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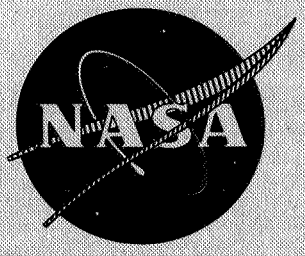

FINAL REPORT

STUDY OF INDUCER LOAD AND STRESS

Pratt & Whitney Aircraft
FLORIDA RESEARCH AND DEVELOPMENT CENTER
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Prepared for
NATIONAL AERONAUTICS
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16. Abstract

Three turbopump inducer computer programs are presented for the prediction of: (1) Inducer internal flow conditions, including blade pressure loading, and inducer performance under both noncavitating and cavitating flow conditions; (2) Inducer blade stress distribution caused by pressure loading and centrifugal force; and (3) Inducer blade natural frequencies and the distribution of relative displacements and stresses at resonance. Input-output descriptions and sample cases for the computer programs are included.

17. Key Words (Suggested by Author(s))		18. Distribution Statement
Inducer	Hydrodynamic Load	Unclassified - Unlimited
Hydrodynamics	Sweepback	
Tip Clearance	Internal Flow	
Cavitation	Blade Loading	

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FOREWORD

This volume (II) documents the computer programs developed under Contract NAS3-11216. The volume was originally published in December 1970 and contained the programs as described in report Volume I. Additional work on the hydrodynamic analysis and computer program (in the areas of tip clearance and leading edge sweepback) was later conducted under Contract Modification 3. This additional work is reported in Volume III and the modified computer program is included in this revised issue of Volume II.

The work was sponsored by the Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio, under the technical direction of the Chemical Rocket Division with Mr. D. D. Scheer, Project Manager. Further information regarding the programs and their application may be obtained by contacting Mr. Scheer.

Pratt and Whitney Aircraft's Florida Research and Development Center at West Palm Beach, Florida was the contractor and Mr. W. E. Young was the Program Manager. The following Pratt & Whitney personnel contributed to the program:

Mr. R. E. Davis supervised the analytic effort.

Mr. H. J. Barten, Mr. L. L. Coons, and Mr. G. G. Roberts performed the analytic work.

Mr. D. R. Edmonds Jr. and Mr. J. A. Scheurenbrand did the computer programming.

CONTENTS

ILLUSTRATIONS

SECTION I

INTRODUCTION

The computer programs that were developed as a result of the work reported in Volumes I and III are listed in this volume. Three computer programs are included:

1) Hydrodynamic Computer Program - This program calculates the internal flow, blade loading, and performance of an inducer under noncavitating and cavitating conditions. The basic flow analysis uses a mean streamline, two dimensional, axisymmetric model. It is assumed that all cavitation is contained in a cavity on the blade suction surface and, because the vapor cavity merely displaces liquid, it is considered that the actual blade can be replaced by a pseudo blade consisting of the real blade plus the cavity. The analysis includes viscous effects and the program input provides for leading edge sweepback and tip clearance.

2) Stress Computer Program - The stress program calculates stresses and deflections of the inducer blade which result from blade pressure loading and centrifugal force. The analysis uses the finite element matrix displacement method where the blade is replaced by contiguous polygonal elastic elements of finite size which are joined at their vertices or nodes. The program input provides for blade lean and for variable thickness blades.

3) Vibration Computer Program - The vibration program calculates blade natural frequencies and the distribution of relative deflections and stresses for each resonance. This program is a finite element analysis which uses many of the same subroutines as the stress program.

Input and output descriptions, and a sample case are included for each program.

The stress and vibration programs are identical to the listings given in the original issue of this volume. The hydrodynamic analysis has been modified as reported in Volume III and the program changes are included in this revised issue of Volume II.

SECTION II
HYDRODYNAMIC COMPUTER PROGRAM (PWA 6091)

A. GENERAL

The hydrodynamic computer program predicts internal flow conditions and blade pressure loadings within an inducer.

The basic flow analysis uses a mean streamline, two-dimensional, meridional flow model. It is assumed that average flow conditions in the blade-to-blade space can be represented on a meridional surface. A two-dimensional streamline balancing analysis is then used to satisfy radial equilibrium and establish mean velocities, pressures, and flow angles. The program also employs a deviation model to calculate flow conditions downstream of the inducer. Inducer inlet and exit conditions are then integrated to obtain predictions of performance.

The program requires approximately 180,000 bytes of core (165,000 bytes program and 15,000 bytes buffer) on an IBM 370 Model 165 Computer. Computer language is Fortran IV-G Release 1.1. Approximate running time for a typical case (one set flow conditions) with tip clearance is 2 minutes.

B. INPUT DESCRIPTION

The hydrodynamic computer program input can be divided into two parts:

1. A geometric description of the inducer; and

2. A description of the inducer operating flow parameters. More than one set of flow parameters may be input for a given inducer geometry.

Unless otherwise specified, data may be input in any consistent set of units. The same units must be used for force and mass. Output will correspond to the input units used. Several examples are listed below.

Input			Output	
Force	Mass	Length	Velocity	Pressure
lb	lb	ft	ft/sec	lb/ft^2
lb	lb	in.	in./sec	$lb/in.^2$
gram	gram	meter	meter/sec	$gram/meter^2$

Input data to be written on each card are described below. "F" format data should be left adjusted in the column field and should contain a decimal point. "I" format data should be right adjusted and should not contain a decimal point.

Columns	Variable		Format
Card 1	Title Card		
1-80		Job Identification data	20A4
Card 2	General Geometry		
1-5	NI	Number of streamlines to be considered Maximum of 15	I5
6-10	NJ	Number of axial stations to be considered Maximum of 60	I5
11-15	NB	Number of inducer blades	I5
16-20	CASES	Number of flow conditions	I5
21-35	G	Gravitational constant	F15.5
36-45	ALPWH	Hub leading edge wedge angle, degrees	F10.4
46-55	ALPWT	Tip leading edge wedge angle, degrees	F10.4
56-65	CBHR	Tip clearance to blade height ratio, may be zero if tip clearance analysis is not required.	F10.4
Card 3	Geometry at Each Axial Station (NJ Cards)		
1-10	Z	Axial dimension from the station to the leading edge. Stations spacing may be varied to provide fine resolution in areas where flow conditions are expected to change rapidly.	F10.4
11-20	RH	Hub radius	F10.4
21-30	RT	Tip radius	F10.4
31-40	BHS	Hub blade angle, degrees from tangential	F10.4
41-50	BTS	Tip blade angle, degrees from tangential	F10.4
51-60	TT	Blade tip thickness	F10.4
61-70	TA	Blade taper angle, degrees	F10.4
Card 4	+NJ Leading Edge Shape		
1-40	Z_o,Z1 Z_2,Z_3	Coefficients of the third degree quadratic equation which defines the leading edge curvature as projected on the meridional plane	4F10.4

Columns	Variable		Format
Card 5	+NJ Fluid Properties, Speed, & Print Option		
1-10	RHO	Specific weight	F10.4
11-20	MU	Kinematic viscosity	F10.4
21-30	PSAT	Saturation pressure	F10.4
31-40	SN	Rotating speed, rev/sec	F10.4
41-50	LOADOP	0 if no blade loading data desired 1 if blade loading data is desired Automatically 1 if CBHR is positive	I10
Card 6	+NJ Inlet Flow Conditions at Each Streamline (NI Cards)		
1-10	PO	Relative inlet total pressure	F10.0
11-20	VA	Inlet axial velocity	F10.0
21-30	ALPHI	Inlet absolute flow angle, degrees from tangential	F10.0

For more than 1 set of flow conditions (CASES > 1), repeat cards (5+NJ) and (6+NJ)

C. OUTPUT DESCRIPTION

The output of the program is in the following seven parts. Parts 3 thru 7 are printed twice if CBHR is a positive number, first for zero and then for the specified tip clearance.

1. Geometry

The input geometry is printed out for reference. Also solidity at the inlet tip is calculated and printed out.

2. Fluid Properties and Inlet Flow Conditions

The input fluid properties (Card 5) and the input inlet flow conditions (Cards 6 thru NI) are printed.

3. Inlet Conditions

The above flow conditions and the following additional inlet conditions are listed for each streamtube.

I	Streamtube number
ALPHA	Absolute flow angle, degrees from tangential
R	Streamtube radius
BETA	Relative flow angle, degrees from tangential
Q	Volumetric flow
K	Cavitation number, k
W	Relative velocity
U	Inducer tangential velocity

PO Absolute total pressure

V Absolute velocity

PREL Relative total pressure

VM Meridional velocity

P Static pressure

VU Absolute tangential velocity

PHI Mass averaged inlet flow coefficient, ϕ

NPSH Mass averaged net positive suction head

THOMA Cavitation parameter

VT Inducer tip speed

PT Mass averaged total pressure

4. Internal Flow Conditions

The following are listed for each axial station

J Station number

Z Axial dimension to station

ITE Number of iterations required to obtain radial pressure equilibrium.

The following are listed for each streamtube at each axial station.

I Streamtube number

P Static pressure

BETA Relative flow angle, degrees from tangential

ALPHA Absolute flow angle, degrees from tangential

RST Streamline radius

PREL Relative total pressure of the core flow

BETA* Blade angle, degrees from tangential

ETA Efficiency

PCR Ratio (RST-RH) / (RT-RH)

POREL	Relative total pressure (mass-averaged)
DEV	Deviation angle, degrees
W	Relative velocity
R	Streamtube radius
PT	Absolute total pressure
DLB*	Vapor cavity slope angle, degrees
U	Inducer tangential velocity
TAU	Blade tangential spacing
M*	Distance along blade
XMTH	Momentum thickness
V	Absolute velocity
THK	Normal blade thickness
BN	Normal cavity height
DEL*	Boundary layer displacement thickness
VU	Absolute tangential velocity
B	Tangential cavity height
PCB	Ratio of tangential cavity height to blade tangential spacing, B/TAU
HSF	Ratio DEL*/XMTH
VM	Meridional velocity

5. Exit Conditions

The following are listed for each streamtube at an axial station downstream of the inducer.

I	Streamtube number
ALPHA	Absolute flow angle, degrees from tangential
R	Radius of streamtube
BETA	Relative flow angle, degrees from tangential
DEV	Deviation angle

V Absolute velocity

H Head rise

VM Meridional velocity

P Static pressure

VU Absolute tangential velocity

PT Total pressure

WU Relative tangential velocity

ETA Efficiency

W Relative velocity

6. Performance Parameters

The following listed parameters represent the mass averaged performance of the inducer.

NPSH Net positive suction head

PHI Flow coefficient

PSI Head coefficient

H Head rise

HI Ideal head rise

RN Reynolds number

ETA Efficiency

SS Specific speed

QI Volumetric flow

CVOL Total blade suction surface cavity volume (all blades)

PSI IDEAL Ideal head coefficient

PSI LOSS Head loss coefficient

7. Blade Loading Data

This data is listed if "LOADOP" is input as 1. The following are listed for each axial station.

J Station number

Z Axial dimension to station

Z/ZT Ratio of axial length to total axial length

The following are listed for each streamtube at each axial station.

I	Streamtube number
R	Streamtube radius
PS	Static pressure on blade suction surface
PP	Static pressure on blade pressure surface
WS	Relative velocity along blade suction surface
WP	Relative velocity along blade pressure surface
DPB	Normal pressure difference across blade
PSIS	Suction surface static head coefficient
PSIP	Pressure surface static head coefficient

D. HYDRODYNAMIC COMPUTER PROGRAM

Sample Case (Noncavitating Flow)

DECK 6091

INDUCER HYDRODYNAMIC PPROGRAM

COURSE GRID - RADIAL L.E. -

NI	NJ	NB	CASES	G	CBHR
7	25	3	1	32.20000	0.0290

	Z	RH	RT	BH*	BT*	TT	TA
1	0.0	0.11680	0.29180	19.34599	8.00000	0.00100	0.0
2	0.00500	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
3	0.01000	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
4	0.01500	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
5	0.02000	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
6	0.02500	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
7	0.03000	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
8	0.03500	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
9	0.04000	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
10	0.04500	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
11	0.05000	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
12	0.05500	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
13	0.06000	0.11680	0.29180	19.34599	8.00000	0.01082	0.0
14	0.08000	0.11760	0.29180	19.32899	8.06000	0.01082	0.0
15	0.10000	0.12000	0.29180	19.31000	8.21000	0.01082	0.0
16	0.12000	0.12250	0.29180	19.30000	8.35000	0.01082	0.0
17	0.14000	0.12600	0.29180	19.20000	8.55000	0.01082	0.0
18	0.16000	0.13000	0.29180	19.10001	8.77000	0.01082	0.0
19	0.18000	0.13500	0.29180	19.00000	9.05000	0.01082	0.0
20	0.20000	0.14100	0.29180	18.80000	9.35000	0.01082	0.0
21	0.22000	0.14600	0.29180	18.89999	9.70000	0.01082	0.0
22	0.24000	0.15000	0.29180	19.00000	10.05000	0.01082	0.0
23	0.26000	0.15370	0.29180	19.25000	10.40000	0.01082	0.0
24	0.28000	0.15610	0.29180	19.60001	10.80000	0.01082	0.0
25	0.29200	0.15610	0.29180	19.89999	11.00000	0.00100	0.0

SWEPT LEADING EDGE COEFFICIENTS
Z0= 0.0
Z1= 0.0
Z2= 0.0
Z3= 0.0

SOLIDITY	ALPWH	ALPWT
2.8948708	19.3499908	7.9999981

CASE NUMBER - 1

RHO	MU	PSAT	SN	LOADOP	FLR
62.30000	0.00064	52.20000	81.81400	1	0.200992

PO	VM	ALPHA
6909.50000	12.60000	90.00000
6909.50000	12.60000	90.00000
6909.50000	12.60000	90.00000
6909.50000	12.60000	90.00000
6909.50000	12.60000	90.00000
6909.50000	12.60000	90.00000
6909.50000	12.60000	90.00000

INLET CONDITIONS

I ALPHA	R BETA	Q K	W U	PO V	PREL VM	P VU
1	0.13563	0.13478	70.84999	6909.50000	11611.9453	6755.91406
89.99997	10.24401	1.38049	69.72055	12.60000	12.60000	0.00000
2	0.16952	0.13478	88.04974	6909.50000	14255.8594	6755.91406
89.99997	8.22733	0.89383	87.14352	12.60000	12.60000	0.00000
3	0.19752	0.13478	102.31271	6909.50000	16882.4570	6755.91406
89.99997	7.07405	0.66199	101.53381	12.60000	12.60000	0.00000
4	0.22195	0.13478	114.78851	6909.50000	19502.6484	6755.91406
89.99997	6.30189	0.52592	114.09462	12.60000	12.60000	0.00000
5	0.24393	0.13478	126.02280	6909.50000	22119.7695	6755.91406
89.99997	5.73813	0.43633	125.39127	12.60000	12.60000	0.00000
6	0.26407	0.13478	136.32800	6909.50000	24735.1914	6755.91406
89.99997	5.30309	0.37286	135.74437	12.60000	12.60000	0.00000
7	0.28277	0.13478	145.90343	6909.50000	27349.5508	6755.91406
89.99997	4.95415	0.32552	145.35822	12.60000	12.60000	0.00000

PHI	NPSH	THOMA	VT	PT	KTIP
0.0840	110.0690	0.3150	150.0009	6909.5000	0.3058

STATION J = 1 , Z = 0.0 , ITE = 1

I	RST	PCR	R	TAU	THK	B
P	PREL	PCREL	PT	M*	BN	PCB
BETA	BETA*	DEV	DLB*	XMTH	DEL*	HSF
ALPHA	ETA	W	U	V	VU	VM
1	0.15446E+00	0.21519E+00	0.13563E+00	0.28406E+00	0.0	0.0
0.67559E+04	0.11612E+05	0.11612E+05	0.69095E+04	0.0	0.0	0.0
0.10244E+02	0.16823E+02	0.65790E+01	0.65790E+01	0.10586E-03	0.0	0.14000E+01
0.90000E+02	0.10000E+01	0.70850E+02	0.69721E+02	0.12600E+02	0.15259E-04	0.12600E+02
2	0.18459E+00	0.38735E+00	0.16952E+00	0.35505E+00	0.0	0.0
0.67559E+04	0.14256E+05	0.14256E+05	0.69095E+04	0.0	0.0	0.0
0.82273E+01	0.13599E+02	0.53717E+01	0.53716E+01	0.94957E-04	0.0	0.14000E+01
0.90000E+02	0.10000E+01	0.88050E+02	0.87143E+02	0.12600E+02	-0.30518E-04	0.12600E+02
3	0.21045E+00	0.53512E+00	0.19752E+00	0.41368E+00	0.0	0.0
0.67559E+04	0.16882E+05	0.16882E+05	0.69095E+04	0.0	0.0	0.0
0.70740E+01	0.11729E+02	0.46552E+01	0.46552E+01	0.88090E-04	0.0	0.14000E+01
0.90000E+02	0.10000E+01	0.10231E+03	0.10153E+03	0.12600E+02	-0.15259E-04	0.12600E+02
4	0.23346E+00	0.66661E+00	0.22195E+00	0.46485E+00	0.0	0.0
0.67559E+04	0.19503E+05	0.19503E+05	0.69095E+04	0.0	0.0	0.0
0.63019E+01	0.10466E+02	0.41664E+01	0.41664E+01	0.83165E-04	0.0	0.14000E+01
0.90000E+02	0.10000E+01	0.11479E+03	0.11409E+03	0.12600E+02	-0.45776E-04	0.12600E+02
5	0.25440E+00	0.78626E+00	0.24393E+00	0.51088E+00	0.0	0.0
0.67559E+04	0.22120E+05	0.22120E+05	0.69095E+04	0.0	0.0	0.0
0.57381E+01	0.95434E+01	0.38053E+01	0.38053E+01	0.79372E-04	0.0	0.14000E+01
0.90000E+02	0.10000E+01	0.12602E+03	0.12539E+03	0.12600E+02	-0.45776E-04	0.12600E+02
6	0.27374E+00	0.89678E+00	0.26407E+00	0.55306E+00	0.0	0.0
0.67559E+04	0.24735E+05	0.24735E+05	0.69095E+04	0.0	0.0	0.0
0.53031E+01	0.88275E+01	0.35244E+01	0.35244E+01	0.76313E-04	0.0	0.14000E+01
0.90001E+02	0.10000E+01	0.13633E+03	0.13574E+03	0.12600E+02	-0.16785E-03	0.12600E+02
7	0.29180E+00	0.10000E+01	0.28277E+00	0.59223E+00	0.0	0.0
0.67559E+04	0.27350E+05	0.27350E+05	0.69095E+04	0.0	0.0	0.0
0.49542E+01	0.82520E+01	0.32979E+01	0.32979E+01	0.73766E-04	0.0	0.14000E+01
0.90001E+02	0.10000E+01	0.14590E+03	0.14536E+03	0.12600E+02	-0.12207E-03	0.12600E+02

STATION J = 2 , Z = 0.00500 , ITE = 100

I	RST	PCR	R	TAU	THK	B
P	PREL	POREL	PT	M*	BN	PCB
BETA	BETA*	DEV	DLB*	XMTH	DEL*	HSF
ALPHA	ETA	W	U	V	VU	VM
1	0.15412E+00	0.21327E+00	0.13546E+00	0.26419E+00	0.56544E-02	0.0
0.78115E+04	0.11600E+05	0.11525E+05	0.79944E+04	0.17269E-01	0.0	0.0
0.12817E+02	0.16843E+02	0.40260E+01	0.0	0.18865E-03	0.27971E-03	0.14627E+01
0.58189E+02	0.93511E+00	0.62582E+02	0.69634E+02	0.16337E+02	0.86113E+01	0.13883E+02
2	0.18442E+00	0.38641E+00	0.16927E+00	0.32876E+00	0.60664E-02	0.21685E-02
0.87722E+04	0.14234E+05	0.14207E+05	0.90931E+04	0.23365E-01	0.51059E-03	0.65962E-02
0.10496E+02	0.13618E+02	0.31227E+01	0.12510E+01	0.19106E-03	0.28528E-03	0.14931E+01
0.46189E+02	0.98772E+00	0.75141E+02	0.87015E+02	0.18968E+02	0.13131E+02	0.13688E+02
3	0.21043E+00	0.53504E+00	0.19743E+00	0.38308E+00	0.61854E-02	0.78720E-02
0.90676E+04	0.16873E+05	0.16837E+05	0.93966E+04	0.32299E-01	0.16010E-02	0.20549E-01
0.88909E+01	0.11734E+02	0.28436E+01	0.28371E+01	0.18028E-03	0.26522E-03	0.14712E+01
0.47166E+02	0.98543E+00	0.89712E+02	0.10149E+03	0.18907E+02	0.12854E+02	0.13865E+02
4	0.23345E+00	0.66659E+00	0.22194E+00	0.43117E+00	0.61163E-02	0.12856E-01
0.92680E+04	0.19502E+05	0.19455E+05	0.95561E+04	0.40161E-01	0.23360E-02	0.29817E-01
0.78484E+01	0.10469E+02	0.26203E+01	0.33288E+01	0.17350E-03	0.25250E-03	0.14553E+01
0.49018E+02	0.98266E+00	0.10285E+03	0.11409E+03	0.18604E+02	0.12201E+02	0.14045E+02
5	0.25440E+00	0.78627E+00	0.24393E+00	0.47517E+00	0.59194E-02	0.18095E-01
0.93982E+04	0.22120E+05	0.22063E+05	0.96643E+04	0.48002E-01	0.30000E-02	0.38080E-01
0.70760E+01	0.95434E+01	0.24675E+01	0.35762E+01	0.16962E-03	0.24501E-03	0.14444E+01
0.50633E+02	0.97975E+00	0.11467E+03	0.12539E+03	0.18272E+02	0.11590E+02	0.14126E+02
6	0.27374E+00	0.89679E+00	0.26407E+00	0.51640E+00	0.56270E-02	0.23246E-01
0.94646E+04	0.24735E+05	0.24668E+05	0.97284E+04	0.55552E-01	0.35673E-02	0.45016E-01
0.64827E+01	0.88275E+01	0.23448E+01	0.36830E+01	0.16731E-03	0.24033E-03	0.14364E+01
0.52216E+02	0.97664E+00	0.12556E+03	0.13575E+03	0.17937E+02	0.10990E+02	0.14176E+02
7	0.29180E+00	0.10000E+01	0.28277E+00	0.55559E+00	0.52596E-02	0.26042E-01
0.95570E+04	0.27350E+05	0.26946E+05	0.94585E+04	0.60609E-01	0.37377E-02	0.46872E-01
0.60647E+01	0.82520E+01	0.21673E+01	0.35289E+01	0.16615E-03	0.23767E-03	0.14305E+01
0.53768E+02	0.86328E+00	0.13562E+03	0.14536E+03	0.17763E+02	0.10499E+02	0.14328E+02

STATION J = 3 , Z = 0.01000 , ITE = 100

I	RST	PCR	R	TAU	THK	B
P	PREL	POREL	PT	M*	BN	PCB
BETA	BETA*	DEV	DLB*	XMTH	DEL*	HSF
ALPHA	ETA	W	U	V	VU	VM
1	0.15406E+00	0.21292E+00	0.13543E+00	0.24631E+00	0.10820E-01	0.0
0.81958E+04	0.11598E+05	0.11504E+05	0.84655E+04	0.34527E-01	0.0	0.0
0.14695E+02	0.16846E+02	0.21513E+01	0.0	0.25479E-03	0.38386E-03	0.15066E+01
0.50837E+02	0.94277E+00	0.59305E+02	0.69618E+02	0.19403E+02	0.12253E+02	0.15044E+02
2	0.18446E+00	0.38665E+00	0.16926E+00	0.30855E+00	0.10820E-01	0.0
0.89098E+04	0.13494E+05	0.13423E+05	0.94184E+04	0.42499E-01	0.0	0.0
0.12178E+02	0.13619E+02	0.14415E+01	0.0	0.28348E-03	0.43682E-03	0.15409E+01
0.36371E+02	0.75584E+00	0.68841E+02	0.87010E+02	0.24468E+02	0.19717E+02	0.14522E+02
3	0.21045E+00	0.53513E+00	0.19746E+00	0.36034E+00	0.10820E-01	0.11271E-01
0.10481E+05	0.16876E+05	0.16826E+05	0.11097E+05	0.60214E-01	0.22920E-02	0.31279E-01
0.10595E+02	0.11733E+02	0.11374E+01	0.0	0.28120E-03	0.42916E-03	0.15262E+01
0.34711E+02	0.98605E+00	0.81307E+02	0.10150E+03	0.26254E+02	0.21582E+02	0.14950E+02
4	0.23349E+00	0.66678E+00	0.22197E+00	0.40533E+00	0.10820E-01	0.16079E-01
0.11364E+05	0.19505E+05	0.19438E+05	0.12062E+05	0.72816E-01	0.32845E-02	0.44602E-01
0.95384E+01	0.10468E+02	0.92906E+00	0.0	0.28558E-03	0.43466E-03	0.15220E+01
0.32744E+02	0.98734E+00	0.91734E+02	0.11410E+03	0.28104E+02	0.23638E+02	0.15201E+02
5	0.25457E+00	0.78723E+00	0.24403E+00	0.44580E+00	0.10820E-01	0.25072E-01
0.12365E+05	0.22132E+05	0.22050E+05	0.13169E+05	0.85048E-01	0.41551E-02	0.56239E-01
0.87581E+01	0.95396E+01	0.78147E+00	0.0	0.29342E-03	0.44686E-03	0.15229E+01
0.30349E+02	0.98704E+00	0.10048E+03	0.12544E+03	0.30281E+02	0.26131E+02	0.15300E+02
6	0.27386E+00	0.89749E+00	0.26421E+00	0.48282E+00	0.10820E-01	0.31861E-01
0.13058E+05	0.24755E+05	0.24655E+05	0.13897E+05	0.96659E-01	0.48867E-02	0.65988E-01
0.81544E+01	0.88227E+01	0.66831E+00	0.0	0.29393E-03	0.44497E-03	0.15139E+01
0.30042E+02	0.98597E+00	0.10996E+03	0.13582E+03	0.31155E+02	0.26970E+02	0.15597E+02
7	0.29180E+00	0.10000E+01	0.28283E+00	0.51909E+00	0.10514E-01	0.35538E-01
0.13447E+05	0.27358E+05	0.26795E+05	0.13814E+05	0.10485E+00	0.50995E-02	0.68462E-01
0.76798E+01	0.82503E+01	0.57042E+00	0.0	0.29057E-03	0.43601E-03	0.15005E+01
0.31118E+02	0.92456E+00	0.11992E+03	0.14539E+03	0.31009E+02	0.26547E+02	0.16026E+02

Printout for Stations J=4 thru J=23 is omitted for Brevity.

STATION J = 24 , Z = 0.28000 , ITE = 100

I	RST	PCR	R	TAU	THK	B
P	PREL	POREL	PT	M*	BN	PCB
BETA	BETA*	DEV	DLB*	XMTH	DEL*	HSF
ALPHA	ETA	W	U	V	VU	VM
1	0.18968E+00	0.24747E+00	0.17289E+00	0.32676E+00	0.10820E-01	0.0
0.12193E+05	0.14551E+05	0.14133E+05	0.13653E+05	0.97354E+00	0.0	0.0
0.16907E+02	0.17826E+02	0.91886E+00	0.0	0.18614E-02	0.26494E-02	0.14233E+01
0.19020E+02	0.94171E+00	0.49364E+02	0.88875E+02	0.44050E+02	0.41645E+02	0.14356E+02
2	0.21263E+00	0.41656E+00	0.20115E+00	0.38069E+00	0.10820E-01	0.0
0.12446E+05	0.16514E+05	0.16253E+05	0.14040E+05	0.11690E+01	0.0	0.0
0.14573E+02	0.15454E+02	0.88132E+00	0.0	0.16299E-02	0.22348E-02	0.13711E+01
0.21874E+02	0.87696E+00	0.64849E+02	0.10340E+03	0.43795E+02	0.40642E+02	0.16316E+02
3	0.23121E+00	0.55351E+00	0.22192E+00	0.42028E+00	0.10820E-01	0.0
0.12557E+05	0.18596E+05	0.18204E+05	0.13817E+05	0.13235E+01	0.0	0.0
0.13215E+02	0.14071E+02	0.85638E+00	0.0	0.16565E-02	0.22642E-02	0.13669E+01
0.25922E+02	0.84215E+00	0.79010E+02	0.11408E+03	0.41318E+02	0.37161E+02	0.18062E+02
4	0.24773E+00	0.67527E+00	0.23947E+00	0.45374E+00	0.10820E-01	0.0
0.12633E+05	0.20241E+05	0.19721E+05	0.13740E+05	0.14556E+01	0.0	0.0
0.12247E+02	0.13079E+02	0.83145E+00	0.0	0.17547E-02	0.24048E-02	0.13705E+01
0.27308E+02	0.78704E+00	0.88684E+02	0.12310E+03	0.41006E+02	0.36436E+02	0.18813E+02
5	0.26272E+00	0.78568E+00	0.25523E+00	0.48375E+00	0.10820E-01	0.0
0.12696E+05	0.21970E+05	0.21297E+05	0.13593E+05	0.15742E+01	0.0	0.0
0.11492E+02	0.12299E+02	0.80635E+00	0.0	0.18693E-02	0.25756E-02	0.13778E+01
0.28958E+02	0.74690E+00	0.97910E+02	0.13120E+03	0.40290E+02	0.35253E+02	0.19507E+02
6	0.27654E+00	0.88756E+00	0.26963E+00	0.51118E+00	0.10820E-01	0.0
0.12744E+05	0.23687E+05	0.22841E+05	0.13418E+05	0.16820E+01	0.0	0.0
0.10879E+02	0.11662E+02	0.76263E+00	0.0	0.19954E-02	0.27658E-02	0.13861E+01
0.30439E+02	0.71044E+00	0.10635E+03	0.13860E+03	0.39622E+02	0.34161E+02	0.20073E+02
7	0.29160E+00	0.10000E+01	0.28417E+00	0.53868E+00	0.10820E-01	0.0
0.12785E+05	0.26253E+05	0.21783E+05	0.96180E+04	0.17851E+01	0.0	0.0
0.10327E+02	0.11082E+02	0.75501E+00	0.0	0.20657E-02	0.29037E-02	0.13922E+01
0.35188E+02	0.31946E+00	0.11799E+03	0.14608E+03	0.36706E+02	0.29998E+02	0.21152E+02

STATION J = 25 , Z = 0.29200 , ITE = 100

I	RST	PCR	R	TAU	THK	B
P	PREL	POREL	PT	M*	BN	PCB
BETA	BETA*	DEV	DLB*	XMTH	DEL*	HSF
ALPHA	ETA	W	U	V	VU	VM
1	0.18957E+00	0.24666E+00	0.17284E+00	0.35877E+00	0.10000E-02	0.0
0.12452E+05	0.14546E+05	0.14114E+05	0.14095E+05	0.10125E+01	0.0	0.0
0.16799E+02	0.18113E+02	0.13134E+01	0.0	0.22740E-02	0.33752E-02	0.14843E+01
0.16878E+02	0.94328E+00	0.46519E+02	0.88847E+02	0.46308E+02	0.44313E+02	0.13445E+02
2	0.21251E+00	0.41566E+00	0.20104E+00	0.41736E+00	0.10000E-02	0.0
0.13026E+05	0.16502E+05	0.16244E+05	0.14970E+05	0.12137E+01	0.0	0.0
0.14468E+02	0.15718E+02	0.12503E+01	0.0	0.20999E-02	0.30161E-02	0.14363E+01
0.18293E+02	0.88991E+00	0.59943E+02	0.10334E+03	0.47713E+02	0.45302E+02	0.14976E+02
3	0.23107E+00	0.55249E+00	0.22179E+00	0.46047E+00	0.10000E-02	0.0
0.13370E+05	0.18581E+05	0.18195E+05	0.15001E+05	0.13724E+01	0.0	0.0
0.13109E+02	0.14319E+02	0.12093E+01	0.0	0.21092E-02	0.30104E-02	0.14273E+01
0.21378E+02	0.86257E+00	0.73397E+02	0.11401E+03	0.45669E+02	0.42527E+02	0.16647E+02
4	0.24753E+00	0.67376E+00	0.23930E+00	0.49685E+00	0.10000E-02	0.0
0.13602E+05	0.20220E+05	0.19709E+05	0.15102E+05	0.15082E+01	0.0	0.0
0.12145E+02	0.13316E+02	0.11707E+01	0.0	0.22105E-02	0.31577E-02	0.14285E+01
0.22434E+02	0.81665E+00	0.82715E+02	0.12301E+03	0.45601E+02	0.42150E+02	0.17402E+02
5	0.26238E+00	0.78323E+00	0.25496E+00	0.52937E+00	0.10000E-02	0.0
0.13760E+05	0.21934E+05	0.21275E+05	0.15070E+05	0.16300E+01	0.0	0.0
0.11396E+02	0.12530E+02	0.11337E+01	0.0	0.23205E-02	0.33256E-02	0.14332E+01
0.23638E+02	0.78379E+00	0.91812E+02	0.13106E+03	0.44888E+02	0.41059E+02	0.18142E+02
6	0.27604E+00	0.88367E+00	0.26921E+00	0.55899E+00	0.10000E-02	0.0
0.13929E+05	0.23629E+05	0.22604E+05	0.14994E+05	0.17408E+01	0.0	0.0
0.10791E+02	0.11890E+02	0.10995E+01	0.0	0.24483E-02	0.35248E-02	0.14397E+01
0.25100E+02	0.75437E+00	0.10014E+03	0.13639E+03	0.44197E+02	0.40023E+02	0.18746E+02
7	0.29180E+00	0.10000E+01	0.28392E+00	0.58954E+00	0.10000E-02	0.0
0.14075E+05	0.26217E+05	0.21644E+05	0.11119E+05	0.18469E+01	0.0	0.0
0.10237E+02	0.11295E+02	0.10584E+01	0.0	0.25012E-02	0.36007E-02	0.14396E+01
0.29146E+02	0.41756E+00	0.11203E+03	0.14595E+03	0.40879E+02	0.35702E+02	0.19910E+02

