN17542
              C                                                                 DYN17545
 0053            90 CONTINUE                                                    DYN17550
              C                                                                 DYN17553
 0054               RETURN                                                      DYN17560
 0055               END                                                         DYN17570
```


TFORCE
1
CALCULATE THE LINEAR THERMAL LOADS
2
RETURN


TFORCE
1
PROCESS
2
IELM.EQ.1
YES
NO
3
IELM.EQ.NELENS
NO
YES
5
PROCESS
4
PROCESS
6
PROCESS
7
PROCESS
8
DECISION
YES
NO
9
PROCESS
10
KYP.EQ.0
NO
YES
11
PROCESS
12
PROCESS
13
PROCESS
14
DO LOOP
REPEAT
DONE
15
DO LOOP
REPEAT
DONE
16
PROCESS
17
DO LOOP
REPEAT
DONE
18
DO LOOP
REPEAT
DONE
19
RETURN

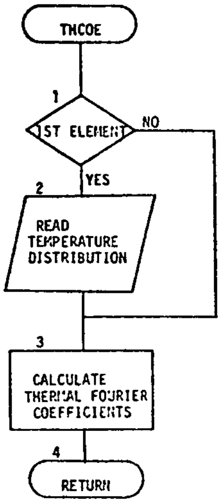

TFORCE
1
PI=3.14159265
2
CES(1)=PI*E1(IELM)*T(IELM)/(1.-FNU1(IELM)*FNU2(IELM))*(ALS(IELM)+FNU1(IELM)*ALT(IELM))
3
CES(2)=PI*E2(IELM)*T(IELM)/(1.-FNU1(IELM)*FNU2(IELM))*(ALT(IELM)+FNU2(IELM)*ALS(IELM))
4
CES(3)=PI*E1(IELM)*T(IELM)**3/(12.*(1.-FNU1(IELM)*FNU2(IELM)))*ALS(IELM)+FNU1(IELM)*ALT(IELM))
5
CES(4)=PI*E2(IELM)*T(IELM)**3/(12.*(1.-FNU1(IELM)*FNU2(IELM)))*(ALT(IELM)+FNU2(IELM)*ALS(IELM))
6
IELM.EQ.1
YES
NO
7
IELM.EQ.NELEMS
YES
NO
11
10
PHPP=(PHP(IELM+1)-PHP(IELM))/(ARCL(IELM)+ARCL(IELM+1))*2.
8
20
PHPP=(PHP(IELM)-PHP(IELM-1))/(ARCL(IELM)+ARCL(IELM-1))*2.
9
PHPP1=(PHP(IELM)-PHP(IELM-1))/(ARCL(IELM)+ARCL(IELM-1))*2.
PHPP2=(PHP(IELM+1)-PHP(IELM))/(ARCL(IELM)+ARCL(IELM+1))*2.
10
PHPP=(PHPP1+PHPP2)/2.
12
30
CONTINUE
13
IBP1=IB+1
14
IH=1
C
15
KYP=IHARM(IH)
YKP=KYP
16
TH(IELM,IH,IBP1).EQ.0.AND.DTH(IELM,IH,IBP1).EQ.0
YES
90
2.6
NO
17
Q(1)=(-CES(1)*AL(4)+CES(2)*AL(17))*TH(IELM,IH,IBP1)+YKP**2*CES(4)*AL(44)*DTH(IELM,IH,IBP1)
18
Q(2)=(-CES(1)*AL(5)+CES(2)*AL(18))*TH(IELM,IH,IBP1)+(YKP**2*AL(45)-AL(21))*CES(4)*DTH(IELM,IH,IBP1)
19
Q(3)=(-CES(1)*AL(6)+CES(2)*AL(19))*TH(IELM,IH,IBP1)+(-2.*CES(3)*AL(1)+CES(4)*(YKP**2*AL[illegible]-2.*AL(22)))*DTH(IELM,IH,IBP1)
A
1.20


A
20
Q(4)=(-CES(1)*AL(7)+CES(2)*AL(20))*TH(IELM,IH,IBP1)+(-6.*CES(3)*AL(2)+CES(4)*(YKP**2*AL(47)-3.*AL(23)))*DTH(IELM,IH,IBP1)
21
Q(5)=CES(2)*AL(21)*TH(IELM,IH,IBP1)-(CES(3)*AL(1)*PHPP+CES(4)*AL(37)*DTH(IELM,IH,IBP1)
22
Q(6)=(CES(1)*AL(1)+CES(2)*AL(22))*TH(IELM,IH,IBP1)-CES(3)*(AL(4)+AL(2)*PHPP)+CES(4)*AL(38)*DTH(IELM,IH,IBP1)
23
Q(7)=CES(2)*AL(15)*YKP*TH(IELM,IH,IBP1)+CES(4)*AL(49)*YKP*DTH(IELM,IH,IBP1)
24
Q(8)=CES(2)*AL(16)*YKP*TH(IELM,IH,IBP1)+CES(4)*AL(50)*YKP*DTH(IELM,IH,IBP1)
25
KYP.EQ.0
NO
YES
26
40
J=1
27
50
Q(J)=2.*Q(J)
28
J=J+1
29
J.LE.8
NO
YES
30
60
I=1
31
QQ(I)=0.0
32
J=1
33
70
QQ(I)=QQ(I)+CHECK(J,I)*Q(J)
34
J=J+1
35
J.LE.8
NO
YES
36
I=I+1
37
I.LE.8
NO
YES
B
2.38

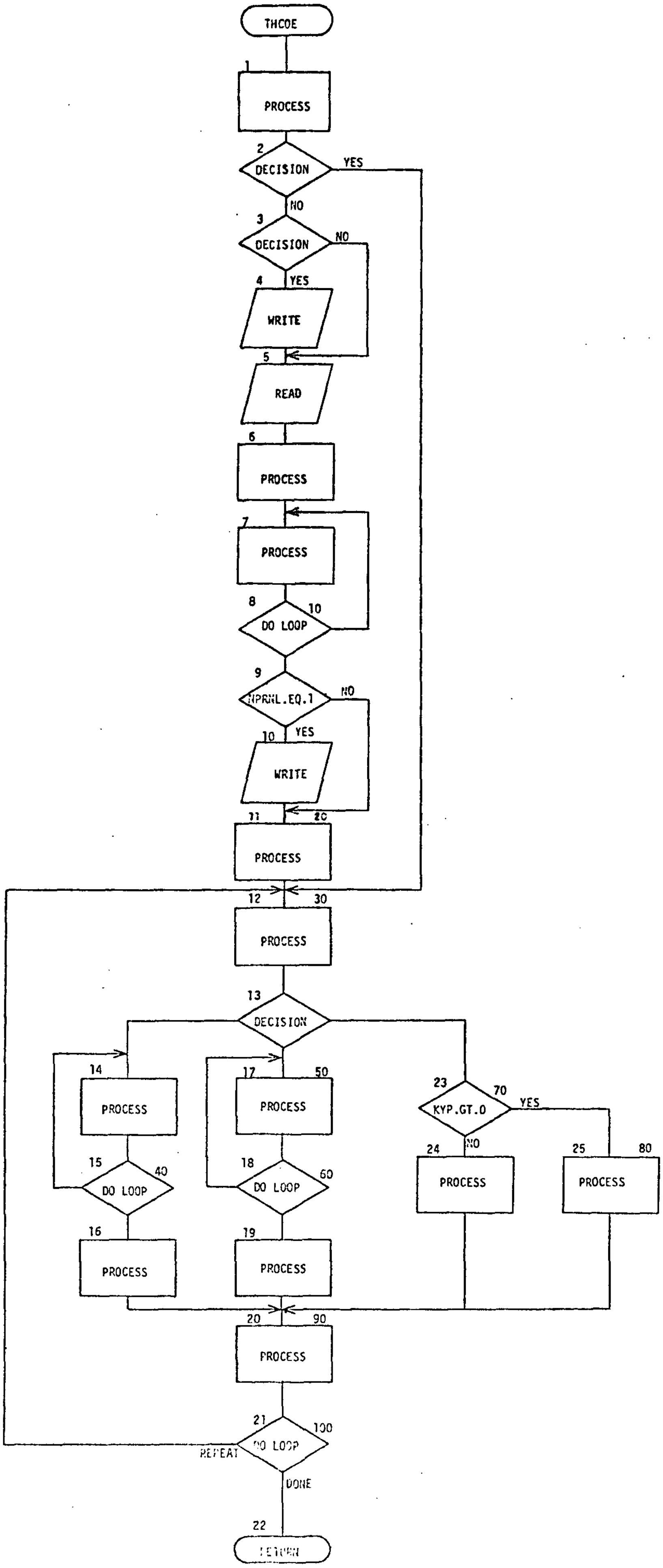

B
1
I=1
2
J=4*(IELM-1)+
I+(IH-1)*NEQ+
IB*NEQT
3
80
FORCE(J)=
FORCE(J)+QQ(I
4
I=I+1
5
I.LE.8
90
6
90
CONTINUE
7
IH=IH+1
8
IH.LE.NH
C
1.15
9
RETURN

```
                CE(THCOE)                                                        DYN16102
                C                                                                DYN16104
                C     DESCRIPTION - TO READ IN THE TEMPERATURE AND TEMPERATURE   DYN16106
                C            GRADIENTS FOR UTILIZATION IN COMPUTING THE THERMAL  DYN16108
                C            FOURIER COEFFICIENTS.                               DYN16110
                C                                                                DYN16112
                C  INPUT ARGUMENTS.                                              DYN16114
                C     IB      = FORCE ARRAY STEPPING PARAMETER, USED TO MODIFY CURRENT  DYN16116
                C               BLOCK OF STORAGE FOR FORCE.                      DYN16118
                C     IELM    = NUMBER OF SHELL ELEMENTS.                        DYN16120
                C     IHARM   = MATRIX OF HARMONIC NUMBERS FOR WHICH DISPLACEMENTS  DYN16122
                C               AND/OR STRESSES WILL BE CALCULATED.              DYN16124
                C     NH      = TOTAL NUMBER OF HARMONICS USED IN THE DYNAMIC ANALYSIS.  DYN16126
                C                                                                DYN16128
                C  OUTPUT ARGUMENTS.                                             DYN16130
                C     DTH     = MATRIX OF FOURIER COEFFICIENTS FOR THE CIRCUMFERENTIAL  DYN16132
                C               TEMPERATURE GRADIENT DISTRIBUTION.               DYN16134
                C     TH      = MATRIX WHOSE ELEMENTS ARE THE FOURIER COEFFICIENTS  DYN16136
                C               OF THE CIRCUMFERENTIAL TEMPERATURE DISTRIBUTION.  DYN16138
                C                                                                DYN16140
                C  EXTERNALS.                                                    DYN16142
                C     CALLED BY                                                  DYN16144
                C               INPUT                                            DYN16146
                C                                                                DYN16148
  0001              SUBROUTINE THCOE (IELM,IB)                                   DYN16150
  0002              IMPLICIT REAL*8 (A-H,O-Z)                                    DYN16152
  0003              COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS,  DYN16154
                   1         DT2,NPRNTL,NPRNTF,IDELF,IDCOE                       DYN16156
  0004              COMMON /FRCE/ P(74),R(74),S(74),THETB(74)                    DYN16158
  0005              COMMON /THER/ TH(50,5,2),DTH(50,5,2),ALS(50),ALT(50)         DYN16160
  0006              COMMON /HARM/ NHP,IHARM(5)                                   DYN16162
  0007              COMMON /TAPES/ NT,ND,NS                                      DYN16170
  0008              IF (IELM.EQ.1) IELM2=0                                       DYN16220
  0009              PI=3.14159265                                                DYN16230
                C1    FIRST ELEMENT//NO(30)                                      DYN16232
  0010              IF (IELM.LE.IELM2.AND.IELM.NE.1) GO TO 30                    DYN16240
  0011              IF (NPRNTL.EQ.1.AND.IELM.EQ.1) WRITE (6,110)                 DYN16250
                C                                                                DYN16260
                C1S(IO) READ TEMPERATURE DISTRIBUTION                            DYN16262
                C                                                                DYN16280
                C      READ INPUT DATA FOR CARD TYPE IX - D - 1                  DYN16290
  0012              READ (ND,120) IELM1,IELM2,NDP,(THETB(I),P(I),R(I),I=1,NDP)   DYN16300
  0013              NDP2=2*NDP+1                                                 DYN16310
                C                                                                DYN16318
  0014              DO 10 IF=1,NDP                                               DYN16320
  0015                 ANG=360.0-THETB(NDP)                                      DYN16330
  0016                 KEY=NDP2-IF                                               DYN16340
  0017                 THETB(KEY)=ANG                                            DYN16350
```

```
 0018                   P(KEY)=P(IF)                                                   DYN16360
 0019                   R(KEY)=R(IF)                                                   DYN16370
 0020             10 CONTINUE                                                          DYN16380
             C                                                                         DYN16383
 0021                IF (NPRNTL.EQ.1) WRITE (6,130) IELM1,IELM2,(P(I),R(I),THETB(I),   DYN16390
                    1          THETB(I+1),I=1,NDP)                                     DYN16400
 0022                ND2=2*NDP                                                         DYN16410
             C                                                                         DYN16418
 0023                DO 20 IDP=1,ND2                                                   DYN16420
 0024                   THETB(IDP)=THETB(IDP)/57.2957795                               DYN16430
 0025             20 CONTINUE                                                          DYN16432
             C                                                                         DYN16435
 0026             30 CONTINUE                                                          DYN16440
             C1      CALCULATE THERMAL FOURIER COEFFICIENTS                            DYN16442
             C                                                                         DYN16448
 0027                DO 100 IH=1,NH                                                    DYN16450
 0028                   KYP=IHARM(IH)                                                  DYN16460
 0029                   YKP=KYP                                                        DYN16470
 0030                   PINT=0.0                                                       DYN16480
 0031                   RINT=0.0                                                       DYN16490
 0032                   IF (NDP.EQ.1) GO TO 70                                         DYN16500
 0033                   IF (KYP.GT.0) GO TO 50                                         DYN16510
             C                                                                         DYN16518
 0034                   DO 40 I=1,NDP                                                  DYN16520
 0035                      PINT=PINT+P(I)*(THETB(I+1)-THETB(I))                        DYN16530
 0036                      RINT=RINT+R(I)*(THETB(I+1)-THETB(I))                        DYN16540
 0037             40    CONTINUE                                                       DYN16542
             C                                                                         DYN16545
 0038                   PINT=PINT/(2.*PI)                                              DYN16550
 0039                   RINT=RINT/(2.*PI)                                              DYN16560
 0040                   GO TO 90                                                       DYN16570
             C                                                                         DYN16578
 0041             50    DO 60 I=1,NDP                                                  DYN16580
 0042                      X1=THETB(I)*YKP                                             DYN16590
 0043                      X2=THETB(I+1)*YKP                                           DYN16600
 0044                      PINT=PINT+P(I)*(DSIN(X2)-DSIN(X1))/YKP                      DYN16610
 0045                      RINT=RINT+R(I)*(DSIN(X2)-DSIN(X1))/YKP                      DYN16620
 0046             60    CONTINUE                                                       DYN16622
             C                                                                         DYN16625
 0047                   PINT=PINT/PI                                                   DYN16630
 0048                   RINT=RINT/PI                                                   DYN16640
 0049                   GO TO 90                                                       DYN16650
 0050             70    IF (KYP.GT.0) GO TO 80                                         DYN16660
 0051                   PINT=P(1)                                                      DYN16670
 0052                   RINT=R(1)                                                      DYN16680
 0053                   GO TO 90                                                       DYN16690
 0054             80    PINT=0.0                                                       DYN16700
 0055                   RINT=0.0                                                       DYN16710
 0056          90    IBP1=IB+1                                                      DYN16720
 0057                TH(IELM,IH,IBP1)=PINT                                          DYN16730
 0058                DTH(IELM,IH,IBP1)=RINT                                         DYN16740
 0059         100 CONTINUE                                                          DYN16750
            C                                                                       DYN16753
 0060             RETURN                                                            DYN16760
            C                                                                       DYN16770
 0061         110 FORMAT (1H1,31X,47HTEMPERATURES AND THERMAL GRADIENTS ON,         DYN16780
                1          10H STRUCTURE///                                         DYN16782
                1          27X,11HTEMPERATURE,10X,16HTHERMAL GRADIENT,10X,          DYN16790
                2          29HFROM THETA TO THETA (DEGREES)//)                      DYN16800
 0062         120 FORMAT (3I5/(3F10.0))                                             DYN16810
 0063         130 FORMAT (/,60X,11HELEMENT NO.,I3,1H-,I2,//                         DYN16820
                1          (28X,F9.3,15X,F10.3,16X,F7.2,2X,F7.2))                   DYN16830
 0064             END                                                               DYN16840
```

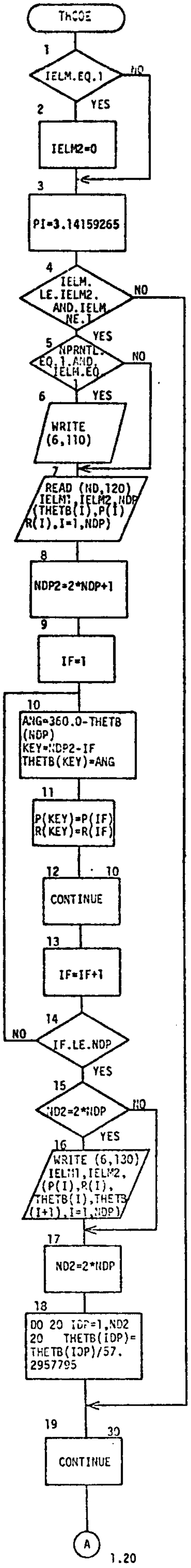

THCOE
1
1ST ELEMENT
NO
YES
2
READ TEMPERATURE DISTRIBUTION
3
CALCULATE THERMAL FOURIER COEFFICIENTS
4
RETURN

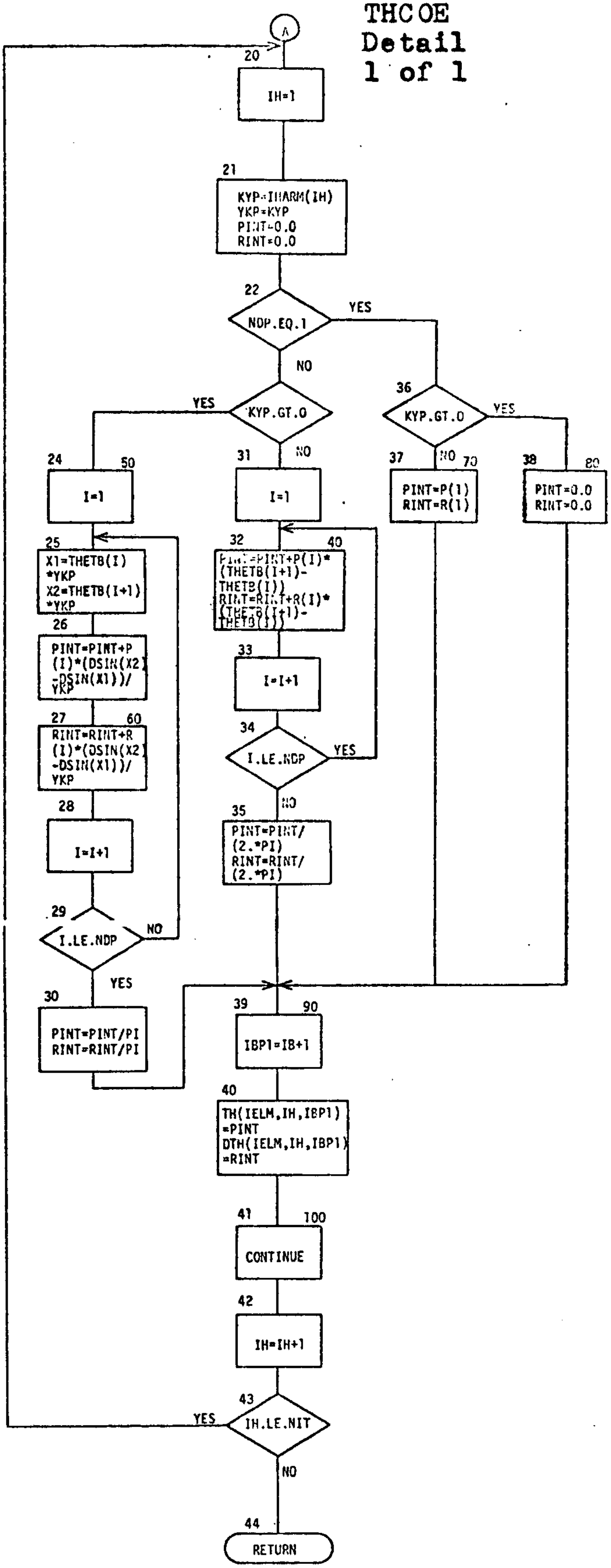
THCOEJ-3.131
Detail Suppressed
1 of 1



J-3.132

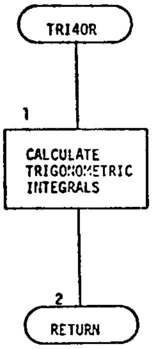
THCOE
Detail
1 of 1



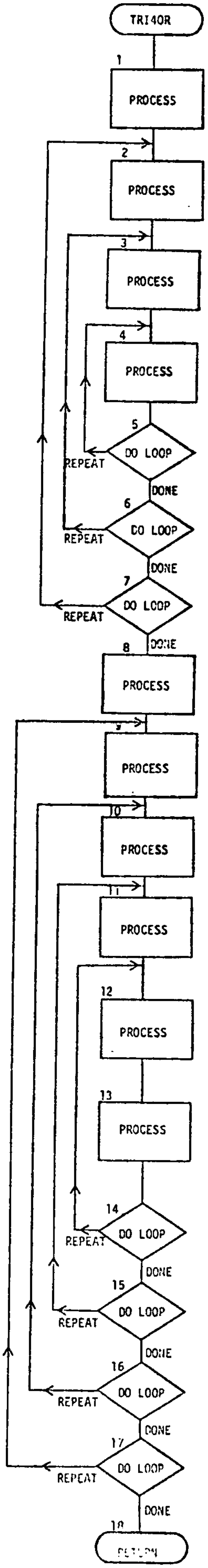


```
                CE(TRI4OR)                                                               DYN17582
                C                                                                        DYN17584
                C     DESCRIPTION - TO CALCULATE THE VARIOUS TRIGONOMETRIC               DYN17586
                C             INTEGRALS REQUIRED IN THE CALCULATIONS OF THE              DYN17588
                C             GENERALIZED NONLINEAR LOADS.                               DYN17590
                C                                                                        DYN17592
                C  INPUT ARGUMENTS.                                                      DYN17594
                C     IHARM   = MATRIX OF HARMONIC NUMBERS FOR WHICH DISPLACEMENTS       DYN17596
                C               AND/OR STRESSES WILL BE CALCULATED.                      DYN17598
                C     NH      = TOTAL NUMBER OF HARMONICS USED IN THE DYNAMIC ANALYSIS.  DYN17600
                C                                                                        DYN17602
                C  OUTPUT ARGUMENTS.                                                     DYN17604
                C     CCC     = MATRIX CONTAINING INTEGRALS FROM 0 TO 2*PI OF            DYN17606
                C               COS(I*THETA) * COS(J*THETA) * COS(K*THETA) * DTHETA.     DYN17608
                C     CCCC    = MATRIX CONTAINING INTEGRALS FROM 0 TO 2*PI OF            DYN17610
                C               COS(I*THETA) * COS(J*THETA) * COS(K*THETA) *             DYN17612
                C               COS(L*THETA) * DTHETA.                                   DYN17614
                C     CSS     = MATRIX CONTAINING INTEGRALS FROM 0 TO 2*PI OF            DYN17616
                C               COS(I*THETA) * SIN(J*THETA) * SIN(K*THETA) * DTHETA.     DYN17618
                C     SSC     = MATRIX CONTAINING INTEGRALS FROM 0 TO 2*PI OF            DYN17620
                C               SIN(I*THETA) * SIN(J*THETA) * COS(K*THETA) * DTHETA.     DYN17622
                C     SSCC    = MATRIX CONTAINING INTEGRALS FROM 0 TO 2*PI OF            DYN17624
                C               SIN(I*THETA) * SIN(J*THETA) * COS(K*THETA) *             DYN17626
                C               COS(L*THETA) * DTHETA.                                   DYN17628
                C     SSSS    = MATRIX CONTAINING INTEGRALS FROM 0 TO 2*PI OF            DYN17630
                C               SIN(I*THETA) * SIN(J*THETA) * SIN(K*THETA) *             DYN17632
                C               SIN(L*THETA) * DTHETA.                                   DYN17634
                C                                                                        DYN17636
                C  EXTERNALS.                                                            DYN17638
                C     CALLED BY                                                          DYN17640
                C               INPUT                                                    DYN17642
                C                                                                        DYN17644
 0001                 SUBROUTINE TRI4OR                                                  DYN17646
 0002                 IMPLICIT REAL*8 (A-H,O-Z)                                          DYN17648
 0003                 COMMON /CS/ CCC(125),SSC(125),CSS(125)                             DYN17650
 0004                 COMMON /CS4/ CCCC(625),SSSS(625),SSCC(625),SCCS(625)               DYN17652
 0005                 COMMON /CONST/ NH,NELEMS,NNODES,NSIZE,NPRNTQ,NEQ,NEQT,N,NN,NHNS,   DYN17654
                     1         DT2,NPRNTL,NPRNTF,IDELF,IDCOE                             DYN17656
 0006                 COMMON /HARM/ NHP,IHARM(5)                                         DYN17658
                C1    CALCULATE TRIGONOMETRIC INTEGRALS                                  DYN17660
 0007                 PIO2=1.570796                                                      DYN17690
 0008                 ITH=0                                                              DYN17700
                C                                                                        DYN17708
 0009                 DO 10 M=1,NH                                                       DYN17710
 0010                    K=IHARM(M)                                                      DYN17720
                C                                                                        DYN17728
 0011                    DO 10 I=1,NH                                                    DYN17730
 0012                       II=IHARM(I)                                                  DYN17740
```

```
                C                                                                         DYN17748
 0013                   DO 10 J=1,NH                                                      DYN17750
 0014                      JJ=IHARM(J)                                                    DYN17760
 0015                      IPJ=II+JJ                                                      DYN17770
 0016                      IMJ=IABS(II-JJ)                                                DYN17780
 0017                      IF (IPJ.NE.K.AND.IMJ.NE.K) GO TO 10                            DYN17790
 0018                      ITH=ITH+1                                                      DYN17800
 0019                      IPM=II+K                                                       DYN17810
 0020                      IMM=IABS(II-K)                                                 DYN17820
 0021                      FONE=0.0                                                       DYN17830
 0022                      FTWO=0.0                                                       DYN17840
 0023                      FTHREE=0.0                                                     DYN17850
 0024                      FFOUR=0.0                                                      DYN17860
 0025                      IF (IPJ.EQ.K) FONE=1.0                                         DYN17870
 0026                      IF (IPJ.EQ.K.AND.K.EQ.0) FONE=2.0                              DYN17880
 0027                      IF (IMJ.EQ.K) FTWO=1.0                                         DYN17890
 0028                      IF (IMJ.EQ.K.AND.K.EQ.0) FTWO=2.0                              DYN17900
 0029                      IF (IPM.EQ.JJ) FTHREE=1.0                                      DYN17910
 0030                      IF (IPM.EQ.JJ.AND.JJ.EQ.0) FTHREE=2.0                          DYN17920
 0031                      IF (IMM.EQ.JJ) FFOUR=1.0                                       DYN17930
 0032                      IF (IMM.EQ.JJ.AND.JJ.EQ.0) FFOUR=2.0                           DYN17940
 0033                      CCC(ITH)=PIO2*(FONE+FTWO)                                      DYN17950
 0034                      SSC(ITH)=PIO2*(-FONE+FTWO)                                     DYN17960
 0035                      CSS(ITH)=PIO2*(-FTHREE+FFOUR)                                  DYN17970
 0036              10 CONTINUE                                                            DYN17980
                C                                                                         DYN17983
 0037                PIO4=0.785398                                                        DYN17990
 0038                IFO=0.0                                                              DYN18000
                C                                                                         DYN18008
 0039                DO 20 L=1,NH                                                         DYN18010
 0040                   LL=IHARM(L)                                                       DYN18020
                C                                                                         DYN18028
 0041                   DO 20 I=1,NH                                                      DYN18030
 0042                      II=IHARM(I)                                                    DYN18040
                C                                                                         DYN18048
 0043                      DO 20 J=1,NH                                                   DYN18050
 0044                         JJ=IHARM(J)                                                 DYN18060
 0045                         IPJ=II+JJ                                                   DYN18070
 0046                         IMJ=IABS(II-JJ)                                             DYN18080
                C                                                                         DYN18088
 0047                         DO 20 K=1,NH                                                DYN18090
 0048                            KK=IHARM(K)                                              DYN18100
 0049                            KPL=KK+LL                                                DYN18110
 0050                            KML=IABS(KK-LL)                                          DYN18120
 0051                            IF (IPJ.NE.KPL.AND.IPJ.NE.KML.AND.IMJ.                   DYN18130
                   1                        NE.KPL.AND.IMJ.NE.KML) GO TO 20               DYN18140
 0052                            IFO=IFO+1                                                DYN18150
 0053                            FONE=0.0                                                 DYN18160
 0054                       FTWO=0.0                                                DYN18170
 0055                       FTHREE=0.0                                              DYN18180
 0056                       FFOUR=0.0                                               DYN18190
 0057                       FFIVE=0.0                                               DYN18200
 0058                       FSIX=0.0                                                DYN18210
 0059                       FSEVEN=0.0                                              DYN18220
 0060                       FEIGHT=0.0                                              DYN18230
 0061                       IF (IPJ.EQ.KPL) FONE=1.0                                DYN18240
 0062                       IF (IPJ.EQ.KPL.AND.KPL.EQ.0) FONE=2.0                   DYN18250
 0063                       IF (IPJ.EQ.KML) FTWO=1.0                                DYN18260
 0064                       IF (IPJ.EQ.KML.AND.KML.EQ.0) FTWO=2.0                   DYN18270
 0065                       IF (IMJ.EQ.KPL) FTHREE=1.0                              DYN18280
 0066                       IF (IMJ.EQ.KPL.AND.KPL.EQ.0) FTHREE=2.0                 DYN18290
 0067                       IF (IMJ.EQ.KML) FFOUR=1.0                               DYN18300
 0068                       IF (IMJ.EQ.KML.AND.KML.EQ.0) FFOUR=2.0                  DYN18310
 0069                       KPJ=KK+JJ                                               DYN18320
 0070                       KMJ=IABS(KK-JJ)                                         DYN18330
 0071                       IPL=II+LL                                               DYN18340
 0072                       IML=IABS(II-LL)                                         DYN18350
 0073                       IF (IML.EQ.KPJ) FFIVE=1.0                               DYN18360
 0074                       IF (IML.EQ.KMJ) FSIX=1.0                                DYN18370
 0075                       IF (IPL.EQ.KPJ) FSEVEN=1.0                              DYN18380
 0076                       IF (IPL.EQ.KMJ) FEIGHT=1.0                              DYN18390
 0077                       IF (IML.EQ.KPJ.AND.KPJ.EQ.0) FFIVE=2.0                  DYN18400
 0078                       IF (IML.EQ.KMJ.AND.KMJ.EQ.0) FSIX=2.0                   DYN18410
 0079                       IF (IPL.EQ.KPJ.AND.KPJ.EQ.0) FSEVEN=2.0                 DYN18420
 0080                       IF (IPL.EQ.KMJ.AND.KMJ.EQ.0) FEIGHT=2.0                 DYN18430
 0081                       CCCC(IFO)=PIO4*(FONE+FTWO+FTHREE+FFOUR)                 DYN18440
 0082                       SSSS(IFO)=PIO4*(FONE-FTWO-FTHREE+FFOUR)                 DYN18450
 0083                       SSCC(IFO)=PIO4*(-FONE-FTWO+FTHREE+FFOUR)                DYN18460
 0084                       SCCS(IFO)=PIO4*(FFIVE+FSIX-FSEVEN-FEIGHT)               DYN18470
 0085              20 CONTINUE                                                      DYN18480
               C                                                                    DYN18483
 0086                 RETURN                                                        DYN18490
 0087                 END                                                           DYN18500
```

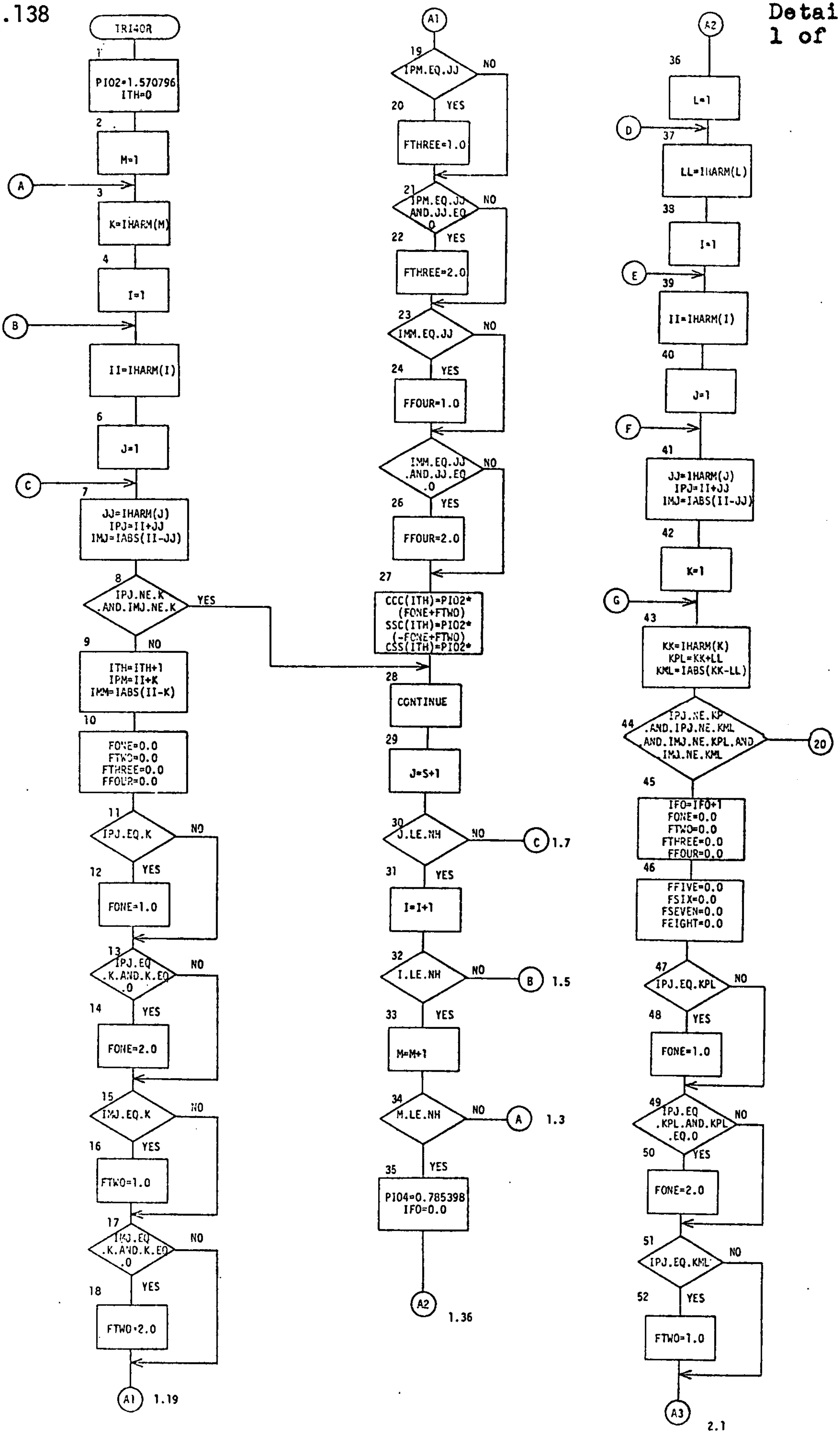

TRI40R
1
CALCULATE
TRIGONOMETRIC
INTEGRALS
2
RETURN

TRI4OR J-3.137
Detail Suppressed
1 of 1

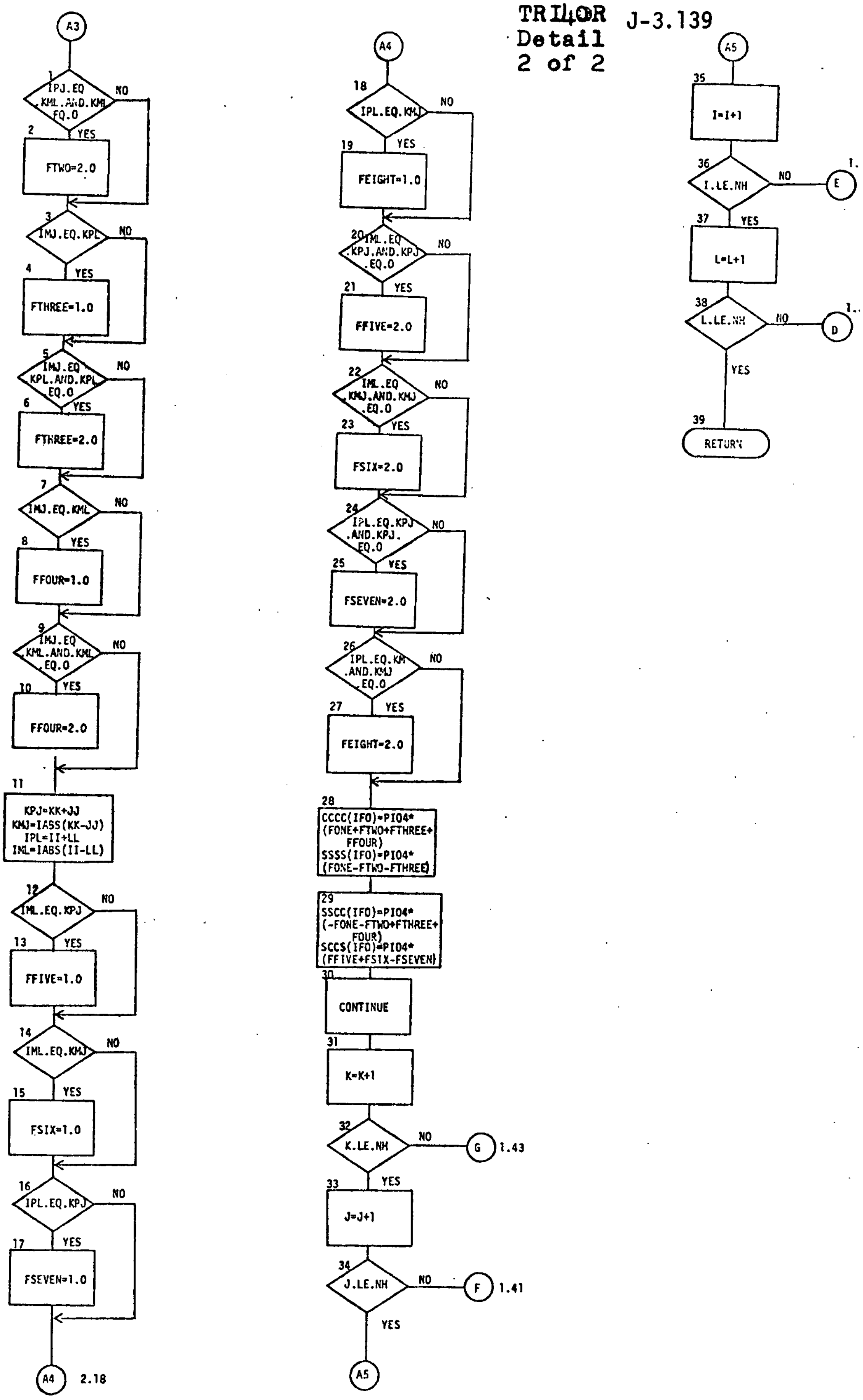


J-3.138

TRI4OR
Detail
1 of 2



TRI4OR J-3.139
Detail
2 of 2



VARIABLE CROSS REFERENCE

The variable cross reference listing gives an alphabetical listing of all variables from each routine along with the type of each variable, the dimension value for variable arrays, the statement number referencing the variable, and a corresponding letter value for each statement reference. The letter values for each reference are one of the following:

U - this indicates that the variable is simply being used in this particular statement reference. No values are being assigned to the variable in this particular reference.

D - a reference with a corresponding letter D indicates that the variable is defined in this statement reference. Examples of statements inwhich variables could be defined are COMMON, DIMENSION, all type statements, and subroutine definitions.

S - this indicates that the variable is set or given a value as in an assignment statement, input statement, etc...

P - the letter P stands for parameter and indicates that the variable appears in the argument list of a subroutine CALL statement.

