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STEADY, OSCILLATORY, AND UNSTEADY SUBSONIC
AND SUPERSONIC AERODYNAMICS - PRODUCTION
VERSION 1.1 (SOUSSA-P 1.1)
VOLUME II - USER/PROGRAMMER MANUAL

Scott A. Smolka, Robert D. Preuss,
Kadin Tseng, and Luigi Morino

AEROSPACE SYSTEMS, INC.
Burlington, Massachusetts 01803

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NASA
National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23665

PREFACE

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SECTION 1

INTRODUCTION

1.1 OVERVIEW OF THE COMPUTER PROGRAM SOUSSA-P

The computer program SOUSSA-P (Steady, Oscillatory, and Unsteady Subsonic and Supersonic Aerodynamics-Production Version) was designed so that accurate and efficient evaluation of steady and unsteady aerodynamic loads on aircraft having arbitrary shapes and motions, including structural deformations, could be obtained. These evaluations are essential for the accurate calculation of aerodynamic and aeroelastic characteristics required for the analysis and design of high-performance aircraft. The program is based upon the theoretical formulation developed by Morino (Refs. 1, 2, and 3) which was originally implemented by the computer program SOUSSA-I (the "I" stands for Interim Version). However, SOUSSA-I was developed in an academic environment for research and proof-of-concept purposes. A more general and efficient version (SOUSSA-P) was planned for "production" applications. With this objective in mind, the SOUSSA-P program has been designed to possess the following qualities:

* Modularity - to facilitate updating and incorporating improved or additional capabilities.

* Computational Efficiency - in terms of both processor time and storage requirements so that the program may be useful for application to complicated configurations such as complete aircraft.

* User Orientation - to enable its use without extensive specialized training.

* Generality - SOUSSA-P was designed to be compatible with most currently available geometry preprocessors. Furthermore, the program has been structured to facilitate the analysis of aerodynamic problems involving a wide range of flight speeds, multiple sets of vibration and deformation modes, and multiple sets of frequencies for flight vehicles having arbitrary shape. The underlying method is applicable to both subsonic and supersonic flows (see Ref. 3), but the supersonic capability has not been incorporated into version 1.1 of SOUSSA-P.

* Accuracy - e.g., the numerical formulation employed for the evaluation of aerodynamic influence coefficients has proven to be accurate and reliable (Ref. 3).

* Simplicity - the expressions for the aerodynamic influence coefficients are very simple.

The incorporation of the sophisticated data handling capabilities of the SPAR Finite-Element Structural Analysis, System Level 11, computer program (Ref. 5) into the SOUSSA-P program was essential in realizing many of the aforementioned characteristics. As a result, the modules that comprise SOUSSA-P are able to communicate via a common data base which resides on auxiliary storage in the form of temporary and/or permanently catalogued files. This data base, which is known as the "data complex", contains one or more direct-access "libraries" that are comprised of "data sets" produced by the various SOUSSA-P modules. (Expressions in quotes denote SPAR terminology. For a more detailed discussion of these expressions, see Section 7.2 as well as Ref. 5.) The term "module" corresponds to the SPAR concept of "processor". Throughout the remainder of this manual, two types of modules will be distinguished: "Technical Modules" (described in Section 3) actually implement the aerodynamic formulation presented in Ref. 3, while "Utility Modules" (described in Section 7) are responsible for such functions as execution sequence control, data handling, and utility operations (e.g., providing a summary of the characteristics of the data sets resident on the data complex). Both the technical and utility modules have been designed with a premium placed on efficiency in terms of core storage and central-processor time.

The structure of the SOUSSA-P program - multiple independent modules communicating by means of the data complex - possesses many inherent characteristics that are advantageous to the user (some of which are pointed out in Ref. 4):

* Checkpointing/Restart - All information generated by a given module or processor may be stored in the data complex and accessed by any other module in future runs. Hence the user may display, examine, print, plot, or verify this data at his/her convenience. This capability is provided automatically and does not require the user´s awareness of the internal structure of the data complex.

* User-Identifiable Data and Data Sharing - Data generated by a SOUSSA-P run may be clearly associated with a given user through data set naming conventions which are outlined in Section 7. Also, a user may allow other users to access his data with file security (read/write authorization) provided by the host system.

* Efficiency - Execution time, central-memory storage, and auxiliary storage requirements are minimized by use of sophisticated data manipulation techniques. Execution times for various test cases

are presented in Section 14. The central memory requirements in general are described in Section 10. Note that no special advantage is taken of the fact that, for steady-state problems, real algebra may be employed and other simplifications may be realized; in such cases, a steady-state (real-algebra) program should yield improved computer memory and time requirements.

* Execution Control and Free-Format Input - SOUSSA-P maintains the command-oriented executive control language of the SPAR program. The interface processor,INTR, allows for the input of data in free-field format.

* Utility Operations - SOUSSA-P has incorporated various SPAR utility processors that perform user-oriented functions, such as providing a display of a Table of Contents (TOC´s) for each library in the data complex (see Section 7 as well as Ref. 4), and editing and display of information contained in the data complex.

1.2 OUTLINE OF THE MANUAL

Section 2 presents the structure of the SOUSSA-P program in terms of its overlay/subroutine hierarchy as well as its logical flow of control. Section 3 briefly describes the purpose of the technical modules. Section 4 defines the meanings of SOUSSA-P FORTRAN variables along with their variable dimensions in the case of array variables. Section 5 presents a brief discussion of the SOUSSA-P subroutines along with their calling sequence. Section 6 describes how the user prepares input for the purpose of executing the technical portion of the program, i.e., to perform an aerodynamic analysis. Section 7 describes the data complex as well as the utility modules and their corresponding input requirements. Section 8 describes the listable output of the program. Section 9 gives an account of output of the program in the form of files. Section 10 presents the hardware/software requirements of SOUSSA-P. Section 11 presents the error detection and reporting capabilities of the program as well as its limitations. Section 12 describes the job control statements needed to run the program. (See Section 13 for the input card deck setup requirements.) Section 13 presents a convenient summary of the procedure for running the SOUSSA-P program. Finally, Section 14 presents test cases that are intended to illustrate various features of SOUSSA-P.

SECTION 2

STRUCTURE OF THE SOUSSA-P PROGRAM

This section presents the overlay/subroutine hierarchy of the SOUSSA-P program, as well as the logical structure relating the SOUSSA-P modules and checkpoints.

2.1 OVERLAY/SUBROUTINE ORGANIZATION

Figure 1 depicts the overlay/subroutine organization of the SOUSSA-P program (actually, the subroutine groupings are only shown for the technical modules). The (0,0) or MAIN overlay is responsible for the overall flow of control of the program. That is, it invokes the various utility modules on the basis of the occurrence of "[XQT Modname" commands in the input stream. These utility modules (the names of which correspond to valid choices of "Modname") and their usage procedures are discussed in Section 7. The MAIN overlay also transfers control to the SOUSEX subroutine (upon encountering a "[XQT SOUS" command in the input stream), which in turn invokes the various technical modules. These technical modules are described in Section 3, and the subroutines that comprise them are described in Section 5. The subroutines contained in the MAIN overlay include SPAR data handling and free-format reader subroutines (see Section 5 and Ref. 5).

Figure 2 illustrates the flow of control for the executive portion of the MAIN overlay. In addition to reading the executive control commands from the input stream and calling the appropriate modules, it is responsible for closing all files that may have been generated during a run.

The flow of control for the SOUSEX subroutine is illustrated in Figure 3. In addition to invoking the various SOUSSA-P modules (which modules are executed for a given run depends on the input values of the LM control parameters; input preparation of the LM´s is described in Section 6), this routine is responsible for reading information required for every execution of one or more of the technical modules.

2.2 LOGICAL STRUCTURE

Figure 4 illustrates the (highly modular) logical structure of the SOUSSA-P program. In this figure, rectangles correspond to SOUSSA-P modules, and numbered circles correspond to checkpoints. Checkpoints are defined to be a collection of one or more SPAR-compatible data sets residing within the data complex; i.e., these data sets are accessible to the technical modules and furthermore may be displayed and examined by the user via the utility modules. The information required for the execution of a given module consists of the contents of the checkpoint(s) that is (are) input to the module; i.e., those checkpoints in Fig. 4 with inwardly directed arrows to the module. The output of the module consists of the contents of the checkpoint with an outwardly directed arrow from the module. The blackened nodes in Figure 4 operate on checkpoints in the

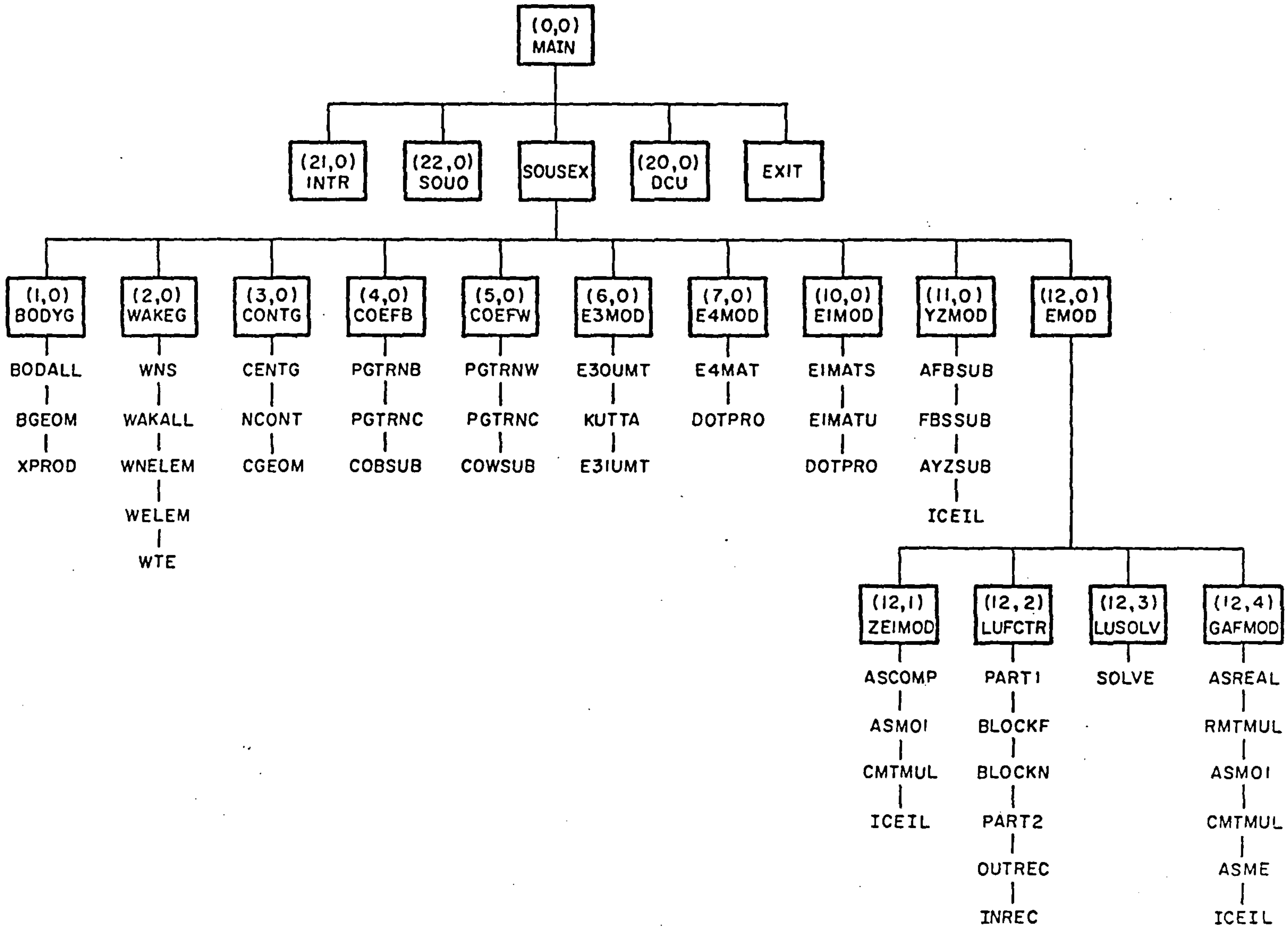


Figure 1. Overlay/Subroutine Organization of the SOUSSA-P Program. (Note: overlay numbers given in octal).

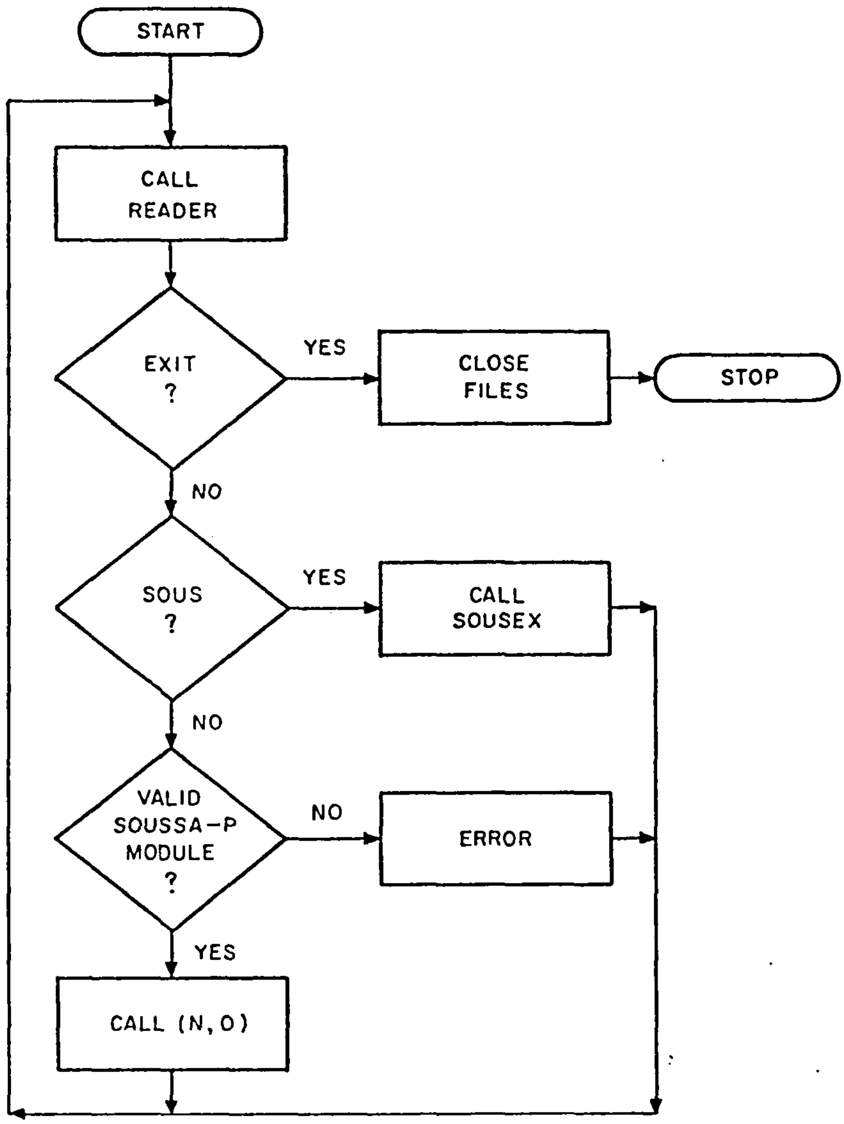


Figure 2. Flow of Control of the Main Executive.

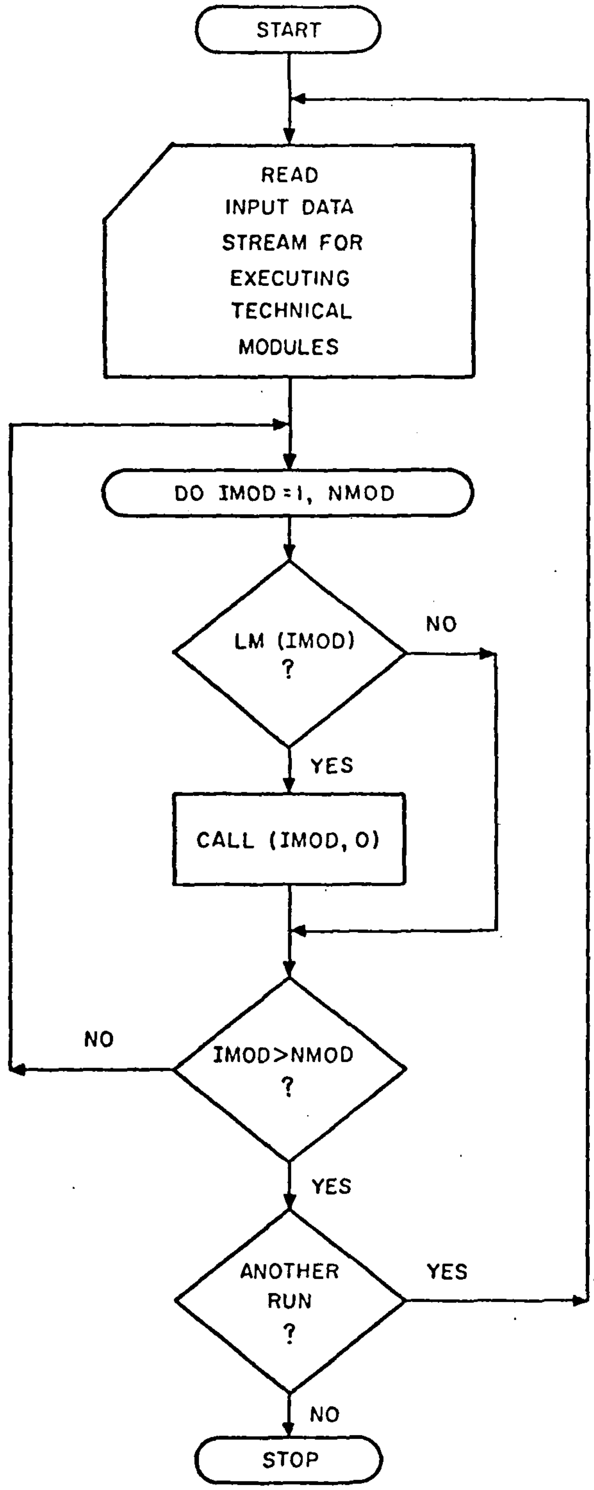


Figure 3. Flow of Control of the SOUSEX Subroutine.

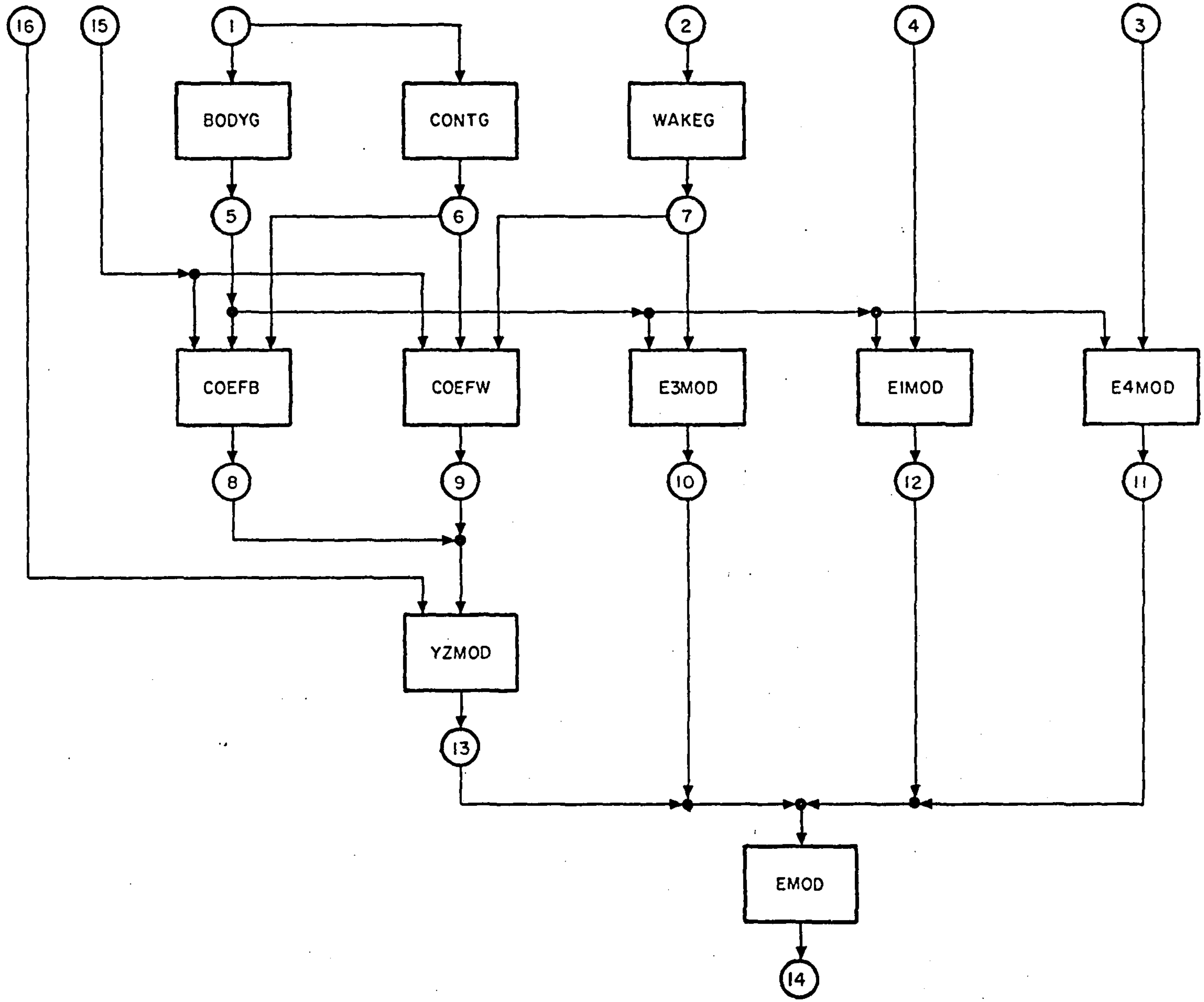


Figure 4. Logical Structure of the SOUSSA-P 1.1 Program.

following manner: the output of a given node (i.e., the outwardly directed arrow from the node) consists of the union of all checkpoints with inwardly directed arrows to the node.

All SOUSSA-P data sets (described in Section 7) that comprise the various checkpoints correspond exactly to SOUSSA-P FORTRAN variables. A description of the SOUSSA-P FORTRAN variables is given in Section 5.

Because of the highly modular logical structure of SOUSSA-P and because of the benefits of the data complex communication system, the checkpoint/restarting capabilities of SOUSSA-P are extensive. For instance, any individual SOUSSA-P module may be executed during a given run provided the appropriate checkpoints reside on the data complex. A discussion of the checkpoint/restart facility of SOUSSA-P is given in Sections 12 and 13.

SECTION 3

DESCRIPTION OF THE SOUSSA-P TECHNICAL MODULES

3.1 INTRODUCTION

This section presents a brief description of each of the SOUSSA-P technical modules. For Version 1.1 of SOUSSA-P, each module corresponds to a unique CDC primary overlay (as indicated by Fig. 1). Throughout the remainder of this Section, the reader is referred to various equations in Ref. 3 to enhance his/her understanding of the purpose of the technical modules.

3.2 DESCRIPTION OF TECHNICAL MODULES

BODYG overlay (sous,1,0) generates the complete body geometry from the user-input body geometry (i.e., from the output of the user's geometry preprocessor); e.g., if the aircraft is symmetric with respect to the x-z plane, the user need only input the right half; the left half is generated automatically within the BODYG module. Also, the base vectors ($\vec{a}_1$, $\vec{a}_2$) and normals ($\vec{a}_1 \times \vec{a}_2$) of the body elements are calculated (see Ref. 3, Eqs. (3-33) to (3-35), respectively). The output of this module is needed for the calculation of body-related coefficients (e.g., source and doublet coefficients), which is performed by module COEFB.

WAKEG overlay (sous,2,0) generates the complete wake geometry from the input wake geometry (i.e., from the output of the user's geometry preprocessor or other wake specification) and divides the wake strips into elements. The output of this module is needed for the calculation of wake-related coefficients (e.g., doublet coefficients), which is performed by module COEFW.

CONTG overlay (sous,3,0) calculates the location of the normalwash control points, $\vec{P}_j$ (which coincide with the centers of the elements for SOUSSA-P 1.1).

COEFB overlay (sous,4,0) calculates for subsonic flow the body-related coefficients B_{jh}, C_{jh}, D_{jh} and Θ_{jh} (see Ref. 3, Eqs. (3-7)), using the procedure described in Ref. 3, Section 3.3. For Version 1.1, these are based on zeroth-order (constant-potential) surface elements.

COEFW overlay (sous,5,0) calculates for subsonic flow the wake-related coefficients F_{jn}, G_{jn}, and $\check{\Theta}_{jn}$ (see Ref. 3, Eqs. (3-7)), using the procedure described in Ref. 3, Section 3.3. For Version 1.1, these are based on zeroth-order (constant-potential) surface elements.

E3MOD overlay (sous,6,0) calculates the matrices, $E_3^{(0)}$ and $E_3^{(1)}$ (see Ref. 3, Eqs. (5.14) and (5.34)), which generate the pressure distribution from the velocity potential distribution via an averaging scheme for the potential and Bernoulli's equation. It should be noted that it is actually the perturbation velocity potential distribution which is transformed into the pressure distribution. The relationship between the perturbation velocity potential and the total velocity potential is given by Ref. 3, Eq. (1-4). From here on, the expression "velocity potential" actually refers to "perturbation velocity potential".

E4MOD overlay (sous,7,0) calculates the matrix E_4 (see Ref. 3, Eq. (5.45)), which generates generalized aerodynamic forces (weighted integrals of pressure) from the pressure distribution. This matrix depends upon the generalized force modes, i.e., the displacement modes acted upon by the aerodynamic forces. These modes may be distinct from the boundary-condition modes (see E1MOD).

E1MOD overlay (sous,10,0) calculates the matrices $E_1^{(0)}$ and $E_1^{(1)}$ (see Ref. 3, Eq. (6-16)), which are real and imaginary parts of the normalwash due to the boundary-condition modes. The expression "boundary-condition modes" refers to modes used to obtain the normalwash, and include the vehicle shape as well as the modes used to describe the rigid-body displacement and deformation of the aircraft and turbulence modes.

YZMOD overlay (sous,11,0) assembles the frequency-dependent matrices of potential and normalwash influence coefficients, Y and Z, where

$$\left[Y_{jh}\right] = \left[\delta_{jh} - (C_{jh} + pD_{jh})\, e^{-p\Theta_{jh}} - \sum_{n=1}^{N_{DPHI}} (F_{jn} + pG_{jn})\, e^{-p\check{\Theta}_{jn}}\, S_{nh}\right]$$

$$\left[Z_{jh}\right] = \left[B_{jh}\, e^{-\Theta_{jh}}\right]$$

In the above equations, p is the complex reduced frequency (nondimensional Laplace parameter), given by

$$p = (\gamma + i)\,k$$

where $k = \omega\ell/U_\infty$ is the reduced frequency, whereas $\gamma = \mathrm{Real}(p)/\mathrm{Imag}(p)$. Note that for simple harmonic motion, $\gamma = 0$.

EMOD overlay (sous,12,0) calculates the matrix E, the matrix of generalized aerodynamic forces, where $E = E_4\, E_{321}$ and

$$E_{321} = E_3\, E_{21}$$

$$E_3 = E_3^{(0)} + pE_3^{(1)}$$

$$E_{21} = Y^{-1}\, ZE_1$$

$$E_1 = E_1^{(0)} + pE_1^{(1)}$$

Module EMOD is comprised of four submodules (secondary overlays) which perform the following computations:

ZE1MOD overlay (sous,12,1) assembles the Y and Z matrices with respect to the boundary-condition mode symmetry conditions, and computes the matrix product ZE_1.

LUFCTR overlay (sous,12,2) LU-factors the matrix Y with pivoting by row interchanges; i.e., computes Y = LU. This operation is performed out of core if necessary.

LUSOLV overlay(sous,12,3) solves the system of equations resulting from the LU-factorization performed by LUFCTR, with out-of-core operations if necessary, i.e.,

$$E_{21} = (U^{-1} L^{-1})ZE_1$$

GAFMOD overlay (sous,12,4) calculates the matrix E_{321} which generates pressure distributions from boundary-condition modes, and the matrix E which generates generalized forces.

SECTION 4

DESCRIPTION OF THE SOUSSA-P FORTRAN VARIABLES

This section presents a description of all primary SOUSSA-P FORTRAN variables. In particular, the variables comprising the contents of the SOUSSA-P checkpoints (see Table 2 in Section 4) are described. Definitions are not provided for variables internal to various routines.

Several naming conventions for variables are maintained throughout the SOUSSA-P program. First, the standard FORTRAN policy that variables with names beginning with a letter in the range I-N are of type integer, and variables beginning with a letter in the range A-H,O-Z are of type real (unless declared complex), is followed. The letter "H" is prefixed to variable names that are to be of type real that would otherwise be of type integer.

Furthermore:

* Variable names that end in "I" (I stands for input) belong to checkpoints 1 and 2 (see Table 2 in Section 4); i.e., they are part of the geometrical definition of the body and wake (see Section 6.2) supplied by the user. Variables NPHI and NPSI are exceptions to this rule.

* Scalar variable names that begin with "N" denote variable dimensions of arrays.

Throughout this section, the reader is referred to the SOUSSA-P Theoretical Manual (Ref. 3) to help convey the meaning of SOUSSA-P variables.

TABLE 1 - DEFINITION OF VARIABLES

Variable Name And Dimensions	Definition
AVG(NNI,NE)	Matrix which generates velocity potential at nodes from velocity potential at centers of elements
A1C(3,NE)	Base vector along coordinate direction 1 at centers of the elements
A2C(3,NE)	Base vector along coordinate direction 2 at centers of the elements

(table continued on next page)

Variable Name And Dimensions	Definition
A1X2(3,NE)	Vector obtained from cross product of vectors A1 and A2 at centers of elements
B(NC,NPSIT)	Matrix defining source influence of discrete nodal values of normalwash on normalwash control points (see Eqs. (3-10) and (3-23) in Ref. 3); note that NPSIT=NPSI*NQ
BCM(3,NNI,NBCM)	Wind-axis three-dimensional boundary-condition mode shapes
BETA	Prandtl-Glauert transformation factor
BER(NEI,NNI)	Matrix which generates pressure coefficients at centers of elements from velocity potentials at nodes
C(NC,NPHIT)	Matrix defining doublet influence of discrete nodal values of velocity potential on normalwash control points (see Eqs. (3-10) and (3-24) in Ref. 3); note that NPHIT=NPHI*NQ
COEF(NTE,NDPH)	Matrix which generates coefficient of influence on body from trailing-edge index number and nodal value number of velocity potential discontinuity along the wake
D(NC,NPHIT)	Matrix defining "rate-doublet" influence of discrete nodal values of velocity potential on normalwash control points (see Eqs. (3-10) and (3-25) of Ref. 3)
E(NGFM,NBCM)	Frequency-dependent matrix of generalized aerodynamic forces; $E = E_4 E_3 E_2 E_1$

(table continued on next page)

Variable Name And Dimensions	Definition
EDEL(NC,NPHIT)	Matrix defining solid angle modification of discrete nodal values of velocity potential on control points $\mathrm{EDEL}(i,j) = 2\delta_{ij} - \sum_j C_{ij}$
ELAM	Integration scheme choice parameter (see Section 6)
E1(NPSI,NBCM)	Frequency-dependent matrix which generates normalwash from boundary-condition modes (see Eq. (4-29) of Ref. 3)
E10(NPSI,NBCM)	Steady part of matrix E1
E11(NPSI,NBCM)	Unsteady part of matrix E1
E21(NPHI,NBCM)	Frequency-dependent matrix which generates velocity potential distributions from boundary-condition modes (see Eq. (6-14) of Ref. 3)
E3(NCP,NPHI)	Frequency-dependent matrix which generates pressure distributions from velocity potential distributions (see Eq. (5-34) of Ref. 3)
E30(NCP,NPHI)	Steady part of matrix E3
E30U(NCP,NPHIT)	Matrix E30 unmodified by trailing-edge Kutta condition (see Eq. (5-14) of Ref. 3)
E31(NCP,NPHI)	Unsteady part of matrix E3
E31U(NCP,NPHI)	Matrix E31 unmodified by trailing-edge Kutta condition (see Eq. (5-14) of Ref. 3)
E321(NCP,NBCM)	Frequency-dependent matrix which generates pressure distributions from boundary-condition modes (see Eq. (6-15) of Ref. 3)
E4(NGFM,NCP)	Matrix which generates generalized aerodynamic forces from pressure coefficients at control points (see Eq. (5-41) of Ref. 3); the corresponding data set represents the transpose of this matrix and is hence denoted E4T

(table continued on next page)

Variable Name And Dimensions	Definition
F(NC,NDPH)	Matrix defining doublet influence of discrete nodal values of velocity potential discontinuity along wake on normalwash control points (see Eqs. (3-10) and (3-38) in Ref. 3)
FREQ(NFRQ)	Complex reduced frequencies
G(NC,NDPH)	Matrix defining "rate-doublet" influence of discrete nodal values of velocity potential discontinuity along wake on normalwash control points (see Eqs. (3-10) and (3-38) of Ref. 3)
GFM(3,NNI,NGFM)	Wind-axis three-dimensional generalized-force mode shapes
HMCH	Free stream Mach number
IBNV(NTE,NDPH)	Matrix which identifies nodal value number of velocity potential on body given trailing-edge index number and nodal value number of velocity potential discontinuity along wake
IEKU(NTES,NSEG)	Matrix which identifies element number on body given trailing-edge block element index number and trailing-edge segment number (see Eq. (5-33) of Ref. 3)
IEKI(NTE,NSGI)	Portion of matrix IEKU input by user (see Section 6)
INV(NTE,NS)	Matrix which identifies global nodal value number of velocity potential on body given wake strip number and trailing-edge index number
IN(NK,NE)	Matrix which identifies global node number given body element number and corner number
INI(NK,NEI)	Portion of matrix IN input by user (see Section 6)

(table continued on next page)

Variable Name And Dimensions	Definition
ISEG(NS)	Array which identifies trailing-edge segment number given wake strip number
ISGI(NSI)	Portion of array ISEG input by user (see Section 6)
KODE(NE)	Integer code for special-purpose elements on body (e.g., elements that have wake strips emanating from one of their edges)
KODI(NEI)	Portion of array KODE input by user (see Section 6)
KBCY,KBCZ	Symmetry conditions in y and z directions, respectively, for boundary-condition modes (-1= antisymmetry, 0= no symmetry, 1= symmetry)
KBDY,KBDZ	Symmetry conditions in y and z directions, respectively, for body geometry (0= no symmetry, 1= symmetry)
KGFY,KGFZ	Symmetry conditions in y and z directions, respectivly, for generalized-force modes (-1= antisymmetry, 0= no symmetry, 1= symmetry)
KNDY(NNI), KNDZ(NNI)	Symmetry line code numbers (see Section 6)
KSGY(NSGI), KSGZ(NSGI)	Symmetry conditions in y and z directions, respectively, for trailing-edge segment associated wake strips; i.e., if a wake strip is symmetric with respect to y (or z) direction, then it will be reflected in x-z (or x-y) plane (see Section 6) (0= no symmetry, 1= symmetry)
LBC	Special boundary-condition indicator (see Section 6)
NBCM	Number of boundary-condition modes considered
NC	Number of normalwash control points on body
NCP	Number of locations at which pressure coefficient is evaluated

(table continued on next page)

Variable Name And Dimensions	Definition
NDPH	Number of discrete nodal values of discontinuity in velocity potential along wake
NE	Number of elements on body= NEI*NQ
NEI	Number of elements input by user; i.e., number of elements defined by user's geometry pre-processor
NFRQ	Number of frequencies considered
NGFM	Number of generalized-force modes considered
NK	Number of corners per element on body (should be input as 4)
NNI	Number of nodes input by user; i.e., number of nodes defined by user's geometry preprocessor
NN	Number of nodes on body= NNI*NQ
NPHI	Number of discrete nodal values of velocity potential
NPSI	Number of discrete nodal values of normalwash
NQ	Equals two (four) if body geometry representation makes use of one (two) planes of symmetry; otherwise, equals one (NQ=(KBDY + 1)*(KBDZ +1))
NS	Total number of strips on wake; includes strips associated with all wake-producing surfaces and reflected wake strips due to symmetry
NSE(NS)	Number of wake elements per wake strip
NSEG	Total number of trailing-edge segments on body (see Section 6); includes reflected trailing-edge segments due to symmetry (see KSGY, KSGZ)

(table continued on next page)

Variable Name And Dimensions	Definition
NSGI	Number of trailing-edge segments input by user
NSEI(NSI)	Number of wake elements per strip input by user
NSI	Number of wake strips input by user; i.e., number of wake strips defined by user's geometry preprocessor
NSK	Number of corners per wake strip (should be input as 4)
NTE	Number of normalwash control points on the body needed to define velocity potential discontinuity along the wake (should be input as 2)
NTES	Number of elements on body needed to define trailing-edge Kutta condition (should be input as 4)
NWE	Total number of wake elements = $\sum_{is=1}^{NS}$ nse(is)
NWK	Number of corners per element on wake (has the value 4)
PC(3,NC)	Wind-axis nondimensional Cartesian coordinates of normalwash control points on body
PCEN(3,NE)	Wind-axis nondimensional Cartesian coordinates of centers of body elements
PN(3,NN)	Wind-axis nondimensional Cartesian coordinates of nodes on body
PNI(3,NNI)	Wind-axis Cartesian coordinates of nodes input by user (see Section 6)
PS(3,NSK,NS)	Wind-axis Cartesian coordinates of corners of wake strips
PSI(3,NSK,NSI)	Portion of array PS input by user (see Section 6)

(table continued on next page)

Variable Name And Dimensions	Definition
PWK(3,NWK,NWE)	Wind-axis nondimensional Cartesian coordinates of corners of wake elements
REFL	Reference length
TEC(NEI,NE)	Matrix implementing trailing-edge Kutta condition; TEC multiplies E30U and E31U to yield E30 and E31 (see Eq.(5-34) of Ref. 3)
THET(NC,NPHIT)	Matrix defining delay times from nodal value locations of velocity potential to normalwash control point locations (see Eqs. (3-10) and (3-40) of Ref.3)
THTB(NC,NDPH)	Matrix defining delay times from nodal value locations of velocity potential discontinuity along wake to normalwash control point locations plus convection times from trailing-edge element centers to nodal value locations of velocity potential discontinuity along wake (see Eq. (3-43) of Ref. 3)
Y(NC,NPHIT)	Frequency-dependent matrix of potential influence coefficients (see Eq. (3-13) in Ref. 3 or the discussion of YZMOD in Section 3 of this manual)
Z(NC,NPSIT)	Frequency-dependent matrix of normalwash influence coefficients (see Eq. (3-14) in Ref. 3 or the discussion of YZMOD in Section 3 of this manual)
ZE1(NC,NBCM)	Frequency-dependent matrix given by the product of matrices Z and E_1

```
Checkpoint  1
     Arrays:
               pni(3,nni)
               ini(nk,nei)
               kndy(nni),kndz(nni)
               kodi(nei)
     Scalars:
               nni
               nk
               nei
               kbdy,kbdz
               refl

Checkpoint  2
     Arrays:
               ieki(ntes,nsgi)
               isgi(nsi)
               psi(3,nsk,nsi)
               nsei(nsi)
               ksgy(nsi),ksgz(nsi)
     Scalars:
               ntes
               nsgi
               nsi
               nsk
               nte
               refl

Checkpoint  3
     Arrays:
               gfm(3,nni,ngfm)
     Scalars:
               ngfm
               nni
               kgfy,kgfz

Checkpoint  4
     Arrays:
               bcm(3,nni,nbcm)
     Scalars:
               nbcm
               nni
               kbcy,kbcz
```

Table 2. Contents of the SOUSSA-P Checkpoints
(page 1 of 4)

```
Checkpoint  5
     Arrays:
             pn(3,nn)
             in(nk,ne)
             kode(ne)
             alc(3,ne)
             a2c(3,ne)
             alx2(3,ne)
     Scalars:
             nn
             nk
             ne
             nq

Checkpoint  6
     Arrays:
             pcen(3,ne)
             pc(3,nc).
     Scalars:
             nc

Checkpoint  7
     Arrays:
             pwk(3,nwk,nwe)
             ibnv(nte,ndph)
             coef(nte,ndph)
             ieku(ntes,nseg)
     Scalars:
             nwe
             nwk
             nte
             ndph
             ntes
             nseg

Checkpoint  8
     Arrays:
             b(nc,npsit)
             c(nc,nphit)
             d(nc,nphit)
             thet(nc,nphit)
             edel(nc,nphit)
     Scalars:
             hmch
             kbdy, kbdz
             nc
             nphi  Note:  npsit=npsi*nq
             npsi         nphit=nphi*nq
             nq
```

Table 2. Contents of the SOUSSA-P Checkpoints (page 2 of 4)

Checkpoint 9

Arrays:

f(nc,ndph)
g(nc,ndph)
thtb(nc,ndph)

Scalars:

nc
ndph
nphi
hmch

Checkpoint 10

Arrays:

tec(nei,ne)
e30u(nei,ne)
e31u(nei,nei)

Scalars:

nq
ne Note: nei=ne/nq
ncp
nphi

Checkpoint 11

Arrays:

e4(ngfm,ncp)

Scalars:

ngfm
ncp

Checkpoint 12

Arrays:

e10(npsi,nbcm)
e11(npsi,nbcm)

Scalars:

npsi
nbcm

Checkpoint 13

Arrays:

y(nc,nphit,nfrq)
z(nc,npsit,nfrq)
freq(nfrq)

Table 2. Contents of the SOUSSA-P Checkpoints (page 3 of 4)

Scalars:

nc
nphi
npsi
nfrq
hmch
nq
kbdy,kbdz
kbcy,kbcz
kgfy,kgfz

Checkpoint 14

Arrays:

zel(nc,nbcm,nfrq)
e21(nphi,nbcm,nfrq)
e321(ncp,nbcm,nfrq)
e(ngfm,nbcm,nfrq)

Scalars:

ngfm
nbcm
ncp
nphi
nfrq
hmch

Checkpoint 15

Scalers:

hmch
elam

Checkpoint 16:

Arrays:

freq(nfrq)

Scalers:

nfrq

Table 2. Contents of the SOUSSA-P Checkpoints
(page 4 of 4)

SECTION 5

DESCRIPTION OF THE SOUSSA-P SUBROUTINES

5.1 INTRODUCTION

This section contains a description of the subroutines that comprise the SOUSSA-P modules. This includes a brief description of SPAR subroutines that are called directly by the SOUSSA-P technical modules. These encompass data handling subroutines as well as free-field format reader subroutines. A more detailed description of these routines and the other SPAR subroutines in the main overlay is given in Ref. 5.

Every SOUSSA-P program and subroutine is introduced by means of FORTRAN comments possessing the following format:

```
c      PURPOSE: <purpose of the program or routine>
c      DATE: <date written>
c      LOCATION: <location written>
c      PROGRAMER: <name of programer>
c      PARAMETERS: <appears only if the routine possesses parameters>
c        PARM1: <description of first parameter including its status
c          i.e. input, output, or input/output>
c        PARM2: <description of second parameter>
c          .
c          .
c          .
c        PARMn: <description of last parameter>
c      LAST UPDATE: <date last update to the program or routine was
c         made and name of updater>
```

Every SOUSSA-P main program (one for each overlay) is divided into the following sections by use of FORTRAN comments:

1)
```
c      *********
c      * INPUT *
c      *********
```

In this section, calls to the SPAR data handling subroutines are made to read into main memory from auxilliary storage, the SOUSSA-P data sets that correspond to input parameters of the subroutines that comprise the overlay.

2)
```
c      ***********************
c      * COMPATIBILITY CHECK *
c      ***********************
```

In this section, compatibility checks are performed on input variables that must satisfy certain conditions. For example, for version 1.1 of SOUSSA-P, the symmetry code parameters for the boundary-condition and generalized-force modes must be the same in absolute value as the corresponding symmetry code parameters for the body geometry (see Section 11 for other compatibility requirements).

```
3)      c       *************
        c       * EXECUTION *
        c       *************
```

In this section, the subroutines that comprise the overlay are called.

```
4)      c       **********
        c       * OUTPUT *
        c       **********
```

In this section, the SPAR data handling subroutines are called to write from main memory to auxilliary storage, the SOUSSA-P data sets that correspond to output parameters of the subroutines that are included in the overlay.

For the sake of readability, clarity and consistency, the parameter sequence of almost all the SOUSSA-P subroutines follow this order:

1) input array parameters
2) OUTPUT ARRAY PARAMETERS
3) input scalar parameters
4) OUTPUT SCALAR PARAMETERS

The terms "input" and "output" in this context mean, respectively, parameters whose values are defined prior to execution of the subroutine under consideration (and not altered by the execution of the subroutine), and parameters whose values are undefined prior to the execution, and defined upon returning from the subroutine.

Another convention followed in the parameter sequence is that, for scalar parameters that serve as dimensions of array parameters, their order coincides with their ordering as dimensions. (see example at the end of this subsection).

In the following definitions, with regard to parameter sequence, output parameters will be entirely capitalized while input parameters will be in lower case, so they may be easily identified. In those rare cases when a parameter serves as both an input and output parameter, the parameter name will appear in lower case and upper case, separated by a slash. Note also that the name of the subroutine will be in capitals.