EXIT CONDITIONS

I ALPHA	R BETA	DEV V	H VM	P VU	PT WU	ETA W
1	0.172035E+00	0.154844E+01	0.137005E+03	0.136596E+05	0.154449E+05	0.112052E+01
0.164293E+02	0.166425E+02	0.464144E+02	0.131275E+02	0.445193E+02	0.439162E+02	0.458362E+02
2	0.200244E+00	0.294012E+01	0.129374E+03	0.128025E+05	0.149695E+05	0.889810E+00
0.160590E+02	0.128369E+02	0.473285E+02	0.130923E+02	0.454816E+02	0.574548E+02	0.589276E+02
3	0.221793E+00	0.197607E+01	0.129868E+03	0.130141E+05	0.150003E+05	0.862470E+00
0.201947E+02	0.123424E+02	0.453118E+02	0.156421E+02	0.425263E+02	0.714872E+02	0.731785E+02
4	0.239159E+00	0.168981E+01	0.131486E+03	0.131129E+05	0.151011E+05	0.816554E+00
0.215175E+02	0.116335E+02	0.453345E+02	0.166281E+02	0.421749E+02	0.807657E+02	0.824596E+02
5	0.254637E+00	0.175825E+01	0.130973E+03	0.131511E+05	0.150691E+05	0.763705E+00
0.225924E+02	0.107868E+02	0.445276E+02	0.171063E+02	0.411106E+02	0.897666E+02	0.914017E+02
6	0.269133E+00	0.218657E+01	0.129747E+03	0.131686E+05	0.149927E+05	0.754285E+00
0.227860E+02	0.970718E+01	0.434241E+02	0.168177E+02	0.400352E+02	0.983138E+02	0.997419E+02
7	0.284021E+00	0.154373E+01	0.667594E+02	0.133931E+05	0.110686E+05	0.412540E+00
0.279670E+02	0.974753E+01	0.404088E+02	0.189502E+02	0.356898E+02	0.110312E+03	0.111926E+03

OVERALL PERFORMANCE

NPSH	PHI	PSI	H	HI	RN	ETA	SS	QI
110.0690	0.08400	0.17484	122.173	154.318	4260759.00	0.79170	1.88276	2.83045

CVOL

0.1092E-03

PSI IDEAL = 0.22084 PSI LOSS = 0.04600

BLADE LOADING DATA

J	Z	Z/ZT
1	0.0	0.0

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.13563E+00	0.52200E+02	0.11612E+05	0.10931E+03	0.0	0.11560E+05	-0.15752E+00	0.10802E+00
2	0.16952E+00	0.52200E+02	0.14256E+05	0.12117E+03	0.0	0.14204E+05	-0.15752E+00	0.16875E+00
3	0.19752E+00	0.52200E+02	0.16882E+05	0.13190E+03	0.0	0.16830E+05	-0.15752E+00	0.22909E+00
4	0.22195E+00	0.52200E+02	0.19503E+05	0.14180E+03	0.0	0.19450E+05	-0.15752E+00	0.28928E+00
5	0.24393E+00	0.52200E+02	0.22120E+05	0.15103E+03	0.0	0.22068E+05	-0.15752E+00	0.34940E+00
6	0.26407E+00	0.52200E+02	0.24735E+05	0.15973E+03	0.0	0.24683E+05	-0.15752E+00	0.40947E+00
7	0.28277E+00	0.52200E+02	0.27350E+05	0.16798E+03	0.0	0.27297E+05	-0.15752E+00	0.46953E+00

J	Z	Z/ZT
2	0.00500	0.01712

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.13546E+00	0.67559E+04	0.87457E+04	0.70850E+02	0.54321E+02	0.19898E+04	-0.35280E-02	0.42180E-01
2	0.16927E+00	0.52200E+02	0.97950E+04	0.12117E+03	0.67741E+02	0.97428E+04	-0.15752E+00	0.66283E-01
3	0.19743E+00	0.52200E+02	0.10981E+05	0.13190E+03	0.78046E+02	0.10929E+05	-0.15752E+00	0.93524E-01
4	0.22194E+00	0.52200E+02	0.11990E+05	0.14180E+03	0.88118E+02	0.11938E+05	-0.15752E+00	0.11671E+00
5	0.24393E+00	0.52200E+02	0.12977E+05	0.15103E+03	0.97217E+02	0.12924E+05	-0.15752E+00	0.13937E+00
6	0.26407E+00	0.52200E+02	0.13712E+05	0.15973E+03	0.10675E+03	0.13659E+05	-0.15752E+00	0.15625E+00
7	0.28277E+00	0.52200E+02	0.14100E+05	0.16798E+03	0.11703E+03	0.14047E+05	-0.15752E+00	0.16516E+00

J	Z	Z/ZT
3	0.01000	0.03425

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.13543E+00	0.67559E+04	0.87259E+04	0.70850E+02	0.54489E+02	0.19700E+04	-0.35280E-02	0.41726E-01
2	0.16926E+00	0.67559E+04	0.98057E+04	0.88050E+02	0.61750E+02	0.30498E+04	-0.35280E-02	0.66529E-01
3	0.19746E+00	0.52200E+02	0.10967E+05	0.13190E+03	0.78159E+02	0.10915E+05	-0.15752E+00	0.93200E-01
4	0.22197E+00	0.52200E+02	0.11985E+05	0.14180E+03	0.88167E+02	0.11932E+05	-0.15752E+00	0.11658E+00
5	0.24403E+00	0.52200E+02	0.12977E+05	0.15103E+03	0.97285E+02	0.12924E+05	-0.15752E+00	0.13937E+00
6	0.26421E+00	0.52200E+02	0.13685E+05	0.15973E+03	0.10697E+03	0.13633E+05	-0.15752E+00	0.15564E+00
7	0.28283E+00	0.52200E+02	0.14048E+05	0.16798E+03	0.11730E+03	0.13996E+05	-0.15752E+00	0.16398E+00

J	Z	Z/ZT
4	0.01500	0.05137

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.13540E+00	0.67559E+04	0.87295E+04	0.70850E+02	0.54434E+02	0.19735E+04	-0.35280E-02	0.41806E-01
2	0.16916E+00	0.67559E+04	0.99256E+04	0.88050E+02	0.60662E+02	0.31697E+04	-0.35280E-02	0.69283E-01
3	0.19735E+00	0.67559E+04	0.10947E+05	0.10231E+03	0.72008E+02	0.41911E+04	-0.35280E-02	0.92745E-01
4	0.22191E+00	0.52200E+02	0.12072E+05	0.14180E+03	0.81061E+02	0.12020E+05	-0.15752E+00	0.11660E+00
5	0.24397E+00	0.52200E+02	0.12952E+05	0.15103E+03	0.91940E+02	0.12900E+05	-0.15752E+00	0.13880E+00
6	0.26417E+00	0.52200E+02	0.13583E+05	0.15973E+03	0.10268E+03	0.13530E+05	-0.15752E+00	0.15329E+00
7	0.28281E+00	0.52200E+02	0.13941E+05	0.16798E+03	0.11453E+03	0.13888E+05	-0.15752E+00	0.16151E+00

Printout for Stations J=5 thru J=21 is omitted for Brevity.

J	Z	Z/ZT
22	0.24000	0.82192

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.16762E+00	0.10244E+05	0.12484E+05	0.37606E+02	0.40761E+02	0.22405E+04	0.76594E-01	0.12806E+00
2	0.19746E+00	0.10811E+05	0.12809E+05	0.59673E+02	0.58660E+02	0.19981E+04	0.89624E-01	0.13552E+00
3	0.21949E+00	0.11298E+05	0.13018E+05	0.75980E+02	0.74050E+02	0.17200E+04	0.10080E+00	0.14031E+00
4	0.23794E+00	0.11696E+05	0.13178E+05	0.89831E+02	0.84308E+02	0.14823E+04	0.10995E+00	0.14400E+00
5	0.25436E+00	0.12019E+05	0.13293E+05	0.10218E+03	0.94085E+02	0.12739E+04	0.11737E+00	0.14664E+00
6	0.26927E+00	0.12305E+05	0.13377E+05	0.11336E+03	0.10299E+03	0.10721E+04	0.12393E+00	0.14856E+00
7	0.28411E+00	0.12539E+05	0.13546E+05	0.12373E+03	0.11457E+03	0.10070E+04	0.12932E+00	0.15245E+00

J	Z	Z/ZT
23	0.26000	0.89041

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.17065E+00	0.10707E+05	0.13654E+05	0.30580E+02	0.45899E+02	0.29467E+04	0.87239E-01	0.15493E+00
2	0.19981E+00	0.11252E+05	0.12798E+05	0.55728E+02	0.58970E+02	0.15462E+04	0.99740E-01	0.13526E+00
3	0.22112E+00	0.11629E+05	0.13013E+05	0.73695E+02	0.73184E+02	0.13846E+04	0.10840E+00	0.14021E+00
4	0.23900E+00	0.11942E+05	0.13112E+05	0.88405E+02	0.82464E+02	0.11700E+04	0.11560E+00	0.14248E+00
5	0.25498E+00	0.12217E+05	0.13150E+05	0.10117E+03	0.91407E+02	0.93287E+03	0.12193E+00	0.14335E+00
6	0.26955E+00	0.12462E+05	0.13168E+05	0.11264E+03	0.99745E+02	0.70569E+03	0.12755E+00	0.14376E+00
7	0.28417E+00	0.12654E+05	0.13393E+05	0.12325E+03	0.11193E+03	0.73902E+03	0.13196E+00	0.14893E+00

J	Z	Z/ZT
24	0.28000	0.95890

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.17269E+00	0.11134E+05	0.13660E+05	0.22233E+02	0.45838E+02	0.25257E+04	0.97035E-01	0.15505E+00
2	0.20115E+00	0.11623E+05	0.12802E+05	0.52173E+02	0.58928E+02	0.11798E+04	0.10827E+00	0.13537E+00
3	0.22192E+00	0.11963E+05	0.13014E+05	0.71311E+02	0.73179E+02	0.10510E+04	0.11608E+00	0.14023E+00
4	0.23947E+00	0.12210E+05	0.13113E+05	0.86822E+02	0.82460E+02	0.90251E+03	0.12177E+00	0.14250E+00
5	0.25523E+00	0.12410E+05	0.13151E+05	0.10019E+03	0.91402E+02	0.74129E+03	0.12635E+00	0.14337E+00
6	0.26963E+00	0.12596E+05	0.13169E+05	0.11202E+03	0.99742E+02	0.57230E+03	0.13063E+00	0.14378E+00
7	0.28417E+00	0.12748E+05	0.13393E+05	0.12286E+03	0.11193E+03	0.64527E+03	0.13411E+00	0.14894E+00

J	Z	Z/ZT
25	0.29200	1.00000

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.17284E+00	0.11259E+05	0.13660E+05	0.19114E+02	0.45836E+02	0.24011E+04	0.99901E-01	0.15506E+00
2	0.20104E+00	0.11718E+05	0.12803E+05	0.51224E+02	0.58928E+02	0.10850E+04	0.11044E+00	0.13537E+00
3	0.22179E+00	0.12046E+05	0.13014E+05	0.70710E+02	0.73178E+02	0.96841E+03	0.11798E+00	0.14023E+00
4	0.23930E+00	0.12276E+05	0.13113E+05	0.86433E+02	0.82460E+02	0.83734E+03	0.12326E+00	0.14250E+00
5	0.25496E+00	0.12450E+05	0.13151E+05	0.99976E+02	0.91402E+02	0.70064E+03	0.12728E+00	0.14337E+00
6	0.26921E+00	0.12619E+05	0.13169E+05	0.11191E+03	0.99742E+02	0.54977E+03	0.13115E+00	0.14378E+00
7	0.28392E+00	0.12760E+05	0.13393E+05	0.12281E+03	0.11193E+03	0.63289E+03	0.13440E+00	0.14894E+00

INLET CONDITIONS

I ALPHA	R BETA	Q K	W U	PO V	PREL VM	P VU
1	0.13563	0.13478	70.84999	6909.50000	11611.9453	6755.91406
89.99997	10.24401	1.38049	69.72055	12.60000	12.60000	0.00000
2	0.16952	0.13478	88.04974	6909.50000	14255.8594	6755.91406
89.99997	8.22733	0.89383	87.14352	12.60000	12.60000	0.00000
3	0.19752	0.13478	102.31271	6909.50000	16882.4570	6755.91406
89.99997	7.07405	0.66199	101.53381	12.60000	12.60000	0.00000
4	0.22195	0.13478	114.78851	6909.50000	19502.6484	6755.91406
89.99997	6.30189	0.52592	114.09482	12.60000	12.60000	0.00000
5	0.24393	0.13478	126.02280	6909.50000	22119.7095	6755.91406

89.99997	5.73813	0.43633	125.39127	12.60000	12.60000	0.00000
6	0.26407	0.13478	136.32800	6909.50000	24735.1914	6755.91406
89.99997	5.30309	0.37266	135.74437	12.60000	12.60000	0.00000
7	0.28277	0.13478	145.90343	6909.50000	27349.5508	6755.91406
89.99997	4.95415	0.32552	145.35822	12.60000	12.60000	0.00000

PHI	NPSH	THOMA	VT	PT	KTIP
0.0840	110.0690	0.3150	150.0009	6909.5000	0.3058

STATION J = 1 , Z = 0.0 , ITE = 1

I	RST	PCR	R	TAU	THK	B
P	PREL	POREL	PT	M*	BN	PCB
BETA	BETA*	DEV	DLB*	XMTH	DEL*	HSF
ALPHA	ETA	W	U	V	VU	VM
1	0.15446E+00	0.21519E+00	0.13563E+00	0.28406E+00	0.0	0.0
0.67559E+04	0.11612E+05	0.11612E+05	0.69095E+04	0.0	0.0	0.0
0.10244E+02	0.16823E+02	0.65790E+01	0.65790E+01	0.10586E-03	0.0	0.14000E+01
0.90000E+02	0.10000E+01	0.70850E+02	0.69721E+02	0.12600E+02	0.15259E-04	0.12600E+02
2	0.18459E+00	0.38735E+00	0.16952E+00	0.35505E+00	0.0	0.0
0.67559E+04	0.14256E+05	0.14256E+05	0.69095E+04	0.0	0.0	0.0
0.82273E+01	0.13599E+02	0.53717E+01	0.53716E+01	0.94957E-04	0.0	0.14000E+01
0.90000E+02	0.10000E+01	0.88050E+02	0.87143E+02	0.12600E+02	-0.30518E-04	0.12600E+02
3	0.21045E+00	0.53512E+00	0.19752E+00	0.41368E+00	0.0	0.0
0.67559E+04	0.16882E+05	0.16882E+05	0.69095E+04	0.0	0.0	0.0
0.70740E+01	0.11729E+02	0.46552E+01	0.46552E+01	0.88090E-04	0.0	0.14000E+01
0.90000E+02	0.10000E+01	0.10231E+03	0.10153E+03	0.12600E+02	-0.15259E-04	0.12600E+02
4	0.23346E+00	0.66661E+00	0.22195E+00	0.46485E+00	0.0	0.0
0.67559E+04	0.19503E+05	0.19503E+05	0.69095E+04	0.0	0.0	0.0
0.63019E+01	0.10468E+02	0.41664E+01	0.41664E+01	0.83165E-04	0.0	0.14000E+01
0.90000E+02	0.10000E+01	0.11479E+03	0.11409E+03	0.12600E+02	-0.45776E-04	0.12600E+02
5	0.25440E+00	0.78626E+00	0.24393E+00	0.51088E+00	0.0	0.0
0.67559E+04	0.22120E+05	0.22120E+05	0.69095E+04	0.0	0.0	0.0
0.57381E+01	0.95434E+01	0.38053E+01	0.38053E+01	0.79372E-04	0.0	0.14000E+01
0.90000E+02	0.10000E+01	0.12602E+03	0.12539E+03	0.12600E+02	-0.45776E-04	0.12600E+02
6	0.27374E+00	0.89678E+00	0.26407E+00	0.55306E+00	0.0	0.0
0.67559E+04	0.24735E+05	0.24735E+05	0.69095E+04	0.0	0.0	0.0
0.53031E+01	0.88275E+01	0.35244E+01	0.35244E+01	0.76313E-04	0.0	0.14000E+01
0.90001E+02	0.10000E+01	0.13633E+03	0.13574E+03	0.12600E+02	-0.16785E-03	0.12600E+02
7	0.29180E+00	0.10000E+01	0.28277E+00	0.59223E+00	0.0	0.0
0.67559E+04	0.27350E+05	0.27350E+05	0.69095E+04	0.0	0.0	0.0
0.49542E+01	0.82520E+01	0.32979E+01	0.32979E+01	0.73766E-04	0.0	0.14000E+01
0.90001E+02	0.10000E+01	0.14590E+03	0.14536E+03	0.12600E+02	-0.12207E-03	0.12600E+02

STATION J = 2 , Z = 0.00500 , ITE = 100

I	RST	PCR	R	TAU	THK	B
P	PREL	POREL	PT	M*	BN	PCB
BETA	BETA*	DEV	DLB*	XMTH	DEL*	HSF
ALPHA	ETA	W	U	V	VU	VM
1	0.15407E+00	0.21299E+00	0.13544E+00	0.26415E+00	0.56537E-02	0.0
0.77981E+04	0.11599E+05	0.11523E+05	0.79797E+04	0.17268E-01	0.0	0.0
0.12817E+02	0.16846E+02	0.40280E+01	0.0	0.18816E-03	0.27879E-03	0.14817E+01
0.58549E+02	0.93421E+00	0.62679E+02	0.69622E+02	0.16300E+02	0.85046E+01	0.13905E+02
2	0.18450E+00	0.38667E+00	0.16929E+00	0.32879E+00	0.60670E-02	0.24840E-02
0.87843E+04	0.14236E+05	0.14208E+05	0.91058E+04	0.23671E-01	0.58481E-03	0.75550E-02
0.10468E+02	0.13617E+02	0.31487E+01	0.14143E+01	0.19133E-03	0.28578E-03	0.14936E+01
0.45925E+02	0.98779E+00	0.75067E+02	0.87023E+02	0.18985E+02	0.13206E+02	0.13639E+02
3	0.21050E+00	0.53540E+00	0.19750E+00	0.38322E+00	0.61851E-02	0.80038E-02
0.90706E+04	0.16881E+05	0.16844E+05	0.93771E+04	0.32431E-01	0.16272E-02	0.20886E-01
0.88811E+01	0.11730E+02	0.28491E+01	0.28722E+01	0.17987E-03	0.26448E-03	0.14704E+01
0.47413E+02	0.98530E+00	0.89852E+02	0.10153E+03	0.18841E+02	0.12750E+02	0.13872E+02
4	0.23349E+00	0.66678E+00	0.22199E+00	0.43128E+00	0.61152E-02	0.12801E-01
0.92579E+04	0.19507E+05	0.19460E+05	0.95451E+04	0.40110E-01	0.23254E-02	0.29681E-01
0.78499E+01	0.10466E+02	0.26165E+01	0.33183E+01	0.17332E-03	0.25217E-03	0.14549E+01
0.49167E+02	0.98258E+00	0.10293E+03	0.11412E+03	0.18580E+02	0.12149E+02	0.14058E+02
5	0.25440E+00	0.78626E+00	0.24394E+00	0.47521E+00	0.59190E-02	0.17943E-01
0.93861E+04	0.22122E+05	0.22065E+05	0.96515E+04	0.47853E-01	0.29746E-02	0.37757E-01
0.70612E+01	0.95428E+01	0.24617E+01	0.35571E+01	0.16949E-03	0.24477E-03	0.14442E+01
0.50799E+02	0.97966E+00	0.11474E+03	0.12540E+03	0.18252E+02	0.11536E+02	0.14144E+02
6	0.27374E+00	0.89682E+00	0.26407E+00	0.51640E+00	0.56270E-02	0.23344E-01
0.94730E+04	0.24736E+05	0.24668E+05	0.97157E+04	0.55650E-01	0.35824E-02	0.45206E-01
0.64799E+01	0.88274E+01	0.23475E+01	0.36833E+01	0.16722E-03	0.24017E-03	0.14362E+01
0.52336E+02	0.97653E+00	0.12561E+03	0.13575E+03	0.17907E+02	0.10942E+02	0.14175E+02
7	0.29180E+00	0.10000E+01	0.28277E+00	0.55559E+00	0.52596E-02	0.25411E-01
0.95131E+04	0.27350E+05	0.26946E+05	0.94105E+04	0.59985E-01	0.36472E-02	0.45737E-01
0.60512E+01	0.82519E+01	0.22007E+01	0.34794E+01	0.16586E-03	0.23717E-03	0.14300E+01
0.54186E+02	0.86094E+00	0.13579E+03	0.14536E+03	0.17652E+02	0.10329E+02	0.14314E+02

STATION J = 3 , Z = 0.01000 , ITE = 100

I	RST	PCR	R	TAU	THK	B
P	PREL	PCREL	PT	M*	BN	PCB
BETA	BETA*	DEV	DLB*	XMTH	DEL*	HSF
ALPHA	ETA	W	U	V	VU	VM
1	0.15393E+00	0.21219E+00	0.13537E+00	0.24619E+00	0.10820E-01	0.0
0.81730E+04	0.11594E+05	0.11499E+05	0.84394E+04	0.34524E-01	0.0	0.0
0.14698E+02	0.16854E+02	0.21554E+01	0.0	0.25353E-03	0.38147E-03	0.15046E+01
0.51349E+02	0.94173E+00	0.59465E+02	0.69585E+02	0.19320E+02	0.12067E+02	0.15088E+02
2	0.18451E+00	0.38691E+00	0.16922E+00	0.30847E+00	0.10820E-01	0.36572E-02
0.96276E+04	0.14230E+05	0.14194E+05	0.10167E+05	0.46055E-01	0.86135E-03	0.11856E-01
0.12179E+02	0.13622E+02	0.14434E+01	0.0	0.28203E-03	0.43386E-03	0.15384E+01
0.36635E+02	0.98902E+00	0.68973E+02	0.86988E+02	0.24385E+02	0.19568E+02	0.14551E+02
3	0.21051E+00	0.53550E+00	0.19751E+00	0.36044E+00	0.10820E-01	0.11453E-01
0.10466E+05	0.16882E+05	0.16631E+05	0.11103E+05	0.60403E-01	0.23284E-02	0.31775E-01
0.10590E+02	0.11730E+02	0.11397E+01	0.0	0.28159E-03	0.42996E-03	0.15269E+01
0.34668E+02	0.98804E+00	0.81310E+02	0.10153E+03	0.26270E+02	0.21606E+02	0.14943E+02
4	0.23360E+00	0.66740E+00	0.22205E+00	0.40549E+00	0.10820E-01	0.18007E-01
0.11410E+05	0.19514E+05	0.19448E+05	0.12119E+05	0.72759E-01	0.32703E-02	0.44409E-01
0.95369E+01	0.10464E+02	0.92659E+00	0.0	0.28698E-03	0.43738E-03	0.15241E+01
0.32410E+02	0.98747E+00	0.91527E+02	0.11415E+03	0.28293E+02	0.23886E+02	0.15164E+02
5	0.25462E+00	0.78752E+00	0.24411E+00	0.44595E+00	0.10820E-01	0.24877E-01
0.12331E+05	0.22142E+05	0.22060E+05	0.13127E+05	0.84867E-01	0.41216E-02	0.55786E-01
0.87582E+01	0.95365E+01	0.77837E+00	0.0	0.29240E-03	0.44488E-03	0.15215E+01
0.30580E+02	0.98695E+00	0.10071E+03	0.12548E+03	0.30142E+02	0.25950E+02	0.15334E+02
6	0.27378E+00	0.89704E+00	0.26420E+00	0.46260E+00	0.10820E-01	0.31959E-01
0.12895E+05	0.24753E+05	0.24653E+05	0.13699E+05	0.96755E-01	0.49020E-02	0.66195E-01
0.81543E+01	0.88232E+01	0.66890E+00	0.0	0.29056E-03	0.43853E-03	0.15092E+01
0.30920E+02	0.98554E+00	0.11071E+03	0.13581E+03	0.30561E+02	0.26218E+02	0.15704E+02
7	0.29160E+00	0.10000E+01	0.28279E+00	0.51899E+00	0.10518E-01	0.34737E-01
0.12818E+05	0.27353E+05	0.26786E+05	0.13047E+05	0.10405E+00	0.49853E-02	0.66932E-01
0.74558E+01	0.82514E+01	0.79564E+00	0.0	0.27970E-03	0.41565E-03	0.14861E+01
0.33721E+02	0.91574E+00	0.12258E+03	0.14537E+03	0.28651E+02	0.23830E+02	0.15905E+02

Printout for Stations J=4 thru J=23 is omitted for Brevity.

STATION J = 24 , Z = 0.28000 , ITE = 100

I	RST	PCR	R	TAU	THK	B
P	PREL	POREL	PT	M*	BN	PCB
BETA	BETA*	DEV	DLB*	XMTH	DEL*	HSF
ALPHA	ETA	W	U	V	VU	VM
1	0.18864E+00	0.23977E+00	0.17237E+00	0.32576E+00	0.10820E-01	0.0
0.11858E+05	0.14505E+05	0.14100E+05	0.13118E+05	0.97327E+00	0.0	0.0
0.16951E+02	0.17876E+02	0.92466E+00	0.0	0.15670E-02	0.21607E-02	0.13789E+01
0.21571E+02	0.93877E+00	0.52305E+02	0.88607E+02	0.41480E+02	0.38575E+02	0.15250E+02
2	0.21043E+00	0.40038E+00	0.19953E+00	0.37760E+00	0.10820E-01	0.0
0.12005E+05	0.16440E+05	0.16168E+05	0.13348E+05	0.11659E+01	0.0	0.0
0.14678E+02	0.15573E+02	0.89511E+00	0.0	0.15518E-02	0.21179E-02	0.13649E+01
0.24830E+02	0.87511E+00	0.67705E+02	0.10257E+03	0.40853E+02	0.37076E+02	0.17155E+02
3	0.22873E+00	0.53522E+00	0.21958E+00	0.41583E+00	0.10820E-01	0.0
0.12113E+05	0.18331E+05	0.17923E+05	0.13211E+05	0.13162E+01	0.0	0.0
0.13342E+02	0.14215E+02	0.87252E+00	0.0	0.16775E-02	0.23049E-02	0.13740E+01
0.27953E+02	0.82763E+00	0.80175E+02	0.11288E+03	0.39470E+02	0.34865E+02	0.18501E+02
4	0.24519E+00	0.65654E+00	0.23696E+00	0.44895E+00	0.10820E-01	0.0
0.12238E+05	0.19934E+05	0.19384E+05	0.13205E+05	0.14458E+01	0.0	0.0
0.12367E+02	0.13212E+02	0.84524E+00	0.0	0.18337E-02	0.25407E-02	0.13856E+01
0.28842E+02	0.77004E+00	0.89193E+02	0.12181E+03	0.39599E+02	0.34687E+02	0.19103E+02
5	0.26020E+00	0.76717E+00	0.25270E+00	0.47893E+00	0.10820E-01	0.0
0.12352E+05	0.21657E+05	0.20939E+05	0.13117E+05	0.15619E+01	0.0	0.0
0.11601E+02	0.12418E+02	0.81665E+00	0.0	0.19868E-02	0.27753E-02	0.13969E+01
0.30242E+02	0.73010E+00	0.98074E+02	0.12990E+03	0.39159E+02	0.33830E+02	0.19722E+02
6	0.27324E+00	0.86322E+00	0.26672E+00	0.50565E+00	0.10820E-01	0.0
0.12458E+05	0.22537E+05	0.21664E+05	0.13386E+05	0.16635E+01	0.0	0.0
0.12225E+02	0.11785E+02	-0.43942E+00	0.0	0.22232E-02	0.31417E-02	0.14132E+01
0.30059E+02	0.65368E+00	0.10208E+03	0.13711E+03	0.43151E+02	0.37348E+02	0.21614E+02
7	0.29180E+00	0.10000E+01	0.28252E+00	0.53573E+00	0.10820E-01	0.0
0.12547E+05	0.27086E+05	0.22444E+05	0.87486E+04	0.17732E+01	0.0	0.0
0.81459E+01	0.11145E+02	0.29991E+01	0.0	0.23252E-02	0.33059E-02	0.14218E+01
0.36038E+02	0.27413E+00	0.12259E+03	0.14523E+03	0.29526E+02	0.23875E+02	0.17370E+02

STATION J = 25 , Z = 0.29200 , ITE = 22

I	RST	PCR	R	TAU	THK	B
P	PREL	PCREL	PT	M*	BN	PCB
BETA	BETA*	DEV	DLB*	XMTH	DEL*	HSF
ALPHA	ETA	W	U	V	VU	VM
1	0.18861E+00	0.23958E+00	0.17236E+00	0.35777E+00	0.10000E-02	0.0
0.12117E+05	0.14503E+05	0.14084E+05	0.13530E+05	0.10121E+01	0.0	0.0
0.16839E+02	0.16160E+02	0.13207E+01	0.0	0.18843E-02	0.26835E-02	0.14242E+01
0.19307E+02	0.94044E+00	0.49664E+02	0.88600E+02	0.43513E+02	0.41065E+02	0.14387E+02
2	0.21039E+00	0.40010E+00	0.19950E+00	0.41417E+00	0.10000E-02	0.0
0.12673E+05	0.16437E+05	0.16168E+05	0.14363E+05	0.12102E+01	0.0	0.0
0.14564E+02	0.15832E+02	0.12683E+01	0.0	0.20173E-02	0.28867E-02	0.14310E+01
0.20397E+02	0.89054E+00	0.62376E+02	0.10255E+03	0.45005E+02	0.42183E+02	0.15685E+02
3	0.22873E+00	0.53523E+00	0.21956E+00	0.45565E+00	0.10000E-02	0.0
0.12998E+05	0.18329E+05	0.17926E+05	0.14468E+05	0.13647E+01	0.0	0.0
0.13227E+02	0.14457E+02	0.12304E+01	0.0	0.21519E-02	0.30956E-02	0.14386E+01
0.22702E+02	0.85258E+00	0.74235E+02	0.11287E+03	0.44010E+02	0.40601E+02	0.16985E+02
4	0.24516E+00	0.65627E+00	0.23694E+00	0.49195E+00	0.10000E-02	0.0
0.13253E+05	0.19932E+05	0.19391E+05	0.14608E+05	0.14978E+01	0.0	0.0
0.12254E+02	0.13443E+02	0.11887E+01	0.0	0.23137E-02	0.33502E-02	0.14480E+01
0.23475E+02	0.80456E+00	0.83089E+02	0.12180E+03	0.44270E+02	0.40606E+02	0.17635E+02
5	0.26005E+00	0.76600E+00	0.25260E+00	0.52448E+00	0.10000E-02	0.0
0.13459E+05	0.21644E+05	0.20942E+05	0.14607E+05	0.16173E+01	0.0	0.0
0.11495E+02	0.12642E+02	0.11476E+01	0.0	0.24607E-02	0.35830E-02	0.14561E+01
0.24778E+02	0.77160E+00	0.91985E+02	0.12985E+03	0.43737E+02	0.39711E+02	0.18330E+02
6	0.27303E+00	0.86166E+00	0.26654E+00	0.55343E+00	0.10000E-02	0.0
0.13625E+05	0.22512E+05	0.21662E+05	0.14974E+05	0.17217E+01	0.0	0.0
0.12049E+02	0.12005E+02	-0.43232E-01	0.0	0.27402E-02	0.40422E-02	0.14752E+01
0.24611E+02	0.70292E+00	0.95848E+02	0.13701E+03	0.47679E+02	0.43278E+02	0.20008E+02
7	0.29180E+00	0.10000E+01	0.28241E+00	0.58641E+00	0.10000E-02	0.0
0.13766E+05	0.27070E+05	0.22303E+05	0.10091E+05	0.18347E+01	0.0	0.0
0.82264E+01	0.11353E+02	0.31269E+01	0.0	0.27234E-02	0.39950E-02	0.14669E+01
0.29961E+02	0.38910E+00	0.11727E+03	0.14518E+03	0.33600E+02	0.29110E+02	0.16780E+02