```
                    INITIAL
VARIABLE TYPE       VALUE       DIMENSION   WHERE/HOW USED

A         REAL*8                   204      10850,U  10870,D  10950,S  11040,S  11040,S  11050,U  11050,S  11060,U  11060,S  11070,S
                                            11070,U  11180,U  11180,S  11190,U  11190,S  11210,S  11210,U  11310,D  11410,S  11460,S
                                            11460,U  11460,U  11470,U  11470,U  11470,S  11470,U  11470,U  11480,S  11480,U  11480,U
                                            11480,U  11490,U  11490,U  11490,S  11490,U  11500,S  11500,U  11500,U  11510,U  11510,S
                                            11510,U  11520,U  11520,S  11520,U  11520,U  11520,U  11520,U  11520,U  11520,U  11530,U
                                            11530,U  11530,U  11530,U  11530,U  11530,S  11540,U  11540,S  11540,U  11550,S  11550,U
                                            11550,U  11560,U  11560,S  11560,U  11570,S  11570,U  11570,U  11570,U  11570,U  11570,U
                                            11570,U  11570,U  11570,U  11570,U  11570,U  11580,U  11590,U  11590,U  11600,U  11600,U
                                            11640,U  11650,U  11660,U  11670,U  11680,U  11690,U  11700,U  11720,U  11730,U  11740,U
                                            11750,U  11760,U  11770,U  11780,U  11790,U  11800,U  11810,U  11820,U  11830,U  11840,U
                                            11850,U  11860,U  11870,U  11880,U  11890,U  11900,U  11910,U  11920,U  11930,U  11940,U
                                            11950,U  11960,U  11970,U  11980,U  11990,U  12000,U  12010,U  12020,U  12030,U  12040,U
                                            12050,U  12060,U  12070,U  12600,S  12610,S  12620,S  12630,S  12640,S  12650,S  12690,S
                                            12690,S  12700,S  12710,S  12720,S  12730,S  12740,S  12750,S  12760,S  12770,S  12780,S
                                            12790,S  12800,S  12810,S  12820,S  12830,S  12840,S  12850,S  12860,S  12870,S  12880,S
                                            12890,S  12900,S  12910,S  12920,S  12930,S  12940,S  12950,S  12960,S  12970,S  12980,S
                                            12990,S  13000,S  13010,S  13020,S  13030,S  13060,U  13070,U  13070,U  13080,U  13080,U
                                            13080,U  13120,U  13120,U  13120,U  13120,U  13130,U  13130,U  13130,U  13130,U  13140,U
                                            13150,U  13150,U  13150,U  13160,U  13160,U  13160,U  13170,U  13170,U  13170,U  13180,U
                                            13180,U  13180,U  13180,U  13240,U  13250,U  13250,U  13260,U  13260,U  13260,U  13270,U
                                            13270,U  13270,U  13270,U  13320,U  13320,U  13320,U  13320,U  13330,U  13340,U  13340,U
                                            13340,U  13340,U  13350,U  13350,U  13360,U  13360,U  13360,U  13360,U  13370,U  13370,U
                                            13370,U  13380,U  13380,U  13380,U  13380,U  13390,U  13390,U  13390,U  13390,U  13410,U
                                            13410,U  13410,U  13410,U  13420,U  13430,U  13430,U  13430,U  13430,U  13440,U  13440,U
                                            13450,U  13450,U  13450,U  13450,U  13460,U  13460,U  13460,U  13470,U  13470,U  13470,U
                                            13470,U  13480,U  13480,U  13480,U  13480,U  13550,U

AAV       REAL*8                            14590,S  14600,U  14620,U

AL        REAL*8                   167        930,D   2650,S   2660,U   4310,S   4490,S  14900,D  15640,U  15650,U  15660,U  15670,U
                                            15680,U  15690,U  15700,U  15710,U  15790,U  15800,U  15810,U  15820,U  15830,U  15840,U
                                            15850,U  15860,U  16910,D  17280,U  17280,U  17290,U  17300,U  17300,U  17300,U  17310,U
                                            17320,U  17320,U  17320,U  17330,U  17330,U  17340,U  17340,U  17340,U  17350,U  17350,U
                                            17360,U  17360,U  17360,U  17380,U  17380,U  17380,U  17390,U  17390,U  17400,U  17400,U
                                            17420,U  17420,U

ALPHK     REAL*8                             4320,P  14870,U

ALS       REAL*8                    50       1080,D   2890,S   2940,S   3020,U   7170,D   8820,U   8830,U  13710,D  14090,U  14150,U
                                            16150,D  16890,D  17020,U  17050,U  17060,U  17090,U

ALSI1     REAL*8                             2870,S   2890,U

ALT       REAL*8                    50       1080,D   2900,S   2950,S   3020,U   7170,D   8820,U   8830,U  13710,D  14100,U  14180,U
                                            16150,D  16890,D  17030,U  17040,U  17070,U  17080,U

ALTI1     REAL*8                             2870,S   2900,U

AM1       REAL*8                            11810,S  12230,U  12310,U  12330,U  12400,U  12430,U  12510,U  12550,U  12770,U

AM10      REAL*8                            11650,S  11720,S  12200,U  12230,U  12280,U  12330,U  12370,U  12430,U  12480,U  12550,U
                                            12630,U  12680,U

AM2       REAL*8                            11800,S  12160,U  12170,U  12180,U  12190,U  12760,U
```

```
                     INITIAL
VARIABLE TYPE        VALUE      DIMENSION   WHERE/HOW USED

AM3      REAL*8                             11790,S  12160,U  12170,U  12180,U  12190,U  12750,U

AM4      REAL*8                             11780,S  12160,U  12170,U  12180,U  12190,U  12740,U

AM5      REAL*8                             11700,S  11770,S  12220,U  12230,U  12300,U  12330,U  12390,U  12430,U  12500,U  12550,U
                                            12650,U  12730,U

AM6      REAL*8                             11690,S  11760,S  12120,U  12130,U  12140,U  12150,U  12640,U  12720,U

AM7      REAL*8                             11680,S  11750,S  12120,U  12130,U  12140,U  12150,U  12630,U  12710,U

AM8      REAL*8                             11670,S  11740,S  12210,U  12230,U  12290,U  12330,U  12380,U  12430,U  12490,U  12550,U
                                            12620,U  12700,U

AM9      REAL*8                             11660,S  11730,S  12080,U  12090,U  12100,U  12110,U  12610,U  12690,U

ANG      REAL*8                             15200,S  15220,U  16330,S  16350,U

ARCL     REAL*8                      50      1030,D   2720,S   2740,S   3030,U   6610,D   7140,D  13650,D  14140,U  14210,U  14210,U
                                            14590,U  14590,U  16880,D  17150,U  17150,U  17160,U  17160,U  17190,U  17190,U  17210,U
                                            17210,U

ARCLI    REAL*8                              7380,S   7440,U   7450,U   7460,U   7470,U   7480,U   7490,U

ARL      REAL*8                              7330,S   7340,U   7350,U   7380,U   7900,U   8670,U

A0       REAL*8                             11820,S  12080,U  12120,U  12160,U  12200,S  12200,U  12230,U  12230,U  12240,U  12250,U
                                            12260,U  12270,U  12780,U

A1       REAL*8                             11830,S  12080,S  12080,U  12120,U  12160,U  12210,S  12210,S  12230,U  12230,U  12240,U
                                            12250,U  12260,U  12270,U  12790,U

A10      REAL*8                             11920,S  12330,U  12330,S  12420,U  12440,U  12530,U  12560,U  12880,U

A11      REAL*8                             11930,S  12100,U  12140,U  12180,U  12250,U  12340,U  12370,U  12370,S  12430,U  12430,U
                                            12450,U  12460,U  12890,U

A12      REAL*8                             11940,S  12100,U  12100,S  12140,U  12180,U  12250,U  12340,U  12380,S  12380,U  12430,U
                                            12430,U  12450,U  12460,U  12900,U

A13      REAL*8                             11950,S  12140,U  12140,S  12180,U  12250,U  12340,U  12390,S  12390,U  12430,U  12430,U
                                            12450,U  12460,U  12910,U

A14      REAL*8                             11960,S  12180,U  12180,S  12250,U  12340,U  12400,S  12400,U  12430,U  12430,U  12450,U
                                            12460,U  12920,U

A15      REAL*8                             11970,S  12250,U  12250,S  12340,U  12410,U  12410,S  12430,U  12430,U  12450,U  12460,U
                                            12930,U

A16      REAL*8                             11980,S  12340,U  12340,S  12420,S  12420,U  12440,U  12440,U  12450,U  12470,U  12940,U

A17      REAL*8                             11990,S  12430,S  12430,U  12540,U  12560,U  12950,U
```

```
                         INITIAL
VARIABLE TYPE            VALUE      DIMENSION   WHERE/HOW USED

A18       REAL*8                                12000,S  12110,U  12150,U  12190,U  12260,U  12350,U  12450,U  12480,S  12480,U  12550,U
                                                12550,U  12570,U  12960,U

A19       REAL*6                                12010,S  12110,S  12110,U  12150,U  12190,U  12260,U  12350,U  12450,U  12490,S  12490,U
                                                12550,U  12550,U  12570,U  12970,U

A2        REAL*8                                11840,S  12120,S  12120,U  12160,U  12220,U  12220,S  12230,U  12230,U  12240,U  12250,U
                                                12260,U  12270,U  12800,U

A20       REAL*8                                12020,S  12150,U  12150,S  12190,U  12260,U  12350,U  12450,U  12500,S  12500,U  12550,U
                                                12550,U  12570,U  12980,U

A21       REAL*8                                12030,S  12190,S  12190,U  12260,U  12350,U  12450,U  12510,S  12510,U  12550,U  12550,U
                                                12570,U  12990,U

A22       REAL*8                                12040,S  12260,U  12260,S  12350,U  12450,U  12520,S  12520,U  12550,U  12550,U  12570,U
                                                13000,U

A23       REAL*8                                12050,S  12350,S  12350,U  12450,U  12530,S  12530,U  12560,U  12560,U  12580,U  13010,U

A24       REAL*8                                12060,S  12450,S  12450,U  12540,U  12540,S  12560,U  12560,U  12580,U  13020,U

A25       REAL*8                                12070,S  12550,S  12550,U  13030,U

A3        REAL*8                                11850,S  12160,S  12160,U  12230,U  12230,U  12240,U  12250,U  12260,U  12270,U  12810,U

A4        REAL*8                                11860,S  12230,U  12230,S  12320,U  12330,U  12410,U  12430,U  12520,U  12550,U  12820,U

A5        REAL*8                                11870,S  12090,U  12130,U  12170,U  12240,U  12280,S  12280,U  12330,U  12330,U  12340,U
                                                12350,U  12360,U  12830,U

A6        REAL*8                                11880,S  12090,S  12090,U  12130,U  12170,U  12240,U  12290,S  12290,U  12330,U  12330,U
                                                12340,U  12350,U  12360,U  12840,U

A7        REAL*8                                11890,S  12130,U  12130,S  12170,U  12240,U  12300,U  12300,S  12330,U  12330,U  12340,U
                                                12350,U  12360,U  12850,U

A8        REAL*8                                11900,S  12170,S  12170,U  12240,U  12310,S  12310,U  12330,U  12330,U  12340,U  12350,U
                                                12360,U  12860,U

A9        REAL*8                                11910,S  12240,S  12240,U  12320,S  12320,U  12330,U  12330,U  12340,U  12350,U  12360,U
                                                12870,U

BSL       REAL*8                                14460,S  14550,U  14650,U

BSTL      REAL*8                                14480,S  14550,U  14650,U

BSTMST    REAL*8                          20    13720,S  14620,U  14630,U  14680,S

BSTRMS    REAL*8                          20    13720,D  14600,U  14660,S
```

```
                    INITIAL
VARIABLE TYPE       VALUE      DIMENSION    WHERE/HOW USED

BSTRMT    REAL*8                      20    13720,D  14610,U  14670,S

BSTTMT    REAL*8                      20    13720,D  14620,U  14700,S

BSTU      REAL*8                            14450,S  14550,U  14650,U

BSU       REAL*8                            14430,S  14540,U  14650,U

BTL       REAL*8                            14470,S  14550,U  14650,U

BTTMST    REAL*8                      20    13720,D  14600,U  14690,S

BTU       REAL*8                            14440,S  14540,U  14650,U

CARD      REAL*8                      20      130,D    140,S    300,S    310,U    330,U    330,U    390,U    400,U

CCC       REAL*8                     125     7090,D   8100,U   8120,U   8150,U   8820,U  17600,D  17950,S

CCCC      REAL*8                     625     7100,D   8520,U  17610,D  18440,S

CC1       REAL*8                             5730,D   6640,D   6780,S   7150,D   8100,U   8120,U   8150,U   8170,U   8510,U   8520,U
                                             8820,U  13660,D  14340,U  14340,U

CC2       REAL*8                             5730,D   6640,D   6790,S   7150,D   8120,U   8170,U   8540,U   8830,U  13660,D  14350,U
                                            14350,U

CES       REAL*8                             7920,S   8100,S   8100,U   8210,U   8240,U   8260,U   8290,U  16970,D  17020,S  17040,S
                                            17060,S  17080,S  17280,U  17280,U  17280,U  17300,U  17300,U  17310,U  17320,U  17320,U
                                            17320,U  17330,U  17340,U  17340,U  17340,U  17350,U  17360,U  17360,U  17360,U  17380,U
                                            17380,U  17380,U  17390,U  17400,U  17400,U  17420,U  17420,U

CEST      REAL*8                             7940,S   8140,U   8140,S   8210,U   8230,U   8240,U   8260,U   8280,U   8290,U

CET       REAL*8                             7930,S   8120,S   8130,U   8230,U   8240,U   8280,U   8290,U

CE13      REAL*8                             7950,S   8150,S   8160,U   8210,U   8240,U   8260,U   8290,U   8690,S   8820,U   8820,S
                                             8860,U   8880,U   8890,U   8910,U

CE23      REAL*8                             7960,S   8170,S   8180,U   8210,U   8230,U   8240,U   8260,U   8280,U   8290,U   8700,S
                                             8830,U   8830,S   8860,U   8870,U   8880,U   8890,U   8900,U   8910,U

CE413     REAL*8                             8340,S   8520,S   8520,S   8580,U   8600,U   8610,U   8630,U

CE423     REAL*8                             8350,S   8540,U   8540,S   8580,U   8590,U   8600,U   8610,U   8620,U   8630,U

CHALS     REAL*8                              930,D  14900,D  16910,D

CHECK     REAL*8                     8,8      930,D   2650,S   2660,U   4310,S   4490,S  14900,D  15910,U  16910,D  17510,U

CHIS      REAL*8                            13880,S  14160,U  14160,S  14370,U  14380,U

CHIST     REAL*8                            13900,S  14240,U  14240,S  14390,U

CHIST1    REAL*8                            14200,S  14240,U  14270,U
```

```
                    INITIAL
VARIABLE TYPE       VALUE      DIMENSION    WHERE/HOW USED

CHIS1     REAL*8                             14140,S  14160,U  14250,U

CHIS2     REAL*8                             14150,S  14160,U  14250,U

CHIT      REAL*8                             13890,S  14190,S  14190,U  14370,U  14380,U

CHIT1     REAL*8                             14170,S  14190,U  14260,U

CHIT2     REAL*8                             14180,S  14190,U  14260,U

CL2R      REAL*8                              7570,S   7650,U

COMENT    REAL*8                       20     1130,D   1150,S   1270,S   1280,U   1490,S   1510,U

CONST     REAL*8                                50,D    980,D   5710,D   6550,D   7070,D   9020,D   9830,D  10280,D  11270,D  13610,D
                                             14930,D  16120,D  16920,D  17620,D

CONSTF    REAL*8                              1160,D   1200,S   3710,U   3980,S   4000,U   4060,U   4720,U

CONSTN    REAL*8  CONSTANT                    1160,D   1170,S   3710,U   4000,U   4720,U

CONST1    REAL*8  8' ' S                      1160,D   1170,S   1200,U

COPH      REAL*8                              7350,S   7420,U   7450,U   7470,U   7550,U   7570,U

COSINE    REAL*8                       51     1030,D   2720,S   2740,S   2740,S   6610,D   7140,D  13650,D  14120,U  14130,U  16880,D

COSM      REAL*8                       50     1030,D   2790,S   6610,D   7140,D  13650,D  14210,U  14220,U  16880,D

CO2R      REAL*8                              7550,S   7630,U

CS        REAL*8                              6120,S   6180,U   7090,D  13980,S  14040,U  14050,U  14070,U  14090,U  14100,U  14160,U
                                             14190,U  14270,U  17600,D

CSS       REAL*8                      125     7090,D   8140,U   8170,U   8830,U  17600,D  17970,S

CS4       REAL*8                              7100,D  17610,D

CTHIS     REAL*8                             13910,S  14250,S  14250,U  14500,U

CTHIST    REAL*8                             13930,S  14270,U  14270,S  14510,U

CTHIT     REAL*8                             13920,S  14260,S  14260,U  14500,U

CYCLE     REAL*8                               110,D   1100,D   1130,D

C1ST      REAL*8                             14410,S  14430,U  14440,U  14450,U  14460,U  14470,U  14480,U

C12       REAL*8                             15740,S  15750,S  15760,U  15770,U  15780,U

C2ST      REAL*8                             14420,S  14430,U  14440,U  14450,U  14460,U  14470,U  14480,U

DABS      REAL*8                              6330,U
```

```
                    INITIAL
VARIABLE TYPE       VALUE       DIMENSION    WHERE/HOW USED

DATA       REAL*8                            1170,S

DCOS       REAL*8                            2790,U    6120,U   13980,U   15540,U   15540,U

DD1        REAL*8                            5730,D    6640,D    6820,S    7150,D   13660,D   14370,U   14370,U

DD2        REAL*8                            5730,D    6640,D    6830,S    7150,D   13660,D   14380,U   14380,U   14500,U   14500,U

DELTE      REAL*8                              70,D     580,U     580,U     630,U     730,U    1010,D    1320,S    1780,U    2010,U    3430,U
                                             4910,U    4950,U    6570,D    7190,D    9050,D    9150,U    9200,U    9860,D   13680,D   13790,U

DELTEP     REAL*8                             100,D    1070,D    3280,S    3430,U    3510,U    5770,D    9060,D

DOUBLE     REAL*8                            1160,D

DRO        REAL*8                            7310,S    7330,U    7330,U    7340,U

DSIN       REAL*8                            2800,U    6110,U   13990,U   14610,U   14630,U   15520,U   15520,U   15530,U   15530,U   16610,U
                                            16610,U   16620,U   16620,U

DSQRT      REAL*8                            7330,U

DTH        REAL*8                   50,5,2   1080,D    3310,S    3650,S    3660,S    3780,S    3780,U    3900,U    3900,S    3920,S    4450,S
                                             4580,U    4780,U    4780,S    4940,U    7170,D   13710,D   14020,U   14020,U   14020,U   16150,D
                                            16740,S   16890,D   17270,U   17290,U   17310,U   17330,U   17350,U   17370,U   17390,U   17400,U
                                            17420,U

DTHT       REAL*8                           14020,S   14150,U   14180,U

DTH1       REAL*8                        5   1130,D    4420,S    4450,U

DT2        REAL*8                              50,D     980,D    2010,S    5710,D    6550,D    7070,D    9020,D    9290,U    9330,U    9350,U
                                             9350,U    9400,U    9650,U    9830,D   10030,U   10280,D   11270,D   13610,D   14930,D   16120,D
                                            16920,D   17620,D

DUM        REAL*8                     1310   1140,D    1150,S    1590,S    1610,S    1640,S    1660,S    1690,S    1730,S

DZ         REAL*8                            7320,S    7330,U    7330,U    7350,U

EES        REAL*8                            6620,D    7110,D   13600,D

EPS        REAL*8                           14300,S   14340,U   14350,U

EPST       REAL*8                           14320,S   14360,U

EPT        REAL*8                           14310,S   14340,U   14350,U

ES         REAL*8                        5   6620,D    7110,D    7820,S    8150,U    8170,U   13600,D   14040,U

ESQ1       REAL*8                            7500,S    7820,U    8210,U

ESQ3       REAL*8                            7510,S    7820,U    8240,U
```

```
                   INITIAL
VARIABLE TYPE      VALUE      DIMENSION    WHERE/HOW USED

ESQ5     REAL*8                            7520,S   7820,U   8260,U

ESQ7     REAL*8                            7530,S   7820,U   8290,U

EST      REAL*8                         5  6620,D   7110,D   7830,S   8160,U   8180,U  13600,D  14060,U

ESTQ1    REAL*8                         5  7230,D   7660,S   7830,U   8210,U

ESTQ2    REAL*8                            7480,S   7830,U   8230,U

ESTQ3    REAL*8                         5  7230,D   7670,S   7830,U   8240,U

ESTQ5    REAL*8                         5  7240,D   7680,S   7830,U   8260,U

ESTQ6    REAL*8                            7490,S   7840,U   8280,U

ESTQ7    REAL*8                         5  7240,D   7690,S   7840,U   8290,U

ESTU     REAL*8                           13850,S  14060,U  14060,S  14320,U

ESU      REAL*8                           13830,S  14040,S  14040,U  14300,U

ESUT     REAL*8                           13940,S  14090,S  14090,U  14300,U

ET       REAL*8                         5  6620,D   7110,D   7800,S   8150,U   8170,U  13600,D  14050,U

ETQ2     REAL*8                         5  7240,D   7700,S   7710,U   7800,U   8230,U

ETQ3     REAL*8                            7400,S   7800,U   8240,U

ETQ6     REAL*8                         5  7240,D   7710,S   7800,U   8280,U

ETQ7     REAL*8                            7410,S   7800,U   8290,U

ETU      REAL*8                           13840,S  14050,S  14050,U  14310,U

ETUT     REAL*8                           14100,U  14100,S  14310,U

E1       REAL*8                        50  1020,D   2680,S   3020,U   6600,D   6780,U   6820,U   7130,D  13640,D  16870,D  17020,U
                                          17060,U

E13      REAL*8                         5  6620,D   7110,D   7850,S   8100,U   8100,U   8120,U   8120,U   8140,U   8150,U   8170,U
                                           8510,U   8520,U   8520,U   8520,U   8540,U   8820,U  13600,D  14070,U  14170,U  14200,U

E13Q1    REAL*8                            7440,S   7510,U   7850,U   8210,U   8580,U   8860,U

E13Q3    REAL*8                            7450,S   7500,U   7850,U   8240,U   8600,U   8880,U

E13Q5    REAL*8                            7460,S   7530,U   7850,U   8260,U   8610,U   8890,U

E13Q7    REAL*8                            7470,S   7520,U   7850,U   8290,U   8630,U   8910,U

E13U     REAL*8                           13860,S  14070,U  14070,S  14300,U  14320,U
```

```
                    INITIAL
VARIABLE TYPE       VALUE       DIMENSION   WHERE/HOW USED

E2         REAL*8                      50    1020,D   2690,S   3020,U   6600,D   6790,U   6830,U   7130,D  13640,D  16870,D  17040,U
                                            17080,U

E23        REAL*8                       5    6620,D   7110,D   7860,S   8100,U   8100,U   8120,U   8120,U   8140,U   8160,U   8170,U
                                             8510,U   8520,U   8540,U   8540,U   8540,U   8830,U  13600,D  14080,U  14170,U  14200,U

E23Q1      REAL*8                       5    7230,D   7620,S   7670,U   7860,U   8210,U   8580,U   8860,U

E23Q2      REAL*8                            7420,S   7430,U   7860,U   8230,U   8590,U   8870,U

E23Q3      REAL*8                       5    7230,D   7630,S   7660,U   7860,U   8240,U   8600,U   8880,U

E23Q5      REAL*8                       5    7230,D   7640,S   7690,U   7860,U   8260,U   8610,U   8890,U

E23Q6      REAL*8                            7430,S   7870,U   8280,U   8620,U   8900,U

E23Q7      REAL*8                       5    7230,D   7650,S   7680,U   7870,U   8290,U   8630,U   8910,U

E23U       REAL*8                           13870,S  14080,S  14080,U  14310,U  14320,U

FEIGHT     REAL*8                           18230,S  18390,S  18430,S  18470,U

FFIVE      REAL*8                           18200,S  18360,S  18400,S  18470,U

FFOUR      REAL*8                           17860,S  17930,S  17940,S  17970,U  18190,S  18300,S  18310,S  18440,U  18450,U  18460,U

FN         REAL*8                            6770,S   6780,U   6790,U   6820,U   6830,U

FNU1       REAL*8                      50    1020,D   2680,S   3020,U   6600,D   6770,U   7130,D   8100,U   8120,U   8150,U   8170,U
                                             8510,U   8820,U  13640,D  14340,U  14370,U  16870,D  17020,U  17020,U  17040,U  17060,U
                                            17070,U  17080,U

FNU2       REAL*8                      50    1020,D   2680,S   3020,U   6600,D   6770,U   7130,D   8830,U  13640,D  14350,U  14380,U
                                            14500,U  16870,D  17020,U  17040,U  17040,U  17060,U  17080,U  17090,U

FONE       REAL*8                           17830,S  17870,S  17880,S  17950,U  17960,U  18160,S  18240,S  18250,S  18440,U  18450,U
                                            18460,U

FOR        REAL*8                            8510,S   8520,U   8540,U

FORCF      REAL*8                    2040      30,D     950,D   3080,S   3090,S   3280,S   3580,S   3590,S   3740,U   3740,S   3840,U
                                             3840,S   3950,S   4190,S   4200,S   4210,S   4220,S   4700,U   4700,U   4700,U   4700,U
                                             4740,U   4740,S   4910,U   5690,D   6580,D   7200,D   8990,D   9220,U   9240,U   9240,U
                                             9240,U   9330,U   9350,U   9360,U   9360,U   9800,D  10010,U  10010,U  10010,U  10270,D
                                            10720,S  10850,U  10870,D  11040,U  11050,U  11060,U  11060,U  11070,U  11070,U  11080,U
                                            11180,U  11190,U  11210,U  13690,D  14910,D  15940,U  15940,S  16940,D  17540,U  17540,S

FRCE       REAL*8                           14890,D  16140,D

FRCES      REAL*8                            4320,U  14870,D
```

```
                        INITIAL
VARIABLE TYPE           VALUE     DIMENSION   WHERE/HOW USED

FSEVEN   REAL*8                               18220,S  18380,S  18420,S  18470,U

FSIX     REAL*8                               18210,S  18370,S  18410,S  18470,U

FTHREE   REAL*8                               17850,S  17910,S  17920,S  17970,U  18180,S  18280,S  18290,S  18440,U  18450,U  18460,U

FTWO     REAL*8                               17840,S  17890,S  17900,S  17950,U  17960,U  18170,S  18260,S  18270,S  18440,U  18450,U
                                              18460,U

F1       REAL*8                                4160,S   4190,U   4230,U

F2       REAL*8                                4160,S   4200,U   4230,U

F3       REAL*8                                4160,S   4210,U   4230,U

F4       REAL*8                                4160,S   4220,U   4230,U

G        REAL*8                          50    1020,D   2690,S   3020,U   6600,D   6800,U   6810,U   7130,D  13640,D  16870,D

GCD      REAL*8                                5730,D   6640,D   7150,D  13660,D

GEOM     REAL*8                                1020,D   6600,D   7130,D  13640,D  16870,D

GG1      REAL*8                                5730,D   6640,D   6800,S   7150,D   8140,U   8150,U   8170,U   8510,U  13660,D  14360,U

GG2      REAL*8                                5730,D   6640,D   6810,S   7150,D  13660,D  14390,U  14510,U

HARM     REAL*8                                  90,D   1060,D   5760,D   7160,D  13670,D  14950,D  16160,D  16900,D  17640,D

HOUBON   REAL*8                                5870,U   9770,D

HOUBQ1   REAL*8                                5860,U   8960,D
```

```
                    INITIAL
VARIABLE TYPE       VALUE       DIMENSION   WHERE/HOW USED


I        INTEGER                              510,D    520,U   1250,S   1340,U   1340,S   1370,S   1370,U   1590,U   1590,S   1610,S
                                             1610,U   1640,U   1640,S   1660,S   1660,U   1690,U   1690,S   1730,S   1730,U   1740,U
                                             1740,S   1800,S   1800,U   1810,U   1810,S   1930,S   1940,U   1940,U   2020,S   2030,U
                                             2040,U   2140,U   2180,U   2550,S   2560,U   2590,U   2650,S   2650,U   2650,S   2650,U
                                             2660,S   2660,U   2660,S   2660,U   2680,S   2680,U   2680,S   2680,U   2680,S   2680,U
                                             2690,S   2690,U   2690,S   2690,U   2690,S   2690,U   2700,S   2710,U   2720,U   2720,U
                                             2720,U   2720,U   2720,U   2720,U   2740,U   2740,U   2740,U   2740,U   2740,U   2740,U
                                             2740,U   2750,U   2770,S   2770,U   2770,S   2770,U   2780,S   2790,U   2790,U   2800,U
                                             2800,U   3020,U   3020,U   3020,U   3020,U   3020,U   3020,U   3020,U   3020,U   3030,U
                                             3030,U   3030,U   3030,S   3030,U   3030,U   3080,U   3080,S   3090,S   3090,U   3130,U
                                             3130,S   3140,S   3140,U   3170,U   3170,S   3190,S   3190,U   3270,U   3270,S   3280,S
                                             3280,U   3290,U   3290,S   3320,U   3320,S   3320,U   3320,S   3320,U   3320,S   3370,S
                                             3380,U   3390,U   3390,U   3400,U   3410,U   3420,U   3420,U   3430,U   3430,U   3430,U
                                             3570,S   3580,U   3590,U   3610,S   3630,U   3640,U   3650,U   3660,U   3730,S   3740,S
                                             3740,S   3750,S   3770,U   3770,U   3780,U   3780,U   3830,S   3840,U   3840,U   3850,U
                                             3870,S   3890,U   3890,U   3900,U   3900,U   3910,U   3920,U   4310,U   4310,S   4310,U
                                             4310,S   4490,U   4490,S   4490,U   4490,S   4680,S   4690,U   4700,U   4730,S   4740,U
                                             4740,U   4750,S   4770,U   4770,U   4780,U   4780,U   4900,S   4900,U   4910,S   4910,U
                                             4920,S   4920,U   4980,S   4990,U   4990,U   4990,U   4990,U   5000,U   5000,U   5000,S
                                             5000,U   5000,S   5000,S   5960,S   5970,U   5980,U   6060,S   6070,U   6250,S   6260,U
                                             6270,U   6730,S   6740,U   7980,S   7990,U   8010,S   8020,U   8100,U   8100,U   8120,U
                                             8120,U   8140,U   8150,U   8160,U   8170,U   8180,U   8370,S   8380,U   8510,U   8520,U
                                             8540,U   8720,S   8730,U   8820,U   8830,U   9180,S   9190,U   9220,U   9220,U   9240,U
                                             9240,U   9300,S   9310,U   9330,U   9330,U   9330,U   9350,U   9350,U   9350,U   9380,S
                                             9390,U   9470,S   9480,U   9490,U   9500,U   9500,U   9520,S   9530,U   9630,S   9640,U
                                             9650,U   9670,S   9680,U   9920,S   9930,U   9990,S  10000,U  10030,U  10030,U  10120,S
                                            10130,U  10190,S  10200,U  10210,U  10420,S  10440,U  10440,U  10440,U  10470,S  10480,U
                                            10480,U  10480,U  10540,S  10550,U  10570,U  10570,U  10570,U  10570,U  10610,S  10620,U
                                            10620,U  10620,U  10620,U  10690,S  10700,U  10700,U  10700,U  10700,U  10800,S  10810,U
                                            10940,S  10950,U  11020,S  11040,U  11040,U  11110,S  11120,U  11390,S  11400,U  11410,U
                                            11420,S  11430,U  11430,U  11620,S  11650,U  11660,U  11670,U  11680,U  11690,U  11700,U
                                            11720,U  11730,U  11740,U  11750,U  11760,U  11770,U  11780,U  11790,U  11800,U  11810,U
                                            11820,U  11830,U  11840,U  11850,U  11860,U  11870,U  11880,U  11890,U  11900,U  11910,U
                                            11920,U  11930,U  11940,U  11950,U  11960,U  11970,U  11980,U  11990,U  12000,U  12010,U
                                            12020,U  12030,U  12040,U  12050,U  12060,U  12070,U  12600,U  12610,U  12620,U  12630,U
                                            12640,U  12650,U  12660,U  12690,U  12700,U  12710,U  12720,U  12730,U  12740,U  12750,U
                                            12760,U  12770,U  12780,U  12790,U  12800,U  12810,U  12820,U  12830,U  12840,U  12850,U
                                            12860,U  12870,U  12880,U  12890,U  12900,U  12910,U  12920,U  12930,U  12940,U  12950,U
                                            12960,U  12970,U  12980,U  12990,U  13000,U  13010,U  13020,U  13030,U  13500,S  13510,U
                                            13510,U  13530,S  13540,U  13550,U  13820,S  13980,U  13990,U  14520,U  14600,U  14600,U
                                            14610,U  14620,U  14620,U  14630,U  14660,U  14670,U  14680,U  14690,U  14700,U  15080,S
                                            15080,U  15080,U  15080,U  15090,S  15090,U  15090,U  15090,U  15090,U  15170,U  15170,U
                                            15170,U  15170,U  15170,S  15270,U  15270,U  15270,U  15270,U  15280,U  15280,S  15310,U
                                            15310,U  15310,U  15320,U  15320,S  15320,U  15400,S  15410,U  15430,U  15450,U  15460,U
                                            15480,U  15480,U  15480,U  15490,U  15490,U  15490,U  15520,U  15530,U  15540,U  15880,S
                                            15890,U  15910,U  15910,U  15910,U  15920,S  15930,U  15940,U  16300,U  16300,S  16300,U
                                            16300,U  16390,U  16390,U  16390,U  16400,S  16400,U  16520,S  16530,U  16530,U  16530,U
                                            16540,U  16540,U  16540,U  16580,S  16590,U  16600,U  16610,U  16620,U  17480,S  17490,U
                                            17510,U  17510,U  17510,U  17520,S  17530,U  17540,U

IABS     INTEGER                              8070,U   8420,U   8460,U   8780,U  17780,U  17820,U  18080,U  18120,U  18330,U  18350,U
```

```
                  INITIAL
VARIABLE TYPE     VALUE       DIMENSION    WHERE/HOW USED

IB       INTEGER                            3940,S    3950,S    3960,U    4000,U    4180,U    4320,P    4390,U    4510,P    4520,P    4650,U
                                            4720,U    4820,U    4820,S    4830,U   14870,U   15930,U   16100,U   16720,U   16850,U   17230,U
                                           17530,U

IBP1     INTEGER                            3300,U    3300,S    3310,S    3310,U    4390,S    4450,U    4460,U    4580,U    4580,U    4930,S
                                            4930,U    4940,S    4940,U   16720,S   16730,U   16740,U   17230,S   17270,U   17270,U   17280,U
                                           17290,U   17300,U   17310,U   17320,U   17330,U   17340,U   17350,U   17360,U   17370,U   17380,U
                                           17390,U   17400,U   17410,U   17420,U   17430,U

IDCOE    INTEGER                              60,D      990,D     3980,S    5720,D    6560,D    7080,D    9030,D    9840,D   10290,D   11280,D
                                           13620,D   14940,D   15050,U   15390,U   16130,D   16930,D   17630,D

IDELF    INTEGER                              60,D      990,D     3980,S    4280,U    5720,D    6560,D    7080,D    9030,D    9840,D   10290,D
                                           11280,D   13620,D   14940,D   16130,D   16930,D   17630,D

IDP      INTEGER                           15330,S   15340,U   15340,U   16420,S   16430,U   16430,U

IELM     INTEGER                            2880,S    2890,U    2900,U    2930,S    2940,U    2950,U    3300,U    3300,S    3310,S    3310,U
                                            4300,S    4320,P    4430,S    4450,U    4460,U    4480,S    4510,P    4520,P    4570,S    4580,U
                                            4530,U    4580,U    4930,U    4930,S    4940,S    4940,U   10400,S   10410,U   10540,U   10570,U
                                           10590,U   10600,U   10620,U   10640,U   10660,U   10670,U   10670,S   10700,U   14870,U   15030,U
                                           15040,U   15040,U   15060,U   15130,U   15930,U   16100,U   16220,U   16240,U   16240,U   16250,U
                                           16730,U   16740,U   16850,U   17020,U   17020,U   17020,U   17020,U   17020,U   17030,U   17030,U
                                           17040,U   17040,U   17040,U   17040,U   17040,U   17050,U   17050,U   17060,U   17060,U   17060,U
                                           17060,U   17070,U   17070,U   17070,U   17080,U   17080,U   17080,U   17080,U   17090,U   17090,U
                                           17090,U   17130,U   17140,U   17150,U   17150,U   17150,U   17150,U   17160,U   17160,U   17160,U
                                           17160,U   17190,U   17190,U   17190,U   17190,U   17210,U   17210,U   17210,U   17210,U   17270,U
                                           17270,U   17280,U   17290,U   17300,U   17310,U   17320,U   17330,U   17340,U   17350,U   17360,U
                                           17370,U   17380,U   17390,U   17400,U   17400,U   17420,U   17420,U   17530,U

IELM1    INTEGER                            2870,S    2880,U    4420,S    4430,U   15080,S   15090,U   15170,S   15270,U   16300,S   16390,U

IELM2    INTEGER                            2870,S    2880,U    2910,U    4420,S    4430,U    4470,U   15030,S   15040,U   15080,S   15090,U
                                           15170,S   15270,U   16220,S   16240,U   16300,S   16390,U

IEQ      INTEGER                           10130,S   10140,U

IFLAG    INTEGER                            2320,S    2330,U    2340,U    2350,U    2360,U    2460,S    2470,U    2480,U    2490,U    2500,U
                                            9130,S    9460,U    9590,S

IFO      INTEGER                            8320,S    8490,S    8490,U    8520,U    8520,U    8540,U    8540,U   18000,S   18150,S   18150,U
                                           18440,U   18450,U   18460,U   18470,U
                  INITIAL
VARIABLE TYPE     VALUE       DIMENSION    WHERE/HOW USED

IH       INTEGER                            2270,S   2280,U   2410,S   2420,U   3040,S   3060,U   3300,U   3300,S   3310,S   3310,U
                                            4080,S   4090,U   4140,U   4420,U   4420,S   4420,U   4440,S   4450,U   4450,U   4460,U
                                            4460,U   4550,S   4560,U   4580,U   4580,U   4640,S   4650,U   4660,U   4930,S   4930,U
                                            4940,U   4940,S   5830,S   5840,U   5850,U   5860,U   5870,P   5880,P   6000,U   7590,S
                                            7600,U   7620,U   7630,U   7640,U   7650,U   7660,U   7660,U   7670,U   7670,U   7680,U
                                            7680,U   7690,U   7690,U   7700,U   7710,U   7710,U   7730,U   7800,U   7800,U   7800,U
                                            7820,U   7830,U   7830,U   7830,U   7830,U   7840,U   7850,U   7860,U   7860,U   7860,U
                                            7860,U   7870,U   8960,U   9170,P   9280,P   9450,P   9770,U   9960,P  10180,P  10850,U
                                           10980,U  10990,U  11240,U  13960,S  13970,U  14000,U  14010,U  14010,U  14010,U  14020,U
                                           14020,U  14020,U  14040,U  14050,U  14060,U  14070,U  14080,U  14170,U  14170,U  14200,U
                                           14200,U  15360,S  15370,U  15760,U  15770,U  15780,U  15930,U  16450,S  16460,U  16730,U
                                           16740,U  17240,S  17250,U  17270,U  17270,U  17280,U  17290,U  17300,U  17310,U  17320,U
                                           17330,U  17340,U  17350,U  17360,U  17370,U  17380,U  17390,U  17400,U  17410,U  17420,U
                                           17430,U  17530,U

IHARM    INTEGER                   5          90,D   1060,D   1370,U   1740,U   1800,U   2590,U   3060,U   3160,U   3180,U   3270,S
                                            4140,U   4560,U   4660,U   4900,U   5760,D   5840,U   6100,U   7160,D   7600,U   7970,U
                                            8020,U   8040,U   8360,U   8380,U   8400,U   8440,U   8710,U   8730,U   8750,U  13670,D
                                           13970,U  14950,D  15370,U  16160,D  16460,U  16900,D  17250,U  17640,D  17720,U  17740,U
                                           17760,U  18020,U  18040,U  18060,U  18100,U

IH1      INTEGER                            4090,S   4180,U

II       INTEGER                            2570,S   2580,U   2590,U   2640,S   6950,S   6960,U   6990,U   7000,U   8020,S   8050,U
                                            8060,U   8380,S   8410,U   8420,U   8730,S   8760,U   8770,U  17740,S  17770,U  17780,U
                                           17810,U  17820,U  18040,S  18070,U  18080,U  18340,U  18350,U

IID      INTEGER                           10850,U  10940,U  10960,U  10990,U

IMJ      INTEGER                            8060,S   8070,U   8420,S   8470,U   8470,U   8770,S   8780,U  17780,S  17790,U  17890,U
                                           17900,U  18080,S  18130,U  18130,U  18280,U  18290,U  18300,U  18310,U

IML      INTEGER                           18350,S  18360,U  18370,U  18400,U  18410,U

IMM      INTEGER                           17820,S  17930,U  17940,U

IN       INTEGER                            4170,S   4180,U   4230,U

INCRST   INTEGER                            1320,S   1780,U   3350,U

INODE    INTEGER                            2310,S   2320,U   2450,S   2460,U

INPUT    INTEGER                             470,U    670,D    910,D   6400,U

IN1      INTEGER                            2300,S   2310,U   2440,S   2450,U   4160,S   4170,U

IN2      INTEGER                            2300,S   2310,U   2370,U   2440,S   2450,U   2510,U   4160,S   4170,U   4250,U

IPJ      INTEGER                            8050,S   8070,U   8410,S   8470,U   8470,U   8760,S   8780,U  17770,S  17790,U  17870,U
                                           17880,U  18070,S  18130,U  18130,U  18240,U  18250,U  18260,U  18270,U

IPL      INTEGER                           18340,S  18380,U  18390,U  18420,U  18430,U

IPM      INTEGER                           17810,S  17910,U  17920,U
```

```
                    INITIAL
VARIABLE TYPE       VALUE        DIMENSION    WHERE/HOW USED

IPRINT    INTEGER                                80,D    1050,D    1320,S    1780,U    5750,D    5890,U    5890,U    6660,D   11290,D

IQ        INTEGER                              2560,S    2590,U    2590,U    2590,U    2590,U    2600,U    2600,U    2600,U    2600,U

ION       INTEGER                              2250,S    2260,U

ION1      INTEGER                              2250,S    2400,U

IRSTRT    INTEGER                               100,D     500,U     610,U    1070,D    1320,S    1370,U    1390,U    1780,U    2060,U    3220,U
                                               5770,D    9060,D    9210,U    9320,U

IT        INTEGER                              5890,S    5910,U    6050,S    6110,U    6120,U    6230,U

ITAM      INTEGER                               110,D     620,S     630,U     650,U     690,P     720,S     740,P    1100,D    4910,U    5020,U
                                               5660,U    5820,U    5820,P    5870,U    5880,U    5890,U    5890,U    5900,U    5910,U    5940,U
                                               6220,U    6350,U    6390,U    6390,U    6530,U    6920,U    6920,U    6920,U    6920,U    6930,P
                                              11300,D   11440,U   13520,U   13580,U   13780,U