An example to illustrate the SOUSSA-P subroutine parameter sequence conventions is now given:

```
OVERLAY(SOUS,n,0)  EXAMP     (  a,b,     X,Y,      j,k,       M,N       )

overlay to which   name of     input   output   input     output
subroutine         subroutine     array              scalar
belongs.  Sub-                  variables          variables
routines are
grouped by
overlays.
```

Note: for this example, array parameters could be dimensioned a(j),b(k),X(M),Y(N). Further note that array and scalar parameters may be both of type real and integer.

5.2 SUBROUTINE DESCRIPTIONS

overlay(sous,0,0) SOUSEX

Determines the flow of control of the SOUSSA-P technical modules; i.e., call technical modules (imod,0) if lm(imod)=.true., imod=1,nmod (see Section 6).

SOUI

Reads control input data for technical modules (see Section 6.3).

RSET(il,m,iea,iflag)

Reads RESET cards (see Section 7), if iflag is set, which appear in the input file after the [XQT command for each module. Also, RSET establishes how much working storage is available for arrays whose size is problem-dependent. (This routine is not contained in the (0,0) overlay but is listed here since it appears in each of the subsequent overlays.)

READER

Interprets the information on an input record having a free-field format which follows the rules given in Ref. 4 and included here as Appendix B.

TCLOCK(i,CP,DCP)

Returns the current time from the CPU clock.

DATIM(IDATE,ITIME)

Returns the current date and wall clock time.

RIO(nu,iwr,iop,kshft/KSHFT,ka,lb)

Data handling subroutine that reads or writes data sets from or to the data complex, block by block, to or from main memory at address ka. The preceding terminology is described in connection with the INTR utility module in Section 7.

DAL(nu,iop,ka,kore,ica,KADR,IERR,nwrds/NWRDS,
    nj/NJ,lb/LB,itype/ITYPE,name1,name2,name3,
    name4)

Data handling subroutine that reads or writes single-block data sets from or to the data complex, to or from main memory at address ka. The parameters appearing in upper case and lower case correspond to input parameters for writes and output parameters for reads. Many of the parameters of DAL are described in the discussion of the INTR utility module, presented in Section 7.

LTOC(nu,j,name1,name2,name3,name4)

Retrieves the jth item in Table of Contents line for data set name1,name2,name3,name4 in library nu (see Section 7.2).

NSECTS(k)

Returns the number of disk sectors required to contain k words.

FIN(nerr,ner)

Called as the last operation in each module, it causes the printing of the cumulative amount of CPU time for the job as well as the cumulative count of both reads and writes between the data complex and main memory. FIN is also used for error reporting, in which case NERR and NER are printed in format A4,I10 as a diagnostic. Section 11 presents all possible cases in which FIN may be called to report an error detected during the execution of SOUSSA-P.

overlay(sous,1,0) BODALL(pni,ini,kodi,kndy,kndz,PN,IN,KODE,nni,
    nk,nei,kbdy,kbdz,NN,NE,refl)

Converts the arrays pni, ini, and kodi into the arrays PN, IN, and KODE,respectively; that is, the input body geometry (i.e., the output of the user's geometry preprocessor) is transformed to account for the whole aircraft - e.g., if the aircraft is left-right symmetric (see kbdy in Section 4) then the user need only define the nodal coordinates, the node function, and the element code numbers for the right half. The left half is generated automatically by BODALL.

BGEOM(pn,in,A1C,A2C,A1X2,nn,nk,ne)

Calculates the base vectors a1 and a2, as well as a1 cross a2, at the centers of the elements on the body (see Eqs. (3-33) to (3-35) of Ref. 3).

XPROD(a,b,j)

Returns the jth component of the cross product of vector a by vector b.

overlay(sous,2,0) WNS(ksgy,ksgz,isgi,ieki,IEKU,ISGF,ntes,nsgi, nsi,nei,kbdy,kbdz,NSEG,NS)

Converts the scalars nsgi and nsi, and the array ieki into NSEG and NS , and IEKU, respectively. The total number of wake strips, NS, encompasses strips associated with all wake producing surfaces on the body, including reflected wake strips due to symmetry.

WAKALL(isgi,psi,nsei,ksgy,ksgz,isgf,IEKU, ISEG,INV,PS,NSE,nsi,nsk,nsgi,ntes,nseg, ns,nte)

Converts the arrays psi, nsei, and isgi into the arrays PS, NSE, and ISEG, respectively; that is, the input wake geometry (i.e., the output of the user's geometry preprocessor) is transformed to account for the whole aircraft. Also the array INV and the total number of trailing-edge segments, NSEG, are calculated.

WNELEM(nse,ns,NWE,NWK)

Calculates the number of wake elements, NWE, and the number of corners per wake element, NWK.

WELEM(ps,nse,PWK,ns,nsk,nwe,nwk,refl,NDPH)

Calculates the coordinates of the corners of the wake elements, PWK, and the value for NDPH (the number of discrete nodal values of the discontinuity in the velocity potential along the wake).

WTE(inv,nse,IBNV,COEF,ns,nte,ndph)

Calculates the arrays IBNV and COEF, which are used in tandem to realize the S matrix (see Eq.(3-5) of Ref. 3).

overlay(sous,3,0) NCONT(nn,ne,NC)

Calculates the number of normalwash control points, NC.

CGEOM(pn,in,PC,nn,nk,ne,nc,refl)

Calculates the coordinates of the normalwash control points.

CENTG(pni,ini,PCEN,nni,nk,nei,kbdy,kbdz,refl)

Calculates the centers of the elements on the entire body.

overlay(sous,4,0) PGTRNB(pn,in,PK,nn,nk,ne,hmch)

Calculates the coordinates of the corners of the elements on the body, PK,in the Prandtl-Glauert domain.

PGTRNC(pc,nc,hmch)

Calculates the coordinates of the normalwash control points in the Prandtl-Glauert domain.

COBSUB(pk,pc,B,C,D,THET,EDEL,SCRTCH,ne,nk,
nc,hmch,elam)

Calculates the body-related coefficients B, C, D, EDEL, and THET for subsonic flow with zeroth-order (constant-potential) elements (see Eqs. (3-10), (3-23) to (3-25), and (3-40) of Ref. 3).

overlay(sous,5,0) PGTRNW(PWK,nwk,nwe,hmach)

Calculates the coordinates of the corners of the wake elements, PWK, in the Prandtl-Glauert domain.

COWSUB(pwk,pc,ibnv,F,G,THETB,nwe,nwk,nc,hmch,elamda)

Calculates the wake-related coefficients F, G, and THETB for subsonic flow for zeroth-order (constant-potential) elements (see Eqs. (3-10), (3-37), to (3-38), and (3-43) of Ref. 3).

overlay(sous,6,0) E30UMT(in,a1c,a2c,a1x2,BER,WEIGH,AVG,E30U,nk,ne,nei, nni,nu,nam2,nam3)

Calculates the matrix E30U, the product of the matrices BER and AVG, which generates the pressure coefficient at the centers from the velocity potential at the element centers; i.e., calculates the matrix E30 unmodified by the trailing-edge Kutta condition.

KUTTA(pn,in,ieku,kode,TECC,TEC,nn,nk,ne,nte,ntes, nseg,nei,nu,nam2,nam3)

Calculates TEC, the trailing-edge Kutta condition matrix (see Eqs. (5-31) and (5-32) of Ref.3).

E31UMT(E31U,nei,nu,nam2,nam3)

Calculates the matrix E31U, the unsteady portion of the matrix E3 (unmodified by the Kutta condition at the trailing edge).

overlay(sous,7,0) E4MAT(gfm,in,a1x2,E4,nni,ngfm,nk,ne,nei,nu,nam2,nam3)

Calculates the matrix E4, which generates the generalized-aerodynamic-forces from the pressure coefficients.

overlay(sous,10,0) E1MATS(bcm,in,a1x2,E10,E11,nni,nbcm,nk,ne,nei,
nu,nam2,nam3)

Invoked when LBC is input as T (see Section 6.3), this routine calculates the matrices E10 and E11 (the steady and unsteady parts of matrix E1), which generate normalwash from boundary-condition modes. In this case E11 = 0.

E1MATU(bcm,inode,a1c,a2c,a1x2,E10,E11,nni,nbcm,
nk,ne,nei,nu,nam2,nam3)

Invoked when LBC is input as F (see Section 6.3), this routine calculates the matrices E10 and E11 (the steady and unsteady parts of matrix E1), which generate normalwash from boundary-condition modes.

overlay(sous,11,0) AFBSUB(f,g,thtb,freq,FB,nc,ndph,nu,nam2,nam3,
ifrq,kore)

Assembles the frequency-dependent matrix FB for subsonic flow:

```
FB(j,n)=(f(j,n)+freq(ifrq)*g(j,n))*
        cexp(-freq(ifrq)*thtb(j,n))
```

FBSSUB(fb,ibnv,coef,FBS,nc,nte,ndph,nphi,ncol,nu,nam2,
nam3,ifrq,kore)

Assembles the frequency-dependent matrix FBS for subsonic flow: FBS=fb*s
where the matrix s (see Eq. (3-5) of Ref. 3) is realized by the matrices ibnv and coef.

AYZSUB(b,c,d,edel,thet,fbs,freq,Y,Z,nc,nphi,
nu,nam2,nam3,ifrq,kore)

Assembles the frequency-dependent matrices Y and Z for subsonic flow:

```
Y(j,h)=edel(j,h)-
    (c(j,h)+freq(ifrq)*d(j,h))*
    cexp(-freq(ifrq)*thet(j,h))- fbs(j,h)
```

and

```
Z(j,h)=b(j,h)*cexp(-freq(ifrq)*thet(j,h))
```

(see Eqs. (3-13) and (3-14) of Ref. 3).

ICEIL(inumer,idenom)

This function computes the ceiling of (i.e., the least integer greater than or equal to) inumer divided by idenom.

overlay(sous,12,1) ASCOMP(a,AASS,m,n,ncol,ksy,ksz,nur,nuw,
namlr,namlw,nam2,nam3,nam4)

Combines (adds or subtracts depending on the values of ksy and ksz) the n/m submatrices of the m by n complex matrix a, to yield the m by m complex matrix AASS, with out-of-core operations if necessary.

ASM01(a0,a1,A,m,n,freq,nu,nam11,nam12,
nam13,nam2,nam3,nam4,ifrq)

Combines frequency-independent matrices a0 and a1 to yield frequency-dependent matrix A where
A(i,j) = a0(i,j)+freq*a1(i,j)

CMTMUL(a,b,C,n1,n2,n3,ncol,nu,nam11,
nam12,nam13,nam2,nam3,nam4)

Performs (out of core if necessary) multiplication of complex matrices a(n1,n2) and b(n2,n3) to yield complex C(n1,n3).

overlay(sous,12,2) PART1(c/C,P,n,mcr,mc,mr)

Invokes routines that LU-factor complex matrix C, with out-of-core operations if necessary.

BLOCKF(p/P,c,L,U,n,nc,KSC)

LU-factors the first block of the complex matrix c.

BLOCKN(cc,cr,LC,LR,UC,UR,p/P,n,nr,ndone,ksc)

LU-factors the nth block of the complex matrix cc.

PART2(P,c/C,n,mcr,ncpr,nclr,nrec)

Rearranges the LU-factored matrix C on external storage.

OUTREC(a,lun,num)

Writes a "num"-word record from location "a" to unit "lun" (used for scratch file output).

INREC(a,lun,num)

Reads a "num"-word record from unit "lun" to location "a" (used for scratch file input).

overlay(sous,12,3) SOLVE(p,c,l,u,w,r,Z,n,m,nclr,nrec,nu,ksw,kslu,ksz)

Solves simultaneous equations using factored matrix resulting from program LUFCTR.

overlay(sous,12,4) ASREAL(a,AASS,m,n,ncol,ksy,ksz,nur,nuw,
namlr,namlw,nam2,nam3,nam4)

Combines (adds or subtracts depending on the values of ksy and ksz) the n/m submatrices of the m by n real matrix a, to yield the m by m real matrix AASS, with out-of-core operations if necessary.

RMTMUL(a,b,C,n1,n2,n3,ncol,nu,naml1,
naml2,naml3,nam2,nam3,nam4)

Performs (out of core if necessary) multiplication of real matrices a(n1,n2) by b(n2,n3) to yield real C(n1,n3).

ASME(e4,e321,E,ngfm,ncp,nbcm,nq,ncol,ifrq,
nu,nam2,nam3)

Calculates the matrix E (the product of the matrices nq*e4 and e321), which generates the generalized aerodynamic forces from the generalized coordinates; i.e., e=Eq, where e is the vector of generalized aerodynamic forces and q is the vector of generalized coordinates (see Eq. (6-13) of Ref. 3).

SECTION 6

PREPARATION OF INPUT FOR THE SOUSSA-P TECHNICAL MODULES

6.1 INTRODUCTION

This section describes the input expected by the SOUSSA-P program (specifically the SOUSEX subroutine) after the "[XQT SOUS" control command has been encountered in the input stream by the executive portion of the MAIN overlay (see Section 2.1).

The occurence of the "[XQT SOUS" command implies the execution of one or more SOUSSA-P technical modules through which a variety of aerodynamic computations may be performed. These include, for example, the following types of aerodynamic analysis:

A. Unsteady State Applications

a) Flutter or Gust Analysis
b) Flutter or Gust Analysis with multiple sets of frequencies
c) Flutter or Gust Analysis with multiple sets of boundary-condition modes and/or generalized-force modes
d) Flutter or Gust Analysis with multiple Mach numbers

B. Steady or Quasi-Steady State Applications

a) Steady-State Pressure Distributions
b) Structural Design Loads
c) Aerodynamic Coefficients
d) Stability Derivatives
e) Static Aeroelastic Analysis

It is important to note that analyses involving multiple frequencies or modes are completely automatic, i.e. no restart is necessary. Furthermore, analyses involving multiple sets of frequencies, sets of modes, or Mach numbers may be performed with a minimal amount of recalculation due to the extensive checkpoint/restart capabilities of the SOUSSA-P program.

6.2 CREATING THE INITIAL INPUT DATA SETS

As indicated by Fig. 4, checkpoints 1 through 4, 15, and 16 are required as initial input to the SOUSSA-P program; i.e., they are not generated by any SOUSSA-P technical module. These checkpoints represent the geometrical definitions of the aircraft body, the prescribed wake, the generalized-force mode(s), the boundary-condition mode(s), the parameters HMCH and ELAM, and the set of complex reduced frequencies, respectively. This information is assumed to be available via state-of-the-art geometry preprocessors (e.g., GEMPAK, Ref. 6) and structural analysis processors (e.g., SPAR, Ref. 4).

The creation of these initial input data sets is accomplished via the INTR utility module, described in Section 7.4. Basically, the INTR utility module transforms data punched in free-field format on 80-column cards into data sets that may be accessed by SOUSSA-P modules. The information comprising the initial input that the user must provide as punched cards is described in Section 4; i.e., the corresponding variables are described. A more detailed explanation of the required input data is now given. Note that in the following descriptions, for the case of array-type parameters, the name of the parameter is followed by its dimensions in parentheses.

CHECKPOINT 1 (see Figure 5a):

PNI(3,NNI): The elements of this matrix are the wind-axis Cartesian coordinates of the nodes on the body of the aircraft - desired orientation of the aircraft is assumed. NNI is the number of nodes on the portion of the aircraft that the user is defining. That is, if the aircraft is symmetric with respect to the x-z plane (i.e., left-right symmetric; see KBDY below) the user need only input the right-hand side. Furthermore, if the aircraft is symmetric with respect to the x-y plane (see KBDZ below) the user need only input the upper half. Finally, if both aforementioned symmetry conditions hold, then only the nodal coordinates of the upper-right quadrant need be input.

INI(NK,NEI): The elements of this matrix are the global node numbers of the nodes comprising the surface of the aircraft body. That is, given the number of an element on the body surface and a corner number local to that element, the entry of the INI array thus indexed is the corresponding global node number. NK is the number of corners per element, and NEI is the number of elements on the portion of the aircraft that the user is defining. For the example shown in Fig. 5a, INI(1,1)=2, INI(2,1)=6, INI(3,1)=5, INI(4,1)=1, etc. This matrix implicity defines the normal to the surface of the aircraft. The element corner numbering convention is corner 1: pm, corner 2: pp, corner 3: mp, and corner 4:

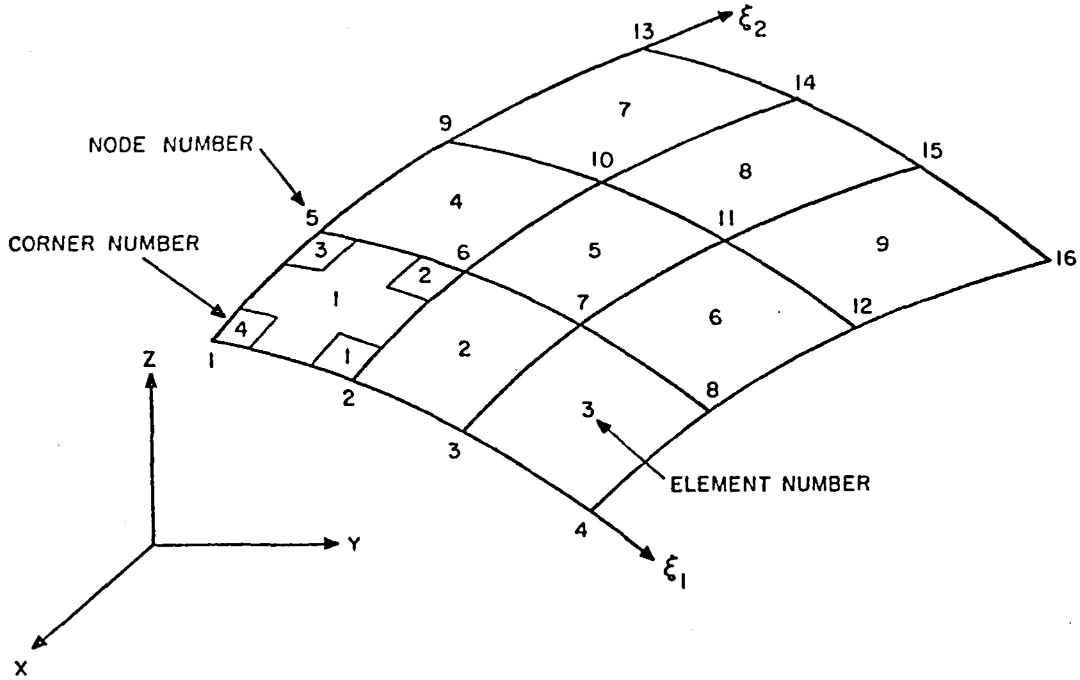


Figure 5a. Checkpoint 1 - Example of the Element and Nodal Numbering on the Body.

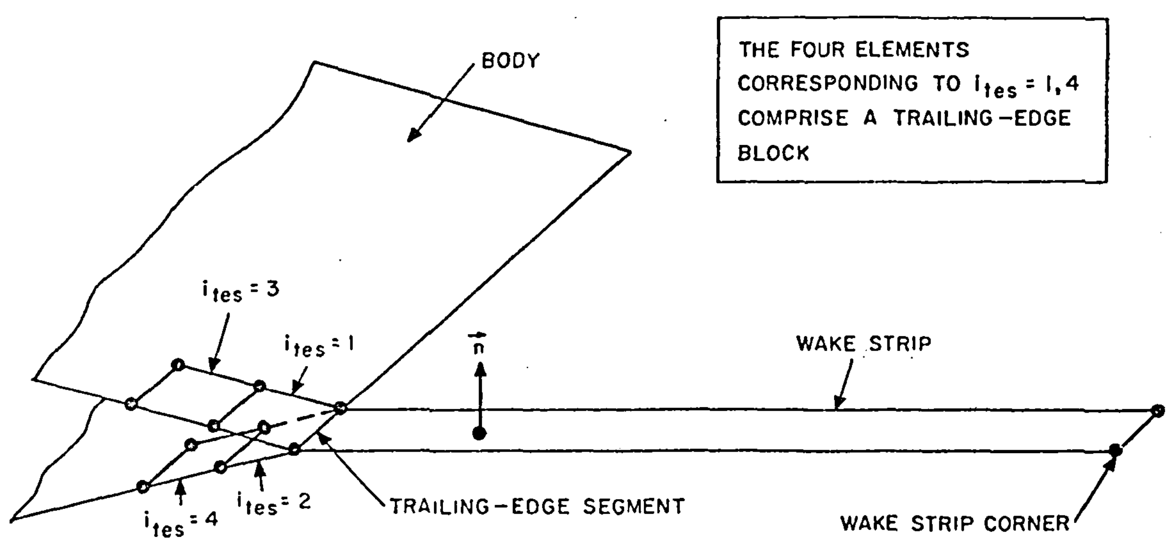


Figure 5b. Checkpoint 2 - Definition of the Terms "Wake Strip" and "Trailing-Edge Segment".

mm, where "m" stands for minus and "p" stands for plus with regard to the local two-dimensional coordinate system of the body surface (e.g., pm means in the positive direction of coordinate direction 1 and in the negative direction of coordinate direction 2). The resulting normal direction to the surface of the aircraft is obtained by taking the cross product of coordinate direction 1 and coordinate direction 2. Figure 6 illustrates how the direction of the normal to the surface of the aircraft is defined by the INI array.

KNDY(NNI), KNDZ(NNI): The elements of these arrays are symmetry line code numbers -
KNDY(ini)=0: node number ini is not on the symmetry plane y=0.
KNDY(ini)=1: node number ini is assumed to be on the symmetry plane y=0.
KNDZ(ini)=0: node number ini is not on the symmetry plane z=0.
KNDZ(ini)=1: node number ini is assumed to be on the symmetry plane z=0.

KODI(NEI): Code numbers for special elements - currently KODI is used to specify from which edge of a trailing-edge element a wake strip emanates. (e.g., see elements corresponding to i_{tes} =1,2 in Fig. 5b).

KODI(iei)=0: no wake strip off any edge of element iei
=1: wake strip off edge 1 (edge between corners 1 and 2) of element iei
=2: wake strip off edge 2 (edge between corners 2 and 3) of element iei
=3: wake strip off edge 3 (edge between corners 3 and 4) of element iei
=4: wake strip off edge 4 (edge between corners 4 and 1) of element iei

NNI: The value of this parameter is the number of nodes being input by the user as part of the description of the aircraft body geometry. It is the second dimension of the array parameter PNI.

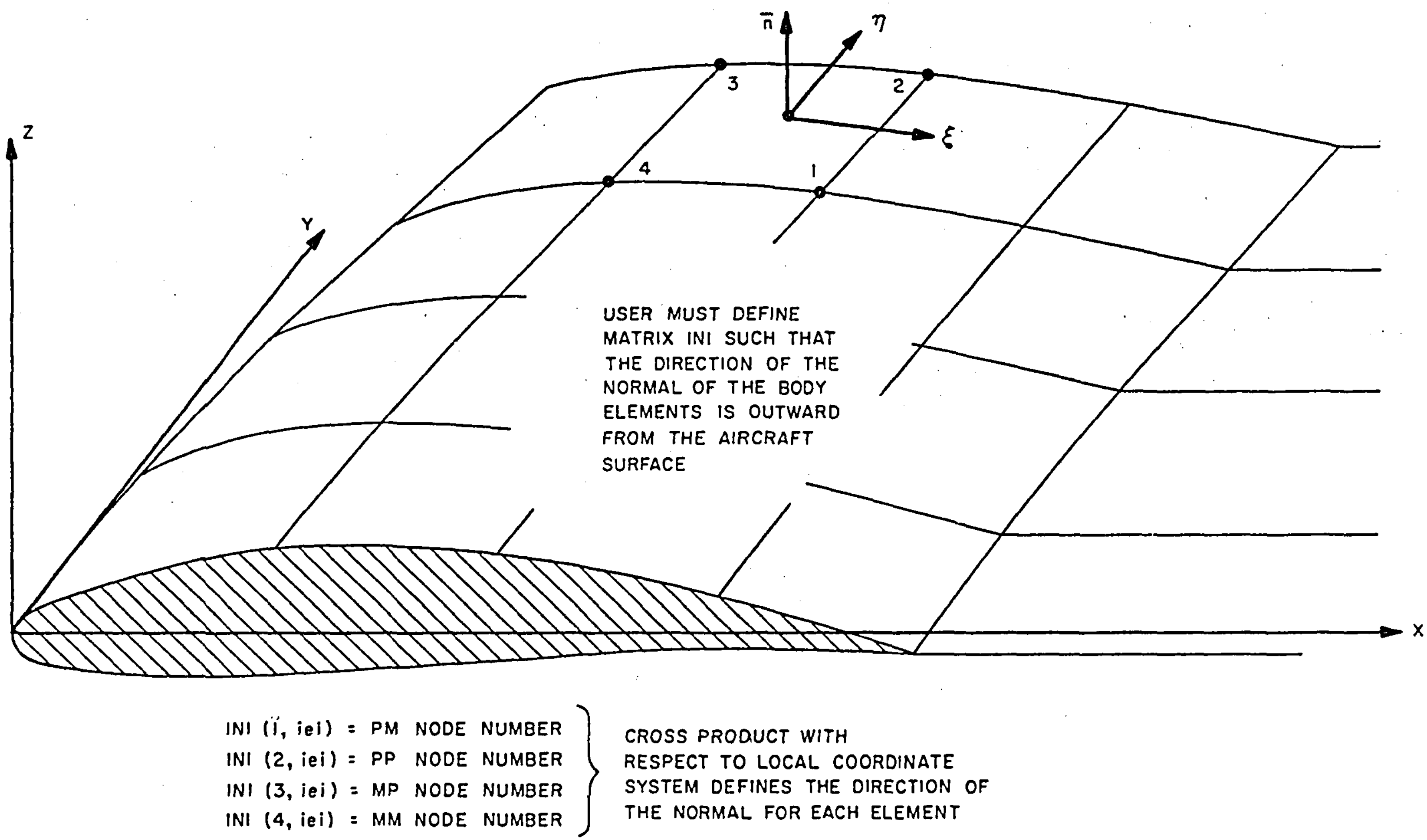


Figure 6. The Matrix INI Determines the Direction of the Normal.

NK: The value of this parameter is the number of corners per element on the surface of the aircraft body. The value 4 should be input for this parameter.

NEI: The value of this parameter is the number of elements being input by the user as part of the description of the aircraft body geometry. It is the second dimension of the array parameter INI.

REFL: The value of this parameter is the reference length of the aircraft body.

KBDY,KBDZ: Body (i.e., entire configuration) symmetry code numbers; i.e., if the body is symmetric with respect to the y (z) direction, then the geometry input by the user will be reflected in the x-z (x-y) plane. The encoding procedure used is: 1= symmetry, 0= no symmetry.

CHECKPOINT 2 (see Fig. 5b):

PSI(3,NSK,NSI): The elements of this matrix are the wind-axis Cartesian coordinates of the corners of the wake strips (which are usually contiguous with the trailing-edge) - desired orientation of the wake with respect to the aircraft is assumed. NSK is the number of corners per wake strip and NSI is the number of wake strips the user is explicitly defining. That is, for each wake strip, its reflection in the x-z plane or the x-y plane may be automatically generated by the SOUSSA-P program. The location of the wake-strip corners with respect to the local coordinate system possesses the same relationship as described for the corners of the body elements (see INI in Checkpoint 1). The direction of the normal of the wake is assumed to be codirectional to the direction of the normal of element $i_{tes} = 1$.

IEKI(NTES,NSGI): This matrix identifies the elements in the trailing-edge block corresponding to a given trailing-edge segment. The trailing-edge is divided into NSGI segments; a trailing-edge block is comprised of NTES elements, two of which have an edge that coincide with a trailing-edge segment.

For SOUSSA-P 1.1 NTES=4. Thus a given trailing-edge block is comprised of the elements corresponding to $i_{tes}=1,4$ (see Fig. 5b). NSGI is the number of trailing-edge segments defined by the user, each of which is associated with one or more wake strips. For a given trailing-edge segment, the corresponding wake strips may be automatically reflected in a plane of symmetry - see KSGY, KSGZ below. Figures 7, 8, and 9 illustrate how to input the values for this array parameter under y-symmetry, z-symmetry, and both y and z symmetry, respectively.

ISGI(NSI): Associated with each trailing-edge segment is one or more wake strips. The value of the array ISGI for wake strip isi, is the index number of the trailing-edge segment from which the vorticity of the wake strip originates. Usually, a single wake strip will be associated with each trailing-edge segment, in which case ISGI(isi)=isi, i.e., all wake strips are contiguous with the trailing-edge. An example of the array ISGI is given in Fig. 10.

NSEI(NSI): Wake strip isi is uniformly divided into NSEI(isi) elements. A nonuniform distribution of wake elements may be obtained by defining wake elements rather than wake strips. This is accomplished by inputting NSEI(isi)=1 for isi=1 to NSI, and providing coordinates for wake elements rather than wake strips via array parameter PSK.

KSGY(NSGI), KSGZ(NSGI): The elements of these arrays are symmetry code numbers for trailing-edge segments -

KSGY(isegi)=0: wake strips associated with trailing-edge segment isegi (see ISGI) are not reflected in the x-z plane of symmetry.

KSGY(isegi)=1: wake strips associated with trailing-edge segment isegi (see ISGI) are reflected in the x-z plane of symmetry.

Similar for KSGZ except the plane of symmetry is x-y. Figure 11 provides an example of using the

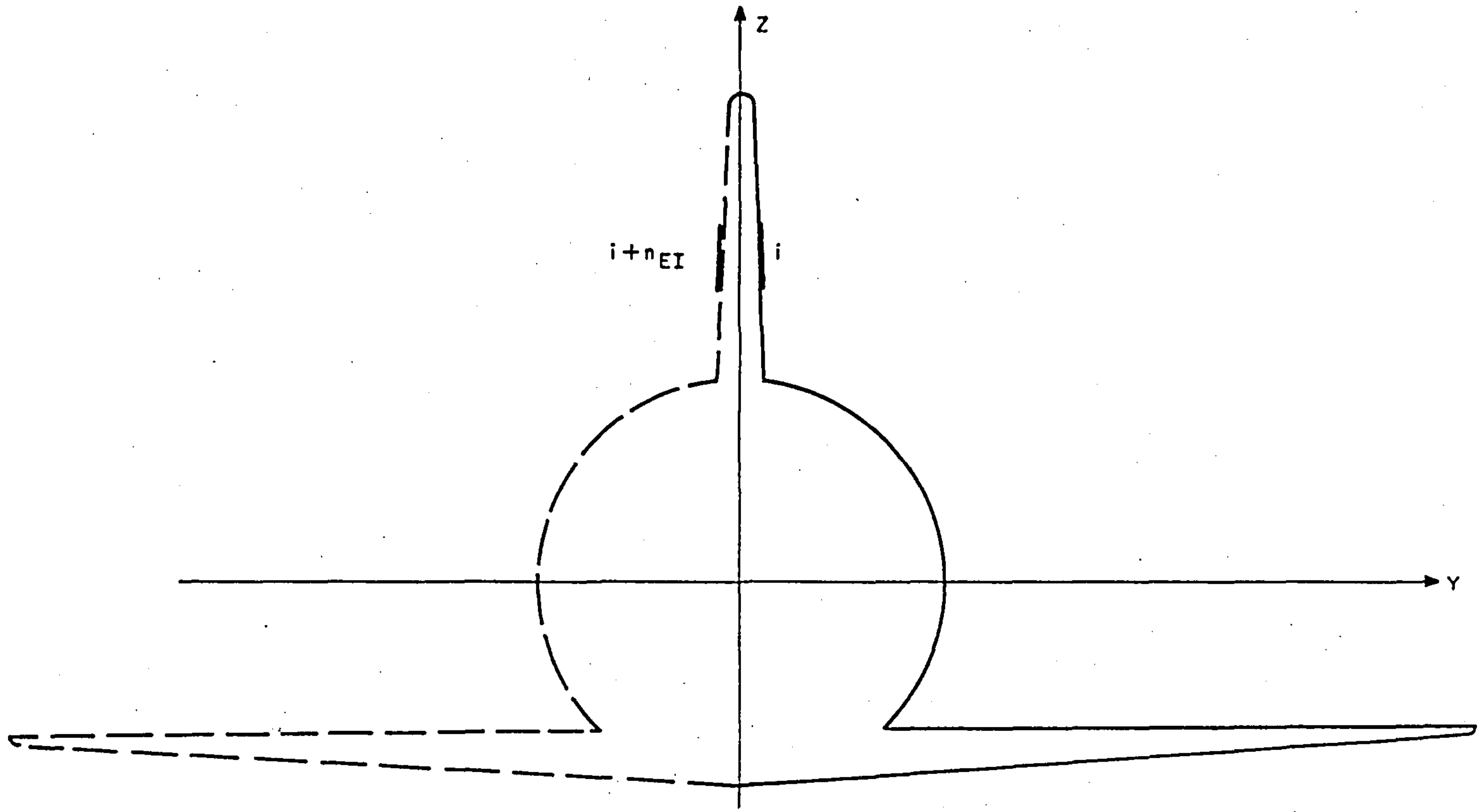


Figure 7. Inputting Values for IEKI Under Y-Symmetry.

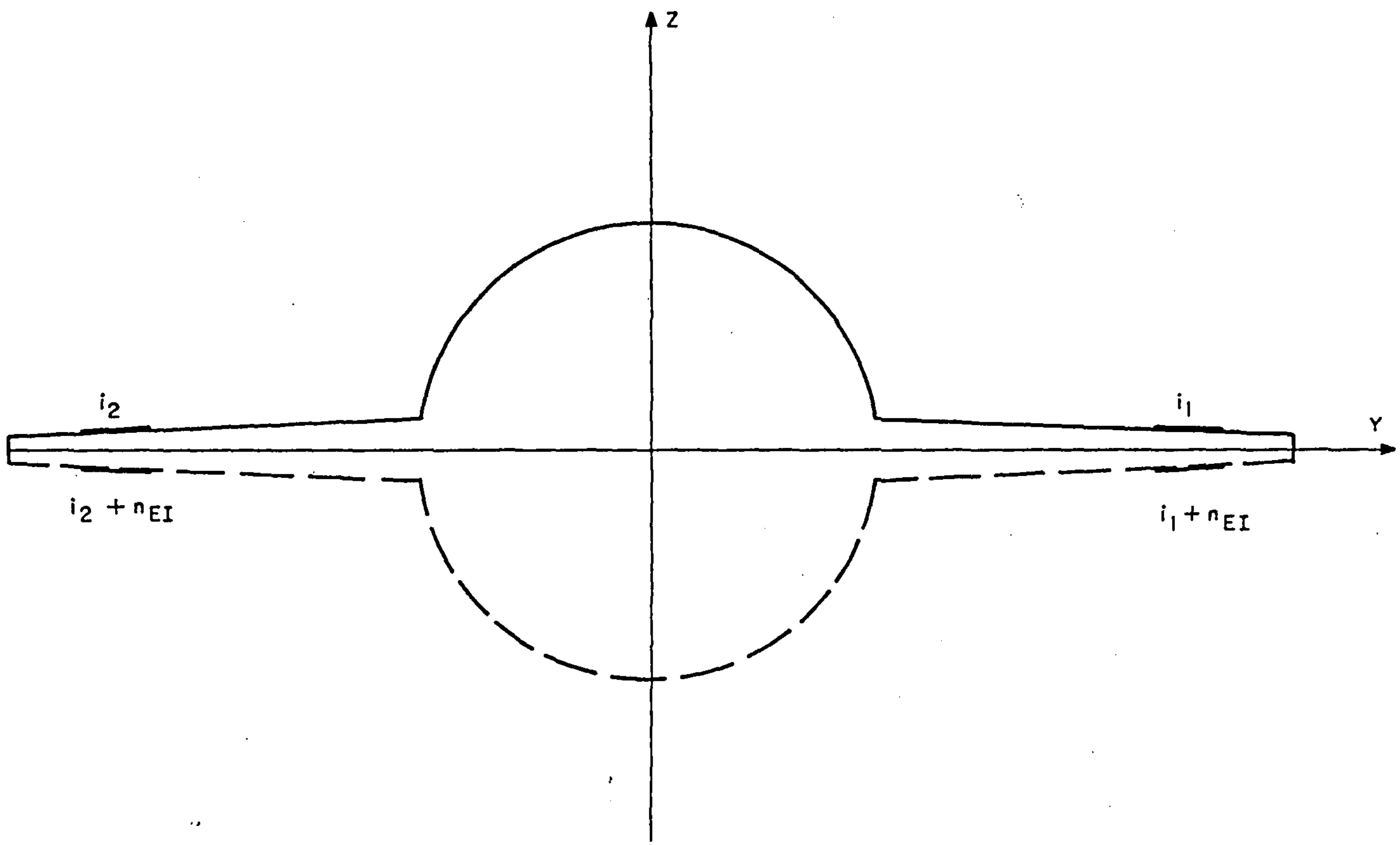


Figure 8. Inputting Values for IEKI Under Z-Symmetry.

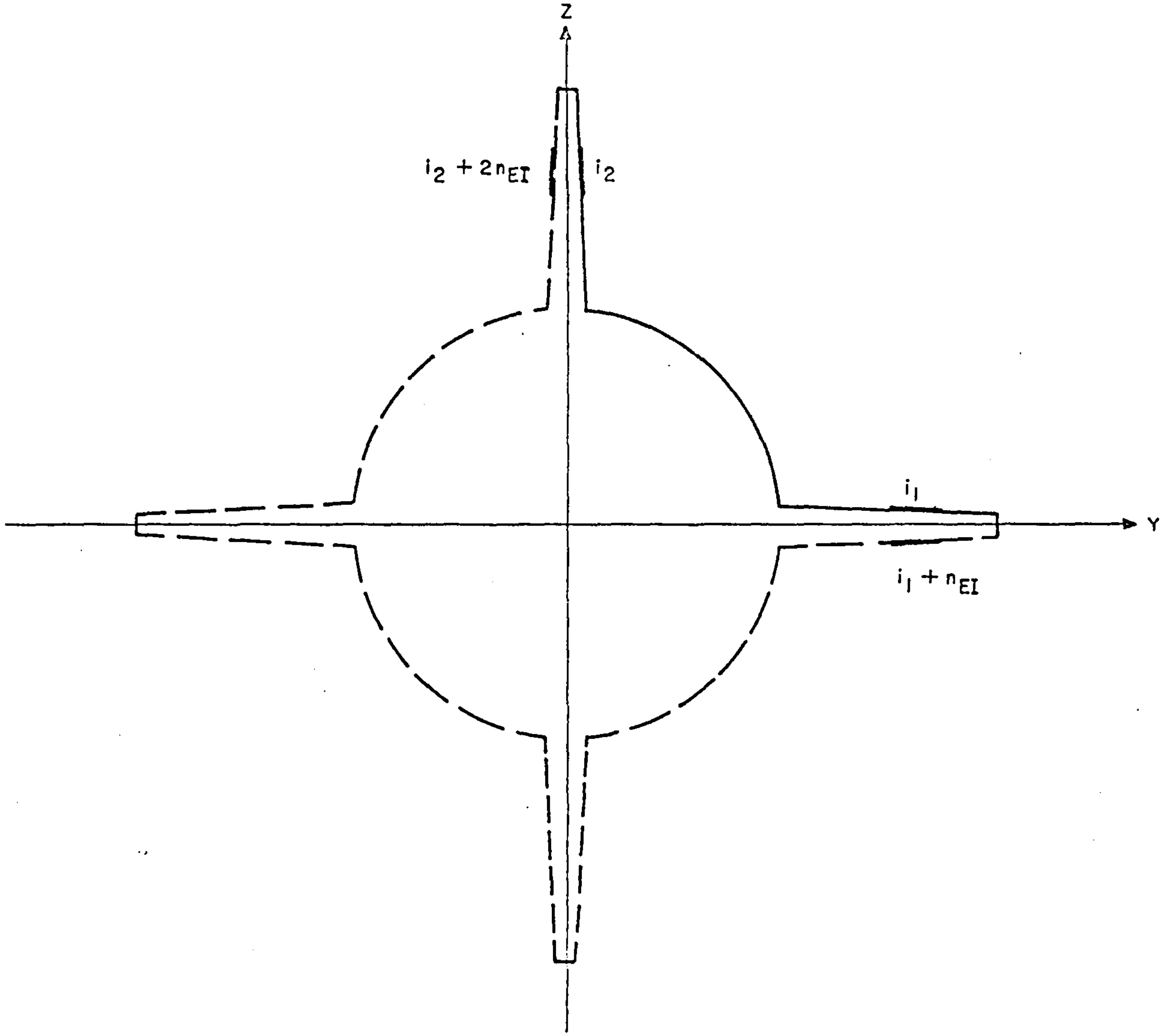
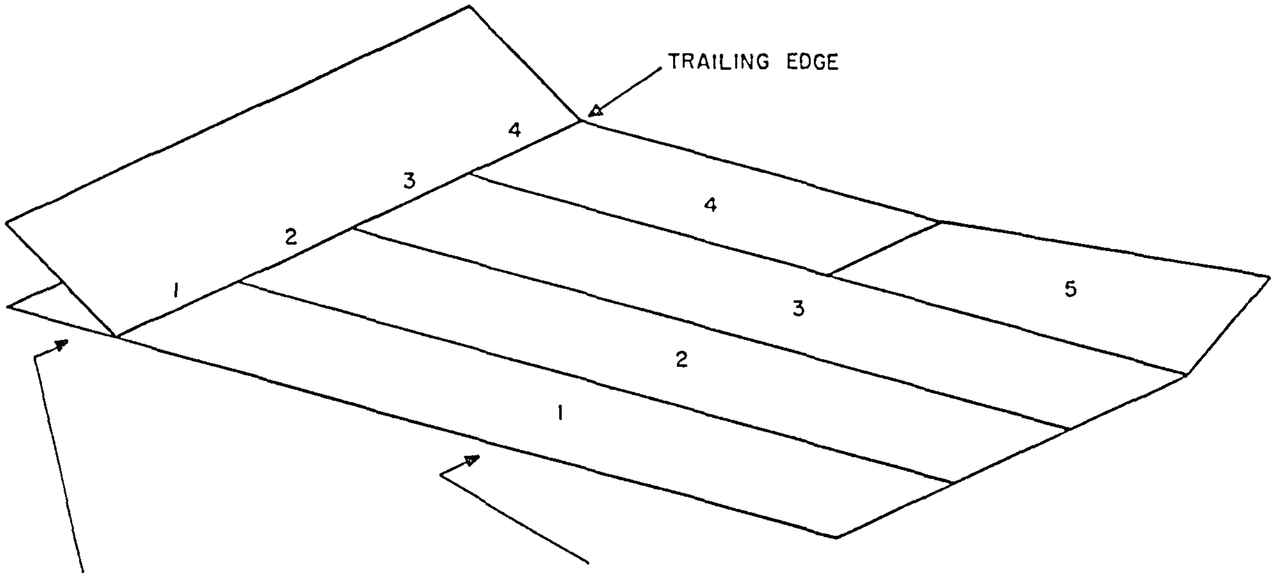


Figure 9. Inputting Values for IEKI Under Both Y and Z-Symmetry.



THESE INDICES
(Isgi = 1 TO 4)
IDENTIFY THE TRAILING-
EDGE SEGMENTS

THESE INDICES
(isi = 1 TO 5)
IDENTIFY THE
WAKE STRIPS

FOR THIS EXAMPLE:

ISGI (1) = 1
ISGI (2) = 2
ISGI (3) = 3
ISGI (4) = 4
ISGI (5) = 4

(NSGI = 4)
(NSI = 5)

Figure 10. Example of the Array ISGI.

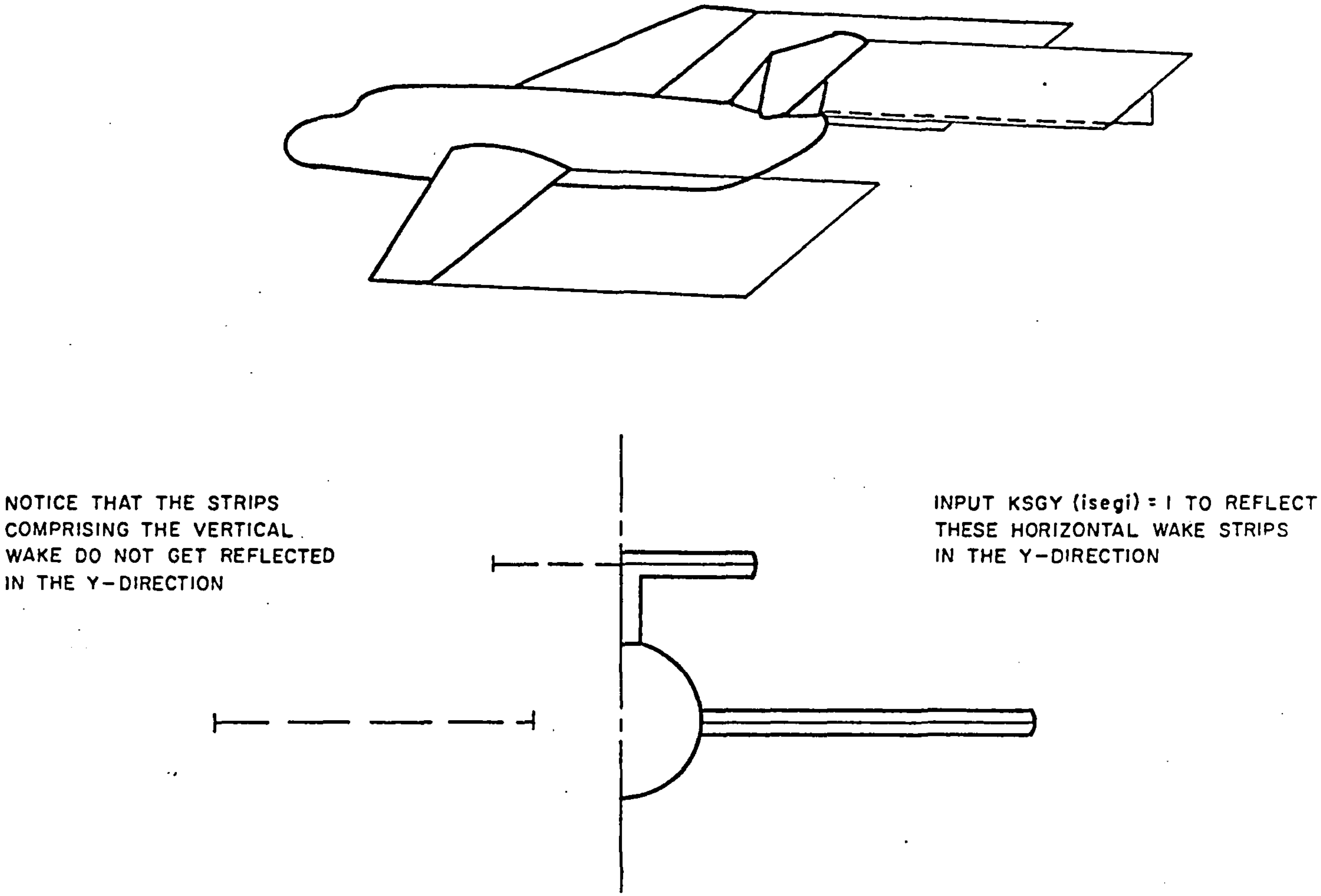


Figure 11. Example of the Array KSGY.

array parameter KSGY.