EXIT CONDITIONS

I ALPHA	R BETA	DEV V	H VM	P VU	PT WU	ETA W
1	0.171517E+00	0.237785E+01	0.126320E+03	0.132517E+05	0.147792E+05	0.111794E+01
0.179004E+02	0.158643E+02	0.433654E+02	0.133289E+02	0.412662E+02	0.469026E+02	0.487598E+02
2	0.198671E+00	0.289563E+01	0.119626E+03	0.124422E+05	0.143622E+05	0.890414E+00
0.180424E+02	0.129993E+02	0.445497E+02	0.137979E+02	0.423591E+02	0.597687E+02	0.613408E+02
3	0.219578E+00	0.198616E+01	0.121316E+03	0.126259E+05	0.144675E+05	0.852463E+00
0.214899E+02	0.124699E+02	0.436307E+02	0.159836E+02	0.405976E+02	0.722772E+02	0.740234E+02
4	0.236798E+00	0.169440E+01	0.123563E+03	0.127349E+05	0.146074E+05	0.804451E+00
0.225566E+02	0.117561E+02	0.439967E+02	0.168770E+02	0.406310E+02	0.810957E+02	0.828332E+02
5	0.252275E+00	0.184470E+01	0.123547E+03	0.127917E+05	0.146065E+05	0.771504E+00
0.233616E+02	0.108132E+02	0.433126E+02	0.171749E+02	0.397619E+02	0.899212E+02	0.915468E+02
6	0.266331E+00	0.995323E+00	0.129427E+03	0.128368E+05	0.149728E+05	0.702833E+00
0.228219E+02	0.110191E+02	0.469896E+02	0.182258E+02	0.433110E+02	0.935972E+02	0.953553E+02
7	0.282380E+00	0.381874E+01	0.512748E+02	0.129023E+05	0.101039E+05	0.390682E+00
0.278028E+02	0.753595E+01	0.329131E+02	0.153517E+02	0.291135E+02	0.116045E+03	0.117056E+03

OVERALL PERFORMANCE

NPSH	PHI	PSI	H	HI	RN	ETA	SS	QI
110.0690	0.08400	0.15274	106.727	145.541	4260759.00	0.73331	1.88276	2.83045

CVOL

0.1090E-03

PSI IDEAL = 0.20828 PSI LOSS = 0.05555

BLADE LOADING DATA

J	Z	Z/ZT
1	0.0	0.0

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.13563E+00	0.52200E+02	0.11612E+05	0.10931E+03	0.0	0.11560E+05	-0.15752E+00	0.10802E+00
2	0.16952E+00	0.52200E+02	0.14256E+05	0.12117E+03	0.0	0.14204E+05	-0.15752E+00	0.16875E+00
3	0.19752E+00	0.52200E+02	0.16882E+05	0.13190E+03	0.0	0.16830E+05	-0.15752E+00	0.22909E+00
4	0.22195E+00	0.52200E+02	0.19503E+05	0.14180E+03	0.0	0.19450E+05	-0.15752E+00	0.28928E+00
5	0.24393E+00	0.52200E+02	0.22120E+05	0.15103E+03	0.0	0.22068E+05	-0.15752E+00	0.34940E+00
6	0.26407E+00	0.52200E+02	0.24735E+05	0.15973E+03	0.0	0.24683E+05	-0.15752E+00	0.40947E+00
7	0.26277E+00	0.52200E+02	0.27350E+05	0.16798E+03	0.0	0.27297E+05	-0.15752E+00	0.46953E+00

J	Z	Z/ZT
2	0.00500	0.01712

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.13544E+00	0.67559E+04	0.89449E+04	0.70850E+02	0.52376E+02	0.21889E+04	-0.35280E-02	0.46754E-01
2	0.16929E+00	0.52200E+02	0.98840E+04	0.12117E+03	0.67069E+02	0.98318E+04	-0.15752E+00	0.68327E-01
3	0.19750E+00	0.52200E+02	0.10976E+05	0.13190E+03	0.78124E+02	0.10924E+05	-0.15752E+00	0.93420E-01
4	0.22199E+00	0.52200E+02	0.11940E+05	0.14180E+03	0.88443E+02	0.11888E+05	-0.15752E+00	0.11556E+00
5	0.24394E+00	0.52200E+02	0.12721E+05	0.15103E+03	0.98580E+02	0.12668E+05	-0.15752E+00	0.13349E+00
6	0.26407E+00	0.52200E+02	0.10435E+05	0.15973E+03	0.12159E+03	0.10382E+05	-0.15752E+00	0.80977E-01
7	0.26277E+00	0.52200E+02	0.22113E+04	0.16798E+03	0.16120E+03	0.21591E+04	-0.15752E+00	-0.10792E+00

J	Z	Z/ZT
3	0.01000	0.03425

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.13537E+00	0.67559E+04	0.89471E+04	0.70850E+02	0.52305E+02	0.21912E+04	-0.35280E-02	0.46807E-01
2	0.16922E+00	0.52200E+02	0.98776E+04	0.12117E+03	0.67073E+02	0.98254E+04	-0.15752E+00	0.68180E-01
3	0.19751E+00	0.52200E+02	0.10973E+05	0.13190E+03	0.78153E+02	0.10921E+05	-0.15752E+00	0.93345E-01
4	0.22205E+00	0.52200E+02	0.11924E+05	0.14180E+03	0.88578E+02	0.11872E+05	-0.15752E+00	0.11519E+00
5	0.24411E+00	0.52200E+02	0.12708E+05	0.15103E+03	0.98752E+02	0.12656E+05	-0.15752E+00	0.13320E+00
6	0.26420E+00	0.52200E+02	0.98319E+04	0.15973E+03	0.12419E+03	0.97797E+04	-0.15752E+00	0.67130E-01
7	0.28279E+00	0.52200E+02	0.15381E+04	0.16798E+03	0.16335E+03	0.14859E+04	-0.15752E+00	-0.12339E+00

J	Z	Z/ZT
4	0.01500	0.05137

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.13530E+00	0.67559E+04	0.89311E+04	0.70850E+02	0.52418E+02	0.21752E+04	-0.35280E-02	0.46439E-01
2	0.16908E+00	0.67559E+04	0.98767E+04	0.88050E+02	0.61789E+02	0.31208E+04	-0.35280E-02	0.68160E-01
3	0.19738E+00	0.67559E+04	0.10965E+05	0.10231E+03	0.71890E+02	0.42095E+04	-0.35280E-02	0.93169E-01
4	0.22197E+00	0.52200E+02	0.11901E+05	0.14180E+03	0.82149E+02	0.11849E+05	-0.15752E+00	0.11466E+00
5	0.24405E+00	0.52200E+02	0.12729E+05	0.15103E+03	0.93223E+02	0.12677E+05	-0.15752E+00	0.13369E+00
6	0.26409E+00	0.52200E+02	0.83918E+04	0.15973E+03	0.12617E+03	0.83396E+04	-0.15752E+00	0.34051E-01
7	0.28270E+00	0.52200E+02	0.15086E+04	0.16798E+03	0.16269E+03	0.14564E+04	-0.15752E+00	-0.12406E+00

Printout for Stations J=5 thru J=21 is omitted for Brevity.

J	Z	Z/ZT
22	0.24000	0.82192

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.16718E+00	0.10120E+05	0.12172E+05	0.39276E+02	0.44104E+02	0.20528E+04	0.73740E-01	0.12089E+00
2	0.19598E+00	0.10551E+05	0.12445E+05	0.61687E+02	0.61304E+02	0.18939E+04	0.83642E-01	0.12715E+00
3	0.21721E+00	0.10836E+05	0.12646E+05	0.79061E+02	0.74858E+02	0.18099E+04	0.90168E-01	0.13176E+00
4	0.23537E+00	0.11095E+05	0.12850E+05	0.93228E+02	0.84405E+02	0.17552E+04	0.96137E-01	0.13646E+00
5	0.25166E+00	0.11338E+05	0.13024E+05	0.10557E+03	0.93729E+02	0.16861E+04	0.10172E+00	0.14045E+00
6	0.26604E+00	0.11507E+05	0.13127E+05	0.11694E+03	0.98143E+02	0.16202E+04	0.10560E+00	0.14282E+00
7	0.28225E+00	0.11855E+05	0.13372E+05	0.12656E+03	0.11869E+03	0.15179E+04	0.11359E+00	0.14846E+00

J	Z	Z/ZT
23	0.26000	0.89041

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.17026E+00	0.10527E+05	0.13244E+05	0.33483E+02	0.48841E+02	0.27166E+04	0.83106E-01	0.14551E+00
2	0.19804E+00	0.10894E+05	0.12437E+05	0.58954E+02	0.61386E+02	0.15432E+04	0.91519E-01	0.12697E+00
3	0.21863E+00	0.11170E+05	0.12625E+05	0.76843E+02	0.74029E+02	0.14549E+04	0.97872E-01	0.13129E+00
4	0.23638E+00	0.11402E+05	0.12734E+05	0.91509E+02	0.82638E+02	0.13322E+04	0.10319E+00	0.13380E+00
5	0.25234E+00	0.11600E+05	0.12791E+05	0.10428E+03	0.91552E+02	0.11904E+04	0.10775E+00	0.13510E+00
6	0.26648E+00	0.11736E+05	0.12836E+05	0.11592E+03	0.95360E+02	0.11001E+04	0.11066E+00	0.13613E+00
7	0.28242E+00	0.12049E+05	0.12902E+05	0.12576E+03	0.11706E+03	0.85332E+03	0.11805E+00	0.13765E+00

J	Z	Z/ZT
24	0.28000	0.95890

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.17237E+00	0.10897E+05	0.13251E+05	0.27180E+02	0.48762E+02	0.23542E+04	0.91603E-01	0.14568E+00
2	0.19953E+00	0.11266E+05	0.12442E+05	0.55589E+02	0.61341E+02	0.11757E+04	0.10008E+00	0.12709E+00
3	0.21958E+00	0.11511E+05	0.12626E+05	0.74518E+02	0.74023E+02	0.11153E+04	0.10569E+00	0.13131E+00
4	0.23696E+00	0.11709E+05	0.12735E+05	0.89759E+02	0.82833E+02	0.10261E+04	0.11024E+00	0.13381E+00
5	0.25270E+00	0.11885E+05	0.12792E+05	0.10286E+03	0.91547E+02	0.90660E+03	0.11429E+00	0.13512E+00
6	0.26672E+00	0.12013E+05	0.12837E+05	0.11466E+03	0.95355E+02	0.82400E+03	0.11723E+00	0.13616E+00
7	0.28252E+00	0.12278E+05	0.12902E+05	0.12482E+03	0.11706E+03	0.62443E+03	0.12332E+00	0.13766E+00

J	Z	Z/ZT
25	0.29200	1.00000

I	R	PS	PP	WS	WP	DPB	PSIS	PSIP
1	0.17236E+00	0.10993E+05	0.13252E+05	0.25286E+02	0.48760E+02	0.22583E+04	0.93810E-01	0.14569E+00
2	0.19950E+00	0.11367E+05	0.12442E+05	0.54650E+02	0.61341E+02	0.10756E+04	0.10238E+00	0.12709E+00
3	0.21956E+00	0.11598E+05	0.12626E+05	0.73910E+02	0.74023E+02	0.10280E+04	0.10770E+00	0.13131E+00
4	0.23694E+00	0.11788E+05	0.12735E+05	0.89298E+02	0.82833E+02	0.94638E+03	0.11208E+00	0.13381E+00
5	0.25260E+00	0.11968E+05	0.12792E+05	0.10244E+03	0.91547E+02	0.82342E+03	0.11620E+00	0.13512E+00
6	0.26654E+00	0.12107E+05	0.12837E+05	0.11426E+03	0.95355E+02	0.73011E+03	0.11938E+00	0.13616E+00
7	0.28241E+00	0.12355E+05	0.12902E+05	0.12450E+03	0.11706E+03	0.54758E+03	0.12508E+00	0.13766E+00

E. HYDRODYNAMIC COMPUTER PROGRAM LISTING

```
C  ****************************************************************      00000010
C  *                    INDUCER HYDRODYNAMIC PROGRAM                *      00000020
C  *                                                                *      00000030
C  ****************************************************************      00000040
C                        F.R.D.C.                                         00000050
      REAL LI,LOW,M1,M2,M3,M4,N1,N2,N3,N4,LOWLIM                         00000060
      REAL ML,M,K,MP,NU,MU,MSTR,NPSH,MOM,MOMP                           00000070
      INTEGER CASE,CASES                                                00000080
      LOGICAL ERROR                                                     00000090
      D I M E N S I O N                                                 00000100
     1    RIN  (15),   BSIN  (15),   TCBSI (15),   WIN  (15),          00000110
     2    PRELI(15),   BSEX  (15),   WJ1   (15),   WEX  (15),          00000120
     3    WNJ  (15),   DBS   (15),   REX   (15),   VEX  (15),          00000130
     4    DBSP (15),   PORELP(15),   RVU   (15),   MOM  (15),          00000140
     5    A    (15),   AP    (15),   MOMP  (15),   PCR  (15),          00000150
     6    SI   (15),   SIB   (15),   R     (15),   M    (15),          00000160
     7    DM   (15),   HIO   (15),   BETA  (15),   W    (15),          00000170
     8    B    (15),   PREL  (15),   RP    (15),   BETAP(15),          00000180
     9    SIP  (15),   MP    (15),   TT    (60),   BP   (15),          00000190
     1    PRELP(15),   DY    (15),   DYP   (15),   BETAS(15),          00000200
     2    TAU  (15),   ZBL   (15),   PX    (15),   TA   (60),          00000210
     3    E    (15),   PCR1  (15),   TAUP  (15),   RSTL (15),          00000220
     4    SIS  (15),   SISP  (15),   WP    (15),   PXP  (15),          00000230
     5    RSTS (15),   PRELEX(15),   ESV   (15),   ITB  (15),          00000240
     6    POREL(15),   DBDM  (15),   DWDM  (15),   HSF  (15),          00000250
     7    XMTH (15),   HSFP  (15),   XMTHP (15),   PO   (15),          00000260
     8    VA   (15),   ALPHI (15),   Q     (15),   HO   (15),          00000270
     9    XIOI (15),   XMTHI (15),   BIN   (15),   TERM1(15)           00000280
      D I M E N S I O N                                                 00000290
     1    TERM2(15),   BTS   (60),   BETASP(15),   T    (15),          00000300
     2    TP   (15),   SBS   (15),   TBS   (15),   CBS  (15),          00000310
     3    TITLE(20),   CSB   (15),   PCBB  (15),   DELW (15),          00000320
     4    Z    (60),    RH   (60),   RT    (60),   BHS  (60)           00000330
      D I M E N S I O N                                                 00000340
     1    TCBS (60,15), ML(60,15),   BL (60,15),   PRELL(60,15),       00000350
     2    PXL  (60,15), DPBN(60,15), RL (60,15)                        00000360
      DIMENSION DC(15),DCP(15)                                          00000370
      DIMENSION WNC(60,15),DBTC(60,15),WPX(60,15),WSX(60,15),           00000380
     1  PSX(60,15),PPX(60,15),WVX(60,15),TAUVX(60,15),DMVX(60,15),      00000390
     2  DYX(60,15),BETASX(60,15),FUNC(60),YOUT(60),TGIF(4),XCODM(20),   00000400
     3  YFLR(20)                                                        00000410
      DATA XCODM / .01,.02,.03,.04,.05,.06,.07,.08,.09,.10,.12,.14,.16, 00000420
     1             .18,.20,.25,.30,.35,.40/,                            00000430
     2     YFLR /  .007,.007,.007,.008,.01,.014,.025,.041,.054,.06,.075,00000440
     3             .085,.094,.10,.107,.123,.134,.143,.152/              00000450
C                                                                       00000460
      CALL ZERO ( NI,TGIF(4) )                                          00000470
C                                                                       00000480
C              *****  INPUT *****                                       00000490
C                                                                       00000500
1     READ(5,2,END=999) TITLE                                           00000510
      WRITE(6,4) TITLE                                                  00000520
      READ(5,3)  NI , NJ  ,NB  ,CASES ,G, ALPWH,  ALPWT, CBHR           00000530
      WRITE(6,5) NI,NJ,NB,CASES,G,CBHR                                  00000540
C                                                                       00000550
```

```
C      BLADE HUB AND TIP DESCRIPTION                                          00000560
C                                                                             00000570
       WRITE(6,6)                                                             00000580
       READ(5,7) (Z(I), RH(I) ,RT(I), BHS(I) , BTS(I) , TT(I) , TA(I) ,       00000590
      1     I = 1,NJ  )                                                      00000600
       WRITE(6,8) (I,Z(I),RH(I),RT(I),BHS(I) , BTS(I) , TT(I) , TA(I) ,       00000610
      1     I = 1 , NJ  )                                                    00000620
       DO 88 J = 1 , NJ                                                       00000630
       BHS(J) = BHS(J) / 57.2958                                              00000640
       BTS(J) = BTS(J) / 57.2958                                              00000650
   88 CONTINUE                                                                00000660
C                                                                             00000670
C  COEFFICIENTS FOR SWEPT LEADING EDGE                                        00000680
       READ(5,6091) Z0,Z1,Z2,Z3                                               00000690
C                                                                             00000700
       ALPWT = ALPWT / 57.29577                                               00000710
       ALPWH = ALPWH / 57.29577                                               00000720
       BTSB = ( BTS(1) + BTS(NJ)) / 2.0                                       00000730
       C2   =  6.2832 / NB                                                    00000740
       XYZ = Z0 + Z1*RT(1) + Z2*RT(1)**2 + Z3*RT(1)**3                        00000750
       SIG = ( Z(NJ) -XYZ)/ (C2* RT(1) * SIN(BTSB))                           00000760
C                                                                             00000770
       IF( CBHR .EQ. 0.0 ) GO TO 770                                          00000780
       CLEAR = CBHR * (RT(1) - RH(1))                                         00000790
       CODM = CLEAR / ((Z(NJ) - Z(1)) * SIN(BTSB))                            00000800
       CALL NEWGG (19, CODM, FLR, XCODM, YFLR )                               00000810
       FLR = FLR * 3.141592                                                   00000820
  770  WRITE(6,760) Z0,Z1,Z2,Z3                                               00000830
 760   FORMAT(//' SWEPT LEADING EDGE COEFFICIENTS'/' Z0=',F10.5/' Z1=',       00000840
      1          F10.5/' Z2=',F10.5/' Z3=',F10.5//)                          00000850
       ALPH = ALPWH * 57.29578                                                00000860
       ALPT = ALPWT * 57.29578                                                00000870
       WRITE(6,761) SIG,ALPH,ALPT                                             00000880
 761   FORMAT(T9,'SOLIDITY',T24,'ALPWH',T38,'ALPWT'/3F15.7)                   00000890
C                                                                             00000900
C                ***** END OF INPUT *****                                     00000910
C                                                                             00000920
C      OPERATING  CONDITIONS                                                  00000930
C                                                                             00000940
       CASE = 1                                                               00000950
    20 READ (5,17,END=999)  RHO, MU, PSAT, SN,    LOADOP                    00000960
       IF( CBHR .EQ. 0.0 ) GO TO 775                                          00000970
       LOADOP = 1                                                             00000980
       WRITE(6,785) CASE,RHO,MU,PSAT,SN,LOADOP,FLR                            00000990
       GO TO 790                                                              00001000
  775  WRITE (6,22) CASE, RHO, MU, PSAT, SN,    LOADOP                       00001010
  790  READ (5,19) (PO(I), VA(I), ALPHI(I), I=1,NI)                          00001020
       WRITE (6,23) (PO(I), VA(I), ALPHI(I), I=1,NI)                          00001030
       NREV = 0                                                               00001040
  926  NREV = NREV + 1                                                        00001050
       KILL = 0                                                               00001060
C                                                                             00001070
C      INTERNAL PROGRAM CONSTANTS                                             00001080
C                                                                             00001090
       NXXI = NI - 1                                                          00001100
       CVOL = 0.0                                                             00001110
       PI = 3.141592                                                          00001120
```

```
      NU = MU / RHO                                                     00001130
      OMEGA =  SN * 6.2832                                              00001140
      C1   =  RHO /2.0 / G                                              00001150
      C3   =  C1 * OMEGA**2                                             00001160
      VT = OMEGA * RT(1)                                                00001170
C                                                                       00001180
C     INLET ROUTINE                                                     00001190
C     ( UPSTREAM )                                                      00001200
C                                                                       00001210
C     CONSTANT PARAMETERS                                               00001220
C                                                                       00001230
      DZ = 0.0                                                          00001240
      DR = RT(1) - RH(1)                                                00001250
      DR2 = ( RT(1)**2 - RH(1)**2) / NI                                 00001260
      CE = 0.284 / SIG **0.5                                            00001270
      SLOP = ( RT(1)*TAN(BTS(1) )- RH(1) *TAN(BHS(1) ) )/ DR            00001280
      SIT = ATAN( (RT(2) - RT(1)) / ( Z (2) - Z (1) ) )                 00001290
      SIH = ATAN( (RH(2) - RH(1)) / ( Z (2) - Z (1) ) )                 00001300
      DSI = SIT - SIH                                                   00001310
      DELS = 0.0                                                        00001320
      ZP = Z(1) - .001*( Z(2) - Z(1) )                                  00001330
      RSTP = RH(1)                                                      00001340
      DRZE = (RT(NJ)**2 - RH(NJ)**2) / NI                               00001350
      RSTEP = RH(NJ)                                                    00001360
      QI = 0.                                                           00001370
      ZZ1 = 0.                                                          00001380
      ZZ2 = 0.                                                          00001390
      WRITE (6,30)                                                      00001400
C                                                                       00001410
C     VARIABLE PARAMETERS                                               00001420
C                                                                       00001430
      DO 40 I = 1 , NI                                                  00001440
      RSTE = SQRT(RSTEP**2 + DRZE)                                      00001450
      RST  = SQRT( RSTP**2 + DR2 )                                      00001460
      RSTS(I) = RST                                                     00001470
      PCR(I) =  ( RST - RH(1) ) / DR                                    00001480
      DY(I) = RST - RSTP                                                00001490
      R(I) = (RSTP + RST ) / 2.0                                        00001500
      TAU(I) = C2 * R(I)                                                00001510
      RTNB = RT(1) * TAN(BTS(1) ) - SLOP * (RT(1) - R(I) )              00001520
      BETAS(I) = ATAN( RTNB / R(I) )                                    00001530
      SI(I) = SIH + (R(I) - RH(1)) / DR * DSI                           00001540
      SIS(I) = SI(I)                                                    00001550
      SIB(I) = SI(I)                                                    00001560
      A(I)  = TAU(I) * DY(I) * COS(SI(I))                               00001570
      U = OMEGA * R(I)                                                  00001580
      ALPHA = ALPHI(I) / 57.29578                                       00001590
      VM = VA(I)                                                        00001600
      V = VM / SIN(ALPHA)                                               00001610
      VU =  V * COS(ALPHA )                                             00001620
      WU = U - VU                                                       00001630
      BETA(I) = ATAN( VM / WU )                                         00001640
      XIOI(I) = BETAS(I) - BETA(I)                                      00001650
      W(I)  =  VM / SIN(BETA(I))                                        00001660
      PX(I) = PO(I) - C1 * V**2                                         00001670
      QD  = C1 * W(I)**2                                                00001680
```

```
      PREL(I)   =   PX(I)+QD                                                    00001690
      K =(PX(I)-PSAT ) / QD                                                    00001700
      HIO(I) =  U * VU / G                                                     00001710
      HO(I) = PO(I) / RHO                                                      00001720
      Q(I) = VM * A(I)                                                         00001730
      QI = QI + Q(I) * FLOAT(NB)                                               00001740
      ZZ1 = ZZ1 + VM                                                           00001750
      ZZ2 = ZZ2 + PO(I) * Q(I)                                                 00001760
      DELW(I)   =   0.0                                                        00001770
      E(I) = 0.                                                                00001780
      T(I) = 0.                                                                00001790
      B(I) = 0.                                                                00001800
      BL(1,I) = 0.                                                             00001810
      M(I)   = 0.0                                                             00001820
      DC(I) = 0.0                                                              00001830
      DM(I) = 0.0                                                              00001840
      HSF(I) = 1.4                                                             00001850
      XMTH(I)=0.278 * SQRT(NU / W(I) )                                         00001860
      ZBL(I) = 0.0                                                             00001870
      F = 1.0                                                                  00001880
      XMTHI(I) = XMTH(I)                                                       00001890
      BIN(I) = BETA(I)                                                         00001900
      MOM(I)=PX(I)*A(I) * SIN(BETAS(I)) + 2.0 * C1 * Q(I) *W(I)*COS(XIOI00001910
     1 (I))                                                                    00001920
      TCBSI(I) = TAU(I) * COS(BETAS(I))                                        00001930
      RVU(I) = R(I) * VU                                                       00001940
      DBS(I) = XIOI(I)                                                         00001950
      RIN(I) = R(I)                                                            00001960
      BSIN(I) = BETAS(I)                                                       00001970
      WIN(I) = W(I)                                                            00001980
      PRELI(I) = PREL(I)                                                       00001990
      RSTP = RST                                                               00002000
      RSTEP = RSTE                                                             00002010
      BETADG = BETA(I) * 57.2958                                               00002020
      ALPHDG = ALPHA * 57.29578                                                00002030
      WRITE (6,41) I, R(I),Q(I),W(I),PO(I),PREL(I),PX(I),ALPHDG, BETADG,00002040
     1 K, U, V, VM, VU                                                         00002050
   40 CONTINUE                                                                 00002060
C                                                                              00002070
C     MAIN PROGRAM                                                             00002080
C                                                                              00002090
      PH = ZZ1 / NI / VT                                                       00002100
      PHCRT = .50    * BTS(1)                                                  00002110
      IF(PH .GT. PHCRT) GOTO47327                                              00002120
47328 FORMAT(/////' FLOW COEFFICIENT=',F10.5,3X,     'AND IS LESS THAN CR00002130
     1ITICAL FLOW = ',F10.5)                                                   00002140
      WRITE(6,47328)PH,PHCRT                                                   00002150
      GOTO4501                                                                 00002160
47327 CONTINUE                                                                 00002170
      PT = ZZ2 / QI * FLOAT(NB)                                                00002180
      NPSH = ( PT - PSAT ) / RHO                                               00002190
      XKTIP = 2.*G*NPSH / VT**2 / (1.+PH**2) - PH**2 / (1.+PH**2)              00002200
      THOMA = 2.0 * G * NPSH / VT**2                                           00002210
       WRITE(6,7090) PH,NPSH,THOMA,VT,PT,XKTIP                                 00002220
      PTU = PT                                                                 00002230
      DB = 0.0                                                                 00002240
      FD = 0.0                                                                 00002250
```

```
      AV = 0.0                                                          00002260
      CGAM = 0.0                                                        00002270
      GAM = 0.0                                                         00002280
      PP = 0.0                                                          00002290
      PS = 0.0                                                          00002300
      V1 = 0.0                                                          00002310
      XLAM = 0.0                                                        00002320
      DO 300 J = 1 , NJ                                                 00002330
C                                                                       00002340
C     J-STATION     CONSTANT PARAMETERS                                 00002350
C                                                                       00002360
1252  PCRDL1 = 0.01 / NI                                                00002370
      ETOL =  .10                                                       00002380
      SMH =0.0                                                          00002390
      SMHI = 0.0                                                        00002400
      DZE = Z(NJ ) - Z(J)                                               00002410
      IF( J .NE. 1 )  ZP = Z(J - 1 )                                    00002420
      DZ = Z(J) - ZP                                                    00002430
      DR = RT(J) - RH(J)                                                00002440
      SLOP = ( RT(J)*TAN(BTS(J))- RH(J)*TAN(BHS(J) ) ) / DR             00002450
      IF( J .EQ. 1 )  GO TO 44                                          00002460
      ZZ5 = PCRDL1*DR/DZ                                                00002470
      IF ( ZZ5 .LE. 0.01 ) GO TO 44                                     00002480
      PCRDL1 = 0.01 * DZ/DR                                             00002490
   44 CONTINUE                                                          00002500
      PCRDL = PCRDL1                                                    00002510
C                                                                       00002520
C     RESET INITIAL VALUES                                              00002530
C                                                                       00002540
      DO 125  I = 1 , NI                                                00002550
      MP(I)    = M(I)                                                   00002560
      RSTL(I) = RSTS(I)                                                 00002570
      RP(I) = R(I)                                                      00002580
      BETASP(I)=BETAS(I)                                                00002590
      TP(I)=T(I)                                                        00002600
      TAUP(I) = TAU(I)                                                  00002610
      AP(I) = A(I)                                                      00002620
      DYP(I) = DY(I)                                                    00002630
      SIP(I)= SI(I)                                                     00002640
      SISP(I) = SIS(I)                                                  00002650
      WP(I) = W(I)                                                      00002660
      BETAP(I) = BETA(I)                                                00002670
      PXP(I) = PX(I)                                                    00002680
      HSFP(I) = HSF(I)                                                  00002690
      XMTHP(I) = XMTH(I)                                                00002700
      MOMP(I) = MOM(I)                                                  00002710
      DBSP(I)  = DBS(I)                                                 00002720
      DBTC(1,I) = 0.                                                    00002730
      WNC(1,I) = 0.                                                     00002740
      BP(I)    = B(I)                                                   00002750
      DCP(I) = DC(I)                                                    00002760
  125 PRELP(I) = PREL(I)                                                00002770
C                                                                       00002780
C     START STREAMLINE ITERATION                                        00002790
C                                                                       00002800
      DO 130 ITE = 1 , 100                                              00002810
```

```
      ERROR = .FALSE.                                                    00002820
      IF( ITE .GE. 25 .AND. ITE .LE. 50)  PCRDL = 0.1 * PCRDL1           00002830
      IF( ITE .GT. 50 )  PCRDL = 0.01 * PCRDL1                           00002840
      SME2 = 0.0                                                         00002850
      RSTP = RH(J)                                                       00002860
      DO 131  I = 1 , NI                                                 00002870
      RST = RH(J)  + PCR(I) * DR                                         00002880
      SIS(I) = ATAN (( RST - RSTL(I)) / DZ )                             00002890
      IF ( J .EQ. 1 ) SIS(I) = SISP(I)                                   00002900
      RSTS(I) = RST                                                      00002910
      DY(I) = RST - RSTP                                                 00002920
      DYX(J,I) = DY(I)                                                   00002930
      R(I) = (RSTP + RST) / 2.0                                          00002940
      RL(J,I) = R(I)                                                     00002950
      ZLE =Z0 + Z1*R(I) + Z2*R(I)**2 + Z3*R(I)**3                        00002960
      DZLE = ZLE - Z(J)                                                  00002970
      U = OMEGA * R(I)                                                   00002980
      RSTP = RST                                                         00002990
      RB    = (RP(I) + R(I) ) / 2.0                                      00003000
      RTNB = RT(J)*TAN(BTS(J)) - SLOP*(RT(J) - R(I) )                    00003010
      BETAS(I) = ATAN( RTNB / R(I) )                                     00003020
      BETASX(J,I) = BETAS(I)                                             00003030
      SBS(I)= SIN(BETAS(I))                                              00003040
      TBS(I)= TAN(BETAS(I))                                              00003050
      CBS(I)= COS(BETAS(I))                                              00003060
      POWER2 = -DZE * NB /2.0/ R(I) /(SBS(I))                            00003070
      IF(J .GT. NJ) GO TO 44444                                          00003080
      T(I) = TT(J) + TA(J) / 57.3 * ( RT(J)- R(I) )                      00003090
      BETASB = ( BETAS(I) + BETASP(I))* 0.5                              00003100
      SBSB = SIN(BETASB)                                                 00003110
      SI(I)  = ATAN((R(I) - RP(I))/DZ)                                   00003120
      IF(J .EQ.1 ) SI(I)= SIP(I)                                         00003130
      SIB(I)= .5*( SI(I) + SIP(I))                                       00003140
      CSB(I)= COS(SIB(I))                                                00003150
      GO TO 135                                                          00003160
C                                                                        00003170
C  SET VALUES FOR EXIT STATION                                           00003180
C                                                                        00003190
44444 BSEX(I) = BETAS(I)                                                 00003200
      SI(I) = 0.0                                                        00003210
      SIB(I) = 0.0                                                       00003220
      T(I) = 0.0                                                         00003230
      REX(I) = R(I)                                                      00003240
      GO TO 126                                                          00003250
135   DM(I) = DZ / CSB(I) / SBSB                                         00003260
      DMVX(J,I) = DM(I)                                                  00003270
      DMB=DM(I)                                                          00003280
      IF(DZLE .LT. 0. .AND. ZLE .GT. ZP) DMB=DM(I) *(-DZLE/DZ)           00003290
      IF(DZLE .GT. 0.) DMB=0.                                            00003300
      M(I) = MP(I)+ DMB                                                  00003310
      IF(DZLE .GE. 0.)M(I)=0.                                            00003320
      ALW =ALPWT - ( RT(J) - R(I))/(RT(J) -RH(J)) *(ALPWT - ALPWH)       00003330
      TLE = M(I) * TAN(ALW) * COS(SI(I))                                 00003340
      IF(TLE .LT. T(I))  T(I) = TLE                                      00003350
      TCBS(J,I) = (C2 *R(I) -T(I) / SBS(I)) * CBS(I)                     00003360
      IF(DZLE .GT. 0) T(I)=0.0                                           00003370
      TAU(I) = C2 * R(I) - T(I) / SBS(I)                                 00003380
```

```
      TAUVX(J,I) = TAU(I)                                                    00003390
      ML(J,I) = M(I)                                                         00003400
      DPDMP = 0.0                                                            00003410
      IF(DZLE .GT. 0) GO TO 1248                                             00003420
C                                                                            00003430
C     START CAVITY ITERATION                                                 00003440
C                                                                            00003450
      DBSSAV = DBS(I)                                                        00003460
      ITB(I) = 1                                                             00003470
      IF( DBSP(I) .GT. (0.10  * BETASP(I)) )  GO TO 140                      00003480
      DBS(I) = 0.0                                                           00003490
      IF(DELW(I) .GT. 0.0 ) GO TO 791                                        00003500
       IF(PCBB(I) .GT. 0.  .AND.  PCBB(I) .LE. 0.05)                         00003510
     1  DELW(I) = (-5.389049E 04) * PCBB(I)**3  +  (2.853374E 04) *          00003520
     2  PCBB(I)**2  +  (-2.984396E 03) * PCBB(I)  +  90.04968                00003530
       IF ( PCBB(I) .GT. 0.05  .AND.  PCBB(I) .LE. 0.069 )                   00003540
     1  DELW(I) = (-5.706232E 10) * PCBB(I)**8  +  (3.597064E 09)             00003550
     2     * PCBB(I)**7  +  (2.303375E 08) * PCBB(I)**6  +                   00003560
     3     (-3.853306E 06) * PCBB(I)**5  +  (1.692314E 05) * PCBB(I)         00003570
     4     **4  +  (-8.575639E 04) * PCBB(I)**3  +  (-6.183219E 02)          00003580
     5     * PCBB(I)**2  +  (-2.479463E 01) * PCBB(I) + 14.903               00003590
       IF ( PCBB(I) .GE. .069 ) DELW(I) = 2.902 -10.4651* PCBB(I)            00003600
       IF ( PCBB(I) .GE. .155 ) DELW(I) = 1.28                               00003610
      DELW(I) = DELW(I) / 57.295                                             00003620
  791 TDW  =  TAN( DELW(I) )                                                 00003630
C                                                                            00003640
C   CALCULATE CAVITY HEIGHT.                                                 00003650
C                                                                            00003660
      B(I) = BP(I) - DZ*TDW/SBS(I)**2                                        00003670
     1    /(1.0 + TDW/TBS(I))                                               00003680
      IF (B(I) .LT. 0.0) B(I) = 0.0                                          00003690
      GO TO 1248                                                             00003700
  140 CONTINUE                                                               00003710
      DBSB = 0.5 * (DBS(I) + DBSP(I) )                                       00003720
      IF(ZLE .GE. ZP) DBSB=DBS(I)                                            00003730
      DB= DMB * SIN(DBSB) /SIN(BETASB - DBSB)                                00003740
      B(I) = BP(I) + DB                                                      00003750
      PCBB(I)  =  B(I) / TAU(I)                                              00003760
      IF( DZLE .EQ. 0.0)  B(I) = 0.0                                         00003770
 1248 BL(J,I)=B(I)                                                           00003780
      TAUL= TAU(I) -B(I)                                                     00003790
      ZZ1 = 2.0                                                              00003800
      IF(B(I) .GT. 0.0) ZZ1=1.0                                              00003810
      ZZ2 = ZZ1 * DELS * DY(I) * COS(SI(I)) / SBS(I)                         00003820
      IF(I .EQ. 1 .OR. I .EQ. NI) ZZ2 = ZZ2 + DELS * (TAUL - ZZ1 * DELS      00003830
     1  / SBS(I))                                                            00003840
      A(I) = DY(I) * TAUL * COS(SI(I))                                       00003850
      VM = Q(I) / (A(I) - ZZ2)                                               00003860
      IF(DZLE .GE. 0.) BETA(I)=ATAN(VM/(R(I)*OMEGA-RVU(I)/R(I)))             00003870
C                                                                            00003880
C     EXIT DEVIATION                                                         00003890
C                                                                            00003900
      DEL2 = 0.0                                                             00003910
      IF(POWER2 .LT. -100. ) GO TO 1250                                      00003920
      DELE = ( BETAS(I) - BIN(I) ) * CE                                      00003930
      DEL2 = DELE * EXP(POWER2)/(1- DELE * (1- EXP(POWER2)) / TAN            00003940
```

```
     1    (BETAS(I)))                                                          00003950
C                                                                             00003960
C      FLUID INERTIA EFFECTS                                                  00003970
C                                                                             00003980
 1250 BESEF = BETAS(I) -        0.5 * DBS(I)                                  00003990
      DELI = 0.                                                               00004000
      IF(DZLE .GE. 0.) GO TO 137                                              00004010
      IF(DEL2 .GT. 0.001*BETAS(I))  GO TO 1354                                00004020
      POWER1 = -      PI * DMB / TAUL /SIN(BETAS(I))                          00004030
      DELO = BESEF - BETAP(I)                                                 00004040
      DELI = DELO*EXP(POWER1)/(1.-DELO*(1.-EXP(POWER1))/TBS(I))               00004050
C                                                                             00004060
C      END FLUID INERTIA EFFECTS                                              00004070
C                                                                             00004080
 1354 IF( NREV .EQ. 1 .OR. CBHR .EQ. 0.0 ) DBTC(J,I) = 0.0                    00004090
      BETA(I) = BESEF - DELI - DEL2 + DBTC(J,I)                               00004100
      IF( BETA(I) .LT. 0.0 ) BETA(I) = 0.5/57.2957                            00004110
  137 DBETA = BETA(I) - BETAP(I)                                              00004120
      BETAB = 0.5 * ( BETA(I) + BETAP(I) )                                    00004130
      SBB = SIN(BETAB)                                                        00004140
      CBB = COS(BETAB)                                                        00004150
      DBDM(I) = DBETA / DM(I)                                                 00004160
      IF(DZLE .GE. 0.) DBS(I) = BETAS(I) - BETA(I)                            00004170
      W(I) = VM / SIN (BETA(I))                                               00004180
      WVX(J,I) = W(I)                                                         00004190
      IF(DZLE .GE. 0.)WJ1(I)=W(I)                                             00004200
      IF (J .EQ. NJ) WNJ(I) = W(I)                                            00004210
      QD   = C1 * W(I)**2                                                     00004220
      WB = ( WP(I) + W(I) ) / 2.0                                             00004230
      VMB = WB*SBB                                                            00004240
      WUB = WB*CBB                                                            00004250
      UB = OMEGA*RB                                                           00004260
      VUB = UB-WUB                                                            00004270
      TAULB =(TAU(I) - B(I) + TAUP(I) - BP(I) ) / 2.0                         00004280
      QDB = C1 * WB**2                                                        00004290
      F=1.0                                                                   00004300
      DWDM(I) = ( W(I) - WP(I) ) / DM(I)                                      00004310
      IF(DZLE .GE. 0.) GO TO 996                                              00004320
      IF ( MU .NE. 0.0 ) GO TO 1372                                           00004330
      XMTH(I) = 0.0                                                           00004340
      DELS = 0.0                                                              00004350
      CF = 0.0                                                                00004360
      GO TO 996                                                               00004370
 1372 CONTINUE                                                                00004380
C                                                                             00004390
C      START BOUNDARY LAYER CALCULATIONS                                      00004400
C                                                                             00004410
      RET = WP(I) * XMTHP(I) / NU                                             00004420
      XKL=XMTHP(I)/WP(I)* DWDM(I)                                             00004430
      CF = 0.246/(10.**(0.678*HSFP(I)) * RET**0.268 )                         00004440
      DTDM = CF / 2.0 - ( HSFP(I) + 2.0 ) * XKL                               00004450
      CL = RET**0.16666 * XMTHP(I) / 0.0135 / EXP(5.0*(HSFP(I) - 1.4))        00004460
      HSF(I) = 1.4 - RET**0.16666 * XKL / 0.0135                              00004470
      HSF(I)=HSF(I) -(HSF(I)-HSFP(I))*EXP(-DMB/CL)                            00004480
      IF( HSF(I) .GT. 3.0 )  HSF(I) = 3.0                                     00004490
      IF( HSF(I) .LT. 1.0 )  HSF(I) = 1.0                                     00004500
      XMTH(I)= DTDM * DMB +XMTHP(I)                                           00004510
```

```
      ZZ5=.05 * TAUL * SBS(I)                                                  00004520
      IF(XMTH(I) .GT. ZZ5) XMTH(I) =ZZ5                                        00004530
      IF( XMTH(I) .LE. 0.0 )  XMTH(I) = XMTHI(I)                               00004540
      DELS = XMTH(I) * HSF(I)                                                  00004550
      F = 1.0  - ZZ1 *XMTH(I) / TAUL / SBS(I)*2.                               00004560
      IF( I .EQ. 1 .OR. I .EQ. NI ) F = F*(1.0-XMTH(I) / DY(I) * 2.0)          00004570
  996 IF( DZLE .GE. 0.0 ) DELS = 0.0                                           00004580
      ZBL(I) = DELS                                                            00004590
C                                                                              00004600
C     END BOUNDARY LAYER CALCULATIONS                                          00004610
C                                                                              00004620
      IF( DBSP(I) .GT. ( 0.10 * BETASP(I)) ) GO TO 997                         00004630
      IF( BP(I) .EQ. 0.0 ) GO TO 997                                           00004640
      AR = W(I) / WP(I)                                                        00004650
      ZZ5=(TAUL +TAUP(I)-BP(I))*(DY(I)-DYP(I))/(2*TAUL*DY(I))                  00004660
      DPDMP = C1*(WP(I)*(1.0 - AR))**2 + (PXP(I) - PSAT)*(1. - AR-ZZ5)         00004670
      IF( DPDMP .LT. 0.0) DPDMP =0.0                                           00004680
  997 CONTINUE                                                                 00004690
      PREL(I) = PRELP(I) + C3 * ( R(I)**2 - RP(I)**2 ) - DPDMP                 00004700
      PRELL(J,I) = PREL(I)                                                     00004710
      WNC(J,I) = ABS(WNC(J,I))                                                 00004720
      IF( NREV .EQ. 1 .OR. CBHR .EQ. 0.0 ) WNC(J,I) = 0.0                      00004730
      POREL(I) = PREL(I) - ( 1.0 - F ) * QD -(RHO/2./G*WNC(J,I)**2.)           00004740
      PX(I)  = PREL(I) - QD                                                    00004750
      PXL(J,I) = PX(I)                                                         00004760
       DC(I)=0.0                                                               00004770
      XA = A(I) - DY(I) * COS(SI(I)) * DC(I)                                   00004780
       XA=A(I)                                                                 00004790
      IF(DZLE .LT. 0.)GO TO 96                                                 00004800
      DPBN(J,I) = 2.0* (PX(I) - PSAT)                                          00004810
      GO TO 952                                                                00004820
   96 TERM1(I) = ( 2.0 * OMEGA / WB - CBB / R(I)) * SIN(SI(I))                 00004830
      TERM2(I) = DBDM(I)                                                       00004840
      DPBN(J,I) = 2.0 * TAULB * QDB * SBB**2/SBS(I)                            00004850
     1 * (TERM1(I) + TERM2(I))                                                 00004860
      IF( DBSP(I) .GT. (0.10 * BETASP(I)) )  GO TO 121                         00004870
      GO TO 204                                                                00004880
C                                                                              00004890
C     CHECK MOMENTUM BALANCE  (FOR EACH STREAMTUBE)                            00004900
C                                                                              00004910
  121 DTH=T(I)-TP(I)                                                           00004920
      DYB = ( DY(I) + DYP(I)) * 0.5                                            00004930
      AB=(AP(I)*SIN(BETASP(I))+ XA *SBS(I))/2.                                 00004940
      PB = ( PX(I) + PXP(I)) / 2.0                                             00004950
      IF( J .EQ. 1 )  GO TO 951                                                00004960
      WETP = ZZ1 * DYB                                                         00004970
      IF(I .EQ. 1) WETP= ZZ1*DYB + TAULB*(RH(J-1) + RH(J))/(RP(I) + R(         00004980
     1 I))* SBSB                                                               00004990
      IF(I .EQ.NI) WETP= ZZ1*DYB + TAULB*(RT(J-1) + RT(J))/(RP(I) + R(         00005000
     1 I))* SBSB                                                               00005010
      FD =CF * QDB * WETP * DMB                                                00005020
  951 FC = 2.0 *C1*AB*(R(I)-RP(I))*VUB**2/RB                                   00005030
      ZZ1 = PSAT * DYB * DTH                                                   00005040
      DB = DB + DC(I) - DCP(I)                                                 00005050
      ZZ2=PSAT*DYB*DB*SBSB                                                     00005060
      ZZ3 = 2.0 * PB *(DYB - DY(I)) * SBSB * (TAULB - DC(I) / 2.)              00005070
```

```
      ZZ3=ZZ3+PB*C2*(RP(I)*SIN(BETASP(I))-R(I)*SBS(I))*DYB                00005080
      FP = (ZZ1 + ZZ2 + ZZ3) * CSB(I)                                    00005090
      DMOM=  FC - FP - FD                                                00005100
952   MOM(I) = PX(I) *   XA * SBS(I)         + 2.0 * C1 *Q(I)* W(I) *    00005110
     1          COS(BETAS(I) - BETA(I)) * F **0.5                       00005120
      IF(DZLE .GE. 0.) GO TO 204                                         00005130
      ERROR1= MOM(I) - MOMP(I) - DMOM                                    00005140
C     IF( B(I) .GE.(.8*TAU(I))) GO TO 204                                00005150
C   CONVERENGE TEST FOR MOMENTUM BALANCE.                                00005160
      IF ( ABS (ERROR1 ) .LT. 0.0001*MOM(I))  GO TO 204                  00005170
C                                                                        00005180
C     ADJUST CAVITY SLOPE                                                00005190
C                                                                        00005200
      DDBSSV = DBS(I) - DBSSAV                                           00005210
      DBSSAV = DBS(I)                                                    00005220
      IF ( ERROR1 ) 142, 204 , 150                                       00005230
  142 DBS(I) = DBS(I) - 0.001 * BETAS(I)                                 00005240
      IF ( DBS(I) .LT. 0.0 )  DBS(I) = 0.0                               00005250
      GO TO 151                                                          00005260
  150 DBS(I) = DBS(I) + 0.001 * BETAS(I)                                 00005270
      IF(DBS(I) .GT. BETAS(I))  DBS(I)=0.95*BETAS(I)                     00005280
  151 ITB(I)= ITB(I)+1                                                   00005290
      IF( ITB(I) .LE. 2 )  GO TO 140                                     00005300
      IF( ( DBS(I) - DBSSAV) * DDBSSV .GT. 0.0 )  GO TO 140              00005310
      GO TO 204                                                          00005320
C                                                                        00005330
C     END CAVITY ITERATION                                               00005340
C                                                                        00005350
C                                                                        00005360
C     EXIT STATION FLOW CALCULATIONS                                     00005370
C                                                                        00005380
126   PREL(I) = PRELP(I) + C3 * ( R(I)**2 - RP(I)**2)                    00005390
      PRELEX(I) = PREL(I)                                                00005400
      ZZ1 = 0.0                                                          00005410
      IF (I .EQ. 1 .OR. I .EQ. NI ) ZZ1 = ZBL(I)                         00005420
      VM = Q(I) / (DY(I)*COS(SI(I))-ZZ1)/C2/R(I)                         00005430
      VU = RVU(I) / R(I)                                                 00005440
      WU = U - VU                                                        00005450
      BETA(I) = ATAN( VM/WU)                                             00005460
      W(I) = VM / SIN(BETA(I))                                           00005470
      WEX(I) = W(I)                                                      00005480
      QD = C1 * W(I)**2                                                  00005490
      PX(I) = PREL(I) - QD                                               00005500
C                                                                        00005510
C     CALCULATE RADIAL PRESSURE GRADIENT                                 00005520
C     FOR ALL STREAM TUBES                                               00005530
C                                                                        00005540
  204 IF( I .EQ. 1 )  GO TO 131                                          00005550
C     GOTO131                                                            00005560
      DPR = PX(I) - PX(I-1)                                              00005570
      DSR = R(I) - R(I-1)                                                00005580
      ZZ5=(R(I) *OMEGA - W(I) * COS(BETA(I))) ** 2 /R(I)                 00005590
      ZZ6=(R(I-1) * OMEGA - W(I-1) * COS(BETA(I-1))) **2 /R(I-1)         00005600
      DPDSR=         RHO  * (ZZ5 + ZZ6) / G/2.0                          00005610
      IF ( J .GT. NJ .OR. DZLE .GE.0.)GOTO 1311                          00005620
      ZZ1 = SIS(I-1)                                                     00005630
      ZZ5=(SIS(I-1) -SISP(I-1)) / DZ                                     00005640
```