ITAM1     INTEGER                             13780,S   13810,U

ITCOE     INTEGER                              1090,D    3980,S    4400,U    4500,U    7180,D

ITELF     INTEGER                              1090,D    1320,S    1790,U    2820,U    4340,U    7180,D    8650,U

ITH       INTEGER                              7890,S    8080,U    8080,S    8100,U    8100,U    8120,U    8120,U    8140,U    8150,U    8150,U
                                               8170,U    8660,S    8800,S    8800,U    8820,U    8830,U   17700,S   17800,S   17800,U   17950,U
                                              17960,U   17970,U

ITP       INTEGER                               100,D     550,S     580,U     610,U     630,U    1070,D    3280,S    3350,U    3510,U    5770,D
                                               9060,D

IT1       INTEGER                              6390,S    6400,U

IX        INTEGER                              2590,S    2590,U    2590,U    2590,U    2600,U    2600,U    2600,U    2600,U    2600,U

I1        INTEGER                              6130,S    6140,U    6760,S    6770,U    6770,U    6780,U    6780,U    6790,U    6790,U    6800,U
                                               6800,U    6810,U    6810,U    6820,U    6820,U    6830,U    6830,U    6870,P    6930,P    6960,U
                                               7050,U    7290,U    7300,U    7730,U    8100,U    8120,U    8150,U    8170,U    8510,U    8790,U
                                               8790,U    8790,U    8820,U    8820,U    8820,U    8830,U    8830,U    8830,U   13580,U   13810,U
                                              14000,U   14010,U   14010,U   14010,U   14020,U   14020,U   14020,U   14090,U   14100,U   14120,U
                                              14120,U   14130,U   14130,U   14140,U   14150,U   14170,U   14170,U   14180,U   14200,U   14200,U
                                              14210,U   14210,U   14210,U   14210,U   14220,U   14220,U   14220,U   14220,U   14220,U   14340,U
                                              14350,U   14370,U   14380,U   14410,U   14420,U   14500,U   14530,U   14540,U   14570,U   14570,U
                                              14580,U   14580,U   14590,U   14590,U   14600,U   14600,U   14620,U   14620,U   14640,U
```

```
                       INITIAL
VARIABLE TYPE          VALUE       DIMENSION     WHERE/HOW USED

J          INTEGER                                1270,S    1270,U    1280,U    1280,S    1490,S    1490,U    1510,U    1510,S    1600,U    1610,U
                                                  1680,S    1690,U    1700,S    1720,U    2650,U    2650,S    2660,S    2660,U    3620,S    3630,U
                                                  3640,U    3650,U    3660,U    3760,S    3770,U    3770,U    3780,U    3780,U    3880,S    3890,U
                                                  3890,U    3900,U    3900,U    3910,U    3920,U    4310,S    4310,U    4490,U    4490,S    4760,S
                                                  4770,U    4770,U    4780,U    4780,U    5980,S    5980,U    6160,S    6170,U    6180,U    6180,U
                                                  6180,U    6200,U    6200,U    6200,U    6270,U    6270,U    8030,S    8040,U    8100,U    8100,U
                                                  8120,U    8120,U    8140,U    8150,U    8150,U    8160,U    8170,U    8170,U    8170,U    8390,S
                                                  8400,U    8520,U    8520,U    8540,U    8540,U    8740,S    8750,U    8790,U    8790,U    8790,U
                                                 10430,S   10440,U   10460,S   10480,U   10560,S   10570,U   10590,S   10620,U   10640,U   10680,U
                                                 10680,S   10700,U   11010,S   11020,U   11040,U   11140,U   11150,U   11180,U   11190,U   11190,U
                                                 11210,U   11210,U   11210,U   11630,S   12270,U   12270,U   12270,U   12270,U   12270,U   12270,U
                                                 12360,U   12360,U   12360,U   12360,U   12360,U   12360,U   12360,U   12460,U   12460,U   12460,U
                                                 12460,U   12460,U   12460,U   12460,U   12470,U   12570,U   12570,U   12570,U   12570,U   12570,U
                                                 12570,U   12570,U   12580,U   12580,U   15900,S   15910,U   15910,U   15930,S   15940,U   15940,U
                                                 17460,S   17470,U   17470,U   17500,S   17510,U   17510,U   17530,U   17540,U   17540,U

JH         INTEGER                                3050,S    3060,U    3120,U    3160,U    3180,U    6080,S    6090,S    6100,U

JJ         INTEGER                                6970,S    6980,U    6990,U    7000,U    8040,S    8050,U    8060,U    8400,S    8410,U    8420,U
                                                  8750,S    8760,U    8770,U   17760,S   17770,U   17780,U   17910,U   17920,U   17920,U   17930,U
                                                 17940,U   17940,U   18060,S   18070,U   18080,U   18320,U   18330,U

JM1        INTEGER                               11150,S   11160,U

JUNK       INTEGER                         20     1130,D    1450,S    1530,S    1740,S    3270,S    4900,U

J1         INTEGER                                7290,S    7310,U    7320,U    7360,U

J11        INTEGER                                7300,U    7310,U    7320,U    7360,U

K          INTEGER                                1480,S    1580,S    1620,S    1630,U    1720,S    4180,S    4190,U    4200,U    4210,U    4220,U
                                                  4690,S    4700,U    4700,U    4700,U    4700,U    5970,S    5980,U    6140,S    6150,U    6180,U
                                                  6180,U    6200,U    6200,U    6260,S    6270,U    7600,S    7610,U    7970,S    8070,U    8070,U
                                                  8430,S    8440,U    8510,U    8520,U    8540,U    8710,S    8780,U    8780,U   10440,S   10450,U
                                                 10480,S   10490,U   10500,S   10510,U   10570,S   10580,U   10620,S   10630,U   10640,S   10650,U
                                                 10700,S   10710,U   10810,S   10820,U   11610,S   11620,U   11630,U   13090,S   13100,U   13110,U
                                                 13280,S   13290,U   13300,U   14000,S   14120,U   14120,U   14130,U   14130,U   14140,U   14140,U
                                                 14210,U   14210,U   14220,U   14220,U

KA         INTEGER                                6960,S    6980,U

KEY        INTEGER                                 910,U    1180,U    3710,U    3950,U   11450,S   11640,U   12590,U   12660,S   15210,S   15220,U
                                                 15230,U   15240,U   15250,U   16340,S   16350,U   16360,U   16370,U

KEYRS      INTEGER                                1380,S    1390,S    1500,U    1540,U    1750,S

KK         INTEGER                                4650,S    4690,U    6980,S    6990,U    6990,U    7000,U    7730,S    7740,U    7750,U    7760,U
                                                  7770,U    7780,U    7790,U    8440,S    8450,U    8460,U   18100,S   18110,U   18120,U   18320,U
                                                 18330,U

KKP2       INTEGER                                 580,S     590,U     620,U     650,U     720,U

KK1        INTEGER                                7740,U    7820,U    7830,U    7850,U    7860,U
```

```
                     INITIAL
VARIABLE TYPE        VALUE      DIMENSION   WHERE/HOW USED

KK2        INTEGER                          7750,S   7800,U   7830,U   7860,U

KK3        INTEGER                          7760,S   7800,U   7820,U   7830,U   7850,U   7860,U

KK5        INTEGER                          7770,S   7820,U   7840,U   7850,U   7870,U

KK6        INTEGER                          7780,S   7800,U   7840,U   7870,U

KK7        INTEGER                          7790,S   7800,U   7820,U   7840,U   7850,U   7870,U

KMJ        INTEGER                         18330,S  18370,U  18390,U  18410,U  18410,U  18430,U  18430,U

KML        INTEGER                          8460,S   8470,U   8470,U  18120,S  18130,U  18130,U  18260,U  18270,U  18270,U  18300,U
                                           18310,U  18310,U

KPJ        INTEGER                         18320,S  18360,U  18380,U  18400,U  18400,U  18420,U  18420,U

KPL        INTEGER                          8450,S   8470,U   8470,U  18110,S  18130,U  18130,U  18240,U  18250,U  18250,U  18280,U
                                           18290,U  18290,U

KY         INTEGER                          5840,S   5870,P   5880,P   5950,U   8960,U   9430,P   9740,P   9770,U  10100,U  10250,U
                                           10360,U  10780,U

KYP        INTEGER                          4660,S   4670,U  15370,S  15380,U  15470,U  15560,U  15750,U  16460,S  16470,U  16510,U
                                           16660,U  17250,S  17260,U  17440,U

L          INTEGER                          8330,S   8360,U   8580,U   8580,U   8580,U   8590,U   8590,U   8600,U   8600,U   8600,U
                                            8610,U   8610,U   8610,U   8620,U   8620,U   8630,U   8630,U   8630,U  10380,S  10390,U
                                           11160,S  11180,U  11180,U  11190,U  13110,U  13120,U  13120,U  13120,U  13120,U  13130,U
                                           13130,S  13130,U  13130,U  13140,U  13150,U  13150,U  13150,U  13160,U  13160,U  13160,U
                                           13170,U  13170,U  13170,U  13180,U  13180,U  13180,U  13180,U  13290,S  13310,U  13320,U
                                           13320,U  13320,U  13320,U  13330,U  13340,U  13340,U  13340,U  13340,U  13350,U  13350,U
                                           13360,U  13360,U  13360,U  13360,U  13370,U  13370,U  13370,U  13380,U  13380,U  13380,U
                                           13380,U  13390,U  13390,U  13390,U  13390,U  13410,U  13410,U  13410,U  13410,U  13420,U
                                           13430,U  13430,U  13430,U  13430,U  13440,U  13440,U  13450,U  13450,U  13450,U  13450,U
                                           13460,U  13460,U  13460,U  13470,U  13470,U  13470,U  13470,U  13480,U  13480,U  13480,U
                                           13480,U

LARGE      INTEGER                           490,S    690,P    700,U   5660,U   6340,S

LE         INTEGER                          6330,U  15040,U  16240,U

LK         INTEGER                  204      970,D   2180,S   2190,S   2200,S   3280,S   3330,S   3340,S   4910,U   9010,D   9820,D
                                           10130,U  10300,D  10390,U

LL         INTEGER                            80,D    600,S    610,S    620,U   1050,D   5750,D   5820,U   5870,U   5880,U   6660,D
                                            8360,S   8450,U   8460,U  11290,D  11440,U  13520,U  18020,S  18110,U  18120,U  18340,U
                                           18350,U
                     INITIAL
VARIABLE TYPE        VALUE       DIMENSION     WHERE/HOW USED

M          INTEGER                             7910,S    7970,U    7990,U    8210,U    8210,U    8210,U    8220,U    8230,U    8230,U    8230,U
                                               8240,U    8240,U    8240,U    8250,U    8260,U    8260,U    8260,U    8270,U    8280,U    8280,U
                                               8280,U    8290,U    8290,U    8290,U    8300,U    8680,U    8710,U    8860,U    8860,U    8860,U
                                               8870,U    8870,U    8880,U    8880,U    8880,U    8890,U    8890,U    8890,U    8900,U    8900,U
                                               8910,U    8910,U    8910,U   10280,D   13230,S   13240,U   13240,U   13250,U   13250,U   13250,U
                                              13260,U   13260,U   13260,U   13260,U   13270,U   13270,S   13270,U   13270,U   13270,U

MATMUT     INTEGER                             9170,U    9280,U    9960,U   10850,D

MPRINT     INTEGER                              290,S     340,U     370,S     380,S     380,U

N          INTEGER                               50,D     980,D    2280,S    2320,U    2420,S    2460,U    5710,D    5860,S    5970,U    6090,S
                                               6150,U    6330,U    6550,D    7070,D    9020,D    9190,U    9310,U    9480,U    9640,U    9830,D
                                               9930,U   10000,U   10200,U   10550,S   10560,U   10600,S   10610,U   10640,U   10640,U   10640,U
                                              10640,U   13110,U   13120,U   13120,U   13120,U   13120,U   13120,U   13120,U   13130,U   13130,U
                                              13130,U   13130,U   13130,U   13130,U   13140,U   13150,U   13150,U   13150,U   13150,U   13150,U
                                              13150,U   13160,U   13160,U   13170,U   13170,U   13170,U   13170,U   13170,U   13170,U   13180,U
                                              13180,U   13180,U   13220,S   13240,U   13250,U   13250,U   13260,    13260,U   13260,U   13270,U
                                              13270,U   13270,U   13270,U   13300,S   13320,U   13320,U   13320,U   13320,U   13320,U   13330,U
                                              13340,U   13340,U   13340,U   13340,U   13340,U   13340,U   13350,U   13360,U   13360,U   13360,U
                                              13360,U   13360,U   13370,U   13370,U   13370,U   13380,U   13380,U   13380,U   13380,U   13380,U
                                              13380,U   13390,U   13390,U   13390,U   13410,U   13410,U   13410,U   13410,U   13410,U   13420,U
                                              13430,U   13430,U   13430,U   13430,U   13430,U   13430,U   13440,U   13450,U   13450,U   13450,U
                                              13450,U   13450,U   13450,U   13460,U   13460,U   13470,U   13470,U   13470,U   13470,U   13470,U
                                              13470,U   13480,U   13480,U   13480,U   13610,D   14930,D   16120,D   16920,D

NA         INTEGER                            11600,S   11630,S   11630,S   11640,U

NCARD      INTEGER                              270,S     310,U     320,U     320,S     410,U

NCARDS     INTEGER                             1230,S    1240,U    1250,U    1450,S    1460,U    1480,U

NCASE      INTEGER                              220,S     280,U   — 280,S     350,U     420,S     420,U     430,U     460,S     480,S     480,U
                                                750,U

NCASES     INTEGER                              200,S     210,U     430,U     750,U

NCF        INTEGER                             3980,S    4070,U

NCF1       INTEGER                             4110,S    4120,U

NCLCST     INTEGER                             1040,D    1330,S    1790,U    5740,D    6650,D    6930,U   13630,D

NCLOSE     INTEGER                              970,D    1320,S    1790,U    9010,D    9820,D   10100,U   10300,D   10360,U

ND         INTEGER                              120,D     200,S     260,U     330,U     440,U    1110,D    1230,U    1270,U    1320,U    1340,U
                                               1370,U    1790,U    2110,U    2160,U    2250,U    2300,U    2440,U    2870,U    3980,U    4110,U
                                               4160,U    4420,U   14970,D   15080,U   15170,U   16170,D   16300,U

NDIRCT     INTEGER                             2160,S    2170,U    2160,U

NDP        INTEGER                            15170,U   15170,S   15180,U   15190,U   15280,U   15290,U   15300,U   15310,U   15420,U   15440,U
                                              16300,S   16300,U   16310,U   16320,U   16330,U   16400,U   16410,U   16500,U   16520,U   16580,U
```

```
                   INITIAL
VARIABLE TYPE      VALUE      DIMENSION    WHERE/HOW USED


NDPP2     INTEGER                          15300,S  15320,U

NDP1      INTEGER                          15420,S  15430,U

NDP2      INTEGER                          15180,S  15210,U  16310,S  16340,U

ND2       INTEGER                          15290,S  15320,U  15330,U  16410,S  16420,U

NELEMS    INTEGER                             50,D     980,D   1530,S   1580,U   1600,U   1620,U   1630,U   1680,U   1710,U   1790,U
                                            1960,U   1990,U   2640,U   2680,U   2680,U   2680,U   2690,U   2690,U   2690,U   2700,U
                                            2710,U   2780,U   2910,U   2930,U   3030,U   3300,U   3310,U   3610,U   3750,U   3870,U
                                            4300,U   4470,U   4480,U   4570,U   4750,U   4930,U   4940,U   5710,D   6550,D   6760,U
                                            7070,D   9020,D   9830,D  10280,U  10660,D  11270,D  11610,U  13090,U  13220,U  13230,U
                                           13280,U  13290,U  13300,U  13610,D  14930,D  16120,U  16920,D  17140,U  17620,D

NEQ       INTEGER                             50,D     980,D   1970,S   1980,U   2280,U   2420,U   2560,U   4180,U   4650,U   5710,D
                                            5860,U   6060,U   6090,U   6550,D   6960,U   7070,D   7730,U   9020,D   9170,P   9180,U
                                            9280,P   9300,U   9470,U   9630,U   9830,D   9920,U   9960,P   9990,U  10190,U  10390,U
                                           10400,U  10420,U  10430,U  10460,U  10470,U  10500,U  10500,U  10500,U  10500,U  10540,U
                                           10590,U  10600,U  10720,U  11270,D  11420,U  13500,U  13610,D  14000,U  14930,D  15930,U
                                           16120,D  16920,D  17530,U  17620,D

NEQT      INTEGER                             50,D     510,U    980,D   1980,S   2020,U   3260,U   3320,U   3320,U   3320,U   3370,U
                                            3570,U   3590,U   3730,U   3740,U   3930,U   3840,U   3850,U   4180,U   4650,U   4730,U
                                            4740,U   4890,U   4980,U   5000,U   5000,U   5000,U   5710,D   6550,D   6730,U   7070,D
                                            9020,D   9240,U   9360,U   9830,D  10010,U  10280,D  11270,D  13610,D  14930,D  15930,U
                                          '16120,D  16920,D  17530,U  17620,D

NF        INTEGER                          10990,S  11040,U  11050,U  11060,U  11060,U  11070,U  11070,U  11080,U  11130,U

NFF       INTEGER                          11130,S  11180,U  11190,U  11210,U

NH        INTEGER                             50,D     980,D   1370,U   1370,S   1740,U   1740,S   1800,U   1800,U   1980,U   2000,U
                                            2270,U   2410,U   2550,U   3050,U   3270,U   3270,S   3300,U   3310,U   3620,U   3760,U
                                            3880,U   4080,U   4420,U   4440,U   4550,U   4640,U   4760,U   4900,U   4900,U   4930,U
                                            4940,U   5710,D   5830,U   6000,U   6010,U   6080,U   6550,D   6950,U   7070,D   7590,U
                                            7910,U   8010,U   8030,U   8330,U   8370,U   8390,U   8430,U   8680,U   8720,U   8740,U
                                            9020,D   9830,D  10280,D  11270,D  13610,D  13960,U  14930,D  15080,U  15090,U  15360,U
                                           16120,D  16450,U  16920,D  17240,U  17620,D  17710,U  17730,U  17750,U  18010,U  18030,U
                                           18050,U  18090,U

NHNS      INTEGER                             50,D     980,D   2000,S   5710,D   6550,D   7070,D   9020,D   9830,D  10280,D  11270,D
                                           13610,D  14930,D  15120,D  16920,D  17620,D

NHP       INTEGER                             90,D    1060,D   1530,S   1700,U   3040,U   5760,D   7160,D  13670,D  14950,D  16160,D
                                           16900,D  17640,D

NI        INTEGER                          11120,S  11130,U  11180,U  11180,U  11190,U  11190,U  11210,U  11210,U

NIX       INTEGER                          10280,D

NK        INTEGER                          10980,S  11000,U  11050,U  11060,U  11060,U  11070,U  11070,U  11070,U  11090,U

NKK       INTEGER                          11090,S  11170,U  11170,S  11180,U  11190,U  11200,S  11200,S  11210,U
```

```
              INITIAL
VARIABLE TYPE VALUE    DIMENSION  WHERE/HOW USED

NLTERM  INTEGER                    740,U  3360,U  5820,U  6530,D

NLTRMS  INTEGER                   6630,D  7120,D

NM1     INTEGER                  11100,S 11110,U

NN      INTEGER                     50,D   980,D  3120,S  3130,U  3140,U  3170,U  3190,U  5710,D  5850,S  6550,D
                                  7070,D  9020,D  9390,U  9530,U  9680,U  9830,D 10280,D 10440,U 10480,U 10500,U
                                 10570,U 10620,U 10640,U 10700,U 10960,S 10970,U 11100,U 11270,D 11400,U 13540,U
                                 13610,D 14930,D 16120,D 16920,D 17620,D

NNODES  INTEGER                     50,D   980,D  1960,S  1970,U  2370,U  2510,U  2570,U  2770,U  2770,U  4250,U
                                  4680,U  5710,D  5960,U  6130,U  6250,U  6550,D  7070,D  9020,D  9830,D 10280,U
                                 10800,D 11270,D 13610,D 14930,D 16120,D 16920,D 17620,D

NNPI    INTEGER                   9390,S  9400,U  9400,U  9400,U  9530,S  9540,U  9550,U  9550,U  9560,U  9680,S
                                  9690,U  9700,U  9700,U  9700,U  9710,U 11400,S 11410,U 13540,S 13550,S

NODRE   INTEGER                  10090,S 10100,S 10100,U 10110,U 10120,U 10350,S 10360,S 10360,U 16370,U 10380,U

NODRES  INTEGER                    970,D  2110,S  2120,U  2130,U  2140,U  2190,U  2200,U  3280,U  3280,S  3330,U
                                  3340,U  4910,U  4910,U  9810,D  9820,D 10090,U 10300,U 10350,D

NOIT    INTEGER                     80,D   590,S  1050,D  1350,S  5750,D  5900,U  6660,D  6930,U 11290,D

NP      INTEGER                   2160,S  2170,U  2180,U

NPI     INTEGER                   9190,S  9200,U  9200,U  9200,U  9220,U  9240,U  9240,U  9240,U  9250,U  9310,S
                                  9330,U  9350,U  9350,U  9360,U  9360,U  9480,S  9490,U  9640,S  9650,U  9650,U
                                  9650,U  9930,S  9940,U  9940,U  9940,U  9940,U 10000,S 10010,U 10010,U 10010,U
                                 10010,U 10010,U 10040,U 10040,U 10050,U 10050,U 10060,U 10060,U 10200,S 10210,U

NPK     INTEGER                   6150,S  6180,U  6200,U

NPRNIT  INTEGER                    100,D  1070,D  1330,S  1780,U  5770,D  6390,U  6390,U  9060,D

NPRNMS  INTEGER                   1330,S  1800,U  3150,U

NPRNT   INTEGER                    100,D  1070,D  1330,S  1780,U  5770,D  6380,U  6400,U  9060,D

NPRNTF  INTEGER                     60,D   990,D  1330,S  1790,U  4010,U  4600,U  5720,D  6560,D  7080,D  9030,D
                                  9840,D 10290,D 11280,D 13620,D 14940,D 16130,D 16930,D 17630,D

NPRNTH  INTEGER                   1090,D  1330,S  1790,U  4540,U  7180,D

NPRNTL  INTEGER                     60,D   990,D  1330,S  1790,U  4010,U  4130,U  4230,U  5720,D  6560,D  7080,D
                                  9030,D  9840,D 10290,D 11280,D 13620,D 14940,D 15060,U 15090,U 15130,U 15270,U
                                 15310,U 16130,D 16250,U 16390,U 16930,D 17630,D

NPRNTQ  INTEGER                     50,D   980,D  1320,S  1780,U  5710,D  5920,U  6550,D  7070,D  9020,D  9830,D
                                 10280,D 11270,D 13610,D 14930,D 16120,D 16920,D 17620,D
```

```
                   INITIAL
VARIABLE TYPE      VALUE       DIMENSION    WHERE/HOW USED


NPESTR   INTEGER                             9430,U   9740,U  10250,D

NS       INTEGER                              120,D    200,S   1110,D   1790,U   2630,U   2660,U   4290,U   4310,U   4380,U   4490,U
                                            14970,D  16170,D

NSIZE    INTEGER                               50,D    980,D   1710,S   1730,U   1990,S   2000,U   3080,U   3090,U   3120,U   3130,U
                                             3140,U   3170,U   3190,U   5710,D   5850,U   6550,D   7070,D   9020,D   9380,U   9520,U
                                             9670,U   9830,D  10280,D  11270,D  11390,U  13530,U  13610,D  14930,D  16120,D  16920,D
                                            17620,D

NSTRSS   INTEGER                             1040,D   1330,S   1790,U   5740,D   6650,D   6910,U   6920,U   6920,U   6930,U  13630,D

NT       INTEGER                              120,D   1110,D   1230,S   1440,U   1450,U   1490,U   1530,U   1590,U   1610,U   1640,U
                                             1660,U   1690,U   1730,U   1740,U   1790,U   2650,U   2680,U   2720,U   2740,U   2770,U
                                             3080,U   3090,U   3130,U   3140,U   3270,U   3280,U   3300,U   3320,U   4900,U   4910,U
                                             4930,U   5000,U  10970,S  10980,U  14970,D  16170,D

NTF      INTEGER                             3260,S   3290,U   4890,S   4920,U

NTHETA   INTEGER                             1040,D   1340,S   1340,U   1810,U   1810,U   1930,U   5740,D   6050,U   6650,D  13630,D
                                            13820,U

NW       INTEGER                            11270,D

P        REAL*8                     74      14890,D  15080,S  15090,U  15170,S  15230,S  15230,U  15270,U  15310,U  15480,U  15520,U
                                            15570,U  15760,U  16140,D  16300,S  16360,U  16360,S  16390,U  16530,U  16610,U  16670,U

PAV      REAL*8                             14580,S  14610,U  14630,U

PH       REAL*8                     50       1030,D   2720,S   2740,S   2790,U   2800,U   3030,U   6610,D   7140,D  13650,D  14580,U
                                            14580,U  16880,D

PHP      REAL*8                     50       1030,D   2720,S   2740,S   3030,U   6610,D   7140,D  13650,D  14220,U  16880,D  17150,U
                                            17150,U  17160,U  17160,U  17190,U  17190,U  17210,U  17210,U

PHPP     REAL*8                             17170,S  17190,S  17210,S  17360,U  17390,U

PHPP1    REAL*8                             17150,S  17170,U

PHPP2    REAL*8                             17160,S  17170,U

PI       REAL*8                              1910,S   1920,U  15020,S  15570,U  15580,U  15760,U  15770,U  15780,U  16230,S  16550,U
                                            16560,U  16630,U  16640,U  17010,S  17020,U  17040,U  17060,U  17080,U

PINT     REAL*8                             15480,S  15520,S  15570,S  15610,S  15680,U  15690,U  15760,S  15830,U  15840,U  16480,S
                                            16530,S  16530,U  16550,U  16550,S  16610,U  16610,S  16630,S  16630,U  16670,S  16700,U
                                            16730,U

PIO2     REAL*8                             17690,S  17950,U  17960,U  17970,U

PIO4     REAL*8                             17990,S  18440,U  18450,U  18460,U  18470,U
```

```
                      INITIAL
VARIABLE TYPE         VALUE     DIMENSION   WHERE/HOW USED

PRINT      REAL*8                                80,D     1050,D     5750,D     6660,D    11290,D

PS         REAL*8                              1000,D     9040,D     9850,D

Q          REAL*8                        8    14960,D    15410,S    15640,U    15640,S    15650,S    15650,U    15660,S    15660,U    15670,S    15670,U
                                              15680,S    15680,U    15690,S    15690,U    15700,U    15700,S    15710,S    15710,U    15790,S    15800,S
                                              15810,S    15820,S    15830,S    15840,S    15850,S    15860,S    15910,U    16960,D    17280,S    17300,S
                                              17320,S    17340,S    17360,S    17380,S    17400,S    17420,S    17470,S    17470,S    17510,U

QB3        REAL*8                             14120,S    14200,U    14210,U

QB7        REAL*8                             14130,S    14200,U    14210,U

QDC1       REAL*8                              4970,S     4990,U

QDC2       REAL*8                              4960,S     4990,U

QDC3       REAL*8                              4950,S     4960,U     4970,U     4990,U

QLOAD      REAL*8                      204      940,D     5680,D     6070,S     6180,U     6180,S     6200,S     6200,U     6270,U     8980,D     9280,P
                                               9330,U     9330,S     9350,S     9350,U     9490,U     9500,S     9650,U     9790,D     9960,P    10030,S
                                              10030,U    10140,S    10210,U

QLOAD1     REAL*8                     1020     9070,D     9170,P     9220,U     9220,S     9240,S     9240,U     9330,S     9350,S     9500,S

QN         REAL*8                     1020       30,D      140,S      950,D     2030,S     2330,S     2340,S     2350,S     2360,S     2590,U     2590,U
                                               2590,U     2590,U     3320,S     3380,U     3390,U     4990,U     5000,U     5690,D     5980,U     6130,U
                                               6200,U     6330,U     6580,D     7200,D     7800,U     7800,U     7800,U     7800,U     7820,U     7820,U
                                               7820,U     7820,U     7830,U     7830,U     7830,U     7840,U     7840,U     7840,U     7850,U     7850,U
                                               7850,U     7850,U     7860,U     7860,U     7860,U     7870,U     7870,U     7870,U     8990,D     9200,U
                                               9200,S     9280,P     9490,S     9650,U     9800,D     9940,U    10050,U    10210,S    13690,D    14120,U
                                              14120,U    14130,U    14130,U    14140,U    14140,U    14210,U    14210,U    14220,U    14220,U    14910,D
                                              16940,D

QN1        REAL*8                     1020       30,D      950,D     2040,S     2470,S     2480,S     2490,S     2500,S     2600,U     2600,U     2600,U
                                               2600,U     3320,S     3390,U     3400,S     4990,U     5690,D     6580,D     7200,D     8990,D     9170,P
                                               9200,U     9650,U     9800,D     9940,U    10040,U    10050,S    13690,D    14910,D    16940,D

QN2        REAL*8                     1020       30,D      950,D     4990,U     5690,D     6580,D     7200,D     8990,D     9650,S     9800,D     9940;U
                                               9940,S     9960,P    10040,S    13690,D    14910,D    16940,D

QP         REAL*8                     1020       30,D      950,D     3420,U     3430,S     3430,U     3430,U     4990,S     5000,U     5690,D     6580,D
                                               6740,S     6990,S     6990,U     7000,S     7200,D     8990,D     9350,U     9800,D    10010,U    10060,U
                                              13690,D    14910,D    16940,D

QPR        REAL*8                      8,5     6630,D     6990,U     7000,U     7120,D     7990,S     8210,S     8210,U     8230,S     8230,U     8240,S
                                               8250,U     8260,S     8260,U     8280,U     8280,S     8290,S     8300,U     8580,U     8580,S     8590,U
                                               8590,S     8600,S     8600,U     8610,S     8610,U     8620,U     8620,S     8630,S     8630,U     8360,U
                                               8860,S     8870,U     8870,S     8880,S     8880,U     8890,S     8890,U     8900,U     8900,S     8910,U
                                               8910,S

QPRIME     REAL*8                              6870,U     7050,D
```

```
                INITIAL
VARIABLE TYPE   VALUE       DIMENSION   WHERE/HOW USED

QP1        REAL*8                   1020      30,D     520,S     950,D    3320,S    3410,U    3420,S    5000,U    5690,D    6580,D    7200,D
                                            8990,D    9240,U    9800,D   10010,U   10060,S   13690,D   14910,D   16940,D

QQ         REAL*8                      8   14960,D   15890,S   15910,S   15910,U   15940,U   16960,D   17490,S   17510,S   17510,U   17540,U

QS         REAL*8                             30,D     950,D    5690,D    6580,D    7200,D    8990,D    9800,D   13690,D   14910,D   16940,D

QSS        REAL*8                          10010,S   10030,U

QUES       REAL*8                          14960,D   16960,D

Q1         REAL*8                           2300,S    2330,U    2440,S    2470,U

Q2         REAL*8                           2300,S    2340,U    2440,S    2480,U

Q3         REAL*8                           2300,S    2350,U    2440,S    2490,U

Q4         REAL*8                           2300,S    2360,U    2440,S    2500,U

R          REAL*8                     50    1030,D    2720,S    2740,S    3020,U    6610,D    7140,D   11310,D   11430,S   11580,S   11580,U
                                           11580,U   11590,U   11590,U   11590,S   11590,U   11600,U   11600,S   11600,U   11600,U   11600,U
                                           12270,U   12270,S   12270,U   12270,U   12270,U   12270,U   12360,U   12360,U   12360,U   12360,U
                                           12360,U   12360,S   12360,U   12460,U   12460,U   12460,U   12460,U   12460,S   12460,U   12460,U
                                           12470,U   12570,S   12570,U   12570,U   12570,U   12570,U   12570,U   12570,U   12580,U   12580,U
                                           13060,U   13060,S   13060,U   13070,U   13070,S   13070,U   13070,U   13080,S   13080,U   13080,U
                                           13080,U   13080,U   13120,U   13120,U   13120,U   13120,U   13120,U   13120,S   13130,U   13130,U
                                           13130,U   13130,S   13130,U   13130,U   13140,U   13150,U   13150,S   13150,U   13150,U   13150,U
                                           13150,U   13160,U   13160,U   13170,U   13170,U   13170,U   13170,U   13170,U   13170;S   13180,U
                                           13180,U   13180,U   13240,U   13240,S   13250,U   13250,U   13250,S   13260,U   13260,U   13260,U
                                           13260,S   13270,U   13270,U   13270,U   13270,S   13270,U   13320,U   13320,S   13320,U   13320,U
                                           13320,U   13320,U   13340,S   13340,S   13340,U   13340,U   13340,U   13340,U   13350,U   13360,S
                                           13360,U   13360,U   13360,U   13360,U   13360,U   13370,U   13370,U   13380,U   13380,U   13380,U
                                           13380,S   13380,U   13380,U   13390,U   13390,U   13390,U   13410,S   13410,U   13410,U   13410,U
                                           13410,U   13410,U   13430,S   13430,U   13430,U   13430,U   13430,U   13430,U   13440,U   13450,U
                                           13450,U   13450,S   13450,U   13450,U   13450,U   13460,U   13460,U   13470,S   13470,U   13470,U
                                           13470,U   13470,U   13470,U   13480,U   13480,U   13480,U   13510,U   13650,D   14170,U   14210,U
                                           14220,U   14220,U   14570,U   14570,U   14600,U   14600,U   14620,U   14620,U   14890,D   15080,S
                                           15090,U   15170,S   15240,S   15240,U   15270,U   15310,U   15490,U   15530,U   15580,U   15770,U
                                           16140,D   16300,S   16370,S   16370,U   16390,U   16540,U   16620,U   16680,U   16880,D

RAD        REAL*8                           1920,S    1940,U

RAV        REAL*8                          14570,S   14600,U   14620,U

RESTRT     REAL*8                            100,D    1070,D    5770,D    9060,D

RINT       REAL*8                          15490,S   15530,S   15580,S   15620,S   15640,U   15650,U   15660,U   15670,U   15770,S   15790,S
                                           15800,U   15810,U   15820,U   16490,S   16540,U   16540,S   16560,U   16560,S   16620,S   16620,U
                                           16640,S   16640,U   16660,S   16710,S   16740,U

RL         REAL*8                           8670,S    8860,U    8870,U    8880,U    8890,U    8900,U    8910,U
```

```
                      INITIAL
VARIABLE TYPE         VALUE      DIMENSION   WHERE/HOW USED

RM          REAL*8                            7360,S    7370,U    7900,U    8670,U

RSL         REAL*8                            7900,S    8210,U    8230,U    8250,U    8260,U    8280,U    8300,U    8580,U    8590,U    8600,U
                                              8610,U    8620,U    8630,U

RSTRNT      REAL*8                             970,D    9010,D    9820,D   10300,D

RZ          REAL*8                            1120,D    7220,D

RO          REAL*8                     51     1120,D    2770,S    7220,D    7310,U    7310,U    7360,U    7360,U

R2I         REAL*8                            7370,S    7400,U    7410,U    7420,U    7480,U    7490,U    7550,U    7560,U    7570,U    7580,U
                                              7700,U

S           REAL*8                     74    14890,D   15080,S   15090,U   15170,S   15250,U   15250,S   15270,U   15310,U   15540,U   15780,U
                                             16140,D

SCCS        REAL*8                    625     7100,D    8540,U   17610,D   18470,U

SETUP       REAL*8                             690,U    5660,D

SHRS        REAL*8                           14600,S   14640,U

SHRT        REAL*8                           14620,S   14650,U

SINE        REAL*8                     51     1020,D    2720,S    2740,S    2740,S    6600,D    7130,D   13640,D   14120,U   14130,U   16870,D

SINM        REAL*8                     50     1030,D    2800,S    6610,D    7140,D   13650,D   14170,U   14200,U   14200,U   14220,U   16880,D

SINT        REAL*8                           15500,S   15540,S   15590,S   15630,S   15700,U   15710,U   15780,S   15850,U   15860,U

SIPH        REAL*8                            7340,S    7440,U    7460,U    7480,U    7490,U    7560,U    7580,U

SLVEEQ      REAL*8                             940,D    5680,D    8980,D    9790,D   10270,D   11260,D

SL2R        REAL*8                            7560,S    7640,U

SN          REAL*8                            6110,S    6200,U   13990,S   14060,U   14080,U   14240,U   14250,U   14260,U

SOLVEQ      REAL*8                            9450,U   10180,U   11240,D

SO2R        REAL*8                            7580,S    7620,U

SPA         REAL*8                   6550    11260,D   11410,U   13550,S

SPR         REAL*8                    204    11260,D   11430,U   13510,S

SSC         REAL*8                    125     7090,D    8100,U    8120,U    8150,U   17600,D   17960,S

SSCC        REAL*8                    625     7100,D    8520,U   17610,D   18460,S

SSSS        REAL*8                    625     7100,D    8540,U   17610,D   18450,S
```

```
                   INITIAL
 VARIABLE TYPE     VALUE       DIMENSION    WHERE/HOW USED

 STIFM    REAL*8                    6550    10270,D  10450,S  10490,S  10510,S  10580,S  10630,S  10650,S  10710,S  10790,S  10820,S
                                            10850,U  10870,D  11040,U  11050,U  11060,U  11060,U  11070,U  11070,U  11070,U  11180,U
                                            11190,U  11210,U

 STRESS   REAL*8                             6930,U  13580,D

 STRMS    REAL*8                            14370,S  14430,U  14460,U  14540,U  14600,U  14640,U  14660,U

 STRMST   REAL*8                            14390,S  14450,U  14480,U  14540,U  14620,U  14630,U  14640,U  14680,U

 STRMT    REAL*8                            14380,S  14440,U  14470,U  14540,U  14610,U  14640,U  14670,U

 STRNS    REAL*8                            14340,S  14430,U  14460,U  14540,U  14640,U

 STRNST   REAL*8                            14360,S  14450,U  14490,U  14540,U  14640,U

 STRNT    REAL*8                            14350,S  14440,U  14470,U  14540,U  14640,U

 STTMST   REAL*8                            14510,S  14600,U  14690,U

 STTRMT   REAL*8                            14500,S  14620,U  14700,U

 T        REAL*8                      50     1020,D   2690,S   3030,U   6600,D   6780,U   6790,U   6800,U   6810,U   6820,U   6830,U
                                             7130,D  13640,D  14410,U  14420,U  16870,D  17020,U  17040,U  17060,U  17080,U

 TAPES    REAL*8                              120,D   1110,D  14970,D  16170,D

 TDT2     REAL*8                             9290,S   9330,U   9350,U

 TEST     REAL*8  END                         150,S    310,U    330,U    400,U

 TFORCE   REAL*8                             4520,U  16850,D

 TH       REAL*8                  50,5,2     1080,D   3300,S   3630,S   3640,S   3770,U   3770,S   3890,U   3890,S   3910,S   4460,S
                                             4580,U   4770,S   4770,U   4930,U   7170,D   8790,U   8790,U   8790,U  13710,D  14010,U
                                            14010,U  14010,U  16150,D  16730,S  16890,D  17270,U  17280,U  17300,U  17320,U  17340,U
                                            17360,U  17380,U  17400,U  17420,U

 THCOE    REAL*8                             4510,U  16100,D

 THCON    REAL*8                             1090,D   7180,D

 THER     REAL*8                             1080,D   7170,D  13710,D  16150,D  16890,D

 THETA    REAL*8                             1040,D   1340,D   1810,S   1940,S   1940,U   5740,D   6110,U   6120,U   6230,U   6650,D
                                            13630,D  13980,U  13990,U  14520,U

 THETAS   REAL*8                             1040,U   5740,D   6650,D  13630,D

 THETA1   REAL*8                             6230,S   6240,U  14520,S  14540,U  14640,U
```

```
                        INITIAL
VARIABLE    TYPE        VALUE       DIMENSION  WHERE/HOW USED

THETB       REAL*8                      74  14890,D  15170,S  15200,U  15220,S  15270,U  15280,U  15310,U  15320,U  15340,U  15340,S
                                            15450,U  15460,U  15480,U  15480,U  15490,U  15490,U  16140,D  16300,S  16330,U  16350,S
                                            16390,U  16390,U  16430,U  16430,S  16530,U  16530,U  16540,U  16540,U  16590,U  16600,U

THT         REAL*8                           8790,S   8820,U   8830,U  14010,S  14090,U  14100,U

TH1         REAL*8                       5   1130,D   4420,S   4460,U

TIM         REAL*8                           3990,S   4050,U

TIME        REAL*8                             70,D    630,S    640,U    690,P    730,U    730,S   1010,D   4910,U   5010,U   5660,U
                                             5930,U   6350,U   6570,D   7190,D   8790,U   9050,D   9140,U   9150,U   9860,D   9980,U
                                            13680,D  13790,U  14010,U  14020,U

TIMEP       REAL*8                            100,D    560,S    580,U    630,U   1070,D   3280,S   3500,U   5770,D   9060,D

TMET        REAL*8                             70,D   1010,D   6570,D   7190,D   9050,D   9860,D  13680,D

TM1         REAL*8                          13790,S  13800,U

TOTIME      REAL*8                             70,D    580,U   1010,D   1320,S   1780,U   3800,U   4000,U   6570,D   7190,D   9050,D
                                             9860,D  13680,D

TPRINT      REAL*8                          13800,S  13810,U

TPRNT       REAL*8                           3500,S   3510,U   4050,S   4060,U   5010,S   5020,U   5930,S   5940,U   6220,U

TRI4OR      REAL*8                           3210,U  17580,D

TO          REAL*8                             70,D    570,S    660,S   1010,D   3280,S   3790,S   3960,S   4910,U   6570,D   7190,D
                                             8790,U   8790,U   9050,D   9140,U   9140,U   9150,U   9150,U   9860,D   9980,U   9980,U
                                            13680,D  14010,U  14010,U  14020,U  14020,U