NTE: The value of this parameter is the number of values of the velocity potential on the trailing-edge needed to define the velocity potential discontinuity along the wake. NTE should be input as 2 for SOUSSA-P 1.1.

NTES: The value of this parameter is the number of elements on the surface of the aircraft that comprise a single trailing-edge block. The value of 4 should be input for this parameter.

NSGI: The value of this parameter is the number of trailing-edge segments being input by the user as part of the description of the wake geometry. It is the second dimension of the array parameter IEKI.

NSI: The value of this parameter is the number of wake segments being input by the user as part of the description of the wake geometry. It is the third dimension of the array parameter IEKI.

NSK: The value of this parameter is the number of corners per wake strip and should be input having the value 4.

REFL: Same as in CHECKPOINT 1.

CHECKPOINT 3

GFM(3,NNI,NGFM): Three-dimensional nodal displacements of the generalized-force modes.

NGFM: The value of this parameter is the number of generalized-force modes being considered for analysis.

KGFY,KGFZ: The values of these parameters are generalized-force mode symmetry code numbers, where KGFY encodes the symmetry condition for the y direction and KGFZ for the z direction. The encoding scheme used is;

-1 for antisymmetry
0 for no symmetry
1 for symmetry

The user must take care to insure that

abs(KGFY) = KBDY and abs(KGFZ) = KBDZ, as well as that KGFY = KBCY and KGFZ = KBCZ (see Section 11).

CHECKPOINT 4:

BCM(3,NNI,NBCM): Three-dimensional nodal displacements of the boundary-condition modes.

NBCM: The value of this parameter is the number of boundary-condition modes being considered for analysis.

KBCY,KBCZ: The values of these parameters are boundary-condition mode symmetry code numbers, where KBCY encodes the symmetry condition for the y direction and KBCZ for the z direction. The encoding scheme used is;

- -1 for antisymmetry
- 0 for no symmetry
- 1 for symmetry

The user must take care to insure that abs(KBCY) = KBDY and abs(KBCZ) = KBDZ, as well as that KBCY = KGFY and KBCZ = KGFZ (see Section 11).

CHECKPOINT 15:

ELAM: Integration-scheme choice parameter; elam=r_1/ℓ where ℓ is a reference length, and r_1 is the distance such that for $r<r_1$ analytic integration will be performed, while for $r>r_1$ numerical integration will be performed in the process of calculating the various body and wake-related coefficients (recommended value= 2.). The variable r is the distance between a given normalwash control point and a point on the influencing element.

HMCH: The value of this parameter is the free-stream Mach number. For SOUSSA-P 1.1, the value of HMCH must be < 1.

CHECKPOINT 16:

FREQ(NFRQ): Vector of complex reduced frequencies being considered for analysis.

NFRQ: The value of this parameter is the number of complex reduced frequencies being considered for analysis.

6.3 CONTROL INPUT FOR TECHNICAL MODULES

The input data stream for executing one or more of the SOUSSA-P technical modules consists of the following:

a) "[XQT SOUS" card: the presence of this control command in the input stream causes the transfer of control from the MAIN executive to the SOUSEX subroutine.

b) Title Card: one card of up to 80 alphanumerical characters punched in free-field format. This card will be part of the listable output of the program (see Section 8) to aid the users in identifying their runs. Note that this card should not include any special characters recognized by the free-field format reader (except blanks, of course; see Table B.1)

c) The LMs: format 10L1- these logical flags are read in as the LM vector such that LM(i)=T implies overlay(i,0) will be executed (see Fig. 1 and Section 3 for the relationship between the primary overlays and technical modules) LM(i)=F means overlay (i,0) will not be executed.

d) Special Boundary-Condition Indicator: format 1L1 - this logical value corresponds to variable LBC. Use LBC = F if the boundary-condition modes are to be multiplied by a generalized coordinate; i.e.,

(1) rigid-body modes in wind-axis formulation
(2) deformation modes.

Use LBC = T if the boundary-condition modes are to be multiplied by a generalized velocity; i.e.,

(1) rigid-body modes in body-axis formulation
(2) steady-state normalwash*

$$\psi = -\bar{n} \cdot \bar{i}$$

Note that the input data stream consisting of b, c, and d may be repeated for multiple executions of SOUSSA-P technical modules accessing the same initially input data sets.

It is important to note that each type of aerodynamic calculation listed in Section 6.1 may be realized by the appropriate choice of the LMs (c). For example, to generate generalized aerodynamic forces for use in flutter or gust analysis, the following data card should be supplied for the LMs:

TTTTTTTTTT

---

*For the case LBC = F, the matrix E1 is given by (see Eq. (D-10) of Ref. 3)

$$E_{hm}^{(1)} = \left[p\bar{M}_m \cdot \bar{n} - \frac{\ell}{|\bar{a}_1 \times \bar{a}_2|} \left(\frac{\partial \bar{M}_m}{\partial \xi^1} \times \bar{a}_2 + \bar{a}_1 \times \frac{\partial \bar{M}_m}{\partial \xi^2} \right) \cdot \bar{i} \right]_{\bar{p} = \bar{p}_h}$$

($\bar{M}_m$ is nodal-displacement vector for the mth deformation mode.)
For the case LBC = T, we have (see Eq. (D-9) of Ref. 3)

$$E_{hm}^{(1)} = \left[\bar{M}_m^{(R)} \cdot \bar{n} \right]_{\bar{p} = \bar{p}_h}$$

(The $\bar{M}_m^{(R)}$ are the nodal-displacement vectors for the six rigid-body modes.)

Analyses involving multiple sets of modes, multiple sets of frequencies, or multiple Mach numbers, can be performed with a minimal amount of recomputation due to the SOUSSA-P checkpoint/restart capability. The use of this capability is facilitated by the input format of the LMs, since the modules to be executed are easily specified. Usage of the checkpoint/restart facility is described in Section 13.

An example of the input data stream for executing technical modules is now given (expressions in angle brackets denote comments by the authors):

```
[XQT SOUS                       <causes MAIN executive to invoke
                                 the SOUSEX subroutine>
EXAMPLE OF INPUT DATA STREAM    <title card for run>
TTTTTTTTTT                      <the LMs; this example is
                                 appropriate for aerodynamic
                                 analysis>
F                               <special boundary condition
                                 indicator>
[XQT whatever                   <on to another module>
```

SECTION 7

THE SOUSSA-P UTILITY MODULES

7.1 INTRODUCTION

This Section presents a discussion of the SOUSSA-P utility modules. These modules perform vital functions such as converting punched-card data into SOUSSA-P data sets (INTR), displaying the output of the SOUSSA-P program (SOUO), and providing general manipulative capabilities with regard to the data complex (DCU).

The modules described here - INTR, SOUO, DCU, and EXIT - correspond to legal choices of module names that can appear on the "XQT" input executive control command. The other legal choice of modname, SOUS, implies the execution of one or more SOUSSA-P technical modules and is discussed in Section 6.

Before describing the various utility modules, the data base complex employed by the SOUSSA-P program is discussed.

7.2 THE DATA BASE COMPLEX

The need for sophisticated data handling capabilities by the SOUSSA-P program is well founded due to the large volumes of data encountered during aerodynamic analyses. Consider the situation in which 1,000 elements or panels are used to describe the aircraft surface; this implies the presence of 1,000,000 aerodynamic influence coeficients. (Note that large matrices of aerodynamic influence coefficients are not peculiar to SOUSSA-P but inherent to all aerodynamic panelling methods.)

Under such circumstances it becomes highly advantageous to be able to manipulate partitions of arrays of data within the central memory of a computer system as opposed to having these arrays entirely core-resident. To this end, the data handling routines developed for the SPAR Finite Element Structural Analysis Program (Ref. 5) have been incorporated into SOUSSA-P.

The data complex which resides on auxiliary storage is composed of 26 library files known to the CDC NOS operating system as SPARLA, SPARLB,...,SPARLZ and designated by the user as library 1,2,...,26. Libraries 11 through 13 and 21 through 26 are not available for general use.

Library files are composed of data sets. Data sets are identified by a four part name (as in SPAR)- NAM1,NAM2,NAM3,NAM4 - and the library number assigned to them. Here NAM1, NAM2 are alphanumeric values (up to four characters long) and NAM3, NAM4 are integer values. Every data set in the data complex is stored as one or more two-dimensional arrays (column-major order) with NI rows and NJ columns. The size of these arrays, known as "blocks" (a block can be thought of as a sector on a disk), is NI*NJ or LB words. The size of the data set is NWRD words. Thus, if NWRD is not a multiple of LB, the last block of the data set will be only partially filled. The type of data stored in a data set is encoded by the variable ITYP:

ITYP = -1: real
= 0: integer

Note that complex data is stored as ITYP=-1 (i.e., real) with a factor of two included in NI.

Table 3 depicts the above mentioned characteristics for all SOUSSA-P array data sets. These entail data sets generated via the INTR processor (indicated by a blank entry in the Module Output column) and data sets generated via the SOUSSA-P modules (the values in the Module-Output column correspond to primary overlay numbers - e.g., a "1" indicates output from overlay (1,0)=BODYG; see Fig. 1). The Module Input column specifies which modules require the data set as input (this information is very important for restarting; see Sections 12 and 13).

The actual physical size of a given data set depends upon the values for the SOUSSA-P scalar variables appearing in the NWRD, NJ, and LB columns. For example, consider the first data set in Table 3, PNI. Suppose NNI equals nine (i.e., the user has defined the coordinates of nine nodes). Then the PNI data set will contain a total of 27 words (NWRD=27), will have one block (PNI is a single-block data set) 27 words long (LB=27), and will have nine columns in the block (NJ=9).

The SOUSSA-P data base is illustrated in Fig. 12.

Seq #	NAM1	NAM4	NWRD	NJ	LB	ITYP	Mods In	Mod Out
1	PNI	0	3*NNI	NNI	3*NNI	-1	1,3	
2	INI	0	NK*NEI	NEI	NK*NEI	0	1,3	
3	KNDY	0	NNI	1	NNI	0	1	
4	KNDZ	0	NNI	1	NNI	0	1	
5	KODI	0	NEI	1	NEI	0	1	
6	IEKI	0	NTES*NSGI	NSGI	NTES*NSGI	0	2	
7	ISGI	0	NSI	1	NSI	0	2	
8	PSI	0	3*NSK*NSI	NSI	3*NSK*NSI	-1	2	
9	NSEI	0	NSI	1	NSI	0	2	
10	KSGY	0	NSGI	1	NSGI	0	2	
11	KSGZ	0	NSGI	1	NSGI	0	2	
12	GFM	0	3*NNI*NGFM	NGFM	3*NNI*NGFM	-1	7	
13	BCM	0	3*NNI*NBCM	NBCM	3*NNI*NBCM	-1	8	
14	PN	0	3*NN	NN	3*NN	-1	4,6	1
15	IN	0	NK*NE	NE	NE	0	4,6,7	1
16	KODE	0	NE	1	NE	0	6	1
17	A1C	0	3*NE	NE	NE	-1	6,8	1
18	A2C	0	3*NE	NE	NE	-1	6,8	1
19	A1X2	0	3*NE	NE	NE	-1	6,7,8	1
20	PC	0	3*NC	NC	3*NC	-1	4,5	3
21	PCEN	0	3*NE	NE	3*NE	-1	4,5	3
22	PWK	0	3*NWK*NWE	NWE	3*NWK*NWE	-1	5	2
23	IBNV	0	NTE*NDPH	NDPH	NTE*NDPH	0	5,9	2
24	COEF	0	NTE*NDPH	NDPH	NTE*NDPH	-1	9	2

Table 3. Description of SOUSSA-P Data Sets
(page 1 of 2)

Seq #	NAM1	NAM4	NWRD	NJ	LB	ITYP	Mods In	Mod Out
25	IEKU	0	4*NSEG	NSEG	4*NSEG	0	6	
26	INV	0	NTE*NS	NS	NTE*NS	0	2	2
27	B	0	NC*NPSI*NQ	1	NC	-1	9	4
28	C	0	NC*NPHI*NQ	1	NC	-1	9	4
29	D	0	NC*NPHI*NQ	1	NC	-1	9	4
30	EDEL	0	NC*NPHI*NQ	1	NC	-1	9	4
31	THET	0	NC*NPHI*NQ	1	NC	-1	9	4
32	F	0	NC*NDPH	1	NC	-1	9	5
33	G	0	NC*NDPH	1	NC	-1	9	5
34	THTB	0	NC*NDPH	1	NC	-1	9	5
35	TEC	0	NEI*NE	1	NEI	-1	10	6
36	E31U	0	NEI*NE	1	NEI	-1	10	6
37	E30U	0	NEI*NEI	1	NEI	-1	10	6
38	E4T	0	NGFM*NCP	1	NCP	-1	10	7
39	E10	0	NPSI*NBCM	1	NPSI	-1	10	8
40	E11	0	NPSI*NBCM	1	NPSI	-1	10	8
41	FB	IFRQ	2*NC*NDPH	1	2*NC	-1	9	9
42	FBS	IFRQ	2*NC*NPHI	1	2*NC	-1	9	9
43	Y	IFRQ	2*NC*NPSI*NQ	1	2*NC	-1	10	9
44	Z	IFRQ	2*NC*NSPI*NQ	1	2*NC	-1	10	9
45	FREQ	0	2*NFRQ	1	2*NFRQ	-1	9,10	
46	YASS	IFRQ	2*NC*NPHI	1	2*NC	-1	10	10
47	ZASS	IFRQ	2*NC*NPSI	1	2*NC	-1	10	10
48	E1	IFRQ	2*NPHI*NBCM	1	2*NPHI	-1	10	10
49	ZE1	IFRQ	NC*NBCM*2	1	NC*2	-1	10	10
50	LUMT	IFRQ	2*NC*NC	NCPR	2*NC*NCPR	-1	10	10
51	INTV	IFRQ	NC	1	NC	0	10	10
52	E21	IFRQ	NPHI*NBCM*2	1	NPHI*2	-1	10	10
53	TECA	0	NCP*NCP	1	NCP	-1	10	10
54	E30A	0	NCP*NPHI	1	NCP	-1	10	10
55	E30	0	NCP*NPHI	1	NCP	-1	10	10
56	E31	0	NCP*NPHI	1	NCP	-1	10	10
57	E3	IFRQ	2*NCP*NPHI	1	2*NCP	-1	10	10
58	E321	IFRQ	NCP*NBCM*2	1	NCP*2	-1	10	10
59	E	IFRQ	NGFM*NBCM*2	1	NGFM*2	-1		10

Table 3. Description of SOUSSA-P Data Sets (page 2 of 2)

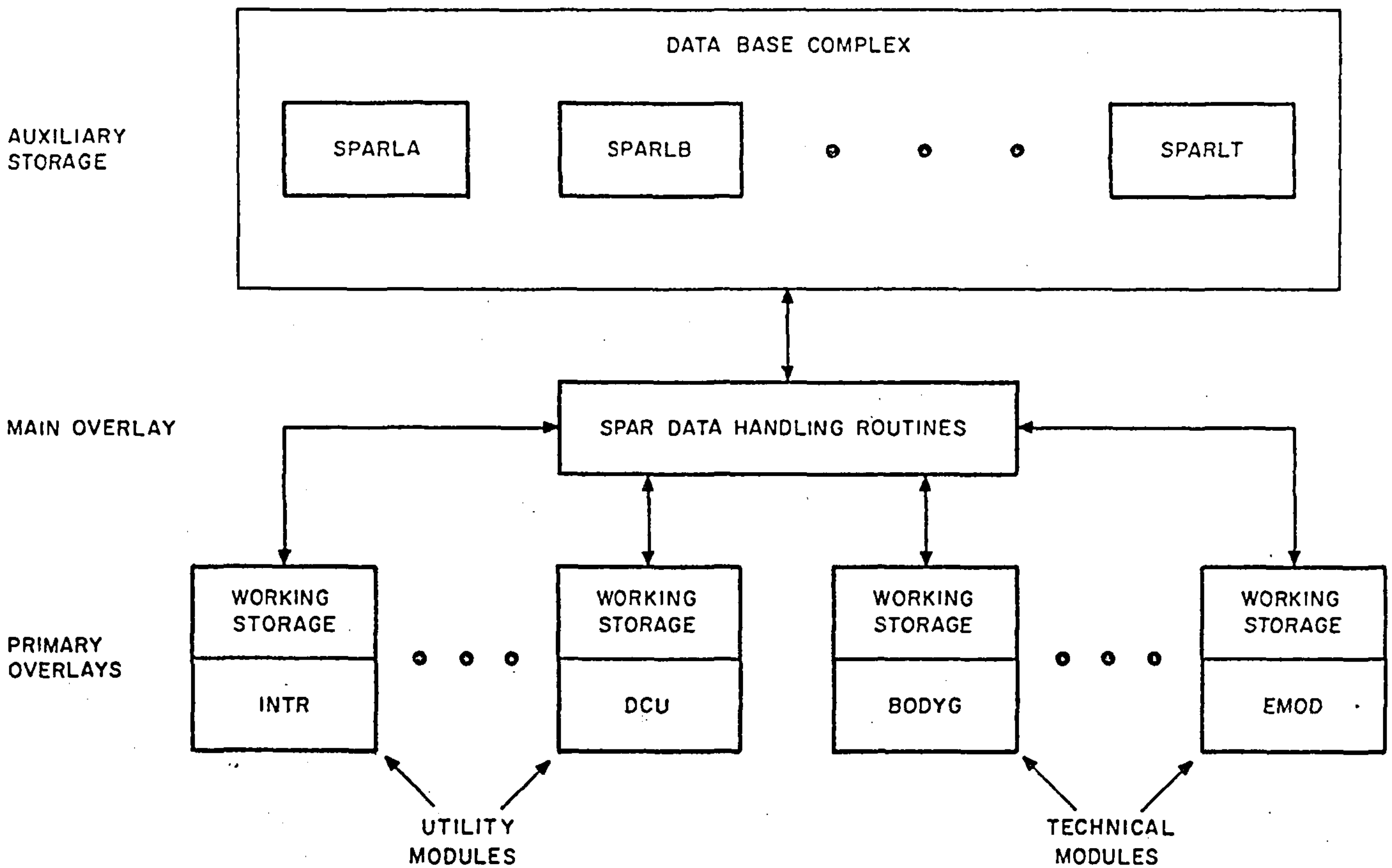


Figure 12. SOUSSA-P Data Base System.

7.3 THE RESET FACILITY

The RESET facility of the SPAR computer program (Ref. 4), allows the user to specify parameters that control the operation of the technical modules. The form of a RESET statement is:

$$\text{RESET } p_1=v_1, p_2=v_2, \ldots, p_n=v_n \$$$

where v_i is the value to be assigned to parameter p_i. It is important to note here, that every RESET parameter is provided a default value. If a parameter is not specified in a RESET statement, then the default value will be used, unless the parameter was specified in an earlier RESET statement within the input stream. In that case, the last value specified for the RESET parameter will remain in effect, until it is once again respecified (see example below). One or more RESET statements may immediately follow a [XQT card. This facility is used extensively by the INTR utility module for supplying values for the above-described parameters which specify data set characteristics. (These values are to be distinguished from those supplied as actual data set values.)

7.4 THE INTR UTILITY MODULE

The SOUSSA-P Interface Utility Module, INTR, enables the user to transform data punched in free-field format on 80-column cards, into data sets residing on the data complex. In particular, it is expected that the INTR module will be used to transform data representing checkpoints 1 through 4 (provided by, say, the user's geometry preprocessor), and checkpoints 15 and 16, into data sets that can be accessed by the appropriate SOUSSA-P technical modules. These are the only data sets not generated internally by the SOUSSA-P program and hence must be supplied via the INTR utility module.

The following RESET parameters are recognized by the INTR utility modules:

NU: user-designated, primary library. NU can be an integer value in the range 1 to 10 or 14 to 20 (corresponds to SPAR logical files SPARLA to SPABLJ and SPARLP to SPARLT, respectively; see Section 9). Libraries 11 to 13 are reserved for use by the SOUSSA-P program and are described in Section 9.
All data sets created by the INTR module will reside on library NU. Furthermore, library NU will contain the majority of data sets produced by the technical modules of SOUSSA-P. Some generated data sets will reside on auxiliary libraries 11 through 13 (SPARLK-SPARLM; see Section 9 for details).
Default value =1.

NAM2: Every data set created by the INTR utility module or by the SOUSSA-P technical modules will possess the value specified for the NAM2 RESET parameter as the second part of its four part name. NAM2 can be an alphanumeric value up to four characters in length. Users may, for example, choose their initials as the value for NAM2 to enable them to distinguish their data sets from other users. Also, users may use NAM2 to identify the problem being analyzed. The default value for NAM2 is "mask".

NAM3: Every data set created by the INTR utility module or by the SOUSSA-P technical modules will possess the value specified for the NAM3 RESET parameter as the third part of its four part name. NAM3 can be any integer value within the host system limits. Users may choose this value to sequence or uniquely identify their runs. Default value =1.

Note, the above three RESET parameters, NU, NAM2, and NAM3, will effect the execution of the SOUSSA-P INTR module as well as the execution of the technical modules in the manner so described. The remaining RESET parameters will only affect the execution of the INTR module, and are used to specify characteristics of data sets for which the user is supplying data. Thus, RESET statements (cards) of this nature act as header cards for the data being supplied. It is important to note that data corresponding to a block of a data set, must appear in column major order (considering a block as an NI by NJ matrix) within the input stream. Also, the data must be punched to meet (the fairly lenient) specifications of the free-field input decoder given in Appendix B.

NAM1: first part of the four part data set naming convention. NAM1 can be an alphanumeric value up to four characters long. Furthermore, the value specified for NAM1 should be same as the name of the variable to which the input data corresponds. The default value for NAM1 is "mask".

NAM4: fourth part of the four part data set naming convention. NAM4 indicates the frequency index for frequency-dependent data sets. NAM4 is equal to zero for all frequency-independent data sets. The default value for NAM4 is 0, and the user should not alter this value.

NWRD: total number of words in the data set (i.e., the number of data values supplied by the user for the data set being created). See the "NWRD" column of Table 3. Default value =1.

NJ: number of columns per block of the data set. See the "NJ" column of Table 3. Default value =1.

LB: number of words per block of the data set. See the "LB" column of Table 3. Note that LB equals NWRD for single-block data sets. Default value =1.

ITYP: type of data contained in data set (e.g., integer: ITYP=0, real: ITYP=-1). See the "ITYP" column of Table 3. Default value =0.

Note that Table 3 only contains entries for data sets corresponding to array SOUSSA-P variables. For data sets corresponding to scalar SOUSSA-P variable, RESET parameters NWRD, NJ, and LB should be set to 1 (their default values). The value for RESET parameter ITYP is determined by the SOUSSA-P variable naming convention (Section 4) for the corresponding scalar variables.

The following procedure is recommended for using the INTR utility module:

1) provide a RESET card for parameters that affect the global operation of the program (i.e. NU, NAM2, NAM3). This step may be omitted if one wishes to use the default values.

2) provide a RESET card for each data set that is to be created by the INTR module, corresponding to a scalar variable, followed by the data value for the scalar variable. In this case, the RESET parameters for NWRD, NJ, and LB need not be specified, for the default values are appropriate. Hence, only the NAM1 and possibly the ITYP parameters need be specified for each of these data sets.

3) provide a RESET card for each data set that is to be created by the INTR module, corresponding to an array variable. In this case, the NAM1 and possibly the NWRD, NJ, LB, and and ITYP parameters need be specified for each of these data sets.

An example of this procedure is now given for the creation of data sets in checkpoint 1 (expressions in angle brackets denote comments by the authors):

```
[XQT INTR                                  <causes MAIN executive to
                                            invoke the INTR Module>
RESET NAM2=SAS,NAM3=1$                     <specification of global
                                            parameters; default value
                                            of NU=1 is implied>
RESET NAM1=NNI$                            <data value for data set
                                            corresponding to the scalar
                                            NNI is to follow; default
                                            values of NAM4=1, NWRD=
                                            NJ=LB=1, and ITYP=0 assumed>
4                                          <NNI gets the value 4>
RESET NAM1=NK$                             <NAM1 needs to be reset for
                                            every data set>
4
RESET NAM1=NEI$
1
RESET NAM1=REFL,ITYP=-1$                   <REFL is a real scalar
                                            variable, thus ITYP must
                                            be reset to -1>
1.                                         <the presence of a decimal
                                            point indicates a real
                                            value>
RESET NAM1=PNI,NWRD=12,NE=4,LB=12$         <NWRD, NJ, and LB must be
                                            reset; ITYP=-1 implied now>
0. 0. 0.                                   <values are entered in
2.5926-1 0. 0.                              column-major order; the
2.5926-1 .5556 0.                           FORTRAN xx.Exx is not
0. .5556 0.                                 acceptable>
RESET NAM1=INI,NWRD=4,NE=1,LB=4,ITYP=0$    <RESET ITYPE back to 0
                                            for integer data>
1 2 3 4
RESET NAM1=KNDY$                           <values for NWRD, NJ, LB
                                            and ITYP are the same as
                                            values used above for NNI>
1 1 0 0
RESET NAM1=KNDZ$
1 1 1 1
RESET NAM1=KODI,NWRD=1,NE=1,LB=1$
1
[XQT whatever                              <on to another module>
```

The input stream for the general usage of the INTR utility module is depicted in Fig. 13. This is intended as a visual aid to the user in preparing his input data to the SOUSSA-P program. Note, how each RESET card in effect acts as a header for the data it describes.

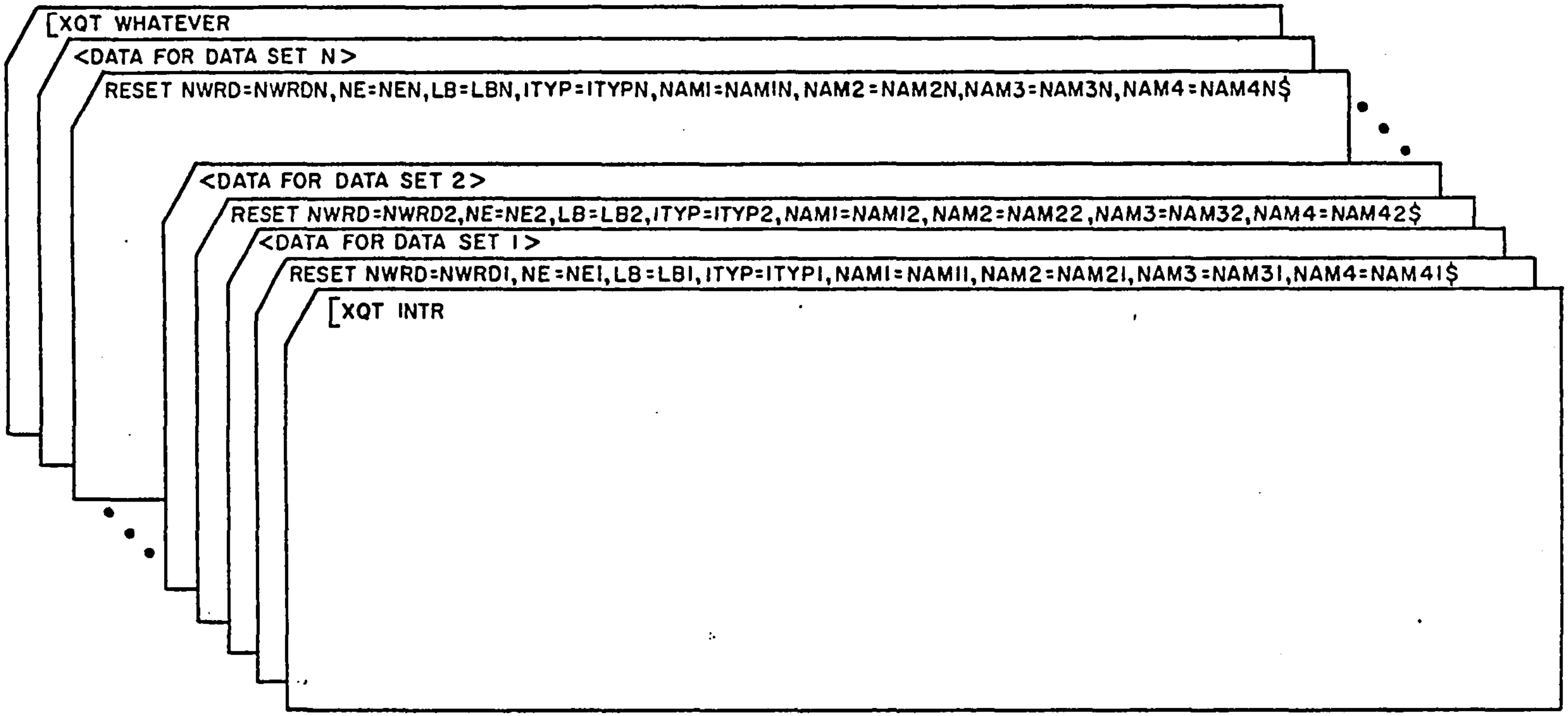


Figure 13. Input Stream for the SOUSSA-P Utility Module INTR.

7.5 THE SOUO UTILITY MODULE

The SOUO utility module allows the user to examine the output of the technical modules. That is, module SOUO controls the printing of the information (data sets) contained in the 16 SOUSSA-P checkpoints. The procedure for using this utility module is now given (the precise format in which the printing of checkpoints is accomplished, is described in Section 8.2):

1) decide which checkpoints you would like printed. This, of course, depends on which modules have been executed during the run. The outwardly-directed checkpoints in Fig. 4 correspond to the output of the various technical modules. Furthermore, Table 2 indicates which data sets comprise the various checkpoints. Finally, Section 4.2 defines the variables that identically correspond to the various data sets.

2) prepare the input stream for the SOUO utility module, which consists of the following (expressions in angle brackets denote comments by the authors):

```
[XQT SOUO                        <causes MAIN executive to
                                  invoke the SOUO utility
                                  module>
RESET NCPL=5$                    <optional; specify NCPL=5 for
                                  teletype printout>
k1,k2,...,k16$THE KPRINTS        <note, the use of the record
                                  terminator ($) to begin a comment>
[XQT whatever                    <on to another module>
```

Here k1, k2,...,k16 are flags (integer values entered in free-field format) for the printing of checkpoints 1, 2,...,16, respectively; i.e. if ki=1 then the data sets that comprise checkpoint i will be printed. If ki=0 then the contents of checkpoint i will not be printed.

The SOUO utility module recognizes one RESET parameter, namely NCPL. (Note, this is not to be confused with the DCU utility module NCPL command, although it serves exactly the same purpose.) This parameter dictates how many values of a data set are contained on a printed line. NCPL=10 is recommended when a line printer is used, while NCPL=5 is suggested for teletype displays. The default value is 10.

7.6 THE DCU MODULE

The DCU (Data Complex Utility) module performs a variety of functions involving the data complex. These include obtaining a Table of Contents listing (see Section 8.3) of the library files and transfering data sets or libraries to and from serial devices. The DCU commands are given in Ref. 4 and included here as Appendix A.

The input stream for the DCU module is as follows:

[XQT DCU	<causes MAIN executive to invoke the DCU module>
any DCU command	<see Appendix A for available commands>
[XQT whatever	<on to another module>

7.7 EXIT

EXIT provides a means for halting execution of the SOUSSA-P program. Unlike the other SOUSSA-P modules, EXIT is not a primary overlay, but rather a section of the MAIN executive. EXIT also closes all files that may have been generated during the run (see Section 9). NOTE - VERY IMPORTANT - "[XQT EXIT" must be the last card appearing in the input stream for every execution of the SOUSSA-P program.

SECTION 8

DESCRIPTION OF LISTABLE OUTPUT OF THE SOUSSA-P PROGRAM

This section describes printed or listed output produced by the SOUSSA-P program. Output in the form of files (e.g., direct access or sequential) is described in Section 9.

8.1 FLOW OF CONTROL PRINTOUT

The executive module (0,0) as well as the SOUSEX subroutine print information that enables the user to follow that flow of control of the SOUSSA-P program for a given run. That is, the executive will indicate which SOUSSA-P utility module it has been requested to run (this is determined by the "[XQT" commands appearing in the input data stream) by the following printout:

*EXECUTE <SOUSSA-P module name>

Immediately following, the number of 60 bit words of central memory available for arrays with sizes that are problem-dependent is displayed in the following manner:

DATA SPACE = <number of words>

For the case when the SOUS module has been requested for execution (that is, one or more of the SOUSSA-P technical modules are to be run), the following additional printout is produced:

DATE: <date of SOUSSA-P run, yy/mm/dd>
TIME: <time of SOUSSA-P run, hh.mm.ss>
<title card for run; see Section 6>
THE LMS ARE: <the logical values of the LM vector; see Section 6>
SPECIAL BOUNDARY CONDITION INDICATOR: <the logical value of LBC; see Section 6>

From this point on, each time a SOUSSA-P module is executed, the "*EXECUTE <SOUSSA-P Module Name>" and the "DATA SPACE=" printout that accompanies the execution of a module will appear.

Execution of technical module EMOD will result in the printing of the LU-condition number of the assembled matrix Y (data set YASS), the matrix of potential influence coefficients.

Finally, the normal termination of execution of a utility or technical module is indicated by the following printout:

EXIT <CPU time for SOUSSA-P run> <number of writes from central memory to auxiliary storage> <number of reads from auxiliary storage to central memory>

Consider the following example of flow of control printout (expressions in angle brackets are comments by the authors):

```
*EXECUTE INTR          <indicates execution of the INTR
                        utilty module (see Section 7)>
DATA SPACE=15000       <number of words (in decimal) of
                        available working storage>
EXIT 1.921 15 28       <execution time, number of disk writes,
                        and number of disk reads for INTR>

*EXECUTE SOUS          <indicates execution of the SOUS
                        module; i.e., the execution of one or
                        more of the technical modules is to
                        follow>

DATE:  05/19/78
TIME:  11/91/47        <date and time of run>

EXAMPLE OF FLOW OF CONTROL PRINTOUT    <title card>
CONTROL PRINTOUT       <title card>

THE LMS ARE:  TTFFFFFFFF
SPECIAL BOUNDARY CONDITION INDICATOR:  F
*EXECUTE BODG          <indicates execution of the BODYG
                        module>
DATA SPACE= 12928
EXIT 2.380 19 32       <execution statistics for BODYG>

*EXECUTE WAKG          <indicates execution of the WAKEG
                        module>
DATA SPACE= 12544
EXIT 2.477 34 40       <execution statistics for WAKEG>

                       <that's all folks>
```

8.2 PRINTING OF THE CHECKPOINTS

The information contained in each of the SOUSSA-P checkpoints (see Table 2 for the variables comprising the checkpoints; see Table 3 for a description of the corresponding data sets comprising the checkpoints) may be printed by executing the "SOUO" utility module. The input data stream for this module is as follows: (described in detail in Section 7)

```
[XQT SOUO
k1,k2,...,k16$THE KPRINTS
[XQT whatever
```

Here k1, k2,..., k16 correspond to flags indicating whether to print the contents of checkpoint i (ki =1) or not to print checkpoint i (ki =0). Thus, those data sets comprising the checkpoints corresponding to ki=1 will be printed. It is very important to note that for single-block data sets, a column at a time (corresponding to j=1,2,...,nj) is printed; i.e., considering a block as a matrix, the matrix will be printed in transposed form. For multi-block data sets, a block at a time (displayed sequentially), corresponding to j=1,2,...,nb (nb is the number of blocks in the data set: nb=nwrd/lb), is printed. Preceding the printing of the actual values of each data set will be a heading of the following form:

```
NU=nu   nam1   nam2   nam3   nam4
```

For example, consider the printout of the matrix of generalized aerodynamic forces corresponding to the first frequency considered (i.e., nam4=1) with user-supplied nu=1, nam2=sas and nam3=1:

```
NU=1  E  SAS  1  1
J=  1  -.55151E+01 -.19375E+01 .14357E+01 -.11225E+00
```

In this case nj=NBCM=1 (E is a single-block data set), hence one column was printed. Furthermore, the first two values correspond to IGFM=1 (remember this matrix is complex, i.e., frequency-dependent) and the last two values correspond to IGFM=2.

8.3 ADDITIONAL PRINTOUT

Additional printouts may be obtained by use of the DCU processor. For example, it is strongly recommended that the user obtain a Table of Contents (TOC) printout of his libraries after executing the INTR module and upon completion of every execution of SOUSSA-P. In this way, he may inspect the contents of his library files to determine which data sets are present (particularly important if the checkpointing facility is being used). To obtain a TOC listing, the following input data is used:

```
[XQT DCU
TOC nu $
[XQT whatever
```

In this case, nu refers to the number of the user-designated library (1-20). Examples of TOC printouts are given in Refs. 4 and 5.

SECTION 9

DESCRIPTION OF THE CONTENTS OF THE FILES CREATED BY THE SOUSSA-P PROGRAM

9.1 INTRODUCTION

The logical unit of communication among SOUSSA-P modules is the checkpoint. Each module expects one or more checkpoints as input and produces exactly one checkpoint as output. This interconnection of modules is graphically depicted in Figure 4. Each checkpoint is composed of one or more array variables and one or more scalar variables. The actual mechanism which enables modules to access output of other modules is the data complex. The data complex in the SOUSSA-P framework consists of 20 direct-access library files (SPAR primary libraries, Ref. 5) that contain data sets corresponding to SOUSSA-P FORTRAN variables. These libraries are referred to, within the SOUSSA-P program, as integers 1, 2, ..., 20 which correspond to CDC logical (local) files SPARLA, SPARLB, ..., SPARLT.

Table 3 describes important characteristics of all the possible array-variable data sets that the SOUSSA-P modules may create. The NAM1 column identically corresponds to a SOUSSA-P array variable name. Columns NWRD, NJ, and LB determine the size of the data sets which are dependent on the particular problem being run (i.e., the values of the scalar variables in these columns). Column ITYP denotes the kind of data that is contained in the data sets. The terms NWRD, NJ, LB, and ITYP are described in more detail in Section 7.2. The Mods In column denotes which SOUSSA-P modules require a given data set as input. A blank entry in this column denotes data sets that are final output of the program (i.e., Checkpoint 14). The Mod Out column denotes which module creates a given data set. A blank entry in this column implies that the corresponding data sets must be supplied by the user via the INTR utility module. The Mod Out column may be used to facilitate checkpointing. That is, given a set of modules have been run, this column will indicate which data sets reside in the data complex library. In turn, the Mod In column is useful for restarting purposes. In other words, when a user wishes to execute some subset of the SOUSSA-P modules, this column relates which data sets must be resident in the data complex library for successful execution. The procedure for checkpoint/restart is described in Section 13.

Consequently, the library files, consisting of data sets that are described in Table 3, are the only files generated by SOUSSA-P that need concern the user. Section 12 describes the job control statements for permanently saving library files and for accessing them for future runs. The DCU processor (Appendix A) allows for an array of utility functions to be performed on library files. Some of these include copying a library onto a sequential file (e.g., tape) and vice versa, disabling data sets (making them inaccessible to modules) within the library, and obtaining a table of contents listing of a library file.

Finally, note that module EMOD makes use of scratch file LUSCR in connection with the LU-decomposition of the matrix of potential influence coefficients. Users need not concern themselves with this file.

9.2 LIBRARY FILES AND DATA SETS

All SOUSSA-P data sets (corresponding to scalar and array variables) will reside on library NU, where NU is specified via a RESET card in the input stream for the INTR utility module (Section 7.4) with the following possible exceptions:

Library (internal-logical)	Data Sets			
11-SPARLK	Z	NAM2	NAM3	ifrq
	C	NAM2	NAM3	0
	G	NAM2	NAM3	0
	E11	NAM2	NAM3	0
12-SPARLL	D	NAM2	NAM3	0
	THTB	NAM2	NAM3	0
13-SPARLM	THET	NAM2	NAM3	0

The values for NAM2 and NAM3 are also supplied by the user via an INTR RESET card. Note that NU may not coincide with any of the above mentioned auxiliary libraries (11 through 13).

The job control statements needed for permanently saving SOUSSA-P library files are described in Section 12.

SECTION 10

HARDWARE/SOFTWARE REQUIREMENTS OF THE SOUSSA-P PROGRAM

10.1 INTRODUCTION

The SOUSSA-P program was designed to operate on the CDC 6000/7000 computer series under the NOS, NOS/BE, or SCOPE Operating Systems. SOUSSA-P is written in CDC FORTRAN for use with the FTN compiler. Some of the routines in the (0,0) overlay are extracted from the SPAR program and are written in CDC COMPASS assembly language. Optimization level 0 is recommended for initially compiling the source program to ensure that it has been transported correctly (i.e., without errors). For subsequent usage, optimization level 2 is recommended so that fast execution may be obtained. Note that the standard CDC Loader should be used for loading the resulting object deck.

SOUSSA-P assumes that the following FORTRAN functions are supplied by the host operating system:

ALOG(x): computes natural logarithm of x
ATAN2(x,y): computes arctangent of the ratio x to y
ABS(x): computes the absolute value of x
SQRT(x): computes the square root of x
CEXP(z): computes the complex exponential of z
CABS(z): computes the complex absolute value of z
LOCF(x): returns the address of the argument

No special hardware is required for running SOUSSA-P. If the user desires to copy his/her library files (i.e., SPARLA - SPARLT, see Section 8) onto magnetic tape (via say, the DCU TWRITE command; see Appendix A), then a tape drive and tape volume are required. Furthermore, if the user wishes to examine the various data sets in the libraries (e.g., print, punch, or plot), then the appropriate hardware devices should be available for use (e.g. line printer, card punch, or graphics plotter).

10.2 CENTRAL PROCESSOR TIME REQUIREMENTS

The amount of central processor time required per run is, of course, dependent upon which modules are to be executed, as well as several parameters to the program. These parameters include:

* NE - number of elements on the body
* NWE - number of elements on the wake

* NC - number of normalwash control points
* NGFM - number of generalized-force modes considered
* NBCM - number of boundary-condition modes considered
* NFRQ - number of frequencies considered

The CPU time required for several test cases is given in Section 10.4.

10.3 CENTRAL MEMORY REQUIREMENTS

The SOUSSA-P program employs a "semi-dynamic storage allocation scheme". Numerical values contained in various arrays are stacked in the working storage area (a single large vector located in blank common) of each module as depicted in Fig. 12. The lengths of these arrays are problem dependent, and the starting address of each array within working storage is calculated internally by the main program of the appropriate module. Efficient use of the central memory of the computer is obtained via this scheme, and, furthermore, the program need not be recompiled due to a change in dimension of an array whose size is problem dependent.

Like the central processor time requirements, the central memory requirements depend on the particular modules being run. A list of the central memory requirements for the SOUSSA-P modules is given in Table 4. The column "INSTRUCTIONS AND FIXED ARRAYS" indicates the number of words (in both octal and decimal) needed for the instructions and fixed-size arrays (this amount accounts for the (0,0) overlay) of each module. The entries in the "WORKING STORAGE" column are simple expressions involving parameters of the program which dictate the number of words required for arrays whose sizes are problem dependent, for each of the modules.

The central memory requirements for a given run are determined by summing the values in the "INSTRUCTIONS AND FIXED ARRAYS" and "WORKING STORAGE" columns (after having evaluated the working storage requirements based on the problems´ parameters), individually for each module to be executed. The value corresponding to the module having the maximal requirement represents the lower bound for the job´s field length.

It is important to emphasize that for modules YZMOD and EMOD, the minimum central memory requirements are presented in Table 4. That is, the execution time of these modules may be decreased by providing additional central memory. (This is a typical space-time tradeoff.)