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      ZZ6 = (W(I)*SIN(BETA(I)) + w(I-1)*SIN(BETA(I-1))) *0.5          00005650
      DPDSR = DPDSR - 2.0*C1*ZZ6*ZZ6*ZZ5*COS(ZZ1)**2                 00005660
      ZZ4 = (WP(I)*SIN(BETAP(I)) + WP(I-1)*SIN(BETAP(I-1)))*0.5      00005670
      ZZ2=(ZZ6 - ZZ4)/DZ                                             00005680
      DPDSR = DPDSR - C1*ZZ2*SIN(2.0*ZZ1)*ZZ6                        00005690
 1311 ESV(I) = E(I)                                                  00005700
      E(I) = (DPR/DSR - DPDSR)                                       00005710
      SME2  = SME2  + ABS(E(I))                                      00005720
  131 CONTINUE                                                       00005730
C      GOTO144                                                       00005740
C                                                                    00005750
C     CHECK RADIAL EQUILIBRIUM                                       00005760
C                                                                    00005770
      IF( SME2 .LT. ( ETOL * PX(NI)) / DR ) GO TO 144                00005780
      IF( ITE .LT. 53 ) GO TO 133                                    00005790
      DO 132 I = 2 , NI                                              00005800
      IF( ESV(I) * E(I) .LT. 0.0 )  GO TO 132                        00005810
      ERROR=.TRUE.                                                   00005820
  132 CONTINUE                                                       00005830
      IF( .NOT. ERROR )   GO TO 144                                  00005840
  133 CONTINUE                                                       00005850
      IF(ITE .EQ. 200) GO TO 130                                     00005860
C                                                                    00005870
C     ADJUST STREAMLINES                                             00005880
C                                                                    00005890
      DO 141   I = 1,NXXI                                           00005900
      NXI = I + 1                                                    00005910
      ZZ4 = PCRDL                                                    00005920
      ZZ5 = E( NXI)                                                  00005930
      IF (ITE .EQ. 1 ) GO TO 139                                     00005940
      ZZ6 = ESV( NXI)                                                00005950
      ZZ1 = PCR(I) - PCR1(I)                                         00005960
      ZZ2 = ABS(ZZ6) - ABS(ZZ5)                                      00005970
      IF ((ZZ1*ZZ2) .LT. 0.0) ZZ4 = -PCRDL                           00005980
  139 PCR1(I) = PCR(I)                                               00005990
  141  PCR(I) = PCR(I) + ZZ4 / SME2 * ABS( ZZ5 )                     00006000
  130 CONTINUE                                                       00006010
C                                                                    00006020
C     END STREAMLINE ITERATION                                       00006030
C                                                                    00006040
144   IF ( J .GT. NJ ) GO TO 404                                     00006050
      VOL = 0.                                                       00006060
C                                                                    00006070
C     CALCULATE J-STATION STREAM TUBE PARAMETERS                     00006080
C                                                                    00006090
      CALL PRNT5(J,Z(J),ITE)                                         00006100
      JSTOP = 0                                                      00006110
      DO 299 I=1,NI                                                  00006120
      VOL = VOL + (B(I) * SIN(BETAS(I)) + BP(I) * SIN(BETASP(I)))    00006130
     1       * DM(I) * (DY(I) + DYP(I) ) / 4.                        00006140
      U = OMEGA * R(I)                                               00006150
      VM = W(I) * SIN(BETA(I) )                                      00006160
      WU = W(I) * COS(BETA(I) )                                      00006170
      VU = U - WU                                                    00006180
      RVU(I) = R(I) * VU                                             00006190
      ALPHA=ATAN2(VM,VU)                                             00006200
```

```
      V = VM / SIN(ALPHA)                                                    00006210
      PT  = POREL(I) +  C1 * (V**2 - W(I)**2 )                               00006220
      H = PT / RHO - H0(I)                                                   00006230
      HII = U * VU / G - HI0(I)                                              00006240
      ETA = H / HII                                                          00006250
      IF(M(I) .LE. 0.)ETA=1.0                                                00006260
      PCB = B(I) / TAU(I)                                                    00006270
      DEV = ( BETAS(I) - BETA(I) )                                           00006280
      BN = B(I) * SIN(BETAS(I))                                              00006290
      MSTR= M(I) + B(I) * COS(BETAS(I))                                      00006300
      IF (PX(I) .GE. 0.0) GO TO 9085                                         00006310
      JSTOP = 1                                                              00006320
      PXS = PX(I)                                                            00006330
 9085 CONTINUE                                                               00006340
      CALL PRNT67(J,Z(J),I,RSTS(I),PCR(I),R(I),TAU(I),T(I),B(I),PX(I),       00006350
     1            PREL(I),POREL(I),PT,MSTR,BN,PCB,BETA(I),BETAS(I),DEV,      00006360
     2            DBS(I),XMTH(I),ZBL(I),HSF(I),ALPHA,ETA,W(I),U,V,VU,        00006370
     3            VM,ITE)                                                    00006380
      IF ( J .NE. NJ) GO TO 299                                              00006390
      POREL(I) = POREL(I) - QD * (T(I) / C2 / R(I) / SIN(BETAS(I)))**2       00006400
      PREL(I) = POREL(I)                                                     00006410
      IF (I .EQ. 1 .OR. I .EQ. NI)  PREL(I)=POREL(I) + 2.0*XMTH(I)/          00006420
     1  DY(I)*QD                                                            00006430
299   CONTINUE                                                               00006440
      CVOL = CVOL + VOL * NB                                                 00006450
      IF( JSTOP .EQ. 0 ) GO TO 300                                           00006460
      WRITE(6,9086) PXS                                                      00006470
9086  FORMAT(//////' NEGATIVE PRESSURE OF  ',F16.5,                         00006480
     1  '  EXECUTION SUPPRESSED' )                                          00006490
      GO TO 4501                                                             00006500
  300 CONTINUE                                                               00006510
      J = NJ + 1                                                             00006520
      Z(J) = Z(NJ) + DZ                                                      00006530
      RT(J) = RT(NJ)                                                         00006540
      RH(J) = RH(NJ)                                                         00006550
      BTS(J) = BTS(NJ)                                                       00006560
      BHS(J) = BHS(NJ)                                                       00006570
      GO TO 1252                                                             00006580
C                                                                            00006590
C     EXIT ROUTINE                                                           00006600
C     (DOWNSTREAM)                                                           00006610
C                                                                            00006620
404   CONTINUE                                                               00006630
      WRITE (6,405)                                                          00006640
  405 FORMAT (1H1, T54, 'EXIT CONDITIONS'// T19, 'I', T33, 'R', T46, 'DE00006650
     1V', T61, 'H', T75, 'P', T88, 'PT', T102, 'ETA' /T17, 'ALPHA', T31,00006660
     2 'BETA', T47, 'V', T60, 'VM', T74, 'VU', T88, 'WU', T103, 'W')         00006670
      SMH = 0.                                                               00006680
      SMHI = 0.                                                              00006690
      DO 450 I = 1,NI                                                        00006700
      U = OMEGA * R(I)                                                       00006710
      VU = RVU(I) / R(I)                                                     00006720
      WU = U - VU                                                            00006730
      VM = W(I) * SIN(BETA(I))                                               00006740
      VEX(I) = VM                                                            00006750
      ALPHA=ATAN2(VM,VU)                                                     00006760
      V = VM / SIN(ALPHA)                                                    00006770
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      BETAE = ATAN(VM/WU)                                                    00006780
      QD = C1 * WP(I)**2                                                     00006790
      POREL(I) = PREL(I)                                                     00006800
      IF (I .EQ. 1 .OR. I .EQ. NI) POREL(I) =PREL(I)-2.*XMTH(I)/DY(I)*QD00006810
      PT = POREL(I)  + C1 * ( V**2 - W(I)**2 )                               00006820
      H = PT / RHO - HO(I)                                                   00006830
      HII = U * VU / G - HIO(I)                                              00006840
      ETA = H / HII                                                          00006850
      SMH = SMH + H * Q(I)                                                   00006860
      SMHI = SMHI + HII    * Q(I)                                            00006870
      DEV = (BETAS(I) - BETAE  ) * 57.2958                                   00006880
      ALPHA = ALPHA * 57.2958                                                00006890
      BETAE = BETAE * 57.2958                                                00006900
      WRITE (6,411) I, R(I), DEV, H, PX(I), PT, ETA, ALPHA, BETAE, V,        00006910
     1              VM, VU, WU, W(I)                                         00006920
  411 FORMAT ( 1H0 , T12,10X,I4,6E14.6 / T12, 7E14.6 )                       00006930
  450 CONTINUE                                                               00006940
C                                                                            00006950
C                                                                            00006960
C     OVERALL PERFORMANCE                                                    00006970
C                                                                            00006980
      H = SMH / QI * FLOAT(NB)                                               00006990
      HII = SMHI / QI * FLOAT(NB)                                            00007000
      ETA =  SMH / SMHI                                                      00007010
      SIOP = G * H / ( OMEGA * RT(1)) **2                                    00007020
      RN  = OMEGA * RT(1)**2  / NU                                           00007030
      SS = OMEGA * QI**.5 / (G * NPSH)**.75                                  00007040
      SIID = SIOP/ETA                                                        00007050
      SIL = SIID - SIOP                                                      00007060
C                                                                            00007070
      IF( CBHR .EQ. 0.0 .OR. NREV .EQ. 1 ) GO TO 250                         00007080
      DELTR = (RT(1) - RH(1) + RT(NJ) - RH(NJ)) / 2.                         00007090
      ARR = DELTR / (Z(NJ) - Z(1)) * SIN(BTSB)                               00007100
      SIL = (SILSAV/SIID +(0.7 * CBHR/ SIN(BTSB) * SIID) * (1.+10.0*(        00007110
     1  PH/SIID * CBHR / SIN(BTSB) * ARR)**0.5 )) * SIID                     00007120
      SIOP = SIID - SIL                                                      00007130
      ETA = SIOP / SIID                                                      00007140
      H = SIOP / G * (OMEGA*RT(1))**2                                        00007150
      HII = SIID / G * (OMEGA*RT(1))**2                                      00007160
  250 SILSAV = SIL                                                           00007170
      CALL PRNT8  (NPSH, PH, SIOP, H, HII, RN, ETA, SS, QI,CVOL)             00007180
      WRITE(6,27) SIID,SIL                                                   00007190
27    FORMAT(///' PSI IDEAL = ',F10.5,5X,'PSI LOSS =',F10.5)                 00007200
C                                                                            00007210
      IF(LOADOP .EQ. 0) GO TO 4501                                           00007220
      CALL LOAD(PXL,ML,DPBN,NJ,NI,TCBSI,TCBS,PSAT,BL,PRELL,C1,WIN,WJ1,       00007230
     1NB,RIN,BSIN,PRELI,VA,WNJ,REX,BSEX,VEX,Z,RL, WEX ,PRELEX, VT, PTU ,00007240
     1  RHO,G,PCZ,TP,T,BETAS,DZ,C2,WPX,WSX,PPX,PSX)                         00007250
      IF( CBHR .EQ. 0.0 .OR. NREV .EQ. 2 ) GO TO 4501                        00007260
C                                                                            00007270
C   VORTEX CALCULATIONS                                                      00007280
C                                                                            00007290
      DO 906 J=2,NJ                                                          00007300
      CGAMP = CGAM                                                           00007310
      GAMP = GAM                                                             00007320
      AVP = AV                                                               00007330
```

```
      V1P = V1                                                          00007340
      XLAMP = XLAM                                                      00007350
      I = NI                                                            00007360
      IF ( KILL .EQ. 1) GO TO 9081                                      00007370
      IF ( PSX(J,I) .LE. PPX(J,I) ) GO TO 9078                          00007380
9081  AV = AVP                                                          00007390
      KILL = 1                                                          00007400
      GO TO 9079                                                        00007410
9078  XLAM = ARCOS (WPX(J,I) / WSX(J,I) )                               00007420
      XLAMX = XLAM * 57.2958                                            00007430
      XLAMB = (XLAM + XLAMP ) /2.                                       00007440
      GAM = 2. * WSX(J,I) * SIN(XLAM / 2.)                              00007450
      GAMB = (GAM + GAMP) / 2.                                          00007460
      V1 = WSX(J,I) * COS(XLAM / 2.)                                    00007470
      V1B = (V1 + V1P)/ 2.                                              00007480
C                                                                       00007490
C  VORTEX RADIUS ITERATION                                              00007500
C                                                                       00007510
      KK = 0.                                                           00007520
      AVC = GAMB * DMVX(J,I) / (4. * PI * V1B)                          00007530
      AVC1 = AVC                                                        00007540
925   KK = KK + 1                                                       00007550
      IF (KK .GT. 300)  STOP                                            00007560
      DADM = GAMB /(4.*PI * V1B) *  ALOG( 1 + CLEAR / AVC)              00007570
      IF ( XLAM .EQ. 0.) DADM = 0.                                      00007580
      AV =  AVP + DADM * DMVX(J,I)                                      00007590
      IF ( ABS (( AV - AVC ) / AV ) .LE. .001 ) GO TO 98                00007600
      AVC = (AV + AVC) / 2.                                             00007610
      GO TO 925                                                         00007620
98    CGAM=(CGAMP+GAMB*TAN(XLAMB/2.)*DMVX(J,I) * FLR ) / (1.+ GAMB *    00007630
     1    DMVX(J,I)*FLR /(4. * PI  *(AV + CLEAR) * V1B) )               00007640
9079  OTCV = CGAM /( 2. * PI * AV **2 )                                 00007650
      UPLIM = RT(J)                                                     00007660
      LOWLIM = RT(J) - 2. * AV                                          00007670
C                                                                       00007680
      DO 906 I=1,NI                                                     00007690
      RW = RT(J) + CLEAR                                                00007700
      R1 = RL(J,I) - DYX(J,I) /2.                                       00007710
      R2 = RL(J,I) + DYX(J,I) /2.                                       00007720
      IF(I .EQ. NI ) R2 = R2 + CLEAR                                    00007730
      RC = RT(J) - AV                                                   00007740
      Y1 = RW - R2                                                      00007750
      Y4 = RW - R1                                                      00007760
      Y2 = RW - (RC + AV)                                               00007770
      Y2 = AMAX1(Y2,Y1)                                                 00007780
      Y2 = AMIN1(Y2,Y4)                                                 00007790
      Y3 = RW - (RC - AV)                                               00007800
      Y3 = AMAX1(Y3,Y1)                                                 00007810
      Y3 = AMIN1(Y3,Y4)                                                 00007820
      S  = TAUVX(J,NI) * SIN(BETASX(J,NI))                              00007830
      BTIP = S / 2.                                                     00007840
      LI = TAUVX(J,I) * SIN(BETASX(J,I))                                00007850
      BI = (LI / S) * BTIP                                              00007860
      X1 = BI - AV                                                      00007870
      X2 = BI + AV                                                      00007880
      AFAS = LI *(Y4 - Y1)                                              00007890
      TGIS = AV* (Y3**2 - Y2**2) -2*AV *(RW -RC)* (Y3 -Y2)              00007900
```