T1          REAL*8                             70,D    640,U    660,U   1010,D   3280,S   3790,U   3800,S   3960,U   3980,S   3990,U
                                             4000,S   4910,U   6570,D   7190,D   8790,U   9050,D   9140,U   9150,U   9860,D   9980,U
                                            13680,D  14010,U  14020,U

T3          REAL*8                           9140,S   9350,U   9980,S  10010,U

T3M1        REAL*8                           9150,S   9240,U

XIH1        REAL*8                           6100,S   6110,U   6120,U  13970,S  13980,U  13990,U  14170,U  14200,U  14200,U  14210,U
                                            14250,U  14260,U  14270,U

XK          REAL*8                           7610,S   7620,U   7630,U   7640,U   7650,U   7700,U

XKEEP       REAL*8                           3380,S   3400,U   3410,S   3430,U   9540,S   9560,U   9690,S   9710,U

XN          REAL*8                    6550    940,U   1150,S   1150,S   3130,S   3170,U   5680,D   8980,D   9170,P   9400,U   9400,S
                                             9540,U   9550,S   9690,U   9700,U   9700,S   9790,D

XP          REAL*8                    6550   1000,D   3140,S   3190,U   9040,D   9280,P   9400,U   9550,U   9560,S   9700,U   9710,S
                                             9850,D   9960,P
```

```
                  INITIAL
VARIABLE TYPE     VALUE      DIMENSION   WHERE/HOW USED

X1       REAL*8                          15450,S  15520,U  15530,U  15540,U  16590,S  16610,U  16620,U

X2       REAL*8                          15460,S  15520,U  15530,U  15540,U  16600,S  16610,S  16620,S

YKP      REAL*8                          15380,S  15450,U  15460,U  15520,U  15530,U  15540,U  16470,S  16590,U  16600,U  16610,U
                                         16620,U  17260,S  17280,U  17300,U  17330,U  17350,U  17400,U  17400,U  17420,U  17420,U

Z        REAL*8                     51    1120,D   2770,S   7220,D   7320,U   7320,U
```

```
                                                           FRCES

                    INITIAL
VARIABLE TYPE       VALUE      DIMENSION   WHERE/HOW USED

 AL        REAL*8                     167   14910,D  15640,U  15650,U  15660,U  15670,U  15680,U  15690,U  15700,U  15710,U  15790,U
                                            15800,U  15810,U  15820,U  15830,U  15840,U  15850,U  15860,U

 ALPHK     REAL*8                           14870,U

 ANG       REAL*8                           15200,S  15220,U

 CHALS     REAL*8                           14900,D

 CHECK     REAL*8                     8,8   14920,D  15910,U

 CONST     REAL*8                           14930,D

 C12       REAL*8                           15740,S  15750,S  15760,U  15770,U  15780,U

 DCOS      REAL*8                           15540,U  15540,U

 DSIN      REAL*8                           15520,U  15520,U  15530,U  15530,U

 DT2       REAL*8                           14930,D

 FORCE     REAL*8                    2040   14910,D  15940,S  15940,U

 FRCE      REAL*8                           14990,D

 FRCES     REAL*8                           14870,D

 HARM      REAL*8                           14950,D

 I         INTEGER                          15080,U  15080,U  15080,U  15080,S  15090,U  15090,U  15090,U  15090,U  15090,S  15170,U
                                            15170,U  15170,U  15170,U  15170,S  15270,U  15270,U  15270,U  15270,U  15280,U  15280,S
                                            15310,U  15310,U  15310,U  15320,U  15320,U  15320,S  15400,S  15410,U  15430,U  15450,U
                                            15460,U  15480,U  15480,U  15480,U  15490,U  15490,U  15490,U  15520,U  15530,U  15540,U
                                            15880,S  15890,U  15910,U  15910,U  15910,U  15920,S  15930,U  15940,U

 IB        INTEGER                          14870,U  15930,U

 IDCOF     INTEGER                          14940,D  15050,U  15390,U

 IDELF     INTEGER                          14940,D

 IDP       INTEGER                          15330,S  15340,U  15340,U

 IELM      INTEGER                          14870,U  15030,U  15040,U  15040,U  15060,U  15130,U  15930,U

 IELM1     INTEGER                          15080,S  15090,U  15170,S  15270,U

 IELM2     INTEGER                          15030,S  15040,U  15080,S  15090,U  15170,S  15270,U

 IH        INTEGER                          15360,S  15370,U  15760,U  15770,U  15780,U  15930,U

 IHARM     INTEGER                          14950,D  15370,U
```

```
                           INITIAL
VARIABLE  TYPE             VALUE     DIMENSION   WHERE/HOW USED

J         INTEGER                                15900,S  15910,U  15910,U  15930,S  15940,U  15940,U

KEY       INTEGER                                15210,S  15220,U  15230,U  15240,U  15250,U

KYP       INTEGER                                15370,S  15380,U  15470,U  15560,U  15750,U

LE        INTEGER                                15040,U

N         INTEGER                                14930,D

ND        INTEGER                                14970,D  15080,U  15170,U

NDP       INTEGER                                15170,S  15170,U  15180,U  15190,U  15280,U  15290,U  15300,U  15310,U  15420,U  15440,U

NDPP2     INTEGER                                15300,S  15320,U

NDP1      INTEGER                                15420,S  15430,U

NDP2      INTEGER                                15180,S  15210,U

ND2       INTEGER                                15290,S  15320,U  15330,U

NELEMS    INTEGER                                14930,D

NEQ       INTEGER                                14930,D  15930,U

NEQT      INTEGER                                14930,D  15930,U

NH        INTEGER                                14930,D  15080,U  15090,U  15360,U

NHNS      INTEGER                                14930,D

NHP       INTEGER                                14950,D

NN        INTEGER                                14930,D

NNODES    INTEGER                                14930,D

NPRNTE    INTEGER                                14940,D

NPRNTL    INTEGER                                14940,D  15060,U  15090,U  15130,U  15270,U  15310,U

NPRNTQ    INTEGER                                14930,D

NS        INTEGER                                14970,D

NSIZE     INTEGER                                14930,D

NT        INTEGER                                14970,D
```

```
                                                 FRCES

                     INITIAL
VARIABLE TYPE        VALUE      DIMENSION    WHERE/HOW USED

P        REAL*8                        74    14890,D  15080,S  15090,U  15170,S  15230,S  15230,U  15270,U  15310,U  15480,U  15520,U
                                             15570,U  15760,U

PI       REAL*8                              15020,S  15570,U  15580,U  15760,U  15770,U  15780,U

PINT     REAL*8                              15480,S  15520,S  15570,S  15610,S  15680,U  15690,U  15760,S  15830,U  15840,U

Q        REAL*8                         8    14960,D  15410,S  15640,S  15640,U  15650,S  15650,U  15660,S  15660,U  15670,S  15670,U
                                             15680,S  15680,U  15690,S  15690,U  15700,S  15700,U  15710,S  15710,U  15790,S  15800,S
                                             15810,S  15820,S  15830,S  15840,S  15850,S  15860,S  15910,U

QN       REAL*8                      1020    14910,D

QN1      REAL*8                      1020    14910,D

QN2      REAL*8                      1020    14910,D

QP       REAL*8                      1020    14910,D

QP1      REAL*8                      1020    14910,D

QQ       REAL*8                         8    14960,D  15890,S  15910,S  15910,U  15940,U

QS       REAL*8                              14910,D

QUES     REAL*8                              14960,D

R        REAL*8                        74    14890,D  15080,S  15090,U  15170,S  15240,S  15240,U  15270,U  15310,U  15490,U  15530,U
                                             15580,U  15770,U

RINT     REAL*8                              15490,S  15530,S  15580,S  15620,S  15640,U  15650,U  15660,U  15670,U  15770,S  15790,S
                                             15800,U  15810,U  15820,U

S        REAL*8                        74    14890,D  15080,S  15090,U  15170,S  15250,S  15250,U  15270,U  15310,U  15540,U  15780,U

SINT     REAL*8                              15500,S  15540,S  15590,S  15630,S  15700,U  15710,U  15780,S  15850,U  15860,U

TAPES    REAL*8                              14970,D

THETB    REAL*8                        74    14890,D  15170,S  15200,U  15220,S  15270,U  15280,U  15310,U  15320,U  15340,S  15340,U
                                             15450,U  15460,U  15480,U  15480,U  15490,U  15490,U

X1       REAL*8                              15450,S  15520,U  15530,U  15540,U

X2       REAL*8                              15460,S  15520,U  15530,U  15540,U

YKP      REAL*8                              15380,S  15450,U  15460,U  15520,U  15530,U  15540,U
```

```
                                                       HOUBON

                       INITIAL
  VARIABLE TYPE        VALUE      DIMENSION    WHERE/HOW USED


  CONST     REAL*8                               9830,D

  DELTE     REAL*8                               9860,D

  DT2       REAL*8                               9830,D  10030,U

  FORCE     REAL*8                   2040        9820,D  10010,U  10010,U  10010,U

  HOUBON    REAL*8                               9770,D

  I         INTEGER                              9920,S   9930,U   9990,S  10000,U  10030,U  10030,U  10120,S  10130,U  10190,S  10200,U
                                                10210,U

  IDCOE     INTEGER                              9840,D

  IDELE     INTEGER                              9840,D

  IEQ       INTEGER                             10130,S  10140,U

  IH        INTEGER                              9770,U   9960,P  10180,P

  KY        INTEGER                              9770,U  10100,U

  LK        INTEGER                   204        9820,D  10130,U

  MATMUT    INTEGER                              9960,U

  N         INTEGER                              9930,D   9930,U  10000,U  10200,U

  NCLOSE    INTEGER                              9820,D  10100,U

  NELEMS    INTEGER                              9830,D

  NEQ       INTEGER                              9830,D   9920,U   9960,P   9990,U  10190,U

  NEQT      INTEGER                              9830,D  10010,U

  NH        INTEGER                              9830,D

  NHNS      INTEGER                              9830,D

  NN        INTEGER                              9830,D

  NNODES    INTEGER                              9830,D

  NODRE     INTEGER                             10090,S  10100,S  10100,U  10110,U  10120,U

  NODRES    INTEGER                              9820,D  10090,U

  NPI       INTEGER                              9930,S   9940,U   9940,U   9940,U   9940,U  10000,S  10010,U  10010,U  10010,U  10010,U
                                                10010,U  10040,U  10040,U  10050,U  10050,U  10060,U  10060,U  10200,S  10210,U
```

HOUBON

```
                   INITIAL
VARIABLE TYPE      VALUE     DIMENSION   WHERE/HOW USED

NPRNTE    INTEGER                          9840,D
NPRNTI    INTEGER                          9840,D
NPRNTO    INTEGER                          9830,D
NSIZE     INTEGER                          9830,D
PS        REAL*8                           9850,D
QLOAD     REAL*8                   204     9790,D   9960,P  10030,S  10030,U  10140,S  10210,U
QN        REAL*8                  1020     9800,D   9940,U  10050,U  10210,S
QN1       REAL*8                  1020     9800,D   9940,U  10040,U  10050,S
QN2       REAL*8                  1020     9800,D   9940,S   9940,U   9960,P  10040,S
QP        REAL*8                  1020     9800,D  10010,U  10060,U
QP1       REAL*8                  1020     9800,D  10010,U  10060,S
QS        REAL*8                           9800,D
QSS       REAL*8                          10010,S  10030,U
RSTRNT    REAL*8                           9820,D
SLVEEQ    REAL*8                           9790,D
SOLVEQ    REAL*8                          10180,U
TIME      REAL*8                           9860,D   9980,U
TMET      REAL*8                           9860,D
TOTIME    REAL*8                           9860,D
T0        REAL*8                           9860,D   9980,U   9980,U
T1        REAL*8                           9860,D   9980,U
T3        REAL*8                           9980,S  10010,U
XN        REAL*8                  6550     9790,D
XP        REAL*8                  6550     9850,D   9960,P
```

```
                     INITIAL
VARIABLE TYPE        VALUE      DIMENSION    WHERE/HOW USED

CONST    REAL*8                              9020,D

DELTE    REAL*8                              9050,D    9150,U    9200,U

DELTEP   REAL*8                              9060,D

DT2      REAL*8                              9020,D    9290,U    9330,U    9350,U    9350,U    9400,U    9650,U

FORCE    REAL*8                     2040     8990,D    9220,U    9240,U    9240,U    9240,U    9330,U    9350,U    9360,U    9360,U

HOUR01   REAL*8                              8960,D

I        INTEGER                             9180,S    9190,U    9220,U    9220,U    9240,U    9240,U    9300,S    9310,U    9330,U    9330,U
                                             9330,U    9350,U    9350,U    9350,U    9380,S    9390,U    9470,S    9480,U    9490,U    9500,U
                                             9500,U    9520,S    9530,U    9630,S    9640,U    9650,U    9670,S    9680,U

IDCOF    INTEGER                             9030,D

IDELE    INTEGER                             9030,D

IFLAG    INTEGER                             9130,S    9460,U    9590,S

IH       INTEGER                             8960,U    9170,P    9280,P    9450,P

IRSTRT   INTEGER                             9060,D    9210,U    9320,U

ITP      INTEGER                             9060,D

KV       INTEGER                             8960,U    9430,P    9740,P

LK       INTEGER                     204     9010,D

MATMUT   INTEGER                             9170,U    9280,U

N        INTEGER                             9020,D    9190,U    9310,U    9480,U    9640,U

NCLOSE   INTEGER                             9010,D

NELEMS   INTEGER                             9020,D

NEQ      INTEGER                             9020,D    9170,P    9180,U    9280,P    9300,U    9470,U    9630,U

NEQT     INTEGER                             9020,D    9240,U    9360,U

NH       INTEGER                             9020,D

NHNS     INTEGER                             9020,D

NN       INTEGER                             9020,D    9390,U    9530,U    9680,U

NNODES   INTEGER                             9020,D
```

```
                    INITIAL
VARIABLE TYPE       VALUE      DIMENSION    WHERE/HOW USED

NNPI     INTEGER                            9390,S   9400,U   9400,U   9400,U   9530,S   9540,U   9550,U   9550,U   9560,U   9680,S
                                            9690,U   9700,U   9700,U   9700,U   9710,U

NODRES   INTEGER                            9010,D

NPI      INTEGER                            9190,S   9200,U   9200,U   9200,U   9220,U   9240,U   9240,U   9240,U   9250,U   9310,S
                                            9330,U   9350,U   9350,U   9360,U   9360,U   9480,S   9490,U   9640,S   9650,U   9650,U
                                            9650,U

NPRNIT   INTEGER                            9060,D

NPRNT    INTEGER                            9060,D

NPRNTF   INTEGER                            9030,D

NPRNTL   INTEGER                            9030,D

NPRNTO   INTEGER                            9020,D

NRESTR   INTEGER                            9420,U   9740,U

NSIZE    INTEGER                            9020,D   9380,U   9520,U   9670,U

PS       REAL*8                             9040,D

QLOAD    REAL*8                      204    8980,D   9290,P   9330,S   9330,U   9350,S   9350,U   9490,U   9500,S   9650,U

QLOAD1   REAL*8                     1020    9070,D   9170,P   9220,S   9220,U   9240,S   9240,U   9330,S   9350,S   9500,S

QN       REAL*8                     1020    8990,D   9200,S   9200,U   9280,P   9490,S   9650,U

QN1      REAL*8                     1020    8990,D   9170,P   9200,U   9650,U

QN2      REAL*8                     1020    8990,D   9650,S

QP       REAL*8                     1020    8990,D   9350,U

QP1      REAL*8                     1020    8990,D   9240,U

QS       REAL*8                             8990,D

RESTRT   REAL*8                             9060,D

RSTRNT   REAL*8                             9010,D

SLVEEQ   REAL*8                             8980,D

SOLVEQ   REAL*8                             9450,U

TOT2     REAL*8                             9290,S   9330,U   9350,U

TIME     REAL*8                             9050,D   9140,U   9150,U
```

```
                      INITIAL
VARIABLE TYPE         VALUE          DIMENSION    WHERE/HOW USED

TIMEP      REAL*8                                  9060,D

TMET       REAL*8                                  9050,D

TOTIME     REAL*8                                  9050,D

T0         REAL*8                                  9050,D    9140,U    9140,U    9150,U    9150,U

T1         REAL*8                                  9050,D    9140,U    9150,U

T3         REAL*8                                  9140,S    9350,U

T3M1       REAL*8                                  9150,S    9240,U

XKEEP      REAL*8                                  9540,S    9560,U    9690,S    9710,U

XV         REAL*8                       6550       8980;D    9170,P    9400,S    9400,U    9540,U    9550,S    9690,U    9700,S    9700,U

XP         REAL*8                       6550       9040,D    9280,P    9400,U    9550,U    9560,S    9700,U    9710,S
```

```
                                                 INPUT

                   INITIAL
VARIABLE TYPE      VALUE       DIMENSION   WHERE/HOW USED

AL          REAL*8                   167     930,D    2650,S    2660,U    4310,S    4490,S

ALPHK       REAL*8                          4320,P

ALS         REAL*8                    50    1080,D    2890,S    2940,S    3020,U

ALST1       REAL*8                          2870,S    2890,U

ALT         REAL*8                    50    1080,D    2900,S    2950,S    3020,U

ALTT1       REAL*8                          2870,S    2900,U

ARCL        REAL*8                    50    1030,D    2720,S    2740,S    3030,U

CHALS       REAL*8                           930,D

CHECK       REAL*8                   8,8     930,D    2650,S    2660,U    4310,S    4490,S

COMENT      REAL*8                    20    1130,D    1150,S    1270,S    1280,U    1490,S    1510,U

CONST       REAL*8                           980,D

CONSTE      REAL*8                          1160,D    1200,S    3710,U    3980,S    4000,U    4060,U    4720,U

CONSTN      REAL*8   CONSTANT               1160,D    1170,S    3710,U    4000,U    4720,U

CONST1      REAL*8   8' ' S                 1160,D    1170,S    1200,U

COSINE      REAL*8                    51    1030,D    2720,S    2740,S    2740,S

COSM        REAL*8                    50    1030,D    2790,S

CYCLE       REAL*8                          1100,D

DATA        REAL*8                          1170,S

DCOS        REAL*8                          2790,U

DELTE       REAL*8                          1010,D

DELTEP      REAL*8                          1070,D    3280,S    3430,U    3510,U

DELTF       REAL*8                          1320,S    1780,U    2910,U    3430,U    4910,U    4950,U

DOUBLE      REAL*8                          1160,D

DSIN        REAL*8                          2800,U

DTH         REAL*8                50,5,2    1080,D    3310,S    3650,S    3660,S    3780,S    3780,U    3900,S    3900,U    3920,S    4450,S
                                            4580,U    4780,S    4780,U    4940,U

DTH1        REAL*8                     5    1130,D    4420,S    4450,U
```

INPUT

```
                     INITIAL
VARIABLE TYPE        VALUE      DIMENSION    WHERE/HOW USED

DT2        REAL*8                              980,D    2010,S

DUM        REAL*8                   1310      1140,D    1150,S    1590,S    1610,S    1640,S    1660,S    1690,S    1730,S

E1         REAL*8                     50      1020,D    2680,S    3020,U

E2         REAL*8                     50      1020,D    2690,S    3020,U

ENU1       REAL*8                     50      1020,D    2680,S    3020,U

ENU2       REAL*8                     50      1020,D    2680,S    3020,U

FORCE      REAL*8                   2040       950,D    3080,S    3090,S    3280,S    3580,S    3590,S    3740,S    3740,U    3840,S    3840,U
                                              3850,S    4190,S    4200,S    4210,S    4220,S    4700,U    4700,U    4700,U    4700,U    4740,S
                                              4740,U    4910,U

FRCES      REAL*9                             4220,U

F1         REAL*8                             4160,S    4190,U    4230,U

F2         REAL*8                             4160,S    4200,U    4230,U

F3         REAL*8                             4160,S    4210,U    4230,U

F4         REAL*8                             4160,S    4220,U    4230,U

G          REAL*8                     50      1020,D    2690,S    3020,U

GEOM       REAL*8                             1020,D

HARM       REAL*8                             1060,D

I          INTEGER                            1250,S    1340,U    1340,S    1370,U    1370,S    1590,U    1590,S    1610,U    1610,S    1640,U
                                              1640,S    1660,U    1660,S    1690,U    1690,S    1730,U    1730,S    1740,U    1740,S    1800,U
                                              1800,S    1810,U    1810,S    1930,S    1940,U    1940,U    2020,S    2030,U    2040,U    2140,U
                                              2180,U    2550,S    2560,U    2590,U    2650,U    2650,S    2650,U    2650,S    2660,U    2660,S
                                              2660,U    2660,S    2680,U    2680,S    2680,U    2680,S    2680,U    2680,S    2690,U    2690,S
                                              2690,U    2690,S    2690,U    2690,S    2700,S    2710,U    2720,U    2720,U    2720,U    2720,U
                                              2720,U    2720,U    2740,U    2740,U    2740,U    2740,U    2740,U    2740,U    2740,U    2750,U
                                              2770,U    2770,S    2770,U    2770,S    2780,S    2790,U    2790,U    2800,U    2800,U    3020,U
                                              3020,U    3020,U    3020,U    3020,U    3020,U    3020,U    3020,U    3030,U    3030,U    3030,U
                                              3030,U    3030,U    3030,S    3080,U    3080,S    3090,U    3090,S    3130,U    3130,S    3140,U
                                              3140,S    3170,U    3170,S    3190,U    3190,S    3270,U    3270,S    3280,U    3280,S    3290,U
                                              3290,S    3320,U    3320,S    3320,U    3320,S    3320,U    3320,S    3370,S    3380,U    3390,U
                                              3390,U    3400,U    3410,U    3420,U    3420,U    3430,U    3430,U    3430,U    3570,S    3580,U
                                              3590,U    3610,S    3630,U    3640,U    3650,U    3660,U    3730,S    3740,S    3740,S    3750,S
                                              3770,U    3770,U    3780,U    3780,U    3830,S    3840,U    3840,U    3850,U    3870,S    3890,U
                                              3890,U    3900,U    3900,U    3910,U    3920,U    4310,U    4310,S    4310,U    4310,S    4490,U
                                              4490,S    4490,U    4490,S    4680,S    4690,U    4700,U    4730,S    4740,U    4740,U    4750,S
                                              4770,U    4770,U    4780,U    4780,U    4900,U    4900,S    4910,U    4910,S    4920,U    4920,S
                                              4980,S    4990,U    4990,U    4990,U    4990,U    5000,U    5000,S    5000,U    5000,S    5000,U
                                              5000,S
```

INPUT

```
                   INITIAL
VARIABLE TYPE      VALUE      DIMENSION    WHERE/HOW USED

IB        INTEGER                           3940,S   3950,S   3960,U   4000,U   4180,U   4320,P   4390,U   4510,P   4520,P   4650,U
                                            4720,U   4820,S   4820,U   4830,U

IBP1      INTEGER                           3300,U   3300,S   3310,U   3310,S   4390,S   4450,U   4460,U   4580,U   4580,U   4930,U
                                            4930,S   4940,U   4940,S

IDCOF     INTEGER                            990,D   3980,S

IDELF     INTEGER                            990,D   3990,S   4280,U

IELM      INTEGER                           2880,S   2890,U   2900,U   2930,S   2940,U   2950,U   3300,U   3300,S   3310,U   3310,S
                                            4300,S   4320,P   4430,S   4450,U   4460,U   4480,S   4510,P   4520,P   4570,S   4580,U
                                            4580,U   4580,U   4930,U   4930,S   4940,U   4940,S

IELM1     INTEGER                           2870,S   2880,U   4420,S   4430,U

IELM2     INTEGER                           2870,S   2880,U   2910,U   4420,S   4430,U   4470,U

IFLAG     INTEGER                           2320,S   2330,U   2340,U   2350,U   2360,U   2460,S   2470,U   2480,U   2490,U   2500,U

IH        INTEGER                           2270,S   2280,U   2410,S   2420,U   3040,S   3060,U   3300,U   3300,S   3310,U   3310,S
                                            4000,S   4000,U   4140,U   4420,U   4420,U   4420,S   4440,S   4450,U   4450,U   4460,U
                                            4460,U   4550,S   4560,U   4580,U   4580,U   4640,S   4650,U   4660,U   4930,U   4930,S
                                            4940,U   4940,S

IHARM     INTEGER                     5     1060,D   1370,U   1740,U   1800,U   2590,U   3060,U   3160,U   3180,U   3270,S   4140,U
                                            4560,U   4660,U   4900,U

IH1       INTEGER                           4090,S   4180,U

II        INTEGER                           2570,S   2580,U   2590,U   2640,S

IN        INTEGER                           4170,S   4180,U   4230,U

INCRST    INTEGER                           1320,S   1780,U   3350,U

INODE     INTEGER                           2310,S   2320,U   2450,S   2460,U

INPUT     INTEGER                            910,D

IN1       INTEGER                           2300,S   2310,U   2440,S   2450,U   4160,S   4170,U

IN2       INTEGER                           2300,S   2310,U   2370,U   2440,S   2450,U   2510,U   4160,S   4170,U   4250,U

IPRINT    INTEGER                           1050,D   1320,S   1780,U

IO        INTEGER                           2560,S   2590,U   2590,U   2590,U   2590,U   2600,U   2600,U   2600,U   2600,U

ION       INTEGER                           2250,S   2260,U

ION1      INTEGER                           2250,S   2400,U
```

INPUT

```
                    INITIAL
VARIABLE TYPE       VALUE      DIMENSION   WHERE/HOW USED

IPSTRT   INTEGER                            1070,D    1320,S    1370,U    1390,U    1780,U    2060,U    3220,U

ITAM     INTEGER                            1100,D    4910,U    5020,U

ITCOE    INTEGER                            1090,D    3980,S    4400,U    4500,U

ITELE    INTEGER                            1090,D    1320,S    1790,U    2820,U    4340,U

ITR      INTEGER                            1070,D    3280,S    3350,U    3510,U

IX       INTEGER                            2580,S    2590,U    2590,U    2590,U    2600,U    2600,U    2600,U    2600,U    2600,U

J        INTEGER                            1270,U    1270,S    1280,U    1280,S    1490,U    1490,S    1510,U    1510,S    1600,U    1610,U
                                            1680,S    1690,U    1700,S    1720,U    2650,U    2650,S    2660,U    2660,S    3620,S    3630,U
                                            3640,U    3650,U    3660,U    3760,S    3770,U    3770,U    3780,U    3780,U    3880,S    3890,U
                                            3890,U    3900,U    3900,U    3910,U    3920,U    4310,U    4310,S    4490,U    4490,S    4760,S
                                            4770,U    4770,U    4780,U    4780,U

JH       INTEGER                            3050,S    3060,U    3120,U    3160,U    3180,U

JUNK     INTEGER                       20   1130,D    1450,S    1530,S    1740,S    3270,S    4900,U

K        INTEGER                            1480,S    1580,S    1620,S    1630,U    1720,S    4180,S    4190,U    4200,U    4210,U    4220,U
                                            4690,S    4700,U    4700,U    4700,U    4700,U

KEY      INTEGER                             910,U    1180,U    3710,U    3950,U

KEYRS    INTEGER                            1380,S    1390,S    1500,U    1540,U    1750,S

KK       INTEGER                            4650,S    4690,U

KYR      INTEGER                            4660,S    4670,U

LK       INTEGER                      204    970,D    2180,S    2190,S    2200,S    3280,S    3330,S    3340,S    4910,U

LL       INTEGER                            1050,D

N        INTEGER                             980,D    2280,S    2320,U    2420,S    2460,U

NCARDS   INTEGER                            1230,S    1240,U    1250,U    1450,S    1460,U    1480,U

NCE      INTEGER                            3990,S    4070,U

NCE1     INTEGER                            4110,S    4120,U

NCLCST   INTEGER                            1040,D    1330,S    1790,U

NCLOSE   INTEGER                             970,D    1320,S    1790,U

ND       INTEGER                            1110,D    1230,U    1270,U    1320,U    1340,U    1370,U    1790,U    2110,U    2160,U    2250,U
                                            2300,U    2440,U    2870,U    3980,U    4110,U    4160,U    4420,U
                    INITIAL
VARIABLE TYPE       VALUE      DIMENSION    WHERE/HOW USED

NDIRCT   INTEGER                              2160,S   2170,U   2180,U

NELEMS   INTEGER                               980,D   1530,S   1580,U   1600,U   1620,U   1630,U   1680,U   1710,U   1790,U   1960,U
                                              1990,U   2640,U   2680,U   2680,U   2680,U   2690,U   2690,U   2690,U   2700,U   2710,U
                                              2780,U   2910,U   2930,U   3030,U   3300,U   3310,U   3610,U   3750,U   3870,U   4300,U
                                              4470,U   4480,U   4570,U   4750,U   4930,U   4940,U

NEQ      INTEGER                               980,D   1970,S   1980,U   2280,U   2420,U   2560,U   4180,U   4650,U

NEQT     INTEGER                               980,D   1980,S   2020,U   3260,U   3320,U   3320,U   3320,U   3370,U   3570,U   3590,U
                                              3730,U   3740,U   3830,U   3840,U   3850,U   4180,U   4650,U   4730,U   4740,U   4890,U
                                              4980,U   5000,U   5000,U   5000,U

NH       INTEGER                               980,D   1370,S   1370,U   1740,S   1740,U   1800,U   1800,U   1980,U   2000,U   2270,U
                                              2410,U   2550,U   3050,U   3270,S   3270,U   3300,U   3310,U   3620,U   3760,U   3880,U
                                              4080,U   4420,U   4440,U   4550,U   4640,U   4760,U   4900,U   4900,U   4930,U   4940,U

NHNS     INTEGER                               980,D   2000,S

NHP      INTEGER                              1060,D   1530,S   1700,U   3040,U

NLTERM   INTEGER                              3360,U

NN       INTEGER                               980,D   3120,S   3130,U   3140,U   3170,U   3190,U

NNODES   INTEGER                               980,D   1960,S   1970,U   2370,U   2510,U   2570,U   2770,U   2770,U   4250,U   4680,U

NODRES   INTEGER                               970,D   2110,S   2120,U   2130,U   2140,U   2190,U   2200,U   3280,S   3280,U   3330,U
                                              3340,U   4910,U   4910,U

NOIT     INTEGER                              1050,D   1350,S

NP       INTEGER                              2160,S   2170,U   2180,U

NPRNIT   INTEGER                              1070,D   1330,S   1780,U

NPRNMS   INTEGER                              1330,S   1800,U   3150,U

NPRNT    INTEGER                              1070,D   1330,S   1780,U

NPRNTE   INTEGER                               990,D   1330,S   1790,U   4010,U   4600,U

NPRNTH   INTEGER                              1090,D   1330,S   1790,U   4540,U

NPRNTL   INTEGER                               990,D   1330,S   1790,U   4010,U   4130,U   4230,U

NPRNTQ   INTEGER                               980,D   1320,S   1780,U

NS       INTEGER                              1110,D   1790,U   2630,U   2660,U   4290,U   4310,U   4380,U   4490,U
```

```
                    INITIAL
VARIABLE TYPE       VALUE       DIMENSION   WHERE/HOW USED

NSIZE    INTEGER                              980,D   1710,S   1730,U   1990,S   2000,U   3080,U   3090,U   3120,U   3130,U   3140,U
                                             3170,U   3190,U

NSTRSS   INTEGER                             1040,D   1330,S   1790,U

NT       INTEGER                             1110,D   1230,S   1440,U   1450,U   1490,U   1530,U   1590,U   1610,U   1640,U   1660,U
                                             1690,U   1730,U   1740,U   1790,U   2650,U   2680,U   2720,U   2740,U   2770,U   3080,U
                                             3090,U   3130,U   3140,U   3270,U   3280,U   3300,U   3320,U   4900,U   4910,U   4930,U
                                             5000,U

NTE      INTEGER                             3260,S   3290,U   4890,S   4920,U

NTHETA   INTEGER                             1040,D   1340,S   1340,U   1810,U   1810,U   1930,U

PH       REAL*8                        50    1030,D   2720,S   2740,S   2790,U   2800,U   3030,U

PHP      REAL*8                        50    1030,D   2720,S   2740,S   3030,U

PI       REAL*8                              1910,S   1920,U

PPINT    REAL*8                              1050,D

PS       REAL*8                              1030,D

QDC1     REAL*8                              4970,S   4990,U

QDC2     REAL*8                              4960,S   4990,U

QDC3     REAL*8                              4950,S   4960,U   4970,U   4990,U

QLOAD    REAL*8                       204     940,D

QN       REAL*8                      1020     950,D   2030,S   2330,S   2340,S   2350,S   2360,S   2590,U   2590,U   2590,U   2590,U
                                             3320,S   3380,U   3390,U   4990,U   5000,U

QN1      REAL*8                      1020     950,D   2040,S   2470,S   2480,S   2490,S   2500,S   2600,U   2600,U   2600,U   2600,U
                                             3320,S   3390,U   3400,S   4990,U

QN2      REAL*8                      1020     950,D   4990,U

QP       REAL*8                      1020     950,D   3420,U   3430,U   3430,S   3430,U   4990,S   5000,U

QP1      REAL*8                      1020     950,D   3320,S   3410,U   3420,S   5000,U

QS       REAL*8                               950,D

Q1       REAL*8                              2300,S   2330,U   2440,S   2470,U

Q2       REAL*8                              2300,S   2340,U   2440,S   2480,U

Q3       REAL*8                              2300,S   2350,U   2440,S   2490,U
```

```
                      INITIAL
VARIABLE TYPE         VALUE       DIMENSION    WHERE/HOW USED

Q4        REAL*8                               2300,S    2360,U    2440,S    2500,U

R         REAL*8                          50   1030,D    2720,S    2740,S    3020,U

RAD       REAL*8                               1920,S    1940,U

RESTRT    REAL*8                               1070,D

RSTRNT    REAL*8                                970,D

R7        REAL*8                               1120,D

R9        REAL*8                          51   1120,D    2770,S

SINE      REAL*8                          51   1020,D    2720,S    2740,S    2740,S

SINM      REAL*8                          50   1030,D    2800,S

SLVEEQ    REAL*8                                940,D

T         REAL*8                          50   1020,D    2690,S    3030,U

TAPES     REAL*8                               1110,D

TFORCE    REAL*8                               4520,U

TH        REAL*8                      50,5,2   1080,D    3300,S    3630,S    3640,S    3770,S    3770,U    3890,S    3890,U    3910,S    4460,S
                                               4580,U    4770,S    4770,U    4930,U

THCOE     REAL*8                               4510,U

THCON     REAL*8                               1090,D

THER      REAL*8                               1080,D

THETA     REAL*8                               1040,D    1340,D    1810,S    1940,U    1940,S

THETAS    REAL*8                               1040,U

TH1       REAL*8                           5   1130,D    4420,S    4460,U

TIM       REAL*8                               3990,S    4050,U

TIME      REAL*8                               1010,D    4910,U    5010,U

TIMEP     REAL*8                               1070,D    3280,S    3500,U

TMET      REAL*8                               1010,D

TOTIME    REAL*8                               1010,D    1320,S    1780,U    3800,U    4900,U

TPRNT     REAL*8                               3500,S    3510,U    4950,S    4960,U    5010,S    5020,U
```

```
                                                   INPUT

                  INITIAL
VARIABLE TYPE     VALUE       DIMENSION   WHERE/HOW USED

TRI40R   REAL*8                            3210,U
T0       REAL*8                            1010,D   3280,S   3790,S   3960,S   4910,U
T1       REAL*8                            1010,D   3280,S   3790,U   3800,S   3960,U   3980,S   3990,U   4000,S   4910,U
XKEEP    REAL*8                            3380,S   3400,U   3410,S   3430,U
XN       REAL*8                   6550      940,D   1150,S   1150,S   3130,S   3170,U
XP       REAL*8                   6550     1000,D   3140,S   3190,U
Z        REAL*8                     51     1120,D   2770,S
```

```
                                                            MAIN

                  INITIAL
VARIABLE TYPE     VALUE      DIMENSION   WHERE/HOW USED

CARD      REAL*8                    20      130,D    140,S    300,S    310,U    330,U    330,U    390,U    400,U

CONST     REAL*8                             50,D

CYCLE     REAL*8                            110,D

DELTE     REAL*8                             70,D    580,U    580,U    630,U    730,U

DELTEP    REAL*8                            100,D

DT2       REAL*8                             50,D

FORCE     REAL*8                  2040       30,D

HARM      REAL*8                             90,D

I         INTEGER                           510,D    520,U

IDCOE     INTEGER                            60,D

IDELE     INTEGER                            60,D

IHARM     INTEGER                    5       90,D

INPUT     INTEGER                           470,U    670,D

IPRINT    INTEGER                            80,D

IRSTRT    INTEGER                           100,D    500,U    610,U

ITAM      INTEGER                           110,D    620,S    630,U    650,U    690,P    720,S    740,P

ITP       INTEGER                           100,D    550,S    580,U    610,U    630,U

KKP2      INTEGER                           580,S    590,U    620,U    650,U    720,U

LARGE     INTEGER                           490,S    690,P    700,U

LL        INTEGER                            80,D    600,S    610,S    620,U

MPRINT    INTEGER                           290,S    340,U    370,S    380,S    380,U

N         INTEGER                            50,D

NCARD     INTEGER                           270,S    310,U    320,S    320,U    410,U

NCASE     INTEGER                           220,S    280,S    280,U    350,U    420,S    420,U    430,U    460,S    480,S    480,U
                                            750,U

NCASES    INTEGER                           200,S    210,U    430,U    750,U

ND        INTEGER                           120,D    200,S    260,U    330,U    440,U
```

```
                      INITIAL
VARIABLE TYPE         VALUE       DIMENSION    WHERE/HOW USED

NELEMS    INTEGER                                 50,D

NEQ       INTEGER                                 50,D

NEQT      INTEGER                                 50,D      510,U

NH        INTEGER                                 50,D

NHNS      INTEGER                                 50,D

NHP       INTEGER                                 90,D

NLTERM    INTEGER                                740,U

NN        INTEGER                                 50,D

NNODES    INTEGER                                 50,D

NOIT      INTEGER                                 80,D      590,S

NPRNIT    INTEGER                                100,D

NPRNT     INTEGER                                100,D

NPRNTE    INTEGER                                 60,D

NPRNTL    INTEGER                                 60,D

NPRNTQ    INTEGER                                 50,D

NS        INTEGER                                120,D      200,S

NSIZE     INTEGER                                 50,D

NT        INTEGER                                120,D

PRINT     REAL*8                                  80,D

QN        REAL*8                     1020         30,D      140,S

QN1       REAL*8                     1020         30,D

QN2       REAL*8                     1020         30,D

QP        REAL*8                     1020         30,D

QP1       REAL*8                     1020         30,D      520,S

QS        REAL*8                                  30,D

RESTRT    REAL*8                                 100,D
```

```
                                                  MAIN

                  INITIAL
VARIABLE TYPE     VALUE       DIMENSION    WHERE/HOW USED


SETUP    REAL*8                               690,U

TAPES    REAL*8                               120,D

TEST     REAL*8   END                         150,S    310,U    330,U    400,U

TIME     REAL*8                                70,D    630,S    640,U    690,P    730,S    730,U

TIMER    REAL*8                               100,D    560,S    580,U    630,U

TMET     REAL*8                                70,D

TOTIME   REAL*8                                70,D    580,U

T0       REAL*8                                70,D    570,S    660,S

T1       REAL*8                                70,D    640,U    660,U
```

```
                                                        MATMUT

                    INITIAL
VARIABLE TYPE       VALUE      DIMENSION   WHERE/HOW USED


A        REAL*8                      204   10850,U  10870,D  10950,S  11040,S  11040,S  11050,S  11050,U  11060,S  11060,U  11070,S
                                           11070,U  11180,S  11180,U  11190,S  11190,U  11210,S  11210,U

FORCE    REAL*8                     1020   10850,U  10870,D  11040,U  11050,U  11060,U  11060,U  11070,U  11070,U  11080,U  11180,U
                                           11190,U  11210,U

I        INTEGER                           10940,S  10950,U  11020,S  11040,U  11040,U  11110,S  11120,U

IH       INTEGER                           10850,U  10980,U  10990,U

IID      INTEGER                           10850,U  10940,U  10960,U  10990,U

J        INTEGER                           11010,S  11020,U  11040,U  11140,U  11150,U  11180,U  11190,U  11190,U  11210,U  11210,U
                                           11210,U

JM1      INTEGER                           11150,S  11160,U

L        INTEGER                           11160,S  11180,U  11180,U  11190,U

MATMUT   INTEGER                           10850,D

NA       INTEGER                           11020,S  11030,S  11030,S  11040,U

NE       INTEGER                           10990,S  11040,U  11050,U  11060,U  11060,U  11070,U  11070,U  11080,U  11130,U

NEE      INTEGER                           11130,S  11180,U  11190,U  11210,U

NI       INTEGER                           11120,S  11130,U  11180,U  11180,U  11190,U  11190,U  11210,U  11210,U

NK       INTEGER                           10980,S  11000,U  11050,U  11060,U  11060,U  11070,U  11070,U  11070,U  11090,U

NKK      INTEGER                           11090,S  11170,S  11170,U  11180,U  11190,U  11200,S  11200,S  11210,U

NM1      INTEGER                           11100,S  11110,U

NN       INTEGER                           10960,S  10970,U  11100,U

NT       INTEGER                           10970,S  10980,U

STIFM    REAL*8                     6550   10850,U  10870,D  11040,U  11050,U  11060,U  11060,U  11070,U  11070,U  11070,U  11180,U
                                           11190,U  11210,U
```

NLTERM