MODULE	INSTRUCTIONS AND FIXED ARRAYS (OCTAL-DECIMAL)	WORKING STORAGE
DCU	37076-15934	one block of largest data set
SOUO	35610-15240	one block of largest data set
INTR	33165-13941	one block of largest data set
BODYG	34706-14790	5NNI + (NK + 1)NEI + 3NN + (NK + 10)NE
WAKEG	35520-15184	NTES*NSGI + (2 + 3NSK)NSI + 4NSGI + NTES*NSEG + (NTE + 3NSK + 2)NS + 2NTE*NDPH + 3NWK*NNE
CONTG	33754-14316	3NNI + (NK + 3NQ + 3)NEI
COEFB	40003-16387	3NN + 4NK*NE + 9NC
COEFW	36752-15850	NTE*NDPH + 3NWK*NWE + (3NQ + 6)NC
E3MOD	35440-15136	(NK + 10)NE + 3NN + NTES*NSEG + max(NSEG*NTE*NTES + NEI, 2NNI + (NK + 1)NEI)
E4MOD	33543-14179	3NNI*NGFM + (NK + 3)NE + NEI
E1MOD	34465-14645	3NNI*NBCM + (NK + 9)NE + 2NEI
YZMOD	35604-15236	Minimum Requirements: 2NTE*NDPH + 2NFRQ + 11NC
EMOD	40105-16453	Minimum Requirements: 2*NFRQ + 6NC

TABLE 4. Central Memory Requirements for the SOUSSA-P Modules

SECTION 11

LIMITATIONS AND ERROR DIAGNOSTIC CAPABILITIES OF THE SOUSSA-P PROGRAM

11.1 INTRODUCTION

This Section describes the limitations in the present version (1.1) of the SOUSSA-P program, as well as the error detection and reporting capabilities.

The following limitations exist:

* NPHI=NPSI=NCP=NC=NEI , i.e., presently, a zeroth-order (constant-potential) finite element formulation is employed.

* NK=NSK=NWK=4 , i.e., presently, the body and wake geometries must be described using quadrilateral elements; triangular elements may be realized by specifying the same corner twice.

* KBCY=KGFY and KBCZ=KGFZ , i.e., currently, symmetry conditions of boundary-condition modes must be identical to symmetry conditions of generalized-force modes.

* iabs(KBCY)=KBDY and iabs(KBCZ)=KBDZ , i.e., currently, if the y (z) plane of symmetry is considered in the body geometry representation, then the boundary-condition modes must be either symmetric or antisymmetric with respect to the y (z) direction.

11.2 ERROR DETECTION AND REPORTING

SOUSSA-P provides a systematic approach to handling errors that may arise during execution. When a fatal error is discovered, the SPAR subroutine FIN(NERR,NER) is called and the run is aborted. In this case, NERR and NER are printed out in format A4, I10 as a diagnostic for the error. Also, "subroutine FIN causes printing of the time on the clock measuring CPU time for the job as well as the cumulative count of both reads and writes between disk and central memory made by the SOUSSA-P processors for that SOUSSA-P execution" (Ref. 5).

In Table 5 given below, for each error that may be detected, the following information is given: the name of the module in which the error may occur, the name of the corresponding subroutine, the condition associated with the error, the value of NERR - a four character message identifying the error, the value of NER - an integer value that provides diagnostic capabilities, and a brief description of the error including suggested action the user might take to remedy the situation.

Module	Subroutine	Condition	NERR	NER	Description
BODYG	BODALL	kodi(iei).lt.1 .or. kodi(iei).gt.4	KODI	iei	Currently, kodi is used only to denote from which edge(s) of a trailing-edge element a wake emanates.
	BGEOM	refl.eq.0.	REFL	0	Reference length must be non-zero.
WAKEG	WAKALL	ksgy(isgi).eq.1. .and. ksgz(isgi).eq.1.	MISS	isi	A wake strip may not be symmetric in both the y and z directions simultaneously.
	WELEM	refl.eq.0.	REFL	0	Reference length must be non-zero.
CONTG	CGEOM	refl.eq.0.	REFL	0	Reference length must be non-zero.
COEFB	PGTRNB	beta.eq.0.	BETA	0	Mach number may not be unity.
	PGTRNC	beta.eq.0.	BETA	0	Mach number may not be unity.
	COBSUB	nk.ne.4	NK	nk	NK must have the value 4.

Table 5. Description of Possible Error Conditions
(page 1 of 5)

Module	Subroutine	Condition	NERR	NER	Description
		hmch.ge.1.	MACH	1	For subsonic, hmch must be less than one.
		alxml.le.0.	A121	j	Degenerate element. Check coordinates of the element j.
		alm(1)*alm(2)* a2m(1)*a2m(2).le. 0.	A12M	j	Magnitude of two or more base vectors of element j equal zero. Check coordinates of the corners of element j.
		q1q.le.0.	Q1Q	ij	Infinite integrand for 1 pt. Gaussian ij=i+(j-1)*nc where i=control pt. number and j=element number. Increase value of elam. If error persists, obtain programmer support.
		q4q.le.0.	Q4Q	ij	Same as Q1Q but for 4 pt. Gaussian.
		q9q.le.0.	Q9Q	ij	Same as Q1Q but for 9 pt. Gaussian.
COEFW	PGTRNW	beta.eq.0.	BETA	0	Mach number may not be unity.
	COWSUB	nwk.ne.4	NWK	nwk	NWK must have the value 4.

Table 5. Description of Possible Error Conditions (page 2 of 5)

Module	Subroutine	Condition	NERR	NER	Description
		hmch.ge.1.	MACH	1	For subsonic, hmch must be less than one.
		alx2ml.le.0.	A121	j	See A121 in COBSUB.
		alm(1)*alm(2)* a2m(1)*a2m(2) .le.0.	A12M	j	See A12M in COBSUB.
		q1q.le.0.	Q1Q	ij	See Q1Q in COBSUB.
		q4q.le.0.	Q4Q	ij	See Q4Q in COBSUB.
		q9q.le.0.	Q9Q	ij	See Q9Q in COBSUB.
E3MOD	KUTTA	kode(itel).lt.1 .or.kode(itel) .gt.4	KODE	ini	See KODI in BODALL. Check the kodi array.
E1MOD	E1MATS and E1MATU	alxa2m.le.0.	A1X2	ie	Magnitude of normal at center of element ie is zero. Check coordinates of corners of element ie.
EMOD	ZE1MOD	kbcy.ne.kgfy	CSYY	kbcy	Presently, symmetry conditions for boundary-condition modes must be identical to symmetry

Table 5. Description of Possible Error Conditions
(page 3 of 5)

Module	Subroutine	Condition	NERR	NER	Description
					conditions for generalized-force modes. Check that they match.
		kbcz.ne.kgfz	CSYZ	kbcz	Same as CSYY except for z-direction.
		iabs(kbcy).ne. iabs(kbdy)	CSYY	kbcy	Presently, the magnitude of the symmetry conditions for the boundary-condition modes must be identical to the magnitude of the symmetry conditions for the body geometry. Check that they match.
		iabs(kbcz).ne. iabs(kbdz)	CSYZ	kbcz	Same as directly above, except for z-direction.
	LUFCTR	mc.lt.1	LUKR	1	Insufficient working storage for EMOD (submodule LUFCTR). Increase field length (see Section 10).
	BLOCKF	test.eq.0.	SING	1	Matrix of potential influence coefficients (data set YASS) is singular.
	BLOCKN	test.eq.0.	SING	2	Matrix of potential influence coefficients (data set YASS) is singular.

Table 5. Description of Possible Error Conditions (page 4 of 5)

Module	Subroutine	Condition	NERR	NER	Description
	OUTREC	istat.eq.1	OERR	1	Parity error encountered attempting to write scratch file LUSCR.
		istat.eq.0	OERR	0	End of file encountered attempting to write scratch file LUSCR.
	INREC	istat.eq.1	IERR	1	Parity error encountered attempting to read scratch file LUSCR.
		istat.eq.0	IERR	0	End of file encountered attempting to read scratch file LUSCR.
	LUSOLV	npsi.ne.nc	NC	nc	NPSI must equal NC.
		max.lt.1	LUKR	2	Insufficient working storage for EMOD (submodule LUSOLV). Increase field length (see Section 10).
MAIN	DAL	ierr=-1	RERR	nu	Data set not found attempting to read from library nu. Check for proper spelling of data set names in the RESET header cards input to module INTR.

Table 5. Description of Possible Error Conditions (page 5 of 5)

SECTION 12

JOB CONTROL STATEMENTS FOR SOUSSA-P

12.1 INTRODUCTION

This Section describes the job control statements (cards) required for executing the SOUSSA-P program under CDC NOS. Also, the additional job control statements required for implementing the checkpoint/restart capability of SOUSSA-P are examined.

12.2 STANDARD JOB CONTROL STATEMENTS

The following job control cards are required for the execution of SOUSSA-P under NOS:

a) Job Card: specifies the job name as well as default overrides for CPU time (T), central memory (CM) and magnetic tape drives (MT).

b) User Card: specifies the user's name, the user's number, and password.

c) Charge Card: specifies accounting information such as account number and organization billed.

d) FTN Card: specifies file to be compiled (i.e., the file containing the SOUSSA-P source program; default=INPUT) via the CDC FTN compiler and file to contain resulting load module (i.e., the SOUSSA-P load module; default=LGO).

e) RFL Card: specifies the field length assigned to job. This card is needed when the default field length is not large enough to accomodate the problem being run (central memory requirements for SOUSSA-P are considered in Section 10.3).

f) Reduce Card: the statement REDUCE(-) inhibits field length reduction.

g) Load and Execute Card: specifies file to be loaded and executed (i.e., the SOUSSA-P load modules) via the CDC loader (e.g., LGO).

h) EOR Card: (7/8/9 multi-punch) specifies end of job control statements (for example). If file to be compiled is INPUT, then the SOUSSA-P source deck would now follow. This in turn would be delineated by an EOR card and followed by the input data for the various SOUSSA-P modules.

i) EOF Card: (6/7/8/9 multi-punch) last card in input deck for job.

An example of an input stream of job control statements for executing SOUSSA-P is now given (expressions in angle brackets denote comments by authors):

```
JCLEXP,T100,CM70000.             <Job card:  overrides specifications
                                  for CPU time and central memory>
USER,999823N,PWRD.               <User card>
CHARGE,110412,LRC.               <Charge card>
FTN.                             <file default values of INPUT
                                  and LGO assumed>
RFL,70000.                       <set field length to 70000
REDUCE(-)                         words octal, without reduction>
LGO.                             <load and execute file LGO>
7/8/9                            <end of job control statements>
  (SOUSSA-P source deck)         <source deck appears now>
7/8/9                            <end of source deck>
  (data for SOUSSA-P modules)    <data deck appears now>
6/7/8/9                          <end of job>
```

12.3 JOB CONTROL STATEMENTS FOR CHECKPOINT/RESTARTING

Checkpointing an execution of the SOUSSA-P program requires the saving of generated library files as permanent files so they may be accessed in future runs. SOUSSA-P library files are internally designated as 1, 2, ..., 20 and correspond to CDC local files SPARLA, SPARLB, ..., SPARLT. The user can determine precisely which of these files needs to be saved for successful checkpointing, by consulting Section 9.2. The job control statement

    SAVE,Lfn=Pfn.

saves local file Lfn (i.e., SPARLA, SPARLB, ...,SPARLT) as indirect-access permanent file Pfn (user's choice). The SAVE job statements (one for each library file to be saved) should immediately follow the load and execute card (see (g) above) in the job control card stream.

A checkpointed run can now be restarted. This is accomplished by the job control statement

    GET,Lfn=Pfn.

That is, permanent file Pfn (i.e., the name the user has chosen in a previously checkpointed run) will be made accessible to the SOUSSA-P program as local file Lfn (i.e., SPARLA, SPARLB, ..., SPARLT). The GET job control statements (one for each library file that was previously saved) should immediately precede the load and execute card (see (g) above) in the job control card stream.

SECTION 13

SUMMARY OF USAGE PROCEDURE FOR THE SOUSSA-P PROGRAM

13.1 INTRODUCTION

This Section presents the user with a convenient summary (a recipe, if you will) of the procedure for executing the SOUSSA-P utility and technical modules. That is, the salient points of the preceding sections are now reviewed. Also, the procedure required for implementing the checkpoint/restart facility is discussed.

13.2 EXECUTION OF THE UTILITY AND TECHNICAL MODULES

a) Determine the precise nature of the aerodynamic computation to be performed and hence the SOUSSA-P modules to be executed and input required. See Section 6.1 for some typical applications.

b) Punch (in free-field format - see Appendix B) the initial input required for the SOUSSA-P program (described in Section 6.2); this information is assumed to be available from separate geometry and structural-analysis processors.

c) Prepare input stream for the INTR utility module (see Section 7.4), including appropriate RESET statements. These statements act as header cards for the various quantities produced in step (b), above. The INTR module creates SOUSSA-P data sets from the user-supplied punched data.

d) Prepare control input stream required for executing the SOUSSA-P technical modules (see Section 6.3). The values for the LMs, (dictated by (a) above) designate which technical modules are to be executed.

e) Prepare input stream for the SOUO utility module (see Section 7.5). This module enables users to obtain a printout of their results.

f) Prepare input stream for the DCU utility module (see Section 7.6). It is recommended that the user obtain a TOC listing of generated libraries via the DCU module.

g) Punch the "[XQT EXIT" card.

h) Prepare job control input stream as described in Section 12.2.

i) Organize the complete input stream for the job as illustrated by Fig. 14. An example of the input deck is given below.

j) Submit job for execution.

An example of the overall input card deck for executing the SOUSSA-P program is now given (expressions in angle brackets denote comments by the authors):

```
SOUSSA,T100,CM70000.
USER,999823N,PWRD.                          <standard job control
CHARGE,110412,LRC.                           statements required for
FTN.                                         executing SOUSSA-P,
RFL,70000.                                   see Section 12.2>
REDUCE(-)
LGO.
7/8/9
  (SOUSSA-P source deck)
7/8/9
[XQT INTR                                   <invoke the INTR utility
                                             module, see Section 7.4>
RESET NAM2=SAS,NAM3=1$                      <supply values for global
                                             parameters>
  (RESET cards and punched data             <for an example, see
   for generating initial input              Section 7.4>
   data sets)
[XQT SOUS                                   <implies the execution of
                                             one or more technical
                                             modules>
THIS IS A TITLE CARD                        <input stream for executing
                                             technical modules -
                                             see Section 6.3>
TTTTTTTTTT
F
[XQT SOUO                                   <invoke the SOUO utility
                                             module, see Section 7.5>
1,1,1,1,0,0,0,0,0,0,0,0,0,1,1,1             <the Kprints control
                                             printing of the checkpoints>
[XQT DCU                                    <invoke the DCU module,
                                             see Section 7.6>
TOC,1$                                      <obtain a listing of the
                                             Table Of Contents of
                                             internal library 1>
[XQT EXIT                                   <closes files; required
                                             as last input data card>
6/7/8/9                                     <end of job>
```

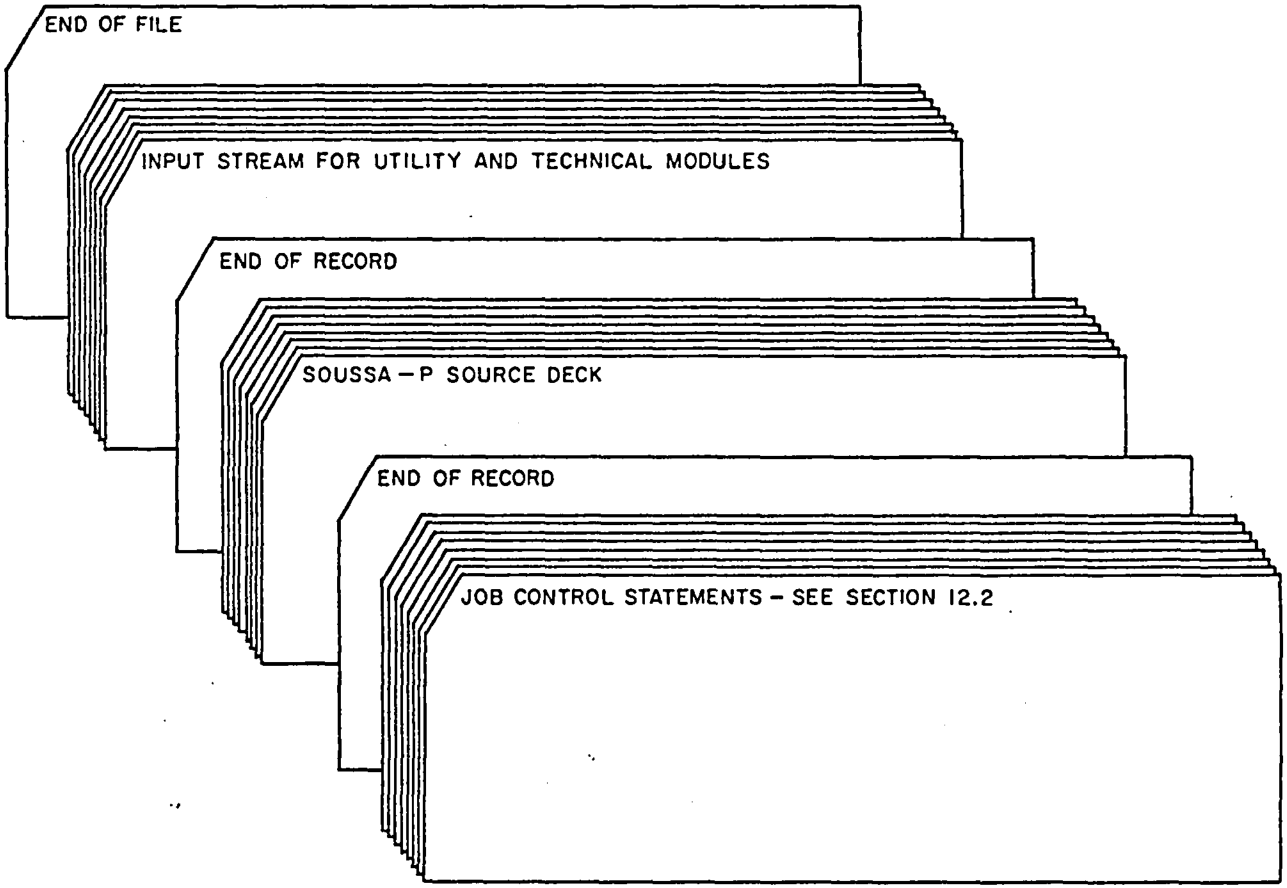


Figure 14. Input Card Deck Setup for SOUSSA-P.

13.3 PROCEDURE FOR CHECKPOINT/RESTART

As a result of the highly modular logical structure of the SOUSSA-P program (see, for instance, Figure 4), and a sophisticated communication protocol available for use by the SOUSSA-P modules (i.e., the data complex and the associated data handling routines), SOUSSA-P possesses extensive checkpoint/restart capabilities. Checkpoint/restart means here the facility to run almost any combination of modules during a given execution of SOUSSA-P.

The user declares exactly which modules are to be executed via the values supplied for the LMs in the input data stream (see Section 6.3). A precaution the user must take is that for every module to be executed, the appropriate checkpoints (i.e., data sets corresponding to array and scalar variables) reside a'priori in the data complex (i.e., the user-designated library, or the auxiliary libraries). This is accomplished by the "SAVE" and "GET" job control statements, described in Section 12.3. That is, the SAVE job control statement implements checkpointing by permanently saving generated library files for use in future runs. The GET job control statement implements restarting by accessing library files that were permanently saved in a previously checkpointed run.

Consider, checkpoint/restart for the purpose of aerodynamic analysis involving multiple sets of modes, set of frequencies, or Mach numbers (see Section 6.1). For multiple sets of modes (both boundary-condition and generalized-force modes vary), the following mode-independent checkpoints (see Fig. 4) should be saved:

Checkpoints 1, 2, 5, 6, 7, 8, 9, 10, 13, 15, and 16

These checkpoints are generated by the following modules:

Modules BODYG, WAKEG, CONTG, COEFB, COEFW, E3MOD, and YZMOD

That is, the following values should be supplied for the LMs as part of step (d) described above:

LMs=TTTTTTFFTF

Therefore, the run that performs the checkpointing requires SAVE job control cards for the following local files; these include the user-designated library and auxiliary libraries whose contents are described in Section 9.2:

Local Files:

SPARLnu (user-designated),
SPARLK, SPARLL and SPARLM

With regard to the restart of the SOUSSA-P program for the purpose of calculating the final mode-dependent output (i.e., checkpoint 14), the following modules should be executed:

Modules E4MOD, E1MOD, and EMOD

corresponding to the following values of the LMs:

LMs=FFFFFFTTFT

These are the only modules that need be reexecuted when a new set of mode shapes is input by the user (i.e., checkpoints 3 or 4). Similar discussions now follow for aerodynamic analyses involving multiple sets of frequencies and multiple Mach numbers.

Multiple Sets of Frequencies:

Checkpointing -

Frequency-independent Checkpoints : 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 15

Frequency-independent Modules: BODYG, WAKEG, CONTG, COEFB, COEFW, E3MOD, E4MOD and E1MOD

Corresponding LMs: TTTTTTTTFF

Library Files to be saved:
SPARLnu (user-designated), SPARLK, SPARLL and SPARLM

Restarting -

Frequency-dependent Modules: YZMOD and EMOD

Corresponding LMs: FFFFFFFFTT

Frequency-dependent checkpoints: 13, 14, and 16

Multiple Mach Numbers:

Checkpointing -

Mach-Number-independent checkpoints : 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, and 16

Mach-Number-independent Modules: BODYG, WAKEG, CONTG, E3MOD, E4MOD, and E1MOD

Corresponding LMs: TTTFFTTTFF

Library Files to be saved: SPARLnu (user-designated) and SPARLK

Restarting -

Mach-Number-dependent Modules: COEFB, COEFW, YZMOD, and EMOD

Corresponding LMs: FFFTTFFFTT

Mach-Number-dependent checkpoints: 8, 9, 13, 14, and 15

It is important to note that these are just a few of the possible checkpoint/restart combinations that may prove to be valuable to the user. In general, the extensive checkpoint/restart facility of the SOUSSA-P program provides a flexible method for reducing the number of overall computations required for aerodynamic problems.

SECTION 14

TEST CASES

14.1 INTRODUCTION

Included in this section are the input and output of two test cases exercised by the SOUSSA-P program. The output of these sample problems are provided as standard solutions for preliminary check out of the program under the host computer system. The two test cases presented are:

1) rectangular wing in pitching oscillations (see Ref. 7).
   * circular biconvex sections
   * aspect ratio 3
   * thickness-to-chord ratio 0.05
   * Mach number 0.2
   * pitch axis at mid chord
   * complex frequencies
     p = (0.0,0.5)
     p = (0.0,1.0)

2) wing-body in steady state flow.
   * Mach number 0.6
   * complex frequency
     p = (0.0,0.0)
   * see Figs. 15a and 15b for specifications

Input and output for Test Case 1 are included in Subsections 14.2 and 14.3, respectively, and those of Test Case 2 follow in Subsections 14.4 and 14.5.

14.2 INPUT DATA FOR TEST CASE 1

This Subsection lists the initial data required by the SOUSSA-P program (see Section 6.2) input via the INTR utility module (see Section 7.4) for Test Case 1 as well as the input stream for executing the technical modules (see Section 6.3) and the other utility modules. The geometrical definition of the body makes use of two planes of symmetry; i.e., only the upper right quadrant of the wing is input. The surface of the wing is divided into 9 elements; the emanating wake is composed of three strips. Two generalized-force modes and one boundary-condition mode are considered.

The input data listing follows:

```
 [xqt intr
 reset nam2=sas
 reset nam3=   1
 reset naml=hmch nwrd=     1 nj=     1 lb=     1 ityp=-1$
.2
 reset naml= nsk nwrd=     1 nj=     1 lb=     1 ityp= 0$
       4
 reset naml= nte nwrd=     1 nj=     1 lb=     1 ityp= 0$
```

```
      2
reset naml=ntes nwrd=     1 nj=     1 lb=     1 ityp= 0$
      4
reset naml= nni nwrd=     1 nj=     1 lb=     1 ityp= 0$
     16
reset naml=  nk nwrd=     1 nj=     1 lb=     1 ityp= 0$
      4
reset naml= nei nwrd=     1 nj=     1 lb=     1 ityp= 0$
      9
reset naml=kbdy nwrd=     1 nj=     1 lb=     1 ityp= 0$
      1
reset naml=kbdz nwrd=     1 nj=     1 lb=     1 ityp= 0$
      1
reset naml=refl nwrd=     1 nj=     1 lb=     1 ityp=-1$
     1.00000
reset naml=elam nwrd=     1 nj=     1 lb=     1 ityp=-1$
  3000.00000
reset naml= pni nwrd=    48 nj=    16 lb=    48 ityp=-1$
     -.50000     0.00000     0.00000
     -.24074     0.00000      .00768
      .24074     0.00000      .00768
      .50000     0.00000     0.00000
     -.50000      .83333     0.00000
     -.24074      .83333      .00768
      .24074      .83333      .00768
      .50000      .83333     0.00000
     -.50000     1.33333     0.00000
     -.24074     1.33333      .00768
      .24074     1.33333      .00768
      .50000     1.33333     0.00000
     -.50000     1.50000     0.00000
     -.24074     1.50000     0.00000
      .24074     1.50000     0.00000
      .50000     1.50000     0.00000
reset naml= ini nwrd=    36 nj=     9 lb=    36 ityp= 0$
      2      6      5      1
      3      7      6      2
      4      8      7      3
      6     10      9      5
      7     11     10      6
      8     12     11      7
     10     14     13      9
     11     15     14     10
     12     16     15     11
reset naml=kndy nwrd=    16 nj=     1 lb=    16 ityp= 0$
      1      1      1      1      0      0      0      0      0      0
      0      0      0      0      0      0
reset naml=kndz nwrd=    16 nj=     1 lb=    16 ityp= 0$
      1      0      0      1      1      0      0      1      1      0
      0      1      1      1      1      1
reset naml= nsi nwrd=     1 nj=     1 lb=     1 ityp= 0$
      3
reset naml=nsgi nwrd=     1 nj=     1 lb=     1 ityp= 0$
      3
reset naml=ieki nwrd=    12 nj=     3 lb=    12 ityp= 0$
      3     12      2     11
      6     15      5     14
      9     18      8     17
reset naml=isgi nwrd=     3 nj=     1 lb=     3 ityp= 0$
```

```
     1       2       3
reset naml=nsei nwrd=     3 nj=      1 lb=      3 ityp= 0$
    18      18      18
reset naml=ksgy nwrd=     3 nj=      1 lb=      3 ityp= 0$
     1       1       1
reset naml=ksgz nwrd=     3 nj=      1 lb=      3 ityp= 0$
     0       0       0
reset naml=kodi nwrd=     9 nj=      1 lb=      9 ityp= 0$
     0       0       1       0       0       1       0       0       1
reset naml= psi nwrd=    36 nj=      3 lb=     36 ityp=-1$
    6.50000    0.00000    0.00000    6.50000     .83333    0.00000
     .50000     .83333    0.00000     .50000    0.00000    0.00000
    6.50000     .83333    0.00000    6.50000    1.33333    0.00000
     .50000    1.33333    0.00000     .50000     .83333    0.00000
    6.50000    1.33333    0.00000    6.50000    1.50000    0.00000
     .50000    1.50000    0.00000     .50000    1.33333    0.00000
reset naml=ngfm nwrd=     1 nj=      1 lb=      1 ityp= 0$
     2
reset naml=kgfy nwrd=     1 nj=      1 lb=      1 ityp= 0$
     1
reset naml=kgfz nwrd=     1 nj=      1 lb=      1 ityp= 0$
    -1
reset naml= gfm nwrd=    96 nj=      2 lb=     96 ityp=-1$
    0.00000    0.00000    1.00000    0.00000    0.00000    1.00000
    0.00000    0.00000    1.00000    0.00000    0.00000    1.00000
    0.00000    0.00000    1.00000    0.00000    0.00000    1.00000
    0.00000    0.00000    1.00000    0.00000    0.00000    1.00000
    0.00000    0.00000    1.00000    0.00000    0.00000    1.00000
    0.00000    0.00000    1.00000    0.00000    0.00000    1.00000
    0.00000    0.00000    1.00000    0.00000    0.00000    1.00000
    0.00000    0.00000    1.00000    0.00000    0.00000    1.00000
    0.00000    0.00000    -.50000    0.00000    0.00000    -.24074
    0.00000    0.00000     .24074    0.00000    0.00000     .50000
    0.00000    0.00000    -.50000    0.00000    0.00000    -.24074
    0.00000    0.00000     .24074    0.00000    0.00000     .50000
    0.00000    0.00000    -.50000    0.00000    0.00000    -.24074
    0.00000    0.00000     .24074    0.00000    0.00000     .50000
    0.00000    0.00000    -.50000    0.00000    0.00000    -.24074
    0.00000    0.00000     .24074    0.00000    0.00000     .50000
reset naml=nbcm nwrd=     1 nj=      1 lb=      1 ityp= 0$
     1
reset naml=kbcy nwrd=     1 nj=      1 lb=      1 ityp= 0$
     1
reset naml=kbcz nwrd=     1 nj=      1 lb=      1 ityp= 0$
    -1
reset naml= bcm nwrd=    48 nj=      1 lb=     48 ityp=-1$
    0.00000    0.00000    -.50000    0.00000    0.00000    -.24074
    0.00000    0.00000     .24074    0.00000    0.00000     .50000
    0.00000    0.00000    -.50000    0.00000    0.00000    -.24074
    0.00000    0.00000     .24074    0.00000    0.00000     .50000
    0.00000    0.00000    -.50000    0.00000    0.00000    -.24074
    0.00000    0.00000     .24074    0.00000    0.00000     .50000
    0.00000    0.00000    -.50000    0.00000    0.00000    -.24074
    0.00000    0.00000     .24074    0.00000    0.00000     .50000
reset naml=nfrq nwrd=     1 nj=      1 lb=      1 ityp= 0$
     2
reset naml=freq nwrd=     4 nj=      1 lb=      4 ityp=-1$
    0.00000    0.5    0.0    1.00000
[xqt dcu
```

```
toc 1 $ table of contents
[xqt sous
rectangular wing with biconvex section in unsteady flow
tttttttttt
f
[xqt dcu
toc 1 $ table of contents
[xqt souo
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 $ check points to be printed
[xqt exit
```

14.3 OUTPUT OF TEST CASE 1

This Subsection lists the results obtained for Test Case 1. The central processor time requirement for this test case was 10.224 seconds using the CDC 6600 computer, with the program having been compiled by the FTN compiler under optimization level zero. The Mach number used for this analysis was 0.2 while the two frequencies considered were (0.0,0.5) and (0.0,1.0). For completeness, the contents of all sixteen checkpoints are listed. Checkpoint 14 includes the velocity potential distribution (E21), the pressure distribution (E321) and the matrix of generalized aerodynamic forces (E), for each frequency.

The output listing now follows.

```
the contents of checkpoint  1


nni,nk,nei,kbdy,kbdz,refl=
      16       4       9       1       1  .10000e+01


nu=  1     pni  sas      1    0

j=    1  -.50000e+00 0.           0.
j=    2  -.24074e+00 0.            .76800e-02
j=    3   .24074e+00 0.            .76800e-02
j=    4   .50000e+00 0.           0.
j=    5  -.50000e+00  .83333e+00 0.
j=    6  -.24074e+00  .83333e+00  .76800e-02
j=    7   .24074e+00  .83333e+00  .76800e-02
j=    8   .50000e+00  .83333e+00 0.
j=    9  -.50000e+00  .13333e+01 0.
j=   10  -.24074e+00  .13333e+01  .76800e-02
j=   11   .24074e+00  .13333e+01  .76800e-02
j=   12   .50000e+00  .13333e+01 0.
j=   13  -.50000e+00  .15000e+01 0.
j=   14  -.24074e+00  .15000e+01 0.
j=   15   .24074e+00  .15000e+01 0.
j=   16   .50000e+00  .15000e+01 0.


nu=  1     ini  sas      1    0

j=    1        2        6        5        1
j=    2        3        7        6        2
j=    3        4        8        7        3
j=    4        6       10        9        5
j=    5        7       11       10        6
j=    6        8       12       11        7
j=    7       10       14       13        9
j=    8       11       15       14       10
j=    9       12       16       15       11
```

```
 nu=  1     kndy sas       1    0

 j=      1         1             1            1            1
0
                  0             0            0            0
0
                  0             0            0            0
0
                  0

 nu=  1     kndz sas       1    0

 j=      1         1             0            0            1
1
                  0             0            1            1
0
                  0             1            1            1
1
                  1

 nu=  1     kodi sas       1    0

 j=      1         0             0            1            0
0
                  1          0           0           1


 the contents of checkpoint  2


 ntes,nsgi,nsi,nsk,refl=
        4         3         3         4  .10000e+01

 nu=  1     ieki sas       1    0

 j=    1         3          12           2          11
 j=    2         6          15           5          14
 j=    3         9          18           8          17

 nu=  1     isgi sas       1    0

 j=    1         1           2           3

 nu=  1     psi  sas       1    0

 j=      1    .65000e+01  0.           0.            .65000e+01
.83333e+00
          0.             .50000e+00      .83333e+00      0.
.50000e+00
          0.         0.
 j=      2    .65000e+01   .83333e+00 0.            .65000e+01
.13333e+01
```

```
          0.                  .50000e+00        .13333e+01      0.
.50000e+00
           .83333e+00 0.
 j=     3   .65000e+01    .13333e+01 0.                .65000e+01
.15000e+01
          0.                  .50000e+00        .15000e+01      0.
.50000e+00
           .13333e+01 0.


 nu=  1      nsei sas       1     0

 j=     1        18           18           18


 nu=  1      ksgy sas       1     0

 j=     1         1            1            1


 nu=  1      ksgz sas       1     0

 j=     1         0            0            0


 the contents of checkpoint  3


 nni,ngfm,kgfy,kgfz=
        16         2          1        -1


 nu=  1      gfm  sas       1     0

 j=     1  0.          0.          .10000e+01 0.          0.
            .10000e+01 0.          0.          .10000e+01 0.

           0.                .10000e+01      0.            0.
.10000e+01
           0.          0.          .10000e+01 0.          0.
            .10000e+01 0.          0.          .10000e+01 0.
           0.                .10000e+01      0.            0.
.10000e+01
           0.          0.          .10000e+01 0.          0.
            .10000e+01 0.          0.          .10000e+01 0.
           0.                .10000e+01      0.            0.
.10000e+01
           0.          0.          .10000e+01
 j=     2  0.          0.         -.50000e+00 0.          0.
           -.24074e+00 0.          0.          .24074e+00 0.
           0.                .50000e+00      0.            0.
-.50000e+00
           0.          0.         -.24074e+00 0.          0.
            .24074e+00 0.          0.          .50000e+00 0.
           0.               -.50000e+00      0.            0.
-.24074e+00
           0.          0.          .24074e+00 0.          0.
```

```
          .50000e+00 0.           0.          -.50000e+00 0.
         0.          -.24074e+00      0.               0.
.24074e+00
         0.          0.           .50000e+00
```

the contents of checkpoint 4

```
nni,nbcm,kbcy,kbcz=
      16         1         1        -1
```

```
nu=  1      bcm   sas       1    0

j=    1  0.          0.           -.50000e+00 0.          0.
         -.24074e+00 0.           0.          .24074e+00 0.
         0.          .50000e+00      0.               0.
-.50000e+00
         0.          0.           -.24074e+00 0.          0.
          .24074e+00 0.           0.          .50000e+00 0.
         0.          -.50000e+00      0.               0.
-.24074e+00
         0.          0.           .24074e+00 0.          0.
          .50000e+00 0.           0.          -.50000e+00 0.
         0.          -.24074e+00      0.               0.
.24074e+00
         0.          0.           .50000e+00
```

the contents of checkpoint 5

```
nn,nk,ne,nq=
      64         4        36         4
```

```
nu=  1      pn    sas       1    0

j=    1  -.50000e+00 0.          0.
j=    2  -.24074e+00 0.           .76800e-02
j=    3   .24074e+00 0.           .76800e-02
j=    4   .50000e+00 0.          0.
j=    5  -.50000e+00  .83333e+00 0.
j=    6  -.24074e+00  .83333e+00  .76800e-02
j=    7   .24074e+00  .83333e+00  .76800e-02
j=    8   .50000e+00  .83333e+00 0.
j=    9  -.50000e+00  .13333e+01 0.
j=   10  -.24074e+00  .13333e+01  .76800e-02
j=   11   .24074e+00  .13333e+01  .76800e-02
j=   12   .50000e+00  .13333e+01 0.
j=   13  -.50000e+00  .15000e+01 0.
j=   14  -.24074e+00  .15000e+01 0.
j=   15   .24074e+00  .15000e+01 0.
j=   16   .50000e+00  .15000e+01 0.
```

j=	17	-.50000e+00	0.	0.
j=	18	-.24074e+00	0.	-.76800e-02
j=	19	.24074e+00	0.	-.76800e-02
j=	20	.50000e+00	0.	0.
j=	21	-.50000e+00	.83333e+00	0.
j=	22	-.24074e+00	.83333e+00	-.76800e-02
j=	23	.24074e+00	.83333e+00	-.76800e-02
j=	24	.50000e+00	.83333e+00	0.
j=	25	-.50000e+00	.13333e+01	0.
j=	26	-.24074e+00	.13333e+01	-.76800e-02
j=	27	.24074e+00	.13333e+01	-.76800e-02
j=	28	.50000e+00	.13333e+01	0.
j=	29	-.50000e+00	.15000e+01	0.
j=	30	-.24074e+00	.15000e+01	0.
j=	31	.24074e+00	.15000e+01	0.
j=	32	.50000e+00	.15000e+01	0.
j=	33	-.50000e+00	0.	0.
j=	34	-.24074e+00	0.	.76800e-02
j=	35	.24074e+00	0.	.76800e-02
j=	36	.50000e+00	0.	0.
j=	37	-.50000e+00	-.83333e+00	0.
j=	38	-.24074e+00	-.83333e+00	.76800e-02
j=	39	.24074e+00	-.83333e+00	.76800e-02
j=	40	.50000e+00	-.83333e+00	0.
j=	41	-.50000e+00	-.13333e+01	0.
j=	42	-.24074e+00	-.13333e+01	.76800e-02
j=	43	.24074e+00	-.13333e+01	.76800e-02
j=	44	.50000e+00	-.13333e+01	0.
j=	45	-.50000e+00	-.15000e+01	0.
j=	46	-.24074e+00	-.15000e+01	0.
j=	47	.24074e+00	-.15000e+01	0.
j=	48	.50000e+00	-.15000e+01	0.
j=	49	-.50000e+00	0.	0.
j=	50	-.24074e+00	0.	-.76800e-02
j=	51	.24074e+00	0.	-.76800e-02
j=	52	.50000e+00	0.	0.
j=	53	-.50000e+00	-.83333e+00	0.
j=	54	-.24074e+00	-.83333e+00	-.76800e-02
j=	55	.24074e+00	-.83333e+00	-.76800e-02
j=	56	.50000e+00	-.83333e+00	0.
j=	57	-.50000e+00	-.13333e+01	0.
j=	58	-.24074e+00	-.13333e+01	-.76800e-02
j=	59	.24074e+00	-.13333e+01	-.76800e-02
j=	60	.50000e+00	-.13333e+01	0.
j=	61	-.50000e+00	-.15000e+01	0.
j=	62	-.24074e+00	-.15000e+01	0.
j=	63	.24074e+00	-.15000e+01	0.
j=	64	.50000e+00	-.15000e+01	0.