```
      TPS=2. * PI / S                                                          00007910
      APC = AV + CLEAR                                                         00007920
      M1 = TPS * (Y1-APC)                                                      00007930
      M2 = TPS * (Y2-APC)                                                      00007940
      M3 = TPS * (Y3-APC)                                                      00007950
      M4 = TPS * (Y4-APC)                                                      00007960
      N1 = TPS * (Y1+APC)                                                      00007970
      N2 = TPS * (Y2+APC)                                                      00007980
      N3 = TPS * (Y3+APC)                                                      00007990
      N4 = TPS * (Y4+APC)                                                      00008000
      DO 57 N=1,4                                                              00008010
      GO TO(51,52,54,54),N                                                     00008020
 51   UP = LI                                                                  00008030
      LOW = X2                                                                 00008040
      GO TO 58                                                                 00008050
 52   UP = X1                                                                  00008060
      LOW = 0.                                                                 00008070
      GO TO 58                                                                 00008080
 54   UP = X2                                                                  00008090
      LOW = X1                                                                 00008100
 58   DX =(UP - LOW) /25.                                                      00008110
      XX = LOW -DX                                                             00008120
      DO 59 KX=1,26                                                            00008130
      XX = XX + DX                                                             00008140
      XL = 2. * PI / S * (XX - BI)                                             00008150
      GO TO (61,61,63,64),N                                                    00008160
 61   FUNC(KX) = ALOG(  ((COSH(M4)-COS(XL))/(COSH(M1)-COS(XL))) /((            00008170
     1          COSH(N4)-COS(XL))/(COSH(N1)-COS(XL)) ))                       00008180
      GO TO 59                                                                 00008190
      GO TO 59                                                                 00008190
 63   FUNC(KX)= ALOG( ((COSH(M2)-COS(XL))/(COSH(M1)-COS(XL))) /((              00008200
     1          COSH(N2)-COS(XL))/(COSH(N1)-COS(XL)) ))                       00008210
      GO TO 59                                                                 00008220
 64   FUNC(KX)= ALOG( ((COSH(M4)-COS(XL))/(COSH(M3)-COS(XL))) /((              00008230
     1          COSH(N4)-COSH(XL))/(COSH(N3)-COS(XL)) ))                      00008240
 59   CONTINUE                                                                 00008250
      CALL QSF(DX,FUNC,YOUT,26)                                                00008260
 57   TGIF(N) = S / (2.*PI) * YOUT(26)                                         00008270
      TGSUM = TGIF(1) + TGIF(2) + TGIF(3) + TGIF(4)                            00008280
      WNC(J,I) =1./ AFAS  *(FLR * CGAM /(2.*S ) * TGSUM + OTCV * TGIS)         00008290
      DBTC(J,I) = ATAN( WNC(J,I) / WVX(J,I) )                                  00008300
      R1 = R1*12.                                                              00008310
      R2 = R2*12.                                                              00008320
      RC = RC*12.                                                              00008330
      RW = RW*12.                                                              00008340
      AVX = AV * 12.                                                           00008350
      X1 = X1*12.                                                              00008360
      X2 = X2*12.                                                              00008370
      Y1 = Y1*12.                                                              00008380
      Y2 = Y2*12.                                                              00008390
      Y3 = Y3*12.                                                              00008400
      Y4 = Y4*12.                                                              00008410
      TGIS = TGIS*12.                                                          00008420
      TGSUM= TGSUM*12.                                                         00008430
      S = S * 12.                                                              00008440
      LI = LI * 12.                                                            00008450
```

```
      BTIP = BTIP * 12.                                                  00008460
      BI = BI * 12.                                                      00008470
      APC = APC * 12.                                                    00008480
      TPS = TPS * 12.                                                    00008490
      AFAS = AFAS * 12.                                                  00008500
      M1 = M1 *12.                                                       00008510
      M2 = M2*12.                                                        00008520
      M3 = M3*12.                                                        00008530
      M4 = M4*12.                                                        00008540
      N1 = N1*12.                                                        00008550
      N2 = N2*12.                                                        00008560
      N3 = N3*12.                                                        00008570
      N4 = N4*12.                                                        00008580
      TX = FLR * CGAM /(2.*S )                                           00008590
      DO 68 KKK=1,4                                                      00008600
68    TGIF(KKK) = TGIF(KKK) *12.                                         00008610
906   CONTINUE                                                           00008620
      IF ( NREV .EQ. 1) GO TO 926                                        00008630
 4501 IF( CASE .EQ. CASES ) GO TO 1                                      00008640
      CASE = CASE +1                                                     00008650
      GO TO 20                                                           00008660
    2 FORMAT( 20A4 )                                                     00008670
6091  FORMAT(4F10.0)                                                     00008680
    4 FORMAT(1H1 , 61X , 'DECK  6091' //  51X ,'INDUCER  HYDRODYNAMIC  P00008690
     1PROGRAM' ///  3X, 20A4 // )                                        00008700
    3 FORMAT( 4I5 , F15.5  ,3F10.4)                                      00008710
    5 FORMAT( 4X ,'NI', 9X, 'NJ ',7X,                    'NB',9X,'CASES',00008720
     16X, 'G',10X,'CBHR'//3X,I3,8X,I3,2(7X,I4),4X,F10.5,F12.4)           00008730
6     FORMAT(////6X,'Z',14X,'RH',13X,'RT',13X,'BH*',12X,'BT*',12X,       00008740
     1'TT',13X, 'TA' // )                                                00008750
    8 FORMAT(1X,I3, F9.5,     6F15.5     )                               00008760
   23 FORMAT (// T45, 'PO', T60, 'VM', T75, 'ALPHA' /(T36, 3F15.5))      00008770
17    FORMAT(4F10.4,I10)                                                 00008780
7     FORMAT(7F10.4)                                                     00008790
22     FORMAT(1H1,10X,'CASE NUMBER -',I4//31X,'RHO',13X,'MU',            00008800
     1 11X, 'PSAT', 12X, 'SN',          12X,'LOADOP'//23X,4F15.5,I10//) 00008810
 785  FORMAT(1H1,10X,'CASE NUMBER -',I4//31X,'RHO',13X,'MU',11X,         00008820
     1  'PSAT',12X,'SN',12X,'LOADOP',12X,'FLR'//23X,4F15.5,I10,F20.6//) 00008830
   19 FORMAT (3F10.0)                                                    00008840
7090   FORMAT(////T21,'PHI',T36,'NPSH',T51,'THOMA',T66,'VT',T81,'PT',    00008850
     1     T96,'KTIP'//11X,6F15.4)                                       00008860
   30 FORMAT(//T54,'INLET CONDITIONS' // T12, 'I', T29, 'R', T46, 'Q',   00008870
     1 T63, 'W', T80, 'PO', T95, 'PREL', T114, 'P' / T10, 'ALPHA', T27,  00008880
     2 'BETA', T46, 'K', T63, 'U', T81, 'V', T96, 'VM', T113, 'VU')      00008890
   41 FORMAT ( / T11, I2, T18, 6(5X, F12.5) / T6, F12.5, 6(5X,F12.5))    00008900
999   CONTINUE                                                           00008910
      END                                                                00008920
```

```
      SUBROUTINE LOAD( PX , M , DPBN , NJ , NI , TCBSI , TCBS , PSAT ,
     1   B , PREL , C11, WIN , WJ1 , NB , RIN , BSIN , PRELI , VA ,
     2   WNJ , REX , BSEX , VEX , Z , R , WEX, PRELEX, VT,PTU,RHO,G,PCZ,
     3   TP,T,BETAS,DZ,C22,WP,WS,PP,PS)
      REAL M
                D I M E N S I O N
     1   M( 30 , 15 )  ,  PX( 30 , 15 )  ,  DPBN( 30 , 15 )   ,
     2  A1( 30 , 15 )  ,  B1( 30 , 15 )  ,    C1( 30 , 15 )   ,
     3  D1( 30 , 15 )  ,  A2( 30 , 15 )  ,    B2( 30 , 15 )   ,
     4  C2( 30 , 15 )  ,  D2( 30 , 15 )  ,  TCBS( 30 , 15 )   ,
     5   B( 30 , 15 )  ,PREL( 30 , 15 )  ,  TCBSI( 15 )     ,
     6  DPB( 15 )     ,    PS( 30,15 )        ,    PXC( 15 )     ,
     7   WS(30,15)    ,     W( 15 )          ,    WIN( 15 )     ,
     8  WJ1( 15 )     , PRELI( 15 )          ,   BETA( 15 )     ,
     9   VA( 15 )     ,   RIN( 15 )          ,   BSIN( 15 )     ,
     A   PP( 30,15 )     ,   WEX( 15 )          ,    WNJ( 15 )     ,
     B  VEX( 15 )     ,  BSEX( 15 )          ,    REX( 15 )     ,
     C   WP(  30,15),  Z(30)                 ,  R( 30 , 15 )
     D,PRELEX(15)    ,PSIS(15)    ,PSIP(15),TP(15),T(15),XSI(15),BETAS(15)
      DATA IFV , ZRO , PI   / 5 , 0.0 , 3.141592 /
      DO 2 I = 1,NI
      CALL BMFIT( IFV , NJ , M(1,I) , PX(1,I) , ZRO , ZRO ,
     1     A1(1,I) , B1(1,I)  , C1(1,I)  , D1(1,I)   )
      CALL BMFIT( IFV , NJ , M(1,I),DPBN(1,I) , ZRO , ZRO ,
     1     A2(1,I) , B2(1,I)  , C2(1,I)  , D2(1,I)   )
    2 CONTINUE
      J = 1
    9 I = 1
C
C     CALCULATE SUCTION  SURFACE CONDITIONS
C
   10 SMN = M(J,I) - TCBS(J ,I) / 2.0
      XSI(I) = 0.
      DT    =ATAN((TP(I)-T(I))/2. * SIN(BETAS(I))/DZ)
      IF(DT    .GT. 0.0) XSI(I) = (C22 * R(J,I)/2. -T(I)/SIN(BETAS(I)))*
     1  SIN(BETAS(I))*TAN(DT)
      IF(DT    .GT. 0.0) SMN = SMN  + XSI(I)
      IF( SMN .LT. 0.0 )  GO TO 30
      PS(J,I) = PSAT
      IF( J .EQ. 1 ) GO TO 31
      IF( B(J,I) .GT. 0.0 ) GO TO 31
      CALL BMEVAL ( NJ , M(1,I) , PX(1,I) , SMN , MERR , A1(1,I)  ,
     1             B1(1,I)  , C1(1,I)  , D1(1,I) ,  PXC(I) , DUM )
      CALL BMEVAL ( NJ , M(1,I),DPBN(1,I) , SMN , MERR , A2(1,I)  ,
     1             B2(1,I)  , C2(1,I)  , D2(1,I) ,  DPB(I) , DUM )
      PS(J,I) = PXC(I) - DPB(I) / 2.0
      IF( PS(J,I) .LT. PSAT )  PS(J,I) = PSAT
      GO TO 31
C
C     UNCOVERED LEADING EDGE REGION
C
   30 W(I) = WIN(I) - ( WIN(I) - WJ1(I) ) * EXP( SMN * NB / RIN(I)  /
     1  SIN(BSIN(I)) )
      PS(J,I) = PSAT
      IF (J .EQ. 1) GO TO 31
```

```
      IF( B(J,I) .GT. 0.0 ) GO TO 31                                    00560
      PXC(I) = PRELI(I) - C11* W(I)**2                                  00570
      BETA(I) =  ARSIN( VA(I) / W(I) )                                  00580
      DPB(I) = 2.0 * PI * C11* VA(I) / COS(BETA(I)) *  SIN(BETA(I))**2  00590
     1   /  SIN( BSIN(I))**2 * ( WIN(I) - WJ1(I) ) *  EXP( SMN * NB /   00600
     2  RIN(I) / SIN( BSIN(I)) )                                         00610
      PS(J,I) = PXC(I) - DPB(I) / 2.0                                   00620
      IF( PS(J,I) .LT. PSAT )  PS(J,I) = PSAT                           00630
   31 WS(J,I)=SQRT((PRELI(I) - PS(J,I)) / C11                           00640
C                                                                       00650
C     CALCULATE  PRESS. SURFACE CONDITIONS                              00660
C                                                                       00670
   40 SMN = M(J,I) + TCBS(J,I) /2.0 + XSI(I)                            00680
      PP(J,I) = PREL(J,I)                                               00690
      IF ( J .EQ. 1    ) GO TO 59                                       00700
      IF( SMN .GT. M(NJ,I)  )  GO TO 50                                 00710
      CALL BMEVAL ( NJ , M(1,I) , PX(1,I) , SMN , MERR , A1(1,I)  ,     00720
     1              B1(1,I)  , C1(1,I)  , D1(1,I) ,  PXC(I) , DUM )     00730
      CALL BMEVAL ( NJ , M(1,I),DPBN(1,I) , SMN , MERR , A2(1,I)  ,     00740
     1              B2(1,I)  , C2(1,I)  , D2(1,I) ,  DPB(I) , DUM )     00750
      PP(J,I) = PXC(I) + DPB(I) / 2.0                                   00760
      IF( PP(J,I) .GT. PREL(J,I) ) PP(J,I) = PREL(J,I)                  00770
   59 WP(J,I)=SQRT((PREL( J,I) - PP(J,I)) / C11)                        00780
      GO TO 60                                                          00790
C                                                                       00800
C     UNCOVERED TRAILING EDGE REGION                                    00810
C                                                                       00820
   50 SMNE = SMN - M(NJ,I)                                              00830
      W(I) = WEX(I) - ( WEX(I) - WNJ(I) ) * EXP( -SMNE * NB / REX(I) /  00840
     1 SIN( BSEX(I))  )                                                 00850
      PXC(I) = PRELEX(I)   - C11* W(I)**2                               00860
      BETA(I) =ARSIN( VEX(I) / W(I) )                                   00870
      DPB(I) = 2.0 * PI * C11* VEX(I) / COS(BETA(I)) * SIN(BETA(I))**2  00880
     1  / SIN(BSEX(I))**2 *( WEX(I) - WNJ(I)) * EXP(-SMNE * NB /        00890
     2   REX(I) / SIN( BSEX(I)) )                                       00900
      PP(J,I) = PXC(I) + DPB(I) /2.0                                    00910
      IF( PP(J,I) .GT. PRELEX(I) ) PP(J,I) = PRELEX(I)                  00920
      WP(J,I)=SQRT((PRELEX(I) - PP(J,I))/ C11)                          00930
   60 DPB(I) = PP(J,I) - PS(J,I)                                        00940
      PSIS(I)= G* (PS(J,I)-PTU)/RHO/VT **2                              00950
      PSIP(I)= G* (PP(J,I)-PTU)/RHO/VT **2                              00960
      I = I + 1                                                         00970
      IF( I .LE. NI )  GO TO 10                                         00980
      PCZ  =  Z(J) / Z(NJ)                                              00990
C                                                                       01000
      IF(J .EQ. 1) WRITE(6,11)                                          01010
11    FORMAT(1H1,T45,'BLADE LOADING DATA')                              01020
      WRITE(6,1)J,Z(J),PCZ                                              01030
1     FORMAT(//////10X,'J',14X,'Z',14X,'Z/ZT'//I11,2F19.5)              01040
      WRITE(6,7)(I,R(J,I),PS(J,I),PP(J,I),WS(J,I),WP(J,I),DPB(I),PSIS(I)  01050
     1     ,   PSIP(I),I=1,NI)                                          01060
    7 FORMAT(/// 9X,'I',14X,'R',13X,'PS',13X,'PP',13X,'WS',13X,'WP',13X,  01070
     1'DPB',12X,'PSIS',12X,'PSIP'//(I11,8E15.5/))                       01080
      J = J + 1                                                         01090
      IF( J .LE. NJ)  GO TO 9                                           01100
      RETURN                                                            01110
      END                                                               01120
```

```
C     PRINT SUBROUTINE FOR DECK 6091                                    *
      SUBROUTINE PRNT5(J ,Z ,ITE )                                      00000010
      WRITE(6,22) J , Z  , ITE                                          00000020
   22 FORMAT(1H1,' STATION J =',I3, ' , Z = ' F10.5 , '  , ITE = ',I4)  00000030
      WRITE(6,1)                                                        00000040
1     FORMAT(//  T8,'I',T23,'RST ',T38,'PCR',T53,'R',T68,'TAU',T83,     00000050
     1 'THK',T98,'B'/T8,'P',T23,'PREL',T38,'POREL',T53,'PT',T68,'M*',   00000060
     2  T83,'BN',T98,'PCB'/T8,'BETA',T23,'BETA*',T38,'DEV',T53,'DLB*',  00000070
     3  T68,'XMTH',T83,'DEL*',T98,'HSF'/T8,'ALPHA',T23,'ETA',T38,'W',   00000080
     4  T53,'U',T68,'V',T83,'VU',T98,'VM')                              00000090
      RETURN                                                            00000100
      ENTRY PRNT67(J,Z,I,RSTS,PCR,R,TAU,T,B,P,PREL,POREL,PT,MSTR,BN,    00000110
     1             PCB,BETA,BETAS,DEV,DBS,XMTH,ZBL,HSF,ALPHA,ETA,W,U,V, 00000120
     2  VU,VM,ITE)                                                     00000130
   25 BETADG = BETA * 57.2958                                           00000140
      ALPH = ALPHA * 57.2958                                            00000150
      DE =DEV * 57.2958                                                 00000160
      BETS =BETAS * 57.2958                                             00000170
      DB1 = DBS * 57.2957                                               00000180
       WRITE(6,2) I,RSTS,PCR,R,TAU,T  ,B,P,PREL,POREL,PT,MSTR,BN,PCB,   00000190
     1BETADG,BETS ,DE ,DB1,XMTH,ZBL,HSF,ALPH ,ETA,W,U,V,VU,VM           00000200
2     FORMAT( /6X,I3,6X,E15.5,                                          00000210
     1    5E15.5 / 7E15.5 / 7E15.5 / 7E15.5)                           00000220
      RETURN                                                            00000230
      ENTRY PRNT8 (NPSH, PHI, PSI, H, HI, RN, ETA, SS, QI, CVOL )       00000240
      WRITE (6,3) NPSH, PHI, PSI, H, HI, RN, ETA, SS, QI                00000250
3      FORMAT(/// 45X,' OVERALL PERFORMANCE'//T6,'NPSH',T21,'PHI',T35,  00000260
     1 'PSI', T50, 'H', T65, 'HI', T79, 'RN', T95, 'ETA', T110, 'SS',   00000270
     2 T123, 'QI' // T3,F10.4, 2(2X,F12.5), 2(2X, F13.3), 2X, F14.2,    00000280
     3 3(2X, F12.5))                                                    00000290
      WRITE(6,30) CVOL                                                  00000300
30    FORMAT(// T6,' CVOL' // E15.4)                                    00000310
      RETURN                                                            00000320
      END                                                               00000330
```

```
                                                                        *
      SUBROUTINE QSF H,Y,Z,NDIM                                         00010
      DIMENSION Y 1 ,Z 1                                                00020
      HT .3333333*H                                                     00030
      L1 1                                                              00040
      L2 2                                                              00050
      L3 3                                                              00060
      L4 4                                                              00070
      L5 5                                                              00080
      L6 6                                                              00090
      IF NDIM-5 7,8,1                                                   00100
C     NDIM IS GREATER THAN 5. PREPARATIONS OF INTEGRATION LOOP           00110
    1 SUM1 Y L2 &Y L2                                                   00120
      SUM1 SUM1&SUM1                                                    00130
      SUM1 HT* Y L1 &SUM1&Y L3                                          00140
      AUX1 Y L4 &Y L4                                                   00150
      AUX1 AUX1&AUX1                                                    00160
      AUX1 SUM1&HT* Y L3 &AUX1&Y L5                                     00170
      AUX2 HT* Y L1 &3.875* Y L2 &Y L5  &2.625* Y L3 &Y L4  &Y L6       00180
      SUM2 Y L5 &Y L5                                                   00190
      SUM2 SUM2&SUM2                                                    00200
      SUM2 AUX2-HT* Y L4 &SUM2&Y L6                                     00210
      Z L1  0.                                                          00220
      AUX Y L3 &Y L3                                                    00230
      AUX AUX&AUX                                                       00240
      Z L2  SUM2-HT* Y L2 &AUX&Y L4                                     00250
      Z L3  SUM1                                                        00260
      Z L4  SUM2                                                        00270
      IF NDIM-6 5,5,2                                                   00280
C     INTEGRATION LOOP                                                  00290
    2 DO 4 I 7,NDIM,2                                                   00300
      SUM1 AUX1                                                         00310
      SUM2 AUX2                                                         00320
      AUX1 Y I-1 &Y I-1                                                 00330
      AUX1 AUX1&AUX1                                                    00340
      AUX1 SUM1&HT* Y I-2 &AUX1&Y I                                     00350
      Z I-2  SUM1                                                       00360
      IF I-NDIM 3,6,6                                                   00370
    3 AUX2 Y I &Y I                                                     00380
      AUX2 AUX2&AUX2                                                    00390
      AUX2 SUM2&HT* Y I-1 &AUX2&Y I&1                                   00400
    4 Z I-1  SUM2                                                       00410
    5 Z NDIM-1  AUX1                                                    00420
      Z NDIM  AUX2                                                      00430
      RETURN                                                            00440
    6 Z NDIM-1  SUM2                                                    00450
      Z NDIM  AUX1                                                      00460
      RETURN                                                            00470
C     END OF INTEGRATION LOOP                                           00480
    7 IF NDIM-3 12,11,8                                                 00490
C     NDIM IS EQUAL TO 4 OR 5                                           00500
    8 SUM2 1.125*HT* Y L1 &Y L2 &Y L2 &Y L2 &Y L3 &Y L3 &Y L3 &Y L4      00510
      SUM1 Y L2 &Y L2                                                   00520
      SUM1 SUM1&SUM1                                                    00530
      SUM1 HT* Y L1 &SUM1&Y L3                                          00540
      Z L1  0.                                                          00550
```

```
      AUX1 Y L3 &Y L3                                                    00560
      AUX1 AUX1&AUX1                                                     00570
      Z L2  SUM2-HT* Y L2 &AUX1&Y L4                                     00580
      IF NDIM-5 10,9,9                                                   00590
    9 AUX1 Y L4 &Y L4                                                    00600
      AUX1 AUX1&AUX1                                                     00610
      Z L5  SUM1&HT* Y L3 &AUX1&Y L5                                     00620
   10 Z L3  SUM1                                                         00630
      Z L4  SUM2                                                         00640
      RETURN                                                             00650
C     NDIM IS EQUAL TO 3                                                 00660
   11 SUM1 HT* 1.25*Y L1 &Y L2 &Y L2 -.25*Y L3                           00670
      SUM2 Y L2 &Y L2                                                    00680
      SUM2 SUM2&SUM2                                                     00690
      Z L3  HT* Y L1 &SUM2&Y L3                                          00700
      Z L1  0.                                                           00710
      Z L2  SUM1                                                         00720
   12 RETURN                                                             00730
      END                                                                00740
```

```
      SUBROUTINE NEWGG (NPT, Z, W, X, Y)                                *  00010
      DIMENSION X(1),Y(1)                                                  00020
C                                                                          00030
C     SUBROUTINE NEWGN(NPT,X,Y,XBLK,YBLK)                                  00040
C     NPT  = NUMBER OF POINTS PER BLOCK                                    00050
C     X    = KNOWN VALUE                                                   00060
C     Y    = UNKNOWN (OUTPUT)                                              00070
C     XBLK = BLOCK OF X VALUES                                             00080
C     YBLK = BLOCK OF Y VALUES                                             00090
C                                                                          00100
      IF (Z-X(1))5,5,6                                                     00110
    5 W=Y(1)                                                               00120
      GO TO 10                                                             00130
    6 DO 7 I=2,NPT                                                         00140
      IF (Z-X(I))9,8,7                                                     00150
    7 CONTINUE                                                             00160
      I=NPT                                                                00170
    8 W=Y(I)                                                               00180
      GO TO 10                                                             00190
    9 W=(Y(I)-Y(I-1))/(X(I)-X(I-1))*(Z-X(I-1))+Y(I-1)                      00200
   10 RETURN                                                               00210
      END                                                                  00220
```

```
      SUBROUTINE BMFIT L,N,X,Y,SLOPE0,SLOPEN,A,B,C,D                    *  00010
      DIMENSION X 100 ,Y 100 ,A 100 ,B 100 ,C 100 ,D 100                   00020
      KN    3* L-L/3  - 2*L                                                00030
      K0     L-1 /3                                                        00040
      DO 1 J 2,N                                                           00050
      A J      X J -X J-1                                                  00060
    1 D J      Y J -Y J-1  /A J                                            00070
      K2  N-2                                                              00080
      IF  KN-1  4,5,6                                                      00090
    4 C N     3.0* SLOPEN-D N  /A N                                       00100
      B N     0.5                                                          00110
      K3 N                                                                 00120
      K1   1                                                               00130
      GO TO 8                                                              00140
    5 T   2.0* A N &A N-1                                                  00150
      B N  SLOPEN                                                          00160
      GO TO 7                                                              00170
    6 T   3.0*A N &A N-1 &A N-1                                            00180
      SLOPEN   0.0                                                         00190
    7 C N-1      6.0* D N -D N-1  -SLOPEN*A N  /T                          00200
      B N-1     A N-1 /T                                                   00210
      K3   N-1                                                             00220
      K1   2                                                               00230
    8 DO 9  J  K1,K2                                                       00240
      K   N-J                                                              00250
      T   2.0* A K &A K&1  -A K&1 *B K&1                                   00260
      B K     A K /T                                                       00270
    9 C K      6.0* D K&1 -D K  -A K&1 *C K&1  /T                         00280
   10 IF  K0-1  12,13,11                                                   00290
   11 B 1     6.0*  D 2 -SLOPE0 -C 2 *A 2  / A 2 * 2.0-B 2                00300
      K1   2                                                               00310
      GO TO 15                                                             00320
   12 B 1     SLOPE0                                                       00330
      B 2     C 2 -B 2 *B 1                                                00340
      GO TO 14                                                             00350
   13 B 1      6.0* D 3 -D 2  -A 3 *C 3  / 3.0*A 2 &A 3 * 2.0-B 3          00360
      B 2     B 1                                                          00370
   14 K1   3                                                               00380
   15 DO 16  J K1,K3                                                       00390
   16 B J     C J -B J *B J-1                                              00400
      IF  KN-1  18,18,17                                                   00410
   17 B N     B N-1                                                        00420
C     CUBIC COEFFICIENTS                                                   00430
   18 DO 19 J 2,N                                                          00440
      TA   6.0 * A J                                                       00450
      TM   B J-1 *X J                                                      00460
      TN   X J-1 *B J                                                      00470
      TX   X J * X J -X J-1 -X J-1                                         00480
      TY   X J-1 * X J &X J -X J-1                                         00490
      A J-1      B J -B J-1  /TA                                           00500
      C J-1  D J & B J * -TX &2.*X J-1 *TN-B J-1 *TY-2.*X J *TM /TA         00510
      B J-1      TM-TN *3.0/TA                                             00520
   19 D J-1     TX*TN &TY*TM /TA &Y J-1 -X J-1 *D J                        00530
   20 RETURN                                                               00540
       END                                                                 00550
```

```
CSBMVAL BEAM EVALUATION SUBROUTINE                                              *
      SUBROUTINE  BMEVAL N,X,Y,VALU,L,A,B,C,D,YVALU,DERIV                       00010
      DIMENSION X 100 ,Y 100 ,A 100 ,B 100 ,C 100 ,D 100                        00020
      L   0                                                                     00030
      DO 1 J 1,N                                                                00040
      IF  X J -VALU  1,2,3                                                      00050
    1 CONTINUE                                                                  00060
C     OUT OF RANGE                                                              00070
      L   1                                                                     00080
      J   N                                                                     00090
    2 YVALU   Y J                                                               00100
      DERIV   VALU* 3.0*VALU*A J &2.0*B J  &C J                                 00110
      RETURN                                                                    00120
    3 IF  J-1  5,5,4                                                            00130
    4 YVALU   VALU* VALU* VALU*A J-1 &B J-1  &C J-1  &D J-1                     00140
      DERIV   VALU* 3.0*VALU*A J-1 &2.0*B J-1  &C J-1                           00150
      RETURN                                                                    00160
    5 L   -1                                                                    00170
      GO TO 2                                                                   00180
       END                                                                      00190
                                                                               00200
```

```
*                                                                      *
*            ZEROC - FILL DESIGNATED AREA OF CORE WITH ZERO OR WITH     ZERO0000
*                    A CONSTANT SUPPLIED IN THE CALLING SEQUENCE.       ZERO0010
*                                                                       ZERO0020
*                         CALLING SEQUENCE                             ZERO0030
*                           CALL ZEROC (FROM,TO)                       ZERO0040
*                                  OR                                  ZERO0050
*                           CALL ZEROC (FROM,TO,CONST)                 ZERO0060
*                                                                       ZERO0070
*                           WHERE-FROM-IS THE STARTING ADDRESS          ZERO0080
*                                 TO-FINAL ADDRESS TO BE CLEARED        ZERO0090
*                                 CONST-THE CONSTANT CORE IS TO BE      ZERO0100
*                                       FILLED WITH. IF NOT SUPPLIED    ZERO0110
*                                       IN CALLING SEQUENCE, CORE       ZERO0120
*                                       WILL BE FILLED WITH ZEROES.     ZERO0130
*                                                                       ZERO0140
PWZERO START 0                                                          ZERO0150
BR0     EQU   0                    BASE REGISTER 0                      ZERO0160
BR1     EQU   1                                                         ZERO0170
BR2     EQU   2                                                         ZERO0180
BR3     EQU   3                                                         ZERO0190
BR4     EQU   4                                                         ZERO0200
BR5     EQU   5                                                         ZERO0210
BR6     EQU   6                                                         ZERO0220
BR7     EQU   7                                                         ZERO0230
BR8     EQU   8                                                         ZERO0240
BR9     EQU   9                                                         ZERO0250
BR10    EQU   10                                                        ZERO0260
BR11    EQU   11                                                        ZERO0270
BR12    EQU   12                                                        ZERO0280
BR13    EQU   13                                                        ZERO0290
BR14    EQU   14                                                        ZERO0300
BR15    EQU   15                                                        ZERO0310
*                                                                       ZERO0320
        ENTRY ZERO                                                      ZERO0325
        USING *,BR15                                                    ZERO0340
ZERO    SAVE  (14,12),,*                                                ZERO0330
        ST    BR13,SAVE+4                                               ZERO0350
        LA    BR10,SAVE                                                 ZERO0360
        ST    BR10,8(0,BR13)                                            ZERO0370
        L     BR3,0(0,BR1)                                              ZERO0390
        L     BR4,4(0,BR1)                                              ZERO0400
        N     BR3,BIGAD            INSURE ADDRESS ONLY.                 ZERO0410
        N     BR4,BIGAD            INSURE ADDRESS ONLY.                 ZERO0420
        CLR   BR3,BR4              1ST ARG. LESS THAN 2ND ARG.          ZERO0430
        BNL   SWITCH               NO, THEN SWITCH REGISTERS.           ZERO0440
MODE1   TM    4(BR1),X'80'                                              ZERO0470
        BZ    NTZRO                MORE ARGUMENTS.                      ZERO0480
MODE    A     BR4,FORBT            YES,CALCULATE BYTES TO BE CLEARED.   ZERO0450
        SR    BR4,BR3              BR4 EQUAL NO. OF BYTES.              ZERO0460
MORE    C     BR4,TWO56            OVER 255 BYTES TO CLEAR              ZERO0500
        BL    LESTN                YES                                  ZERO0510
        S     BR4,TWO56            REDUCE BY 256                        ZERO0520
        L     BR5,TWO56                                                 ZERO0530
MONE    S     BR5,TWO                                                   ZERO0540
        STC   BR5,MOVE+1                                                ZERO0550
MOVE    XC    0(0,BR3),0(BR3)                                           ZERO0560
```