```
                     INITIAL
VARIABLE TYPE        VALUE      DIMENSION    WHERE/HOW USED

ARCL        REAL*8                      50     6610,D

CC1         REAL*8                             6640,D    6780,S

CC2         REAL*8                             6640,D    6790,S

CONST       REAL*8                             6550,D

COSINE      REAL*8                      51     6610,D

COSM        REAL*8                      50     6610,D

DD1         REAL*8                             6640,D    6820,S

DD2         REAL*8                             6640,D    6830,S

DELTE       REAL*8                             6570,D

DT2         REAL*8                             6550,D

EES         REAL*8                             6620,D

ES          REAL*8                       5     6620,D

EST         REAL*8                       5     6620,D

ET          REAL*8                       5     6620,D

E1          REAL*8                      50     6600,D    6780,U    6820,U

E13         REAL*8                       5     6620,D

E2          REAL*8                      50     6600,D    6790,U    6830,U

E23         REAL*8                       5     6620,D

EN          REAL*8                             6770,S    6780,U    6790,U    6820,U    6830,U

ENU1        REAL*8                      50     6600,D    6770,U

ENU2        REAL*8                      50     6600,D    6770,U

FORCE       REAL*8                    2540     6580,D

G           REAL*8                      50     6600,D    6800,U    6810,U

GCD         REAL*8                             6640,D

GEOM        REAL*8                             6600,D

GG1         REAL*8                             6640,D    6800,S
```

NLTERM

```
                       INITIAL
VARIABLE TYPE          VALUE      DIMENSION    WHERE/HOW USED

GG2         REAL*8                              6640,D    6810,S

I           INTEGER                             6730,S    6740,U

IDCOE       INTEGER                             6560,D

IDELE       INTEGER                             6560,D

II          INTEGER                             6950,S    6960,U    6990,U    7000,U

IPRINT      INTEGER                             6660,D

ITAM        INTEGER                             6530,U    6920,U    6920,U    6920,U    6920,U    6930,P

TI          INTEGER                             6760,S    6770,U    6770,U    6780,U    6780,U    6790,U    6790,U    6800,U    6800,U    6810,U
                                                5810,U    6820,U    6820,U    6830,U    6830,U    6870,P    6930,P    6960,U

JJ          INTEGER                             6970,S    6980,U    6990,U    7000,U

KA          INTEGER                             6960,S    6980,U

KK          INTEGER                             6980,S    6990,U    6990,U    7000,U

LL          INTEGER                             6660,D

N           INTEGER                             6550,D

NCLCST      INTEGER                             6650,D    6930,U

NELEMS      INTEGER                             6550,D    6760,U

NEQ         INTEGER                             6550,D    6960,U

NEQT        INTEGER                             6550,D    6730,U

NH          INTEGER                             6550,D    6950,U

NHNS        INTEGER                             6550,D

NLTERM      INTEGER                             6530,D

NLTRMS      INTEGER                             6620,D

NN          INTEGER                             6550,D

NNODES      INTEGER                             6550,D

NOIT        INTEGER                             6660,D    6930,U

NPRNTE      INTEGER                             6560,D

NPRNTL      INTEGER                             6560,D
```

```
                                                      NLTERM

                        INITIAL
VARIABLE TYPE     VALUE       DIMENSION   WHERE/HOW USED


NPRNTO   INTEGER                           6550,D

NSIZE    INTEGER                           6550,D

NSTRSS   INTEGER                           6650,D   6910,U   6920,U   6920,U   6930,U

NTHETA   INTEGER                           6650,D

PH       REAL*8                      50    6610,D

PHP      REAL*8                      50    6610,D

PRINT    REAL*8                            6660,D

QN       REAL*8                    1020    6580,D

QN1      REAL*8                    1020    6580,D

QN2      REAL*8                    1020    6580,D

QP       REAL*8                    1020    6590,D   6740,S   6990,S   6990,U   7000,S

QPR      REAL*8                     8,5    6630,D   6990,U   7000,U

QPRIME   REAL*8                            6870,U

QP1      REAL*8                    1020    6580,D

QS       REAL*8                            6580,D

R        REAL*8                      50    6610,D

SINE     REAL*8                      51    6600,D

SINM     REAL*8                      50    6610,D

STRESS   REAL*8                            6930,U

T        REAL*8                      50    6600,D   6780,U   6790,U   6800,U   6810,U   6820,U   6830,U

THETA    REAL*8                      20    6650,D

THETAS   REAL*8                            6650,D

TIME     REAL*8                            6570,D

TMET     REAL*8                            6570,D

TOTIME   REAL*8                            6570,D

T0       REAL*8                            6570,D
```

NLTERM

VARIABLE	TYPE	INITIAL VALUE	DIMENSION	WHERE/HOW USED
TI	REAL*8			6570,D

NRESTR

```
                      INITIAL
VARIABLE TYPE         VALUE       DIMENSION    WHERE/HOW USED

CONST       REAL*8                             10280,D

DT2         REAL*8                             10290,D

FORCE       REAL*8                      204    10270,D  10720,S

I           INTEGER                            10420,S  10440,U  10440,U  10440,U  10470,S  10480,U  10480,U  10480,U  10540,S  10550,U
                                               10570,U  10570,U  10570,U  10570,U  10610,S  10620,U  10620,U  10620,U  10620,U  10690,S
                                               10700,U  10700,U  10700,U  10700,U  10800,S  10810,U

IDCOF       INTEGER                            10290,D

IDELF       INTEGER                            10290,D

IELM        INTEGER                            10400,S  10410,U  10540,U  10570,U  10590,U  10600,U  10620,U  10640,U  10660,U  10670,S
                                               10670,U  10700,U

J           INTEGER                            10430,S  10440,U  10460,S  10480,U  10560,S  10570,U  10590,S  10620,U  10640,U  10680,S
                                               10680,U  10700,U

K           INTEGER                            10440,S  10450,U  10480,S  10490,U  10500,S  10510,U  10570,S  10580,U  10620,S  10630,U
                                               10640,S  10650,U  10700,S  10710,U  10810,S  10820,U

KY          INTEGER                            10250,U  10360,U  10780,U

L           INTEGER                            10380,S  10390,U

LK          INTEGER                     204    10300,D  10390,U

M           INTEGER                            10280,D

N           INTEGER                            10550,S  10560,U  10600,S  10610,U  10640,U  10640,U  10640,U  10640,U

NCLOSE      INTEGER                            10300,D  10360,U

NELEMS      INTEGER                            10280,D  10660,U

NEQ         INTEGER                            10390,U  10400,U  10420,U  10430,U  10460,U  10470,U  10500,U  10500,U  10500,U  10500,U
                                               10540,U  10590,U  10600,U  10720,U

NEQT        INTEGER                            10280,D

NH          INTEGER                            10280,D

NHNS        INTEGER                            10280,D

NIX         INTEGER                            10280,D

NN          INTEGER                            10280,D  10440,U  10480,U  10500,U  10570,U  10620,U  10640,U  10700,U

NNODES      INTEGER                            10280,D  10800,U
```

```
                                                        NRESTR

                   INITIAL
VARIABLE TYPE      VALUE      DIMENSION    WHERE/HOW USED

NODRE     INTEGER                          10350,S  10360,S  10360,U  10370,U  10380,U

NODRES    INTEGER                          10330,D  10350,U

NPRNTE    INTEGER                          10290,D

NPRNTL    INTEGER                          10290,D

NPRNTO    INTEGER                          10280,D

NRESTR    INTEGER                          10250,D

NSIZE     INTEGER                          10280,D

RSTRNT    REAL*8                           10330,D

SLVEEQ    REAL*8                           10270,D

STIEM     REAL*8                    6553   10270,D  10450,S  10490,S  10510,S  10580,S  10630,S  10650,S  10710,S  10790,S  10820,S
```

```
                          INITIAL
VARIABLE TYPE             VALUE       DIMENSION    WHERE/HOW USED

ALS         REAL*8                           50    7170,D    8820,U    8830,U

ALT         REAL*8                           50    7170,D    8820,U    8830,U

ARCL        REAL*8                           50    7140,D

ARCLT       REAL*8                                 7380,S    7440,U    7450,U    7460,U    7470,U    7480,U    7490,U

ARL         REAL*8                                 7330,S    7340,U    7350,U    7380,U    7900,U    8670,U

CCC         REAL*8                          125    7090,D    8100,U    8120,U    8150,U    8820,U

CCCC        REAL*8                          625    7100,D    8520,U

CC1         REAL*8                                 7150,D    8100,U    8120,U    8150,U    8170,U    8510,U    8520,U    8820,U

CC2         REAL*8                                 7150,D    8120,U    8170,U    8540,U    8830,U

CES         REAL*8                                 7920,S    8100,S    8100,U    8210,U    8240,U    8260,U    8290,U

CEST        REAL*8                                 7940,S    8140,S    8140,U    8210,U    8230,U    8240,U    8260,U    8280,U    8290,U

CET         REAL*8                                 7930,S    8120,S    8130,U    8230,U    8240,U    8280,U    8290,U

CE13        REAL*8                                 7950,S    8150,S    8160,U    8210,U    8240,U    8260,U    8290,U    8690,S    8820,S    8820,U
                                                   8860,U    8880,U    8890,U    8910,U

CE23        REAL*8                                 7960,S    8170,S    8180,U    8210,U    8230,U    8240,U    8260,U    8280,U    8290,U    8700,S
                                                   8820,S    8830,U    8860,U    8870,U    8880,U    8890,U    8900,U    8910,U

CE413       REAL*8                                 8340,S    8520,S    8520,S    8580,U    8600,U    8610,U    8630,U

CE423       REAL*8                                 8350,S    8540,S    8540,U    8580,U    8590,U    8600,U    8610,U    8620,U    8630,U

CL2R        REAL*8                                 7570,S    7650,U

CONST       REAL*8                                 7070,D

COPH        REAL*8                                 7350,S    7420,U    7450,U    7470,U    7550,U    7570,U

COSINE      REAL*8                           51    7140,D

COSM        REAL*8                           50    7140,D

CO2R        REAL*8                                 7550,S    7630,U

CS          REAL*8                                 7090,D

CSS         REAL*8                          125    7090,D    8140,U    8170,U    8830,U

CS4         REAL*8                                 7100,D
```

```
                                                            QPRIME

                       INITIAL
VARIABLE TYPE          VALUE      DIMENSION   WHERE/HOW USED

DD1        REAL*8                             7150,D

DD2        REAL*8                             7150,D

DELTE      REAL*8                             7190,D

DRO        REAL*8                             7310,S    7330,U    7330,U    7340,U

DSQRT      REAL*8                             7330,U

DTH        REAL*8                 50,5,2      7170,D

DT2        REAL*8                             7070,D

DZ         REAL*8                             7320,S    7330,U    7330,U    7350,U

EES        REAL*8                             7110,D

ES         REAL*8                      5      7110,D    7820,S    8150,U    8170,U

ESQ1       REAL*8                             7500,S    7820,U    8210,U

ESQ3       REAL*8                             7510,S    7820,U    8240,U

ESQ5       REAL*8                             7520,S    7820,U    8260,U

ESQ7       REAL*8                             7530,S    7820,U    8290,U

EST        REAL*8                      5      7110,D    7830,S    8160,U    8180,U

ESTQ1      REAL*8                      5      7230,D    7660,S    7830,U    8210,U

ESTQ2      REAL*8                             7480,S    7830,U    8230,U

ESTQ3      REAL*8                      5      7230,D    7670,S    7830,U    8240,U

ESTQ5      REAL*8                      5      7240,D    7680,S    7830,U    8260,U

ESTQ6      REAL*8                             7490,S    7840,U    8290,U

ESTQ7      REAL*8                      5      7240,D    7690,S    7840,U    8290,U

ET         REAL*8                      5      7110,D    7800,S    8150,U    8170,U

ETQ2       REAL*8                      5      7240,D    7700,S    7710,U    7800,U    8230,U

ETQ3       REAL*8                             7400,S    7800,U    8240,U

ETQ6       REAL*8                      5      7240,D    7710,S    7800,U    8280,U

ETQ7       REAL*8                             7410,S    7800,U    8290,U
```

```
                          INITIAL
VARIABLE TYPE             VALUE      DIMENSION   WHERE/HOW USED

E1          REAL*8                          50   7130,D

E13         REAL*8                           5   7110,D   7850,S   8100,U   8100,U   8120,U   8120,U   8140,U   8150,U   8170,U   8510,U
                                                 8520,U   8520,U   8520,U   8540,U   8820,U

E1301       REAL*8                               7440,S   7510,U   7850,U   8210,U   8580,U   8860,U

E1303       REAL*8                               7450,S   7500,U   7850,U   8240,U   8600,U   8880,U

E1305       REAL*8                               7460,S   7530,U   7850,U   8260,U   8610,U   8890,U

E1307       REAL*8                               7470,S   7520,U   7850,U   8290,U   8630,U   8910,U

E2          REAL*8                          50   7130,D

E23         REAL*8                           5   7110,D   7860,S   8100,U   8100,U   8120,U   8120,U   8140,U   8160,U   8170,U   8510,U
                                                 8520,U   8540,U   8540,U   8540,U   8830,U

E2301       REAL*8                           5   7230,D   7620,S   7670,U   7860,U   8210,U   8580,U   8860,U

E2302       REAL*8                               7420,S   7430,U   7860,U   8230,U   8590,U   8870,U

E2303       REAL*8                           5   7230,D   7630,S   7660,U   7860,U   8240,U   8600,U   8880,U

E2305       REAL*8                           5   7230,D   7640,S   7690,U   7860,U   8260,U   8610,U   8890,U

E2306       REAL*8                               7430,S   7870,U   8280,U   8620,U   8900,U

E2307       REAL*8                           5   7230,D   7650,S   7680,U   7870,U   8290,U   8630,U   8910,U

ENU1        REAL*8                          50   7130,D   8100,U   8120,U   8150,U   8170,U   8510,U   8820,U

ENU2        REAL*8                          50   7130,D   8830,U

EOR         REAL*8                               8510,S   8520,U   8540,U

FORCE       REAL*8                        2040   7200,D

G           REAL*8                          50   7130,D

GCO         REAL*8                               7150,D

GEOM        REAL*8                               7130,D

GG1         REAL*8                               7150,D   8140,U   8150,U   8170,U   8510,U

GG2         REAL*8                               7150,D

HARM        REAL*8                               7160,D
```

```
                                                    QPRIMA
                       INITIAL
VARIABLE TYPE          VALUE      DIMENSION    WHERE/HOW USED

I         INTEGER                              7980,S   7990,U   8010,S   8020,U   8100,U   8100,U   8120,U   8120,U   8140,U   8150,U
                                               8160,U   8170,U   8180,U   8370,S   8380,U   8510,U   8520,U   8540,U   8720,S   8730,U
                                               8820,U   8830,U

IABS      INTEGER                              8070,U   8420,U   8460,U   8780,U

IDCOE     INTEGER                              7080,D

IDELE     INTEGER                              7080,D

IEQ       INTEGER                              8320,S   8490,S   8490,U   8520,U   8520,U   8540,U   8540,U

IH        INTEGER                              7590,S   7600,U   7620,U   7630,U   7640,U   7650,U   7660,U   7660,U   7670,U   7670,U
                                               7680,U   7690,U   7690,U   7690,U   7700,U   7710,U   7710,U   7730,U   7800,U   7800,U
                                               7800,U   7820,U   7820,U   7830,U   7830,U   7830,U   7840,U   7850,U   7860,U   7860,U
                                               7860,U   7860,U   7870,U

IHARM     INTEGER                       5      7160,D   7600,U   7970,U   8020,U   8040,U   8360,U   8380,U   8400,U   8440,U   8710,U
                                               8730,U   8750,U

II        INTEGER                              8020,S   8050,U   8060,U   8380,S   8410,U   8420,U   8730,S   8760,U   8770,U

IMJ       INTEGER                              8060,S   8070,U   8420,S   8470,U   8470,U   8770,S   8780,U

IPJ       INTEGER                              8050,S   8070,U   8410,S   8470,U   8470,U   8760,S   8780,U

ITCOE     INTEGER                              7180,D

ITELE     INTEGER                              7180,D   8650,U

ITH       INTEGER                              7890,S   8080,S   8080,U   8100,U   8100,U   8120,U   8120,U   8140,U   8150,U   8150,U
                                               8170,U   8660,S   8800,S   8800,U   8820,U   8830,U

I1        INTEGER                              7050,U   7290,U   7300,U   7730,U   8100,U   8120,U   8150,U   8170,U   8510,U   8790,U
                                               8790,U   8790,U   8820,U   8820,U   8820,U   8830,U   8830,U   8830,U

J         INTEGER                              8030,S   8040,U   8100,U   8100,U   8120,U   8120,U   8140,U   8150,U   8150,U   8160,U
                                               8170,U   8170,U   8170,U   8390,S   8400,U   8520,U   8520,U   8540,U   8540,U   8740,S
                                               8750,U   8790,U   8790,U   8790,U

JJ        INTEGER                              8040,S   8050,U   8060,U   8400,S   8410,U   8420,U   8750,S   8760,U   8770,U

J1        INTEGER                              7290,S   7310,U   7320,U   7360,U

J11       INTEGER                              7300,U   7310,U   7320,U   7360,U

K         INTEGER                              7600,S   7610,U   7970,S   8070,U   8070,U   8430,S   8440,U   8510,U   8520,U   8540,U
                                               8710,S   8780,U   8780,U

KK        INTEGER                              7730,S   7740,U   7750,U   7760,U   7770,U   7780,U   7790,U   8440,S   8450,U   8460,U
```

OPRIME

```
                      INITIAL
VARIABLE TYPE         VALUE        DIMENSION    WHERE/HOW USED

KK1       INTEGER                               7740,U   7820,U   7830,U   7850,U   7860,U

KK2       INTEGER                               7750,S   7800,U   7830,U   7860,U

KK3       INTEGER                               7760,S   7800,U   7820,U   7830,U   7850,U   7860,U

KK5       INTEGER                               7770,S   7820,U   7840,U   7850,U   7870,U

KK6       INTEGER                               7780,S   7800,U   7840,U   7870,U

KK7       INTEGER                               7790,S   7800,U   7820,U   7840,U   7850,U   7870,U

KML       INTEGER                               8460,S   8470,U   8470,U

KPL       INTEGER                               8450,S   8470,U   8470,U

L         INTEGER                               8330,S   8360,U   8580,U   8580,U   8580,U   8590,U   8590,U   8600,U   8600,U   8600,U
                                                8610,U   8610,U   8610,U   8620,U   8620,U   8630,U   8630,U   8630,U

LL        INTEGER                               8360,S   8450,U   8460,U

M         INTEGER                               7910,S   7970,U   7990,U   8210,U   8210,U   8210,U   8220,U   8230,U   8230,U   8230,U
                                                8240,U   8240,U   8240,U   8250,U   8260,U   8260,U   8260,U   8270,U   8280,U   8280,U
                                                8280,U   8290,U   8290,U   8290,U   8300,U   8680,U   8710,U   8860,U   8860,U   8860,U
                                                8870,U   8870,U   8880,U   8880,U   8880,U   8890,U   8890,U   8890,U   8900,U   8900,U
                                                8910,U   8910,U   8910,U

N         INTEGER                               7070,D

NELEMS    INTEGER                               7070,D

NEQ       INTEGER                               7070,D   7730,U

NEQT      INTEGER                               7070,D

NH        INTEGER                               7070,D   7590,U   7910,U   8010,U   8030,U   8330,U   8370,U   8390,U   8430,U   8680,U
                                                8720,U   8740,U

NHNS      INTEGER                               7070,D

NHP       INTEGER                               7160,D

NLTRMS    INTEGER                               7120,D

NN        INTEGER                               7070,D

NNODES    INTEGER                               7070,D

NPRNTE    INTEGER                               7080,D

NPRNTH    INTEGER                               7190,D
```

QPRIME

```
                     INITIAL
VARIABLE TYPE        VALUE        DIMENSION   WHERE/HOW USED

NPRNTL   INTEGER                              7080,D

NPRNTO   INTEGER                              7070,D

NSIZE    INTEGER                              7070,D

PH       REAL*8                          50   7140,D

PHP      REAL*8                          50   7140,D

QN       REAL*8                        1020   7200,D  7800,U  7800,U  7800,U  7800,U  7820,U  7820,U  7820,U  7820,U  7830,U
                                              7830,U  7830,U  7840,U  7840,U  7840,U  7850,U  7850,U  7850,U  7850,U  7860,U
                                              7860,U  7860,U  7870,U  7870,U  7870,U

QN1      REAL*8                        1020   7200,D

QN2      REAL*8                        1020   7200,D

QP       REAL*8                        1020   7200,D

QPP      REAL*8                         8,5   7120,D  7990,S  8210,S  8210,U  8230,S  8230,U  8240,S  8250,U  8260,S  8260,U
                                              8280,S  8290,U  8290,S  8300,U  8580,S  8580,U  8590,S  8590,U  8600,S  8600,U
                                              8610,S  8610,U  8620,S  8620,U  8630,S  8630,U  8860,S  8860,U  8870,S  8870,U
                                              8880,S  8880,U  8890,S  8890,U  8900,S  8900,U  8910,S  8910,U

QPRIME   REAL*8                               7050,D

QP1      REAL*8                        1020   7200,D

QS       REAL*8                               7200,D

R        REAL*8                          50   7140,D

RL       REAL*8                               8670,S  8860,U  8870,U  8880,U  8890,U  8900,U  8910,U

RM       REAL*8                               7360,S  7370,U  7900,U  8670,U

RO       REAL*8                          51   7220,D  7310,U  7310,U  7360,U  7360,U

RSL      REAL*8                               7900,S  8210,U  8230,U  8250,U  8260,U  8280,U  8300,U  8580,U  8590,U  8600,U
                                              8610,U  8620,U  8630,U

RZ       REAL*8                               7220,D

RZI      REAL*8                               7370,S  7400,U  7410,U  7420,U  7480,U  7490,U  7550,U  7560,U  7570,U  7580,U
                                              7700,U

SCCS     REAL*8                         625   7100,D  8540,U

SINE     REAL*8                          51   7130,D

SINM     REAL*8                          50   7140,D
```

QPRIME

```
                    INITIAL
VARIABLE TYPE       VALUE       DIMENSION    WHERE/HOW USED

STPH      REAL*8                             7340,S   7440,U   7460,U   7480,U   7490,U   7560,U   7580,U

SL2R      REAL*8                             7560,S   7640,U

SO2R      REAL*8                             7580,S   7620,U

SSC       REAL*8                      125    7090,D   8100,U   8120,U   8150,U

SSCC      REAL*8                      625    7100,D   8520,U

SSSS      REAL*8                      625    7100,D   8540,U

T         REAL*8                       50    7130,D

TH        REAL*8                   50,5,2    7170,D   8790,U   8790,U   8790,U

THCON     REAL*8                             7180,D

THER      REAL*8                             7170,D

THT       REAL*8                             8790,S   8820,U   8830,U

TIME      REAL*8                             7190,D   8790,U

TMET      REAL*8                             7190,D

TOTIME    REAL*8                             7190,D

T0        REAL*8                             7190,D   8790,U   8790,U

T1        REAL*8                             7190,D   8790,U

XK        REAL*8                             7610,S   7620,U   7630,U   7640,U   7650,U   7700,U

Z         REAL*8                       51    7220,D   7320,U   7320,U
```

```
                                                            SETUP

                     INITIAL
VARIABLE TYPE        VALUE       DIMENSION   WHERE/HOW USED

CC1        REAL*8                              5730,D

CC2        REAL*8                              5730,D

CONST      REAL*8                              5710,D

CS         REAL*8                              6120,S   6180,U

DABS       REAL*8                              6330,U

DCOS       REAL*8                              6120,U

DD1        REAL*8                              5730,D

DD2        REAL*8                              5730,D

DELTER     REAL*8                              5770,D

DSIN       REAL*8                              6110,U

DT2        REAL*8                              5710,D

FORCE      REAL*8                        2040  5690,D

GCD        REAL*8                              5730,D

GG1        REAL*8                              5730,D

GG2        REAL*8                              5730,D

HARM       REAL*8                              5760,D

HOURO1     REAL*8                              5880,U

HOURON     REAL*8                              5870,U

I          INTEGER                             5960,S   5970,U   5980,U   6060,S   6070,U   6250,S   6260,U   6270,U

IDCDE      INTEGER                             5720,D

IDELE      INTEGER                             5720,D

IH         INTEGER                             5830,S   5840,U   5850,U   5860,U   5870,P   5880,P   6000,U

IHARM      INTEGER                          5  5760,D   5840,U   6100,U

INPUT      INTEGER                             6400,U

IPRINT     INTEGER                             5750,D   5890,U   5890,U

IRSTRT     INTEGER                             5770,D
```

```
                        INITIAL
VARIABLE TYPE           VALUE       DIMENSION     WHERE/HOW USED

IT       INTEGER                                   5890,S    5910,U    6050,S    6110,U    6120,U    6230,U

ITAM     INTEGER                                   5660,U    5820,U    5820,P    5870,U    5880,U    5890,U    5890,U    5900,U    5910,U    5940,U
                                                   6220,U    6350,U    6390,U    6390,U

ITP      INTEGER                                   5770,D

IT1      INTEGER                                   6390,S    6400,U

I1       INTEGER                                   6130,S    6140,U

J        INTEGER                                   5980,U    5980,S    6160,S    6170,U    6180,U    6180,U    6180,U    6200,U    6200,U    6200,U
                                                   6270,U    6270,U

JH       INTEGER                                   6080,S    6090,S    6100,U

K        INTEGER                                   5970,S    5980,U    6140,S    6150,U    6180,U    6180,U    6200,U    6200,U    6260,S    6270,U

KY       INTEGER                                   5840,S    5870,P    5880,P    5950,U

LARGE    INTEGER                                   5660,U    6340,S

LF       INTEGER                                   6330,U

LL       INTEGER                                   5750,D    5820,U    5870,U    5880,U

N        INTEGER                                   5710,D    5860,S    5970,U    6090,S    6150,U    6330,U

NELOST   INTEGER                                   5740,D

NELEMS   INTEGER                                   5710,D

NEQ      INTEGER                                   5710,D    5860,U    6060,U    6090,U

NEQT     INTEGER                                   5710,D

NH       INTEGER                                   5710,D    5830,U    6000,U    6010,U    6080,U

NHNS     INTEGER                                   5710,D

NHP      INTEGER                                   5760,D

NLTERM   INTEGER                                   5820,U

NN       INTEGER                                   5710,D    5850,S

NNODES   INTEGER                                   5710,D    5960,U    6130,U    6250,U

NOIT     INTEGER                                   5750,D    5900,U

NPK      INTEGER                                   6150,S    6180,U    6200,U
```

SETUP

```
                    INITIAL
VARIABLE TYPE       VALUE     DIMENSION    WHERE/HOW USED

NPRNIT   INTEGER                           5770,D   6390,U   6390,U

NPRNT    INTEGER                           5770,D   6390,U   6400,U

NPRNTF   INTEGER                           5720,D

NPRNTL   INTEGER                           5720,D

NPRNTQ   INTEGER                           5710,D   5920,U

NSIZE    INTEGER                           5710,D   5850,U

NSTRSS   INTEGER                           5740,D

NTHETA   INTEGER                           5740,D   6050,U

PRINT    REAL*8                            5750,D

QLOAD    REAL*8                   204      5680,D   6070,S   6180,S   6180,U   6200,S   6200,U   6270,U

QN       REAL*8                  1020      5690,D   5980,U   6180,U   6200,U   6330,U

QN1      REAL*8                  1020      5690,D

QN2      REAL*8                  1020      5690,D

QP       REAL*8                  1020      5690,D

QP1      REAL*8                  1020      5690,D

QS       REAL*8                            5690,D

RESTRT   REAL*8                            5770,D

SETUP    REAL*8                            5660,D

SLVEFD   REAL*8                            5680,D

SN       REAL*8                            6110,S   6200,U

THETA    REAL*8                    20      5740,D   6110,U   6120,U   6230,U

THETAS   REAL*8                            5740,D

THETA1   REAL*8                            6230,S   6240,U

TIME     REAL*8                            5660,U   5930,U   6350,U

TIMEP    REAL*8                            5770,D

TPRNT    REAL*8                            5930,S   5940,U   6220,U
```

```
                                                                SETUP

                      INITIAL
VARIABLE TYPE         VALUE        DIMENSION   WHERE/HOW USED

XIH1      REAL*8                                6100,S   6110,U   6120,U

XV        REAL*8                         6550   5680,D
```

```
                    INITIAL
VARIABLE TYPE       VALUE       DIMENSION   WHERE/HOW USED

A        REAL*8                     1310    11310,D  11410,S  11460,S  11460,U  11460,U  11470,S  11470,U  11470,U  11470,U  11470,U
                                            11480,S  11480,U  11480,U  11480,U  11490,S  11490,U  11490,U  11490,U  11500,S  11500,U
                                            11500,U  11510,S  11510,U  11510,U  11520,S  11520,U  11520,U  11520,U  11520,U  11520,U
                                            11520,U  11520,U  11530,S  11530,U  11530,U  11530,U  11530,U  11530,U  11540,S  11540,U
                                            11540,U  11550,S  11550,U  11550,U  11560,S  11560,U  11560,U  11570,S  11570,U  11570,U
                                            11570,U  11570,U  11570,U  11570,U  11570,U  11570,U  11570,U  11570,U  11580,U  11590,U
                                            11590,U  11600,U  11600,U  11600,U  11650,U  11660,U  11670,U  11680,U  11690,U  11700,U
                                            11720,U  11730,U  11740,U  11750,U  11760,U  11770,U  11780,U  11790,U  11800,U  11810,U
                                            11820,U  11830,U  11840,U  11850,U  11860,U  11870,U  11880,U  11890,U  11900,U  11910,U
                                            11920,U  11930,U  11940,U  11950,U  11960,U  11970,U  11980,U  11990,U  12000,U  12010,U
                                            12020,U  12030,U  12040,U  12050,U  12060,U  12070,U  12600,S  12610,S  12620,S  12630,S
                                            12640,S  12650,S  12680,S  12690,S  12700,S  12710,S  12720,S  12730,S  12740,S  12750,S
                                            12760,S  12770,S  12780,S  12790,S  12800,S  12810,S  12820,S  12830,S  12840,S  12850,S
                                            12860,S  12870,S  12880,S  12890,S  12900,S  12910,S  12920,S  12930,S  12940,S  12950,S
                                            12960,S  12970,S  12980,S  12990,S  13000,S  13010,S  13020,S  13030,S  13060,U  13070,U
                                            13070,U  13080,U  13080,U  13090,U  13120,U  13120,U  13120,U  13120,U  13130,U  13130,U
                                            13130,U  13130,U  13140,U  13150,U  13150,U  13150,U  13160,U  13160,U  13160,U  13170,U
                                            13170,U  13170,U  13180,U  13180,U  13180,U  13180,U  13240,U  13250,U  13250,U  13260,U
                                            13260,U  13260,U  13270,U  13270,U  13270,U  13270,U  13320,U  13320,U  13320,U  13320,U
                                            13330,U  13340,U  13340,U  13340,U  13340,U  13350,U  13350,U  13360,U  13360,U  13360,U
                                            13360,U  13370,U  13370,U  13370,U  13380,U  13380,U  13380,U  13380,U  13390,U  13390,U
                                            13390,U  13390,U  13410,U  13410,U  13410,U  13410,U  13420,U  13430,U  13430,U  13430,U
                                            13430,U  13440,U  13440,U  13450,U  13450,U  13450,U  13450,U  13460,U  13460,U  13460,U
                                            13470,U  13470,U  13470,U  13470,U  13480,U  13480,U  13480,U  13480,U  13550,U

AM1      REAL*8                             11910,U  12230,U  12310,U  12330,U  12400,U  12430,U  12510,U  12550,U  12770,U

AM10     REAL*8                             11650,S  11720,S  12200,U  12230,U  12280,U  12330,U  12370,U  12430,U  12480,U  12550,U
                                            12600,U  12680,U

AM2      REAL*8                             11800,S  12160,U  12170,U  12180,U  12190,U  12760,U

AM3      REAL*8                             11790,S  12160,U  12170,U  12180,U  12190,U  12750,U

AM4      REAL*8                             11780,S  12160,U  12170,U  12180,U  12190,U  12740,U

AM5      REAL*8                             11700,S  11770,S  12220,U  12230,U  12300,U  12330,U  12390,U  12430,U  12500,U  12550,U
                                            12650,U  12730,U

AM6      REAL*8                             11690,S  11760,S  12120,U  12130,U  12140,U  12150,U  12640,U  12720,U

AM7      REAL*8                             11680,S  11750,S  12120,U  12130,U  12140,U  12150,U  12630,U  12710,U

AM8      REAL*8                             11670,S  11740,S  12210,U  12230,U  12290,U  12330,U  12380,U  12430,U  12490,U  12550,U
                                            12620,U  12700,U

AM9      REAL*8                             11660,S  11730,S  12080,U  12090,U  12100,U  12110,U  12610,U  12690,U

AT       REAL*8                             11820,S  12090,U  12120,U  12160,U  12200,S  12200,U  12230,U  12230,U  12240,U  12250,U
                                            12260,U  12270,U  12780,U
```

```
                                                       SOLVED

                            INITIAL
VARIABLE TYPE               VALUE        DIMENSION      WHERE/HOW USED


A1          REAL*8                                      11830,S  12080,S  12080,U  12120,U  12160,U  12210,S  12210,S  12230,U  12230,U  12240,U
                                                        12250,U  12260,U  12270,U  12790,U

A10         REAL*8                                      11920,S  12330,S  12330,U  12420,U  12440,U  12530,U  12560,U  12880,U

A11         REAL*8                                      11930,S  12100,U  12140,U  12180,U  12250,U  12340,U  12370,S  12370,U  12430,U  12430,U
                                                        12450,U  12460,U  12890,U

A12         REAL*8                                      11940,S  12100,S  12100,U  12140,U  12180,U  12250,U  12340,U  12380,S  12380,U  12430,U
                                                        12430,U  12450,U  12460,U  12900,U

A13         REAL*8                                      11950,S  12140,S  12140,U  12180,U  12250,U  12340,U  12390,S  12390,U  12430,U  12430,U
                                                        12450,U  12460,U  12910,U

A14         REAL*8                                      11960,S  12180,S  12180,U  12250,U  12340,U  12400,S  12400,U  12430,U  12430,U  12450,U
                                                        12460,U  12920,U

A15         REAL*8                                      11970,S  12250,S  12250,U  12340,U  12410,S  12410,U  12430,U  12430,U  12450,U  12460,U
                                                        12930,U

A16         REAL*8                                      11980,S  12340,S  12340,U  12420,S  12420,U  12440,U  12440,U  12450,U  12470,U  12940,U

A17         REAL*8                                      11990,S  12430,S  12430,U  12540,U  12560,U  12950,U

A18         REAL*8                                      12000,S  12110,U  12150,U  12190,U  12260,U  12350,U  12450,U  12480,S  12480,U  12550,U
                                                        12550,U  12570,U  12960,U

A19         REAL*8                                      12010,S  12110,S  12110,U  12150,U  12190,U  12260,U  12350,U  12450,U  12490,S  12490,U
                                                        12550,U  12550,U  12570,U  12970,U

A2          REAL*8                                      11840,S  12120,S  12120,U  12160,U  12220,S  12220,U  12230,U  12230,U  12240,U  12250,U
                                                        12260,U  12270,U  12800,U

A20         REAL*8                                      12020,S  12150,S  12150,U  12190,U  12260,U  12350,U  12450,U  12500,S  12500,U  12550,U
                                                        12550,U  12570,U  12980,U

A21         REAL*8                                      12030,S  12190,S  12190,U  12260,U  12350,U  12450,U  12510,S  12510,U  12550,U  12550,U
                                                        12570,U  12990,U

A22         REAL*8                                      12040,S  12260,S  12260,U  12350,U  12450,U  12520,S  12520,U  12550,U  12550,U  12570,U
                                                        13000,U

A23         REAL*8                                      12050,S  12350,S  12350,U  12450,U  12530,S  12530,U  12560,U  12560,U  12580,U  13010,U

A24         REAL*8                                      12060,S  12450,S  12450,U  12540,S  12540,U  12560,U  12560,U  12580,U  13020,U

A25         REAL*8                                      12070,S  12550,S  12550,U  13030,U

A3          REAL*8                                      11850,S  12160,S  12160,U  12230,U  12230,U  12240,U  12250,U  12260,U  12270,U  12810,U
```

```
                     INITIAL
VARIABLE TYPE        VALUE        DIMENSION    WHERE/HOW USED

A4         REAL*8                              11860,S  12230,S  12230,U  12320,U  12330,U  12410,U  12430,U  12520,U  12550,U  12820,U

A5         REAL*8                              11870,S  12090,U  12130,U  12170,U  12240,U  12280,S  12280,U  12330,U  12330,U  12340,U
                                               12350,U  12360,U  12830,U

A6         REAL*8                              11890,S  12090,S  12090,U  12130,U  12170,U  12240,U  12290,S  12290,U  12330,U  12330,U
                                               12340,U  12350,U  12360,U  12840,U

A7         REAL*8                              11890,S  12130,S  12130,U  12170,U  12240,U  12300,S  12300,U  12330,U  12330,U  12340,U
                                               12350,U  12360,U  12850,U

A8         REAL*8                              11900,S  12170,S  12170,U  12240,U  12310,S  12310,U  12330,U  12330,U  12340,U  12350,U
                                               12360,U  12860,U

A9         REAL*8                              11910,S  12240,S  12240,U  12320,S  12320,U  12330,U  12330,U  12340,U  12350,U  12360,U
                                               12870,U

CONST      REAL*8                              11270,D

CYCLE      REAL*8                              11300,D

DT2        REAL*8                              11270,D

I          INTEGER                             11390,S  11400,U  11410,U  11420,S  11430,U  11430,U  11620,S  11650,U  11660,U  11670,U
                                               11680,U  11690,U  11700,U  11720,U  11730,U  11740,U  11750,U  11760,U  11770,U  11780,U
                                               11790,U  11800,U  11810,U  11820,U  11830,U  11840,U  11850,U  11860,U  11870,U  11880,U
                                               11890,U  11900,U  11910,U  11920,U  11930,U  11940,U  11950,U  11960,U  11970,U  11980,U
                                               11990,U  12000,U  12010,U  12020,U  12030,U  12040,U  12050,U  12060,U  12070,U  12600,U
                                               12610,U  12620,U  12630,U  12640,U  12650,U  12680,U  12690,U  12700,U  12710,U  12720,U
                                               12730,U  12740,U  12750,U  12760,U  12770,U  12780,U  12790,U  12800,U  12810,U  12820,U
                                               12830,U  12840,U  12850,U  12860,U  12870,U  12880,U  12890,U  12900,U  12910,U  12920,U
                                               12930,U  12940,U  12950,U  12960,U  12970,U  12980,U  12990,U  13000,U  13010,U  13020,U
                                               13030,U  13500,S  13510,U  13510,U  13530,S  13540,U  13550,U

IDCOF      INTEGER                             11280,D

IDELE      INTEGER                             11280,D

IH         INTEGER                             11240,U

IPRINT     INTEGER                             11290,D

ITAM       INTEGER                             11300,D  11440,U  13520,U

J          INTEGER                             11630,S  12270,U  12270,U  12270,U  12270,U  12270,U  12270,U  12360,U  12360,U  12360,U
                                               12360,U  12360,U  12360,U  12360,U  12460,U  12460,U  12460,U  12460,U  12460,U  12460,U
                                               12460,U  12470,U  12570,U  12570,U  12570,U  12570,U  12570,U  12570,U  12570,U  12580,U
                                               12580,U

K          INTEGER                             11610,S  11620,U  11630,U  13090,S  13100,U  13110,U  13280,S  13290,U  13300,U
```

```
                                                      SOLVEQ

                   INITIAL
VARIABLE TYPE      VALUE      DIMENSION   WHERE/HOW USED

KEY      INTEGER                          11450,S  11640,U  12590,U  12660,S

L        INTEGER                          13110,U  13120,U  13120,U  13120,U  13120,U  13130,S  13130,U  13130,U  13130,U  13140,U
                                          13150,U  13150,U  13150,U  13160,U  13160,U  13160,U  13170,U  13170,U  13170,U  13180,U
                                          13180,U  13180,U  13180,U  13290,S  13310,U  13320,U  13320,U  13320,U  13320,U  13330,U
                                          13340,U  13340,U  13340,U  13340,U  13350,U  13350,U  13360,U  13360,U  13360,U  13360,U
                                          13370,U  13370,U  13370,U  13380,U  13380,U  13380,U  13380,U  13390,U  13390,U  13390,U
                                          13390,U  13410,U  13410,U  13410,U  13410,U  13420,U  13430,U  13430,U  13430,U  13430,U
                                          13440,U  13440,U  13450,U  13450,U  13450,U  13450,U  13460,U  13460,U  13460,U  13470,U
                                          13470,U  13470,U  13470,U  13480,U  13480,U  13480,U  13480,U

LL       INTEGER                          11290,S  11440,U  13520,U

M        INTEGER                          13230,S  13240,U  13240,U  13250,U  13250,U  13250,U  13260,U  13260,U  13260,U  13260,U
                                          13270,U  13270,U  13270,U  13270,S  13270,U

N        INTEGER                          13110,U  13120,U  13120,U  13120,U  13120,U  13120,U  13120,U  13130,U  13130,U  13130,U
                                          13130,U  13130,U  13130,U  13140,U  13150,U  13150,U  13150,U  13150,U  13150,U  13150,U
                                          13160,U  13160,U  13170,U  13170,U  13170,U  13170,U  13170,U  13170,U  13180,U  13180,U
                                          13180,U  13220,S  13240,U  13250,U  13250,U  13260,    13260,U  13260,U  13270,U  13270,U
                                          13270,U  13270,U  13300,S  13320,U  13320,U  13320,U  13320,U  13320,U  13330,U  13340,U
                                          13340,U  13340,U  13340,U  13340,U  13340,U  13350,U  13360,U  13360,U  13360,U  13360,U
                                          13360,U  13370,U  13370,U  13370,U  13380,U  13380,U  13380,U  13380,U  13380,U  13380,U
                                          13390,U  13390,U  13390,U  13410,U  13410,U  13410,U  13410,U  13410,U  13420,U  13430,U
                                          13430,U  13430,U  13430,U  13430,U  13430,U  13440,U  13450,U  13450,U  13450,U  13450,U
                                          13450,U  13450,U  13460,U  13460,U  13470,U  13470,U  13470,U  13470,U  13470,U  13470,U
                                          13480,U  13480,U  13480,U