nu= 1 in sas 1 0

j=	1	2	6	5	1
j=	2	3	7	6	2
j=	3	4	8	7	3
j=	4	6	10	9	5
j=	5	7	11	10	6
j=	6	8	12	11	7
j=	7	10	14	13	9

j=	8	11	15	14	10
j=	9	12	16	15	11
j=	10	22	18	1	5
j=	11	23	19	18	22
j=	12	8	4	19	23
j=	13	26	22	5	9
j=	14	27	23	22	26
j=	15	12	8	23	27
j=	16	14	26	9	13
j=	17	15	27	26	14
j=	18	16	12	27	15
j=	19	38	2	1	37
j=	20	39	3	2	38
j=	21	40	4	3	39
j=	22	42	38	37	41
j=	23	43	39	38	42
j=	24	44	40	39	43
j=	25	46	42	41	45
j=	26	47	43	42	46
j=	27	48	44	43	47
j=	28	18	54	37	1
j=	29	19	55	54	18
j=	30	4	40	55	19
j=	31	54	58	41	37
j=	32	55	59	58	54
j=	33	40	44	59	55
j=	34	58	46	45	41
j=	35	59	47	46	58
j=	36	44	48	47	59

nu= 1 alc sas 1 0

j=	1	.12963e+00	0.	.38400e-02
j=	2	.24074e+00	0.	0.
j=	3	.12963e+00	0.	-.38400e-02
j=	4	.12963e+00	0.	.38400e-02
j=	5	.24074e+00	0.	0.
j=	6	.12963e+00	0.	-.38400e-02
j=	7	.12963e+00	0.	.19200e-02
j=	8	.24074e+00	0.	0.
j=	9	.12963e+00	0.	-.19200e-02
j=	10	.12963e+00	0.	-.38400e-02
j=	11	.24074e+00	0.	0.
j=	12	.12963e+00	0.	.38400e-02
j=	13	.12963e+00	0.	-.38400e-02
j=	14	.24074e+00	0.	0.
j=	15	.12963e+00	0.	.38400e-02
j=	16	.12963e+00	0.	-.19200e-02
j=	17	.24074e+00	0.	0.
j=	18	.12963e+00	0.	.19200e-02
j=	19	.12963e+00	0.	.38400e-02
j=	20	.24074e+00	0.	0.
j=	21	.12963e+00	0.	-.38400e-02
j=	22	.12963e+00	0.	.38400e-02
j=	23	.24074e+00	0.	0.
j=	24	.12963e+00	0.	-.38400e-02
j=	25	.12963e+00	0.	.19200e-02
j=	26	.24074e+00	0.	0.

```
j=    27    .12963e+00 0.          -.19200e-02
j=    28    .12963e+00 0.          -.38400e-02
j=    29    .24074e+00 0.          0.
j=    30    .12963e+00 0.           .38400e-02
j=    31    .12963e+00 0.          -.38400e-02
j=    32    .24074e+00 0.          0.
j=    33    .12963e+00 0.           .38400e-02
j=    34    .12963e+00 0.          -.19200e-02
j=    35    .24074e+00 0.          0.
j=    36    .12963e+00 0.           .19200e-02


nu=   1      a2c   sas       1     0

j=     1  0.               .41667e+00 0.
j=     2  0.               .41667e+00 0.
j=     3  0.               .41667e+00 0.
j=     4  0.               .25000e+00 0.
j=     5  0.               .25000e+00 0.
j=     6  0.               .25000e+00 0.
j=     7  0.               .83335e-01 -.19200e-02
j=     8  0.               .83335e-01 -.38400e-02
j=     9  0.               .83335e-01 -.19200e-02
j=    10  0.              -.41667e+00 0.
j=    11  0.              -.41667e+00 0.
j=    12  0.              -.41667e+00 0.
j=    13  0.              -.25000e+00 0.
j=    14  0.              -.25000e+00 0.
j=    15  0.              -.25000e+00 0.
j=    16  0.              -.83335e-01 -.19200e-02
j=    17  0.              -.83335e-01 -.38400e-02
j=    18  0.              -.83335e-01 -.19200e-02
j=    19  0.               .41667e+00 0.
j=    20  0.               .41667e+00 0.
j=    21  0.               .41667e+00 0.
j=    22  0.               .25000e+00 0.
j=    23  0.               .25000e+00 0.
j=    24  0.               .25000e+00 0.
j=    25  0.               .83335e-01  .19200e-02
j=    26  0.               .83335e-01  .38400e-02
j=    27  0.               .83335e-01  .19200e-02
j=    28  0.              -.41667e+00 0.
j=    29  0.              -.41667e+00 0.
j=    30  0.              -.41667e+00 0.
j=    31  0.              -.25000e+00 0.
j=    32  0.              -.25000e+00 0.
j=    33  0.              -.25000e+00 0.
j=    34  0.              -.83335e-01  .19200e-02
j=    35  0.              -.83335e-01  .38400e-02
j=    36  0.              -.83335e-01  .19200e-02


nu=   1      a1x2  sas       1     0

j=     1  -.16000e-02 0.            .54012e-01
j=     2  0.          0.            .10031e+00
j=     3   .16000e-02 0.            .54012e-01
j=     4  -.96000e-03 0.            .32408e-01
j=     5  0.          0.            .60185e-01
```

j=	6	.96000e-03	0.	.32408e-01
j=	7	-.16000e-03	.24889e-03	.10803e-01
j=	8	0.	.92444e-03	.20062e-01
j=	9	.16000e-03	.24889e-03	.10803e-01
j=	10	-.16000e-02	0.	-.54012e-01
j=	11	0.	0.	-.10031e+00
j=	12	.16000e-02	0.	-.54012e-01
j=	13	-.96000e-03	0.	-.32408e-01
j=	14	0.	0.	-.60185e-01
j=	15	.96000e-03	0.	-.32408e-01
j=	16	-.16000e-03	.24889e-03	-.10803e-01
j=	17	0.	.92444e-03	-.20062e-01
j=	18	.16000e-03	.24889e-03	-.10803e-01
j=	19	-.16000e-02	0.	.54012e-01
j=	20	0.	0.	.10031e+00
j=	21	.16000e-02	0.	.54012e-01
j=	22	-.96000e-03	0.	.32408e-01
j=	23	0.	0.	.60185e-01
j=	24	.96000e-03	0.	.32408e-01
j=	25	-.16000e-03	-.24889e-03	.10803e-01
j=	26	0.	-.92444e-03	.20062e-01
j=	27	.16000e-03	-.24889e-03	.10803e-01
j=	28	-.16000e-02	0.	-.54012e-01
j=	29	0.	0.	-.10031e+00
j=	30	.16000e-02	0.	-.54012e-01
j=	31	-.96000e-03	0.	-.32408e-01
j=	32	0.	0.	-.60185e-01
j=	33	.96000e-03	0.	-.32408e-01
j=	34	-.16000e-03	-.24889e-03	-.10803e-01
j=	35	0.	-.92444e-03	-.20062e-01
j=	36	.16000e-03	-.24889e-03	-.10803e-01

the contents of checkpoint 6

nc= 9

nu= 1 pcen sas 1 0

j=	1	-.37037e+00	.41667e+00	.38400e-02
j=	2	0.	.41667e+00	.76800e-02
j=	3	.37037e+00	.41667e+00	.38400e-02
j=	4	-.37037e+00	.10833e+01	.38400e-02
j=	5	0.	.10833e+01	.76800e-02
j=	6	.37037e+00	.10833e+01	.38400e-02
j=	7	-.37037e+00	.14167e+01	.19200e-02
j=	8	0.	.14167e+01	.38400e-02
j=	9	.37037e+00	.14167e+01	.19200e-02
j=	10	-.37037e+00	.41667e+00	-.38400e-02
j=	11	0.	.41667e+00	-.76800e-02
j=	12	.37037e+00	.41667e+00	-.38400e-02
j=	13	-.37037e+00	.10833e+01	-.38400e-02
j=	14	0.	.10833e+01	-.76800e-02
j=	15	.37037e+00	.10833e+01	-.38400e-02
j=	16	-.37037e+00	.14167e+01	-.19200e-02

```
j=    17   0.              .14167e+01  -.38400e-02
j=    18    .37037e+00   .14167e+01  -.19200e-02
j=    19   -.37037e+00  -.41667e+00   .38400e-02
j=    20   0.            -.41667e+00   .76800e-02
j=    21    .37037e+00  -.41667e+00   .38400e-02
j=    22   -.37037e+00  -.10833e+01   .38400e-02
j=    23   0.            -.10833e+01   .76800e-02
j=    24    .37037e+00  -.10833e+01   .38400e-02
j=    25   -.37037e+00  -.14167e+01   .19200e-02
j=    26   0.            -.14167e+01   .38400e-02
j=    27    .37037e+00  -.14167e+01   .19200e-02
j=    28   -.37037e+00  -.41667e+00  -.38400e-02
j=    29   0.            -.41667e+00  -.76800e-02
j=    30    .37037e+00  -.41667e+00  -.38400e-02
j=    31   -.37037e+00  -.10833e+01  -.38400e-02
j=    32   0.            -.10833e+01  -.76800e-02
j=    33    .37037e+00  -.10833e+01  -.38400e-02
j=    34   -.37037e+00  -.14167e+01  -.19200e-02
j=    35   0.            -.14167e+01  -.38400e-02
j=    36    .37037e+00  -.14167e+01  -.19200e-02


nu=   1       pc    sas       1     0

j=     1   -.37037e+00   .41667e+00   .38400e-02
j=     2   0.             .41667e+00   .76800e-02
j=     3    .37037e+00   .41667e+00   .38400e-02
j=     4   -.37037e+00   .10833e+01   .38400e-02
j=     5   0.             .10833e+01   .76800e-02
j=     6    .37037e+00   .10833e+01   .38400e-02
j=     7   -.37037e+00   .14167e+01   .19200e-02
j=     8   0.             .14167e+01   .38400e-02
j=     9    .37037e+00   .14167e+01   .19200e-02


the contents of checkpoint   7


nwk,nwe,nte,ndph,nseg,ntes=
        4       108          2        108          6          4


nu=   1       pwk   sas       1     0

 j=      1    .83333e+00  0.            0.                .83333e+00
.83333e+00
          0.                .50000e+00        .83333e+00      0.
.50000e+00
          0.            0.
 j=      2    .11667e+01  0.            0.                .11667e+01
.83333e+00
          0.                .83333e+00        .83333e+00      0.
.83333e+00
          0.            0.
 j=      3    .15000e+01  0.            0.                .15000e+01
.83333e+00
          0.                .11667e+01        .83333e+00      0.
```

```
.11667e+01
          0.          0.
 j=     4   .18333e+01  0.          0.               .18333e+01
.83333e+00
          0.                .15000e+01      .83333e+00      0.
.15000e+01
          0.          0.
 j=     5   .21667e+01  0.          0.               .21667e+01
.83333e+00
          0.                .18333e+01      .83333e+00      0.
.18333e+01
          0.          0.
 j=     6   .25000e+01  0.          0.               .25000e+01
.83333e+00
          0.                .21667e+01      .83333e+00      0.
.21667e+01
          0.          0.
 j=     7   .28333e+01  0.          0.               .28333e+01
.83333e+00
          0.                .25000e+01      .83333e+00      0.
.25000e+01
          0.          0.
 j=     8   .31667e+01  0.          0.               .31667e+01
.83333e+00
          0.                .28333e+01      .83333e+00      0.
.28333e+01
          0.          0.
 j=     9   .35000e+01  0.          0.               .35000e+01
.83333e+00
          0.                .31667e+01      .83333e+00      0.
.31667e+01
          0.          0.
 j=    10   .38333e+01  0.          0.               .38333e+01
.83333e+00
          0.                .35000e+01      .83333e+00      0.
.35000e+01
          0.          0.
 j=    11   .41667e+01  0.          0.               .41667e+01
.83333e+00
          0.                .38333e+01      .83333e+00      0.
.38333e+01
          0.          0.
 j=    12   .45000e+01  0.          0.               .45000e+01
.83333e+00
          0.                .41667e+01      .83333e+00      0.
.41667e+01
          0.          0.
 j=    13   .48333e+01  0.          0.               .48333e+01
.83333e+00
          0.                .45000e+01      .83333e+00      0.
.45000e+01
          0.          0.
 j=    14   .51667e+01  0.          0.               .51667e+01
.83333e+00
          0.                .48333e+01      .83333e+00      0.
.48333e+01
          0.          0.
 j=    15   .55000e+01  0.          0.               .55000e+01
.83333e+00
```

```
          0.                  .51667e+01      .83333e+00     0.
.51667e+01
          0.          0.
 j=    16   .58333e+01  0.           0.              .58333e+01
.83333e+00
          0.                  .55000e+01      .83333e+00     0.
.55000e+01
          0.          0.
 j=    17   .61667e+01  0.           0.              .61667e+01
.83333e+00
          0.                  .58333e+01      .83333e+00     0.
.58333e+01
          0.          0.
 j=    18   .65000e+01  0.           0.              .65000e+01
.83333e+00
          0.                  .61667e+01      .83333e+00     0.
.61667e+01
          0.          0.
 j=    19  .83333e+00 -.83333e+00 0.             .83333e+00 0.
          0.                  .50000e+00     0.              0.
.50000e+00
          -.83333e+00 0.
 j=    20  .11667e+01 -.83333e+00 0.             .11667e+01 0.
          0.                  .83333e+00     0.              0.
.83333e+00
          -.83333e+00 0.
 j=    21  .15000e+01 -.83333e+00 0.             .15000e+01 0.
          0.                  .11667e+01     0.              0.
.11667e+01
          -.83333e+00 0.
 j=    22  .18333e+01 -.83333e+00 0.             .18333e+01 0.
          0.                  .15000e+01     0.              0.
.15000e+01
          -.83333e+00 0.
 j=    23  .21667e+01 -.83333e+00 0.             .21667e+01 0.
          0.                  .18333e+01     0.              0.
.18333e+01
          -.83333e+00 0.
 j=    24  .25000e+01 -.83333e+00 0.             .25000e+01 0.
          0.                  .21667e+01     0.              0.
.21667e+01
          -.83333e+00 0.
 j=    25  .28333e+01 -.83333e+00 0.             .28333e+01 0.
          0.                  .25000e+01     0.              0.
.25000e+01
          -.83333e+00 0.
 j=    26  .31667e+01 -.83333e+00 0.             .31667e+01 0.
          0.                  .28333e+01     0.              0.
.28333e+01
          -.83333e+00 0.
 j=    27  .35000e+01 -.83333e+00 0.             .35000e+01 0.
          0.                  .31667e+01     0.              0.
.31667e+01
          -.83333e+00 0.
 j=    28  .38333e+01 -.83333e+00 0.             .38333e+01 0.
          0.                  .35000e+01     0.              0.
.35000e+01
          -.83333e+00 0.
 j=    29  .41667e+01 -.83333e+00 0.             .41667e+01 0.
```

```
          0.                  .38333e+01     0.               0.
.38333e+01
          -.83333e+00 0.
 j=    30  .45000e+01 -.83333e+00 0.              .45000e+01 0.
          0.                  .41667e+01     0.               0.
.41667e+01
          -.83333e+00 0.
 j=    31  .48333e+01 -.83333e+00 0.              .48333e+01 0.
          0.                  .45000e+01     0.               0.
.45000e+01
          -.83333e+00 0.
 j=    32  .51667e+01 -.83333e+00 0.              .51667e+01 0.
          0.                  .48333e+01     0.               0.
.48333e+01
          -.83333e+00 0.
 j=    33  .55000e+01 -.83333e+00 0.              .55000e+01 0.
          0.                  .51667e+01     0.               0.
.51667e+01
          -.83333e+00 0.
 j=    34  .58333e+01 -.83333e+00 0.              .58333e+01 0.
          0.                  .55000e+01     0.               0.
.55000e+01
          -.83333e+00 0.
 j=    35  .61667e+01 -.83333e+00 0.              .61667e+01 0.
          0.                  .58333e+01     0.               0.
.58333e+01
          -.83333e+00 0.
 j=    36  .65000e+01 -.83333e+00 0.              .65000e+01 0.
          0.                  .61667e+01     0.               0.
.61667e+01
          -.83333e+00 0.
 j=    37   .83333e+00   .83333e+00 0.              .83333e+00
.13333e+01
          0.                  .50000e+00     .13333e+01      0.
.50000e+00
           .83333e+00 0.
 j=    38   .11667e+01   .83333e+00 0.              .11667e+01
.13333e+01
          0.                  .83333e+00     .13333e+01      0.
.83333e+00
           .83333e+00 0.
 j=    39   .15000e+01   .83333e+00 0.              .15000e+01
.13333e+01
          0.                  .11667e+01     .13333e+01      0.
.11667e+01
           .83333e+00 0.
 j=    40   .18333e+01   .83333e+00 0.              .18333e+01
.13333e+01
          0.                  .15000e+01     .13333e+01      0.
.15000e+01
           .83333e+00 0.
 j=    41   .21667e+01   .83333e+00 0.              .21667e+01
.13333e+01
          0.                  .18333e+01     .13333e+01      0.
.18333e+01
           .83333e+00 0.
 j=    42   .25000e+01   .83333e+00 0.              .25000e+01
.13333e+01
          0.                  .21667e+01     .13333e+01      0.
```

```
.21667e+01
           .83333e+00 0.
 j=    43   .28333e+01   .83333e+00 0.          .28333e+01
.13333e+01
          0.              .25000e+01      .13333e+01     0.
.25000e+01
           .83333e+00 0.
 j=    44   .31667e+01   .83333e+00 0.          .31667e+01
.13333e+01
          0.              .28333e+01      .13333e+01     0.
.28333e+01
           .83333e+00 0.
 j=    45   .35000e+01   .83333e+00 0.          .35000e+01
.13333e+01
          0.              .31667e+01      .13333e+01     0.
.31667e+01
           .83333e+00 0.
 j=    46   .38333e+01   .83333e+00 0.          .38333e+01
.13333e+01
          0.              .35000e+01      .13333e+01     0.
.35000e+01
           .83333e+00 0.
 j=    47   .41667e+01   .83333e+00 0.          .41667e+01
.13333e+01
          0.              .38333e+01      .13333e+01     0.
.38333e+01
           .83333e+00 0.
 j=    48   .45000e+01   .83333e+00 0.          .45000e+01
.13333e+01
          0.              .41667e+01      .13333e+01     0.
.41667e+01
           .83333e+00 0.
 j=    49   .48333e+01   .83333e+00 0.          .48333e+01
.13333e+01
          0.              .45000e+01      .13333e+01     0.
.45000e+01
           .83333e+00 0.
 j=    50   .51667e+01   .83333e+00 0.          .51667e+01
.13333e+01
          0.              .48333e+01      .13333e+01     0.
.48333e+01
           .83333e+00 0.
 j=    51   .55000e+01   .83333e+00 0.          .55000e+01
.13333e+01
          0.              .51667e+01      .13333e+01     0.
.51667e+01
           .83333e+00 0.
 j=    52   .58333e+01   .83333e+00 0.          .58333e+01
.13333e+01
          0.              .55000e+01      .13333e+01     0.
.55000e+01
           .83333e+00 0.
 j=    53   .61667e+01   .83333e+00 0.          .61667e+01
.13333e+01
          0.              .58333e+01      .13333e+01     0.
.58333e+01
           .83333e+00 0.
 j=    54   .65000e+01   .83333e+00 0.          .65000e+01
.13333e+01
```

0. .61667e+01 .13333e+01 0.
.61667e+01
.83333e+00 0.
j= 55 .83333e+00 -.13333e+01 0. .83333e+00
-.83333e+00
0. .50000e+00 -.83333e+00 0.
.50000e+00
-.13333e+01 0.
j= 56 .11667e+01 -.13333e+01 0. .11667e+01
-.83333e+00
0. .83333e+00 -.83333e+00 0.
.83333e+00
-.13333e+01 0.
j= 57 .15000e+01 -.13333e+01 0. .15000e+01
-.83333e+00
0. .11667e+01 -.83333e+00 0.
.11667e+01
-.13333e+01 0.
j= 58 .18333e+01 -.13333e+01 0. .18333e+01
-.83333e+00
0. .15000e+01 -.83333e+00 0.
.15000e+01
-.13333e+01 0.
j= 59 .21667e+01 -.13333e+01 0. .21667e+01
-.83333e+00
0. .18333e+01 -.83333e+00 0.
.18333e+01
-.13333e+01 0.
j= 60 .25000e+01 -.13333e+01 0. .25000e+01
-.83333e+00
0. .21667e+01 -.83333e+00 0.
.21667e+01
-.13333e+01 0.
j= 61 .28333e+01 -.13333e+01 0. .28333e+01
-.83333e+00
0. .25000e+01 -.83333e+00 0.
.25000e+01
-.13333e+01 0.
j= 62 .31667e+01 -.13333e+01 0. .31667e+01
-.83333e+00
0. .28333e+01 -.83333e+00 0.
.28333e+01
-.13333e+01 0.
j= 63 .35000e+01 -.13333e+01 0. .35000e+01
-.83333e+00
0. .31667e+01 -.83333e+00 0.
.31667e+01
-.13333e+01 0.
j= 64 .38333e+01 -.13333e+01 0. .38333e+01
-.83333e+00
0. .35000e+01 -.83333e+00 0.
.35000e+01
-.13333e+01 0.
j= 65 .41667e+01 -.13333e+01 0. .41667e+01
-.83333e+00
0. .38333e+01 -.83333e+00 0.
.38333e+01
-.13333e+01 0.
j= 66 .45000e+01 -.13333e+01 0. .45000e+01

```
-.83333e+00
             0.                .41667e+01     -.83333e+00      0.
.41667e+01
             -.13333e+01 0.
 j=     67    .48333e+01  -.13333e+01 0.                  .48333e+01
-.83333e+00
             0.                .45000e+01     -.83333e+00      0.
.45000e+01
             -.13333e+01 0.
 j=     68    .51667e+01  -.13333e+01 0.                  .51667e+01
-.83333e+00
             0.                .48333e+01     -.83333e+00      0.
.48333e+01
             -.13333e+01 0.
 j=     69    .55000e+01  -.13333e+01 0.                  .55000e+01
-.83333e+00
             0.                .51667e+01     -.83333e+00      0.
.51667e+01
             -.13333e+01 0.
 j=     70    .58333e+01  -.13333e+01 0.                  .58333e+01
-.83333e+00
             0.                .55000e+01     -.83333e+00      0.
.55000e+01
             -.13333e+01 0.
 j=     71    .61667e+01  -.13333e+01 0.                  .61667e+01
-.83333e+00
             0.                .58333e+01     -.83333e+00      0.
.58333e+01
             -.13333e+01 0.
 j=     72    .65000e+01  -.13333e+01 0.                  .65000e+01
-.83333e+00
             0.                .61667e+01     -.83333e+00      0.
.61667e+01
             -.13333e+01 0.
 j=     73    .83333e+00   .13333e+01 0.                  .83333e+00
.15000e+01
             0.                .50000e+00      .15000e+01      0.
.50000e+00
              .13333e+01 0.
 j=     74    .11667e+01   .13333e+01 0.                  .11667e+01
.15000e+01
             0.                .83333e+00      .15000e+01      0.
.83333e+00
              .13333e+01 0.
 j=     75    .15000e+01   .13333e+01 0.                  .15000e+01
.15000e+01
             0.                .11667e+01      .15000e+01      0.
.11667e+01
              .13333e+01 0.
 j=     76    .18333e+01   .13333e+01 0.                  .18333e+01
.15000e+01
             0.                .15000e+01      .15000e+01      0.
.15000e+01
              .13333e+01 0.
 j=     77    .21667e+01   .13333e+01 0.                  .21667e+01
.15000e+01
             0.                .18333e+01      .15000e+01      0.
.18333e+01
              .13333e+01 0.
```

j= 78 .25000e+01 .13333e+01 0. .25000e+01
.15000e+01
0. .21667e+01 .15000e+01 0.
.21667e+01
.13333e+01 0.
j= 79 .28333e+01 .13333e+01 0. .28333e+01
.15000e+01
0. .25000e+01 .15000e+01 0.
.25000e+01
.13333e+01 0.
j= 80 .31667e+01 .13333e+01 0. .31667e+01
.15000e+01
0. .28333e+01 .15000e+01 0.
.28333e+01
.13333e+01 0.
j= 81 .35000e+01 .13333e+01 0. .35000e+01
.15000e+01
0. .31667e+01 .15000e+01 0.
.31667e+01
.13333e+01 0.
j= 82 .38333e+01 .13333e+01 0. .38333e+01
.15000e+01
0. .35000e+01 .15000e+01 0.
.35000e+01
.13333e+01 0.
j= 83 .41667e+01 .13333e+01 0. .41667e+01
.15000e+01
0. .38333e+01 .15000e+01 0.
.38333e+01
.13333e+01 0.
j= 84 .45000e+01 .13333e+01 0. .45000e+01
.15000e+01
0. .41667e+01 .15000e+01 0.
.41667e+01
.13333e+01 0.
j= 85 .48333e+01 .13333e+01 0. .48333e+01
.15000e+01
0. .45000e+01 .15000e+01 0.
.45000e+01
.13333e+01 0.
j= 86 .51667e+01 .13333e+01 0. .51667e+01
.15000e+01
0. .48333e+01 .15000e+01 0.
.48333e+01
.13333e+01 0.
j= 87 .55000e+01 .13333e+01 0. .55000e+01
.15000e+01

0. .51667e+01 .15000e+01 0.
.51667e+01
.13333e+01 0.
j= 88 .58333e+01 .13333e+01 0. .58333e+01
.15000e+01
0. .55000e+01 .15000e+01 0.
.55000e+01
.13333e+01 0.
j= 89 .61667e+01 .13333e+01 0. .61667e+01
.15000e+01
0. .58333e+01 .15000e+01 0.

```
.58333e+01
          .13333e+01 0.
 j=     90   .65000e+01   .13333e+01 0.              .65000e+01
.15000e+01
          0.                .61667e+01      .15000e+01     0.
.61667e+01
          .13333e+01 0.
 j=     91   .83333e+00  -.15000e+01 0.              .83333e+00
-.13333e+01
          0.                .50000e+00     -.13333e+01     0.
.50000e+00
          -.15000e+01 0.
 j=     92   .11667e+01  -.15000e+01 0.              .11667e+01
-.13333e+01
          0.                .83333e+00     -.13333e+01     0.
.83333e+00
          -.15000e+01 0.
 j=     93   .15000e+01  -.15000e+01 0.              .15000e+01
-.13333e+01
          0.                .11667e+01     -.13333e+01     0.
.11667e+01
          -.15000e+01 0.
 j=     94   .18333e+01  -.15000e+01 0.              .18333e+01
-.13333e+01
          0.                .15000e+01     -.13333e+01     0.
.15000e+01
          -.15000e+01 0.
 j=     95   .21667e+01  -.15000e+01 0.              .21667e+01
-.13333e+01
          0.                .18333e+01     -.13333e+01     0.
.18333e+01
          -.15000e+01 0.
 j=     96   .25000e+01  -.15000e+01 0.              .25000e+01
-.13333e+01
          0.                .21667e+01     -.13333e+01     0.
.21667e+01
          -.15000e+01 0.
 j=     97   .28333e+01  -.15000e+01 0.              .28333e+01
-.13333e+01
          0.                .25000e+01     -.13333e+01     0.
.25000e+01
          -.15000e+01 0.
 j=     98   .31667e+01  -.15000e+01 0.              .31667e+01
-.13333e+01
          0.                .28333e+01     -.13333e+01     0.
.28333e+01
          -.15000e+01 0.
 j=     99   .35000e+01  -.15000e+01 0.              .35000e+01
-.13333e+01
          0.                .31667e+01     -.13333e+01     0.
.31667e+01
          -.15000e+01 0.
 j=    100   .38333e+01  -.15000e+01 0.              .38333e+01
-.13333e+01
          0.                .35000e+01     -.13333e+01     0.
.35000e+01
          -.15000e+01 0.
 j=    101   .41667e+01  -.15000e+01 0.              .41667e+01
-.13333e+01
```

```
                0.                   .38333e+01      -.13333e+01      0.
.38333e+01
                -.15000e+01 0.
 j=    102    .45000e+01  -.15000e+01 0.                 .45000e+01
-.13333e+01
                0.                   .41667e+01      -.13333e+01      0.
.41667e+01
                -.15000e+01 0.
 j=    103    .48333e+01  -.15000e+01 0.                 .48333e+01
-.13333e+01
                0.                   .45000e+01      -.13333e+01      0.
.45000e+01
                -.15000e+01 0.
 j=    104    .51667e+01  -.15000e+01 0.                 .51667e+01
-.13333e+01
                0.                   .48333e+01      -.13333e+01      0.
.48333e+01
                -.15000e+01 0.
 j=    105    .55000e+01  -.15000e+01 0.                 .55000e+01
-.13333e+01
                0.                   .51667e+01      -.13333e+01      0.
.51667e+01
                -.15000e+01 0.
 j=    106    .58333e+01  -.15000e+01 0.                 .58333e+01
-.13333e+01
                0.                   .55000e+01      -.13333e+01      0.
.55000e+01
                -.15000e+01 0.
 j=    107    .61667e+01  -.15000e+01 0.                 .61667e+01
-.13333e+01
                0.                   .58333e+01      -.13333e+01      0.
.58333e+01
                -.15000e+01 0.
 j=    108    .65000e+01  -.15000e+01 0.                 .65000e+01
-.13333e+01
                0.                   .61667e+01      -.13333e+01      0.
.61667e+01
                -.15000e+01 0.


 nu=   1      ibnv sas       1     0

 j=     1          3          12
 j=     2          3          12
 j=     3          3          12
 j=     4          3          12
 j=     5          3          12
 j=     6          3          12
 j=     7          3          12
 j=     8          3          12
 j=     9          3          12
 j=    10          3          12
 j=    11          3          12
 j=    12          3          12
 j=    13          3          12
 j=    14          3          12
 j=    15          3          12
 j=    16          3          12
 j=    17          3          12
```

j=	18	3	12
j=	19	21	30
j=	20	21	30
j=	21	21	30
j=	22	21	30
j=	23	21	30
j=	24	21	30
j=	25	21	30
j=	26	21	30
j=	27	21	30
j=	28	21	30
j=	29	21	30
j=	30	21	30
j=	31	21	30
j=	32	21	30
j=	33	21	30
j=	34	21	30
j=	35	21	30
j=	36	21	30
j=	37	6	15
j=	38	6	15
j=	39	6	15
j=	40	6	15
j=	41	6	15
j=	42	6	15
j=	43	6	15
j=	44	6	15
j=	45	6	15
j=	46	6	15
j=	47	6	15
j=	48	6	15
j=	49	6	15
j=	50	6	15
j=	51	6	15
j=	52	6	15
j=	53	6	15
j=	54	6	15
j=	55	24	33
j=	56	24	33
j=	57	24	33
j=	58	24	33
j=	59	24	33
j=	60	24	33
j=	61	24	33
j=	62	24	33
j=	63	24	33
j=	64	24	33
j=	65	24	33
j=	66	24	33
j=	67	24	33
j=	68	24	33
j=	69	24	33
j=	70	24	33
j=	71	24	33
j=	72	24	33
j=	73	9	18
j=	74	9	18
j=	75	9	18
j=	76	9	18

j=	77	9	18
j=	78	9	18
j=	79	9	18
j=	80	9	18
j=	81	9	18
j=	82	9	18
j=	83	9	18
j=	84	9	18
j=	85	9	18
j=	86	9	18
j=	87	9	18
j=	88	9	18
j=	89	9	18
j=	90	9	18
j=	91	27	36
j=	92	27	36
j=	93	27	36
j=	94	27	36
j=	95	27	36
j=	96	27	36
j=	97	27	36
j=	98	27	36
j=	99	27	36
j=	100	27	36
j=	101	27	36
j=	102	27	36
j=	103	27	36
j=	104	27	36
j=	105	27	36
j=	106	27	36
j=	107	27	36
j=	108	27	36

nu=	1	coef sas	1 0
j=	1	.10000e+01	-.10000e+01
j=	2	.10000e+01	-.10000e+01
j=	3	.10000e+01	-.10000e+01
j=	4	.10000e+01	-.10000e+01
j=	5	.10000e+01	-.10000e+01
j=	6	.10000e+01	-.10000e+01
j=	7	.10000e+01	-.10000e+01
j=	8	.10000e+01	-.10000e+01
j=	9	.10000e+01	-.10000e+01
j=	10	.10000e+01	-.10000e+01
j=	11	.10000e+01	-.10000e+01
j=	12	.10000e+01	-.10000e+01
j=	13	.10000e+01	-.10000e+01
j=	14	.10000e+01	-.10000e+01
j=	15	.10000e+01	-.10000e+01
j=	16	.10000e+01	-.10000e+01
j=	17	.10000e+01	-.10000e+01
j=	18	.10000e+01	-.10000e+01
j=	19	.10000e+01	-.10000e+01
j=	20	.10000e+01	-.10000e+01
j=	21	.10000e+01	-.10000e+01
j=	22	.10000e+01	-.10000e+01
j=	23	.10000e+01	-.10000e+01
j=	24	.10000e+01	-.10000e+01

j=	25	.10000e+01	-.10000e+01
j=	26	.10000e+01	-.10000e+01
j=	27	.10000e+01	-.10000e+01
j=	28	.10000e+01	-.10000e+01
j=	29	.10000e+01	-.10000e+01
j=	30	.10000e+01	-.10000e+01
j=	31	.10000e+01	-.10000e+01
j=	32	.10000e+01	-.10000e+01
j=	33	.10000e+01	-.10000e+01
j=	34	.10000e+01	-.10000e+01
j=	35	.10000e+01	-.10000e+01
j=	36	.10000e+01	-.10000e+01
j=	37	.10000e+01	-.10000e+01
j=	38	.10000e+01	-.10000e+01
j=	39	.10000e+01	-.10000e+01
j=	40	.10000e+01	-.10000e+01
j=	41	.10000e+01	-.10000e+01
j=	42	.10000e+01	-.10000e+01
j=	43	.10000e+01	-.10000e+01
j=	44	.10000e+01	-.10000e+01
j=	45	.10000e+01	-.10000e+01
j=	46	.10000e+01	-.10000e+01
j=	47	.10000e+01	-.10000e+01
j=	48	.10000e+01	-.10000e+01
j=	49	.10000e+01	-.10000e+01
j=	50	.10000e+01	-.10000e+01
j=	51	.10000e+01	-.10000e+01
j=	52	.10000e+01	-.10000e+01
j=	53	.10000e+01	-.10000e+01
j=	54	.10000e+01	-.10000e+01
j=	55	.10000e+01	-.10000e+01
j=	56	.10000e+01	-.10000e+01
j=	57	.10000e+01	-.10000e+01
j=	58	.10000e+01	-.10000e+01
j=	59	.10000e+01	-.10000e+01
j=	60	.10000e+01	-.10000e+01
j=	61	.10000e+01	-.10000e+01
j=	62	.10000e+01	-.10000e+01
j=	63	.10000e+01	-.10000e+01
j=	64	.10000e+01	-.10000e+01
j=	65	.10000e+01	-.10000e+01
j=	66	.10000e+01	-.10000e+01
j=	67	.10000e+01	-.10000e+01
j=	68	.10000e+01	-.10000e+01
j=	69	.10000e+01	-.10000e+01
j=	70	.10000e+01	-.10000e+01
j=	71	.10000e+01	-.10000e+01
j=	72	.10000e+01	-.10000e+01
j=	73	.10000e+01	-.10000e+01
j=	74	.10000e+01	-.10000e+01
j=	75	.10000e+01	-.10000e+01
j=	76	.10000e+01	-.10000e+01
j=	77	.10000e+01	-.10000e+01
j=	78	.10000e+01	-.10000e+01
j=	79	.10000e+01	-.10000e+01
j=	80	.10000e+01	-.10000e+01
j=	81	.10000e+01	-.10000e+01
j=	82	.10000e+01	-.10000e+01
j=	83	.10000e+01	-.10000e+01

```
j=   84   .10000e+01 -.10000e+01
j=   85   .10000e+01 -.10000e+01
j=   86   .10000e+01 -.10000e+01
j=   87   .10000e+01 -.10000e+01
j=   88   .10000e+01 -.10000e+01
j=   89   .10000e+01 -.10000e+01
j=   90   .10000e+01 -.10000e+01
j=   91   .10000e+01 -.10000e+01
j=   92   .10000e+01 -.10000e+01
j=   93   .10000e+01 -.10000e+01
j=   94   .10000e+01 -.10000e+01
j=   95   .10000e+01 -.10000e+01
j=   96   .10000e+01 -.10000e+01
j=   97   .10000e+01 -.10000e+01
j=   98   .10000e+01 -.10000e+01
j=   99   .10000e+01 -.10000e+01
j=  100   .10000e+01 -.10000e+01
j=  101   .10000e+01 -.10000e+01
j=  102   .10000e+01 -.10000e+01
j=  103   .10000e+01 -.10000e+01
j=  104   .10000e+01 -.10000e+01
j=  105   .10000e+01 -.10000e+01
j=  106   .10000e+01 -.10000e+01
j=  107   .10000e+01 -.10000e+01
j=  108   .10000e+01 -.10000e+01


the contents of checkpoint  8


nc,npsi,nphi,hmch,elam=
          9         9         9  .20000e+00  .30000e+04


nu=  1      b     sas      1    0

j=      1  -.23999e+00  -.82125e-01 -.44733e-01  -.60902e-01
-.48726e-01
           -.35161e-01 -.37235e-01 -.34209e-01 -.28474e-01
j=      2  -.16260e+00  -.35168e+00 -.16260e+00  -.90740e-01
-.10973e+00
           -.90740e-01 -.63270e-01 -.68477e-01 -.63270e-01
j=      3  -.44733e-01  -.82125e-01 -.23999e+00  -.35161e-01
-.48726e-01
           -.60902e-01 -.28474e-01 -.34209e-01 -.37235e-01
j=      4  -.32945e-01  -.28090e-01 -.21008e-01  -.19811e+00
-.53992e-01
           -.27640e-01 -.76006e-01 -.42702e-01 -.25460e-01
j=      5  -.52034e-01  -.60016e-01 -.52034e-01  -.10948e+00
-.27812e+00
           -.10948e+00 -.81994e-01 -.12730e+00 -.81994e-01
j=      6  -.21008e-01  -.28090e-01 -.32945e-01  -.27640e-01
-.53992e-01
           -.19811e+00 -.25460e-01 -.42702e-01 -.76006e-01
j=      7  -.70174e-02  -.65684e-02 -.56059e-02  -.20940e-01
-.14067e-01
           -.85465e-02 -.11599e+00 -.19206e-01 -.93647e-02
```

```
j=     8  -.12159e-01  -.12950e-01 -.12159e-01  -.26590e-01
-.36814e-01
          -.26590e-01 -.40402e-01 -.14779e+00 -.40402e-01
j=     9  -.56059e-02  -.65684e-02 -.70174e-02  -.85465e-02
-.14067e-01
          -.20940e-01 -.93647e-02 -.19206e-01 -.11599e+00
j=    10  -.23246e+00  -.82086e-01 -.44731e-01  -.60894e-01
-.48718e-01
          -.35160e-01 -.37234e-01 -.34208e-01 -.28474e-01
j=    11  -.16250e+00  -.33667e+00 -.16250e+00  -.90726e-01
-.10967e+00
          -.90726e-01 -.63268e-01 -.68471e-01 -.63268e-01
j=    12  -.44731e-01  -.82086e-01 -.23246e+00  -.35160e-01
-.48718e-01
          -.60894e-01 -.28474e-01 -.34208e-01 -.37234e-01
j=    13  -.32942e-01  -.28087e-01 -.21008e-01  -.19059e+00
-.53961e-01
          -.27639e-01 -.75976e-01 -.42694e-01 -.25460e-01
j=    14  -.52028e-01  -.59997e-01 -.52028e-01  -.10940e+00
-.26319e+00
          -.10940e+00 -.81979e-01 -.12714e+00 -.81979e-01
j=    15  -.21008e-01  -.28087e-01 -.32942e-01  -.27639e-01
-.53961e-01
          -.19059e+00 -.25460e-01 -.42694e-01 -.75976e-01
j=    16  -.70173e-02  -.65682e-02 -.56058e-02  -.20936e-01
-.14064e-01
          -.85463e-02 -.11221e+00 -.19203e-01 -.93645e-02
j=    17  -.12159e-01  -.12949e-01 -.12159e-01  -.26586e-01
-.36792e-01
          -.26586e-01 -.40392e-01 -.14035e+00 -.40392e-01
j=    18  -.56058e-02  -.65682e-02 -.70173e-02  -.85463e-02
-.14064e-01
          -.20936e-01 -.93645e-02 -.19203e-01 -.11221e+00
j=    19  -.45978e-01  -.40384e-01 -.31668e-01  -.24002e-01
-.23189e-01
          -.21195e-01 -.19472e-01 -.19040e-01 -.17903e-01
j=    20  -.74772e-01  -.84062e-01 -.74772e-01  -.42935e-01
-.44398e-01
          -.42935e-01 -.35277e-01 -.36064e-01 -.35277e-01
j=    21  -.31668e-01  -.40384e-01 -.45978e-01  -.21195e-01
-.23189e-01
          -.24002e-01 -.17903e-01 -.19040e-01 -.19472e-01
j=    22  -.14157e-01  -.13713e-01 -.12601e-01  -.97599e-02
-.96122e-02
          -.92069e-02 -.84505e-02 -.83543e-02 -.80845e-02
j=    23  -.25393e-01  -.26194e-01 -.25393e-01  -.17819e-01
-.18090e-01
          -.17819e-01 -.15492e-01 -.15669e-01 -.15492e-01
j=    24  -.12601e-01  -.13713e-01 -.14157e-01  -.92069e-02
-.96122e-02
          -.97599e-02 -.80845e-02 -.83543e-02 -.84505e-02
j=    25  -.38293e-02  -.37507e-02 -.35409e-02  -.28084e-02
-.27769e-02
          -.26884e-02 -.24780e-02 -.24563e-02 -.23944e-02
j=    26  -.69579e-02  -.71014e-02 -.69579e-02  -.51552e-02
-.52132e-02
          -.51552e-02 -.45611e-02 -.46011e-02 -.45611e-02
j=    27  -.35409e-02  -.37507e-02 -.38293e-02  -.26884e-02
-.27769e-02
```

```
        -.28084e-02 -.23944e-02 -.24563e-02 -.24780e-02
 j=     28  -.45975e-01  -.40380e-01 -.31667e-01  -.24002e-01
-.23188e-01
        -.21195e-01 -.19472e-01 -.19039e-01 -.17903e-01
 j=     29  -.74765e-01  -.84041e-01 -.74765e-01  -.42934e-01
-.44395e-01
        -.42934e-01 -.35277e-01 -.36064e-01 -.35277e-01
 j=     30  -.31667e-01  -.40380e-01 -.45975e-01  -.21195e-01
-.23188e-01
        -.24002e-01 -.17903e-01 -.19039e-01 -.19472e-01
 j=     31  -.14157e-01  -.13713e-01 -.12601e-01  -.97598e-02
-.96121e-02
        -.92068e-02 -.84505e-02 -.83543e-02 -.80845e-02
 j=     32  -.25392e-01  -.26192e-01 -.25392e-01  -.17819e-01
-.18089e-01
        -.17819e-01 -.15492e-01 -.15669e-01 -.15492e-01
 j=     33  -.12601e-01  -.13713e-01 -.14157e-01  -.92068e-02
-.96121e-02
        -.97598e-02 -.80845e-02 -.83543e-02 -.84505e-02
 j=     34  -.38293e-02  -.37506e-02 -.35409e-02  -.28084e-02
-.27769e-02
        -.26884e-02 -.24780e-02 -.24563e-02 -.23944e-02
 j=     35  -.69578e-02  -.71012e-02 -.69578e-02  -.51552e-02
-.52131e-02
        -.51552e-02 -.45611e-02 -.46011e-02 -.45611e-02
 j=     36  -.35409e-02  -.37506e-02 -.38293e-02  -.26884e-02
-.27769e-02
        -.28084e-02 -.23944e-02 -.24563e-02 -.24780e-02


 nu= 11      c     sas       1     0

 j=      1     0.            -.36918e-02    -.16440e-02   0.
-.85673e-03
        -.83912e-03 -.97218e-04 -.41071e-03 -.48135e-03
 j=      2  -.61628e-02  0.           -.61628e-02  -.93028e-03
.11309e-14
        -.93028e-03 -.39995e-03 -.34901e-03 -.39995e-03
 j=      3  -.16440e-02  -.36918e-02 0.           -.83912e-03
-.85673e-03
        0.          -.48135e-03 -.41071e-03 -.97218e-04
 j=      4     -.11309e-14   -.39081e-03    -.47592e-03   0.
-.28425e-02
        -.10754e-02 -.39286e-02 -.22702e-02 -.92056e-03
 j=      5  -.39935e-03   .11309e-14 -.39935e-03 -.51829e-02 0.
        -.51829e-02 -.30489e-02 -.10080e-01 -.30489e-02
 j=      6  -.47592e-03  -.39081e-03   .11309e-14  -.10754e-02
-.28425e-02
        0.          -.92056e-03 -.22702e-02 -.39286e-02
 j=      7  -.14899e-03  -.13985e-03 -.12277e-03  -.11390e-02
-.56592e-03
        -.23718e-03 0.          -.58162e-03 -.18840e-03
 j=      8  -.49165e-03  -.54187e-03 -.49165e-03  -.19600e-02
-.35991e-02
        -.19600e-02 -.12680e-02 0.          -.12680e-02
 j=      9  -.12277e-03  -.13985e-03 -.14899e-03  -.23718e-03
-.56592e-03
        -.11390e-02 -.18840e-03 -.58162e-03 0.
 j=     10  -.96130e+00  -.11620e-01 -.22190e-02  -.22889e-02
```

-.27000e-02
-.11327e-02 -.29163e-03 -.69813e-03 -.55878e-03
j= 11 -.18428e-01 -.95386e+00 -.18428e-01 -.27888e-02
-.74777e-02
-.27888e-02 -.66651e-03 -.10467e-02 -.66651e-03
j= 12 -.22190e-02 -.11620e-01 -.96130e+00 -.11327e-02
-.27000e-02
-.22889e-02 -.55878e-03 -.69813e-03 -.29163e-03
j= 13 -.71743e-03 -.12320e-02 -.64241e-03 -.95827e+00
-.89445e-02
-.14515e-02 -.11758e-01 -.38563e-02 -.10686e-02
j= 14 -.11976e-02 -.24969e-02 -.11976e-02 -.15491e-01
-.94429e+00
-.15491e-01 -.50764e-02 -.30001e-01 -.50764e-02
j= 15 -.64241e-03 -.12320e-02 -.71743e-03 -.14515e-02
-.89445e-02
-.95827e+00 -.10686e-02 -.38563e-02 -.11758e-01
j= 16 -.20316e-03 -.22872e-03 -.15038e-03 -.26559e-02
-.14794e-02
-.33665e-03 -.96538e+00 -.18329e-02 -.25433e-03
j= 17 -.57354e-03 -.73877e-03 -.57354e-03 -.29381e-02
-.83794e-02
-.29381e-02 -.37994e-02 -.93834e+00 -.37994e-02
j= 18 -.15038e-03 -.22872e-03 -.20316e-03 -.33665e-03
-.14794e-02
-.26559e-02 -.25433e-03 -.18329e-02 -.96538e+00
j= 19 0. -.45935e-03 -.61254e-03 0.
-.77405e-04
-.17830e-03 -.12122e-04 -.64478e-04 -.11545e-03
j= 20 -.46739e-03 .11309e-14 -.46739e-03 -.76890e-04
.11309e-14
-.76890e-04 -.62534e-04 -.44693e-04 -.62534e-04
j= 21 -.61254e-03 -.45935e-03 0. -.17830e-03
-.77405e-04
0. -.11545e-03 -.64478e-04 -.12122e-04
j= 22 .11309e-14 -.42485e-04 -.10080e-03 .11309e-14
-.14449e-04
-.39001e-04 -.26362e-05 -.14550e-04 -.28649e-04
j= 23 -.42212e-04 .11309e-14 -.42212e-04 -.14393e-04
.11309e-14
-.14393e-04 -.14143e-04 -.97572e-05 -.14143e-04
j= 24 -.10080e-03 -.42485e-04 -.11309e-14 -.39001e-04
-.14449e-04
-.11309e-14 -.28649e-04 -.14550e-04 -.26362e-05
j= 25 -.45997e-04 -.45887e-04 -.47619e-04 -.25033e-04
-.25188e-04
-.26751e-04 -.20157e-04 -.20872e-04 -.21536e-04
j= 26 -.16737e-03 -.16976e-03 -.16737e-03 -.92708e-04
-.92660e-04
-.92708e-04 -.73813e-04 -.74671e-04 -.73813e-04
j= 27 -.47619e-04 -.45887e-04 -.45997e-04 -.26751e-04
-.25188e-04
-.25033e-04 -.21536e-04 -.20872e-04 -.20157e-04
j= 28 -.80567e-03 -.14481e-02 -.82685e-03 -.93310e-04
-.24410e-03
-.24070e-03 -.36364e-04 -.10961e-03 -.13402e-03
j= 29 -.14016e-02 -.28184e-02 -.14016e-02 -.23065e-03
-.34248e-03
-.23065e-03 -.10422e-03 -.13407e-03 -.10422e-03

```
 j=     30  -.82685e-03   -.14481e-02 -.80567e-03   -.24070e-03
-.24410e-03
          -.93310e-04 -.13402e-03 -.10961e-03 -.36364e-04
 j=     31  -.50478e-04   -.13398e-03 -.13607e-03   -.16299e-04
-.45568e-04
          -.52651e-04 -.79085e-05 -.24734e-04 -.33259e-04
 j=     32  -.12663e-03   -.18557e-03 -.12663e-03   -.43178e-04
-.60252e-04
          -.43178e-04 -.23571e-04 -.29271e-04 -.23571e-04
 j=     33  -.13607e-03   -.13398e-03 -.50478e-04   -.52651e-04
-.45568e-04
          -.16299e-04 -.33259e-04 -.24734e-04 -.79085e-05
 j=     34  -.54757e-04   -.62351e-04 -.54546e-04   -.28485e-04
-.31863e-04
          -.29779e-04 -.21343e-04 -.23181e-04 -.22606e-04
 j=     35  -.18258e-03   -.20209e-03 -.18258e-03   -.98887e-04
-.10544e-03
          -.98887e-04 -.75953e-04 -.79062e-04 -.75953e-04
 j=     36  -.54546e-04   -.62351e-04 -.54757e-04   -.29779e-04
-.31863e-04
          -.28485e-04 -.22606e-04 -.23181e-04 -.21343e-04


 nu= 12      d     sas       1     0

 j=      1      0.              -.28487e-03     -.25370e-03    0.
-.13402e-03
          -.17265e-03 -.19845e-04 -.89626e-04 -.12317e-03
 j=      2  -.47555e-03  0.              -.47555e-03   -.14553e-03
.15389e-15
          -.14553e-03 -.87279e-04 -.71241e-04 -.87279e-04
 j=      3  -.25370e-03   -.28487e-03 0.                -.17265e-03
-.13402e-03
          0.          -.12317e-03 -.89626e-04 -.19845e-04
 j=      4      -.15389e-15     -.61137e-04     -.97920e-04    0.
-.21934e-03
          -.16596e-03 -.26732e-03 -.23354e-03 -.15526e-03
 j=      5  -.62474e-04   .15389e-15 -.62474e-04 -.39994e-03 0.
          -.39994e-03 -.31368e-03 -.68591e-03 -.31368e-03
 j=      6  -.97920e-04   -.61137e-04   .15389e-15   -.16596e-03
-.21934e-03
          0.          -.15526e-03 -.23354e-03 -.26732e-03
 j=      7  -.30413e-04   -.30520e-04 -.31415e-04   -.77504e-04
-.58223e-04
          -.40001e-04 0.          -.44878e-04 -.29074e-04
 j=      8  -.10729e-03   -.11061e-03 -.10729e-03   -.20164e-03
-.24491e-03
          -.20164e-03 -.97840e-04 0.          -.97840e-04
 j=      9  -.31415e-04   -.30520e-04 -.30413e-04   -.40001e-04
-.58223e-04
          -.77504e-04 -.29074e-04 -.44878e-04 0.
 j=     10  -.15070e-02   -.89704e-03 -.34245e-03   -.31150e-03
-.42242e-03
          -.23306e-03 -.59530e-04 -.15235e-03 -.14299e-03
 j=     11  -.14226e-02   -.29907e-02 -.14226e-02   -.43632e-03
-.10178e-02
          -.43632e-03 -.14545e-03 -.21367e-03 -.14545e-03
 j=     12  -.34245e-03   -.89704e-03 -.15070e-02   -.23306e-03
-.42242e-03
```