```
         A       BR3,TWO56                                          ZERO0570
         LTR     BR4,BR4                                            ZERO0580
         BC      2,MORE                                             ZERO0590
RETRN    RETURN (14,12),T          RESTORE AND RETURN               ZERO0600
LESTN    LR      BR5,BR4                                            ZERO0610
         LA      BR4,0                                              ZERO0620
         B       MONE                                               ZERO0630
SWITCH   LR      BR5,BR3                                            ZERO0640
         LR      BR3,BR4                                            ZERO0650
         LR      BR4,BR5                                            ZERO0660
         B       MODE1                                              ZERO0670
NTZRO    L       BR6,8(0,BR1)                                       ZERO0680
         L       BR6,0(0,BR6)                                       ZERO0685
NTZR1    ST      BR6,0(0,BR3)                                       ZERO0690
         CR      BR3,BR4                                            ZERO0700
         BE      RETRN                                              ZERO0710
         A       BR3,FORBT                                          ZERO0720
         B       NTZR1                                              ZERO0730
SAVE     DS      18F                                                ZERO1000
BIGAD    DC      X'00FFFFFF'                                        ZERO1010
FORBT    DC      F'4'                                               ZERO1020
TWO56    DC      F'256'                                             ZERO1030
TWO      DC      F'1'                                               ZERO1050
         END                                                        ZERO9990
```

SECTION III
STRESS COMPUTER PROGRAM (PWA 6098)

A. GENERAL

The stress computer program breaks the inducer blade into flat triangular elements for analysis. The program then calculates stress magnitude and distribution caused by pressure loading and centrifugal force using the matrix displacement method.

Computer capacity limits the number of free element nodes to 150 which is equivalent to 900 simultaneous equations. Computer time for handling such a problem is approximately 90 minutes. An input option is provided to permit analysis by subsystems. This is a conventional technique in which the structure is divided into a maximum of 10 subsystems with a total of 200 nodes (including hub nodes). Use of the subsystem option reduces computing time by as much as a factor of 10 for a typical inducer. The program requires 180,000 bytes of core (including buffers) on an IBM 360 Model 75 computer. Single precision with 4 bytes/word and 8 bites/byte is used. Fortran IV-G, Level 1, Mod. 3 compilations dated March 1969 were used.

B. INPUT DESCRIPTION

The input to the stress computer program generally consists of: a physical description of the inducer, a description of the finite element breakup to be used, and a description of the blade pressure distribution.

The inducer physical description and blade pressure distribution input are straightforward but the finite element breakup input requires further explanation. When preparing the finite element breakup input it is helpful to sketch the desired pattern as in the example of figure 1. The following limitations should be remembered:

1. The maximum number of free boundary nodes (on boundary generator lines) for the entire system is 50. The minimum is 3.

2. The maximum number of free boundary nodes per subsystem is 15.

3. The maximum number of free internal nodes per subsystem is 15.

4. The maximum number of nodes (fixed, free, boundary and internal) per subsystem is 30.

5. The maximum number of nodes for the entire system is 200.

6. The maximum number of elements for the entire system is 200.

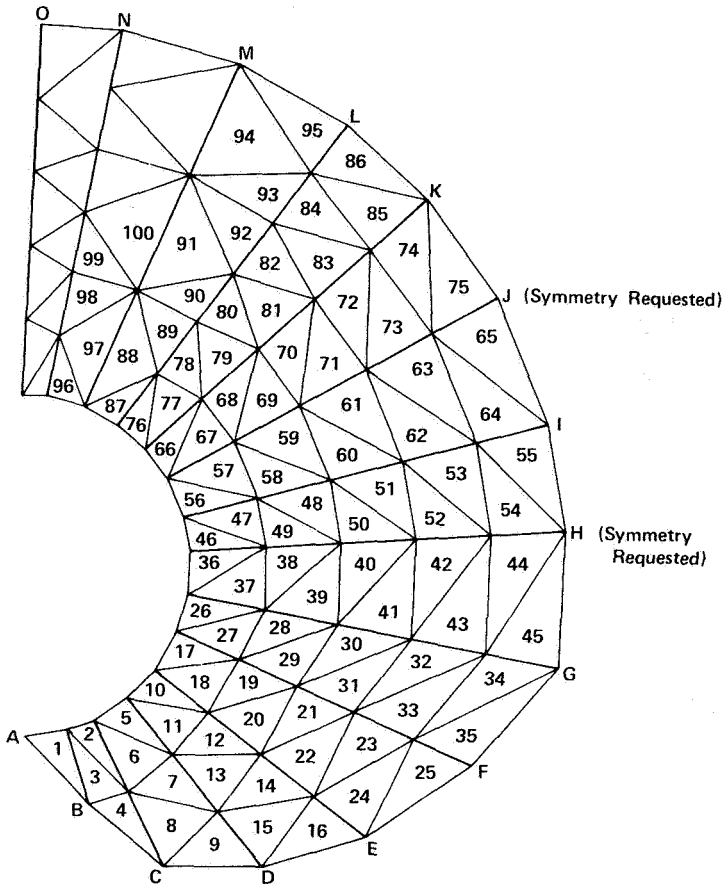

Figure 1. Finite Element Breakup FD 48167

The computer program will reproduce the sketched elemental breakup properly if the following is remembered when writing the input:

1. If generator line "i" has "ii" points and generator line "i+1 has "ii±1" points, then the lines forming the edges of the finite elements start at the first point of the generator with the least number of points and zig zag between the generator lines. The areas between generators A and B, B and C, D and E, etc., of figure 1 are examples.

2. The area between the first two generator lines with the same number of points will be broken up as shown between generators F and G and G and H of figure 1.

3. The procedure of (2) will be followed for all generators with the same number of points until symmetry about a generator is requested, as was done about generator H in figure 1.

4. The altered breakup will continue for sections between generators with the same number of points, until symmetry is again requested, as was done about generator J in figure 1. After symmetry is again requested, the breakup will revert to the original pattern.

5. If two generators "i" and "j" have "m" and "n" points respectively such that

   $m = 2n-1$ and $n > 2$

   or

   $n = 2m-1$ and $m > 2$

   then the breakup will be as in the sections between K and L, and L and M of figure 1.

6. Notice that generator A of figure 1 has only one point. In this case

   RHUB = RTIP and THHUB = THTIP

7. Elements are identified as shown in figure 2.

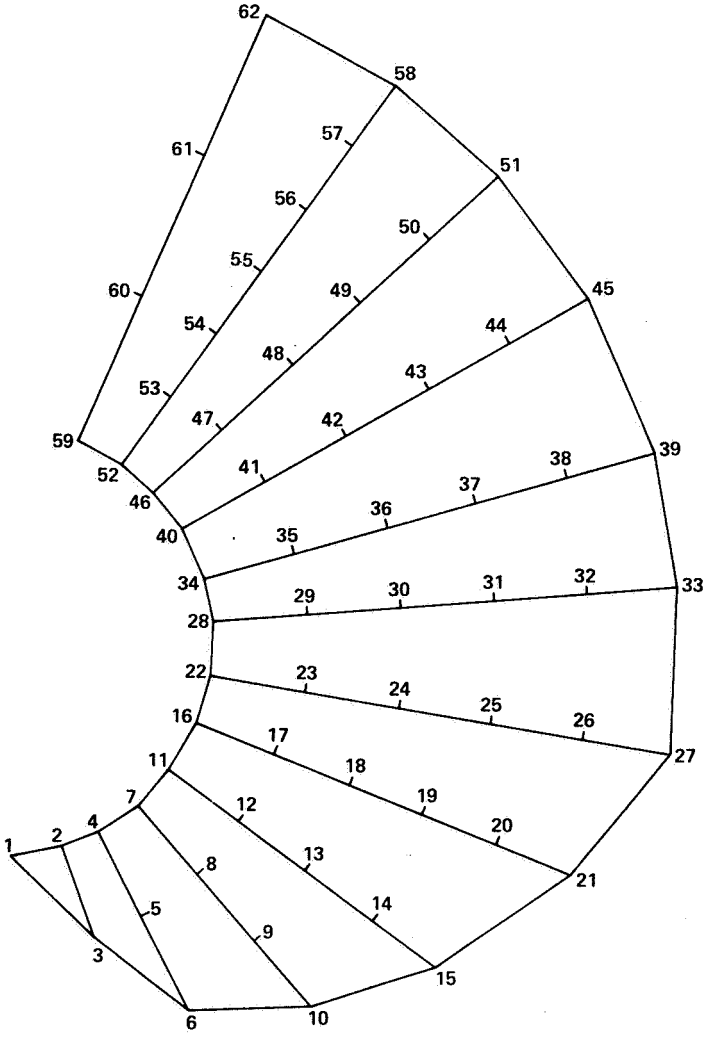

Figure 2. Finite Element Nodes

FD 48168

Unless otherwise specified, data may be input in any consistent set of units. The same units may be used for force and mass. Output will correspond to the input units used. Several examples are listed below:

Input			Output	
Force	Mass	Length	Displacement	Stress
lb	lb	ft	ft	lb/ft^2
lb	lb	in.	in.	$lb/in.^2$
gram	gram	meter	meter	$gram/meter^2$

Input data to be written on each card is described below. "F" format data should be left adjusted in the column field and should contain a decimal point. "E" format data (.300E08) must be right adjusted. "I" format data should not contain a decimal point and should be right adjusted.

Column	Variable		Format
Card 1	Title Card		
1-80		Input job identification data. As many title cards as required may be input. With a 1 in column 1 the machine will read in another title card. Omit the 1 in column 1 on the last title card to stop the machine from reading title cards.	
Card 2			
1-10	RHO	Specific weight of the inducer blade material (MASS=RHO/G).	F10.0
11-20	RPM	Rotational speed of the inducer blade (revolutions per minute)	F10.0
21-30	POISSO	Poisson's ratio for the material of the inducer blade.	F10.0
31-40	YOUNGS	Young's modulus of elasticity for the material of the inducer blade	E10.0
41-50	RADGEN	Generator line offset radius. R_G in figure 3 (May be 0).	F10.0
51-55	NCF	Centrifugal force option.	I5

Leave blank if the following approximate equation is desired
This equation should be used where bending stresses due to gas loading alone are predominant.

$$\left\{F_c\right\}_N = \begin{bmatrix} F_{x_1} \\ F_{y_1} \\ F_{z_1} \\ M_{x_1} \\ M_{y_1} \\ M_{z_1} \\ F_{x_2} \\ F_{y_2} \\ F_{z_2} \\ M_{x_2} \\ M_{y_2} \\ M_{z_2} \\ F_{x_3} \\ F_{y_3} \\ F_{z_3} \\ M_{x_3} \\ M_{y_3} \\ M_{z_3} \end{bmatrix}_N = \frac{\rho\omega^2\bar{A}_i}{3} \begin{bmatrix} \bar{t}_1 x_1 \\ \bar{t}_1 y_1 \\ 0 \\ 0 \\ 0 \\ 0 \\ \bar{t}_2 x_2 \\ \bar{t}_2 y_2 \\ 0 \\ 0 \\ 0 \\ 0 \\ \bar{t}_3 x_3 \\ \bar{t}_3 y_3 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}_N$$

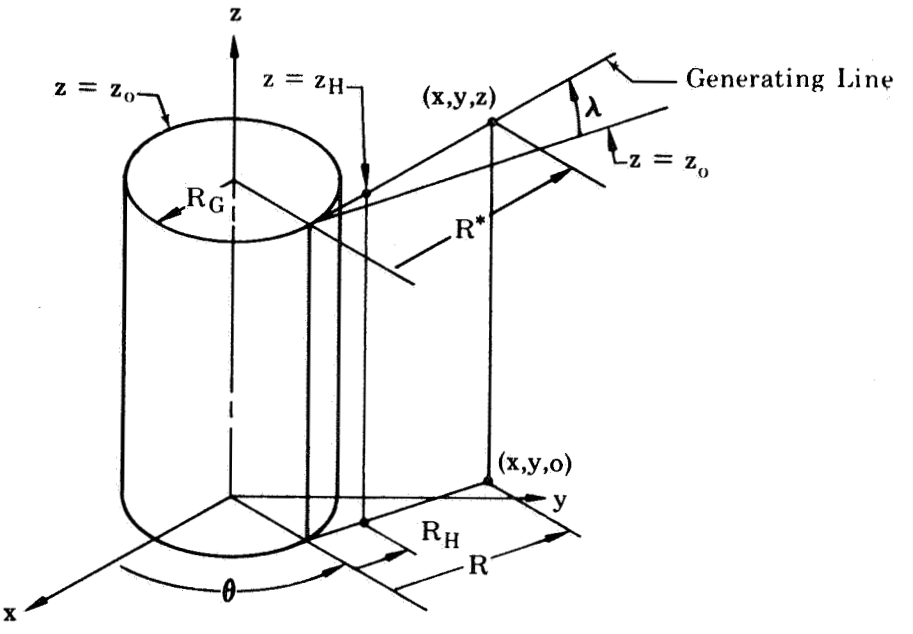

Figure 3. Geometric Parameters of Middle Surface of Inducer Blade FD 25602A

Input as 1 if the following equation is desired. Use this equation where bending stresses due to centrifugal loads dominate.

$$\left\{\bar{F}_c\right\}_N = \rho\omega^2 \int_S \bar{t} \left[H\right]^T \begin{Bmatrix} I_3 \\ 0_3 \end{Bmatrix} \left[R_I\right]^T \left[\begin{Bmatrix} x_1 \\ y_1 \\ -\bar{x}\cos(z,\bar{x}) \;\; -\bar{y}\cos(z,\bar{y}) \end{Bmatrix} + \left[R_I\right] \begin{Bmatrix} \bar{x} \\ \bar{y} \\ 0 \end{Bmatrix} \right] d\bar{x}d\bar{y}$$

Column		Variable	Format
55-60	NGL	Total number of input generator lines. Maximum of 100.	I5
61-65	NGS	Number of generator lines about which geometric break-up symmetry is desired.	I5
66-70	NGP	Total number of input elemental pressures	I5
71-75	NSUBS	Total number of subsystems into which the inducer blade is to be divided. Maximum of 100.	I5
76-80	IPRINT	Intermediate print option which should be used only for the checkout of the program. Leave blank for no intermediate print.	I5

Input as 1 for the following intermediate print:

a. Elemental local membrane stiffness matrices.
b. Elemental local bending stiffness matrices.
c. Elemental local pressure force matrices.
d. Elemental common centrifugal force matrices.
e. Elemental assembled common stiffness matrices.

Input as 2 (right adjusted with no decimal point) for the following intermediate print:

a. All of the above
b. The 6 (N + 1) coefficients for each of the 6 (N) simultaneous equations for nodal deflections (only for NSUBS = 0).

Column		Variable	Format
Card 3	Boundary Lines and G		
1-5 6-10 etc. 41-45	LBOUND (1)- LBOUND (9)	Generator line numbers which form the boundaries between adjacent subsystems If NSUBS = 0, leave blank. Otherwise LBOUND (1) is the number of the generator line which forms the boundary between subsystems I and I+1. In the latter case there must be NSUBS-1 values input.	15
71-80	G	The gravitational constant in the appropriate units. If left blank or input as 0.0, a value of 386.4 is used. MASS = RHO/G.	F10.0
Card 4	(Symmetry Requests (Optional)		
1-5 6-10 etc.	NCHB(1)- NCBH(NGS)	Numbers of the generator lines about which geometric break-up symmetry is desired. The only condition allowing this request for break-up symmetry is that the previous generator line and the next generator line must each have the same number of points as does the generator line about which symmetry is requested that is $NUP_{I-1} = NUP_I = NUP_{I+1}$ Sixteen values per card, as many cards as needed. If NGS on Card 3 was input as zero or left blank, omit this card	I5

Column	Variable		Format
Cards 5, 7, 9, 11		Generator Line Properties (NGL Cards)	
1-10	RAPANG(I)	Wrap angle in degrees of the Ith generator line (θ_1, and θ_2 in figure 4). No two adjacent wrap angles may be equal. All wrap angles must be either continually increasing or continually decreasing in size.	F10.0
11-20	ZGL(I)	z value at the hub of the Ith generator line (z_1 and z_2 in figure 4). No two adjacent generator lines may have the same z value unless one of the two lean angles is non-zero.	F10.0
21-30	RHUB(I)	If RADGEN $\neq$ 0, then RHUB(I) is the horizontal (x-y plane) distance from the point where the generator line is tangent to a cylinder with a radius of RADGEN to the hub of the Ith generator. If RADGEN = 0, then RHUB (I) is the radial distance from the z-axis to the hub of the Ith generator.	F10.0
31-40	RTIP(I)	Measured the same as RHUB(I) except that it is the distance to the tip instead of the hub of the Ith generator.	F10.0

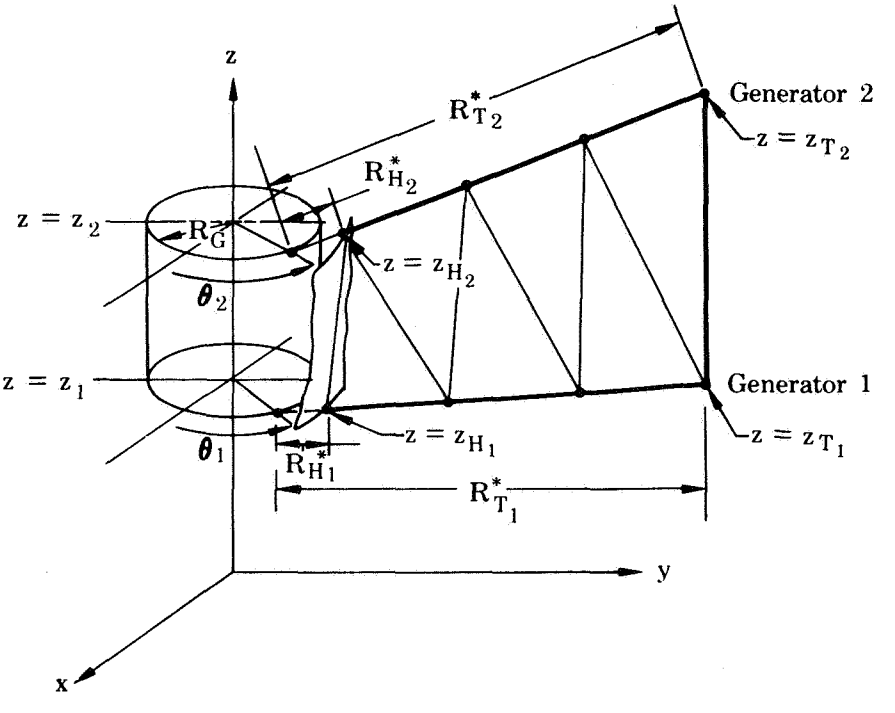

Figure 4. Triangulation of Inducer Blade FD 25630A

Column	Variable		Format
41-50	THHUB(I)	Thickness of the inducer blade at the hub of the Ith generator line.	F10.0
51-60	THTIP(I)	Thickness of the inducer blade at the tip of the Ith generator line. Thickness is varied linearly from the hub to the tip of a generator line.	F10.0
61-65	NUP(I)	Number of points on the Ith generator line which are used for the division of the inducer blade into triangualr elements These points are evenly spaced between and including the hub and the tip.	I5
66-70	NI	Number of pressures on the following card(s) which describes the pressure distribution along the Ith generator line. The pressures will correspond to the points on the generator line which are obtained by dividing the line into NI-1 equal segments. Minimum of 2 and maximum of 15.	I5
71-80	ALEAN(I)	Lean angle in degrees of the Ith generator line measured positive upward from the horizontal (x-y plane). These are illustrated in figure 3.	F10.0

Cards 6, 8, 10 Inducer Blade Pressure Distribution (NGL Cards)

1-10 11-20 etc.	PRESSI(1)- PRESS NGL(NI)	Pressures (positive upward) which describe the pressure distribution along the Ith generator line. Linear interpolation between points is used. Eight values per card; as many cards as needed. Input starting with the hub and ending with the tip.	F10.0

Card 13 NGP Elemental Pressures -(Optional) (NGP Cards)

These cards are used for inputting elemental pressures which cannot cannot be obtained from the generator line pressures.

1-5	JI	Number of the element to which the following input pressure corresponds.	I5
11-20	PRESSE(JI)- PRESS E(JNGP)	Pressure which corresponds to element JI. This pressure will override the pressure obtained from the generator line pressure distributions.	F10.0

C. OUTPUT DESCRIPTION

X, Y, Z or X COMMON, Y COMMON, Z COMMON	Common coordinates of vertices or nodes of triangular elements.
XL, YL, or X LOCAL, Y LOCAL	Local coordinates of vertices or nodes of triangular elements.
TH	Nodal thickness at vertices of triangular elements.
PRESSURE	Average normal pressure acting on triangular element.
AREA	Area of triangular element.
LOAD	Normal uniform load acting on triangular element.
U, V, W, THETAX, THETAY	Common displacements of nodes or vertices of triangular elements.
U LOCAL, V LOCAL, W LOCAL	Local displacement of nodes or vertices of triangular elements.
SIGMA X BAR, SIGMA Y BAR SHEAR	Stresses at centroid of triangular element.
PRINCIPAL SIGMA X BAR, PRINCIPAL SIGMA Y BAR	Principal stresses at centroid of triangular element.
PRINCIPAL THETA	Principal direction of principal stress at centroid of triangular element.
MAXIMUM SHEAR	Maximum shear stress at centroid of triangular element.
EFFECTIVE STRESS	Relative effective stress at centroid of triangular element.
A, B, C	Bending stress coefficients.
KM	Triangular element local membrane stiffness matrix.
KB	Triangular element local bending stiffness matrix.

D. STRESS COMPUTER PROGRAM

Sample Case (89 Deg Helicoid with Pressure Load)

LISTING OF INPUT CARDS