NELEMS   INTEGER                          11270,U  11610,U  13090,U  13220,U  13230,U  13280,U  13290,U  13300,U

NEQ      INTEGER                          11270,D  11420,U  13500,U

NEQT     INTEGER                          11270,D

NH       INTEGER                          11270,D

NHNS     INTEGER                          11270,D

NM       INTEGER                          11270,D  11400,U  13540,U

NNODES   INTEGER                          11270,D

NNPI     INTEGER                          11400,S  11410,U  13540,S  13550,S

NOIT     INTEGER                          11290,D

NPRNTE   INTEGER                          11280,D

NPRNTL   INTEGER                          11280,D

NPRNTO   INTEGER                          11270,D
```

SOLVEQ

```
                   INITIAL
  VARIABLE TYPE    VALUE        DIMENSION   WHERE/HOW USED

  NSIZE    INTEGER                           11270,D  11390,U  13530,U

  NW       INTEGER                           11270,D

  PRINT    REAL*8                            11290,D

  R        REAL*8                    204     11310,D  11430,S  11580,S  11580,U  11580,U  11590,S  11590,U  11590,U  11590,U  11600,S
                                             11600,U  11600,U  11600,U  11600,U  12270,S  12270,U  12270,U  12270,U  12270,U  12270,U
                                             12360,S  12360,U  12360,U  12360,U  12360,U  12360,U  12360,U  12460,S  12460,U  12460,U
                                             12460,U  12460,U  12460,U  12460,U  12470,U  12570,S  12570,U  12570,U  12570,U  12570,U
                                             12570,U  12570,U  12580,U  12580,U  13060,S  13060,U  13060,U  13070,S  13070,U  13070,U
                                             13070,U  13080,S  13080,U  13080,U  13080,U  13080,U  13120,S  13120,U  13120,U  13120,U
                                             13120,U  13120,U  13130,S  13130,U  13130,U  13130,U  13130,U  13130,U  13140,U  13150,S
                                             13150,U  13150,U  13150,U  13150,U  13150,U  13160,U  13160,U  13170,S  13170,U  13170,U
                                             13170,U  13170,U  13170,U  13180,U  13180,U  13180,U  13240,S  13240,U  13250,S  13250,U
                                             13250,U  13260,S  13260,U  13260,U  13260,U  13270,S  13270,U  13270,U  13270,U  13270,U
                                             13320,S  13320,U  13320,U  13320,U  13320,U  13320,U  13340,S  13340,S  13340,U  13340,U
                                             13340,U  13340,U  13350,U  13360,S  13360,U  13360,U  13360,U  13360,U  13360,U  13370,U
                                             13370,U  13380,S  13380,U  13380,U  13380,U  13380,U  13390,U  13390,U  13390,U  13390,U
                                             13410,S  13410,U  13410,U  13410,U  13410,U  13410,U  13430,S  13430,U  13430,U  13430,U
                                             13430,U  13430,U  13440,U  13450,S  13450,U  13450,U  13450,U  13450,U  13450,U  13460,U
                                             13460,U  13470,S  13470,U  13470,U  13470,U  13470,U  13470,U  13480,U  13480,U  13480,U
                                             13510,U

  SLVEEQ   REAL*8                            11260,D

  SOLVEQ   REAL*8                            11240,D

  SPA      REAL*8                   6550     11260,D  11410,U  13550,S

  SPR      REAL*8                    204     11260,D  11430,U  13510,S
```

```
                                              STRESS

                     INITIAL
VARIABLE TYPE        VALUE       DIMENSION    WHERE/HOW USED

AAV        REAL*8                             14590,S  14600,U  14620,U

ALS        REAL*8                        50   13710,D  14090,U  14150,U

ALT        REAL*8                        50   13710,D  14100,U  14180,U

ARCL       REAL*8                        50   13650,D  14140,U  14210,U  14210,U  14590,U  14590,U

BSL        REAL*8                             14460,S  14550,U  14650,U

BSTL       REAL*8                             14480,S  14550,U  14650,U

BSTMST     REAL*8                        20   13720,S  14620,U  14630,U  14680,S

BSTRMS     REAL*8                        20   13720,D  14600,U  14660,S

BSTRMT     REAL*8                        20   13720,D  14610,U  14670,S

BSTTMT     REAL*8                        20   13720,D  14620,U  14700,S

BSTU       REAL*8                             14450,S  14550,U  14650,U

BSU        REAL*8                             14430,S  14540,U  14650,U

BTL        REAL*8                             14470,S  14550,U  14650,U

BTTMST     REAL*8                        20   13720,D  14690,U  14690,S

BTU        REAL*8                             14440,S  14540,U  14650,U

CC1        REAL*8                             13660,D  14340,U  14340,U

CC2        REAL*8                             13660,D  14350,U  14350,U

CHIS       REAL*8                             13890,S  14160,S  14160,U  14370,U  14380,U

CHIST      REAL*8                             13930,S  14240,S  14240,U  14390,U

CHIST1     REAL*8                             14230,S  14240,U  14270,U

CHIS1      REAL*8                             14140,S  14160,U  14250,U

CHIS2      REAL*8                             14150,S  14160,U  14250,U

CHIT       REAL*8                             13890,S  14190,S  14190,U  14370,U  14380,U

CHIT1      REAL*8                             14170,S  14190,U  14260,U

CHIT2      REAL*8                             14180,S  14190,U  14260,U

CONST      REAL*8                             13610,D
```

```
                                              STRESS

                        INITIAL
 VARIABLE TYPE          VALUE      DIMENSION   WHERE/HOW USED

 COSINE    REAL*8                      51      13650,D  14120,U  14130,U

 COSM      REAL*8                      50      13650,D  14210,U  14220,U

 CS        REAL*8                              13980,S  14040,U  14050,U  14070,U  14090,U  14100,U  14160,U  14190,U  14270,U

 CTHIS     REAL*8                              13910,S  14250,S  14250,U  14500,U

 CTHIST    REAL*8                              13930,S  14270,S  14270,U  14510,U

 CTHIT     REAL*8                              13920,S  14260,S  14260,U  14500,U

 C1ST      REAL*8                              14410,S  14430,U  14440,U  14450,U  14460,U  14470,U  14480,U

 C2ST      REAL*8                              14420,S  14430,U  14440,U  14450,U  14460,U  14470,U  14480,U

 DCOS      REAL*8                              13980,U

 DD1       REAL*8                              13660,D  14370,U  14370,U

 DD2       REAL*8                              13660,D  14380,U  14380,U  14500,U  14500,U

 DELTE     REAL*8                              13680,D  13790,U

 DSIN      REAL*8                              13900,U  14610,U  14630,U

 DTH       REAL*8                  50,5,2      13710,D  14020,U  14020,U  14020,U

 DTHT      REAL*8                              14020,S  14150,U  14180,U

 DT2       REAL*8                              13610,D

 EES       REAL*8                              13600,D

 EPS       REAL*8                              14300,S  14340,U  14350,U

 EPST      REAL*8                              14320,S  14360,U

 EPT       REAL*8                              14310,S  14340,U  14350,U

 ES        REAL*8                       5      13600,D  14040,U

 EST       REAL*8                       5      13600,D  14060,U

 ESTU      REAL*8                              13850,S  14060,S  14060,U  14320,U

 ESU       REAL*8                              13830,S  14040,S  14040,U  14300,U

 ESUT      REAL*8                              13940,S  14090,S  14090,U  14300,U

 ET        REAL*8                       5      13600,D  14050,U
```

```
                    INITIAL
  VARIABLE TYPE     VALUE      DIMENSION   WHERE/HOW USED


   ETU      REAL*8                         13840,S  14050,S  14050,U  14310,U

   ETUT     REAL*8                         14100,S  14100,U  14310,U

   E1       REAL*8                    50   13640,D

   E13      REAL*8                     5   13690,D  14070,U  14170,U  14200,U

   E13U     REAL*8                         13860,S  14070,S  14070,U  14300,U  14320,U

   E2       REAL*8                    50   13640,D

   E23      REAL*8                     5   13690,D  14080,U  14170,U  14200,U

   E23U     REAL*8                         13870,S  14080,S  14080,U  14310,U  14320,U

   ENU1     REAL*8                    50   13640,D  14340,U  14370,U

   ENU2     REAL*8                    50   13640,D  14350,U  14380,U  14500,U

   FORCE    REAL*8                  2040   13690,D

   G        REAL*8                    50   13640,D

   GCD      REAL*8                         13660,D

   GEOM     REAL*8                         13640,D

   GG1      REAL*8                         13660,D  14360,U

   GG2      REAL*8                         13660,D  14390,U  14510,U

   HARM     REAL*8                         13670,D

   I        INTEGER                        13820,S  13980,U  13990,U  14520,U  14600,U  14600,U  14610,U  14620,U  14620,U  14630,U
                                           14660,U  14670,U  14680,U  14690,U  14700,U

   IDCOF    INTEGER                        13620,U

   IDELE    INTEGER                        13620,D

   IH       INTEGER                        13960,S  13970,U  14000,U  14010,U  14010,U  14010,U  14020,U  14020,U  14020,U  14040,U
                                           14050,U  14060,U  14070,U  14080,U  14170,U  14170,U  14200,U  14200,U

   IHARM    INTEGER                    5   13670,D  13970,U

   ITAM     INTEGER                        13580,U  13780,U

   ITAM1    INTEGER                        13780,S  13810,U
```

```
                     INITIAL
VARIABLE TYPE        VALUE      DIMENSION   WHERE/HOW USED

I1       INTEGER                            13580,U  13810,U  14000,U  14010,U  14010,U  14010,U  14020,U  14020,U  14020,U  14090,U
                                            14100,U  14120,U  14120,U  14130,U  14130,U  14140,U  14150,U  14170,U  14170,U  14180,U
                                            14200,U  14200,U  14210,U  14210,U  14210,U  14210,U  14220,U  14220,U  14220,U  14220,U
                                            14220,U  14340,U  14350,U  14370,U  14380,U  14410,U  14420,U  14500,U  14530,U  14540,U
                                            14570,U  14570,U  14580,U  14580,U  14590,U  14590,U  14600,U  14600,U  14620,U  14620,U
                                            14640,U

K        INTEGER                            14000,U  14120,U  14120,U  14130,U  14130,U  14140,U  14140,U  14210,U  14210,U  14220,U
                                            14220,U

N        INTEGER                            13610,D

NCLCST   INTEGER                            13630,D

NELEMS   INTEGER                            13610,D

NEQ      INTEGER                            13610,D  14000,U

NEQT     INTEGER                            13610,D

NH       INTEGER                            13610,D  13960,U

NHNS     INTEGER                            13610,D

NHP      INTEGER                            13670,D

NN       INTEGER                            13610,D

NNODES   INTEGER                            13610,D

NPRNTE   INTEGER                            13620,D

NPRNTL   INTEGER                            13620,D

NPRNTQ   INTEGER                            13610,D

NSIZE    INTEGER                            13610,D

NSTRSS   INTEGER                            13630,D

NTHETA   INTEGER                            13630,D  13820,U

PAV      REAL*8                             14580,S  14610,U  14630,U

PH       REAL*8                      50     13650,D  14580,U  14580,U

PHP      REAL*8                      50     13650,D  14220,U

QB3      REAL*8                             14120,S  14200,U  14210,U

QB7      REAL*8                             14130,S  14200,U  14210,U
```

```
                    INITIAL
VARIABLE TYPE       VALUE      DIMENSION   WHERE/HOW USED

QN       REAL*8                     1020   13690,D  14120,U  14120,U  14130,U  14130,U  14140,U  14140,U  14210,U  14210,U  14220,U
                                           14220,U

QN1      REAL*8                     1020   13690,D

QN2      REAL*8                     1020   13690,D

QP       REAL*8                     1020   13690,D

QP1      REAL*8                     1020   13690,D

QS       REAL*8                            13690,D

R        REAL*8                       50   13650,D  14170,U  14210,U  14220,U  14220,U  14570,U  14570,U  14600,U  14600,U  14620,U
                                           14620,U

RAV      REAL*8                            14570,U  14600,U  14620,U

SHRS     REAL*8                            14600,S  14640,U

SHRT     REAL*8                            14620,S  14650,U

SINE     REAL*8                       51   13640,D  14120,U  14130,U

SINM     REAL*8                       50   13650,D  14170,U  14200,U  14200,U  14220,U

SM       REAL*8                            13920,S  14060,U  14080,U  14240,U  14250,U  14260,U

STRESS   REAL*8                            13580,D

STRMS    REAL*8                            14370,S  14430,U  14460,U  14540,U  14600,U  14640,U  14660,U

STRMST   REAL*8                            14390,S  14450,U  14480,U  14540,U  14620,U  14630,U  14640,U  14680,U

STRMT    REAL*8                            14380,S  14440,U  14470,U  14540,U  14610,U  14640,U  14670,U

STRNS    REAL*8                            14340,S  14430,U  14460,U  14540,U  14640,U

STRNST   REAL*8                            14360,S  14450,U  14480,U  14540,U  14640,U

STRNT    REAL*8                            14350,S  14440,U  14470,U  14540,U  14640,U

STTMST   REAL*8                            14510,S  14600,U  14690,U

STTRMT   REAL*8                            14500,S  14620,U  14700,U

T        REAL*8                       50   13640,D  14410,U  14420,U

TH       REAL*8                   50,5,2   13710,D  14010,U  14010,U  14010,U

THER     REAL*8                            13710,D
```

```
                                                  STRESS

                 INITIAL
VARIABLE TYPE    VALUE      DIMENSION   WHERE/HOW USED

THETA    REAL*8                    20   13630,D  13980,U  13990,U  14520,U

THETAS   REAL*8                         13630,D

THETA1   REAL*8                         14520,S  14540,U  14640,U

THT      REAL*8                         14010,S  14090,U  14100,U

TIME     REAL*8                         13680,D  13790,U  14010,U  14020,U

TMET     REAL*8                         13680,D

TM1      REAL*8                         13790,S  13800,U

TOTIME   REAL*8                         13680,D

TPRINT   REAL*8                         13800,S  13810,U

T0       REAL*8                         13680,D  14010,U  14010,U  14020,U  14020,U

T1       REAL*8                         13680,D  14010,U  14020,U

XIH1     REAL*8                         13970,S  13980,U  13990,U  14170,U  14200,U  14200,U  14210,U  14250,U  14260,U  14270,U
```

```
                                              TFORCE

                         INITIAL
VARIABLE TYPE     VALUE       DIMENSION    WHERE/HOW USED

AL         REAL*8                      167    16910,D  17290,U  17280,U  17290,U  17300,U  17300,U  17300,U  17310,U  17320,U  17320,U
                                              17320,U  17330,U  17330,U  17340,U  17340,U  17340,U  17350,U  17350,U  17360,U  17360,U
                                              17360,U  17380,U  17390,U  17380,U  17390,U  17390,U  17400,U  17400,U  17420,U  17420,U

ALS        REAL*8                       50    16890,U  17020,U  17050,U  17060,U  17090,U

ALT        REAL*8                       50    16890,D  17030,U  17040,U  17070,U  17080,U

ARCL       REAL*8                       50    16880,D  17150,U  17150,U  17160,U  17160,U  17190,U  17190,U  17210,U  17210,U

CES        REAL*8                        4    16970,D  17020,S  17040,S  17060,S  17080,S  17280,U  17280,U  17280,U  17300,U  17300,U
                                              17310,U  17320,U  17320,U  17320,U  17330,U  17340,U  17340,U  17340,U  17350,U  17360,U
                                              17360,U  17360,U  17380,U  17380,U  17380,U  17390,U  17400,U  17400,U  17420,U  17420,U

CHALS      REAL*8                             16910,D

CHECK      REAL*8                      8,8    16910,D  17510,U

CONST      REAL*8                             16920,D

COSINE     REAL*8                       51    16880,D

COSM       REAL*8                       50    16880,D

DTH        REAL*8                   50,5,2    16890,D  17270,U  17290,U  17310,U  17330,U  17350,U  17370,U  17390,U  17400,U  17420,U

DT2        REAL*8                             16920,D

F1         REAL*8                       50    16870,D  17020,U  17060,U

F2         REAL*8                       50    16870,D  17040,U  17080,U

FNU1       REAL*8                       50    16870,D  17020,U  17020,U  17040,U  17060,U  17070,U  17080,U

FNU2       REAL*8                       50    16870,D  17020,U  17040,U  17040,U  17060,U  17080,U  17090,U

FORCE      REAL*8                     2040    16940,D  17540,S  17540,U

G          REAL*8                       50    16870,D

GEOM       REAL*8                             16870,D

HARM       REAL*8                             16900,D

I          INTEGER                            17480,S  17490,U  17510,U  17510,U  17510,U  17520,S  17530,U  17540,U

IB         INTEGER                            16850,U  17230,U  17530,U
```

```
                                                 TFORCE

                      INITIAL
VARIABLE TYPE         VALUE      DIMENSION    WHERE/HOW USED


IRPI        INTEGER                           17230,S  17270,U  17270,U  17280,U  17290,U  17300,U  17310,U  17320,U  17330,U  17340,U
                                              17350,U  17360,U  17370,U  17380,U  17390,U  17400,U  17410,U  17420,U  17430,U

IDCOF       INTEGER                           16930,D

IDELE       INTEGER                           16930,D

IELM        INTEGER                           16850,U  17020,U  17020,U  17020,U  17020,U  17020,U  17030,U  17030,U  17040,U  17040,U
                                              17040,U  17040,U  17040,U  17050,U  17050,U  17050,U  17060,U  17060,U  17060,U  17070,U
                                              17070,U  17070,U  17080,U  17080,U  17080,U  17080,U  17090,U  17090,U  17090,U  17130,U
                                              17140,U  17150,U  17150,U  17150,U  17150,U  17160,U  17160,U  17160,U  17160,U  17190,U
                                              17190,U  17190,U  17190,U  17210,U  17210,U  17210,U  17210,U  17270,U  17270,U  17280,U
                                              17290,U  17300,U  17310,U  17320,U  17330,U  17340,U  17350,U  17360,U  17370,U  17380,U
                                              17390,U  17400,U  17400,U  17420,U  17420,U  17530,U

IH          INTEGER                           17240,U  17250,U  17270,U  17270,U  17280,U  17290,U  17300,U  17310,U  17320,U  17330,U
                                              17340,U  17350,U  17360,U  17370,U  17380,U  17390,U  17400,U  17410,U  17420,U  17430,U
                                              17530,U

IHARM       INTEGER                        5  16900,D  17250,U

J           INTEGER                           17460,S  17470,U  17470,U  17500,S  17510,U  17510,U  17530,U  17540,U  17540,U

KYP         INTEGER                           17250,S  17260,U  17440,U

N           INTEGER                           16920,D

NELEMS      INTEGER                           16920,D  17140,U

NEQ         INTEGER                           16920,D  17530,U

NEQT        INTEGER                           16920,D  17530,U

NH          INTEGER                           16920,D  17240,U

NHNS        INTEGER                           16920,D

NHP         INTEGER                           16920,D

NN          INTEGER                           16920,D

NNODES      INTEGER                           16920,D

NPRNTE      INTEGER                           16930,D

NPRNTL      INTEGER                           16930,D

NPRNTQ      INTEGER                           16920,D

NSIZE       INTEGER                           16920,D

PH          REAL*8                        50  16880,D
```

```
                                                  TFORCE

                    INITIAL
VARIABLE TYPE       VALUE      DIMENSION    WHERE/HOW USED

PHP        REAL*8                     50    16880,D  17150,U  17150,U  17160,U  17160,U  17190,U  17190,U  17210,U  17210,U

PHPP       REAL*8                           17170,S  17190,S  17210,S  17360,U  17390,U

PHPP1      REAL*8                           17150,S  17170,U

PHPP2      REAL*8                           17160,S  17170,U

PI         REAL*8                           17010,S  17020,U  17040,U  17060,U  17080,U

Q          REAL*8                      8    16960,D  17280,S  17300,S  17320,S  17340,S  17360,S  17380,S  17400,S  17420,S  17470,S
                                            17470,S  17510,U

QN         REAL*8                   1020    16940,D

QN1        REAL*8                   1020    16940,D

QN2        REAL*8                   1020    16940,D

QP         REAL*8                   1020    16940,D

QP1        REAL*8                   1020    16940,D

QQ         REAL*8                      8    16960,D  17490,S  17510,S  17510,U  17540,U

QS         REAL*8                           16940,D

QUES       REAL*8                           16960,D

R          REAL*8                     50    16880,D

SINF       REAL*8                     51    16870,D

SINM       REAL*8                     50    16880,D

T          REAL*8                     50    16870,D  17020,U  17040,U  17060,U  17080,U

TFORCE     REAL*8                           16850,D

TH         REAL*8                 50,5,2    16890,D  17270,U  17280,U  17300,U  17320,U  17340,U  17360,U  17380,U  17400,U  17420,U

THER       REAL*8                           16890,D

YKP        REAL*8                           17260,S  17280,U  17300,U  17330,U  17350,U  17400,U  17400,U  17420,U  17420,U
```

```
                                                THCOF

                      INITIAL
VARIABLE TYPE         VALUE        DIMENSION   WHERE/HOW USED


ALS         REAL*8                        50   16150,D

ALT         REAL*8                        50   16150,D

ANG         REAL*8                             16330,S  16350,U

CONST       REAL*8                             16120,D

DSIN        REAL*8                             16610,U  16610,U  16620,U  16620,U

DTH         REAL*8                    50,5,2   16150,D  16740,S

DT2         REAL*8                             16120,D

FRCE        REAL*8                             16140,D

HARM        REAL*8                             16160,D

I           INTEGER                            16300,U  16300,U  16300,U  16300,S  16390,U  16390,U  16390,U  16400,U  16400,S  16520,S
                                               16530,U  16530,U  16530,U  16540,U  16540,U  16540,U  16580,S  16590,U  16600,U  16610,U
                                               16620,U

IB          INTEGER                            16100,U  16720,U

IBP1        INTEGER                            16720,S  16730,U  16740,U

IDCOF       INTEGER                            16130,D

IDELE       INTEGER                            16130,D

IDP         INTEGER                            16420,S  16430,U  16430,U

IELM        INTEGER                            16100,U  16220,U  16240,U  16240,U  16250,U  16730,U  16740,U

IELM1       INTEGER                            16300,S  16390,U

IELM2       INTEGER                            16220,S  16240,U  16300,S  16390,U

IH          INTEGER                            16450,S  16460,U  16730,U  16740,U

IHARM       INTEGER                        5   16160,D  16460,U

KEY         INTEGER                            16340,S  16350,U  16360,U  16370,U

KYP         INTEGER                            16460,S  16470,U  16510,U  16660,U

LE          INTEGER                            16240,U

N           INTEGER                            16120,D

NO          INTEGER                            16170,D  16300,U
```

THCOF

```
                    INITIAL
VARIABLE TYPE       VALUE      DIMENSION   WHERE/HOW USED

NDP      INTEGER                           16300,S  16300,U  16310,U  16320,U  16330,U  16400,U  16410,U  16500,U  16520,U  16580,U

NDP2     INTEGER                           16310,S  16340,U

ND2      INTEGER                           16410,S  16420,U

NELEMS   INTEGER                           16120,D

NEQ      INTEGER                           16120,D

NEQT     INTEGER                           16120,D

NH       INTEGER                           16120,D  16450,U

NHNS     INTEGER                           16120,D

NHP      INTEGER                           16160,D

NN       INTEGER                           16120,D

NNODES   INTEGER                           16120,D

NPRNTE   INTEGER                           16130,D

NPRNTL   INTEGER                           16130,D  16250,U  16390,U

NPRNTQ   INTEGER                           16120,D

NS       INTEGER                           16170,D

NSIZE    INTEGER                           16120,D

NT       INTEGER                           16170,D

P        REAL*8                       74   16140,D  16300,S  16360,S  16360,U  16390,U  16530,U  16610,U  16670,U

PI       REAL*8                            16230,S  16550,U  16560,U  16630,U  16640,U

PINT     REAL*8                            16480,S  16530,S  16530,U  16550,S  16550,U  16610,S  16610,U  16630,S  16630,U  16670,S
                                           16700,U  16730,U

R        REAL*8                       74   16140,D  16300,S  16370,S  16370,U  16390,U  16540,U  16620,U  16680,U

RINT     REAL*8                            16490,S  16540,S  16540,U  16560,S  16560,U  16620,S  16620,U  16640,S  16640,U  16680,S
                                           16710,S  16740,U

S        REAL*8                       74   16140,D

TAPES    REAL*8                            16170,D

TH       REAL*8                   50,5,2   16150,D  16730,S
```

```
                                                                         THCOF

                        INITIAL
VARIABLE TYPE           VALUE       DIMENSION    WHERE/HOW USED

THCOF       REAL*8                               16100,D

THER        REAL*8                               16150,D

THETB       REAL*8                          74   16140,D  16300,S  16330,U  16350,S  16390,U  16390,U  16430,S  16430,U  16530,U  16530,U
                                                 16540,U  16540,U  16590,U  16600,U

X1          REAL*8                               16590,S  16610,U  16620,U

X2          REAL*8                               16600,S  16610,S  16620,S

YKP         REAL*8                               16470,S  16590,U  16600,U  16610,U  16620,U
```

```
                  INITIAL
VARIABLE TYPE     VALUE      DIMENSION   WHERE/HOW USED

CCC      REAL*8                  125     17600,D  17950,S

CCCC     REAL*8                  625     17610,D  18440,S

CONST    REAL*8                          17620,D

CS       REAL*8                          17600,D

CSS      REAL*8                  125     17600,D  17970,S

CS4      REAL*8                          17610,D

DT2      REAL*8                          17620,D

EEIGHT   REAL*8                          18230,S  18390,S  18430,S  18470,U

EFIVE    REAL*8                          18200,S  18360,S  18400,S  18470,U

EFOUR    REAL*8                          17860,S  17930,S  17940,S  17970,U  18190,S  18300,S  18310,S  18440,U  18450,U  18460,U

EONE     REAL*8                          17830,S  17870,S  17880,S  17950,U  17960,U  18160,S  18240,S  18250,S  18440,U  18450,U
                                         18460,U

ESEVEN   REAL*8                          18220,S  18380,S  18420,S  18470,U

ESIX     REAL*8                          18210,S  18370,S  18410,S  18470,U

ETHREE   REAL*8                          17850,S  17910,S  17920,S  17970,U  18180,S  18280,S  18290,S  18440,U  18450,U  18460,U

ETWO     REAL*8                          17840,S  17890,S  17900,S  17950,U  17960,U  18170,S  18260,S  18270,S  18440,U  18450,U
                                         18460,U

HARM     REAL*8                          17640,D

IABS     INTEGER                         17790,U  17820,U  18080,U  18120,U  18330,U  18350,U

IDCOF    INTEGER                         17630,D

IDELE    INTEGER                         17630,D

IEQ      INTEGER                         18000,S  18150,S  18150,U  18440,U  18450,U  18460,U  18470,U

IHARM    INTEGER                   5     17640,D  17720,U  17740,U  17760,U  18020,U  18040,U  18060,U  18100,U

II       INTEGER                         17740,S  17770,U  17780,U  17810,U  17820,U  18040,S  18070,U  18080,U  18340,U  18350,U

IMJ      INTEGER                         17780,S  17790,U  17890,U  17920,U  18080,S  18130,U  18130,U  18280,U  18290,U  18300,U
                                         18310,U
                  INITIAL
VARIABLE TYPE     VALUE       DIMENSION    WHERE/HOW USED

IML       INTEGER                          18350,S  18360,U  18370,U  18400,U  18410,U

IMM       INTEGER                          17820,S  17930,U  17940,U

IPJ       INTEGER                          17770,S  17790,U  17870,U  17880,U  18070,S  18130,U  18130,U  18240,U  18250,U  18260,U
                                           18270,U

IPL       INTEGER                          18340,S  18380,U  18390,U  18420,U  18430,U

IPM       INTEGER                          17810,S  17910,U  17920,U

ITH       INTEGER                          17790,S  17800,S  17800,U  17950,U  17960,U  17970,U

IJ        INTEGER                          17760,S  17770,U  17780,U  17910,U  17920,U  17920,U  17930,U  17940,U  17940,U  18060,S
                                           18070,U  18080,U  18320,U  18330,U

KK        INTEGER                          18100,S  18110,U  18120,U  18320,U  18330,U

KMI       INTEGER                          18330,S  18370,U  18390,U  18410,U  18410,U  18430,U  18430,U

KML       INTEGER                          18120,S  18130,U  18130,U  18260,U  18270,U  18270,U  18300,U  18310,U  18310,U

KPJ       INTEGER                          18320,S  18360,U  18380,U  18400,U  18400,U  18420,U  18420,U

KPL       INTEGER                          18110,S  18130,U  18130,U  18240,U  18250,U  18250,U  18280,U  18290,U  18290,U

LI        INTEGER                          18020,S  18110,U  18120,U  18340,U  18350,U

NELEMS    INTEGER                          17620,D

NEQ       INTEGER                          17620,D

NEQT      INTEGER                          17620,D

NH        INTEGER                          17620,D  17710,U  17730,U  17750,U  18010,U  18030,U  18050,U  18090,U

NHNS      INTEGER                          17620,D

NHP       INTEGER                          17640,D

NN        INTEGER                          17620,D

NNODES    INTEGER                          17620,D

NPRNTE    INTEGER                          17630,D

NPRNTL    INTEGER                          17630,D

NPRNTQ    INTEGER                          17620,D

NSIZE     INTEGER                          17620,D
```

```
                                                  TRI40R

                     INITIAL
VARIABLE TYPE        VALUE        DIMENSION    WHERE/HOW USED


PIO2      REAL*8                               17690,S  17950,U  17960,U  17970,U

PIO4      REAL*8                               17990,S  18440,U  18450,U  18460,U  18470,U

SCCS      REAL*8                         625   17610,D  18470,U

SSC       REAL*8                         125   17600,D  17960,S

SSCC      REAL*8                         625   17610,D  18460,S

SSSS      REAL*8                         625   17610,D  18450,S

TRI40R    REAL*8                               17580,D
```

COMMON MAP

COMMON BLOCKS	ROUTINES														
	MAIN	INPUT	SETUP	NLTERM	QPRIME	HOUBQ1	HOUBQN	NRESTR	MATMUT	SOLVEQ	STRESS	FRCES	THCOE	TFORCE	TRI4OR
CHALS		X										X		X	
CONST	X	X	X	X	X	X	X	X		X	X	X	X	X	X
CS					X										X
CS4					X										X
CYCLE	X	X								X					
EES				X	X						X				
FRCE												X	X		
GCD			X	X	X						X				
GEOM		X		X	X						X			X	
HARM	X	X	X		X						X	X	X	X	X
NLTRMS				X	X										
PRINT	X	X	X	X						X					
PS		X				X	X								
QS	X	X	X	X	X	X	X				X	X		X	
QUES												X		X	
RESTRT	X	X	X			X									
RSTRNT		X				X	X	X							
RZ		X			X										
SLVEEQ		X	X			X	X	X		X					
TAPES	X	X										X	X		
THCON		X			X										
THER		X			X						X		X		
THETAS		X	X	X							X			X	
TMFT	X	X		X	X	X	X				X				

EQUIVALENCES

FRCES

EQUIVALENT VARIABLES

NONE

HOUBQN

EQUIVALENT VARIABLES

NONE

HOUBQ1

EQUIVALENT VARIABLES

NONE

INPUT

EQUIVALENT VARIABLES

DUM(1),XN(1)
XN(1),COMENT(1)

MAIN

EQUIVALENT VARIABLES

QN(1),CARD(1)

MATMUT

EQUIVALENT VARIABLES

NONE

NLTERM

EQUIVALENT VARIABLES

NONE

EQUIVALENCES (continued)

NRESTR

EQUIVALENT VARIABLES

NONE

QPRIME

EQUIVALENT VARIABLES

NONE

SETUP

EQUIVALENT VARIABLES

NONE

SOLVEQ

EQUIVALENT VARIABLES

NONE

STRESS

EQUIVALENT VARIABLES

NONE

TFORCE

EQUIVALENT VARIABLES

NONE

THCOE

EQUIVALENT VARIABLES

NONE

EQUIVALENCES (continued)

TRI40R

EQUIVALENT VARIABLES

NONE

FRCES

FORMAT STATEMENT MAP

LOCATION	STATEMENT NUMBER	SPECIFICATION

15980	160	1H1,35X,49HFOURIER COEFFICIENTS OF
		  APPLIED PRESSURE LOADINGS,//,20X,
		  10HMERIDIONAL,20X,6HNORMAL,20X,
		  10HTANGENTIAL,10X,12HHARMONIC NO.,//
		WRITE (6,160)

16010	170	2I5/(3F10.0) READ(ND,170)IELM1,IELM2,(P(I),R(I), S(I),I=1,NH)

16020	180	/60X,11HELEMENT NO.,I3,1H-,I3,
		  //(2X,3D28.7,15X,I2)
		WRITE(6,180)IELM1,IELM2,(P(I),R(I),
		  S(I),I,I=1,NH)

	190	1H1,51X,30HAPPLIED LOADS ON THE
		  STRUCTURE///56X,19HPRESSURE COMPONENTS
		  //20X,10HMERIDIONAL,20X,6HNORMAL,
		  20X,10HTANGENTIAL,11X,19HFROM THETA
		  TO THETA,9H(DEGREES)
		WRITE(6,190)

16060	200	3I5/(4F10.0) READ(ND,200)IELM1,IELM2,NDP,(THETB(I), P(I),R(I),S(I),I=1,NDP)

16070	210	/60X,11HELEMENT NO.,I3,1H-,I2//(2X,
		  3F28.3,12X,2F10.3)
		WRITE(6,210)IELM1,IELM2,(P(I),R(I),
		  S(I),THETB(I),THETB(I+1),I=1,NDP)

16070	220	2X,3F28.3,12X,2F10.3 WRITE(6,220)(P(I),R(I),S(I),THETB(I-1), THETB(I),I=NDPP2,ND2)

INPUT

FORMAT STATEMENT MAP

LOCATION	STATEMENT NUMBER	SPECIFICATION
05050	730	1H1,38X,65HDYNASOR-II - DYNAMIC NONLINEAR ANALYSIS OF SHELLS OF REVOLUTION// WRITE(6,730)
05070	740	2I5 READ(ND,740)NCARDS,NT
05080	750	20A4 READ(ND,750)(COMENT(J),J=1,20)
05090	760	2F10.0,4I5,/,10I5 READ(ND,760)TOTIME,DELTE,IRSTRT,INCRST, NCLOSE,ITELF,NPRNTQ,IPRINT,NCLCST, NSTRSS,NPRNT,NPRNIT,NPRNTL,NPRNTF, NPRNTH,NPRNMS
05100	770	I5,/,(8F10.0) READ(ND,770)NTHETA,(THETA(I),I=1,NTHETA)
05110	780	16I5 READ(ND,780)NODRES READ(ND,780)NP,NDIRCT READ(ND,780)IQN,IQN1
05120	790	///,2X,46H**SHELL IDENTIFICATION COMMENTS FROM SAMMSOR** WRITE(6,790)
05130	800	/5X,20A4 WRITE(6,800)(COMENT(J),J=1,20)
05140	810	1H1,50X,33HCONTROL CONSTANTS AND COMMENTS///35X,8HTOTIME =,F12.9,22X, 7HDELTE =,F13.9/35X,8HIRSTRT =,I12, 22X,8HINCRST =,I12/35X,7HNPRNT =, I13,22X,8HNPRNIT =,I12/35X,8HNPRNTQ =, I12,22X,8HNPRNIT =,I12/35X,8HNCLCST =, I12,22X,8HNSTRSS =,I12/35X,8HNPRNTL =, I2,22X,8HNPRNTF =,I12/35X,8NHPRNTH =, I12,22X,4HNT =,I16/35X,4HNS =,I16,22X, 4HND =,I16,/35X,8HNCLOSE =,I12,22X, 7HITELF =,I13/35X,8HNELEMS =,I12,22X, 8HNPRNMS =,I12/35X,4HNH =,I16,/35X, 7HIHARM =,5I11//

INPUT

FORMAT STATEMENT MAP

LOCATION	STATEMENT NUMBER	SPECIFICATION
		WRITE(6,810)TOTIME,DELTE,IRSTRT, INCRST,NPRNT,NPRNIT,NPRNTQ,IPRIT, NCLCST,NSTRSS,NPRNTL,NPRNTF,NPRNTF, NPRNTH,NT,NS,ND,NCLOSE,ITELF,NELEMS, NPRNMS,NH,(IHARM(I),I=1,NH)
05210	820	35X,8HNTHETA =,I12,/35X,7HTHETA =, 5F10.2,(/,42X,5F10.2) WRITE(6,820)NTHETA,(THETA(I),I=1,NTHETA)
05220	830	/////50X,29HNUMBER OF NODAL RESTRAINTS ISI5//52X,9HDIRECTION,12X,7HAPPLIES, //,57X,1H1,10X,15HAXIAL RESTRAINT,/, 57X,1H2,10X,20HTANGENTIAL RESTRAINT, /,57X,1H3,10X,16HRADIAL RESTRAINT,/, 57X,1H4,10X,17HANGULAR RESTRAINT,//, 58X,15HNODE DIRECTION/ WRITE(6,830)NODRES
05260	840	58X,I3,7X,I1 WRITE(6,840)NP,NDIRCT
05270	850	2I5,4F10.0 READ(ND,850)IN1,IN2,Q1,Q2,Q3,Q4 READ(ND,850)IN1,IN2,Q1,Q2,Q3,Q4
05280	860	1H1,7X,7HINITIAL,29X,10HVELOCITIES,22X, 3HAND,19X,13HDISPLACEMENTS//4X, 124HNODE HARMONIC AXIAL TANGENTIAL RADIAL ANGULAR AXIAL TANGENTIAL RADIAL ANGULAR // WRITE(6,860)
05320	870	5X,I2,6X,I2,3X,8D14.4 WRITE(6,870)II,IHARM(I),QN(IQ+IX+1), QN(IQ+IX+2),QN(IQ+IX+3),QN(Q+IX+4), QN1(IQ+IX+1),QN1(IQ+IX+2),QN1(IQ+IX+3), QN1(IQ+IX+4)
05330	880	2I5,2F10.0 READ(ND,880)IELM1,IELM2,ALSI1,ALTI1

INPUT

FORMAT STATEMENT MAP

LOCATION	STATEMENT NUMBER	SPECIFICATION
05340	890	1H1,45X,41HELEMENT ELASTIC AND GEOMETRIC PROPERTIES,///67HELEMENT ALPHA--S ALPHA--T E1 E2 FNU1 FNU2 G,11X,1HR,11X,1HT,9X,4HARCL,9X,2HPH, 10X,3HPHP// WRITE(6,890)
05370	900	3X,I2,2X,4D10.2,2F6.3,6D12.4 WRITE(6,900)(I,ALS(I),ALT(I),E1(I),E2(I), FNU1(I),FNU2(I),B(I),R(I),T(I),ARCL(I), PH(I),PHP(I),I=1,NELEMS)
05380	910	1H1,38X,15HHARMONIC NUMBER,I5,37H HAS THE FOLLOWING STIFFNESS MATRIX// WRITE(6,910)IHARM(JH)
05400	920	2X,D16.8,/,2X,2D16.8,/,2X,3D16.8,/,2X, 4D16.8,/,2X,5D16.8,/,2X,6D16.8,/, 2X,7D16.8,/,2X,8D16.8,/,(2X,5D16.8,/, 2X,6D16.8,/,2X,7D16.8,/,2X,8D16.8,/) WRITE(6,920)(XN(I+NN),I=1,NSIZE) WRITE(6,920)(XP(I+NN),I=1,NSIZE)
05430	930	1H1,38X,15HHARMONIC NUMBER,I5,32H HAS THE FOLLOWING MASS MATRIX// WRITE(6,930)IHARM(JH)
05450	940	1H1//////5X,45HTHIS SOLUTION STARTS AFTER TIME INCREMENT NO.,I5,19H WHERE THE TIME WAS,F12.4,13H MICROSECONDS,/,5X, 27H AND THE TIME INCREMENT WAS,D12.5////// WRITE(6,940)ITP,TPRNT,DELTEP
05480	950	F10.0,4I5,A8 READ(ND,950)T1,NCF,IDELF,IDCOE,ITCOE,CONSTF
05490	960	40H1FOLLOWING IS LOAD DESCRIPTION AT TIME =, F12.4,13H MICROSECONDS,5X,A8 WRITE(6,960)TPRNT,CONSTF
05510	970	2I5,4F10.0 READ(ND,970)NCF1 READ(ND,970)IN1,IN2,F1,F2,F3,F4

INPUT

FORMAT STATEMENT MAP

LOCATION	STATEMENT NUMBER	SPECIFICATION
05520	980	///20X,30HCONCENTRATED FORCES HARMONIC , I5//6X,8HNODE NO.,6X,5HAXIAL,10X, 10HTANGENTIAL,10X,6HRADIAL,13X, 7HANGULAR/ WRITE(6,980)IHARM(IH)
05540	990	I10,4D20.8 WRITE(6,990)IN,F1,F2,F3,F4
05550	1000	2I5,/,(2F10,0) READ(ND,1000)IELM1,IELM2,(TH1(IH),DTH1(IH), IH=1,NH)
05560	1010	1H1,25X,39HTEMPERATURE COEFFICIENTS, HARMONIC NO. I3//10X,11HELEMENT NO., 17X,12HTEMP. COEFF.,12X,18HTEMP. GRAD. COEFF./// WRITE(6,1010)IHARM(IH)
05580	1020	I20,2D30.5 WRITE(6,1020)IELM,TH(IELMIN,IBP1), DTH(IELM,IH,IBP1)
05590	1030	1H1,25X,32HGENERALIZED FORCES, HARMONIC NO.,I3,//6X,8HNODE NO.,6X,5HAXIAL, 13X,10HTANGENTIAL,11X,6HRADIAL,13X, 7HANGULAR/// WRITE(6,1030)KYP
05610	1040	I9,4D19.8 WRITE(6,1040)I,FORCE(K+1),FORCE(K+2), FORCE(K+3),FORCE(K+4)
05620	1050	1H1//////5X,42HRESTART INFORMATION FOR TIME INCREMENT NO.,I5,/,10X,22H CORRESPONDING TO TIME,F12.4,13H MICROSECONDS,/,2X,51H HAS BEEN PLACED ON TAPE FOR USE IN SUBSEQUENT RUNS// WRITE(6,1050)ITAM,TPRNT