-.31150e-03 -.14299e-03 -.15235e-03 -.59530e-04
j= 13 -.97636e-04 -.19275e-03 -.13218e-03 -.15022e-02
-.69048e-03
-.22401e-03 -.80016e-03 -.39677e-03 -.18023e-03
j= 14 -.18736e-03 -.33987e-03 -.18736e-03 -.11959e-02
-.29607e-02
-.11959e-02 -.52233e-03 -.20425e-02 -.52233e-03
j= 15 -.13218e-03 -.19275e-03 -.97636e-04 -.22401e-03
-.69048e-03
-.15022e-02 -.18023e-03 -.39677e-03 -.80016e-03
j= 16 -.41471e-04 -.49914e-04 -.38482e-04 -.18074e-03
-.15222e-03
-.56778e-04 -.75670e-03 -.14145e-03 -.39248e-04
j= 17 -.12516e-03 -.15081e-03 -.12516e-03 -.30229e-03
-.57049e-03
-.30229e-03 -.29320e-03 -.14710e-02 -.29320e-03
j= 18 -.38482e-04 -.49914e-04 -.41471e-04 -.56778e-04
-.15222e-03
-.18074e-03 -.39248e-04 -.14145e-03 -.75670e-03
j= 19 0. -.85801e-04 -.14068e-03 0.
-.24441e-04
-.61135e-04 -.45362e-05 -.24637e-04 -.46733e-04
j= 20 -.87303e-04 .19236e-15 -.87303e-04 -.24279e-04
.34625e-15
-.24279e-04 -.23894e-04 -.16725e-04 -.23894e-04
j= 21 -.14068e-03 -.85801e-04 0. -.61135e-04
-.24441e-04
0. -.46733e-04 -.24637e-04 -.45362e-05
j= 22 .34625e-15 -.13415e-04 -.34561e-04 .50014e-15
-.64869e-05
-.18269e-04 -.13453e-05 -.75093e-05 -.15274e-04
j= 23 -.13329e-04 .34625e-15 -.13329e-04 -.64619e-05
.50014e-15
-.64619e-05 -.72994e-05 -.49792e-05 -.72994e-05
j= 24 -.34561e-04 -.13415e-04 -.34625e-15 -.18269e-04
-.64869e-05
-.50014e-15 -.15274e-04 -.75093e-05 -.13453e-05
j= 25 -.17213e-04 -.17534e-04 -.19276e-04 -.12774e-04
-.13000e-04
-.14262e-04 -.11658e-04 -.12178e-04 -.12891e-04
j= 26 -.63952e-04 -.63530e-04 -.63952e-04 -.47848e-04
-.47285e-04
-.47848e-04 -.43068e-04 -.43186e-04 -.43068e-04
j= 27 -.19276e-04 -.17534e-04 -.17213e-04 -.14262e-04
-.13000e-04
-.12774e-04 -.12891e-04 -.12178e-04 -.11658e-04
j= 28 -.13705e-03 -.27051e-03 -.18991e-03 -.28571e-04
-.77079e-04
-.82531e-04 -.13609e-04 -.41882e-04 -.54253e-04
j= 29 -.26183e-03 -.47950e-03 -.26183e-03 -.72831e-04
-.10487e-03
-.72831e-04 -.39823e-04 -.50174e-04 -.39823e-04
j= 30 -.18991e-03 -.27051e-03 -.13705e-03 -.82531e-04
-.77079e-04
-.28571e-04 -.54253e-04 -.41882e-04 -.13609e-04
j= 31 -.15456e-04 -.42307e-04 -.46657e-04 -.72087e-05
-.20458e-04
-.24663e-04 -.40358e-05 -.12766e-04 -.17731e-04
j= 32 -.39984e-04 -.56822e-04 -.39984e-04 -.19385e-04

-.26648e-04
-.19385e-04 -.12165e-04 -.14937e-04 -.12165e-04
j= 33 -.46657e-04 -.42307e-04 -.15456e-04 -.24663e-04
-.20458e-04
-.72087e-05 -.17731e-04 -.12766e-04 -.40358e-05
j= 34 -.20492e-04 -.23825e-04 -.22080e-04 -.14536e-04
-.16445e-04
-.15876e-04 -.12344e-04 -.13526e-04 -.13531e-04
j= 35 -.69765e-04 -.75628e-04 -.69765e-04 -.51037e-04
-.53806e-04
-.51037e-04 -.44317e-04 -.45726e-04 -.44317e-04
j= 36 -.22080e-04 -.23825e-04 -.20492e-04 -.15876e-04
-.16445e-04
-.14536e-04 -.13531e-04 -.13526e-04 -.12344e-04

nu= 13 thet sas 1 0

j= 1 0. .61732e-01 .12346e+00 .13608e+00
.14101e+00
.17489e+00 .20412e+00 .20279e+00 .22503e+00
j= 2 .92596e-01 .56656e-17 .61732e-01 .17187e+00
.13608e+00
.14101e+00 .23366e+00 .20413e+00 .20279e+00
j= 3 .18519e+00 .92596e-01 0. .23661e+00
.17187e+00
.13608e+00 .28676e+00 .23365e+00 .20412e+00
j= 4 .13608e+00 .14101e+00 .17489e+00 .72519e-15
.61732e-01
.12346e+00 .68043e-01 .87444e-01 .13779e+00
j= 5 .17187e+00 .13608e+00 .14101e+00 .92596e-01
.72522e-15
.61732e-01 .11831e+00 .68046e-01 .87450e-01
j= 6 .23661e+00 .17187e+00 .13608e+00 .18519e+00
.92596e-01
.72519e-15 .19952e+00 .11831e+00 .68043e-01
j= 7 .20412e+00 .20279e+00 .22503e+00 .68043e-01
.87450e-01
.13779e+00 .72520e-15 .61729e-01 .12346e+00
j= 8 .23365e+00 .20413e+00 .20279e+00 .11831e+00
.68046e-01
.87444e-01 .92593e-01 .72519e-15 .61729e-01
j= 9 .28676e+00 .23366e+00 .20412e+00 .19952e+00
.11831e+00
.68043e-01 .18519e+00 .92593e-01 .72519e-15
j= 10 .15677e-02 .61764e-01 .12346e+00 .13609e+00
.14102e+00
.17489e+00 .20413e+00 .20279e+00 .22503e+00
j= 11 .92628e-01 .31353e-02 .61764e-01 .17189e+00
.13612e+00
.14102e+00 .23366e+00 .20414e+00 .20280e+00
j= 12 .18519e+00 .92628e-01 .15677e-02 .23662e+00
.17189e+00
.13609e+00 .28676e+00 .23366e+00 .20413e+00
j= 13 .13609e+00 .14102e+00 .17489e+00 .15677e-02
.61764e-01
.12346e+00 .68052e-01 .87456e-01 .13780e+00
j= 14 .17189e+00 .13612e+00 .14102e+00 .92628e-01
.31353e-02

.61764e-01 .11833e+00 .68082e-01 .87462e-01
j= 15 .23662e+00 .17189e+00 .13609e+00 .18519e+00
.92628e-01
.15677e-02 .19952e+00 .11832e+00 .68052e-01
j= 16 .20413e+00 .20280e+00 .22503e+00 .68052e-01
.87462e-01
.13780e+00 .78384e-03 .61737e-01 .12346e+00
j= 17 .23366e+00 .20414e+00 .20279e+00 .11832e+00
.68082e-01
.87456e-01 .92601e-01 .15677e-02 .61737e-01
j= 18 .28676e+00 .23366e+00 .20413e+00 .19952e+00
.11833e+00
.68052e-01 .18519e+00 .92601e-01 .78384e-03
j= 19 .17010e+00 .17135e+00 .19881e+00 .30619e+00
.30033e+00
.31201e+00 .37423e+00 .36667e+00 .37393e+00
j= 20 .20222e+00 .17010e+00 .17135e+00 .33119e+00
.30619e+00
.30033e+00 .39753e+00 .37423e+00 .36667e+00
j= 21 .26054e+00 .20222e+00 .17010e+00 .37374e+00
.33119e+00
.30619e+00 .43566e+00 .39753e+00 .37423e+00
j= 22 .30619e+00 .30033e+00 .31201e+00 .44227e+00
.43352e+00
.43755e+00 .51031e+00 .50068e+00 .50227e+00
j= 23 .33119e+00 .30619e+00 .30033e+00 .46438e+00
.44227e+00
.43352e+00 .53154e+00 .51031e+00 .50068e+00
j= 24 .37374e+00 .33119e+00 .30619e+00 .49928e+00
.46438e+00
.44227e+00 .56400e+00 .53154e+00 .51031e+00
j= 25 .37423e+00 .36667e+00 .37393e+00 .51031e+00
.50068e+00
.50227e+00 .57835e+00 .56804e+00 .56772e+00
j= 26 .39753e+00 .37423e+00 .36667e+00 .53154e+00
.51031e+00
.50068e+00 .59891e+00 .57835e+00 .56804e+00
j= 27 .43566e+00 .39753e+00 .37423e+00 .56400e+00
.53154e+00
.51031e+00 .62945e+00 .59891e+00 .57835e+00
j= 28 .17011e+00 .17137e+00 .19881e+00 .30619e+00
.30033e+00
.31202e+00 .37423e+00 .36667e+00 .37393e+00
j= 29 .20223e+00 .17013e+00 .17137e+00 .33120e+00
.30620e+00
.30033e+00 .39754e+00 .37423e+00 .36667e+00
j= 30 .26054e+00 .20223e+00 .17011e+00 .37374e+00
.33120e+00
.30619e+00 .43566e+00 .39753e+00 .37423e+00
j= 31 .30619e+00 .30033e+00 .31202e+00 .44227e+00
.43352e+00
.43756e+00 .51031e+00 .50068e+00 .50227e+00
j= 32 .33120e+00 .30620e+00 .30033e+00 .46439e+00
.44228e+00
.43352e+00 .53155e+00 .51031e+00 .50068e+00
j= 33 .37374e+00 .33120e+00 .30619e+00 .49928e+00
.46439e+00
.44227e+00 .56400e+00 .53154e+00 .51031e+00
j= 34 .37423e+00 .36667e+00 .37393e+00 .51031e+00

```
.50068e+00
           .50227e+00  .57835e+00  .56804e+00  .56772e+00
 j=    35   .39753e+00   .37423e+00  .36667e+00   .53154e+00
.51031e+00
           .50068e+00  .59891e+00  .57835e+00  .56804e+00
 j=    36   .43566e+00   .39754e+00  .37423e+00   .56400e+00
.53155e+00
           .51031e+00  .62945e+00  .59891e+00  .57835e+00


 nu=  1      edel sas       1    0

 j=     1  .10000e+01 0.          0.          0.          0.
          0.          0.          0.          0.
 j=     2  0.          .10000e+01 0.          0.          0.
          0.          0.          0.          0.
 j=     3  0.          0.          .10000e+01 0.          0.
          0.          0.          0.          0.
 j=     4  0.          0.          0.          .10000e+01 0.
          0.          0.          0.          0.
 j=      5    0.            0.             0.             0.
.10000e+01
          0.          0.          0.          0.
 j=     6  0.          0.          0.          0.          0.
           .10000e+01 0.          0.          0.
 j=     7  0.          0.          0.          0.          0.
          0.          .10000e+01 0.          0.
 j=     8  0.          0.          0.          0.          0.
          0.          0.          .10000e+01 0.
 j=     9  0.          0.          0.          0.          0.
          0.          0.          0.          .10000e+01
 j=    10  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    11  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    12  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    13  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    14  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    15  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    16  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    17  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    18  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    19  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    20  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    21  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    22  0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    23  0.          0.          0.          0.          0.
          0.          0.          0.          0.
```

```
j=   24  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   25  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   26  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   27  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   28  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   29  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   30  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   31  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   32  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   33  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   34  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   35  0.           0.           0.           0.           0.
         0.           0.           0.           0.
j=   36  0.           0.           0.           0.           0.
         0.           0.           0.           0.


the contents of checkpoint  9


nc,ndph,nphi,hmch,elam=
       9      108        9  .20000e+00  .30000e+04


nu=  1     f    sas      1    0

j=     1   .14254e-03   .10409e-02  .57796e-02   .92695e-04
.47213e-03
         .78186e-03  .29998e-04  .11405e-03  .10191e-03
j=     2   .62416e-04   .31736e-03  .61455e-03   .47307e-04
.20149e-03
         .26297e-03  .17587e-04  .63867e-04  .60820e-04
j=     3   .32646e-04   .13541e-03  .17736e-03   .26960e-04
.10133e-03
         .10973e-03  .10896e-04  .37223e-04  .34013e-04
j=     4   .19153e-04   .69710e-04  .73617e-04   .16664e-04
.57140e-04
         .54343e-04  .71067e-05  .22922e-04  .19709e-04
j=     5   .12177e-04   .40463e-04  .37270e-04   .10958e-04
.35040e-04
         .30309e-04  .48459e-05  .14870e-04  .12063e-04
j=     6   .82148e-05   .25527e-04  .21393e-04   .75648e-05
.22902e-04
         .18435e-04  .34315e-05  .10093e-04  .77828e-05
j=     7   .58005e-05   .17122e-04  .13389e-04   .54294e-05
.15733e-04
```

```
             .11973e-04  .25087e-05  .71193e-05  .52579e-05
 j=      8   .42464e-05   .12035e-04  .89268e-05   .40226e-05
.11247e-04
             .81842e-05  .18844e-05  .51877e-05  .36941e-05
 j=      9   .32013e-05   .87786e-05  .62455e-05   .30600e-05
.83061e-05
             .58274e-05  .14486e-05  .38859e-05  .26828e-05
 j=     10   .24728e-05   .65984e-05  .45387e-05   .23801e-05
.63015e-05
             .42893e-05  .11361e-05  .29801e-05  .20039e-05
 j=     11   .19495e-05   .50841e-05  .34011e-05   .18868e-05
.48902e-05
             .32451e-05  .90645e-06  .23322e-05  .15330e-05
 j=     12   .15641e-05   .39998e-05  .26139e-05   .15204e-05
.38689e-05
             .25124e-05  .73426e-06  .18575e-05  .11972e-05
 j=     13   .12738e-05   .32031e-05  .20520e-05   .12427e-05
.31122e-05
             .19838e-05  .60273e-06  .15023e-05  .95178e-06
 j=     14   .10512e-05   .26047e-05  .16403e-05   .10285e-05
.25400e-05
             .15930e-05  .50061e-06  .12314e-05  .76852e-06
 j=     15   .87756e-06   .21465e-05  .13317e-05   .86070e-06
.20995e-05
             .12982e-05  .42019e-06  .10215e-05  .62908e-06
 j=     16   .74014e-06   .17897e-05  .10959e-05   .72742e-06
.17549e-05
             .10716e-05  .35601e-06  .85647e-06  .52120e-06
 j=     17   .62998e-06   .15079e-05  .91264e-06   .62023e-06
.14816e-05
             .89465e-06  .30420e-06  .72494e-06  .43649e-06
 j=     18   .54064e-06   .12822e-05  .76806e-06   .53307e-06
.12621e-05
             .75453e-06  .26193e-06  .61888e-06  .36908e-06
 j=     19   .75240e-04   .32832e-03  .37136e-03   .29841e-04
.85849e-04
             .55623e-04  .96438e-05  .25015e-04  .14856e-04
 j=     20   .41145e-04   .16183e-03  .17849e-03   .20888e-04
.62039e-04
             .44326e-04  .73371e-05  .19848e-04  .12785e-04
 j=     21   .24417e-04   .87615e-04  .87133e-04   .14651e-04
.43476e-04
             .32234e-04  .55077e-05  .15142e-04  .10208e-04
 j=     22   .15483e-04   .51565e-04  .46693e-04   .10432e-04
.30461e-04
             .22623e-04  .41366e-05  .11374e-04  .78107e-05
 j=     23   .10357e-04   .32481e-04  .27248e-04   .75784e-05
.21646e-04
             .15836e-04  .31323e-05  .85379e-05  .58721e-05
 j=     24   .72351e-05   .21611e-04  .17047e-04   .56226e-05
.15688e-04
             .11231e-04  .24003e-05  .64577e-05  .44060e-05
 j=     25   .52374e-05   .15030e-04  .11279e-04   .42574e-05
.11612e-04
             .81214e-05  .18642e-05  .49415e-05  .33288e-05
 j=     26   .39050e-05   .10841e-04  .78095e-05   .32852e-05
.87736e-05
             .59974e-05  .14677e-05  .38319e-05  .25437e-05
 j=     27   .29850e-05   .80584e-05  .56118e-05   .25792e-05
```

.67565e-05
.45212e-05 .11710e-05 .30124e-05 .19695e-05
j= 28 .23305e-05 .61440e-05 .41587e-05 .20566e-05
.52946e-05
.34747e-05 .94598e-06 .23999e-05 .15460e-05
j= 29 .18529e-05 .47864e-05 .31625e-05 .16631e-05
.42150e-05
.27178e-05 .77318e-06 .19362e-05 .12299e-05
j= 30 .14967e-05 .37984e-05 .24582e-05 .13620e-05
.34034e-05
.21600e-05 .63880e-06 .15805e-05 .99088e-06
j= 31 .12257e-05 .30630e-05 .19470e-05 .11281e-05
.27835e-05
.17415e-05 .53303e-06 .13043e-05 .80785e-06
j= 32 .10161e-05 .25048e-05 .15674e-05 .94408e-06
.23028e-05
.14223e-05 .44883e-06 .10872e-05 .66589e-06
j= 33 .85145e-06 .20738e-05 .12799e-05 .79743e-06
.19250e-05
.11753e-05 .38111e-06 .91459e-06 .55445e-06
j= 34 .72042e-06 .17358e-05 .10583e-05 .67927e-06
.16244e-05
.98137e-06 .32611e-06 .77590e-06 .46596e-06
j= 35 .61486e-06 .14672e-05 .88479e-06 .58309e-06
.13824e-05
.82729e-06 .28102e-06 .66337e-06 .39495e-06
j= 36 .52889e-06 .12511e-05 .74709e-06 .50406e-06
.11857e-05
.70343e-06 .24374e-06 .57121e-06 .33739e-06
j= 37 .54911e-04 .26036e-03 .32102e-03 .89725e-04
.69654e-03
.49189e-02 .39122e-04 .25874e-03 .92583e-03
j= 38 .28453e-04 .11897e-03 .14286e-03 .38509e-04
.20046e-03
.41605e-03 .17753e-04 .86590e-04 .15007e-03
j= 39 .16273e-04 .60894e-04 .64535e-04 .19947e-04
.83675e-04
.11246e-03 .94544e-05 .38408e-04 .48074e-04
j= 40 .10061e-04 .34484e-04 .32624e-04 .11639e-04
.42628e-04
.45565e-04 .56042e-05 .20158e-04 .20817e-04
j= 41 .66128e-05 .21157e-04 .18288e-04 .73754e-05
.24601e-04
.22810e-04 .35858e-05 .11829e-04 .10760e-04
j= 42 .45617e-05 .13821e-04 .11131e-04 .49648e-05
.15466e-04
.13013e-04 .24293e-05 .75130e-05 .62480e-05
j= 43 .32717e-05 .94878e-05 .72262e-05 .35004e-05
.10350e-04
.81148e-05 .17204e-05 .50614e-05 .39382e-05
j= 44 .24225e-05 .67780e-05 .49360e-05 .25598e-05
.72638e-05
.53974e-05 .12622e-05 .35685e-05 .26378e-05
j= 45 .18419e-05 .50025e-05 .35120e-05 .19283e-05
.52925e-05
.37701e-05 .95303e-06 .26087e-05 .18513e-05
j= 46 .14321e-05 .37932e-05 .25834e-05 .14885e-05
.39747e-05
.27366e-05 .73704e-06 .19640e-05 .13485e-05

j= 47 .11348e-05 .29424e-05 .19535e-05 .11730e-05
.30606e-05
.20489e-05 .58163e-06 .15152e-05 .10122e-05
j= 48 .91417e-06 .23271e-05 .15118e-05 .94070e-06
.24067e-05
.15737e-05 .46698e-06 .11932e-05 .77891e-06
j= 49 .74702e-06 .18714e-05 .11932e-05 .76592e-06
.19266e-05
.12348e-05 .38056e-06 .95627e-06 .61209e-06
j= 50 .61814e-06 .15270e-05 .95792e-06 .63189e-06
.15661e-05
.98662e-06 .31420e-06 .77810e-06 .48966e-06
j= 51 .51720e-06 .12618e-05 .78042e-06 .52740e-06
.12903e-05
.80075e-06 .26241e-06 .64155e-06 .39779e-06
j= 52 .43705e-06 .10546e-05 .64406e-06 .44474e-06
.10756e-05
.65879e-06 .22140e-06 .53515e-06 .32753e-06
j= 53 .37260e-06 .89020e-06 .53763e-06 .37849e-06
.90606e-06
.54851e-06 .18850e-06 .45102e-06 .27288e-06
j= 54 .32020e-06 .75822e-06 .45335e-06 .32477e-06
.77034e-06
.46153e-06 .16181e-06 .38364e-06 .22973e-06
j= 55 .17225e-04 .48228e-04 .30386e-04 .75364e-05
.18112e-04
.10159e-04 .26327e-05 .60714e-05 .33118e-05
j= 56 .12261e-04 .35727e-04 .24826e-04 .61407e-05
.15389e-04
.91923e-05 .22358e-05 .53520e-05 .30706e-05
j= 57 .86877e-05 .25480e-04 .18517e-04 .48979e-05
.12580e-04
.78527e-05 .18573e-05 .45594e-05 .27189e-05
j= 58 .62225e-05 .18047e-04 .13238e-04 .38698e-05
.10051e-04
.64416e-05 .15231e-05 .37949e-05 .23238e-05
j= 59 .45353e-05 .12905e-04 .93736e-05 .30536e-05
.79463e-05
.51563e-05 .12417e-05 .31153e-05 .19382e-05
j= 60 .33711e-05 .93860e-05 .66924e-05 .24188e-05
.62692e-05
.40792e-05 .10116e-05 .25408e-05 .15929e-05
j= 61 .25551e-05 .69612e-05 .48574e-05 .19293e-05
.49630e-05
.32180e-05 .82624e-06 .20696e-05 .12997e-05
j= 62 .19728e-05 .52651e-05 .35946e-05 .15520e-05
.39552e-05
.25461e-05 .67808e-06 .16897e-05 .10586e-05
j= 63 .15492e-05 .40570e-05 .27130e-05 .12601e-05
.31786e-05
.20273e-05 .55985e-06 .13859e-05 .86394e-06
j= 64 .12355e-05 .31802e-05 .20863e-05 .10326e-05
.25779e-05
.16276e-05 .46534e-06 .11434e-05 .70818e-06
j= 65 .99911e-06 .25320e-05 .16324e-05 .85402e-06
.21105e-05
.13187e-05 .38950e-06 .94968e-06 .58387e-06
j= 66 .81819e-06 .20446e-05 .12975e-05 .71255e-06
.17437e-05

```
             .10785e-05  .32830e-06  .79427e-06  .48457e-06
 j=    67    .67768e-06  .16721e-05  .10462e-05  .59949e-06
.14535e-05
             .89014e-06  .27861e-06  .66896e-06  .40496e-06
 j=    68    .56708e-06  .13833e-05  .85446e-06  .50834e-06
.12217e-05
             .74127e-06  .23801e-06  .56729e-06  .34080e-06
 j=    69    .47897e-06  .11563e-05  .70600e-06  .43421e-06
.10351e-05
             .62252e-06  .20461e-06  .48428e-06  .28879e-06
 j=    70    .40797e-06  .97566e-06  .58949e-06  .37344e-06
.88345e-06
             .52697e-06  .17696e-06  .41604e-06  .24635e-06
 j=    71    .35018e-06  .83029e-06  .49691e-06  .32322e-06
.75924e-06
             .44941e-06  .15391e-06  .35957e-06  .21149e-06
 j=    72    .30270e-06  .71210e-06  .42249e-06  .28142e-06
.65670e-06
             .38594e-06  .13457e-06  .31254e-06  .18267e-06
 j=    73    .11377e-04  .39620e-04  .30503e-04  .26408e-04
.17216e-03
             .43035e-03  .15347e-04  .12404e-03  .12202e-02
 j=    74    .69013e-05  .24080e-04  .20861e-04  .11954e-04
.58450e-04
             .99253e-04  .65126e-05  .34360e-04  .74730e-04
 j=    75    .43375e-05  .14569e-04  .12743e-04  .63497e-05
.25870e-04
             .32450e-04  .33557e-05  .14163e-04  .19320e-04
 j=    76    .28457e-05  .91151e-05  .76932e-05  .37569e-05
.13542e-04
             .14026e-04  .19526e-05  .71747e-05  .77195e-05
 j=    77    .19449e-05  .59517e-05  .47915e-05  .24008e-05
.79311e-05
             .72302e-05  .12352e-05  .41281e-05  .38409e-05
 j=    78    .13782e-05  .40501e-05  .31137e-05  .16250e-05
.50307e-05
             .41900e-05  .83054e-06  .25906e-05  .21842e-05
 j=    79    .10077e-05  .28593e-05  .21096e-05  .11501e-05
.33859e-05
             .26373e-05  .58511e-06  .17316e-05  .13594e-05
 j=    80    .75678e-06  .20838e-05  .14836e-05  .84333e-06
.23857e-05
             .17648e-05  .42766e-06  .12143e-05  .90309e-06
 j=    81    .58160e-06  .15606e-05  .10776e-05  .63655e-06
.17431e-05
             .12378e-05  .32201e-06  .88423e-06  .63028e-06
 j=    82    .45596e-06  .11965e-05  .80480e-06  .49215e-06
.13119e-05
             .90108e-06  .24850e-06  .66379e-06  .45723e-06
 j=    83    .36369e-06  .93607e-06  .61553e-06  .38828e-06
.10118e-05
             .67610e-06  .19578e-06  .51097e-06  .34219e-06
 j=    84    .29452e-06  .74530e-06  .48054e-06  .31169e-06
.79657e-06
             .52013e-06  .15698e-06  .40170e-06  .26273e-06
 j=    85    .24170e-06  .60259e-06  .38191e-06  .25397e-06
.63829e-06
             .40864e-06  .12779e-06  .32150e-06  .20610e-06
 j=    86    .20070e-06  .49382e-06  .30828e-06  .20966e-06
```

.51928e-06
.32684e-06 .10542e-06 .26131e-06 .16464e-06
j= 87 .16842e-06 .40956e-06 .25228e-06 .17508e-06
.42810e-06
.26548e-06 .87974e-07 .21526e-06 .13361e-06
j= 88 .14267e-06 .34331e-06 .20897e-06 .14771e-06
.35706e-06
.21856e-06 .74179e-07 .17942e-06 .10991e-06
j= 89 .12189e-06 .29053e-06 .17497e-06 .12575e-06
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j= 104 .21207e-06 .48195e-06 .27588e-06 .19515e-06
.43871e-06
.24790e-06 .93008e-07 .20788e-06 .11667e-06
j= 105 .19016e-06 .42946e-06 .24417e-06 .17644e-06
.39479e-06
.22200e-06 .84469e-07 .18806e-06 .10513e-06
j= 106 .17138e-06 .38485e-06 .21744e-06 .16016e-06
.35678e-06
.19968e-06 .76976e-07 .17073e-06 .95064e-07
j= 107 .15518e-06 .34665e-06 .19473e-06 .14592e-06
.32371e-06
.18037e-06 .70378e-07 .15552e-06 .86270e-07
j= 108 .14113e-06 .31374e-06 .17531e-06 .13343e-06
.29483e-06
.16358e-06 .64549e-07 .14214e-06 .78559e-07

nu= 12 thtb sas 1 0

j= 1 .55556e+00 .46297e+00 .37038e+00 .59484e+00
.51852e+00
.45807e+00 .63673e+00 .57097e+00 .52190e+00
j= 2 .97222e+00 .87964e+00 .78704e+00 .10030e+01
.92014e+00
.84488e+00 .10377e+01 .96296e+00 .89850e+00
j= 3 .13889e+01 .12963e+01 .12037e+01 .14141e+01
.13278e+01
.12455e+01 .14434e+01 .13632e+01 .12893e+01
j= 4 .18056e+01 .17130e+01 .16204e+01 .18268e+01
.17387e+01
.16527e+01 .18521e+01 .17685e+01 .16888e+01
j= 5 .22222e+01 .21296e+01 .20370e+01 .22406e+01

```
.21513e+01
          .20633e+01  .22627e+01  .21769e+01  .20937e+01
 j=    6   .26389e+01   .25463e+01  .24537e+01   .26551e+01
.25650e+01
          .24758e+01  .26747e+01  .25874e+01  .25018e+01
 j=    7   .30556e+01   .29630e+01  .28704e+01   .30700e+01
.29794e+01
          .28893e+01  .30877e+01  .29993e+01  .29121e+01
 j=    8   .34722e+01   .33796e+01  .32870e+01   .34853e+01
.33943e+01
          .33037e+01  .35013e+01  .34121e+01  .33238e+01
 j=    9   .38889e+01   .37963e+01  .37037e+01   .39008e+01
.38095e+01
          .37185e+01  .39154e+01  .38257e+01  .37366e+01
 j=   10   .43056e+01   .42130e+01  .41204e+01   .43165e+01
.42250e+01
          .41337e+01  .43300e+01  .42398e+01  .41501e+01
 j=   11   .47222e+01   .46296e+01  .45370e+01   .47323e+01
.46407e+01
          .45492e+01  .47448e+01  .46543e+01  .45641e+01
 j=   12   .51389e+01   .50463e+01  .49537e+01   .51483e+01
.50565e+01
          .49648e+01  .51599e+01  .50691e+01  .49786e+01
 j=   13   .55556e+01   .54630e+01  .53704e+01   .55643e+01
.54724e+01
          .53807e+01  .55752e+01  .54842e+01  .53934e+01
 j=   14   .59722e+01   .58796e+01  .57870e+01   .59805e+01
.58885e+01
          .57966e+01  .59907e+01  .58994e+01  .58084e+01
 j=   15   .63889e+01   .62963e+01  .62037e+01   .63967e+01
.63046e+01
          .62126e+01  .64063e+01  .63149e+01  .62237e+01
 j=   16   .68056e+01   .67130e+01  .66204e+01   .68129e+01
.67208e+01
          .66287e+01  .68220e+01  .67305e+01  .66391e+01
 j=   17   .72222e+01   .71296e+01  .70370e+01   .72292e+01
.71370e+01
          .70449e+01  .72378e+01  .71462e+01  .70547e+01
 j=   18   .76389e+01   .75463e+01  .74537e+01   .76455e+01
.75533e+01
          .74611e+01  .76537e+01  .75620e+01  .74704e+01
 j=   19   .61448e+00   .54368e+00  .48960e+00   .71424e+00
.66029e+00
          .62099e+00  .77162e+00  .72324e+00  .68793e+00
 j=   20   .10191e+01   .94026e+00  .87067e+00   .11054e+01
.10416e+01
          .98897e+00  .11574e+01  .10996e+01  .10524e+01
 j=   21   .14275e+01   .13442e+01  .12661e+01   .15027e+01
.14319e+01
          .13691e+01  .15497e+01  .14846e+01  .14277e+01
 j=   22   .18384e+01   .17524e+01  .16695e+01   .19045e+01
.18287e+01
          .17586e+01  .19470e+01  .18762e+01  .18118e+01
 j=   23   .22507e+01   .21630e+01  .20773e+01   .23094e+01
.22300e+01
          .21547e+01  .23480e+01  .22730e+01  .22028e+01
 j=   24   .26640e+01   .25752e+01  .24877e+01   .27167e+01
.26347e+01
          .25556e+01  .27519e+01  .26737e+01  .25991e+01
```

j= 25 .30780e+01 .29884e+01 .28997e+01 .31257e+01
.30418e+01
.29600e+01 .31579e+01 .30772e+01 .29994e+01
j= 26 .34925e+01 .34024e+01 .33128e+01 .35361e+01
.34506e+01
.33668e+01 .35657e+01 .34831e+01 .34027e+01
j= 27 .39074e+01 .38168e+01 .37267e+01 .39474e+01
.38608e+01
.37755e+01 .39749e+01 .38907e+01 .38083e+01
j= 28 .43226e+01 .42317e+01 .41411e+01 .43596e+01
.42720e+01
.41855e+01 .43851e+01 .42997e+01 .42157e+01
j= 29 .47380e+01 .46468e+01 .45559e+01 .47723e+01
.46841e+01
.45967e+01 .47961e+01 .47098e+01 .46246e+01
j= 30 .51535e+01 .50622e+01 .49710e+01 .51856e+01
.50968e+01
.50087e+01 .52079e+01 .51208e+01 .50346e+01
j= 31 .55693e+01 .54777e+01 .53864e+01 .55993e+01
.55100e+01
.54213e+01 .56203e+01 .55325e+01 .54455e+01
j= 32 .59851e+01 .58934e+01 .58019e+01 .60134e+01
.59237e+01
.58345e+01 .60331e+01 .59448e+01 .58571e+01
j= 33 .64010e+01 .63092e+01 .62176e+01 .64277e+01
.63377e+01
.62481e+01 .64464e+01 .63576e+01 .62693e+01
j= 34 .68170e+01 .67252e+01 .66334e+01 .68423e+01
.67520e+01
.66621e+01 .68600e+01 .67709e+01 .66821e+01
j= 35 .72331e+01 .71412e+01 .70493e+01 .72571e+01
.71666e+01
.70763e+01 .72740e+01 .71844e+01 .70953e+01
j= 36 .76492e+01 .75572e+01 .74653e+01 .76721e+01
.75814e+01
.74909e+01 .76882e+01 .75983e+01 .75088e+01
j= 37 .59484e+00 .51852e+00 .45807e+00 .55556e+00
.46297e+00
.37038e+00 .56602e+00 .47874e+00 .40051e+00
j= 38 .10030e+01 .92014e+00 .84488e+00 .97222e+00
.87964e+00
.78704e+00 .98022e+00 .89046e+00 .80364e+00
j= 39 .14141e+01 .13278e+01 .12455e+01 .13889e+01
.12963e+01
.12037e+01 .13954e+01 .13045e+01 .12149e+01
j= 40 .18268e+01 .17387e+01 .16527e+01 .18056e+01
.17130e+01
.16204e+01 .18110e+01 .17196e+01 .16288e+01
j= 41 .22406e+01 .21513e+01 .20633e+01 .22222e+01
.21296e+01
.20370e+01 .22269e+01 .21351e+01 .20438e+01
j= 42 .26551e+01 .25650e+01 .24758e+01 .26389e+01
.25463e+01
.24537e+01 .26430e+01 .25510e+01 .24593e+01
j= 43 .30700e+01 .29794e+01 .28893e+01 .30556e+01
.29630e+01
.28704e+01 .30592e+01 .29671e+01 .28752e+01
j= 44 .34853e+01 .33943e+01 .33037e+01 .34722e+01
.33796e+01

.32870e+01 .34755e+01 .33833e+01 .32912e+01
j= 45 .39008e+01 .38095e+01 .37185e+01 .38889e+01
.37963e+01
.37037e+01 .38919e+01 .37996e+01 .37074e+01
j= 46 .43165e+01 .42250e+01 .41337e+01 .43056e+01
.42130e+01
.41204e+01 .43083e+01 .42160e+01 .41237e+01
j= 47 .47323e+01 .46407e+01 .45492e+01 .47222e+01
.46296e+01
.45370e+01 .47248e+01 .46324e+01 .45401e+01
j= 48 .51483e+01 .50565e+01 .49648e+01 .51389e+01
.50463e+01
.49537e+01 .51412e+01 .50489e+01 .49565e+01
j= 49 .55643e+01 .54724e+01 .53807e+01 .55556e+01
.54630e+01
.53704e+01 .55578e+01 .54653e+01 .53730e+01
j= 50 .59805e+01 .58885e+01 .57966e+01 .59722e+01
.58796e+01
.57870e+01 .59743e+01 .58819e+01 .57894e+01
j= 51 .63967e+01 .63046e+01 .62126e+01 .63889e+01
.62963e+01
.62037e+01 .63908e+01 .62984e+01 .62059e+01
j= 52 .68129e+01 .67208e+01 .66287e+01 .68056e+01
.67130e+01
.66204e+01 .68074e+01 .67149e+01 .66225e+01
j= 53 .72292e+01 .71370e+01 .70449e+01 .72222e+01
.71296e+01
.70370e+01 .72240e+01 .71315e+01 .70390e+01
j= 54 .76455e+01 .75533e+01 .74611e+01 .76389e+01
.75463e+01
.74537e+01 .76405e+01 .75481e+01 .74556e+01
j= 55 .71424e+00 .66029e+00 .62099e+00 .83172e+00
.78764e+00
.75520e+00 .89367e+00 .85295e+00 .82267e+00
j= 56 .11054e+01 .10416e+01 .98897e+00 .12131e+01
.11602e+01
.11172e+01 .12715e+01 .12225e+01 .11828e+01
j= 57 .15027e+01 .14319e+01 .13691e+01 .16010e+01
.15408e+01
.14887e+01 .16556e+01 .15995e+01 .15514e+01
j= 58 .19045e+01 .18287e+01 .17586e+01 .19941e+01
.19280e+01
.18685e+01 .20449e+01 .19830e+01 .19277e+01
j= 59 .23094e+01 .22300e+01 .21547e+01 .23913e+01
.23206e+01
.22551e+01 .24385e+01 .23718e+01 .23105e+01
j= 60 .27167e+01 .26347e+01 .25556e+01 .27918e+01
.27174e+01
.26471e+01 .28357e+01 .27650e+01 .26987e+01
j= 61 .31257e+01 .30418e+01 .29600e+01 .31948e+01
.31175e+01
.30435e+01 .32357e+01 .31618e+01 .30915e+01
j= 62 .35361e+01 .34506e+01 .33668e+01 .35999e+01
.35203e+01
.34433e+01 .36381e+01 .35615e+01 .34879e+01
j= 63 .39474e+01 .38608e+01 .37755e+01 .40067e+01
.39252e+01
.38458e+01 .40424e+01 .39636e+01 .38873e+01
j= 64 .43596e+01 .42720e+01 .41855e+01 .44148e+01