```
0.298       0.0         0.333       0.30000E08   0.0                    5    3         2
    3
    2       3    4
0.0         0.0         1.0         4.0          0.1          0.1            7    2
10.0        10.0
0.25        0.5         1.0         4.0          0.1          0.1            7    2
10.0        10.0
0.50        1.0         1.0         4.0          0.1          0.1            7    2
10.0        10.0
0.75        1.5         1.0         4.0          0.1          0.1            7    2
10.0        10.0
1.0         2.0         1.0         4.0          0.1          0.1            7    2
10.0        10.0
```

OUTPUT

INDUCER STRESS PROGRAM - DECK 6098

DATE 6/29/70

TEST CASE FOR 89 DEGREE HELICOID WITH PRESSURE LOAD .

NO. OF SUB-SYSTEMS = 2 CENTRIFUGAL FORCE OPTION = 0
SUB-SYSTEM BOUNDARIES FORMED BY GENERATOR LINES 3 0 0 0 0 0 0 0 0 0

DENSITY = 0.2980 G = 0.3864E 03 RPM = 0.0 POISSON'S RATIO = 0.333 YOUNG'S MODULUS = 0.3000E 08

NO. OF GENERATING LINES = 5 NO. OF SYMMETRY CHANGES REQUESTED = 3

GENERATOR LINE OFFSET RADIUS = 0.0

0 INPUT ELEMENT PRESSURES

SYMMETRY CHANGE ABOUT GENERATOR LINES 2 3 4

INDUCER STRESS PROGRAM - DECK 6098

GENERATOR LINE NUMBER 1 (ANGLES IN DEG.)

WRAP ANGLE = 0.0 ZHUB = 0.0 LEAN ANGLE = 0.0 HUB RADIUS = 1.0000 TIP RADIUS = 4.0000
HUB THICKNESS = 0.1000 TIP THICKNESS = 0.1000 NO. OF POINTS = 7 NO. OF PRESSURES = 2

PRESSURES

10.0000 10.0000

GENERATOR LINE NUMBER 2 (ANGLES IN DEG.)

WRAP ANGLE = 0.250000 ZHUB = 0.500 LEAN ANGLE = 0.0 HUB RADIUS = 1.0000 TIP RADIUS = 4.0000
HUB THICKNESS = 0.1000 TIP THICKNESS = 0.1000 NO. OF POINTS = 7 NO. OF PRESSURES = 2

PRESSURES

10.0000 10.0000

GENERATOR LINE NUMBER 3 (ANGLES IN DEG.)

WRAP ANGLE = 0.500000 ZHUB = 1.000 LEAN ANGLE = 0.0 HUB RADIUS = 1.0000 TIP RADIUS = 4.0000
HUB THICKNESS = 0.1000 TIP THICKNESS = 0.1000 NO. OF POINTS = 7 NO. OF PRESSURES = 2

PRESSURES

10.0000 10.0000

GENERATOR LINE NUMBER 4 (ANGLES IN DEG.)

WRAP ANGLE = 0.750000 ZHUB = 1.500 LEAN ANGLE = 0.0 HUB RADIUS = 1.0000 TIP RADIUS = 4.0000
HUB THICKNESS = 0.1000 TIP THICKNESS = 0.1000 NO. OF POINTS = 7 NO. OF PRESSURES = 2

PRESSURES

10.0000 10.0000

GENERATOR LINE NUMBER 5 (ANGLES IN DEG.)

WRAP ANGLE = 1.000000 ZHUB = 2.000 LEAN ANGLE = 0.0 HUB RADIUS = 1.0000 TIP RADIUS = 4.0000
HUB THICKNESS = 0.1000 TIP THICKNESS = 0.1000 NO. OF POINTS = 7 NO. OF PRESSURES = 2

PRESSURES

10.0000 10.0000

RESULTING TRIANGULAR ELEMENTS

ELEMENT NO. 1

AREA = 0.125005 PRESSURE = 0.10000E 02 LOAD = 0.12500E 01

NODE NO.	X	Y	Z	TH	XL	YL
LA 8	-0.004	1.000	0.500	0.1000	0.0	0.0
LB 9	-0.007	1.500	0.500	0.1000	0.5000	0.0
LC 1	0.0	1.000	0.0	0.1000	-0.0000	-0.5000

ELEMENT NO. 2

AREA = 0.125011 PRESSURE = 0.10000E 02 LOAD = 0.12501E 01

NODE NO.	X	Y	Z	TH	XL	YL
LA 1	0.0	1.000	0.0	0.1000	0.0	0.0
LB 2	0.0	1.500	0.0	0.1000	0.5000	0.0
LC 9	-0.007	1.500	0.500	0.1000	0.5000	0.5000

ELEMENT NO. 3

AREA = 0.125011 PRESSURE = 0.10000E 02 LOAD = 0.12501E 01

NODE NO.	X	Y	Z	TH	XL	YL
LA 9	-0.007	1.500	0.500	0.1000	0.0	0.0
LB 10	-0.009	2.000	0.500	0.1000	0.5000	0.0
LC 2	0.0	1.500	0.0	0.1000	-0.0000	-0.5000

ELEMENT NO. 4

AREA = 0.125019 PRESSURE = 0.10000E 02 LOAD = 0.12502E 01

NODE NO.	X	Y	Z	TH	XL	YL
LA 2	0.0	1.500	0.0	0.1000	0.0	0.0
LB 3	0.0	2.000	0.0	0.1000	0.5000	0.0
LC 10	-0.009	2.000	0.500	0.1000	0.5000	0.5001

ELEMENT NO. 5

AREA = 0.125019 PRESSURE = 0.10000E 02 LOAD = 0.12502E 01

NODE NO.	X	Y	Z	TH	XL	YL
LA 10	-0.009	2.000	0.500	0.1000	0.0	0.0
LB 11	-0.011	2.500	0.500	0.1000	0.5000	0.0
LC 3	0.0	2.000	0.0	0.1000	-0.0000	-0.5001

ELEMENT NO. 6

AREA = 0.125030 PRESSURE = 0.10000E 02 LOAD = 0.12503E 01

NODE NO.	X	Y	Z	TH	XL	YL
LA 3	0.0	2.000	0.0	0.1000	0.0	0.0
LB 4	0.0	2.500	0.0	0.1000	0.5000	0.0
LC 11	-0.011	2.500	0.500	0.1000	0.5000	0.5001

ELEMENT NO. 7

AREA = 0.125030 PRESSURE = 0.10000E 02 LOAD = 0.12503E 01

NODE NO.	X	Y	Z	TH	XL	YL
LA 11	-0.011	2.500	0.500	0.1000	0.0	0.0
LB 12	-0.013	3.000	0.500	0.1000	0.5000	0.0
LC 4	0.0	2.500	0.0	0.1000	-0.0000	-0.5001

(CONTINUING TO ELEMENT NO. 48)

COMMON SYSTEM
DEFLECTION PRINTOUT

NODE NO.	X	Y	Z	U	V	W	THETAX	THETAY
1	0.0	1.000	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	1.500	0.0	0.26089E-02	0.17052E-06	0.24327E-04	0.38714E 00	-0.53928E-03
3	0.0	2.000	0.0	0.98944E-02	0.26466E-06	0.11042E-03	0.30205E 00	-0.68889E-03
4	0.0	2.500	0.0	0.20361E-01	0.27758E-06	0.25211E-03	0.20527E 00	-0.65898E-03
5	0.0	3.000	0.0	0.32631E-01	0.24037E-06	0.43287E-03	0.12100E 00	-0.55074E-03
6	0.0	3.500	0.0	0.45705E-01	0.18167E-06	0.63427E-03	0.63318E-01	-0.43868E-03
7	0.0	4.000	0.0	0.59018E-01	0.16761E-06	0.84282E-03	0.44800E 00	-0.44323E-03
8	-0.004	1.000	0.500	0.0	0.0	0.0	0.0	0.0
9	-0.007	1.500	0.500	0.23020E-02	0.99425E-05	0.20302E-04	0.14297E 00	0.48113E-03
10	-0.009	2.000	0.500	0.95196E-02	0.41318E-04	0.10388E-03	0.44259E-01	-0.70705E-05
11	-0.011	2.500	0.500	0.20009E-01	0.87003E-04	0.24445E-03	-0.84348E-02	-0.24951E-03
12	-0.013	3.000	0.500	0.32343E-01	0.14079E-03	0.42536E-03	-0.35288E-01	-0.34709E-03
13	-0.015	3.500	0.500	0.45486E-01	0.19813E-03	0.62760E-03	-0.39057E-01	-0.34380E-03
14	-0.017	4.000	0.500	0.58810E-01	0.25627E-03	0.83556E-03	-0.37464E-01	-0.34855E-03
15	-0.009	1.000	1.000	0.0	0.0	0.0	0.0	0.0
16	-0.013	1.500	1.000	0.24665E-02	0.21536E-04	0.22431E-04	0.42030E 00	0.36714E-02
17	-0.017	2.000	1.000	0.96494E-02	0.84231E-04	0.10613E-03	0.31171E 00	0.27319E-02
18	-0.022	2.500	1.000	0.20098E-01	0.17543E-03	0.24640E-03	0.20020E 00	0.17702E-02
19	-0.026	3.000	1.000	0.32396E-01	0.28277E-03	0.42677E-03	0.10203E 00	0.92733E-03
20	-0.031	3.500	1.000	0.45509E-01	0.39721E-03	0.62834E-03	0.38456E-01	0.39161E-03
21	-0.035	4.000	1.000	0.58828E-01	0.51345E-03	0.83623E-03	0.11255E 02	0.98275E-01
22	-0.013	1.000	1.500	0.0	0.0	0.0	0.0	0.0
23	-0.020	1.500	1.500	0.23050E-02	0.30261E-04	0.20342E-04	0.14309E 00	0.20231E-02
24	-0.026	2.000	1.500	0.95296E-02	0.12494E-03	0.10407E-03	0.44731E-01	0.79626E-03
25	-0.033	2.500	1.500	0.20027E-01	0.26244E-03	0.24488E-03	-0.75670E-02	0.12469E-03
26	-0.039	3.000	1.500	0.32370E-01	0.42405E-03	0.42613E-03	-0.34728E-01	-0.25220E-03
27	-0.046	3.500	1.500	0.45522E-01	0.59621E-03	0.62878E-03	-0.38685E-01	-0.32426E-03
28	-0.052	4.000	1.500	0.58852E-01	0.77071E-03	0.83717E-03	-0.37969E-01	-0.25258E-03
29	-0.017	1.000	2.000	0.0	0.0	0.0	0.0	0.0
30	-0.026	1.500	2.000	0.26164E-02	0.45414E-04	0.24442E-04	0.38722E 00	0.73072E-02
31	-0.035	2.000	2.000	0.99145E-02	0.17261E-03	0.11082E-03	0.30149E 00	0.59716E-02
32	-0.044	2.500	2.000	0.20395E-01	0.35543E-03	0.25294E-03	0.20423E 00	0.42543E-02
33	-0.052	3.000	2.000	0.32679E-01	0.56980E-03	0.43428E-03	0.11952E 00	0.26772E-02
34	-0.061	3.499	2.000	0.45762E-01	0.79818E-03	0.63625E-03	0.64346E-01	0.16011E-02
35	-0.070	3.999	2.000	0.59082E-01	0.10307E-02	0.84537E-03	-0.98223E 00	-0.16653E-01

LOCAL SYSTEM
DEFLECTION AND STRESS PRINTOUT

ELEMENT NO. 1

	NODE NO.	X COMMON	Y COMMON	Z COMMON	U LOCAL	V LOCAL	W LOCAL
LA	8	-0.004	1.000	0.500	0.0	0.0	0.0
LB	9	-0.007	1.500	0.500	-0.10169E-06	0.21391E-06	0.23021E-02
LC	1	0.0	1.000	0.0	0.0	0.0	0.0

BENDING STRESSES = A * (LOCAL X VALUE) + B * (LOCAL Y VALUE) + C

	A	B	C	VALUE AT CENTROID
SIGMAXBAR	-0.63342E 05	0.19262E 04	-0.20513E 05	-0.31391E 05
SIGMAYBAR	-0.21094E 05	0.64141E 03	-0.68309E 04	-0.10453E 05
SHEAR	-0.12847E 04	0.10956E 01	0.0	-0.21430E 03

	SIGMAXBAR	SIGMAYBAR	SHEAR	PRINCIPAL SIGMAXBAR	PRINCIPAL SIGMAYBAR	PRINCIPAL THETA (DEG)	MAXIMUM SHEAR	EFFECTIVE STRESS
MEMBRANE	-0.68627E 01	-0.22855E 01	0.48143E 01	-0.99047E 01	0.75644E 00	-0.32287E 02	-0.53306E 01	0.10304E 02
BEND.(TOP)	-0.31391E 05	-0.10453E 05	-0.21430E 03	-0.31393E 05	-0.10451E 05	0.58636E 00	-0.10471E 05	0.27689E 05
TOT. (TOP)	-0.31398E 05	-0.10456E 05	-0.20949E 03	-0.31400E 05	-0.10454E 05	0.57306E 00	-0.10473E 05	0.27695E 05
BEND.(BOT)	0.31391E 05	0.10453E 05	0.21430E 03	0.31393E 05	0.10451E 05	0.58636E 00	0.10471E 05	0.27689E 05
TOT. (BOT)	0.31384E 05	0.10451E 05	0.21912E 03	0.31386E 05	0.10449E 05	0.59966E 00	0.10469E 05	0.27683E 05

ELEMENT NO. 2

	NODE NO.	X COMMON	Y COMMON	Z COMMON	U LOCAL	V LOCAL	W LOCAL
LA	1	0.0	1.000	0.0	0.0	0.0	0.0
LB	2	0.0	1.500	0.0	0.17052E-06	-0.98223E-05	0.26090E-02
LC	9	-0.007	1.500	0.500	0.99425E-05	-0.98292E-05	0.23020E-02

BENDING STRESSES = A * (LOCAL X VALUE) + B * (LOCAL Y VALUE) + C

	A	B	C	VALUE AT CENTROID
SIGMAXBAR	0.54296E 05	-0.84832E 04	-0.35774E 05	-0.19089E 05
SIGMAYBAR	-0.27530E 05	-0.44909E 05	0.18353E 05	0.16910E 04
SHEAR	-0.48548E 04	0.34216E 05	0.0	0.40850E 04

	SIGMAXBAR	SIGMAYBAR	SHEAR	PRINCIPAL SIGMAXBAR	PRINCIPAL SIGMAYBAR	PRINCIPAL THETA (DEG)	MAXIMUM SHEAR	EFFECTIVE STRESS
MEMBRANE	0.11345E 02	0.33455E 01	-0.11497E 01	0.11507E 02	0.31835E 01	-0.80186E 01	0.41617E 01	0.10291E 02
BEND.(TOP)	-0.19089E 05	0.16910E 04	0.40850E 04	-0.19864E 05	0.24651E 04	-0.10731E 02	-0.11164E 05	0.21204E 05
TOT. (TOP)	-0.19078E 05	0.16943E 04	0.40838E 04	-0.19852E 05	0.24683E 04	-0.10732E 02	-0.11160E 05	0.21194E 05
BEND.(BOT)	0.19089E 05	-0.16910E 04	-0.40850E 04	0.19864E 05	-0.24651E 04	-0.10731E 02	0.11164E 05	0.21204E 05
TOT. (BOT)	0.19101E 05	-0.16876E 04	-0.40861E 04	0.19875E 05	-0.24619E 04	-0.10730E 02	0.11168E 05	0.21213E 05

LOCAL SYSTEM
DEFLECTION AND STRESS PRINTOUT

ELEMENT NO. 3

	NODE NO.	X COMMON	Y COMMON	Z COMMON	U LOCAL	V LOCAL	W LOCAL
LA	9	-0.007	1.500	0.500	-0.10169E-06	-0.98294E-05	0.23020E-02
LB	10	-0.009	2.000	0.500	-0.21986E-06	-0.20728E-04	0.95203E-02
LC	2	0.0	1.500	0.0	-0.11213E-04	-0.98219E-05	0.26090E-02

BENDING STRESSES = A * (LOCAL X VALUE) + B * (LOCAL Y VALUE) + C

	A	B	C	VALUE AT CENTROID
SIGMAXBAR	-0.46165E 05	0.16183E 05	-0.92761E 04	-0.19667E 05
SIGMAYBAR	0.17295E 05	0.46526E 05	0.93997E 03	-0.39326E 04
SHEAR	-0.51739E 03	-0.24507E 05	0.0	0.39986E 04

	SIGMAXBAR	SIGMAYBAR	SHEAR	PRINCIPAL SIGMAXBAR	PRINCIPAL SIGMAYBAR	PRINCIPAL THETA (DEG)	MAXIMUM SHEAR	EFFECTIVE STRESS
MEMBRANE	-0.81366E 01	-0.31418E 01	0.47579E 01	-0.11013E 02	-0.26573E 00	-0.31153E 02	-0.53735E 01	0.10882E 02
BEND.(TOP)	-0.19667E 05	-0.39326E 04	0.39986E 04	-0.20625E 05	-0.29747E 04	-0.13471E 02	-0.88252E 04	0.19310E 05
TOT. (TOP)	-0.19676E 05	-0.39357E 04	0.40034E 04	-0.20635E 05	-0.29760E 04	-0.13481E 02	-0.88296E 04	0.19320E 05
BEND.(BOT)	0.19667E 05	0.39326E 04	-0.39986E 04	0.20625E 05	0.29747E 04	-0.13471E 02	0.88252E 04	0.19310E 05
TOT. (BOT)	0.19659E 05	0.39294E 04	-0.39938E 04	0.20615E 05	0.29735E 04	-0.13461E 02	0.88209E 04	0.19301E 05

ELEMENT NO. 4

	NODE NO.	X COMMON	Y COMMON	Z COMMON	U LOCAL	V LOCAL	W LOCAL
LA	2	0.0	1.500	0.0	0.17052E-06	-0.21203E-04	0.26089E-02
LB	3	0.0	2.000	0.0	0.26466E-06	-0.62256E-04	0.98949E-02
LC	10	-0.009	2.000	0.500	0.41318E-04	-0.62257E-04	0.95200E-02

BENDING STRESSES = A * (LOCAL X VALUE) + B * (LOCAL Y VALUE) + C

	A	B	C	VALUE AT CENTROID
SIGMAXBAR	0.59587E 05	-0.87910E 04	-0.32870E 05	-0.14473E 05
SIGMAYBAR	-0.84919E 04	-0.31792E 05	0.83927E 04	0.26268E 03
SHEAR	-0.13468E 04	0.21256E 05	0.0	0.30943E 04

	SIGMAXBAR	SIGMAYBAR	SHEAR	PRINCIPAL SIGMAXBAR	PRINCIPAL SIGMAYBAR	PRINCIPAL THETA (DEG)	MAXIMUM SHEAR	EFFECTIVE STRESS
MEMBRANE	0.63159E 01	0.20000E 01	-0.14551E 00	0.63208E 01	0.19951E 01	-0.19288E 01	0.21629E 01	0.55966E 01
BEND.(TOP)	-0.14473E 05	0.26268E 03	0.30943E 04	-0.15097E 05	0.88605E 03	-0.11390E 02	-0.79914E 04	0.15559E 05
TOT. (TOP)	-0.14467E 05	0.26468E 03	0.30942E 04	-0.15091E 05	0.88817E 03	-0.11393E 02	-0.79894E 04	0.15554E 05
BEND.(BOT)	0.14473E 05	-0.26268E 03	-0.30943E 04	0.15097E 05	-0.88605E 03	-0.11390E 02	0.79914E 04	0.15559E 05
TOT. (BOT)	0.14480E 05	-0.26068E 03	-0.30945E 04	0.15103E 05	-0.88395E 03	-0.11388E 02	0.79935E 04	0.15564E 05

LOCAL SYSTEM
DEFLECTION AND STRESS PRINTOUT

ELEMENT NO. 5

	NODE NO.	X COMMON	Y COMMON	Z COMMON	U LOCAL	V LOCAL	W LOCAL
LA	10	-0.009	2.000	0.500	-0.21986E-06	-0.62258E-04	0.95201E-02
LB	11	-0.011	2.500	0.500	-0.30360E-06	-0.10476E-03	0.20011E-01
LC	3	0.0	2.000	0.0	-0.42908E-04	-0.62255E-04	0.98948E-02

BENDING STRESSES = A * (LOCAL X VALUE) + B * (LOCAL Y VALUE) + C

	A	B	C	VALUE AT CENTROID
SIGMAXBAR	-0.26366E 05	0.96982E 04	-0.63263E 04	-0.12337E 05
SIGMAYBAR	0.15965E 05	0.28674E 05	-0.11633E 04	-0.32823E 04
SHEAR	-0.11263E 03	-0.18562E 05	0.0	0.30754E 04

	SIGMAXBAR	SIGMAYBAR	SHEAR	PRINCIPAL SIGMAXBAR	PRINCIPAL SIGMAYBAR	PRINCIPAL THETA (DEG)	MAXIMUM SHEAR	EFFECTIVE STRESS
MEMBRANE	-0.56875E 01	-0.19883E 01	0.41050E 01	-0.83403E 01	0.66454E 00	-0.32872E 02	-0.45024E 01	0.86917E 01
BEND.(TOP)	-0.12337E 05	-0.32823E 04	0.30754E 04	-0.13283E 05	-0.23365E 04	-0.17094E 02	-0.54731E 04	0.12282E 05
TOT. (TOP)	-0.12343E 05	-0.32843E 04	0.30795E 04	-0.13290E 05	-0.23365E 04	-0.17106E 02	-0.54770E 04	0.12290E 05
BEND.(BOT)	0.12337E 05	0.32823E 04	-0.30754E 04	0.13283E 05	0.23365E 04	-0.17094E 02	0.54731E 04	0.12282E 05
TOT. (BOT)	0.12331E 05	0.32803E 04	-0.30713E 04	0.13275E 05	0.23365E 04	-0.17082E 02	0.54693E 04	0.12275E 05

ELEMENT NO. 6

	NODE NO.	X COMMON	Y COMMON	Z COMMON	U LOCAL	V LOCAL	W LOCAL
LA	3	0.0	2.000	0.0	0.26466E-06	-0.10541E-03	0.98945E-02
LB	4	0.0	2.500	0.0	0.27758E-06	-0.19204E-03	0.20361E-01
LC	11	-0.011	2.500	0.500	0.87003E-04	-0.19203E-03	0.20010E-01

BENDING STRESSES = A * (LOCAL X VALUE) + B * (LOCAL Y VALUE) + C

	A	B	C	VALUE AT CENTROID
SIGMAXBAR	0.40188E 05	-0.70864E 04	-0.20935E 05	-0.87210E 04
SIGMAYBAR	-0.17507E 04	-0.20203E 05	0.38288E 04	-0.12277E 03
SHEAR	0.26925E 03	0.11353E 05	0.0	0.19823E 04

	SIGMAXBAR	SIGMAYBAR	SHEAR	PRINCIPAL SIGMAXBAR	PRINCIPAL SIGMAYBAR	PRINCIPAL THETA (DEG)	MAXIMUM SHEAR	EFFECTIVE STRESS
MEMBRANE	0.10547E 01	0.84375E 00	0.17061E 01	0.26585E 01	-0.76009E 00	0.43231E 02	0.17093E 01	0.31091E 01
BEND.(TOP)	-0.87210E 04	-0.12277E 03	0.19823E 04	-0.91561E 04	0.31225E 03	-0.12377E 02	-0.47342E 04	0.93161E 04
TOT. (TOP)	-0.87200E 04	-0.12193E 03	0.19840E 04	-0.91557E 04	0.31382E 03	-0.12387E 02	-0.47348E 04	0.93166E 04
BEND.(BOT)	0.87210E 04	0.12277E 03	-0.19823E 04	0.91561E 04	-0.31225E 03	-0.12377E 02	0.47342E 04	0.93161E 04
TOT. (BOT)	0.87221E 04	0.12362E 03	-0.19806E 04	0.91564E 04	-0.31068E 03	-0.12368E 02	0.47335E 04	0.93156E 04

LOCAL SYSTEM
DEFLECTION AND STRESS PRINTOUT

ELEMENT NO. 7

	NODE NO.	X COMMON	Y COMMON	Z COMMON	U LOCAL	V LOCAL	W LOCAL
LA	11	-0.011	2.500	0.500	-0.30360E-06	-0.19203E-03	0.20010E-01
LB	12	-0.013	3.000	0.500	-0.33756E-06	-0.28020E-03	0.32345E-01
LC	4	0.0	2.500	0.0	-0.88563E-04	-0.19204E-03	0.20361E-01

BENDING STRESSES = A * (LOCAL X VALUE) + B * (LOCAL Y VALUE) + C

	A	B	C	VALUE AT CENTROID
SIGMAXBAR	-0.11476E 05	0.45882E 04	-0.39954E 04	-0.66728E 04
SIGMAYBAR	0.12030E 05	0.14485E 05	-0.21150E 04	-0.25248E 04
SHEAR	0.17628E 03	-0.11891E 05	0.0	0.20117E 04

	SIGMAXBAR	SIGMAYBAR	SHEAR	PRINCIPAL SIGMAXBAR	PRINCIPAL SIGMAYBAR	PRINCIPAL THETA (DEG)	MAXIMUM SHEAR	EFFECTIVE STRESS
MEMBRANE	-0.20977E 01	-0.18750E 00	0.16069E 01	-0.30119E 01	0.72676E 00	-0.29637E 02	-0.18693E 01	0.34335E 01
BEND.(TOP)	-0.66728E 04	-0.25248E 04	0.20117E 04	-0.74882E 04	-0.17095E 04	-0.22063E 02	-0.28894E 04	0.67966E 04
TOT. (TOP)	-0.66749E 04	-0.25250E 04	0.20133E 04	-0.74911E 04	-0.17088E 04	-0.22068E 02	-0.28912E 04	0.67997E 04
BEND.(BOT)	0.66728E 04	0.25248E 04	-0.20117E 04	0.74882E 04	0.17095E 04	-0.22063E 02	0.28894E 04	0.67966E 04
TOT. (BOT)	0.66707E 04	0.25246E 04	-0.20101E 04	0.74852E 04	0.17101E 04	-0.22058E 02	0.28876E 04	0.67936E 04

ELEMENT NO. 8

	NODE NO.	X COMMON	Y COMMON	Z COMMON	U LOCAL	V LOCAL	W LOCAL
LA	4	0.0	2.500	0.0	0.27758E-06	-0.28083E-03	0.20360E-01
LB	5	0.0	3.000	0.0	0.24037E-06	-0.42126E-03	0.32631E-01
LC	12	-0.013	3.000	0.500	0.14079E-03	-0.42124E-03	0.32343E-01

BENDING STRESSES = A * (LOCAL X VALUE) + B * (LOCAL Y VALUE) + C

	A	B	C	VALUE AT CENTROID
SIGMAXBAR	0.22784E 05	-0.48489E 04	-0.11054E 05	-0.42677E 04
SIGMAYBAR	0.15478E 04	-0.10656E 05	0.99019E 03	-0.27051E 03
SHEAR	0.97439E 03	0.45308E 04	0.0	0.10802E 04

	SIGMAXBAR	SIGMAYBAR	SHEAR	PRINCIPAL SIGMAXBAR	PRINCIPAL SIGMAYBAR	PRINCIPAL THETA (DEG)	MAXIMUM SHEAR	EFFECTIVE STRESS
MEMBRANE	-0.21953E 01	0.12891E 00	0.15366E 01	-0.29598E 01	0.89337E 00	-0.26450E 02	-0.19266E 01	0.34932E 01
BEND.(TOP)	-0.42677E 04	-0.27051E 03	0.10802E 04	-0.45409E 04	0.27222E 01	-0.14195E 02	-0.22718E 04	0.45423E 04
TOT. (TOP)	-0.42699E 04	-0.27038E 03	0.10817E 04	-0.45437E 04	0.34421E 01	-0.14205E 02	-0.22736E 04	0.45454E 04
BEND.(BOT)	0.42677E 04	0.27051E 03	-0.10802E 04	0.45409E 04	-0.27222E 01	-0.14195E 02	0.22718E 04	0.45423E 04
TOT. (BOT)	0.42655E 04	0.27064E 03	-0.10786E 04	0.45381E 04	-0.20027E 01	-0.14185E 02	0.22701E 04	0.45391E 04

(CONTINUING TO ELEMENT NO. 48)

E. STRESS COMPUTER PROGRAM LISTING

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C     THIS IS THE MAIN PROGRAM FOR THE INDUCER STRESS PROGRAM -DECK 6098MAIN0001
C                                                                    MAIN0002
      COMMON X     ( 200) , Y     ( 200) , Z     ( 200) , TH    ( 200) ,MAIN0003
     1       PRESSE( 200) , XL  ( 200,3) , YL  ( 200,3) ,             MAIN0004
     2       RAPANG( 100) , ZGL    ( 100) , RHUB  ( 100) , RTIP  ( 100) ,MAIN0005
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM  ( 3,3) ,MAIN0006
     4       RHO , OMEGA , POISSO , YOUNGS , RADGEN ,                 MAIN0007
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,  MAIN0008
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,      MAIN0009
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) , MAIN0010
     8       PFCGN(18,1), CFCGN(18,1), MEX(200,8), IMEX(200), FORCE(  MAIN0011
     9       200,6) , ALEAN(100)                                      MAIN0012
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10), MAIN0013
     1    INTN(10)                                                    MAIN0014
      COMMON / TBAR / THBAR(200)                                     MAIN0015
      DEFINE FILE 1(200,324,U,IR1),3(900,900,U,IR3),4(500,602,U,IR4) MAIN0016
C     SET UP ALL ELEMENTAL AND NODAL INFORMATION .                   MAIN0017
   5  CALL MAIN1 ( IPUNCH )                                          MAIN0018
      IF ( NSUBS .EQ. 0 ) GO TO 10                                   MAIN0019
C     ASSEMBLE THE KAA AND KAB PORTIONS OF THE COMMON STIFFNESS MATRIX MAIN0020
C     FOR EACH SUB-SYSTEM .                                          MAIN0021
      CALL ASSEM1                                                    MAIN0022
C     ASSEMBLE THE KBA AND KBB-1 PORTIONS OF THE COMMON STIFFNESS    MAIN0023
C     MATRIX FOR EACH SUB-SYSTEM .                                   MAIN0024
      CALL ASSEM2                                                    MAIN0025
      IF ( NSUBS .LT. 0 ) GO TO 5                                    MAIN0026
C     CALCULATE THE SUB-SYSTEM PORTIONS OF THE SYSTEM STIFFNESS MATRIX MAIN0027
C     AND SYSTEM BOUNDARY FORCE COEFFICIENT MATRIX .                 MAIN0028
      CALL CALC                                                      MAIN0029
C     ASSEMBLE THE SUB-SYSTEM MATRICES INTO THE SYSTEM MATRIX .      MAIN0030
      CALL ASSEM3 ( NBNODE )                                         MAIN0031
C     SOLVE FOR THE BOUNDARY NODE DEFLECTIONS IN THE COMMON COORDINATE MAIN0032
C     SYSTEM .                                                       MAIN0033
      CALL BDEFL ( NBNODE )                                          MAIN0034
      IF ( NSUBS .LT. 0 ) GO TO 5                                    MAIN0035
C     SOLVE FOR THE INTERNAL NODE DEFLECTIONS OF EACH SUB-SYSTEM .   MAIN0036
      CALL IDEFL .                                                   MAIN0037
C     CALCULATE THE LOCAL NODAL DISPLACEMENT MATRIX (DISPLL), THE    MAIN0038
C     LOCAL MEMBRANE STRESS MATRIX (STRSLM), AND THE LOCAL BENDING   MAIN0039
C     STRESS MATRIX (STRSLB) .                                       MAIN0040
  10  CALL STRESS ( IPUNCH )                                         MAIN0041
      GO TO 5                                                        MAIN0042
      END                                                            MAIN0043
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      SUBROUTINE MAIN1 ( IPUNCH )                                       MAIN1001
C                                                                       MAIN1002
      COMMON X     ( 200) , Y     ( 200) , Z     ( 200) , TH    ( 200) ,MAIN1003
     1       PRESSE( 200) , XL  ( 200,3) , YL  ( 200,3) ,              MAIN1004
     2       RAPANG( 100) , ZGL   ( 100) , RHUB  ( 100) , RTIP  ( 100) ,MAIN1005
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM  ( 3,3) ,MAIN1006
     4       RHO , OMEGA  , POISSO , YOUNGS , RADGEN ,                  MAIN1007
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,    MAIN1008
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,        MAIN1009
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) , MAIN1010
     8       PFCGN(18,1) , CFCGN(18,1), MEX(200,8), IMEX(200),          MAIN1011
     9       FORCE(200,6) , ALEAN(100)                                  MAIN1012
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10),  MAIN1013
     1    INTN(10)                                                      MAIN1014
      COMMON / TBAR / THBAR(200)                                        MAIN1015
      DIMENSION ICOL(15) , NUP(100) , NCHB(100), LBOUND(10)             MAIN1016
      DIMENSION SYS(2) , SYS1(2) , SYS2(2)                              MAIN
      DATA ICOL / 1 , 2 , 7 , 8 , 13 , 14 , 3 , 4 , 5 , 9 , 10 , 11 ,  MAIN1017
     1           15 , 16 , 17 /                                         MAIN1018
      DATA SYS1 , SYS2 / 4H COM , 4HMON , 4H  LO , 4HCAL  /             MAIN
      WRITE (3'1) RHO                                                   MAIN1019
      WRITE (4'1) RHO                                                   MAIN1020
      WRITE (1'1) RHO                                                   MAIN1021
    5 CALL ZERO (X,FORCE(200,6))                                        MAIN1022
C     READ AND PRINT ALL INPUT                                          MAIN1023
      CALL INPUT ( IPRINT,NGP,NUP,NCHB,LBOUND,NCF,IPUNCH )              MAIN1024
      SYS(1) = SYS1(1)                                                  MAIN
      SYS(2) = SYS1(2)                                                  MAIN
      IF ( NCF .EQ. 0 ) GO TO 10                                        MAIN
      SYS(1) = SYS2(1)                                                  MAIN
      SYS(2) = SYS2(2)                                                  MAIN
C     TRIANGULATION OF INDUCER BLADE AND DETERMINATION OF THICKNESS AT  MAIN1025
C     EACH VERTEX AND PRESSURE ON EACH TRIANGLE .                       MAIN1026
   10 CALL GEOM ( NUP,NCHB,LBOUND )                                     MAIN1027
      IF ( NGP .LE. 0 ) GO TO 13                                        MAIN1028
      DO 11 I = 1,NGP                                                   MAIN1029
   11 READ (5,12) J,PRESSE(J)                                           MAIN1030
   12 FORMAT ( I5,5X,F10.0 )                                            MAIN1031
   13 IF ( ( NP .GT. 200 ) .OR. ( NT .GT. 200 ) ) GO TO 5               MAIN1032
      DO 30  I = 1,NT                                                   MAIN1033
      LA = NEXT(I,1)                                                    MAIN1034
      LB = NEXT(I,2)                                                    MAIN1035
      LC = NEXT(I,3)                                                    MAIN1036
      IMEX(LA) = IMEX(LA) + 1                                           MAIN1037
      IMEX(LB) = IMEX(LB) + 1                                           MAIN1038
      IMEX (LC) = IMEX(LC) + 1                                          MAIN1039
      MEX(LA,IMEX(LA)) = I                                              MAIN1040
      MEX(LB,IMEX(LB)) = I                                              MAIN1041
      MEX(LC,IMEX(LC)) = I                                              MAIN1042
C     CALCULATE THE DIRECTION COSINE MATRIX (EDCM) FOR A TRIANGULAR ELEMMAIN1043
      CALL DIRCOS (LA,LB,LC,I)                                          MAIN1044
C     CALCULATE THE LOCAL COORDINATES (XL,YL,ZL) FOR A TRIANGULAR ELEMENMAIN1045
      CALL LCOORD (LA,LB,LC,I)                                          MAIN1046
C     CALCULATE THE MEMBRANE STIFFNESS MATRIX (ELMSM) FOR A TRIANGULAR  MAIN1047
C     ELEMENT IN THE LOCAL COORDINATE SYSTEM (XL,YL,ZL)                 MAIN1048
      CALL MEMSTF ( LA,LB,LC,I )                                        MAIN1049
C     CALCULATE THE BENDING STIFFNESS MATRIX (ELBSM) FOR A TRIANGULAR   MAIN1050
C     ELEMENT IN THE LOCAL COORDINATE SYSTEM (XL,YL,ZL)                 MAIN1051
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```
      CALL BENSTF ( LA,LB,LC,I )                                        MAIN1052
      IF ( IPRINT .GE. 1 )                                              MAIN1053
     1WRITE (6,14) ((ELMSM(J,K),K=1,6),J=1,6),((ELBSM(J,K),K=1,9),J=1,9)MAIN1054
 14   FORMAT(1H1/45X,2HKM / 6(10X,6E14.6/) //65X,2HKB/9( 1X,9E14.6/))   MAIN1055
C     ASSEMBLE LOCAL STIFFNESS MATRIX (ELSTIF) FOR A TRIANGULAR ELEMENT MAIN1056
      DO 20 J = 1,6                                                     MAIN1057
      DO 20 K = 1,6                                                     MAIN1058
 20   ELSTIF(ICOL(J),ICOL(K)) = ELMSM(J,K)                              MAIN1059
      DO 25 J = 1,9                                                     MAIN1060
      DO 25 K = 1,9                                                     MAIN1061
 25   ELSTIF(ICOL(J+6),ICOL(K+6)) = ELBSM(J,K)                          MAIN1062
C     CALCULATE THE LOCAL GENERALIZED PRESSURE FORCE MATRIX (PFLGN) FOR MAIN1063
C     A TRIANGULAR ELEMENT                                              MAIN1064
      CALL NPFORC ( I )                                                 MAIN1065
C     CALCULATE THE COMMON GENERALIZED CENTRIFUGAL FORCE MATRIX (CFLGN) MAIN1066
C     FOR A TRIANGULAR ELEMENT                                          MAIN1067
      CALL NCFORC (LA,LB,LC,I,NCF)                                      MAIN1068
      IF ( IPRINT .GE. 1 ) WRITE (6,24) PFLGN,SYS,CFLGN                 MAIN1069
 24   FORMAT (//20X,39HLOCAL GENERALIZED PRESSURE FORCE MATRIX /9E12.4  MAIN1070
     1 //20X, 2A4 , 36HGENERALIZED CENTRIFUGAL FORCE MATRIX /9E12.4/    MAIN1071
     2 9E12.4 )                                                         MAIN1072
C     CALCULATE THE STIFFNESS MATRIX (ECSTIF), NODAL PRESSURE FORCE     MAIN1073
C     MATRIX (PFCGN), AND NODAL CENTRIFUGAL FORCE MATRIX (CFCGN) OF A   MAIN1074
C     TRIANGULAR ELEMENT IN THE COMMON COORDINATE SYSTEM (X,Y,Z) .      MAIN1075
      CALL COMSTF ( I , NCF )                                           MAIN1076
      WRITE (1'1) ECSTIF                                                MAIN1077
      IF ( IPRINT .GE. 1 ) WRITE (6,15)                                 MAIN1078
 15   FORMAT (1H  //25X,55HCOMMON COORDINATE SYSTEM TRIANGULAR STIFFNESSMAIN1079
     1 MATRIX    )                                                      MAIN1080
      IF ( IPRINT .GE. 1 ) WRITE (6,26) ((ECSTIF(J,K),K=1,18),J=1,18)   MAIN1081
 26   FORMAT (//18(10E12.4/8E12.4/))                                    MAIN1082
C     ADD VALUES OF PFCGN AND CFCGN WHICH ARE COMMON TO A COMMON NODE . MAIN1083
 30   CALL ADDF ( I )                                                   MAIN1084
C     PRINT GEOMETRIC BREAK-UP AND ASSOCIATED PROPERTIES .              MAIN1085
      CALL PRINT1                                                       MAIN1086
      IF ( NSUBS .GT. 0 ) RETURN                                        MAIN1087
C     SOLVE FOR THE NODAL DEFLECTIONS (DISPL) IN THE COMMON COORDINATE  MAIN1088
C     SYSTEM .                                                          MAIN1089
 35   CALL DEFL ( IPRINT )                                             MAIN1090
      IF ( NP .LE. 0 ) GO TO 5                                          MAIN1091
      RETURN                                                            MAIN1092
      END                                                               MAIN1093
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      SUBROUTINE INPUT ( IPRINT,NGP,NUP,NCHB,LBOUND,NCF,IPUNCH )          INPUT001
C     READ AND PRINT ALL INPUT                                            INPUT002
C                                                                         INPUT003
      COMMON X     ( 200) , Y     ( 200) , Z     ( 200) , TH    ( 200) ,INPUT004
     1       PRESSE( 200) , XL  ( 200,3) , YL  ( 200,3) ,                 INPUT005
     2       RAPANG( 100) , ZGL   ( 100) , RHUB  ( 100) , RTIP  ( 100) ,INPUT006
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM  ( 3,3) ,INPUT007
     4       RHO , OMEGA  , POISSO , YOUNGS , RADGEN ,                    INPUT008
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,      INPUT009
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,          INPUT010
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) ,   INPUT011
     8       PFCGN(18,1) , CFCGN(18,1), MEX(200,8), IMEX(200),            INPUT012
     9       FORCE(200,6) , ALEAN(100)                                    INPUT013
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10),    INPUT014
     1    INTN(10)                                                        INPUT015
      DIMENSION NUP(100) , NCHB(100), LBOUND(10)                          INPUT016
      REAL TITLE (18)                                                     INPUT017
    1 WRITE (6,5)                                                         INPUT018
    5 FORMAT (1H1/35HOINDUCER STRESS PROGRAM - DECK 6098 //)              INPUT019
      CALL DATE (BMONTH,DAY,YEAR)                                         INPUT020
      WRITE (6,7) BMONTH,DAY,YEAR                                         INPUT021
    7 FORMAT (6H DATE ,A2,1H/,A2,1H/,A2//)                                INPUT022
   10 READ (5,15,END=50) NT,TITLE                                         INPUT023
   15 FORMAT (I1,18A4)                                                    INPUT024
      WRITE (6,20) TITLE                                                  INPUT025
   20 FORMAT (5X,18A4 /)                                                  INPUT026
      IF ( NT .GT. 0 ) GO TO 10                                           INPUT027
      READ (5,25) RHO,RPM,POISSO,YOUNGS,RADGEN,NCF,NGENLI,LINE1,NGP,      INPUT028
     1    NSUBS,IPRINT,LBOUND,IPUNCH,G                                    INPUT029
   25 FORMAT (3F10.0, E10.0,F10.0,6I5/10I5,15X,I5,F10.0)                  INPUT030
      IF ( G .EQ. 0.0 ) G = 386.4                                         INPUT031
      WRITE (6,26) NSUBS,NCF,LBOUND,IPUNCH                                INPUT031
   26 FORMAT (//10X,20HNO. OF SUB-SYSTEMS = I3,7X,27HCENTRIFUGAL FORCE OINPUT032
     1PTION = I2/10X,47HSUB-SYSTEM BOUNDARIES FORMED BY GENERATOR LINES INPUT033
     2  10I5/10X,15HPUNCH OPTION = ,I5)                                  INPUT034
      IF ( LINE1 .GT. 0 ) READ (5,27) (NCHB(I),I=1,LINE1)                 INPUT035
   27 FORMAT (16I5)                                                       INPUT036
      DO 29 I = 1,100                                                     INPUT037
      IF ( NCHB(I) .GT. 0 ) GO TO 29                                      INPUT038
      NCHB(I) = NGENLI + 1                                                INPUT039
   29 CONTINUE                                                            INPUT040
      WRITE (6,30)RHO,G,RPM,POISSO,YOUNGS,NGENLI,LINE1,RADGEN,NGP         INPUT041
   30 FORMAT(//10X,10HDENSITY = F6.4,5X,4HG = ,E12.4,5X,6HRPM = F10.1,5XINPUT042
     1,18HPOISSON'S RATIO = F5.3,5X,18HYOUNG'S MODULUS = E12.4 //10X,    INPUT043
     2 26HNO. OF GENERATING LINES = I4,5X,40HNO. OF SYMMETRY CHANGES REQINPUT044
     3UESTED     = I3 //10X,31HGENERATOR LINE OFFSET RADIUS = F9.3 //    INPUT045
     4 10X,I5,2X,23HINPUT ELEMENT PRESSURES //)                           INPUT046
      IF ( LINE1 .EQ. 0 ) GO TO 32                                        INPUT047
      WRITE (6,31) (NCHB(I),I=1,LINE1)                                    INPUT048
   31 FORMAT (10X,38HSYMMETRY CHANGE ABOUT GENERATOR LINES 15I5/)         INPUT049
   32 RHO = RHO / G                                                       INPUT050
      OMEGA = RPM * 3.14159265 / 30.0                                     INPUT051
      KOUNT = 0                                                           INPUT052