```
MAIN

     FORMAT STATEMENT MAP

                                    STATEMENT
          LOCATION                  NUMBER          SPECIFICATION

          00790                      110            3I5
          00200                                     READ  (5,110)   NCASES,ND,NS

          00800                      120            1H1,///,30X,31HTHE NUMBER OF CASES TO
                                                      BE RUN=I5
          00210                                     WRITE  (6,120)  NCASES

          00810                      130            20A4
          00300                                     READ  (5,130)  CARD

          00820                      140            //8H1 NCASE=,I1//,28X,22HPRINTOUT OF
                                                      INPUT DATA,/
          00350                                     WRITE  (6,140)  NCASE

          00830                      150            13X,2H10,8X,2H20,8X2H30,8X2H40,8X,2H50,
                                                      8X,2H60,8X,2H70,8X,2H80/5X,80H1234567
                                                      89012345678901234567890123456789901234
                                                      5678901234567890123456789901234567890,/
          00360                                     WRITE  (6,150)

          00860                      160            5X,20A4
          00390                                     WRITE  (6,160)  CARD

          00870                      170            72H THE NUMBER OF INPUT CASES DOES NOT
                                                      AGREE WITH THE VALUE OF NCASES INPUT
          00430                                     WRITE  (6,170)

          00890                      180            1H1//10X,18HALL DATA PROCESSED//10X,
                                                      11H...STOP
          00760                                     WRITE  (6,180)
```

SETUP

FORMAT STATEMENT MAP

LOCATION	STATEMENT NUMBER	SPECIFICATION
06430	110	1H1,30X,6HITAM =,I5,5X,6HTIME =,F12.4, 13H MICROSECONDS// WRITE(6,110)ITAM,TPRNT WRITE(6,110)ITAM,TPRNT
06440	120	36X,22HDISPLACEMENTS OF NODES/38X, 9HHARMONIC ,I5//6X,8HNODE NO.,6X, 5HAXIAL,13X,10HTANGENTIAL,11X, 6HRADIAL,13X,7HANGULAR// WRITE(6,120)KY

06460	130	I10,4D20.8
		WRITE(6,130)I,(QN(K+J),J=1,4)
		WRITE(6,130)I,(QLOAD(K+J),J=1,4)

06470	140	25X,34HDISPLACEMENTS OF NODES AT THETA =, F8.3,9H DEGREES/38X,13HALL HARMONICS/2X, 8HNODE NO.,9X,5HAXIAL,12X,10HTANGENTIAL, 12X,6HRADIAL,13X,7HANGULAR// WRITE(6,140)THETA1
06500	150	1H1,5X,4HITAM,I5,5X,4HTIME,E12.5//6X, 55HEXECUTION TERMINATED - DISPLACEMENTS GREATER THAN 1.E+4 WRITE(6,150)ITAM,TIME

STRESS

FORMAT STATEMENT MAP

```
                            STATEMENT
LOCATION                    NUMBER          SPECIFICATION

14740                         50            1H1,3X,6HITAM =,I5,3X,6HTIME =,F12.4,
                                              13H MICROSECONDS,//,47X,33HSTRESSES
                                              AND  STRESS  RESULTANTS,/,25X,17HFORCE
                                              RESULTANTS,31X,18HMOMENT  RESULTANTS,
                                              18X,17HSHEAR  RESULTANTS,/,19X,
                                              109HN(S)
                                              N(T)    N(ST)    M(S)    M(T)
                                       M(ST)      Q(S)      Q(T),//,12H ELEM THETA,
                                              /,104H
                                    NO  (DEG)  *****  OUTER SURFACE STRESSES  ******
                                     INNER SURFACE STRESSES *****,/,15X,88H* SIGMA(S) S
                                   GMA(T)     SIGMA(ST)   SIGMA(S)   SIGMA(T)  SIGMA(ST
                                   ) */)
                                            WRITE(6,50)ITAM1,TPRINT

14830                         60            I4,F8.2,6(1PD15.4),30H  XXXX  XXXX  ,/,12H
                                              STRESSES **,6(1PD15.4)
                                            WRITE(6,60)I1,THETA1,STRNS,STRNT,STRNST,
                                              STRMT,STRMST,BSU,BTU,BSTU,BSL,BTL,BSTL

14850                         70            I4,F8.2,8(1PD15.4),/,12H STRESSES **,
                                              6(1PD15.4)
                                            WRITE(6,70)I1,THETA1,STRNS,STRNT,STRNST,
                                              STRMS,STRMT,STRMST,SHRS,SHRT,BSU,BTU,
                                              BSTU,BSL,BTL,BSTL
```

THCOE

FORMAT STATEMENT MAP

LOCATION	STATEMENT NUMBER	SPECIFICATION
16780	110	1H1,41X,47HTEMPERATURES AND THERMAL GRADIENTS ON STRUCTURE///27X, 11HTEMPERATURE,10X,16HTHERMAL GRADIENT,10X,29HFROM THETA TO THETA (DEGREES)//
16810	120	3I5/(3F10.0) READ(ND,120)IELM1,IELM2,NDP,(THETB(I), P(I),R(I),I=1,NDP)
16820	130	/,60X,11HELEMENT NO.,I3,1H-,I2,//, (28X,F9.3,15X,F10.3,16X,1F7.2,2X, F7.2) WRITE(6,130)IELM1,IELM2,(P(I),R(I), THETB(I),THETB(I+1),I=1,NDP)

LABEL CROSS REFERENCE MAP

There is a label or statement number cross reference map listed for each routine. This listing gives an ascending statement number listing with corresponding references to that number. The listing gives the statement number being referenced, sequence number of referencing statements, and a corresponding letter value for each statement reference. The letter values for each reference are one of the following:

L - this letter indicates that the referencing statement is a DO LOOP and the statement number given is the lower bound for the loop.

B - this indicates that the referencing statement is a branch to the given statement number.

R - an R indicates that the statement number listed is the label for a READ statement.

W - this indicates that the statement number listed is the label for a WRITE statement.

```
FRCES

     LABEL CROSS REFERENCE MAP

          STATEMENT              REFERENCES
          NUMBER

          10                     15050,B
          20                     15190,L
          30                     15330,L
          40                     15040,B  15110,B
          50                     15400,L
          60                     15470,B
          70                     15440,B
          80                     15560,B
          90                     15510,B  15550,B  15600,B
         100                     15430,L
         110                     15390,B
         120                     15720,B
         130                     15880,L  15900,L
         140                     15920,L
         150                     15360,L
         160                     15050,L
         170                     15080,R
         180                     15090,W
         190                     15130,W
         200                     15170,R
         210                     152[illegible],W
         220                     15310,W
```

```
HOUBQN

     LABEL CROSS REFERENCE MAP

          STATEMENT            REFERENCES
          NUMBER

          10                    9920,L
          20                    9990,L
          30                   10120,L
          40                   10110,B
          50                   10190,L
```

```
HOUBQ1

     LABEL CROSS REFERENCE MAP

          STATEMENT           REFERENCES
          NUMBER

             10               9210,B
             20               9180,L   9230,B
             30               9320,B
             40               9300,L   9340,B
             50               9380,L
             60               9600,B
             70               9470,L
             80               9520,L
             90               9460,B
            100               9630,L
            110               9670,L
```

INPUT

```
          LABEL CROSS REFERENCE MAP

                STATEMENT           REFERENCES
                NUMBER

                10                  1180,B
                20                  1250,L
                30                  1240,B
                40                  1760,B
                50                  1480,L   1500,B
                60                  1460,B
                70                  1580,L
                80                  1630,B
                90                  1620,L   1650,B
                100                 1720,L
                110                 1540,B
                120                 1930,L
                130                 2020,L
                140                 2140,L
                150                 2130,B
                160                 2370,B
                170                 2310,L
                180                 2270,L
                190                 2260,B
                200                 2510,B
                210                 2450,L
                220                 2410,L
                230                 2400,B
                240                 2550,L   2570,L
                250                 2060,B
                260                 2640,L
                270                 2710,B
                280                 2700,L   2730,B
                290                 2780,L
                300                 2910,B
                310                 2880,L
                320                 2820,B
                330                 2930,L
                340                 2920,B
                350                 3050,L
                360                 3060,B
                370                 3040,L   3100,B   3150,B
                380                 3350,B
                390                 3370,L
                400                 3220,B
```

```
INPUT

     LABEL CROSS REFERENCE MAP

          STATEMENT              REFERENCE
          NUMBER

          410                    3570,L
          420                    3610,L  3620,L
          430                    [illegible]80,B
          440                    3710,B
          450                    3730,L
          460                    3750,L  3760,L
          470                    3720,B
          480                    3830,L
          490                    3870,L  3880,L
          500                    4830,B
          510                    4010,B
          520                    [illegible]130,B  4250,B
          530                    [illegible]170,L
          540                    4080,L  4120,B
          550                    4070,B
          560                    4300,L
          570                    4280,B
          580                    4470,B
          590                    4430,L  4440,L
          600                    4400,B
          610                    4500,B
          620                    4480,L
          [illegible]            4550,[illegible]  4570,L
          6[illegible]           4640,[illegible]
          650                    [illegible]40,B
          660                    [illegible],L  4680,L
          670                    [illegible]B
          680                    4730,L
          [illegible]            4750,L
                                 4720,B
          [illegible]            [illegible]
          [illegible]            [illegible]
          [illegible]            [illegible]
          740                    [illegible],R
          750                    [illegible]70,R
          [illegible]            [illegible]0,R
                                 [illegible],R
          7[illegible]           [illegible]  2[illegible]  [illegible]60,R  2250,R
          [illegible]            [illegible]
          [illegible]            [illegible]280,[illegible]  1510,A
```

INPUT

LABEL CROSS REFERENCE MAP

STATEMENT NUMBER	REFERENCE	
810	1780,W	
820	1810,W	
830	2120,W	
840	2170,W	
850	2300,R	2440,R
860	2540,W	
870	2590,W	
880	2870,R	
890	3010,W	
900	3020,W	
910	3160,W	
920	3170,W	3190,W
930	3180,W	
940	3510,W	
950	3980,R	
960	4060,W	
970	4110,R	4160,R
980	4140,W	
990	4230,W	
1000	4420,R	
1010	4560,W	
1020	4580,L	
1030	4670,W	
1040	4700,W	
1050	5020,W	

```
MAIN

     LABEL CROSS REFERENCE MAP

          STATEMENT                REFERENCES
          NUMBER

          10                       410,B
          20                       400,B
          30                       340,B
          40                       310,B
          50                       750,B
          60                       510,L
          70                       600,B
          80                       640,B  650,B
          90                       620,L
          100                      700,B
          110                      200,R
          120                      210,W
          130                      300,R  330,W
          140                      350,W
          150                      360,W
          160                      390,W
          170                      460,W
          180                      750,W
```

MATMUT

```
     LABEL CROSS REFERENCE MAP

          STATEMENT           REFERENCES
          NUMBER

          10                  10940,L
          20                  11010,L  11010,L
          30                  11160,L
          40                  11110,L  11140,L
```

```
NLTERM

     LABEL CROSS REFERENCE MAP

          STATEMENT           REFERENCE
          NUMBER

          10                  6730,L
          20                  6910,B
          30                  6950,L  6970,L
          40                  6760,L
```

```
NRESTR

     LABEL CROSS REFERENCE MAP

          STATEMENT           REFERENCES
          NUMBER

          10                  10430,L
          20                  10420,L
          30                  10410,B
          40                  10560,L
          50                  10610,L
          60                  10690,L
          70                  10520,B  10660,B
          80                  10380,L
          90                  10370,B
         100                  10800,L
```

```
QPRIME

     LABEL CROSS REFERENCE MAP

          STATEMENT            REFERENCE
          NUMBER

          10                   7590,L
          20                   7980,L
          30                   8010,L  8030,L  8070,B
          40                   7910,L
          50                   8370,L  8390,L  8430,L  8470,B
          60                   8330,L
          70                   8720,L  8740,L  8780,B
          80                   8680,L
          90                   8650,B
```

SETUP

LABEL CROSS REFERENCE MAP

```
STATEMENT           REFERENCE
NUMBER

10                  5900,B
20                  5960,L
30                  6060,L
40                  6170,B
50                  6080,L   6130,L   6160,L   6190,B
60                  6250,L
70                  6050,L
80                  6000,B   6010,B
90                  5830,L   5910,B   5920,B   6330,B
100                 6380,B
110                 5940,W   6220,W
120                 5950,W
130                 5980,W   6270,W
140                 6240,W
150                 6350,W
```

```
SOLVEQ

     LABEL CROSS REFERENCE MAP

          STATEMENT           REFERENCES
          NUMBER

          10                  11390,L
          20                  11420,L
          30                  11640,B
          40                  11640,B
          50                  11710,B
          60                  12590,B
          70                  12590,B
          80                  12670,B
          90
         100                  11440,B
         110                  13090,L
         120                  13040,B
         130                  13310,B
         140                  13310,B
         150                  13280,L  13400,B
         160                  13500,L
         170                  13530,L
```

```
STRESS

     LABEL CROSS REFERENCE MAP

          STATEMENT           REFERENCES
          NUMBER

          10                  13960,L
          20                  14530,B
          30                  14560,B
          40                  13820,L
          50                  13810,W
          60                  14540,W
          70                  14640,W
```

```
TFORCE

     LABEL CROSS REFERENCE MAP

          STATEMENT           REFERENCES
          NUMBER

          10                  17130,B
          20                  17140,B
          30                  17180,B
          40                  17200,B  17440,B
          50                  17460,L
          60                  17450,B
          70                  17480,L  17500,L
          80                  17520,L
          90                  17240,L  17270,B
```

```
THCOE

     LABEL CROSS REFERENCE MAP

          STATEMENT            REFERENCES
          NUMBER

          10                   16320,L
          20                   16420,L
          30                   16240,B
          40                   16520,L
          50                   16510,B
          60                   16580,L
          70                   16500,B
          80                   16660,B
          90                   16570,B  16650,B  16690,B
         100                   16450,L
         110                   16250,W
         120                   16300,R
         130                   16390,W
```

```
TRI40R

     LABEL CROSS REFERENCE MAP

          STATEMENT          REFERENCES
          NUMBER

          10                 17710,L  17730,L  17750,L  17790,B
          20                 18010,L  18030,L  18050,L  18090,L  18130,B
```

FRCES

SUBROUTINES CALLED

NAME	LOCATION
NONE	

CALLED BY ROUTINES

INPUT

HOUBQN

SUBROUTINES CALLED

NAME	LOCATION
MATMUT(IH,QN2,XP,QLOAD,NEQ)	09960
SOLVEQ(IH)	10180

CALLED BY ROUTINES

SETUP

HOUBQ1

SUBROUTINES CALLED

NAME	LOCATION
MATMUT(IH,QN,XP,QLOAD,NEQ)	09170
MATMUT(IH,QN,XP,QLOAD,NEQ)	09280
NRESTR(KY)	09430
SOLVEQ(IH)	09450
NRESTR(KY)	09740

CALLED BY ROUTINES

SETUP

INPUT

SUBROUTINES CALLED

NAME	LOCATION
TRI4OR	03210
NLTERM(0)	03360
FRCES(IELM,ALPHK,IB)	04320
THCOE(IELM,IB)	04510
TFORCE(IELM,IB)	04520

CALLED BY ROUTINES

MAIN
SETUP

MAIN

SUBROUTINES CALLED

NAME	LOCATION
INPUT(1)	0470
INPUT(2)	0670
NLTERM(ITAM)	0740
SETUP(ITAM,TIME,LARGE)	0690

CALLED BY ROUTINES

NONE

MATMUT

SUBROUTINES CALLED

NAME	LOCATION
NONE	

CALLED BY ROUTINES

HOUBQ1

HOUBQN

NLTERM

SUBROUTINES CALLED

NAME	LOCATION
QPRIME(I1)	06870
STRESS(I1,ITAM)	06930

CALLED BY ROUTINES

MAIN
INPUT
SETUP

NRESTR

SUBROUTINES CALLED

NAME	LOCATION
NONE	

CALLED BY ROUTINES

HOUBQ1

QPRIME

SUBROUTINES CALLED

NAME	LOCATION
NONE	

CALLED BY ROUTINES

NLTERM

SETUP

SUBROUTINES CALLED

NAME	LOCATION
NLTERM(ITAM)	05820
HOUBQN(KY,IH)	05870
HOUBQ1(KY,IH)	05880
INPUT(3)	06400

CALLED BY ROUTINES

MAIN

SOLVEQ

SUBROUTINES CALLED

NAME	LOCATION
NONE	

CALLED BY ROUTINES

HOUBQ1

HOUBQN

STRESS

SUBROUTINES CALLED

NAME	LOCATION
NONE	

CALLED BY ROUTINES

NLTERM

TFORCE

SUBROUTINES CALLED

NAME	LOCATION
NONE	

CALLED BY ROUTINES

INPUT

THCOE

SUBROUTINES CALLED

NAME	LOCATION
NONE	

CALLED BY ROUTINES

INPUT

TRI4OR

SUBROUTINES CALLED

NAME	LOCATION
NONE	

CALLED BY ROUTINES

INPUT

FRCES

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
NONE		

HOUBQN

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
IH	MATMUT	09960
IH	SOLVEQ	10180
NEQ	MATMUT	09960
QLOAD	MATMUT	09960
QN2	MATMUT	09960
XP	MATMUT	09960

HOUBQ1

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
IH	MATMUT	09170
IH	MATMUT	09280
IH	SOLVEQ	09450
KY	NRESTR	09430
KY	NRESTR	09740
NEQ	MATMUT	09170
NEQ	MATMUT	09280
QLOAD	MATMUT	09170
QLOAD	MATMUT	09280
QN	MATMUT	09170
QN	MATMUT	09280
XP	MATMUT	09170
XP	MATMUT	09280

Preceding page blank

INPUT

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
ALPHK	FRCES	04320
IB	FRCES	04320
IB	THCOE	04510
IB	TFORCE	04520
IELM	FRCES	04320
IELM	THCOE	04510
IELM	TFORCE	04520
O	NLTERM	03360

MAIN

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
ITAM	SETUP	00690
ITAM	NLTERM	00740
LARGE	SETUP	00690
TIME	SETUP	00690

MATMUT

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
NONE		

NLTERM

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
ITAM	STRESS	06930
I1	QPRIME	06870
I1	STRESS	06930

NRESTR

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
NONE		

QPRIME

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
NONE		

SETUP

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
IH	HOUBQN	05870
IH	HOUBQ1	05880
ITAM	NLTERM	05820
KY	HOUBQN	05870
KY	HOUBQ1	05880
3	INPUT	06400

SOLVEQ

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
NONE		

STRESS

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
NONE		

TFORCE

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
NONE		

THCOE

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
NONE		

TRI4OR

SUBROUTINE CALLING ARGUMENTS

VARIABLE	SUBROUTINE	LOCATION
NONE		

October 1972

SECTION III

PROGRAM INPUT

The DYNASOR II code has been written so that the code can be employed by researchers who are not familiar with the inner workings of the program. Utilizing the guidelines and adhering to the limitations presented in the previous section, it is believed that most users will find it relatively easy to employ the code.

The code is available in the FORTRAN IV language using double precision or single prescision arithmetic. This double precision version requires a storage space of about 330K bytes on IBM 360/65 system while the single precision storage space is about 200K bytes. Efforts have been made to make this code compatible with a large number of computing systems. In particular, adaption of the code for use on a CDC 6600 computer requires only minor changes.

The input data for a run consists of one card I (card types will be explained on the following pages) followed by a complete set of data (cards II-X) for each case. The set of cards II-X is the input data required to generate the response of a shell for a given number of harmonics due to a particular loading. The cards comprising the data deck for both an initial run and a restart are schematically represented in Fig. 1. The cards specifying the Fourier harmonics, the initial conditions, and the boundary conditions are omitted from the input deck when using the restart mode. If more than one case is to be run, include a set of data for each of the cases. There is no limit on the number of cases which may be included in a run. A card must be placed at the end of the data for the final case.

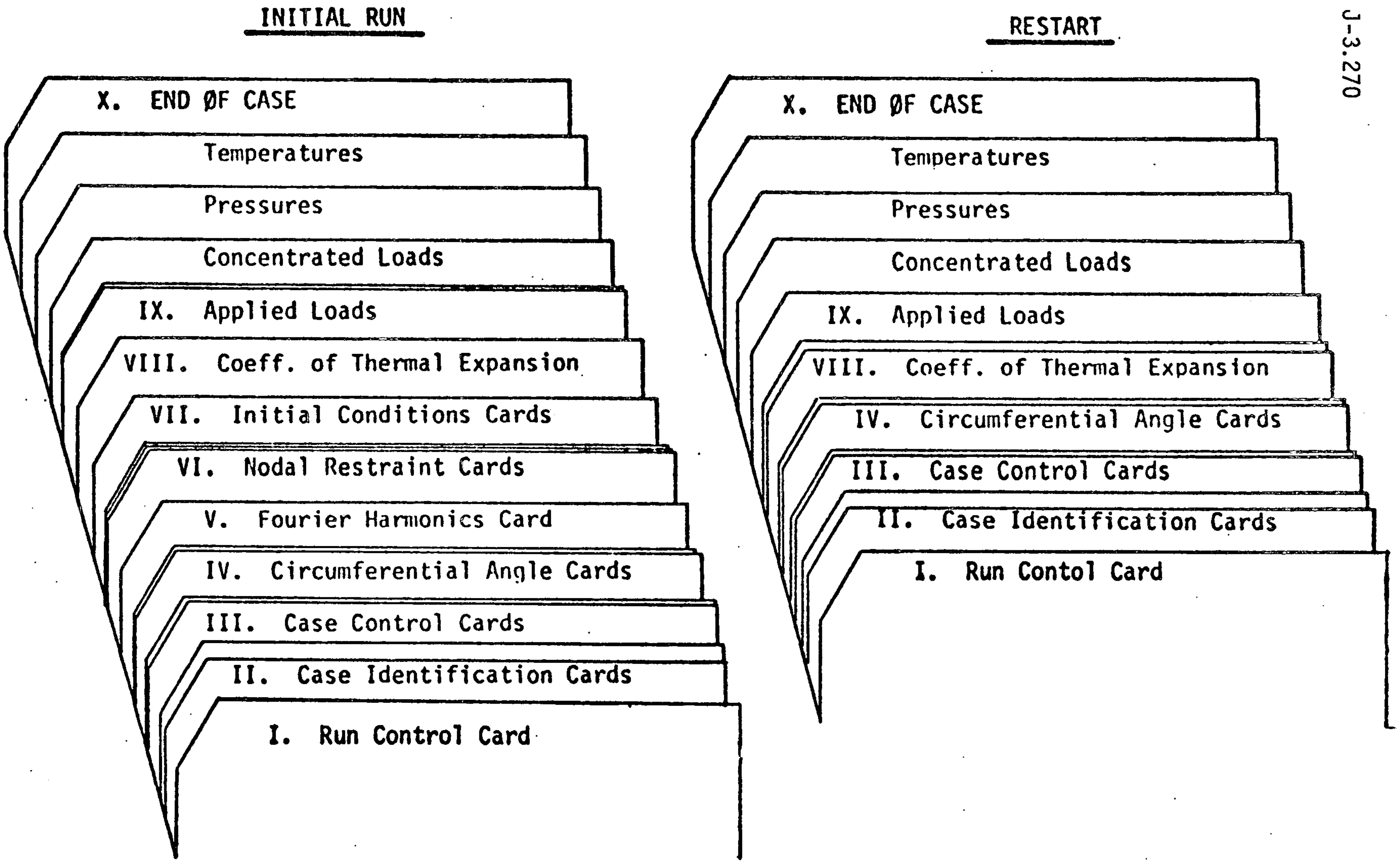

INITIAL RUN
X. END ØF CASE
Temperatures
Pressures
Concentrated Loads
IX. Applied Loads
VIII. Coeff. of Thermal Expansion
VII. Initial Conditions Cards
VI. Nodal Restraint Cards
V. Fourier Harmonics Card
IV. Circumferential Angle Cards
III. Case Control Cards
II. Case Identification Cards
I. Run Control Card
RESTART
X. END ØF CASE
Temperatures
Pressures
Concentrated Loads
IX. Applied Loads
VIII. Coeff. of Thermal Expansion
IV. Circumferential Angle Cards
III. Case Control Cards
II. Case Identification Cards
I. Run Contol Card

FIG. 1 CONSTITUTION OF DATA DECKS - INITIAL RUN AND RESTART MODES.

I. RUN CONTROL CARD

This card is used to identify the number of cases to be run and the logical unit numbers of the scratch tapes used in the run. (ONLY ONE CARD I IS USED PER RUN.)

Card Type I Format (3I5)

Columns	Variable	Description
1-5	NCASES	The number of different data sets utilized for this run.
6-10	ND	Logical unit number of the scratch tape onto which all the data is read at the start of the run.
11-15	NS	Logical unit number of a second scratch tape used by the program.

II. CASE IDENTIFICATION CARDS

These cards allow the user to print out comments which identify the problem being run.

A. Control Card (ONE CARD II-A PER DATA SET)

Card Type II-A Format (2I5)

Columns	Variable	Description
1-5	NCARDS	Number of comment cards (TYPE II-B) which follow.
6-10	NT	Logical unit number of the tape (prepared by SAMMSOR) from which the stiffness and mass matrices, element properties, and restart information, if needed, will be read.

B. Identification Cards - The information punched on these cards is printed as output and should identify the problem being run. These comments should not duplicate those of the SAMMSOR case since the SAMMSOR comments will also appear as output. (IF NCARDS=0, OMIT CARDS II-B, OTHERWISE INCLUDE NCARDS OF TYPE II-B.)

Card Type II-B Format (20A4)

Columns	Variable	Description
1-80	COMENT	Any desired alphanumeric information may be printed on these cards.

III. CASE CONTROL CARDS

A. Control Constants - Time parameters, restart information, and other miscellaneous control constants are input on this card.(INCLUDE ONE CARD III-A PER DATA SET.)

Card Type III-A Format (2F10.0,4I5)

Columns	Variable	Description
1-10	TOTIME	The maximum time (seconds) for which the calculations are to be performed.
11-20	DELTE	Time increment (seconds) used in solving the equations of motion.
21-25	IRSTRT	Control constant which indicates if the solution is being restarted. If the solution is being restarted set IRSTRT = 1. If not, set IRSTRT = 0.
26-30	INCRST	The number of the time increment at which the solution is to be restarted. INCRST must be an integer multiple of the value of NPRNIT used in the previous run. If IRSTRT = 0, set INCRST = 0.
31-35	NCLOSE	For a closed shell (such as a spherical cap or a hemisphere) where node 1 is at the apex, set NCLOSE = 1. Radial and rotational restraints will then be applied for the zeroth harmonic to aid the numerical stability of the solution. If the shell does not fit the above description, set NCLOSE = 0.
36-40	ITELF	If thermal loads are to be applied in the program, set ITELF = 1. Otherwise, set ITELF = 0.

B. Print Control Card - The constants used to control the program output are punched on this card. (INCLUDE ONE CARD III-B PER DATA

SET.)

Card Type III-B Format (10I5)

Columns	Variable	Description
1-5	NPRNTQ	If the displacements are to be printed, set NPRNTQ = 1. If not, set NPRNTQ = 0.
6-10	IPRINT	If NPRNTQ = 1, the displacenents will be printed every IPRINT time increments beginning with the first time step. If NPRNTQ = 0, set IPRINT = 0.
11-15	NCLCST	If the stresses and stress resultants are to be calculated, set NCLCST = 1. If not, set NCLCST = 0.
16-20	NSTRSS	If NCLCST = 1, the stress and stress resultants will be calculated and printed every NSTRSS time increments beginning with the first step. If NCLCST = 0, set NSTRSS = 0.
21-25	NPRNT	If restart information is to be placed on tape, set NPRNT = 1. If not, set NPRNT = 0.
26-30	NPRNIT	If NPRNT = 1, the restart information will be written on the output tape every NPRNIT time increments. If NPRNT = 0, set NPRNIT = 0. It is suggested that relatively large values of NPRNIT be used, say 200, 400,etc., if the total number of time steps is relatively large.
31-35	NPRNTL	If a printout of the applied loads is desired, set NPRNTL = 1. Otherwise, set NPRNTL = 0.
36-40	NPRNTF	If a printout of the generalized forces is desired, set NPRNTF = 1. Otherwise, set NPRNTF = 0.

41-45	NPRNTH	If the Fourier coefficients for the temperature and temperature gradient are to be printed, set NPRNTH = 1. Otherwise, set NPRNTH = 0.
46-50	NPRNMS	If the mass and stiffness matrices are to be printed, set NPRNMS = 1. If not, set NPRNMS = 0.

IV. CIRCUMFERENTIAL ANGLE CARDS

The circumferential angles at which the displacements and stresses are to be calculated are read from these cards.

A. Control Card - (ONE CARD IV-A PER DATA SET.)

Card Type IV-A Format (I5)

Columns	Variable	Description
1-5	NTHETA	The number if circumferential angles at which the displacements and possibly stresses are to be calculated. (1 ≤ NTHETA ≤ 20)

B. Circumferential Angles - (INCLUDE 1-3 CARDS IV-B PER DATA SET, DEPENDING UPON THE VALUE OF NTHETA.)

Card Type IV-B Format (8F10.0)

Columns	Variable	Description
1-10	THETA(1)	Circumferential angles at which the displacements and possible stresses will be calculated.
11-20	THETA(2)	(If it is desired to calculate the displacements only along the line = 0, then include one card IV-B and set THETA(1) = 0.0)
"	"	
"	"	
"	THETA(NTHETA)	

V. FOURIER HARMONICS CARD

This card provides the number of Fourier cosine harmonics to be imployed for this analysis and enumerates the specific harmonics to be used. (IF IRSTRT = 1, OMIT CARD V. OTHERWISE, INCLUDE ONE CARD V PER DATA SET.)

Card Type V Format (6I5)

Columns	Variable	Description
1-5	NH	The total number of Fourier cosine harmonics to be utilized in this analysis (1 ≤ NH ≤ 5).
6-10	IHARM(1)	Specific harmonics numbers to be imployed. NH values must be given and the zero harmonic must always be specified as one of the input harmonic numbers. The user should check to be certain that the information for each of these harmonics has been created and stored on tape by the SAMMSOR code.
11-15	IHARM(2)	
16-20	IHARM(3)	
21-25	IHARM(4)	
26-30	IHARM(5)	

Example: Consider a case where it is desired to utilize harmonics 0, 2, 3, and 4. The input data for card V would then utilize the following values:

NH = 4

IHARM(1) = 0 NOTE: IHARM(1) should always be set equal to zero.

IHARM(2) = 2

IHARM(3) = 3

IHARM(4) = 4

Columns 26-30 corresponding to IHARM(5) should be left blank for this example since only four harmonics are being run.

VI. NODAL RESTRAINT CARDS (Boundary Conditions)

The displacement constraints applied to the shell are described utilizing thes cards. (IF IRSTRT = 1, OMIT CARDS VI-A AND VI-B.)

A. Control Card - (ONE CARD VI-A PER DATA SET, UNLESS IRSTRT = 1.)

Card Type VI-A Format (I5)

Columns	Variable	Description
1-5	NODRES	Total number of displacement constraints to be applied to the shell (0 ≤ NODRES ≤ 204)

B. Boundary Conditions - (THE NUMBER OF CARDS OF TYPE VI-B MUST EQUAL NODRES, UNLESS IRSTRT = 1. IF NODRES = 0, OMIT CARDS VI-B.)

Card Type VI-B Format (2I5)

Columns	Variable	Description
1-5	NP	Number of the node where the restraint is to be applied.

6-10	NDIRCT	Key used to indicate the degree of freedom which is restrained.
		NDIRCT = 1 applies axial restraint
		NDIRCT = 2 applies circumferential restraint
		NDIRCT = 3 applies radial restraint
		NDIRCT = 4 applies rotational restraint

VII. INITIAL CONDITIONS CARDS

The initial velocities and displacements of the nodes are specifies on these cards. (IF IRSTRT = 1, OMIT CARDS VII-Z, VII-B, AND VII-C.)

A. Control Card - Utilization of this control card greatly simplifies the specification of the initial conditions if either the initial velocities or the initial displacements, or both, are equal to zero. (ONE CARD VII-A PER DATA SET)

Card Type VII-A Format (2I5)

Columns	Variable	Description
1-5	IQN	If the initial velocities at all the nodes are zero, set IQN = 0. If not, set IQN = 1.
6-10	IQN1	If the initial displacements ar all the nodes are zero, set IQN1 = 0. If not, set IQN1 = 1.

B. Initial Velocities - The initial nodal velocities must be specified for each node of the shell for each harmonic to be run. The logic used to input the nodal velocities is essentially the same as the procedure used to specify the element properties in the SAMMSOR code. The initial velocities for each of the nodes are specifies for the first of the input harmonics, then for the second input harmonic, etc. This process is repeated until the nodal velocities for the first of the input harmonics, then for the second input harmonic, etc. This process in repeated until the nodal velocities for each harmonic have been specified. (IF IQN = 0, OMIT CARDS

VII-B.)

Card Type VII-B Format (2I5, 4F10.0)

Columns	Variable	Description
1-5	IN1	First node to which the velocities specifies on this card are applied.
6-10	IN2	Last node to which the velocities specified on this card are applied.
11-20	$\dot{q}_1$	Initial nodal velocity in the axial direction for a particular harmonic.
21-30	$\dot{q}_2$	Initial nodal velocity in the circumferential direction for a particular harmonic.
31-40	$\dot{q}_3$	Initial nodal velocity in the radial direction for a particular harmonic.
41-50	$\dot{q}_4$	Initial nodal rotational velocity in the meridional direction for a particular harmonic.

C. Initial Displacements - In identically the same manner as is utilized for the initial velocities, the initial displacements are specified for each harmonic. (IF IQN1 = 0, OMIT CARDS VII-C)

Card Type VII-C Format (2I5, 4F10.0)

Columns	Variable	Description
1-5	IN1	First node to which the displacements specified on this card are applied.
6-10	IN2	Last node to which the displacements specified on this card are applied.
11-20	q_1	Initial nodal displacement in the axial direction for a particular harmonic.
21-30	q_2	Initial nodal displacement in the circumferential direction for a particular harmonic.
31-40	q_3	Initial nodal displacement in the radial direction for a particular harmonic.
41-50	q_4	Initial nodal rotation in the meridional direction for a particular harmonic.

VIII. COEFFICIENTS OF THERMAL EXPANSION

If the thermal effects are to be included in the analysis, the coefficients of thermal expansion must be specified using these cards. These coefficients are assumed to be constant for a given element but may vary from element to element. These coefficients are read in the same manner as the element properties in the SAMMSOR code. (THE NUMBER OF CARDS VIII MUST BE ≤ NELEMS FOR ANY GIVEN DATA SET. IF ITELF = 0, OMIT CARDS VIII.)

Card Type VIII Format (2I5, 2F10.0)

Columns	Variable	Description
1-5	IELM1	Number of the first element to which the properties on this card apply.
6-10	IELM2	Number of the last element to which the properties on this card apply.
11-20	ALSI1	Coefficient of thermal expansion in the meridional direction (in/in/deg).
21-30	ALTI1	Coefficient of thermal expansion in the circumferential direction (in/in/deg).

IX. APPLIED LOADS, TEMPERATURES, AND TEMPERATURE GRADIENTS

Since the concentrated nodal loads, distributed pressures, temperatures, and temperature gradients may vary in time; it may be necessary to specify these loads at a number of points in time. If these loads and temperatures are input at times $T1_i$ and $T1_{i+1}$, the program will calculate generalized forces due to these loads at each of the input times. A linear variation of the generalized forces is then assumed betweed the times the loads are input. As soon as the value of the time reaches $T1_{i+1}$, a new set of loads is read in at $T1_{i+2}$ and the process of calculating the generalized forces is repeated. The time increment, DELTE (CARD III-A), used in the solution of the equations of motion must be less than the difference between any too of the times at which the loads are specified. If the loads and/or temperatures propagate in and direction (moving loads), it is advisable to specify the loads at more times than is necessary if they vary in intensity only.

Ring loads can be applied at the nodes and must be input for each of the harmonics. The ring loads utilize the same sign convention employed for the shell nodal displacements.

The pressure loadings, temperatures and temperature gradients are assumed constant over the meridional length of the element but variations in the circumferential direction are allowed. These loadings may be input in one of two ways. Either the Fourier coefficients can be specified for each harmonic or the values of the loads may be specified at a number of circumferential angles around the shell elements. Utilizing this second procedure a step function variation is assumed in tne circumferential direction. That is, the load is assumed constant from 0_i to $0_{i+1}$with the value of the loads being equal to those specified at 0_i. Sign conventions for the pressure loading are given in Figure 2.

A control card (Card Type IX-A) containing several key variables is used to guide the reading of the loading conditions. Proper selection of the values of these key variables results in a highly efficient procedure for specifying a wide variety of loading conditions. The key words and their meanings are explained in Figure 3.

Before attempting to input loads to the code the user is advised to study the guidelines presented in Section II, the example problems of Section II, and Appendix 6 which presents a thorough discussion of the various procedures necessary for specifying the loads.

A. Load Control Card

This control card is utilized to direct the input of the loads for a given time. This card indicates the presence or absence of concentrated forces and distributed pressure loadings and indicates the procedure to be utilized for creating the generalized thermal forces. (ONE CARD IX-A IS NECESSARY FOR EACH TIME AT WHICH THE LOADS ARE BEING INPUT.)

Card Type IX-A Format (F10.0, 4I5, A8)

Columns	Variable	Description
1-10	T1	The time for which the loads are being input (sec).
11-15	NCF	If concentrated ring loads are applied to the structure at time T1, set NCF = 1. If not, set NCF = 0.
16-20	IDELF	If distributed loads are to be applied to the shell at time T1, set IDELF = 1. If not, set IDELF = 0.
21-25	IDCOE	If the Fourier cosine coefficients for the distributed loadings are to be read in at time T1, set IDCOE = 1. If not, set IDCOE = 0.
26-30	ITCOE	If the Fourier cosine coefficients for the temperatures and temperature gradients are to be read in at time T1, set ITCOE = 1. If not, set ITCOE = 0.
31-38	CONSTF	If the applied loads, temperatures and temperature gradients are constant from time, T1, to the final time, TOTIME (CARD III-A), punch the word CONSTANT in columns 31-38. If these parameters are not constant, leave columns 31-38 blank.

B. Concentrated Ring Loads

The concentrated ring loads must be specified for each harmonic. (IF NCF = 0, OMIT CARDS IX-B.)

1. Control Card - This card indicates the presence or absence of concentrated ring loads for a particular harmonic. (ONE CARD IX-B-1 FOR EACH HARMONIC.)

Card Type IX-B-1 Format (I5)

Columns	Variable	Description
1-5	NCF1	If there are concentrated ring loads for this particular harmonic, set NCF1 = 1. If not, set NCF1 = 0. ....

2. Concentrated Ring Loads - For harmonics having ring loads associated with them, the loads are specified using these cards. (IF NCF1 = 0, OMIT CARDS IX-B-2 FOR THE HARMONIC BEING CONSIDERED.) ONE OR MORE CARDS IX-B-2 MAY BE USED, BUT NEVER UTILIZE MORE THAN 51 PER HARMONIC.

Card Type IX-B-2 Format (2I5, 4F10.0)

Columns	Variable	Description
1-5	IN1	First node to which this loading applies.
6-10	IN2	Last node to which this loading applies.
11-20	F1	Axial ring load applied at a node (lb).*
21-30	F2	Circumferential ring load applied at a node (lb).*
31-40	F3	Radial ring load applied at a node (lb).*
41-50	F4	Concentrated moment applied at a node (in-lb).*

Examples: The use of cards IX-B should become clear after considering the following examples:

1. Consider the case where a uniform tensile ring loading of 100 psi is being applied in the axial direction to the first node of a cylinder. The solution for this problem has been presented in Figure 20 of Reference 31 The thickness of the cylinder is 0.1

* The total value of the ring load for each harmonic is input, not the load per unit length of circumference. For complicated ring loads the value of the load input for each harmonic is obtained by intergrating the product of the load and the corresponding displacement function around the circumference.

inches with the radius being given as 6 inches. Consider that harmonics 0 and 2 are being run. The total ring load for the zero harmonic will be (100) x 2π(6) x (0.1) = 376.9 lb.

Five cards of type IX are required to input these loads assuming they are constant from time T1 = 0.0 to TOTIME and assuming 50 elements are used to idealize the structure.

CARD	VARIABLE	VALUES
IX-A	T1 = 0.0	NCF = 1 IDELF = IDCOE = ITCOE = 0
IX-B	NCF1 = 1	(HARMONIC 0)
IX-C	IN1=1 IN1=1	F1 = -376.9 F2 = F3 = F4 = 0
IX-C	IN1 = 2 IN1 = 51	F1 = F2 = F3 = F4 = 0
IX-B	NCF2 = 0	(HARMONIC 2)

2. The second example considers a radial ring load of F cos0 applied to a cylinder of radius r.

Performing the integration, one obtains the radial ring load for harmonic 1 as

$$F3 = \int_0^{2\pi} (F \cos\Theta) r \cos\Theta d\Theta$$

$$= \pi r F$$

The Fourier coefficients for the other harmonics are zero.

C. Distributed Loads - (IF IDELF = 0, OMIT CARDS IX-C)

The distributed loadings may be input in one of two ways: the Fourier coefficients may be read in for each harmonic or the loadings may be specified at a desired number of circumferential angles (≤ 37). If the second option is used, the Fourier coefficients will then be generated internally. The user should note that it is possible to input distributed loads in only one of two ways.

1. Distributed Loads - (Input at various circumferential angles) Since the choice of the displacement functions utilized in this analysis necessitate the presence of loads symmetric about the meridian Θ = 0, it is necessary to specify the distributed loadings for angles from 0° --> 180°. The code then assumes that the distribution from 180° --> 360° is the mirror image of the input distribution. (IF IDCOE = 1, OMIT CARDS IX-C-1)

   a. Control Card - Utilize this card to indicate the number of angles for which the loads will be specified.

Card Type IX-C-1-a Format (3I5)

Columns	Variable	Description
1-5	IELM1	First element to be distributed loading applies.
6-10	IELM2	Last element to which this distributed loading applies.
11-15	NDP	Number of circumferential angles at which the distributed loads are to be specified (1≤NDP≤37). If the loadings are constant in the circumferential direction set NDP = 1.

   b. Distributed Loads at Specified Angles* This card specifies the angle at which the loads are being input and provides the values of the loads at that angle. (INCLUDE NDP CARDS OF

* The first loading must always be given for Θ = 0°. The next loading is given at the angle where the load changes in value. If the load is constant with respect to Θ, only one card will be necessary to input the load. Do not input values for the loads at Θ = 180° since the load at that angle will be equal in all cases to the load input at the previous value of THETAB.

TYPE IX-C-1-b FOR EACH CARD IX-C-1-a.)

Card Type IX-C-1-b Format (4F10.0)

Columns	Variable	Description
1-10	THETB	Circumferential angle (degrees) for which this data is given.
11-20	P	Distributed load in the meridional direction (psi).
21-30	R	Distributed load in the normal direction (psi).
31-40	S	Distributed load in the circumferential direction (psi).

Example: Consider the normal pressure distribution on an element depicted in Figure 4. To input the pressure on this element requires specification of the pressures for four values of Θ.

THETB	R(I)
0.0	-Q1
30.0	-Q2
90.0	-Q3
2.0	0.0

2. Distributed Loads - (Fourier Coefficients) The Fourier coefficients for the distributed loads mey be specified using these cards. The coefficients must be specified (even though they may be zero) for each harmonic being employed in the analysis. The coefficients are specified for each harmonic of the first group of elements, then for each harmonic of the second group, etc. until the values have been input for all the elements. (IF IDCOE = 0, OMIT CARDS IX-C-2)

a. Control Card

Card Type IX-C-2-a Format (2I5)

Columns	Variable	Description
1-5	IELM1	First element to which these loads apply.
6-10	IELM2	Last element to which these loads apply.

b. Fourier Coefficients - (NH CARDS OF TYPE IX-C-2-b FOR EACH CARD IX-C-2-a.)

Card Type IX-C-2-b Format (3F10.0)

Columns	Variable	Description
1-10	P	Fourier coefficient of the distributed load in the meridional direction for a particular harmonic (psi).
11-20	R	Fourier coefficient of the distributed load in the normal direction for a particular harmonic (psi).
21-30	S	Fourier coefficient of the distributed load in the circumferential direction for a particular harmonic (psi).

D. Temperature Distribution and Gradients

Essentially the same logic is employed for inputting the temperatures and gradients that was used for the specification of the distributed loads. The explanation of this procedure should therefore not need be repeated.

The temperatures are specified for the midsurface of the shell. The temperature gradients (through the thickness) are considered positive if the temperature for the outer surface is greated than the temperature on the inner surface. (IF ITELF = 0, OMIT CARDS IX-D.)

1. Temperature Distribution and Gradients - (Input at various circumferential angles)

Again, the requirement of symmetry about the meridian $\theta = 0$, makes it necessary to specify the temperature distribution and thermal gradients only from 0° --> 180°. The temperature distribution and gradients are input on the same cards for the various angles. (IF ITCOE = 1, OMIT CARDS IX-D-1.)

a. Control Card - Utilize this card to indicate the number of angles for which the temperature and gradients will be specified.

Card Type IX-D-1-a Format (3I5)

Columns	Variable	Description
1-5	IELM1	First element to which this data applies.
6-10	IELM2	Last element to which this data applies.
11-15	NDP	Number of circumferential angles at which the temperature distribution and gradient are to BE SPECIFIED (1 ≤ NDP ≤ 37). If the temperature is constant in the circumferential direction, set NDP = 1.

b. Temperature and Temperature Gradient at Specified Angles -

This card specifies the angle at which the temperature and temperature gradient (through the thickness) is being input and provides the value of the temperature at that angle. (INCLUDE NDP CARDS OF TYPE IX-D-1b

FOR EACH CARD IX-D-1-a.)

Card Type IX-D-1-b Format (3F10.0)

Columns	Variable	Description
1-10	THETB	Circumferential angle for which this temperature and gradient are given.
11-20	P	Distributed temperature at θ = THETB (°F).
21-30	R	Temperature gradient (through the thickness) at θ = THETB (°F/in).

2. Temperature Distribution and Gradient - (Fourier Coefficients)

If the user so desires, the Fourier coefficients for the temperature distribution and gradient may be specified for each of the harmonics being used. Again, the coefficients are specified for all harmonics for the first group of elements, then for the second group, etc., until all the element coefficients have been input. (IF ITCOE = 0, OMIT CARDS IX-D-2)

a. Control Card

Card Type IX-D-2-a Format (2I5)

Columns	Variable	Description
1-5	IELM1	First element to which these properties apply.
6-10	IELM2	Last element to which these properties apply.

b. Fourier Coefficients - (NH CARDS OF TYPE IX-D-2-b FOR EACH

CARD IX-D-2-a.)

Card Type IX-D-2-b Format (2F10.0)

Columns	Variable	Description
1-10	TH1	Fourier coefficient of the temperature distribution (°F) for a particular harmonic.
11-20	DTH1	Fourier coefficient of the temperature gradient (°F/in) for a particular harmonic.

X. FINAL DATA CARD FOR A CASE

Place this card after the last card IX of each data set. This signifies the end of the input data for a case. (ONE CARD X PER DATA SET.)

Card Type X

Columns	Punch
1-11	END OF CASE

XI. FINAL DATA CARD FOR A RUN

This card must be placed after the card X of the last case to be run.

It denotes the end of the input data for a run. (ONE CARD XI PER RUN)

Card Type XI

Columns	Punch
1-10	END OF RUN

EXAMPLE PROBLEMS

The example problems which follow were chosen to demonstrate the versatility of the code and to further acquaint the users with the procedures for inputting the data to the code. The data presented herein is typical for the problems solved by the code and demonstrates many of the input procedures.

Since the most complex portion of the input data is the specification of the loading conditions, a variety of loadings are demonstrated. Response curves are presented so the user may check his output with thhe previously obtained curves. The first two example problems utilize the shells described in example problems 1 and 2 of the SAMMSOR user's guide (Ref. 1) while the third example problem demonstrates the two procedures for specifying distributed pressure loadings.

Example Problem 1

The first example problem was chosen to demonstrate the procedure for inputting a concentrated ring load and to demonstrate the program's capability to solve highly nonlinear problems. For the forty pound load applied in this problem, the static solution shows that the nonlinear displacement is more than four times as large as the linear solution.

The shell to which the load is applied is the shallow spherical cap (λ=6) utilized in the first example problem in the SAMMSOR user's guide. The edges of the shell are assumed to be clamped. Since the loading is symmetric, the displacements and stresses will be calculated only along the line $\theta = 0$. Only the response for the zeroth harmonic will be determined. A set of input data for this case is presented in Figure 5 with the displacement response of the apex of the shell being presented in Figure 6. This response curve should allow the user to check his version of the code.

Example Problem 2

The shell described in the second example problem in the SAMMSOR user's guide is now subjected to a 50 psi internal pressure. The load-in is applied at time T1 = 0.0 and remains constant for the duration of the calculation.

Two sets of input data are provided for this example problem. The first set (Figure 7) allows the program to calculate the response for the first 300 time steps. The second set of input data (Figure 8) will