.43318e+01
.42505e+01 .44483e+01 .43677e+01 .42892e+01
j= 65 .47723e+01 .46841e+01 .45967e+01 .48240e+01
.47397e+01
.46569e+01 .48555e+01 .47735e+01 .46931e+01
j= 66 .51856e+01 .50968e+01 .50087e+01 .52341e+01
.51488e+01
.50647e+01 .52638e+01 .51805e+01 .50987e+01
j= 67 .55993e+01 .55100e+01 .54213e+01 .56449e+01
.55588e+01
.54737e+01 .56731e+01 .55888e+01 .55056e+01
j= 68 .60134e+01 .59237e+01 .58345e+01 .60565e+01
.59696e+01
.58836e+01 .60831e+01 .59979e+01 .59137e+01
j= 69 .64277e+01 .63377e+01 .62481e+01 .64685e+01
.63811e+01
.62943e+01 .64938e+01 .64079e+01 .63228e+01
j= 70 .68423e+01 .67520e+01 .66621e+01 .68811e+01
.67931e+01
.67057e+01 .69051e+01 .68185e+01 .67327e+01
j= 71 .72571e+01 .71666e+01 .70763e+01 .72940e+01
.72056e+01
.71177e+01 .73170e+01 .72298e+01 .71432e+01
j= 72 .76721e+01 .75814e+01 .74909e+01 .77072e+01
.76184e+01
.75301e+01 .77292e+01 .76415e+01 .75544e+01
j= 73 .63673e+00 .57097e+00 .52190e+00 .56602e+00
.47874e+00
.40052e+00 .55556e+00 .46297e+00 .37037e+00
j= 74 .10377e+01 .96297e+00 .89850e+00 .98022e+00
.89047e+00
.80364e+00 .97222e+00 .87963e+00 .78704e+00
j= 75 .14434e+01 .13632e+01 .12893e+01 .13954e+01
.13045e+01
.12149e+01 .13889e+01 .12963e+01 .12037e+01
j= 76 .18521e+01 .17685e+01 .16888e+01 .18110e+01
.17196e+01
.16288e+01 .18056e+01 .17130e+01 .16204e+01
j= 77 .22627e+01 .21769e+01 .20937e+01 .22269e+01
.21352e+01
.20438e+01 .22222e+01 .21296e+01 .20370e+01
j= 78 .26747e+01 .25874e+01 .25018e+01 .26430e+01
.25510e+01
.24593e+01 .26389e+01 .25463e+01 .24537e+01
j= 79 .30877e+01 .29993e+01 .29121e+01 .30592e+01
.29671e+01
.28752e+01 .30556e+01 .29630e+01 .28704e+01
j= 80 .35013e+01 .34121e+01 .33238e+01 .34755e+01
.33833e+01
.32912e+01 .34722e+01 .33796e+01 .32870e+01
j= 81 .39154e+01 .38257e+01 .37366e+01 .38919e+01
.37996e+01
.37074e+01 .38889e+01 .37963e+01 .37037e+01
j= 82 .43300e+01 .42398e+01 .41501e+01 .43083e+01
.42160e+01
.41237e+01 .43056e+01 .42130e+01 .41204e+01
j= 83 .47448e+01 .46543e+01 .45641e+01 .47248e+01
.46324e+01
.45401e+01 .47222e+01 .46296e+01 .45370e+01

j= 84 .51599e+01 .50691e+01 .49786e+01 .51412e+01
.50489e+01
.49565e+01 .51389e+01 .50463e+01 .49537e+01
j= 85 .55752e+01 .54842e+01 .53934e+01 .55578e+01
.54653e+01
.53730e+01 .55556e+01 .54630e+01 .53704e+01
j= 86 .59907e+01 .58994e+01 .58084e+01 .59743e+01
.58819e+01
.57894e+01 .59722e+01 .58796e+01 .57870e+01
j= 87 .64063e+01 .63149e+01 .62237e+01 .63908e+01
.62984e+01
.62059e+01 .63889e+01 .62963e+01 .62037e+01
j= 88 .68220e+01 .67305e+01 .66391e+01 .68074e+01
.67149e+01
.66225e+01 .68056e+01 .67130e+01 .66204e+01
j= 89 .72378e+01 .71462e+01 .70547e+01 .72240e+01
.71315e+01
.70390e+01 .72222e+01 .71296e+01 .70370e+01
j= 90 .76537e+01 .75620e+01 .74704e+01 .76405e+01
.75481e+01
.74556e+01 .76389e+01 .75463e+01 .74537e+01
j= 91 .77162e+00 .72325e+00 .68793e+00 .89367e+00
.85295e+00
.82267e+00 .95689e+00 .91887e+00 .89028e+00
j= 92 .11574e+01 .10996e+01 .10524e+01 .12715e+01
.12225e+01
.11828e+01 .13317e+01 .12860e+01 .12489e+01
j= 93 .15497e+01 .14846e+01 .14277e+01 .16556e+01
.15995e+01
.15514e+01 .17125e+01 .16601e+01 .16152e+01
j= 94 .19470e+01 .18762e+01 .18118e+01 .20449e+01
.19830e+01
.19277e+01 .20985e+01 .20403e+01 .19886e+01
j= 95 .23480e+01 .22730e+01 .22028e+01 .24385e+01
.23718e+01
.23105e+01 .24889e+01 .24258e+01 .23682e+01
j= 96 .27519e+01 .26737e+01 .25991e+01 .28357e+01
.27650e+01
.26987e+01 .28829e+01 .28157e+01 .27531e+01
j= 97 .31579e+01 .30773e+01 .29994e+01 .32357e+01
.31618e+01
.30915e+01 .32801e+01 .32094e+01 .31425e+01
j= 98 .35657e+01 .34831e+01 .34027e+01 .36381e+01
.35615e+01
.34879e+01 .36797e+01 .36062e+01 .35358e+01
j= 99 .39749e+01 .38907e+01 .38083e+01 .40424e+01
.39636e+01
.38873e+01 .40816e+01 .40056e+01 .39323e+01
j= 100 .43851e+01 .42997e+01 .42157e+01 .44483e+01
.43677e+01
.42892e+01 .44852e+01 .44072e+01 .43315e+01
j= 101 .47961e+01 .47098e+01 .46246e+01 .48555e+01
.47735e+01
.46931e+01 .48904e+01 .48107e+01 .47329e+01
j= 102 .52079e+01 .51208e+01 .50346e+01 .52638e+01
.51805e+01
.50987e+01 .52968e+01 .52157e+01 .51361e+01
j= 103 .56203e+01 .55325e+01 .54455e+01 .56731e+01
.55888e+01

```
            .55056e+01  .57044e+01  .56220e+01  .55410e+01
 j=   104    .60331e+01   .59448e+01  .58571e+01   .60831e+01
.59979e+01
            .59137e+01  .61129e+01  .60294e+01  .59471e+01
 j=   105    .64464e+01   .63576e+01  .62693e+01   .64938e+01
.64079e+01
            .63228e+01  .65222e+01  .64378e+01  .63545e+01
 j=   106    .68601e+01   .67709e+01  .66821e+01   .69051e+01
.68185e+01
            .67327e+01  .69322e+01  .68470e+01  .67628e+01
 j=   107    .72740e+01   .71844e+01  .70953e+01   .73170e+01
.72298e+01
            .71432e+01  .73428e+01  .72569e+01  .71719e+01
 j=   108    .76882e+01   .75983e+01  .75088e+01   .77292e+01
.76415e+01
            .75544e+01  .77539e+01  .76675e+01  .75817e+01


 the contents of checkpoint 10


 ncp,nphi,nq,ne=        9        9        4       36


 nu=  1      tec  sas      1    0

 j=    1     10000e+01 0.          0.          0.          0.
           0.          0.          0.          0.
 j=    2   0.           .10000e+01  .25459e+00 0.          0.
           0.          0.          0.          0.
 j=    3   0.          0.           .50000e+00 0.          0.
           0.          0.          0.          0.
 j=    4   0.          0.          0.           .10000e+01 0.
           0.          0.          0.          0.
 j=      5     0.          0.           0.             0.
.10000e+01
            .25459e+00 0.          0.          0.
 j=    6   0.          0.          0.          0.          0.
            .50000e+00 0.          0.          0.
 j=    7   0.          0.          0.          0.          0.
           0.           .10000e+01 0.          0.
 j=    8   0.          0.          0.          0.          0.
           0.          0.           .10000e+01  .25459e+00
 j=    9   0.          0.          0.          0.          0.
           0.          0.          0.           .50000e+00
 j=   10   0.          0.          0.          0.          0.
           0.          0.          0.          0.
 j=   11   0.          0.          -.25459e+00 0.          0.
           0.          0.          0.          0.
 j=   12   0.          0.           .50000e+00 0.          0.
           0.          0.          0.          0.
 j=   13   0.          0.          0.          0.          0.
           0.          0.          0.          0.
 j=   14   0.          0.          0.          0.          0.
           -.25459e+00 0.          0.          0.
 j=   15   0.          0.          0.          0.          0.
            .50000e+00 0.          0.          0.
```

```
j=   16  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   17  0.          0.          0.          0.          0.
         0.          0.          0.          -.25459e+00
j=   18  0.          0.          0.          0.          0.
         0.          0.          0.           .50000e+00
j=   19  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   20  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   21  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   22  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   23  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   24  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   25  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   26  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   27  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   28  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   29  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   30  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   31  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   32  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   33  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   34  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   35  0.          0.          0.          0.          0.
         0.          0.          0.          0.
j=   36  0.          0.          0.          0.          0.
         0.          0.          0.          0.


nu=  1      e30u sas       1    0

j=      1  -.27686e+00   .11217e+01 0.           -.12904e+00
.52283e+00
         0.          0.          0.          0.
j=      2  -.15276e+01   .17764e-14  .15276e+01  -.71202e+00
.17764e-14
           .71202e+00 0.          0.          0.
j=       3    0.           -.11217e+01     .27686e+00    0.
-.52283e+00
           .12904e+00 0.          0.          0.
j=      4  -.16659e+00   .67497e+00 0.           -.27492e+00
.11134e+01
         0.          -.10760e+00  .43848e+00 0.
j=      5  -.91922e+00   .17764e-14  .91922e+00  -.15164e+01
```

```
.35527e-14
          .15164e+01 -.59723e+00 0.          .59723e+00
 j=     6    0.          -.67497e+00     .16659e+00   0.
-.11134e+01
          .27492e+00 0.          -.43848e+00 .10760e+00
 j=     7 0.          0.          0.          -.18764e+00
.75949e+00
          0.          .62791e+00 .13585e+01 0.
 j=     8 0.          0.          0.          -.10337e+01 0.
          .10337e+01 -.18502e+01  .35527e-14  .18502e+01
 j=     9    0.          0.          0.          0.
-.75949e+00
          .18764e+00 0.          -.13585e+01 -.62791e+00
 j=    10 .18045e+01 0.          0.          .84107e+00 0.
          0.          0.          0.          0.
 j=    11 0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    12 0.          0.          -.18045e+01 0.          0.
          -.84107e+00 0.          0.          0.
 j=    13 .10858e+01 0.          0.          .17911e+01 0.
          0.          .70611e+00 0.          0.
 j=    14 0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    15 0.          0.          -.10858e+01 0.          0.
          -.17911e+01 0.          0.          -.70611e+00
 j=    16 0.          0.          0.          .12216e+01 0.
          0.          .20373e+01  .59904e+00 0.
 j=    17 0.          0.          0.          0.          0.
          0.          -.81632e+00 0.          .81632e+00
 j=    18 0.          0.          0.          0.          0.
          -.12216e+01 0.          -.59904e+00 -.20373e+01
 j=    19 -.14782e+00  .59890e+00 0.          0.          0.
          0.          0.          0.          0.
 j=    20 -.81562e+00 -.17764e-14  .81562e+00 0.          0.
          0.          0.          0.          0.
 j=    21 0.          -.59890e+00  .14782e+00 0.          0.
          0.          0.          0.          0.
 j=    22 0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    23 0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    24 0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    25 0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    26 0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    27 0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    28 .96344e+00 0.          0.          0.          0.
          0.          0.          0.          0.
 j=    29 0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    30 0.          0.          -.96344e+00 0.          0.
          0.          0.          0.          0.
 j=    31 0.          0.          0.          0.          0.
          0.          0.          0.          0.
 j=    32 0.          0.          0.          0.          0.
          0.          0.          0.          0.
```

```
j=    33  0.            0.            0.            0.            0.
          0.            0.            0.            0.
j=    34  0.            0.            0.            0.            0.
          0.            0.            0.            0.
j=    35  0.            0.            0.            0.            0.
          0.            0.            0.            0.
j=    36  0.            0.            0.            0.            0.
          0.            0.            0.            0.


nu=  1      e31u sas       1     0

j=     1  -.20000e+01 0.            0.            0.            0.
          0.            0.            0.            0.
j=     2  0.            -.20000e+01 0.            0.            0.
          0.            0.            0.            0.
j=     3  0.            0.            -.20000e+01 0.            0.
          0.            0.            0.            0.
j=     4  0.            0.            0.            -.20000e+01 0.
          0.            0.            0.            0.
j=        5     0.             0.              0.             0.
-.20000e+01
          0.            0.            0.            0.
j=     6  0.            0.            0.            0.            0.
          -.20000e+01 0.            0.            0.
j=     7  0.            0.            0.            0.            0.
          0.            -.20000e+01 0.            0.
j=     8  0.            0.            0.            0.            0.
          0.            0.            -.20000e+01 0.
j=     9  0.            0.            0.            0.            0.
          0.            0.            0.            -.20000e+01


the contents of checkpoint 11


ngfm,ncp=          2         9


nu=  1      e4t   sas       1     0

j=      1  -.21605e+00  -.40123e+00 -.21605e+00  -.12963e+00
-.24074e+00
          -.12963e+00 -.43211e-01 -.80248e-01 -.43211e-01
j=     2   .80018e-01 0.            -.80018e-01  .48011e-01 0.
          -.48011e-01  .16004e-01 0.            -.16004e-01


the contents of checkpoint 12


npsi,nbcm=         9         1


nu=  1      e10   sas       1     0
```

```
 j=     1   .99956e+00   .10000e+01  .99956e+00   .99956e+00
.10000e+01
           .99956e+00  .99963e+00  .99894e+00  .99963e+00


 nu= 11     ell  sas      1    0

 j=    1  -.37021e+00 0.           .37021e+00 -.37021e+00 0.
           .37021e+00 -.37023e+00 0.           .37023e+00


 the contents of checkpoint 13


 nc,nphi,nfrq,npsi,nq,hmch=
        9        9        2        9        4  .20000e+00


 nu=  1     freq sas      1    0

 j=    1  0.           .50000e+00 0.           .10000e+01


 nu=  1     y    sas      1    1

 j=     1   .10000e+01  0.           .36944e-02   .28436e-04
.16487e-02
           .25193e-04  0.           0.           .85932e-03
.64941e-05
           .84346e-03   .12713e-04   .97723e-04  -.34417e-07
.41314e-03
           .30102e-05  .48522e-03  .71529e-05
 j=     2       .61672e-02   -.47705e-04     .10000e+01    0.
.61672e-02
           .47470e-04   .93309e-03  -.73482e-05  -.11335e-14
.11869e-18
           .93309e-03   .70516e-05   .40231e-03  -.32773e-05
.35082e-03
          -.12356e-06  .40231e-03  .29314e-05
 j=     3   .13962e-02   .88094e-04  .21577e-02   .47126e-03
.99346e+00
           .13098e-02   .66248e-03   .80042e-04   .38525e-04
.32871e-03
          -.11905e-02   .37282e-03   .42044e-03   .30618e-04
.17709e-03
           .11725e-03 -.11723e-03  .99083e-04
 j=     4   .11335e-14  -.11869e-18  .39199e-03   .29624e-05
.47837e-03
           .72103e-05   .10000e+01  0.           .28445e-02
.21894e-04
           .10785e-02   .16480e-04   .39309e-02  -.51562e-07
.22731e-02
           .17437e-04  .92372e-03  .14072e-04
 j=     5   .40056e-03  -.31545e-05 -.11335e-14   .11869e-18
.40056e-03
           .30271e-05  .51866e-02 -.40120e-04  .10000e+01 0.
```

.51866e-02 .39922e-04 .30529e-02 -.23695e-04
.10086e-01
-.13232e-06 .30529e-02 .23418e-04
j= 6 .37025e-03 .48547e-04 -.76301e-04 .19432e-03
-.55235e-03
.19564e-03 .92131e-03 .52960e-04 .18386e-02
.29517e-03
.99459e+00 .10288e-02 .85293e-03 .18368e-04
.18758e-02
.11876e-03 .28045e-02 .25381e-03
j= 7 .14977e-03 -.52746e-07 .14068e-03 .10250e-05
.12375e-03
.18243e-05 .11397e-02 -.14950e-07 .56665e-03
.43467e-05
.23799e-03 .36256e-05 .10000e+01 0.
.58203e-03
.44799e-05 .18894e-03 .28871e-05
j= 8 .49455e-03 -.40287e-05 .54468e-03 -.19183e-06
.49456e-03
.36035e-05 .19625e-02 -.15232e-04 .36012e-02
-.47244e-07
.19625e-02 .15054e-04 .12689e-02 -.98153e-05
.10000e+01
0. .12689e-02 .97668e-05
j= 9 .98601e-04 .13244e-04 .53943e-04 .45492e-04
.78225e-04
.36338e-04 .19030e-03 .18307e-04 .30109e-03
.87002e-04
.57385e-03 .14059e-03 .16222e-03 .88186e-05
.40534e-03
.50162e-04 .99870e+00 .23520e-03
j= 10 .96130e+00 -.15432e-09 .11628e-01 .89505e-04
.22253e-02
.34004e-04 .22942e-02 -.24028e-06 .27081e-02
.20466e-04
.11385e-02 .17160e-04 .29315e-03 -.10325e-06
.70225e-03
.51167e-05 .56328e-03 .83037e-05
j= 11 .18441e-01 -.14265e-03 .95386e+00 -.12250e-08
.18441e-01
.14194e-03 .27972e-02 -.22029e-04 .74950e-02
-.78543e-06
.27973e-02 .21139e-04 .67044e-03 -.54615e-05
.10521e-02
-.37062e-06 .67045e-03 .48850e-05
j= 12 .24778e-02 -.14847e-03 .13165e-01 -.58978e-03
.96784e+00
-.13098e-02 .13195e-02 -.11135e-03 .35289e-02
-.35681e-03
.34847e-02 -.37306e-03 .62803e-03 -.47524e-04
.93829e-03
-.12633e-03 .50810e-03 -.99221e-04
j= 13 .71909e-03 -.75311e-07 .12357e-02 .93385e-05
.64573e-03
.97328e-05 .95827e+00 -.15383e-09 .89509e-02
.68895e-04
.14557e-02 .22243e-04 .11765e-01 -.15438e-06
.38613e-02
.29620e-04 .10723e-02 .16335e-04

```
j=    14   .12012e-02  -.94595e-05  .25026e-02  -.26226e-06
.12012e-02
           .90775e-05   .15503e-01  -.11992e-03   .94429e+00
-.12127e-08
           .15503e-01   .11932e-03   .50830e-02  -.39452e-04
.30018e-01
          -.39443e-06  .50830e-02  .38991e-04
j=    15   .75384e-03  -.66301e-04  .17040e-02  -.20714e-03
.12714e-02
          -.19572e-03   .16128e-02  -.92457e-04   .99568e-02
-.38641e-03
           .96368e+00  -.10288e-02   .11430e-02  -.49570e-04
.42586e-02
          -.16637e-03  .12891e-01 -.25402e-03
j=    16   .20422e-03  -.71925e-07  .23007e-03   .16763e-05
.15159e-03
           .22347e-05   .26574e-02  -.34871e-07   .14813e-02
.11363e-04
           .33780e-03   .51461e-05   .96538e+00  -.19372e-10
.18342e-02
           .14118e-04  .25505e-03  .38974e-05
j=    17   .57693e-03  -.46998e-05  .74260e-03  -.26159e-06
.57693e-03
           .42037e-05   .29419e-02  -.22834e-04   .83842e-02
-.11017e-06
           .29419e-02   .22567e-04   .38021e-02  -.29411e-04
.93834e+00
          -.15063e-09  .38021e-02  .29265e-04
j=    18   .17674e-03  -.17684e-04  .31681e-03  -.48512e-04
.27576e-03
          -.36462e-04   .38549e-03  -.27308e-04   .17468e-02
-.10290e-03
           .32233e-02  -.14064e-03   .28177e-03  -.15739e-04
.20109e-02
          -.68853e-04  .96668e+00 -.23520e-03
j=    19   0.           0.           .46134e-03   .34352e-05
.61650e-03
           .92058e-05  0.           0.            .78362e-04
.50337e-06
           .18089e-03   .24930e-05   .12332e-04  -.26378e-07
.65643e-04
           .35718e-06  .11778e-03  .14999e-05
j=    20   .46941e-03  -.37489e-05 -.11349e-14   .23175e-18
.46941e-03
           .34953e-05   .77839e-04  -.70123e-06  -.11440e-14
.13494e-17
           .77840e-04   .50002e-06   .63662e-04  -.63606e-06
.45469e-04
          -.97256e-07  .63664e-04  .34641e-06
j=    21   .46231e-03   .75217e-04 -.16089e-03   .28041e-03
-.67531e-03
           .26158e-03   .10597e-03   .52989e-04  -.14331e-03
.15376e-03
          -.15656e-03   .10665e-03   .91574e-04   .20690e-04
-.56917e-05
           .58866e-04 -.34078e-04  .38636e-04
j=    22  -.11440e-14   .13494e-17   .43010e-04   .27628e-06
.10226e-03
           .14094e-05  -.11582e-14   .40563e-17   .14808e-04
```

```
.60060e-07
            .40054e-04   .45204e-06   .27206e-05  -.14502e-07
.15026e-04
            .33154e-07  .29648e-04  .27794e-06
 j=     23   .42733e-04  -.38498e-06 -.11440e-14   .13494e-17
.42734e-04
            .27451e-06   .14751e-04  -.16781e-06  -.11582e-14
.40563e-17
            .14751e-04   .59828e-07   .14605e-04  -.19317e-06
.10070e-04
           -.53677e-07  .14606e-04  .32227e-07
 j=     24   .58388e-04   .31609e-04 -.84473e-04   .90719e-04
-.88130e-04
            .62172e-04   .18206e-04   .21528e-04  -.40843e-04
.55506e-04
           -.34010e-04   .34506e-04   .21756e-04   .86196e-05
-.42565e-05
            .22221e-04 -.86311e-05  .13467e-04
 j=     25   .46795e-04  -.10009e-06  .46717e-04   .25420e-06
.48581e-04
            .61868e-06   .25834e-04  -.13771e-06   .26013e-04
.57395e-07
            .27684e-04   .25953e-06   .20983e-04  -.16112e-06
.21742e-04
           -.35243e-08  .22479e-04  .15617e-06
 j=     26   .17039e-03  -.17024e-05  .17271e-03  -.36942e-06
.17039e-03
            .92717e-06   .95737e-04  -.12663e-05   .95627e-04
-.50974e-06
            .95745e-04   .21125e-06   .76881e-04  -.11990e-05
.77728e-04
           -.59687e-06  .76890e-04 -.12464e-07
 j=     27   .38457e-04   .81318e-05  .19630e-04   .22842e-04
.29489e-04
            .14887e-04   .22472e-04   .55532e-05   .13317e-04
.14526e-04
            .18380e-04   .87905e-05   .20566e-04   .20380e-05
.17234e-04
            .57463e-05  .18411e-04  .34083e-05
 j=     28   .80858e-03  -.16513e-06  .14544e-02   .10829e-04
.83219e-03
            .12427e-04   .94397e-04  -.11134e-06   .24712e-03
.15874e-05
            .24419e-03   .33655e-05   .36995e-04  -.79133e-07
.11159e-03
            .60719e-06  .13673e-03  .17413e-05
 j=     29   .14077e-02  -.11242e-04  .28286e-02  -.57788e-06
.14077e-02
            .10482e-04   .23350e-03  -.21035e-05   .34647e-03
-.40872e-06
            .23350e-03   .14999e-05   .10610e-03  -.10601e-05
.13640e-03
           -.29177e-06  .10610e-03  .57733e-06
 j=     30   .98636e-03  -.98300e-04  .20766e-02  -.29571e-03
.14839e-02
           -.26175e-03   .31908e-03  -.60250e-04   .46879e-03
-.15670e-03
            .25096e-03  -.10676e-03   .16291e-03  -.25304e-04
.18292e-03
```

```
          -.60637e-04  .83405e-04 -.38742e-04
 j=    31   .51066e-04  -.60234e-07  .13564e-03   .87127e-06
.13805e-03
           .19026e-05   .16693e-04  -.58465e-07   .46702e-04
.18941e-06
           .54072e-04   .61024e-06   .81618e-05  -.43507e-07
.25545e-04
           .56360e-07  .34419e-04  .32267e-06
 j=    32   .12819e-03  -.11548e-05  .18773e-03  -.22146e-06
.12819e-03
           .82345e-06   .44250e-04  -.50343e-06   .61707e-04
-.21613e-06
           .44252e-04   .17947e-06   .24341e-04  -.32195e-06
.30208e-04
          -.16103e-06  .24343e-04  .53709e-07
 j=    33   .18190e-03  -.35714e-04  .26312e-03  -.92328e-04
.13920e-03
          -.62232e-04   .75908e-04  -.23371e-04   .10235e-03
-.56205e-04
           .50704e-04  -.34565e-04   .42299e-04  -.99964e-05
.44824e-04
          -.22757e-04  .19513e-04 -.13525e-04
 j=    34   .55707e-04  -.11916e-06  .63478e-04   .34540e-06
.55648e-04
           .70867e-06   .29397e-04  -.15670e-06   .32907e-04
.72603e-07
           .30818e-04   .28891e-06   .22217e-04  -.17060e-06
.24148e-04
          -.39152e-08  .23596e-04  .16392e-06
 j=    35   .18587e-03  -.18571e-05  .20559e-03  -.43978e-06
.18588e-03
           .10114e-05   .10212e-03  -.13507e-05   .10881e-03
-.58005e-06
           .10213e-03   .22532e-06   .79109e-04  -.12337e-05
.82299e-04
          -.63198e-06  .79119e-04 -.12828e-07
 j=    36   .65762e-04  -.10021e-04  .90560e-04  -.23943e-04
.73013e-04
          -.15106e-04   .36018e-04  -.68103e-05   .45599e-04
-.15305e-04
           .36851e-04  -.90849e-05   .25496e-04  -.31399e-05
.28650e-04
          -.64619e-05  .24788e-04 -.37400e-05


 nu= 11      z    sas      1    1

 j=     1  -.23999e+00  0.          -.82086e-01   .25345e-02
-.44648e-01
           .27596e-02  -.60761e-01   .41407e-02  -.48605e-01
.34325e-02
          -.35027e-01   .30707e-02  -.37041e-01   .37937e-02
-.34034e-01
           .34627e-02 -.28294e-01  .31970e-02
 j=     2  -.16242e+00   .75253e-02 -.35168e+00   .99623e-18
-.16252e+00
           .50180e-02  -.90406e-01   .77882e-02  -.10948e+00
.74603e-02
          -.90515e-01   .63922e-02  -.62839e-01   .73749e-02
```

```
-.68120e-01
           .69768e-02 -.62945e-01  .64044e-02
 j=    3  -.44542e-01   .41361e-02 -.82037e-01   .38009e-02
-.23999e+00
          0.          -.34915e-01   .41501e-02  -.48546e-01
.41821e-02
          -.60761e-01   .41407e-02  -.28182e-01   .40686e-02
-.33976e-01
           .39875e-02 -.37041e-01  .37937e-02
 j=    4  -.32869e-01   .22399e-02 -.28021e-01   .19788e-02
-.20928e-01
           .18347e-02  -.19811e+00   .71834e-16  -.53966e-01
.16662e-02
          -.27588e-01   .17051e-02  -.75962e-01   .25853e-02
-.42661e-01
           .18664e-02 -.25400e-01  .17527e-02
 j=    5  -.51842e-01   .44661e-02 -.59878e-01   .40804e-02
-.51905e-01
           .36655e-02  -.10936e+00   .50668e-02  -.27812e+00
.10085e-15
          -.10942e+00   .33786e-02  -.81851e-01   .48477e-02
-.12722e+00
           .43301e-02 -.81916e-01  .35841e-02
 j=    6  -.20862e-01   .24797e-02 -.27987e-01   .24110e-02
-.32869e-01
           .22399e-02  -.27522e-01   .25556e-02  -.53934e-01
.24988e-02
          -.19811e+00   .71834e-16  -.25334e-01   .25357e-02
-.42627e-01
           .25245e-02 -.75962e-01  .25853e-02
 j=    7  -.69809e-02   .71497e-03 -.65346e-02   .66487e-03
-.55705e-02
           .62942e-03  -.20928e-01   .71226e-03  -.14053e-01
.61487e-03
          -.85263e-02   .58835e-03  -.11599e+00   .42056e-16
-.19197e-01
           .59271e-03 -.93468e-02  .57770e-03
 j=    8  -.12076e-01   .14173e-02 -.12882e-01   .13194e-02
-.12096e-01
           .12307e-02  -.26543e-01   .15720e-02  -.36793e-01
.12523e-02
          -.26565e-01   .11622e-02  -.40359e-01   .18698e-02
-.14779e+00
           .53587e-16 -.40383e-01  .12468e-02
 j=    9  -.55484e-02   .80102e-03 -.65236e-02   .76563e-03
-.69809e-02
           .71497e-03  -.85040e-02   .85119e-03  -.14042e-01
.83166e-02
          -.20928e-01   .71226e-03  -.93246e-02   .86586e-03
-.19186e-01
           .88888e-03 -.11599e+00  .42056e-16
 j=   10  -.23246e+00   .18221e-03 -.82047e-01   .25346e-02
-.44646e-01
           .27596e-02  -.60753e-01   .41404e-02  -.48596e-01
.34323e-02
          -.35025e-01   .30707e-02  -.37040e-01   .37936e-02
-.34033e-01
           .34627e-02 -.28294e-01  .31970e-02
 j=   11  -.16233e+00   .75235e-02 -.33667e+00   .52779e-03
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-.16243e+00
.50176e-02 -.90391e-01 .77877e-02 -.10942e+00
.74584e-02
-.90501e-01 .63919e-02 -.62837e-01 .73749e-02
-.68115e-01
.69767e-02 -.62943e-01 .64043e-02
j= 12 -.44539e-01 .41360e-02 -.81998e-01 .38004e-02
-.23246e+00
.18221e-03 -.34914e-01 .41501e-02 -.48538e-01
.41818e-02
-.60753e-01 .41404e-02 -.28182e-01 .40686e-02
-.33975e-01
.39874e-02 -.37040e-01 .37936e-02
j= 13 -.32866e-01 .22398e-02 -.28017e-01 .19788e-02
-.20927e-01
.18347e-02 -.19059e+00 .14939e-03 -.53935e-01
.16662e-02
-.27586e-01 .17051e-02 -.75932e-01 .25847e-02
-.42653e-01
.18663e-02 -.25399e-01 .17527e-02
j= 14 -.51836e-01 .44660e-02 -.59858e-01 .40802e-02
-.51899e-01
.36655e-02 -.10928e+00 .50648e-02 -.26319e+00
.41260e-03
-.10935e+00 .33779e-02 -.81835e-01 .48473e-02
-.12707e+00
.43272e-02 -.81900e-01 .35839e-02
j= 15 -.20861e-01 .24796e-02 -.27983e-01 .24109e-02
-.32866e-01
.22398e-02 -.27520e-01 .25556e-02 -.53903e-01
.24983e-02
-.19059e+00 .14939e-03 -.25333e-01 .25357e-02
-.42619e-01
.25243e-02 -.75932e-01 .25847e-02
j= 16 -.69807e-02 .71497e-03 -.65344e-02 .66487e-03
-.55704e-02
.62942e-03 -.20924e-01 .71223e-03 -.14051e-01
.61486e-03
-.85260e-02 .58835e-03 -.11221e+00 .43979e-04
-.19194e-01
.59268e-03 -.93467e-02 .57770e-03
j= 17 -.12076e-01 .14172e-02 -.12882e-01 .13194e-02
-.12096e-01
.12307e-02 -.26539e-01 .15719e-02 -.36771e-01
.12522e-02
-.26560e-01 .11622e-02 -.40349e-01 .18695e-02
-.14035e+00
.11001e-03 -.40373e-01 .12467e-02
j= 18 -.55483e-02 .80102e-03 -.65234e-02 .76562e-03
-.69807e-02
.71497e-03 -.85038e-02 .85118e-03 -.14040e-01
.83161e-03
-.20924e-01 .71223e-03 -.93244e-02 .86586e-03
-.19183e-01
.88881e-03 -.11221e+00 .43979e-04
j= 19 -.45812e-01 .39058e-02 -.40236e-01 .34558e-02
-.31511e-01
.31427e-02 -.23721e-01 .36602e-02 -.22928e-01
.34691e-02

-.20938e-01 .32932e-02 -.19132e-01 .36223e-02
-.18721e-01
.34711e-02 -.17591e-01 .33278e-02
j= 20 -.74390e-01 .75473e-02 -.83758e-01 .71410e-02
-.74498e-01
.63984e-02 -.42348e-01 .70774e-02 -.43878e-01
.67704e-02
-.42452e-01 .64231e-02 -.34583e-01 .69659e-02
-.35435e-01
.67088e-02 -.34686e-01 .64314e-02
j= 21 -.31400e-01 .41137e-02 -.40178e-01 .40763e-02
-.45812e-01
.39058e-02 -.20826e-01 .39377e-02 -.22872e-01
.38225e-02
-.23721e-01 .36602e-02 -.17480e-01 .38691e-02
-.18665e-01
.37595e-02 -.19132e-01 .36223e-02
j= 22 -.13991e-01 .21588e-02 -.13559e-01 .20515e-02
-.12448e-01
.19578e-02 -.95222e-02 .21407e-02 -.93873e-02
.20673e-02
-.89874e-02 .19982e-02 -.81769e-02 .21329e-02
-.80939e-02
.20696e-02 -.78309e-02 .20090e-02
j= 23 -.25046e-01 .41858e-02 -.25888e-01 .39944e-02
-.25107e-01
.37988e-02 -.17341e-01 .41004e-02 -.17649e-01
.39677e-02
-.17402e-01 .38323e-02 -.14948e-01 .40691e-02
-.15162e-01
.39548e-02 -.15009e-01 .38379e-02
j= 24 -.12381e-01 .23410e-02 -.13526e-01 .22605e-02
-.13991e-01
.21588e-02 -.89215e-02 .22746e-02 -.93543e-02
.22119e-02
-.95222e-02 .21407e-02 -.77652e-02 .22497e-02
-.80610e-02
.21943e-02 -.81769e-02 .21329e-02
j= 25 -.37625e-02 .71234e-03 -.36878e-02 .68378e-03
-.34792e-02
.65818e-03 -.27175e-02 .70883e-03 -.26903e-02
.68793e-03
-.26040e-02 .66807e-03 -.23752e-02 .70664e-03
-.23579e-02
.68831e-03 -.22986e-02 .67058e-03
j= 26 -.68209e-02 .13739e-02 -.69774e-02 .13210e-02
-.68413e-02
.12685e-02 -.49742e-02 .13540e-02 -.50444e-02
.13158e-02
-.49945e-02 .12771e-02 -.43581e-02 .13455e-02
-.44101e-02
.13121e-02 -.43783e-02 .12781e-02
j= 27 -.34572e-02 .76524e-03 -.36768e-02 .74061e-03
-.37625e-02
.71234e-03 -.25822e-02 .74811e-03 -.26794e-02
.72936e-03
-.27175e-02 .70883e-03 -.22768e-02 .74120e-03
-.23470e-02
.72461e-03 -.23752e-02 .70664e-03

j= 28 -.45809e-01 .39057e-02 -.40232e-01 .34557e-02
-.31511e-01
.31427e-02 -.23721e-01 .36602e-02 -.22928e-01
.34691e-02
-.20937e-01 .32932e-02 -.19132e-01 .36223e-02
-.18720e-01
.34711e-02 -.17591e-01 .33278e-02
j= 29 -.74383e-01 .75470e-02 -.83737e-01 .71404e-02
-.74491e-01
.63983e-02 -.42347e-01 .70774e-02 -.43876e-01
.67704e-02
-.42451e-01 .64231e-02 -.34582e-01 .69659e-02
-.35434e-01
.67088e-02 -.34686e-01 .64314e-02
j= 30 -.31399e-01 .41136e-02 -.40174e-01 .40761e-02
-.45809e-01
.39057e-02 -.20826e-01 .39377e-02 -.22871e-01
.38225e-02
-.23721e-01 .36602e-02 -.17480e-01 .38691e-02
-.18665e-01
.37595e-02 -.19132e-01 .36223e-02
j= 31 -.13991e-01 .21588e-02 -.13558e-01 .20515e-02
-.12448e-01
.19578e-02 -.95222e-02 .21407e-02 -.93872e-02
.20673e-02
-.89874e-02 .19982e-02 -.81769e-02 .21329e-02
-.80939e-02
.20696e-02 -.78309e-02 .20090e-02
j= 32 -.25045e-01 .41858e-02 -.25886e-01 .39944e-02
-.25107e-01
.37988e-02 -.17341e-01 .41004e-02 -.17649e-01
.39677e-02
-.17402e-01 .38323e-02 -.14948e-01 .40691e-02
-.15161e-01
.39548e-02 -.15009e-01 .38379e-02
j= 33 -.12381e-01 .23410e-02 -.13525e-01 .22605e-02
-.13991e-01
.21588e-02 -.89214e-02 .22746e-02 -.93542e-02
.22119e-02
-.95222e-02 .21407e-02 -.77652e-02 .22497e-02
-.80610e-02
.21943e-02 -.81769e-02 .21329e-02
j= 34 -.37625e-02 .71234e-03 -.36878e-02 .68378e-03
-.34792e-02
.65818e-03 -.27175e-02 .70883e-03 -.26903e-02
.68793e-03
-.26040e-02 .66807e-03 -.23752e-02 .70664e-03
-.23579e-02
.68831e-03 -.22986e-02 .67058e-03
j= 35 -.68208e-02 .13739e-02 -.69773e-02 .13210e-02
-.68412e-02
.12685e-02 -.49742e-02 .13540e-02 -.50444e-02
.13158e-02
-.49945e-02 .12771e-02 -.43581e-02 .13455e-02
-.44101e-02
.13121e-02 -.43783e-02 .12781e-02
j= 36 -.34572e-02 .76524e-03 -.36768e-02 .74061e-03
-.37625e-02
.71234e-03 -.25822e-02 .74811e-03 -.26794e-02

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.72936e-03
         -.27175e-02   .70883e-03  -.22768e-02   .74120e-03
-.23470e-02
          .72461e-03 -.23752e-02   .70664e-03


 nu=  1     y    sas      1    2

 j=    1   .10000e+01  0.          .37023e-02   .56574e-04
.16627e-02
          .49325e-04  0.          0.            .86706e-03
.12291e-04
          .85637e-03   .24012e-04   .99222e-04  -.27447e-06
.42035e-03
          .50713e-05  .49669e-03  .12663e-04
 j=    2      .61804e-02    -.96327e-04     .10000e+01   0.
.61804e-02
          .94441e-04   .94146e-03  -.15714e-04  -.11413e-14
.94818e-18
          .94150e-03   .13346e-04   .40929e-03  -.76958e-05
.35620e-03
         -.98536e-06  .40933e-03  .49383e-05
 j=    3   .14774e-02   .10454e-03  .24308e-02   .73298e-03
.99393e+00
          .24226e-02   .73222e-03   .93180e-04   .24298e-03
.47205e-03
         -.99329e-03   .60261e-03   .45575e-03   .29044e-04
.25983e-03
          .15140e-03 -.53177e-04  .13903e-03
 j=    4   .11413e-14  -.94818e-18  .39552e-03   .56066e-05
.48569e-03
          .13619e-04   .10000e+01  0.            .28506e-02
.43559e-04
          .10877e-02   .32266e-04   .39377e-02  -.41235e-06
.22819e-02
          .34394e-04  .93316e-03  .27342e-04
 j=    5   .40415e-03  -.67459e-05 -.11413e-14   .94818e-18
.40417e-03
          .57292e-05  .51977e-02 -.81011e-04  .10000e+01 0.
          .51977e-02   .79424e-04   .30646e-02  -.48403e-04
.10103e-01
         -.10582e-05  .30647e-02  .46192e-04
 j=    6   .41184e-03   .56878e-04  .44838e-04   .27711e-03
-.44049e-03
          .30571e-03   .97142e-03   .62588e-04   .20096e-02
.46311e-03
          .99493e+00   .19318e-02   .88182e-03   .14735e-04
.19589e-02
          .17575e-03  .29153e-02  .45416e-03
 j=    7   .15206e-03  -.42065e-06  .14314e-03   .17268e-05
.12668e-03
          .32296e-05   .11417e-02  -.11955e-06   .56884e-03
.85739e-05
          .24042e-03      .70445e-05      .10000e+01     0.
.58328e-03
          .89129e-05  .19055e-03  .56526e-05
 j=    8   .50313e-03  -.94602e-05  .55304e-03  -.15299e-05
.50319e-03
          .60707e-05   .19701e-02  -.31116e-04   .36074e-02
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-.37782e-06
          .19701e-02   .29695e-04   .12716e-02  -.19819e-04
.10000e+01
         0.           .12716e-02  .19431e-04
 j=    9   .11107e-03   .13909e-04  .86192e-04   .57743e-04
.10444e-03
          .48900e-04   .20581e-03   .22481e-04   .35317e-03
.13298e-03
          .63926e-03   .24597e-03   .17071e-03   .10384e-04
.43465e-03
          .78978e-04  .99877e+00  .44785e-03
 j=   10   .96130e+00  -.12345e-08  .11653e-01   .17807e-03
.22443e-02
          .66575e-04   .23100e-02  -.19196e-05   .27325e-02
.38734e-04
          .11559e-02   .32412e-04   .29764e-03  -.82339e-06
.71450e-03
          .86199e-05  .57660e-03  .14700e-04
 j=   11   .18481e-01  -.28804e-03  .95386e+00  -.97998e-08
.18481e-01
          .28240e-03   .28223e-02  -.47110e-04   .75466e-02
-.62747e-05
          .28225e-02   .40008e-04   .68207e-03  -.12825e-04
.10683e-02
         -.29557e-05  .68214e-03  .82294e-05
 j=   12   .24293e-02  -.22988e-03  .12925e-01  -.97231e-03
.96737e+00
         -.24226e-02   .12797e-02  -.16100e-03   .33565e-02
-.53213e-03
          .33033e-02  -.60453e-03   .61719e-03  -.67944e-04
.87490e-03
         -.17274e-03  .45004e-03 -.14013e-03
 j=   13   .72404e-03  -.60165e-06  .12468e-02   .17674e-04
.65561e-03
          .18383e-04   .95827e+00  -.12306e-08   .89700e-02
.13707e-03
          .14681e-02   .43549e-04   .11785e-01  -.12346e-05
.38763e-02
          .58425e-04  .10832e-02  .31739e-04
 j=   14   .12120e-02  -.20230e-04  .25199e-02  -.20952e-05
.12120e-02
          .17180e-04   .15536e-01  -.24214e-03   .94429e+00
-.97015e-08
          .15536e-01   .23739e-03   .51026e-02  -.80591e-04
.30070e-01
         -.31543e-05  .51026e-02  .76909e-04
 j=   15   .72927e-03  -.95343e-04  .15975e-02  -.30452e-03
.11645e-02
         -.30632e-03   .15841e-02  -.14458e-03   .98110e-02
-.64735e-03
          .96334e+00  -.19318e-02   .11344e-02  -.80156e-04
.41992e-02
         -.27301e-03  .12808e-01 -.45581e-03
 j=   16   .20735e-03  -.57360e-06  .23409e-03   .28240e-05
.15518e-03
          .39560e-05   .26620e-02  -.27887e-06   .14870e-02
.22413e-04
          .34125e-03   .99987e-05   .96538e+00  -.15497e-09
.18382e-02
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.28088e-04 .25722e-03 .76305e-05
j= 17 .58694e-03 -.11036e-04 .75400e-03 -.20861e-05
.58700e-03
.70817e-05 .29532e-02 -.46644e-04 .83988e-02
-.88103e-06
.29533e-02 .44513e-04 .38102e-02 -.59386e-04
.93834e+00
-.12050e-08 .38103e-02 .58223e-04
j= 18 .17069e-03 -.24125e-04 .29099e-03 -.64835e-04
.25497e-03
-.49895e-04 .37581e-03 -.41354e-04 .17027e-02
-.16545e-03
.31644e-02 -.24637e-03 .27703e-03 -.24749e-04
.19868e-02
-.11672e-03 .96661e+00 -.44785e-03
j= 19 0. 0. .46726e-03 .62168e-05
.62826e-03
.16935e-04 0. 0. .81171e-04
.44841e-06
.18846e-03 .34496e-05 .12941e-04 -.20881e-06
.69024e-04
-.11645e-06 .12454e-03 .13329e-05
j= 20 .47540e-03 -.83489e-05 -.11471e-14 .18500e-17
.47543e-03
.63256e-05 .80606e-04 -.20430e-05 -.11826e-14
.10719e-16
.80630e-04 .44543e-06 .66908e-04 -.21787e-05
.47714e-04
-.76990e-06 .66943e-04 -.11295e-06
j= 21 .52646e-03 .85934e-04 .17855e-04 .38574e-03
-.52068e-03
.39352e-03 .14877e-03 .52651e-04 -.39952e-04
.17285e-03
-.84378e-04 .12385e-03 .11242e-03 .16354e-04
.36142e-04
.58529e-04 -.74557e-05 .39615e-04
j= 22 -.11826e-14 .10719e-16 .44552e-04 .24612e-06
.10654e-03
.19502e-05 -.12361e-14 .31976e-16 .15837e-04
-.18273e-06
.43068e-04 .21985e-07 .29574e-05 -.11376e-06
.16369e-04
-.39662e-06 .32464e-04 -.40476e-06
j= 23 .44252e-04 -.11216e-05 -.11826e-14 .10719e-16
.44266e-04
.24454e-06 .15763e-04 -.66878e-06 -.12361e-14
.31976e-16
.15776e-04 -.18202e-06 .15891e-04 -.87634e-06
.10946e-04
-.42107e-06 .15911e-04 -.38553e-06
j= 24 .83701e-04 .31268e-04 -.23275e-04 .10071e-03
-.45722e-04
.70870e-04 .34721e-04 .17509e-04 -.47102e-05
.50064e-04
-.11455e-04 .31206e-04 .29919e-04 .52464e-05
.10654e-04
.17602e-04 .27509e-07 .10813e-04
j= 25 .49106e-04 -.79235e-06 .49123e-04 -.82883e-07
.51370e-04

.54978e-06 .28083e-04 -.10803e-05 .28337e-04
-.68661e-06
.30313e-04 -.37794e-06 .23252e-04 -.12569e-05
.24146e-04
-.96303e-06 .25089e-04 -.71129e-06
j= 26 .17908e-03 -.58312e-05 .18124e-03 -.29244e-05
.17917e-03
-.30227e-06 .10417e-03 -.57444e-05 .10395e-03
-.39987e-05
.10430e-03 -.25271e-05 .85246e-04 -.60393e-05
.86134e-04
-.46559e-05 .85391e-04 -.34058e-05
j= 27 .46820e-04 .62285e-05 .37139e-04 .21761e-04
.41919e-04
.14268e-04 .28629e-04 .28131e-05 .24612e-04
.10643e-04
.26199e-04 .61069e-05 .24532e-04 -.31391e-06
.23102e-04
.28289e-05 .22785e-04 .13300e-05
j= 28 .81725e-03 -.13182e-05 .14731e-02 .19598e-04
.84807e-03
.22860e-04 .97582e-04 -.88450e-06 .25598e-03
.14139e-05
.25441e-03 .46567e-05 .38822e-04 -.62643e-06
.11734e-03
-.19800e-06 .14458e-03 .15473e-05
j= 29 .14257e-02 -.25038e-04 .28589e-02 -.46130e-05
.14258e-02
.18969e-04 .24180e-03 -.61286e-05 .35816e-03
-.32468e-05
.24187e-03 .13360e-05 .11151e-03 -.36311e-05
.14313e-03
-.23097e-05 .11157e-03 -.18829e-06
j= 30 .94952e-03 -.13729e-03 .19223e-02 -.41981e-03
.13379e-02
-.39484e-03 .29376e-03 -.71881e-04 .37700e-03
-.18139e-03
.18196e-03 -.12474e-03 .15637e-03 -.30081e-04
.15012e-03
-.64594e-04 .59219e-04 -.40450e-04
j= 31 .52789e-04 -.47849e-06 .14050e-03 .77606e-06
.14383e-03
.26326e-05 .17816e-04 -.46089e-06 .49947e-04
-.57632e-06
.58141e-04 .29652e-07 .88722e-05 -.34129e-06
.27826e-04
-.67425e-06 .37687e-04 -.46990e-06
j= 32 .13275e-03 -.33646e-05 .19407e-03 -.17593e-05
.13279e-03
.73346e-06 .47288e-04 -.20063e-05 .65860e-04
-.17038e-05
.47327e-04 -.54609e-06 .26485e-04 -.14606e-05
.32837e-04
-.12632e-05 .26518e-04 -.64255e-06
j= 33 .16647e-03 -.42139e-04 .20827e-03 -.10540e-03
.98511e-04
-.71349e-04 .66299e-04 -.23701e-04 .70439e-04
-.52852e-04
.29272e-04 -.31667e-04 .40044e-04 -.10447e-04

.33487e-04
-.20036e-04 .11802e-04 -.11268e-04
j= 34 .58458e-04 -.94327e-06 .66748e-04 -.11265e-06
.58842e-04
.62974e-06 .31956e-04 -.12293e-05 .35846e-04
-.86860e-06
.33744e-04 -.42074e-06 .24620e-04 -.13308e-05
.26817e-04
-.10696e-05 .26335e-04 -.74662e-06
j= 35 .19535e-03 -.63613e-05 .21575e-03 -.34814e-05
.19546e-03
-.32982e-06 .11111e-03 -.61274e-05 .11829e-03
-.45503e-05
.11125e-03 -.26956e-05 .87716e-04 -.62143e-05
.91200e-04
-.49298e-05 .87866e-04 -.35045e-05
j= 36 .63255e-04 -.11850e-04 .78671e-04 -.25532e-04
.65645e-04
-.16004e-04 .35257e-04 -.75619e-05 .39493e-04
-.14178e-04
.33840e-04 -.84165e-05 .26704e-04 -.43136e-05
.27774e-04
-.64332e-05 .25086e-04 -.39177e-05

nu= 11 z sas 1 2

j= 1 -.23999e+00 0. -.81969e-01 .50666e-02
-.44393e-01
.55086e-02 -.60339e-01 .82622e-02 -.48242e-01
.68479e-02
-.34625e-01 .61179e-02 -.36462e-01 .75478e-02
-.33508e-01
.68898e-02 -.27756e-01 .63536e-02
j= 2 -.16190e+00 .15034e-01 -.35168e+00 .19925e-17
-.16229e+00
.10031e-01 -.89404e-01 .15519e-01 -.10871e+00
.14886e-01
-.89840e-01 .12753e-01 -.61551e-01 .14649e-01
-.67055e-01
.13881e-01 -.61974e-01 .12743e-01
j= 3 -.43968e-01 .82367e-02 -.81773e-01 .75936e-02
-.23999e+00
0. -.34181e-01 .82422e-02 -.48008e-01
.83333e-02
-.60339e-01 .82622e-02 -.27311e-01 .80537e-02
-.33280e-01
.79206e-02 -.36462e-01 .75478e-02
j= 4 -.32640e-01 .44694e-02 -.27812e-01 .39478e-02
-.20688e-01
.36554e-02 -.19811e+00 .14367e-15 -.53889e-01
.33309e-02
-.27430e-01 .34037e-02 -.75830e-01 .51677e-02
-.42538e-01
.37292e-02 -.25219e-01 .34971e-02
j= 5 -.51268e-01 .88992e-02 -.59462e-01 .81420e-02
-.51518e-01
.73129e-02 -.10901e+00 .10123e-01 -.27812e+00
.20170e-15