```
         NCASE= 1

                                    PRINTOUT OF INPUT DATA

   CARD              10        20        30        40        50        60        70        80
   TYPE     12345678901234567890123456789012345678901234567890123456789012345678901234567890

  II - A        6    4
     - B    ********************************************************************************
     - B            EXAMPLE PROBLEM NO. 1                          DYNASOR II USER'S MANUAL
     - B         THE SHELL DESCRIBED IN EXAMPLE PROBLEM 1 OF THE SAMMSOR USER'S GUIDE
     - B         IS SUBJECTED TO A 40 LB. APEX LOADING WITH THE SOLUTION BEING DETERMINED
     - B         FOR 400 TIME STEPS
     - B    ********************************************************************************
 III - A        0.0001 .00000025    0    0    1    0
     - B        1    4    1    8    1  100    1    1    0    1
  IV - A        1
     - B           0.0
   V            1    0
  VI - A        4
     - B       31    1
     - B       31    2
     - B       31    3
     - B       31    4
 VII - A        0    0
  IX - A           0.0    1    0    0    0CONSTANT
     - B - 1    1
         - 2    1    1      40.0      0.0       0.0       0.0
         - 2    2   31       0.0      0.0       0.0       0.0
   X        END OF CASE
```

Fig. 5 INPUT DATA - EXAMPLE PROBLEM 1

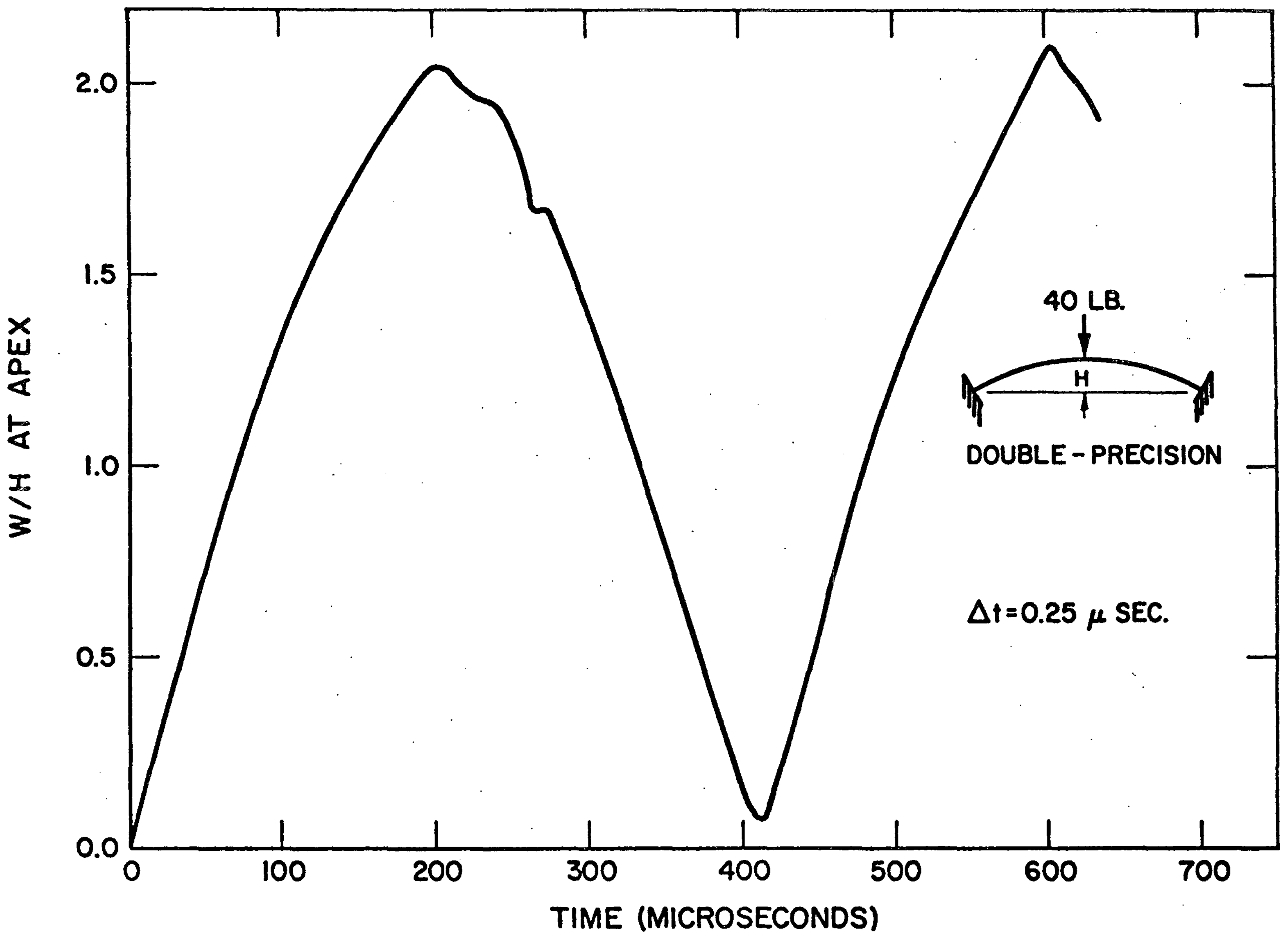
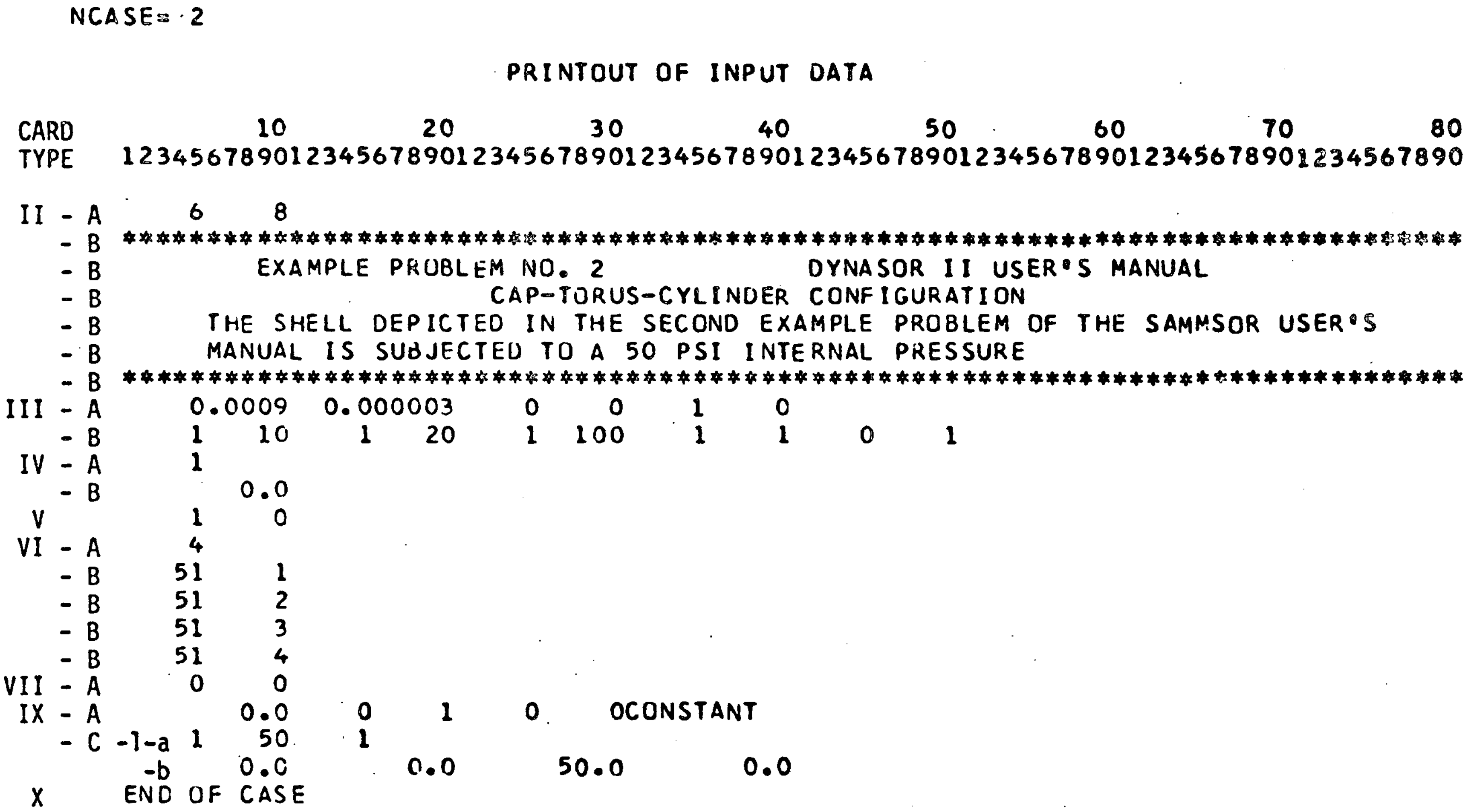


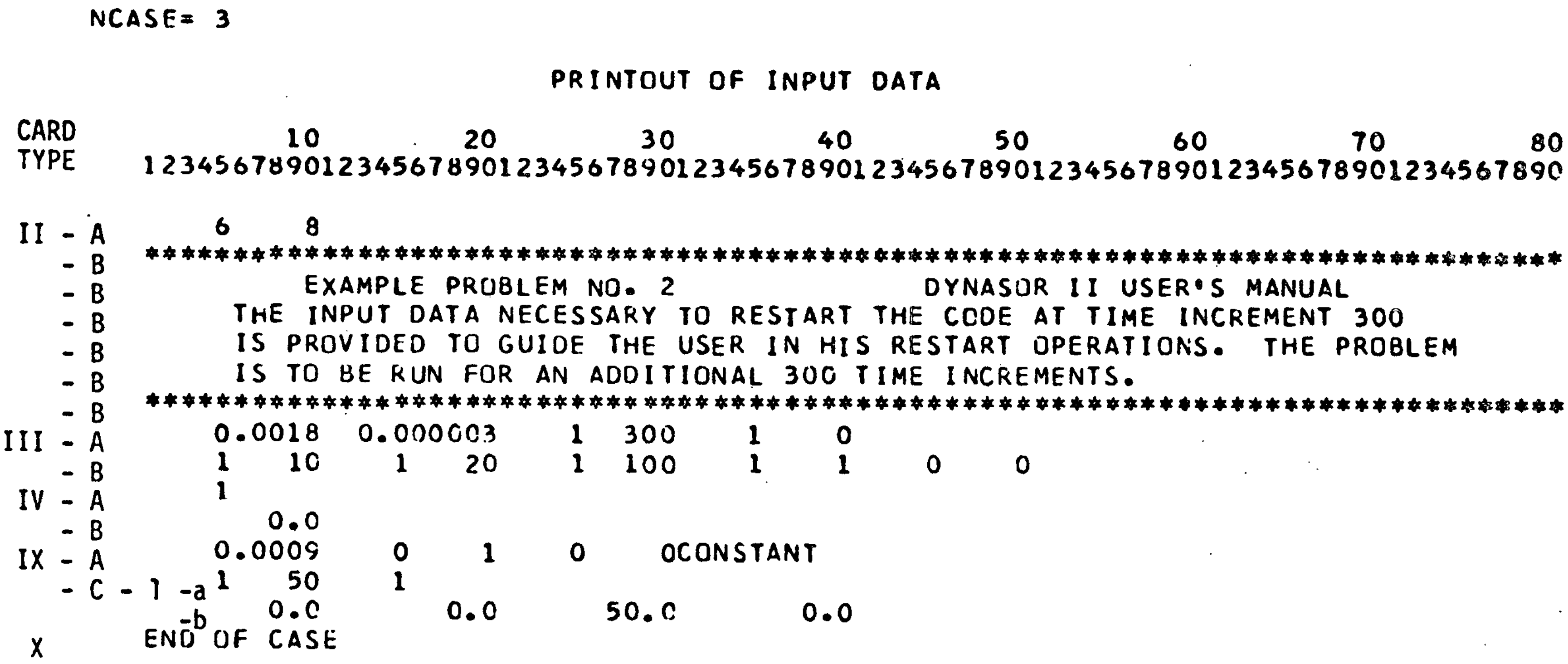
FIG. 6 APEX DISPLACEMENT RESPONSE UNDER CONCENTRATED AXIAL LOAD

J-3.297



```
    NCASE= 2

                                   PRINTOUT OF INPUT DATA

CARD                10        20        30        40        50        60        70        80
TYPE       12345678901234567890123456789012345678901234567890123456789012345678901234567890

   II - A      6    8
      - B  ********************************************************************************
      - B          EXAMPLE PROBLEM NO. 2            DYNASOR II USER'S MANUAL
      - B                        CAP-TORUS-CYLINDER CONFIGURATION
      - B       THE SHELL DEPICTED IN THE SECOND EXAMPLE PROBLEM OF THE SAMMSOR USER'S
      - B       MANUAL IS SUBJECTED TO A 50 PSI INTERNAL PRESSURE
      - B  ********************************************************************************
  III - A      0.0009  0.000003    0    0    1    0
      - B      1   10    1   20    1  100    1    1    0    1
   IV - A      1
      - B         0.0
    V          1    0
   VI - A      4
      - B     51    1
      - B     51    2
      - B     51    3
      - B     51    4
  VII - A      0    0
   IX - A         0.0    0    1    0    0CONSTANT
     - C -1-a  1   50    1
            -b    0.C       0.0      50.0       0.0
    X      END OF CASE
```

Fig. 7 INPUT DATA - EXAMPLE PROBLEM 2



```
NCASE= 3

                                     PRINTOUT OF INPUT DATA

CARD                   10        20        30        40        50        60        70        80
TYPE          12345678901234567890123456789012345678901234567890123456789012345678901234567890

  II - A          6    8
     - B      ********************************************************************************
     - B               EXAMPLE PROBLEM NO. 2              DYNASOR II USER'S MANUAL
     - B           THE INPUT DATA NECESSARY TO RESTART THE CODE AT TIME INCREMENT 300
     - B           IS PROVIDED TO GUIDE THE USER IN HIS RESTART OPERATIONS.  THE PROBLEM
     - B           IS TO BE RUN FOR AN ADDITIONAL 300 TIME INCREMENTS.
     - B      ********************************************************************************
 III - A          0.0018  0.000003    1  300    1    0
     - B          1   10    1   20    1  100    1    1    0    0
  IV - A          1
     - B             0.0
  IX - A          0.0009    0    1    0    OCONSTANT
     - C - 1    -a1   50    1
                -b   0.0       0.0      50.0       0.0
   X          END OF CASE
```

Fig. 8 INPUT DATA - EXAMPLE PROBLEM 2 - RESTART MODE

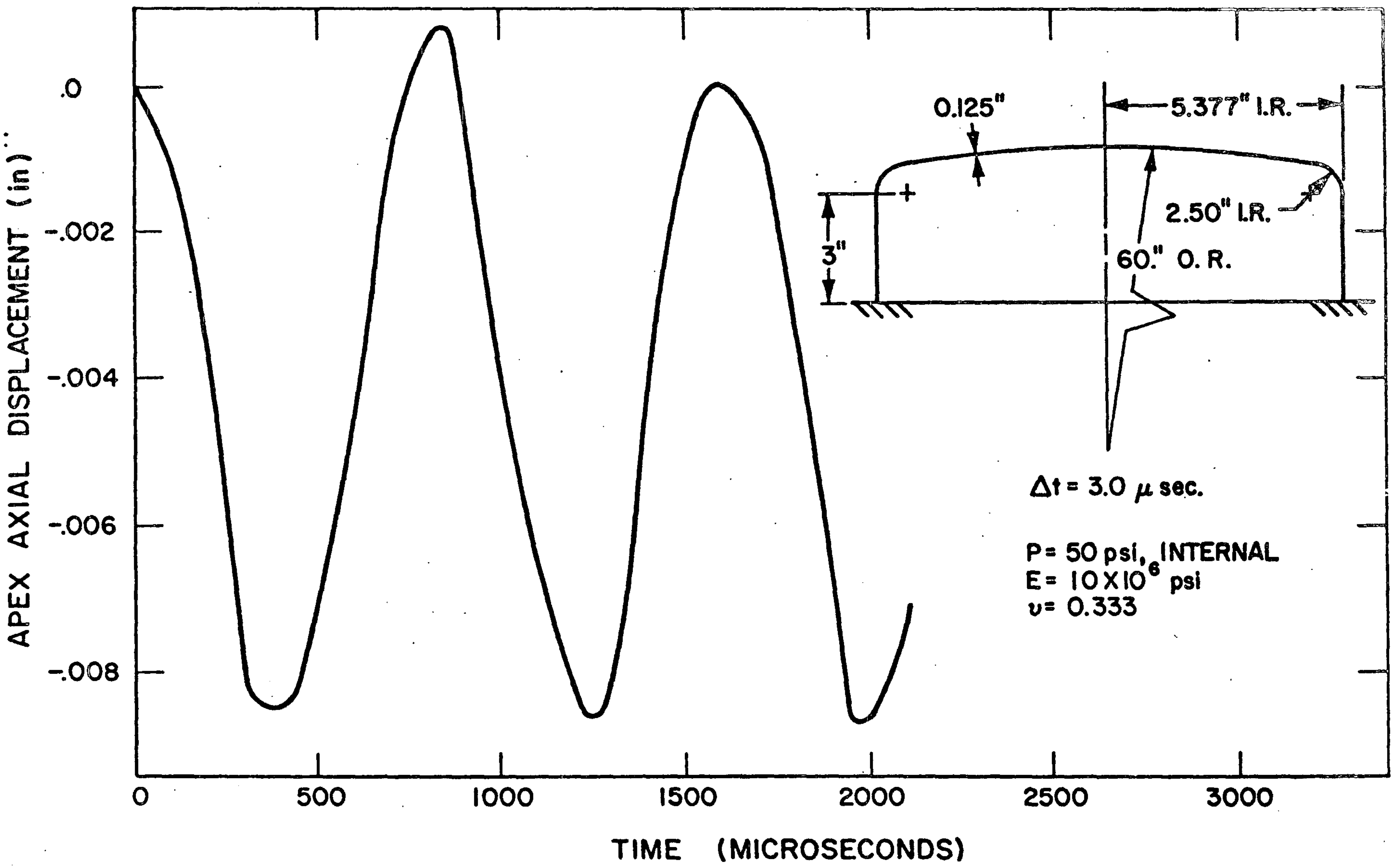


FIG. 9 DISPLACEMENT RESPONSE UNDER INTERNAL PRESSURE

restart the code at the end of the 300th time step and will then allow the program to calculate the response for an additional 300 increments.

Since this problem is only moderately nonlinear, it is interesting to note that a much larger time step can be used for this problem than was employed in the previous example problem. The displacement response obtained for this problem is presented in Figure 9.

Example Problem 3

This example problem was selected to demonstrate the procedures for inputting the distributed loadings on a shell. A cylindrical shell (figure 10) is subjected to a half cosine loading which is symmetric about the meridian = 0. This load is applied along the entire length of the shell. The pressure loading may be specified in one of two ways:

1) The Fourier coefficients may be input for each harmonic.

2) The pressure may be specified at various circumferential angles with the Fourier coefficients then being internally generated.

The first set of input data (Figure 11) utilizes the first of the above procedures and inputs the Fourier coefficients. The input data presented in Figure 12 describes the loading by specifying the value of the pressure at the various angles. The same procedure is employed to describe the temperature and temperature gradient distributions.

Considering the symmetry of the loading and the boundary conditions applied to this shell, it can easily be recognized that the displacements and stresses will be symmetric about the center of this cylindrical tube. Therefore, only one-half of the shell needs to be analyzed. The plane of symmetry is assured by applying an axial and a rotational restraint at node one (1).

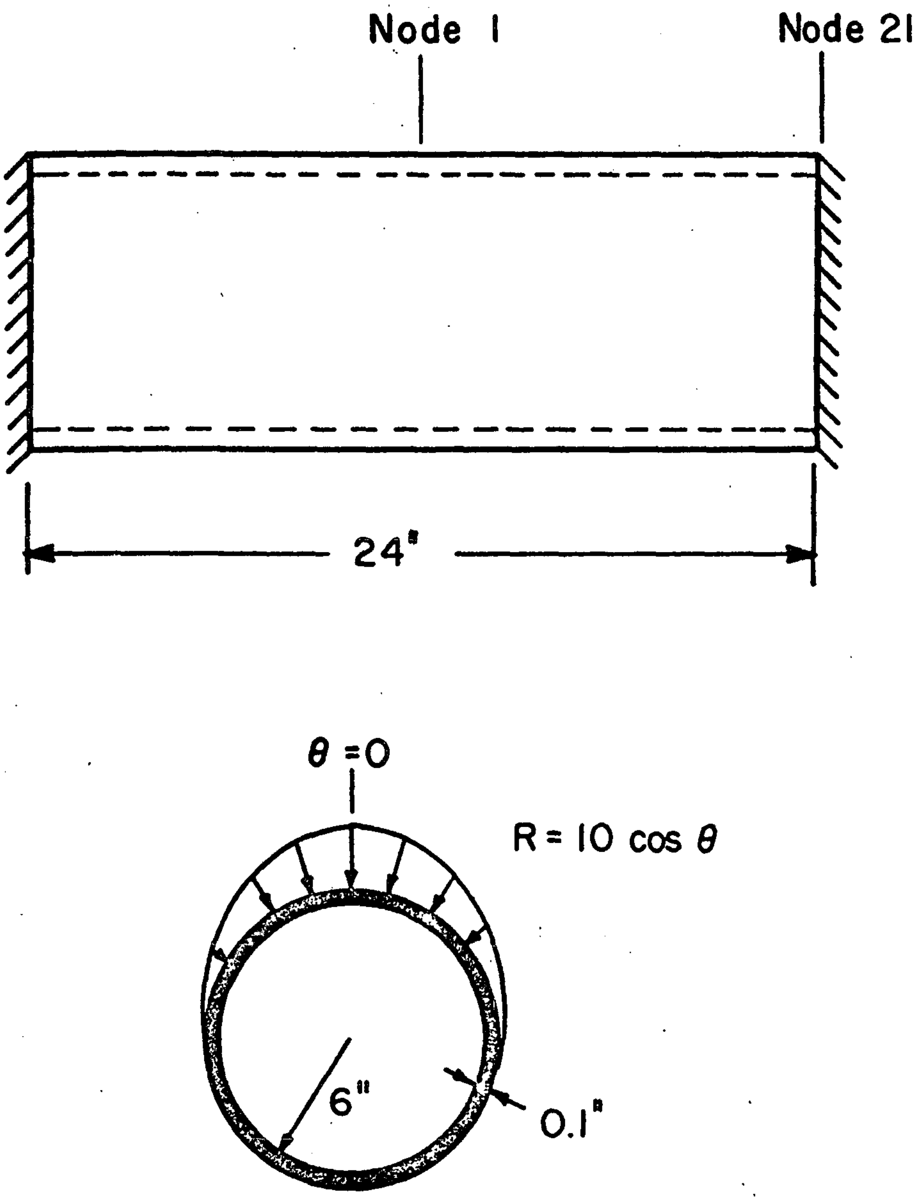
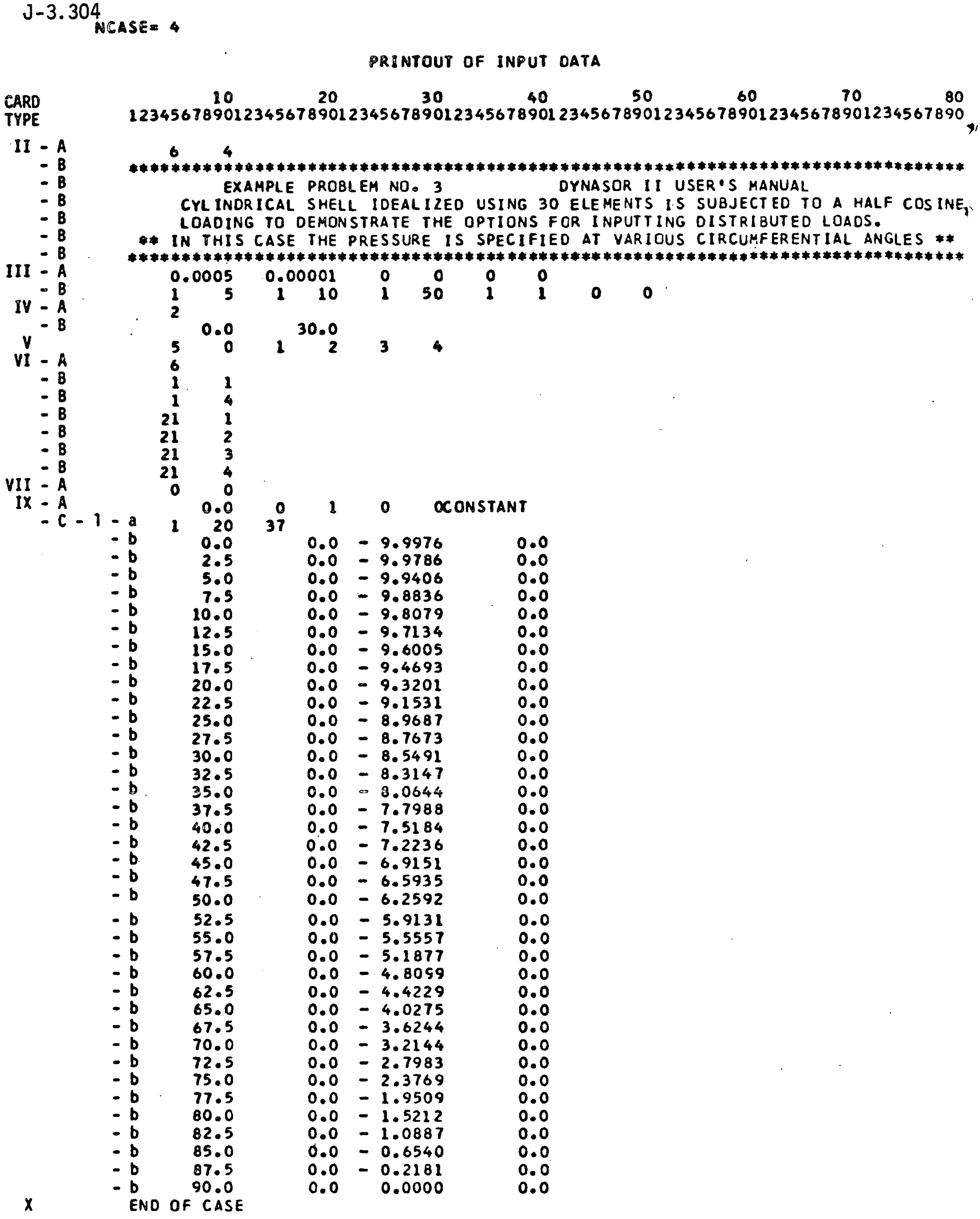


FIG 10 CYLINDRICAL SHELL SUBJECTED TO HALF COSINE PRESSURE LOADING

```
     NCASE= 5

                                   PRINTOUT OF INPUT DATA

CARD              10        20        30        40        50        60        70        80
TYPE     12345678901234567890123456789012345678901234567890123456789012345678901234567890

  II - A     6    4
     - B ********************************************************************************
     - B          EXAMPLE PROBLEM NO. 3           DYNASOR II USER'S MANUAL
     - B      CYLINDRICAL SHELL IDEALIZED USING 30 ELEMENTS IS SUBJECTED TO A HALF COSINE
     - B      LOADING TO DEMONSTRATE THE OPTIONS FOR INPUTTING DISTRIBUTED LOADS.
     - B  ** IN THIS CASE THE PRESSURE IS SPECIFIED BY INPUTTING THE FOURIER COEFFICIENTS
     - B ********************************************************************************
 III - A    0.0005   0.00001    0    0    0    0
     - B     1    5    1   10    1   50    1    1    0    1
  IV - A     2
     - B        0.0      30.0
   V         5    0    1    2    3    4
  VI - A     6
     - B     1    1
     - B     1    4
     - B    21    1
     - B    21    2
     - B    21    3
     - B    21    4
 VII - A     0    0
  IX - A        0.0    0    1    1    0CONSTANT
     - C - 2- a1   20
           - b  0.0   -3.1831       0.0
           - b  0.0   -5.0000       0.0
           - b  0.0   -2.1221       0.0
           - b  0.0    0.0000       0.0
           - b  0.0    0.4244       0.0
   X     END OF CASE
```

Fig. 11 INPUT DATA - (SET #1) - EXAMPLE PROBLEM 3



```
NCASE= 4

                                 PRINTOUT OF INPUT DATA

CARD                     10        20        30        40        50        60        70        80
TYPE            12345678901234567890123456789012345678901234567890123456789012345678901234567890
 II - A             6    4
    - B         ********************************************************************************
    - B                  EXAMPLE PROBLEM NO. 3           DYNASOR II USER'S MANUAL
    - B              CYLINDRICAL SHELL IDEALIZED USING 30 ELEMENTS IS SUBJECTED TO A HALF COSINE
    - B              LOADING TO DEMONSTRATE THE OPTIONS FOR INPUTTING DISTRIBUTED LOADS.
    - B          ** IN THIS CASE THE PRESSURE IS SPECIFIED AT VARIOUS CIRCUMFERENTIAL ANGLES **
    - B         ********************************************************************************
III - A             0.0005   0.00001    0    0    0    0
    - B             1    5    1   10    1   50    1    1    0    0
 IV - A             2
    - B                0.0      30.0
   V                5    0    1    2    3    4
 VI - A             6
    - B             1    1
    - B             1    4
    - B            21    1
    - B            21    2
    - B            21    3
    - B            21    4
VII - A             0    0
 IX - A                0.0    0    1    0    0CONSTANT
    - C - 1 - a     1   20   37
            - b        0.0       0.0  - 9.9976         0.0
            - b        2.5       0.0  - 9.9786         0.0
            - b        5.0       0.0  - 9.9406         0.0
            - b        7.5       0.0  - 9.8836         0.0
            - b       10.0       0.0  - 9.8079         0.0
            - b       12.5       0.0  - 9.7134         0.0
            - b       15.0       0.0  - 9.6005         0.0
            - b       17.5       0.0  - 9.4693         0.0
            - b       20.0       0.0  - 9.3201         0.0
            - b       22.5       0.0  - 9.1531         0.0
            - b       25.0       0.0  - 8.9687         0.0
            - b       27.5       0.0  - 8.7673         0.0
            - b       30.0       0.0  - 8.5491         0.0
            - b       32.5       0.0  - 8.3147         0.0
            - b       35.0       0.0  - 8.0644         0.0
            - b       37.5       0.0  - 7.7988         0.0
            - b       40.0       0.0  - 7.5184         0.0
            - b       42.5       0.0  - 7.2236         0.0
            - b       45.0       0.0  - 6.9151         0.0
            - b       47.5       0.0  - 6.5935         0.0
            - b       50.0       0.0  - 6.2592         0.0
            - b       52.5       0.0  - 5.9131         0.0
            - b       55.0       0.0  - 5.5557         0.0
            - b       57.5       0.0  - 5.1877         0.0
            - b       60.0       0.0  - 4.8099         0.0
            - b       62.5       0.0  - 4.4229         0.0
            - b       65.0       0.0  - 4.0275         0.0
            - b       67.5       0.0  - 3.6244         0.0
            - b       70.0       0.0  - 3.2144         0.0
            - b       72.5       0.0  - 2.7983         0.0
            - b       75.0       0.0  - 2.3769         0.0
            - b       77.5       0.0  - 1.9509         0.0
            - b       80.0       0.0  - 1.5212         0.0
            - b       82.5       0.0  - 1.0887         0.0
            - b       85.0       0.0  - 0.6540         0.0
            - b       87.5       0.0  - 0.2181         0.0
            - b       90.0       0.0    0.0000         0.0
   X            END OF CASE
```

Fig. 12 INPUT DATA - (SET #2) - EXAMPLE PROBLEM 3

October 1972

Use of the Restart Option

In order for efficient use to be made of the DYNASOR II code, the user should become familiar with the option provided for restarting the program. Through effective use of this option the dynamic response studies can be completed using a minimum amount of computer time.

Use of the restart option may prove invaluable in a number of situations. Abnormal termination of the program may occur if a numerical instability is noted in the response. If this occurs, the restart option can be used with a different value of the time increment. Another important use of the restart option arises when the user is satisfied with the results previously obtained but desires to extend the response data to a further point in time. In such a case the program is restarted at the last time step for which the restart information was placed on tape. A most effective use of this option can be made when conducting dynamic stability analyses where it is desirable to evaluate the response to see if buckling has occurred. If it has not, the decision can then be made to extend the run to further points in time.

Utilizing large time steps can result in a damping effect upon the solution so it is advisable to run the problem for a couple of oscillations, check to see if the solution is significantly damped,and then run the problem for the desired number of oscillations. If an evaluation of the initial results indicates that a smaller or larger time step should be used, the restart facility might be used to keep from having to repeat the initial calculations.

The displacements, velocities, and forces should be written on tape for almost all of the cases to insure that the restart information will be available if an evaluation of the calculated response indicates that the program should be restarted. The time required to write the restart information on tape is negligible when compared with the amount of time required to obtain the total response.

If it is desirable to decrease the time increment when restarting the program, the user should exercise care in selection the increment (INRST) at which the program will be restarted. The decision to decrease the size of the time step will usually be based upon the observation that the solution has become unstable or that significant damping is present in the response. To restart the program the user must be sure that the increment (INCRST) has been selected small enough to insure that the inaccuracies created by the larger time step can be neglected.

On the other hand, if the results from a previous run indicate that it is possible to increase the size of the time stip for the remaining calculations, then care must also be taken in the selection of INCRST. For the numerical extrapolation procedure to produce accurrate sets of displacements, it is recommended that the solution be restarted on a relatively straight portion of the displacement response curve. Considering the curve presented in Figure 6, it would be recommended that the program be restarted at 500 microseconds rather than at 600 microseconds because of the extrapolation procedure being utilized (i.e. the curve is smoother at 500 microseconds).

When using the restart option, it is possible to specify different values for a number of the control constants and input parameters. The data on cards I-IV may be changed, but the same Fourier harmonics and boundary conditions must be used. It is alo required that the coefficients of thermal expansion remain the same when restarting the program. These requirements allow the user to omit card types V, VI, and VII when preparing data for restart operations. The considerations effecting the input of the loads for restart operations are presented in Appendix 6.