```
          -.10927e+00   .67540e-02  -.81421e-01   .96785e-02
-.12700e+00
           .86553e-02 -.81681e-01  .71613e-02
 j=    6  -.20423e-01   .49247e-02 -.27677e-01   .48042e-02
-.32640e-01
           .44694e-02  -.27168e-01   .50894e-02  -.53760e-01
.49923e-02
          -.19811e+00   .14367e-15  -.24955e-01   .50462e-02
-.42403e-01
           .50402e-02 -.75830e-01  .51677e-02
 j=    7  -.68717e-02   .14225e-02 -.64338e-02   .13229e-02
-.54646e-02
           .12509e-02  -.20891e-01   .14237e-02  -.14013e-01
.12286e-02
          -.84655e-02   .11739e-02  -.11599e+00   .84112e-16
-.19170e-01
           .11849e-02 -.92934e-02  .11532e-02
 j=    8  -.11828e-01   .28152e-02 -.12681e-01   .26251e-02
-.11910e-01
           .24488e-02  -.26404e-01   .31385e-02  -.36729e-01
.25032e-02
          -.26488e-01   .23222e-02  -.40229e-01   .37356e-02
-.14779e+00
           .10717e-15 -.40325e-01  .24924e-02
 j=    9  -.53770e-02   .15856e-02 -.63899e-02   .15208e-02
-.68717e-02
           .14225e-02  -.83770e-02   .16939e-02  -.13968e-01
.16604e-02
          -.20891e-01   .14237e-02  -.92046e-02   .17243e-02
-.19124e-01
           .17759e-02 -.11599e+00  .84112e-16
 j=   10  -.23246e+00   .36442e-03 -.81929e-01   .50667e-02
-.44390e-01
           .55086e-02  -.60331e-01   .82615e-02  -.48234e-01
.68475e-02
          -.34623e-01   .61179e-02  -.36461e-01   .75478e-02
-.33507e-01
           .68898e-02 -.27756e-01  .63536e-02
 j=   11  -.16181e+00   .15031e-01 -.33667e+00   .10556e-02
-.16219e+00
           .10030e-01  -.89389e-01   .15518e-01  -.10866e+00
.14882e-01
          -.89826e-01   .12752e-01  -.61549e-01   .14649e-01
-.67050e-01
           .13881e-01 -.61972e-01  .12743e-01
 j=   12  -.43966e-01   .82365e-02 -.81734e-01   .75926e-02
-.23246e+00
           .36442e-03  -.34180e-01   .82421e-02  -.48000e-01
.83327e-02
          -.60331e-01   .82615e-02  -.27311e-01   .80537e-02
-.33279e-01
           .79205e-02 -.36461e-01  .75478e-02
 j=   13  -.32638e-01   .44693e-02 -.27808e-01   .39477e-02
-.20687e-01
           .36554e-02  -.19059e+00   .29879e-03  -.53858e-01
.33307e-02
          -.27428e-01   .34037e-02  -.75800e-01   .51663e-02
-.42531e-01
           .37291e-02 -.25218e-01  .34971e-02
```

j= 14 -.51262e-01 .88989e-02 -.59442e-01 .81415e-02
-.51512e-01
.73128e-02 -.10893e+00 .10119e-01 -.26319e+00
.82519e-03
-.10919e+00 .67525e-02 -.81405e-01 .96776e-02
-.12685e+00
.86494e-02 -.81665e-01 .71609e-02
j= 15 -.20422e-01 .49246e-02 -.27673e-01 .48040e-02
-.32638e-01
.44693e-02 -.27166e-01 .50893e-02 -.53729e-01
.49911e-02
-.19059e+00 .29879e-03 -.24955e-01 .50462e-02
-.42396e-01
.50398e-02 -.75800e-01 .51663e-02
j= 16 -.68716e-02 .14225e-02 -.64336e-02 .13229e-02
-.54645e-02
.12509e-02 -.20888e-01 .14236e-02 -.14011e-01
.12285e-02
-.84653e-02 .11739e-02 -.11221e+00 .87957e-04
-.19167e-01
.11848e-02 -.92932e-02 .11532e-02
j= 17 -.11828e-01 .28152e-02 -.12680e-01 .26250e-02
-.11909e-01
.24488e-02 -.26400e-01 .31383e-02 -.36707e-01
.25029e-02
-.26484e-01 .23221e-02 -.40219e-01 .37350e-02
-.14035e+00
.22003e-03 -.40315e-01 .24921e-02
j= 18 -.53769e-02 .15856e-02 -.63897e-02 .15208e-02
-.68716e-02
.14225e-02 -.83768e-02 .16939e-02 -.13966e-01
.16603e-02
-.20888e-01 .14236e-02 -.92044e-02 .17243e-02
-.19121e-01
.17757e-02 -.11221e+00 .87957e-04
j= 19 -.45315e-01 .77834e-02 -.39793e-01 .68862e-02
-.31044e-01
.62545e-02 -.22886e-01 .72348e-02 -.22151e-01
.68601e-02
-.20172e-01 .65064e-02 -.18125e-01 .71182e-02
-.17774e-01
.68258e-02 -.16666e-01 .65397e-02
j= 20 -.73248e-01 .15017e-01 -.82849e-01 .14230e-01
-.73677e-01
.12750e-01 -.40602e-01 .13961e-01 -.42333e-01
.13382e-01
-.41013e-01 .12702e-01 -.32526e-01 .13657e-01
-.33568e-01
.13183e-01 -.32932e-01 .12647e-01
j= 21 -.30599e-01 .81576e-02 -.39561e-01 .81109e-02
-.45315e-01
.77834e-02 -.19732e-01 .77383e-02 -.21929e-01
.75404e-02
-.22886e-01 .72348e-02 -.16231e-01 .75553e-02
-.17555e-01
.73710e-02 -.18125e-01 .71182e-02
j= 22 -.13498e-01 .42672e-02 -.13099e-01 .40568e-02
-.11992e-01 .38681e-02 -.88208e-02 .41771e-02 -.87230e-02

.40378e-02
-.83395e-02 .39012e-02 -.73738e-02 .41276e-02
-.73289e-02
.40102e-02 -.70860e-02 .38920e-02
j= 23 -.24013e-01 .82570e-02 -.24976e-01 .78954e-02
-.24256e-01
.75121e-02 -.15932e-01 .79807e-02 -.16349e-01
.77422e-02
-.16171e-01 .74853e-02 -.13355e-01 .78524e-02
-.13673e-01
.76534e-02 -.13591e-01 .74366e-02
j= 24 -.11731e-01 .46005e-02 -.12968e-01 .44591e-02
-.13498e-01
.42672e-02 -.80830e-02 .44082e-02 -.85943e-02
.43050e-02
-.88208e-02 .41771e-02 -.68324e-02 .43217e-02
-.72016e-02
.42345e-02 -.73738e-02 .41276e-02
j= 25 -.35643e-02 .13998e-02 -.35014e-02 .13446e-02
-.32962e-02
.12934e-02 -.24506e-02 .13718e-02 -.24360e-02
.13330e-02
-.23563e-02 .12942e-02 -.20750e-02 .13546e-02
-.20706e-02
.13215e-02 -.20188e-02 .12875e-02
j= 26 -.64153e-02 .26937e-02 -.66099e-02 .25959e-02
-.64954e-02
.24944e-02 -.44439e-02 .26130e-02 -.45490e-02
.25464e-02
-.45225e-02 .24746e-02 -.37672e-02 .25713e-02
-.38528e-02
.25152e-02 -.38448e-02 .24538e-02
j= 27 -.32102e-02 .14943e-02 -.34582e-02 .14521e-02
-.35643e-02
.13998e-02 -.22720e-02 .14371e-02 -.23937e-02
.14075e-02
-.24506e-02 .13718e-02 -.19355e-02 .14096e-02
-.20288e-02
.13847e-02 -.20750e-02 .13546e-02
j= 28 -.45312e-01 .77832e-02 -.39788e-01 .68860e-02
-.31043e-01
.62545e-02 -.22885e-01 .72348e-02 -.22151e-01
.68601e-02
-.20172e-01 .65064e-02 -.18125e-01 .71182e-02
-.17774e-01
.68258e-02 -.16666e-01 .65397e-02
j= 29 -.73241e-01 .15017e-01 -.82827e-01 .14229e-01
-.73670e-01
.12750e-01 -.40601e-01 .13961e-01 -.42330e-01
.13382e-01
-.41012e-01 .12702e-01 -.32526e-01 .13657e-01
-.33568e-01
.13183e-01 -.32932e-01 .12647e-01
j= 30 -.30598e-01 .81576e-02 -.39557e-01 .81106e-02
-.45312e-01
.77832e-02 -.19732e-01 .77383e-02 -.21928e-01
.75404e-02
-.22885e-01 .72348e-02 -.16231e-01 .75553e-02
-.17555e-01

```
        .73710e-02 -.18125e-01  .71182e-02
 j=   31  -.13498e-01   .42672e-02 -.13099e-01   .40568e-02
-.11992e-01
        .38681e-02  -.88208e-02   .41771e-02  -.87229e-02
.40378e-02
       -.83395e-02   .39012e-02  -.73738e-02   .41276e-02
-.73288e-02
        .40102e-02 -.70860e-02  .38920e-02
 j=   32  -.24012e-01   .82570e-02 -.24974e-01   .78954e-02
-.24256e-01
        .75121e-02  -.15932e-01   .79807e-02  -.16349e-01
.77422e-02
       -.16171e-01   .74853e-02  -.13355e-01   .78524e-02
-.13672e-01
        .76534e-02 -.13591e-01  .74366e-02
 j=   33  -.11731e-01   .46005e-02 -.12968e-01   .44591e-02
-.13498e-01
        .42672e-02  -.80829e-02   .44082e-02  -.85942e-02
.43050e-02
       -.88208e-02   .41771e-02  -.68324e-02   .43217e-02
-.72016e-02
        .42345e-02 -.73738e-02  .41276e-02
 j=   34  -.35643e-02   .13998e-02 -.35013e-02   .13446e-02
-.32962e-02
        .12934e-02  -.24506e-02   .13718e-02  -.24360e-02
.13330e-02
       -.23563e-02   .12942e-02  -.20750e-02   .13546e-02
-.20706e-02
        .13215e-02 -.20188e-02  .12875e-02
 j=   35  -.64152e-02   .26937e-02 -.66098e-02   .25959e-02
-.64953e-02
        .24944e-02  -.44439e-02   .26130e-02  -.45489e-02
.25464e-02
       -.45224e-02   .24746e-02  -.37672e-02   .25713e-02
-.38528e-02
        .25152e-02 -.38448e-02  .24538e-02
 j=   36  -.32102e-02   .14943e-02 -.34582e-02   .14521e-02
-.35643e-02
        .13998e-02  -.22720e-02   .14371e-02  -.23937e-02
.14075e-02
       -.24506e-02   .13718e-02  -.19355e-02   .14096e-02
-.20288e-02
        .13847e-02 -.20750e-02  .13546e-02


 the contents of checkpoint 14


 ngfm,nphi,nbcm,nfrq,nq,ncp,hmch=
          2          9          1          2          4          9
.20000e+00
 kgfy,kgfz,kbcy,kbcz=          1         -1          1         -1
 kbdy,kbdz=          1          1


 nu=  1     freq sas       1 . 0
```

```
j=    1  0.              .50000e+00 0.             .10000e+01

nu=  1     e21   sas       1     1

j=     1  -.56503e+00   .96815e-01 -.82731e+00   .10756e+00
-.89006e+00
           .14272e+00  -.48029e+00   .80341e-01  -.68663e+00
.78556e-01
          -.73414e+00   .95104e-01  -.31726e+00   .55089e-01
-.43155e+00
           .45973e-01 -.45930e+00  .46585e-01

nu=  1     e321  sas       1     1

j=     1   .50720e+01  -.16894e+00   .83817e+00   .73836e+00
.42677e+00
           .37596e+00   .41442e+01  -.10048e+00   .63902e+00
.65265e+00
           .32538e+00   .33231e+00   .17493e+01   .79792e-01
.26516e+00
           .43154e+00  .13501e+00  .21973e+00

nu=  1     e     sas       1     1

j=    1  -.94410e+01 -.23029e+01  .23235e+01 -.26648e+00

nu=  1     e21   sas       1     2

j=     1  -.52668e+00   .13328e+00 -.75198e+00   .11023e+00
-.76969e+00
           .13646e+00  -.45294e+00   .11517e+00  -.63298e+00
.79133e-01
          -.64842e+00   .80710e-01  -.30128e+00   .82754e-01
-.40102e+00
           .46237e-01 -.41088e+00  .29397e-01

nu=  1     e321  sas       1     2

j=     1   .48592e+01   .15255e+00   .77054e+00   .15218e+01
.39234e+00
           .77485e+00   .40115e+01   .17574e+00   .58622e+00
.13432e+01
           .29849e+00   .68392e+00   .17513e+01   .29714e+00
.26143e+00
           .85767e+00  .13311e+00  .43670e+00

nu=  1     e     sas       1     2

j=    1  -.89840e+01 -.53851e+01  .22464e+01 -.30571e+00


the contents of checkpoint 15
```

```
elam,hmch=  .30000e+04  .20000e+00


the contents of checkpoint 16


nfrq=          2

nu=  1      freq sas       1    0

j=     1  0.              .50000e+00 0.              .10000e+01
```

14.4 INPUT DATA FOR TEST CASE 2

This Subsection lists the input data to the utility and technical modules for Test Case 2. The geometry is comprised of an elliptical nose section, fuselage, tail cone, and a mid-mounted wing (see Fig. 15a). Both planes of symmetry are considered so that only a quarter of the wing-body configuration is needed as input. The nose section is divided into 9 elements (3 circumferentially and 3 logitudinally) while the fuselage is divided into a mesh of 6 (circumferential) by 3 (logitudinal) elements. The tail cone is described by 3 circumferential elements and finally, the wing is divided into 16 elements (4 each in the chordwise and spanwise directions). The wake is assumed to come off the wing surface only. Each of the first 4 wake strips has an overall length of 1000. The wake is assumed to emanate from the wing trailing-edge; the wake vortices are convected downstream by the flow. The trajectory of the wake particles emanating from points A, B, C, and D, in Fig. 15b is approximated by straight lines in the unperturbed-flow direction. The wake particle emanating from point E is assumed to follow the contour of the body, line EFG, and then to follow a straight line in the direction of the unperturbed flow (line GH). Therefore, the wake strips emanating from trailing-edge segments AB, BC, and CD (wake strips 4, 3, and 2, respectively) are rectangular, while the portion of the wake emanating from trailing- edge segment DE has the contour DEFGHIJD. The latter region is modelled by dividing it into two quadrilateral strips (strips 1 and 5), both of which represent vorticity emanating from trailing-edge segment DE (segment 1). Hence, the potential discontinuity on strip 5 (as for strip 1) is the one of trailing- edge segment 1. This is reflected by the fact that

isgi(5) = 1

(If strip 5 is thought of as emanating from the body, the line FG would be treated as trailing-edge segment number 5, and correspondingly we would have isgi(5) = 5). For steady state (zero frequency), the wake strips may be considered as long strips (i.e, without having to divide them into smaller elements), provided however, that analytical evaluation of the doublet integrals is ensured (via a large value of ELAMDA). The body and wake element distribution for Test Case 2 is depicted in Fig. 15b.

The input data listing now follows.

```
[xqt intr
 reset nam2=  ss
  reset nam3=   1
 reset naml= nni nwrd=      1 nj=      1 lb=      1 ityp= 0$
      58
 reset naml=  nk nwrd=      1 nj=      1 lb=      1 ityp= 0$
      4
 reset naml= nte nwrd=      1 nj=      1 lb=      1 ityp= 0$
      2
 reset naml= nsk nwrd=      1 nj=      1 lb=      1 ityp= 0$
```

```
      4
reset naml=ntes nwrd=     1 nj=     1 lb=
      4
reset naml= nei nwrd=     1 nj=     1 lb=     1 ityp= 0$
     46
reset naml=kbdy nwrd=     1 nj=     1 lb=     1 ityp= 0$
      1
reset naml=kbdz nwrd=     1 nj=     1 lb=     1 ityp= 0$
      1
reset naml=refl nwrd=     1 nj=     1 lb=     1 ityp=-1$
     1.00000
reset naml= pni nwrd=   174 nj=    58 lb=   174 ityp=-1$
     0.00000     0.00000     0.00000
4.83333  0.0  .83350
9.66667  0.0  1.44366
14.5  0.0  1.667
4.83333  .41675  .72183
9.66667  .72184  1.25025
14.5  .83351  1.44366
4.83333  .72183  .41675
9.66667  1.25025  .72183
14.5  1.44367  .83350
4.83333  .83350  0.0
9.66667  1.44366 0.0
14.5  1.667  0.0
17.63883  0.0  1.6667
20.77767  0.0  1.667
23.91650  0.0  1.667
27.05533  0.0  1.667
30.1941  0.0  1.667
33.333  0.0  1.667
17.63883  .83351  1.44366
20.77767  .83351  1.44366
23.91650  .83351  1.44366
27.05533  .83351  1.44366
30.19417  .83351  1.44366
33.333  .83351  1.44366
17.63883  1.44367  .83350
20.77767  1.44367  .83350
23.91650  1.44367  .83350
27.05533  1.44367  .83350
30.19417  1.44367  .83350
33.333  1.44367  .83350
15.54188  1.667  .08801
17.834  1.667  .1667
20.12613  1.667  .08801
21.168  1.667  0.0
30.19417  1.667  0.0
33.333  1.667  0.0
47.833  0.0  0.0
19.25781  6.18769  0.0
20.15148  6.18769  .07549
22.11756  6.18769  .14299
24.08364  6.18769  .07549
24.97731  6.18769  0.0
22.65625  9.41675  0.0
23.44406  9.41675  .06655
25.17725  9.41675  .12605
26.91044  9.41675  .06655
```

```
27.69825  9.41675  0.0
24.69531  11.35419  0.0
25.41961  11.35419  .06118
27.01306  11.35419  .11589
28.60652  11.35419  .06118
29.33081  11.35419  0.0
25.375  12.0  0.0
26.07813  12.0  0.0
27.625  12.0  0.0
29.17188  12.0  0.0
29.875  12.0  0.0
reset naml= ini nwrd=    184 nj=     46 lb=    184 ityp= 0$
      2       5       1       1
      3       6       5       2
      4       7       6       3
      5       8       1       1
      6       9       8       5
      7      10       9       6
      8      11       1       1
      9      12      11       8
     10      13      12       9
  14  20  7  4
  15  21  20  14
  16  22  21  15
  17  23  22  16
  18  24  23  17
  19  25  24  18
  20  26  10  7
  21  27  26  20
  22  28  27  21
  23  29  28  22
  24  30  29  23
  25  31  30  24
  26  32  13  10
  27  33  32  26
  28  34  33  27
  29  35  34  28
  30  36  35  29
  31  37  36  30
  38  38  25  19
  38  38  31  25
  38  38  37  31
  32  40  39  13
  33  41  40  32
  34  42  41  33
  35  43  42  34
     40      45      44      39
     41      46      45      40
     42      47      46      41
     43      48      47      42
     45      50      49      44
     46      51      50      45
     47      52      51      46
     48      53      52      47
     50      55      54      49
     51      56      55      50
     52      57      56      51
     53      58      57      52
reset naml=kndy nwrd=     58 nj=      1 lb=     58 ityp= 0$
```

```
      1       1       1       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       1       0       0
      0       0       0       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       0
reset naml=kndz nwrd=    58 nj=     1 lb=    58 ityp= 0$
      1       0       0       0       0       0       0       0       0       0
      1       1       1       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       0       0       1
  0  0  0  0  1  1  1  1  1  0
  0  0  1  1  0  0  0  1  1  0
  0  0  1  1  1  1  1  1
reset naml= nsi nwrd=     1 nj=     1 lb=     1 ityp= 0$
      5
reset naml=nsgi nwrd=     1 nj=     1 lb=     1 ityp= 0$
      4
reset naml=kodi nwrd=    46 nj=     1 lb=    46 ityp= 0$
      0       0       0       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       0       0       0
      0       0       0       1       0       0       0       1       0       0
      0       1       0       0       0       1
reset naml=ieki nwrd=    16 nj=     4 lb=    16 ityp= 0$
     34      80      33      79
     38      84      37      83
     42      88      41      87
     46      92      45      91
reset naml=isgi nwrd=     5 nj=     1 lb=     5 ityp= 0$
      1       2       3       4       1
reset naml=nsei nwrd=     5 nj=     1 lb=     5 ityp= 0$
      1       1       1       1       1
reset naml=ksgy nwrd=     4 nj=     1 lb=     4 ityp= 0$
      1       1       1       1
reset naml=ksgz nwrd=     4 nj=     1 lb=     4 ityp= 0$
      0       0       0       0
reset naml= psi nwrd=    60 nj=     5 lb=    60 ityp=-1$
 -1021.16800      1.66670      0.00000 1024.97731      6.18769      0.00000
    24.97731      6.18769      0.00000   21.16800      1.66670      0.0000
 1024.97731      6.18769      0.00000 1027.69825      9.41675      0.00000
    27.69825      9.41675      0.00000   24.97731      6.18769      0.0000
 1027.69825      9.41675      0.00000 1029.33081     11.35419      0.00000
    29.33081     11.35419      0.00000   27.69825      9.41675      0.0000
 1029.33081     11.35419      0.00000 1029.87500     12.0000       0.00000
  29.875  12.0  0.0  29.33081  11.35419  0.0
  1021.168  0.0  0.0  1021.168  1.6667  0.0
  33.333 1.6667  0.0  47.8333  0.0  0.0
reset naml=ngfm nwrd=     1 nj=     1 lb=     1 ityp= 0$
      1
reset naml=kgfy nwrd=     1 nj=     1 lb=       ityp= 0$
      1
reset naml=kgfz nwrd=     1 nj=     1 lb=     1 ityp= 0$
      1
reset naml= gfm nwrd=   174 nj=     1 lb=   174 ityp=-1$
     1.00000      0.00000      0.00000      1.00000      0.00000      0.0000
     1.00000      0.00000      0.00000      1.00000      0.00000      0.0000
     1.00000      0.00000      0.00000      1.00000      0.00000      0.0000
     1.00000      0.00000      0.00000      1.00000      0.00000      0.0000
     1.00000      0.00000      0.00000      1.00000      0.00000      0.0000
```

```
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
     1.00000     0.00000     0.00000     1.00000     0.00000     0.0000
reset naml=nbcm nwrd=     1 nj=     1 lb=     1 ityp= 0$
     1
reset naml=kbcy nwrd=     1 nj=     1 lb=     1 ityp= 0$
     1
reset naml=kbcz nwrd=     1 nj=     1 lb=     1 ityp= 0$
     1
reset naml= bcm nwrd=   174 nj=     1 lb=   174 ityp=-1$
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
```

```
    -1.00000     0.00000     0.00000    -1.00000     0.00000     0.0000
reset naml=hmch nwrd=     1 nj=     1 lb=     1 ityp=-1$
      .60000
reset naml=elam nwrd=     1 nj=     1 lb=
  5000.00000
reset naml=nfrq nwrd=     1 nj=     1 lb=     1 ityp= 0$
      1
reset naml=freq nwrd=     2 nj=     1 lb=     2 ityp=-1$
     0.00000     0.00000
[xqt sous
test case 2 , wing body configurations
ttttttttt
t
[xqt souo
reset ncpl=5$
0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0
[xqt dcu
toc 1$
[xqt exit
```

14.5 OUTPUT OF TEST CASE 2

This Subsection lists the results obtained for Test Case 2. The central processor time required for this Test Case using the CDC computer was 35.363 seconds, with the program having been compiled by the FTN compiler under optimization level zero. The results include the velocity potential distribution (E21), the pressure distribution (E321), and the matrix of generalized aerodynamic forces (E).

The output listing now follows.

```
the contents of checkpoint 14



ngfm,nphi,nbcm,nfrq,nq,ncp,hmch=
        1        46         1         1         4        46  .60000e+00
kgfy,kgfz,kbcy,kbcz=         1         1         1         1
kbdy,kbdz=         1         1


nu=  1      freq ss        1    0

j=     1  0.            0.


nu=  1      e21  ss        1    1

j=     1  -.25598e+00 0.           -.30954e+00 0.           -.18542e+00
          0.           -.25598e+00 0.           -.30956e+00 0.
          -.18601e+00 0.           -.25598e+00 0.           -.30958e+00
          0.           -.18662e+00 0.           -.88923e-01 0.
          -.29947e-01 0.            .17942e-01 0.            .35437e-01
          0.            .56426e-01 0.            .10228e+00 0.
          -.10172e+00 0.           -.26364e-01 0.            .27462e-01
          0.            .38164e-01 0.            .58129e-01 0.
           .10237e+00 0.           -.14268e+00 0.           -.83155e-01
```

```
     0.            .43296e-01 0.           .41828e-01 0.
      .47562e-01 0.           .10235e+00 0.           .26790e+00
     0.            .26790e+00 0.           .26791e+00 0.
     -.13815e+00 0.          -.86369e-01 0.           .37471e-01
     0.            .92388e-01 0.          -.80384e-01 0.
     -.36206e-01 0.           .63268e-01 0.           .10463e+00
     0.           -.51866e-01 0.          -.10267e-01 0.
      .74500e-01 0.           .10190e+00 0.          -.15228e-01
     0.            .18933e-01 0.           .61289e-01 0.
      .68102e-01 0.

nu=  1     e321 ss        1    1

j=    1   .59677e-01 0.          -.97556e-02 0.          -.48594e-01
     0.            .59679e-01 0.          -.96707e-02 0.
     -.44976e-01 0.           .59681e-01 0.          -.95848e-02
     0.           -.41411e-01 0.          -.47169e-01 0.
     -.35823e-01 0.          -.20763e-01 0.          -.11638e-01
     0.           -.21084e-01 0.          -.56277e-01 0.
     -.42649e-01 0.          -.44354e-01 0.          -.26083e-01
     0.           -.80842e-02 0.          -.21674e-01 0.
     -.55646e-01 0.          -.47547e-01 0.          -.66071e-01
     0.           -.43064e-01 0.          -.50215e-02 0.
     -.98479e-02 0.          -.50283e-01 0.           .46252e-02
     0.            .46288e-02 0.           .36483e-02 0.
     -.59385e-01 0.          -.82487e-01 0.          -.74282e-01
     0.           -.24712e-01 0.          -.42844e-01 0.
     -.83316e-01 0.          -.80250e-01 0.          -.38241e-01
     0.           -.42003e-01 0.          -.73076e-01 0.
     -.61584e-01 0.          -.24893e-01 0.          -.39897e-01
     0.           -.58777e-01 0.          -.39890e-01 0.
     -.11829e-01 0.

nu=  1     e    ss        1    1

j=    1  -.13398e+00 0.
```

WING DETAILS

CIRCULAR BICONVEX SECTION	
ZERO THICKNESS AT WING TIP	
AREA	12.
ASPECT RATIO	4
TAPER RATIO	0.6
INCIDENCE, DEG	0
DIHEDRAL, DEG	0
GEOMETRIC TWIST, DEG	0

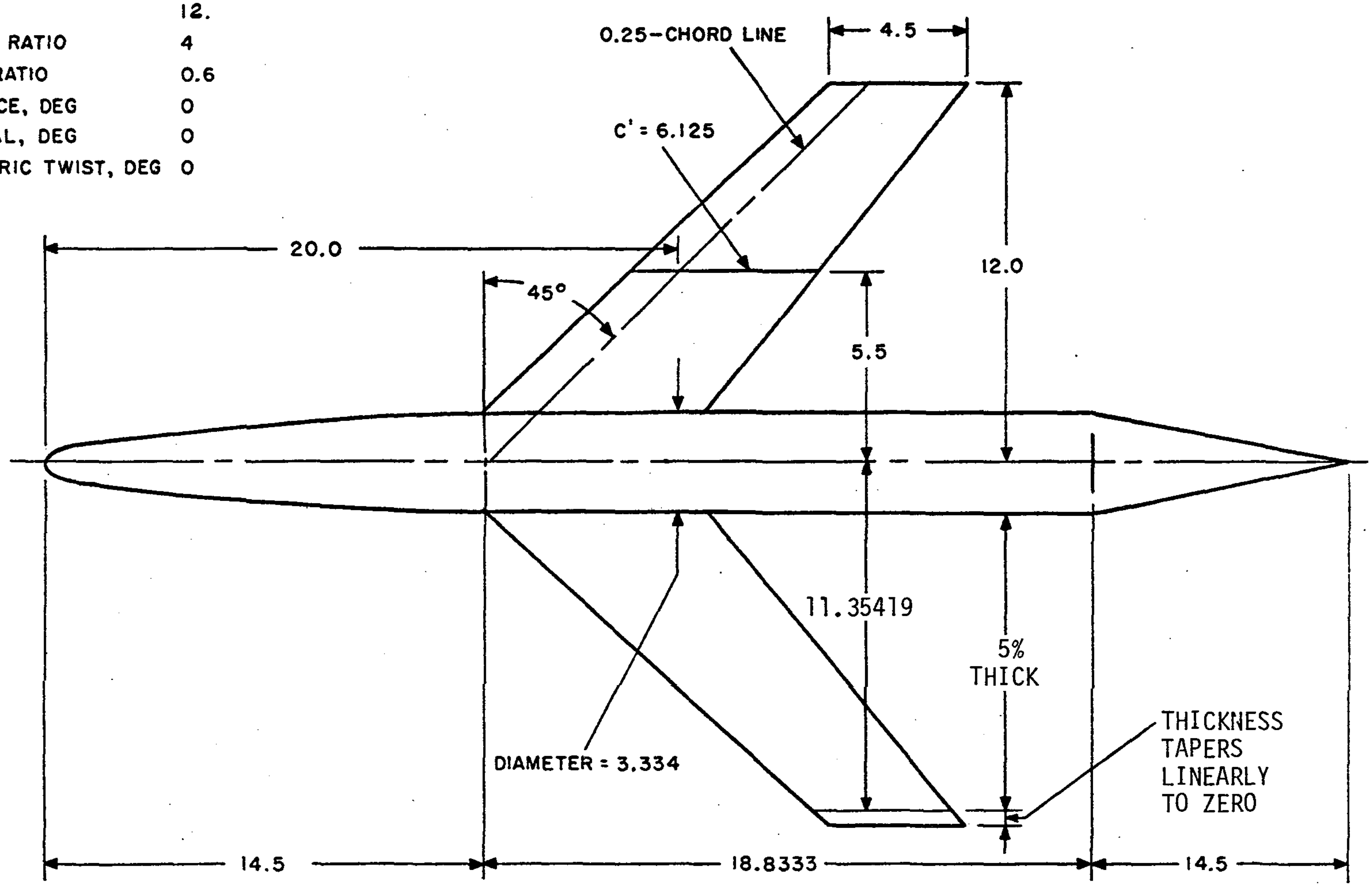

Figure 15a. Specifications of Test Case 2.

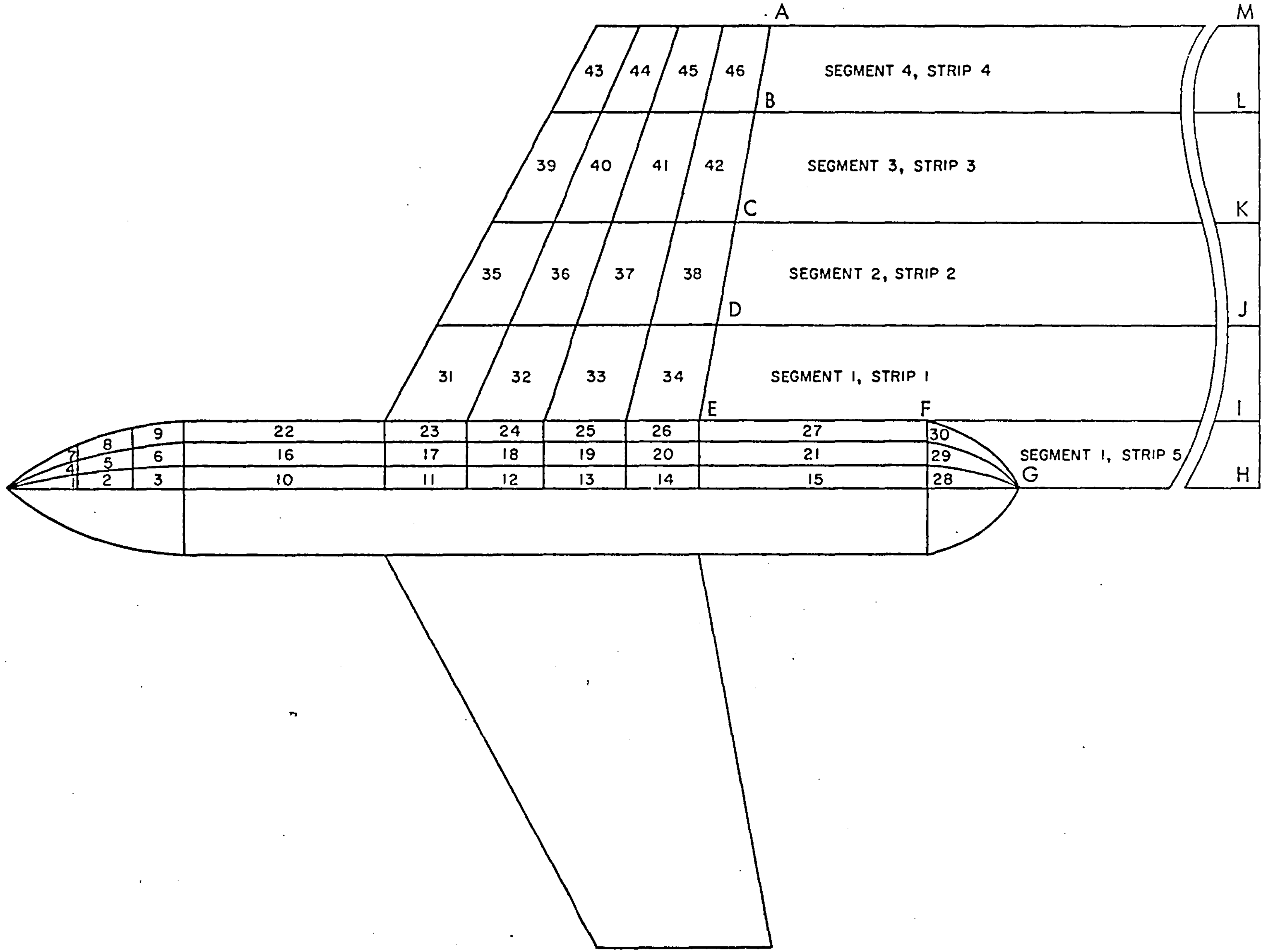

Figure 15b. Body and Wake Element Distribution for Test Case 2.
(not to scale)

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APPENDIX A

DCU - DATA COMPLEX UTILITY MODULE

A.1 INTRODUCTION

This Appendix is an adaption of Section 5.2 of Ref. 4 and is included here for completeness and convenience to the user of the SOUSSA-P Program. Specifically, the terminology in some cases has been modified from a SPAR-oriented nature to one more suitable for the SOUSSA-P environment.

The DCU module allows the user to perform an array of utility functions, as described in subsection A.2. Hence, the user is provided a very powerful means of manipulating the data complex, and is advised to consult Ref. 4 if a deeper understanding of the data complex structure is desired.

A.2 DCU COMMANDS

In defining DCU command syntax, the symbol LIB will be used repeatedly to represent a library internal designation (1, 2, etc.), and Id will identify one or more data sets. Id may be in any of the three forms indicated below, unless specifically stated otherwise:

(1) The four-word data set name, MASK-filled.
Example: B SAS is the same as
B SAS MASK MASK.
i.e., corresponds to the first data set found in a given library having B SAS as the first two words of its four-word name.

(2) An integer, n, indicating the data set associated with sequence number n in the table of contents.

(3) Integers n, m, indicating (m-n+1) data sets associated with sequence numbers n, n+1, ---m.

(4) Omitted - meaning all data sets in a library.

Consider as an example, the most commonly executed command, TOC Lib Id.

Examples:

TOC 1 B SAS$ Id form (1) causes a single line of the Table of Contents of library 1 to be printed, i.e., the line corresponding to the first data set named B SAS MASK MASK to be located.

TOC 1 27$ Id form (2) causes printout of line 27 of the Table Of Contents of library 1.

TOC 1 32,50$ Id form (3) causes printout of lines 32 through 50 of the Table Of Contents of library 1.

TOC 1$ Id form (4) causes the entire Table Of Contents of library 1 to be printed.

Other commands currently available in DCU are summarized below:

* DISABLE Lib Id$. Data set(s) are marked as disabled. The data set(s) are still present in the library, but cannot be accessed until they are re-enabled via the following command:

* ENABLE Lib, Id$. Only forms (2) or (3) of ID are allowed for this command.

* PRINT Lib id$. or
  PRINT Lib N1, N2, n3, n4, j_1 , j_2 , i_1 , i_2 ,b_1 ,b_2 .
  The one or more identified data sets are printed in tabular form (an auxiliary command, NCPL=n, controls the number of columns per printed line, default NCPL=10; for teletype display, select NCPL=5). If the second form is used, the printout will be restricted to columns j_1 through j_2 , rows (items) i_1 through i_2 , for successive blocks b_1 , b_1 +1 ---b_2 (see Section 7 for a description of this terminology).

  NOTE

  PRINT displays data set items sequentially, so that matrices appear in transposed form.

* COPY Lib_1 , Lib_2 , Id$. Copy the indicated data sets from Lib_1 to Lib_2 . Disabled data sets are not copied. This is the recommended method of packing libraries, i.e., producing libraries containing only enabled or accessible data sets.

* XCOPY Lib_1 , n, Id$. The indicated data set (in Lib) is written on ordinary sequential file n in a sequence of physical records identical to individual blocks of the data set as it resides in Lib. As an example,

XCOPY 1, 6, E SAS 1 1$ causes the matrix of generalized aerodynamic forces, E, to be written onto a file known externally as SPARLF corresponding to n=6. The output file will contain one physical record.

* XLOAD n, Lib, nwrds, nj, lb, itype, 1, N2, n3, n4$. This command causes data from sequential file n to be loaded as a data set named N1, N2, n3 n4 in Lib. The other parameters have the same meaning as defined in Section 7. As an example, suppose a sequential file, SPARLD, contains five blocks (physical records produced by direct binary writes, not unformatted FORTRAN writes) of real data and that each block is a matrix with 6 rows and 100 columns. To load these data into library 1 as a data set named B SAS 1 1, the following command would be used:

  XLOAD 4,1, 3000, 100, 600, -1, B SAS 1 1$.

* REWIND n$. Used in conjunction with XCOPY, XLOAD, this command causes sequential file n to be rewound (i.e., set to starting point). It should be noted that neither XCOPY nor XLOAD rewinds sequential files either before or after the data transmission, so that one sequential file may contain many multiblock data sets.

* CHANGE Lib Id_{old} , Id_{new} $. This command causes the name of data set to be changed from Id_{old} , to Id_{new} . Only the full 4-word name form is permitted for both Id's.

* DUPLICATE Lib_1 , Lib_2 $. Lib_2 is created identical to existing Lib_1 , including disabled data sets, if any.

* TWRITE Lib$. Lib is written onto tape nt (see NTAPE command). The complete library is written in physical records as large as the available core will allow, i.e., the more available core there is, the more efficient will be the operation of transferring a library from a direct access storage device through core to a tape.

* TREAD Lib$. Lib is read from tape nt (see NTAPE command). Available working core space must be as large as it was when the TWRITE was executed.

* NTAPE= nt$. The internal unit number of the tape to be used in the next TWRITE or TREAD command is nt (default=20). Note that logical 20 is CDC file SPARLT.

* STORE Lib, ID$. Lib is stored as a data set named Id, in Library nℓ (see LIBLIB command). Id may only be a full 4-word name, the first two words of which are typeless.

* RETRIEVE Lib, Id$. The data set Id is recovered from the library nℓ and constituted as library Lib.

* LIBLIB= nℓ $. The internal unit number of the library library is nℓ (default=12). Note that logical 12 is CDC file SPARLL.

* TITLE Lib - - - Alphanumeric title for Lib - - The label-field title is embedded in Lib, and will be displayed at the beginning of each table of contents printout produced by a TOC command.

* STATUS Lib$. The number of library entries and the current I/O counts for Lib are printed.

* ABORT n$. To cause an error-abort if an abnormal event occurs in DCU, set ABORT=1$.

Core Requirements. Working core must be sufficient to accommodate one block of each data set transmitted through core (e.g., via COPY, XCOPY, etc.). See also the discussion of TWRITE and TREAD.

APPENDIX B

INPUT RULES FOR THE FREE-FIELD FORMAT CARD READER

B.1 INTRODUCTION

This Appendix is an adaption of Section 2.3 of Ref. 4 and is included here for completenes. It is important to note that the special symbols used in this Appendix (e.g., record terminators) and the symbols used throughout this manual correspond to CDC graphic display symbols. The corresponding 026 and 029 punches for these symbols may be determined by consulting Table B.1.

B.2 CARD INPUT RULES

The free-field format input decoder recognizes three types of words: integer, floating-point, and alpha (type-less). Leading blanks are ignored. Each word is ended by a blank, comma, equal sign, slash, left parenthesis, or a right parenthesis, or by a record terminator (e.g., end-of-card). If used, commas, etc., should be carefully placed; for example 45 , is equivalent to 45,0. Floating-point numbers are identified by the presence of a decimal point. Alpha words must begin with a letter. Allowable forms for floating-point numbers are:

5000.= .5+4= 50.00+02, etc.

Note that the Fortran form x.xExx is not permitted.

Each card begins an input record. A record is terminated by end-of-card, or by any of the three following symbols:

Record Terminator	Function
$	Characters to the right of a $ are ignored. This is used for two purposes: (1) to allow the input decoder to stop scanning, and (2) to allow the user to insert comments in the data deck. A card with a $ in Column 1 is interpreted as a comment card, and is ignored by the decoder.

; Terminates one record and initiates a new record on the same card. For example,

3, 4 ; A, 9.5$

is the same as

3, 4$

A, 9.5$

≠ All characters to the right of a ≠ form a continuous alphanumeric label of up to 76 characters. Examples of label usage are shown below.

1 0 0 0 0 0 1 0 0 0 0 0 1 1 1 0 ≠
THE KPRINTS FOR THIS EXAMPLE

0. 5. 0. 1. ≠ THE FREQUENCIES FOR THIS EXAMPLE

Typeless words longer than 4 characters are truncated to 4 characters. Integer of floating-point words must not exceed 7 digits. Exponents may have one or two digits. Floating-point numbers must not exceed host system limits.

B.2.1 Equivalence of Word Terminators

The word terminators, (blank), comma, equal sign, left parenthesis, and right parenthesis, are equivalent. For example, the following statements have identical meaning:

Z= SUM(3.5 R,4.2 Q)

Z, SUM 3.5 R 4.2 Q

B.2.2 Continuation Cards

If an input record will not fit on a single 80-character card, a > may be used to indicate that the current record is continued on the next card. For example, the following record:

1. 2. 3. 4. 5. 6. 7. $

could be written as

1. 2.>
3. 4. 5. 6.>
7. $

The > symbol also acts as a word terminator. Continuation cards must not be used to extend an input record beyond 40 words.

CDC Graphic	026 Punch	029 Punch	Purpose
[	8-7	12-8-2	A [in col. 1 indicates an executive control command i.e. [XQT some module
$	11-8-3	11-8-3	Record terminator
;	12-8-7	11-8-6	Record terminator
≠	8-4	8-7	Record terminator (Indicates the start of a label)
blank	no punch	no punch	Word terminator
,	0-8-3	0-8-3	Word terminator
=	8-3	8-6	Word terminator
(	0-8-4	12-8-5	Word terminator
)	12-8-4	11-8-5	Word terminator
>	11-8-7	0-8-6	Indicates current record is continued on next card

Table B.1 Special Symbols Recognized by Free-Field Format Input Card Reader

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Alternate Monitor: Robert N. Desmarais, NASA Langley Research Center

16. Abstract

Presented here is a user/programmer manual for the computer program SOUSSA-P 1.1 (Steady, Oscillatory, and Unsteady Subsonic and Supersonic Aerodynamics - Production Version 1.1). The theoretical formulation upon which the program is based is described in a companion manual, NASA CR-159130. The overall objective in designing the program was to provide accurate and efficient evaluation of steady and unsteady loads on aircraft having arbitrary shapes and motions, including structural deformations. The SOUSSA-P 1.1 program was therefore designed to be modular, computationally efficient, user-oriented, general, accurate, and simple. These design goals were in part achieved through the incorporation of the data handling capabilities of the SPAR Finite-Element Structural Analysis computer program. As a further result, SOUSSA-P posses an extensive checkpoint/restart facility. The programmer's portion of this manual includes the following: overlay/subroutine hierarchy, logical flow of control, definition of SOUSSA-P 1.1 FORTRAN variables, definition of SOUSSA-P 1.1 subroutines. The user-oriented portion of the manual describes the following: purpose of the SOUSSA-P 1.1 modules, input data to the program, output of the program, hardware/software requirements, error detection and reporting capabilities, job control statements, a summary of the procedure for running the program, two test cases including input and output listings.

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