      WRITE (6,5)                                                         INPUT053
      DO 45 I = 1,NGENLI                                                  INPUT054
      READ (5,35) RAPANG(I),ZGL(I),RHUB(I),RTIP(I),THHUB(I),THTIP(I),     INPUT055
     1    NUP(I),N,ALEAN(I)                                               INPUT056
   35 FORMAT (6F10.0,2I5,F10.0)                                           INPUT057
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      NPRES(I) = N                                                      INPUT058
      READ (5,37) (PRESSL(I,J),J=1,N)                                   INPUT059
37    FORMAT (8F10.0)                                                   INPUT060
      WRITE (6,39) I                                                    INPUT061
39    FORMAT (30X,22HGENERATOR LINE NUMBER I3,5X,16H(ANGLES IN DEG.) /) INPUT062
      WRITE (6,40) RAPANG(I),ZGL(I),ALEAN(I),RHUB(I),RTIP(I),THHUB(I),  INPUT063
     1  THTIP(I),NUP(I),NPRES(I),(PRESSL(I,J),J=1,N)                    INPUT064
40    FORMAT ( 5X,13HWRAP ANGLE = F12.6,5X,       7HZHUB = F7.3,5X,12HLEINPUT065
     1AN ANGLE =F12.6,       5X,13HHUB RADIUS = F8.4,5X,13HTIP RADIUS = INPUT066
     2  F8.4/ 5X,16HHUB THICKNESS = F7.4,4X,16HTIP THICKNESS = F7.4,4X, INPUT067
     3 16HNO. OF POINTS = I2,9X,                                        INPUT068
     419HNO. OF PRESSURES = I3/ 40X,10HPRESSURES /10X,10F12.4/10X,5F12.4INPUT069
     5 //)                                                              INPUT070
      KOUNT = KOUNT + 1                                                 INPUT071
      IF (KCUNT .EQ. 8) WRITE (6,5)                                     INPUT072
      IF (KOUNT .EQ. 8) KOUNT = 0                                       INPUT073
      ALEAN(I) = ALEAN(I) * 0.0174533                                   INPUT074
45    RAPANG(I) = RAPANG(I) * 0.0174533                                 INPUT075
      GO TO 55                                                          INPUT076
50    STOP                                                              INPUT077
55    RETURN                                                            INPUT078
      END                                                               INPUT079
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      SUBROUTINE GEOM (NUP,NCHB,LBOUND )                                GEOM0010
C     TRIANGULATION OF INDUCER BLADE AND DETERMINATION OF THICKNESS AT  GEOM0020
C     EACH VERTEX AND PRESSURE ON EACH TRIANGLE .                       GEOM0030
C                                                                       GEOM0040
      COMMON X     ( 200) , Y     ( 200) , Z     ( 200) , TH    ( 200) ,GEOM0050
     1       PRESSE( 200) , XL  ( 200,3) , YL  ( 200,3) ,               GEOM0060
     2       RAPANG( 100) , ZGL   ( 100) , RHUB  ( 100) , RTIP  ( 100) ,GEOM0070
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM  ( 3,3) ,GEOM0080
     4       RHO , OMEGA  , POISSO ,YOUNGS , RADGEN ,                   GEOM0090
     5       NGENLI , LINEI , NPRES(100) , NEXT ( 200,3) , NP , NT ,    GEOM0100
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,        GEOM0110
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) , GEOM0120
     8       PFCGN(18,1) , CFCGN(18,1), MEX(200,8), IMEX(200),          GEOM0130
     9       FORCE(200,6) , ALEAN(100)                                  GEOM0140
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10),  GEOM0150
     1    INTN(10)                                                      GEOM0160
      DIMENSION PRESN(200) , NUP(100) , NCHB(100), LBOUND(10)           GEOM0170
      ICHB = 1                                                          GEOM0180
      KOUNT = -1                                                        GEOM0190
      IPOS(1) = -1                                                      GEOM0200
      LIP1 = 0                                                          GEOM0210
      LIP2 = 0                                                          GEOM0220
      LSUB = 1                                                          GEOM0230
      NP1 = 1                                                           GEOM0240
      NT  = 0                                                           GEOM0250
      NP = NUP(1)                                                       GEOM0260
      NS  = NGENLI - 1                                                  GEOM0270
      DO 90 I = 1,NS                                                    GEOM0280
      NT1 = NUP(I) + NUP(I+1) - 2                                       GEOM0290
      IF ( I .NE. 1 ) GO TO 15                                          GEOM0300
      LINE = NUP(I)                                                     GEOM0310
      DR = 0.0                                                          GEOM0311
      IF ( LINE .EQ. 1 ) GO TO 1                                        GEOM0312
      DR = ( RTIP(I) - RHUB(I) ) / FLOAT( LINE  - 1 )                   GEOM0320
    1 RADIUS = RHUB(I) - DR                                             GEOM0330
      SINA = SIN( RAPANG(I) )                                           GEOM0340
      COSA = COS( RAPANG(I) )                                           GEOM0350
      TANL = TAN ( ALEAN(I) )                                           GEOM0360
      DRP  = ( RTIP(I) - RHUB(I) ) / FLOAT( NPRES(I) - 1 )              GEOM0370
      LINE = NUP(I)                                                     GEOM0380
      DO 10 J = 1,LINE                                                  GEOM0390
      IF ( J .EQ. 1 ) GO TO 2                                           GEOM0400
      KOUNT = KOUNT + 1                                                 GEOM0410
      IPOS(J) = KOUNT                                                   GEOM0420
      LIP1 = LIP1 + 1                                                   GEOM0430
      NITS(LSUB,LIP1) = J                                               GEOM0440
    2 RADIUS = RADIUS + DR                                              GEOM0450
      Z(J)   = ZGL(I) + ( RADIUS - RHUB(I) ) * TANL                     GEOM0460
      X(J)   = RADGEN * COSA - RADIUS * SINA                            GEOM0470
      Y(J)   = RADGEN * SINA + RADIUS * COSA                            GEOM0480
      TH(J)  = THHUB(I) + ( THTIP(I) - THHUB(I) ) * ( RADIUS - RHUB(I) )GEOM0490
     1         / ( RTIP(I) - RHUB(I) )                                  GEOM0500
      IF ( TH(J) .LT. 0.0 ) TH(J) = 0.0                                 GEOM0510
      J1 = ( RADIUS - RHUB(I) + 0.0001 ) / DRP                          GEOM0520
      J1 = J1 + 1                                                       GEOM0530
      IF ( J1 .GE. NPRES(I) ) GO TO 5                                   GEOM0540
      PRESN(J) = PRESSL(I,J1) + ( PRESSL(I,J1+1) - PRESSL(I,J1) ) *     GEOM0550
     1           ( RADIUS - DRP * FLOAT( J1 - 1 ) - RHUB(I) ) / DRP     GEOM0560
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      GO TO 10                                                          GEOM0570
 5    PRESN(J) = PRESSL(I,NPRES(I))                                     GEOM0580
10    CONTINUE                                                          GEOM0590
15    LINE = NUP(I+1)                                                   GEOM0600
      DR = 0.0                                                          GEOM0601
      IF ( LINE .EQ. 1 ) GO TO 16                                       GEOM0602
      DR = ( RTIP(I+1) - RHUB(I+1) ) / FLOAT( LINE  - 1 )               GEOM0610
16    IF ( I+1 .EQ. LBOUND(LSUB) ) LIP1 = 0                             GEOM0620
      RADIUS = RHUB(I+1) - DR                                           GEOM0630
      DRP =( RTIP(I+1) - RHUB(I+1) ) / FLOAT( NPRES(I+1) - 1 )          GEOM0640
      J2  = NP + 1                                                      GEOM0650
      J3 = NP + NUP(I+1)                                                GEOM0660
      SINA = SIN( RAPANG(I+1) )                                         GEOM0670
      COSA = COS( RAPANG(I+1) )                                         GEOM0680
      TANL = TAN( ALEAN(I+1) )                                          GEOM0690
      IPOS(J2) = -1                                                     GEOM0700
      DO 25  J = J2,J3                                                  GEOM0710
      IF ( J .EQ. J2 ) GO TO 17                                         GEOM0720
      KOUNT = KOUNT + 1                                                 GEOM0730
      IPOS(J) = KOUNT                                                   GEOM0740
      IF ( NSUBS .EQ. 0 ) GO TO 17                                      GEOM0750
      IF ( (LSUB .EQ. 1) .AND. (I+1 .LT. LBOUND(1)) ) LIP1 = LIP1 + 1   GEOM0760
      IF ( (LSUB .EQ. 1) .AND. (I+1 .LT. LBOUND(1)) ) NITS(LSUB,LIP1) =JGEOM0770
      IF ( LSUB .EQ. NSUBS ) LIP1 = LIP1 + 1                            GEOM0780
      IF ( LSUB .EQ. NSUBS ) NITS(LSUB,LIP1) = J                        GEOM0790
      IF ( (LSUB .NE. 1) .AND. (LSUB .NE. NSUBS) .AND. (I+1 .NE.        GEOM0800
     1   LBOUND(LSUB)) ) LIP1 = LIP1 + 1                               GEOM0810
      IF ( (LSUB .NE. 1) .AND. (LSUB .NE. NSUBS) .AND. (I+1 .NE.        GEOM0820
     1   LBOUND(LSUB)) ) NITS(LSUB,LIP1) = J                           GEOM083C
      IF ( I+1 .NE. LBOUND(LSUB) ) GO TO 17                             GEOM0840
      LIP2 = LIP2 + 1                                                   GEOM0850
      NBTS(LSUB,LIP2) =J                                                GEOM0860
      III = LIP2                                                        GEOM0870
      IF ( LSUB .NE. 1 ) K = LBOUND(LSUB-1)                             GEOM0880
      IF ( LSUB .NE. 1 ) III = III - NUP(K) + 1                         GEOM0890
      NBTS(LSUB+1,III) = J                                              GEOM0900
17    RADIUS = RADIUS + DR                                              GEOM0910
      Z(J) = ZGL(I+1) + ( RADIUS - RHUB(I+1) ) * TANL                   GEOM0920
      X(J) = RADGEN * COSA - RADIUS * SINA                              GEOM0930
      Y(J) = RADGEN * SINA + RADIUS * COSA                              GEOM0940
      TH(J)= THHUB(I+1) + ( THTIP(I+1) - THHUB(I+1) ) * ( RADIUS -      GEOM0950
     1       RHUB(I+1) ) / ( RTIP(I+1) - RHUB(I+1) )                    GEOM0960
      J1   = ( RADIUS - RHUB(I+1) + 0.0001 ) / DRP                      GEOM0970
      J1 = J1 + 1                                                       GEOM0980
      IF ( TH(J) .LT. 0.0 ) TH(J) = 0.0                                 GEOM0990
      IF ( J1 .GE. NPRES(I+1) ) GO TO 20                                GEOM1000
      PRESN(J) = PRESSL(I+1,J1) + ( PRESSL(I+1,J1+1) - PRESSL(I+1,J1) ) GEOM1010
     1           * ( RADIUS - DRP * FLOAT(J1-1) - RHUB(I+1) ) / DRP     GEOM1020
      GO TO 25                                                          GEOM1030
20    PRESN(J) = PRESSL(I+1,NPRES(I+1))                                 GEOM1040
25    CONTINUE                                                          GEOM1050
      IF ( I+1 .NE. LBOUND(LSUB) ) GO TO 26                             GEOM1060
      LSUB = LSUB + 1                                                   GEOM1070
      K = LBOUND(LSUB-1)                                                GEOM1080
      LIP2 = NUP(K) - 1                                                 GEOM1090
26    J1 = NT + 1                                                       GEOM1100
      J2 = NT + NT1                                                     GEOM1110
      NB = 0                                                            GEOM1120
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      K = 0                                                          GEOM1130
      NB1 = -2                                                       GEOM1140
      NPT1 = NUP(I)                                                  GEOM1150
      NPT2 = NUP(I+1)                                                GEOM1160
      IF (NPT1 .EQ. NPT2) GO TO 27                                   GEOM1170
      IF (NPT2 - NPT1 .EQ. 1) GO TO 275                              GEOM1180
      IF (NPT1 - NPT2 .EQ. 1) GO TO 270                              GEOM1190
      IF (NPT2 - NPT1 .GT. 1) GO TO 265                              GEOM1200
C     BOTTOM GENERATOR HAS AT LEAST TWO MORE NODES THAN THE TOP      GEOM1210
C     GENERATOR.                                                     GEOM1220
      DO 264 J = J1,J2                                               GEOM1230
      K = K + 1                                                      GEOM1240
      L = MOD(K,3)                                                   GEOM1250
      IF (L .EQ. 0) L = 3                                            GEOM1260
      GO TO (261, 262, 263), L                                       GEOM1270
  261 NB1 = NB1 + 2                                                  GEOM1280
      NEXT(J,1) = NP1 + NB1                                          GEOM1290
      NEXT(J,2) = NP1 + NB1 + 1                                      GEOM1300
      NEXT(J,3) = NP + NB1 / 2 + 1                                   GEOM1310
      GO TO 264                                                      GEOM1320
  262 NEXT(J,1) = NEXT(J-1,3)                                        GEOM1330
      NEXT(J,2) = NEXT(J,1) + 1                                      GEOM1340
      NEXT(J,3) = NEXT(J-1,2)                                        GEOM1350
      GO TO 264                                                      GEOM1360
  263 NEXT(J,1) = NEXT(J-1,3)                                        GEOM1370
      NEXT(J,2) = NEXT(J,1) + 1                                      GEOM1380
      NEXT(J,3) = NEXT(J-1,2)                                        GEOM1390
  264 CONTINUE                                                       GEOM1400
      GO TO 85                                                       GEOM1410
C     TOP GENERATOR HAS AT LEAST TWO MORE NODES THAN                 GEOM1420
C     THE BOTTOM GENERATOR.                                          GEOM1430
  265 DO 269 J = J1, J2                                              GEOM1440
      K = K + 1                                                      GEOM1450
      L = MOD(K,3)                                                   GEOM1460
      IF (L .EQ. 0) L = 3                                            GEOM1470
      GO TO (266,267,268), L                                         GEOM1480
  266 NB1 = NB1 + 2                                                  GEOM1490
      NEXT(J,1) = NP + NB1 + 1                                       GEOM1500
      NEXT(J,2) = NP + NB1 + 2                                       GEOM1510
      NEXT(J,3) = NP1 + NB1 / 2                                      GEOM1520
      GO TO 269                                                      GEOM1530
  267 NEXT(J,1) = NEXT(J-1,3)                                        GEOM1540
      NEXT(J,2) = NEXT(J,1) + 1                                      GEOM1550
      NEXT(J,3) = NEXT(J-1,2)                                        GEOM1560
      GO TO 269                                                      GEOM1570
  268 NEXT(J,1) = NEXT(J-1,3)                                        GEOM1580
      NEXT(J,2) = NEXT(J,1) + 1                                      GEOM1590
      NEXT(J,3) = NEXT(J-1,2)                                        GEOM1600
  269 CONTINUE                                                       GEOM1610
      GO TO 85                                                       GEOM1620
C     BOTTOM GENERATOR HAS ONE MORE NODE THAN THE TOP GENERATOR.     GEOM1630
  270 NEXT(J1,1) = NP1                                               GEOM1640
      NEXT(J1,2) = NP1 + 1                                           GEOM1650
      NEXT(J1,3) = NP + 1                                            GEOM1660
      IF (J1 .EQ. J2) GO TO 85                                       GEOM1670
      J11 = J1 + 1                                                   GEOM1680
      DO 271 J = J11,J2                                              GEOM1690
      NEXT(J,1) = NEXT(J-1,3)                                        GEOM1700
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      NEXT(J,2) = NEXT(J,1)+1                                          GEOM1710
  271 NEXT(J,3) = NEXT(J-1,2)                                          GEOM1720
      GO TO 85                                                         GEOM1730
C     TOP GENERATOR HAS ONE MORE NODE THAN THE BOTTOM GENERATOR.       GEOM1740
  275 NEXT(J1,1) = NP + 1                                              GEOM1750
      NEXT(J1,2) = NP + 2                                              GEOM1760
      NEXT(J1,3) = NP1                                                 GEOM1770
      IF (J1 .EQ. J2) GO TO 85                                         GEOM1780
      J11 = J1 + 1                                                     GEOM1790
      DO 276 J = J11, J2                                               GEOM1800
      NEXT(J,1) = NEXT(J-1,3)                                          GEOM1810
      NEXT(J,2) = NEXT(J,1)+1                                          GEOM1820
  276 NEXT(J,3) = NEXT(J-1,2)                                          GEOM1830
      GO TO 85                                                         GEOM1840
C     SAME NUMBER OF NODES ON TOP AND BOTTOM GENERATORS .              GEOM1850
   27 IF ( RADGEN .NE. 0.0 ) GO TO 55                                  GEOM1860
      IF ( NCHB(ICHB) .EQ. 1 ) GO TO 40                                GEOM1870
      IF ( ICHB .GE. 2 ) GO TO 42                                      GEOM1880
   28 DO 35 J = J1,J2                                                  GEOM1890
      K = J - J1 + 1                                                   GEOM1900
      IF ( MOD(K,2) .EQ. 0 ) GO TO 30                                  GEOM1910
      NB = NB + 1                                                      GEOM1920
      NEXT(J,1) = NP + NB                                              GEOM1930
      NEXT(J,2) = NP + NB + 1                                          GEOM1940
      NEXT(J,3) = NP1 + NB - 1                                         GEOM1950
      GO TO 35                                                         GEOM1960
   30 NEXT(J,1) = NP1 + NB - 1                                         GEOM1970
      NEXT(J,2) = NP1 + NB                                             GEOM1980
      NEXT(J,3) = NP + NB + 1                                          GEOM1990
   35 CONTINUE                                                         GEOM2000
      GO TO 85                                                         GEOM2010
   40 ICHB = ICHB + 1                                                  GEOM2020
   42 IF ( MOD(ICHB,2) .EQ. 1 ) GO TO 28                               GEOM2030
      DO 50 J = J1,J2                                                  GEOM2040
      K = J - J1 + 1                                                   GEOM2050
      IF ( MOD(K,2) .EQ. 0 ) GO TO 45                                  GEOM2060
      NB = NB + 1                                                      GEOM2070
      NEXT(J,1) = NP1 + NB - 1                                         GEOM2080
      NEXT(J,2) = NP1 + NB                                             GEOM2090
      NEXT(J,3) = NP + NB                                              GEOM2100
      GO TO 50                                                         GEOM2110
   45 NEXT(J,1) = NP + NB                                              GEOM2120
      NEXT(J,2) = NP + NB + 1                                          GEOM2130
      NEXT(J,3) = NP1 + NB                                             GEOM2140
   50 CONTINUE                                                         GEOM2150
      GO TO 85                                                         GEOM2160
   55 IF ( NCHB(ICHB) .EQ. 1 ) GO TO 70                                GEOM2170
      IF ( ICHB .GE. 2 ) GO TO 72                                      GEOM2180
   58 DO 65 J = J1,J2                                                  GEOM2190
      K = J - J1 + 1                                                   GEOM2200
      IF ( MOD(K,2) .EQ. 0 ) GO TO 60                                  GEOM2210
      NB = NB + 1                                                      GEOM2220
      NEXT(J,1) = NP1 + NB - 1                                         GEOM2230
      NEXT(J,2) = NP1 + NB                                             GEOM2240
      NEXT(J,3) = NP + NB                                              GEOM2250
      GO TO 65                                                         GEOM2260
   60 NEXT(J,1) = NP + NB                                              GEOM2270
      NEXT(J,2) = NP + NB + 1                                          GEOM2280
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      NEXT(J,3) = NP1 + NB                                              GEOM2290
65    CONTINUE                                                          GEOM2300
      GO TO 85                                                          GEOM2310
70    ICHB = ICHB + 1                                                   GEOM2320
72    IF ( MOD(ICHB,2) .EQ. 1 ) GO TO 58                                GEOM2330
      DO 80 J = J1,J2                                                   GEOM2340
      K = J - J1 + 1                                                    GEOM2350
      IF ( MOD(K,2) .EQ. 0 ) GO TO 75                                   GEOM2360
      NB = NB + 1                                                       GEOM2370
      NEXT(J,1) = NP + NB                                               GEOM2380
      NEXT(J,2) = NP + NB + 1                                           GEOM2390
      NEXT(J,3) = NP1 + NB - 1                                          GEOM2400
      GO TO 80                                                          GEOM2410
75    NEXT(J,1) = NP1 + NB - 1                                          GEOM2420
      NEXT(J,2) = NP1 + NB                                              GEOM2430
      NEXT(J,3) = NP + NB + 1                                           GEOM2440
80    CONTINUE                                                          GEOM2450
85    CONTINUE                                                          GEOM2460
      NP1 = NP + 1                                                      GEOM2470
      NP  = NP + NUP(I+1)                                               GEOM2480
      NT  = NT + NT1                                                    GEOM2490
      IF ( NP .LE. 200 ) GO TO 87                                       GEOM2500
      WRITE (6,86)                                                      GEOM2510
86    FORMAT (//20X,35HMORE THAN 200 POINTS WERE GENERATED ,            GEOM2520
      RETURN                                                            GEOM2530
87    IF ( NT .LE. 200 ) GO TO 90                                       GEOM2540
      WRITE (6,88)                                                      GEOM2550
88    FORMAT (//20X,37HMORE THAN 200 ELEMENTS WERE GENERATED )          GEOM2560
      RETURN                                                            GEOM2570
90    CONTINUE                                                          GEOM2580
      DO 95 I = 1,NT                                                    GEOM2590
      J1 = NEXT(I,1)                                                    GEOM2600
      J2 = NEXT(I,2)                                                    GEOM2610
      J3 = NEXT(I,3)                                                    GEOM2620
95    PRESSE(I) = ( PRESN(J1) + PRESN(J2) + PRESN(J3) ) / 3.0           GEOM2630
      IF ( NSUBS .EQ. 0 ) RETURN                                        GEOM2640
      I = LBOUND(1)                                                     GEOM2650
      NBN(1) = NUP(I) - 1                                               GEOM2660
      DO 110 I = 1,NSUBS                                                GEOM2670
      IF ( I .EQ. 1 ) GO TO 100                                         GEOM2680
      J = LBOUND(I-1)                                                   GEOM2690
      NBN(I) = NUP(J) - 1                                               GEOM2700
      IF ( I .EQ. NSUBS ) GO TO 100                                     GEOM2710
      J = LBOUND(I)                                                     GEOM2720
      NBN(I) = NBN(I) + NUP(J) - 1                                      GEOM2730
100   J2 = LBOUND(I) - 1                                                GEOM2740
      IF ( I .EQ. NSUBS ) J2 = NGENLI                                   GEOM2750
      J1 = 1                                                            GEOM2760
      IF ( I .GT. 1 ) J1 = LBOUND(I-1) + 1                              GEOM2770
      INTN(I) = 0                                                       GEOM2780
      DO 110 J = J1,J2                                                  GEOM2790
110   INTN(I) = INTN(I) + NUP(J) - 1                                    GEOM2800
      RETURN                                                            GEOM2810
      END                                                               GEOM2820
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      SUBROUTINE DIRCOS (LA,LB,LC,I)                                    DIRCOS01
C     CALCULATE THE DIRECTION COSINE MATRIX (EDCM) OF ELEMENT LOCAL AXESDIRCOS02
C     (XL,YL,ZL) RELATIVE TO COMMON AXES (X,Y,Z) .                      DIRCOS03
C                                                                       DIRCOS04
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,DIRCOS05
     1       PRESSE( 200) , XL   ( 200,3) , YL   ( 200,3) ,            DIRCOS06
     2       RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,DIRCOS07
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,DIRCOS08
     4       RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                 DIRCOS09
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT      DIRCOS10
      DOUBLE PRECISION L12 , S1X , S1Y , S1Z , S1 , S2X , S2Y , S2Z ,   DIRCOS11
     1                 S2                                               DIRCOS12
      L12 = SQRT( (X(LB)-X(LA))**2 + (Y(LB)-Y(LA))**2 +(Z(LB)-Z(LA))**2)DIRCOS13
      S1X = (Y(LB)-Y(LA)) * (Z(LC)-Z(LA)) - (Y(LC)-Y(LA))*(Z(LB)-Z(LA)) DIRCOS14
      S1Y = (Z(LB)-Z(LA))*(X(LC)-X(LA)) - (Z(LC)-Z(LA))*(X(LB)-X(LA))   DIRCOS15
      S1Z = (X(LB) - X(LA)) * (Y(LC) - Y(LA)) - (X(LC) - X(LA)) *       DIRCOS16
     1      (Y(LB) - Y(LA))                                             DIRCOS17
      SIGN = 1.0                                                        DIRCOS18
      IF ( LC .LT. LB ) SIGN = -1.0                                     DIRCOS19
    5 S1X = S1X * SIGN                                                  DIRCOS20
      S1Y = S1Y * SIGN                                                  DIRCOS21
      S1Z = S1Z * SIGN                                                  DIRCOS22
   10 S1  =DSQRT( S1X**2 + S1Y**2 + S1Z**2 )                            DIRCOS23
      S2X = S1Y * (Z(LB) - Z(LA)) - S1Z * (Y(LB) - Y(LA))               DIRCOS24
      S2Y = S1Z * (X(LB) - X(LA)) - S1X * (Z(LB) - Z(LA))               DIRCOS25
      S2Z = S1X * (Y(LB) - Y(LA)) - S1Y * (X(LB) - X(LA))               DIRCOS26
      S2  =DSQRT( S2X**2 + S2Y**2 + S2Z**2 )                            DIRCOS27
      EDCM(1,1) = (X(LB) - X(LA)) / L12                                 DIRCOS28
      EDCM(2,1) = (Y(LB) - Y(LA)) / L12                                 DIRCOS29
      EDCM(3,1) = ( Z(LB) - Z(LA) ) / L12                               DIRCOS30
      EDCM(1,2) = S2X / S2                                              DIRCOS31
      EDCM(2,2) = S2Y / S2                                              DIRCOS32
      EDCM(3,2) = S2Z / S2                                              DIRCOS33
      EDCM(1,3) = S1X / S1                                              DIRCOS34
      EDCM(2,3) = S1Y / S1                                              DIRCOS35
      EDCM(3,3) = S1Z / S1                                              DIRCOS36
      RETURN                                                            DIRCOS37
      END                                                               DIRCOS38
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      SUBROUTINE LCOORD (LA,LB,LC,I)                                    LCOORD01
C     DETERMINE LOCAL NODAL COORDINATES (XL,YL,ZL) OF TRIANGULAR ELEMENTLCOORD02
C     FROM COMMON NODAL COORDINATES (X,Y,Z) .                           LCOORD03
C                                                                       LCOORD04
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH   ( 200) ,LCOORD05
     1       PRESSE( 200) , XL   ( 200,3) , YL   ( 200,3) ,            LCOORD06
     2       RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,LCOORD07
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,LCOORD08
     4       RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                LCOORD09
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT     LCOORD10
      XL(I,2)= EDCM(1,1) * (X(LB) - X(LA)) + EDCM(2,1) * (Y(LB) - Y(LA))LCOORD11
     1         +EDCM(3,1) * (Z(LB) - Z(LA))                             LCOORD12
      XL(I,3)= EDCM(1,1) * (X(LC) - X(LA)) + EDCM(2,1) * (Y(LC) - Y(LA))LCOORD13
     1         +EDCM(3,1) * (Z(LC) - Z(LA))                             LCOORD14
      YL(I,3)= EDCM(1,2) * (X(LC) - X(LA)) + EDCM(2,2) * (Y(LC) - Y(LA))LCOORD15
     1         +EDCM(3,2) * (Z(LC) - Z(LA))                             LCOORD16
      RETURN                                                            LCOORD17
      END                                                               LCOORD18
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      SUBROUTINE MEMSTF ( LAA,LBB,LCC,IE )                                  MEMSTF01
C     CALCULATE THE LOCAL MEMBRANE STIFFNESS MATRIX (ELMSM) FOR A           MEMSTF02
C     TRIANGULAR ELEMENT .                                                  MEMSTF03
C                                                                           MEMSTF04
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,MEMSTF05
     1       PRESSE( 200) , XLL ( 200,3) , YLL ( 200,3) ,                   MEMSTF06
     2       RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,MEMSTF07
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,MEMSTF08
     4       RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                     MEMSTF09
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,        MEMSTF10
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,            MEMSTF11
     7       PFLGN(9,1)                                                     MEMSTF12
      COMMON / TBAR / THBAR(200)                                            MEMSTF13
      DIMENSION             AMNIT(6,6) , WM(3,6) , WMT(6,3) , EM(3,3) ,     MEMSTF14
     1            TN(6,1) , ZINT (1,6) , Z1(6,6) , Z2 (6,6)                 MEMSTF15
      DIMENSION YL(3) , XL(3)                                               MEMSTF16
      DOUBLE PRECISION ZINT , XL , YL , TERM , AMNIT , WM , WMT , EM ,      MEMSTF17
     1                 TN , Z1 , Z2                                       MEMSTF18
      DATA LA,LB,LC / 1 , 2 , 3 /                                           MEMSTF19
      DATA WM / 1.0D0,4*0.0D0,1.0D0,2*0.0D0,1.0D0,0.0D0,1.0D0,7*0.0D0 /     MEMSTF20
      DATA WMT / 1.0D0,8*0.0D0,1.0D0,3*0.0D0,2*1.0D0,3*0.0D0 /              MEMSTF21
      DATA     AMNIT,EM,TN / 51*0.0D0 /                                     MEMSTF22
      XL(LB) = XLL(IE,2)                                                    MEMSTF23
      XL(LC) = XLL(IE,3)                                                    MEMSTF24
      YL(LC) = YLL(IE,3)                                                    MEMSTF25
      TERM = YOUNGS / ( 1.0 - POISSO**2 )                                   MEMSTF26
      EM(1,1) = TERM                                                        MEMSTF27
      EM(1,2) = TERM * POISSO                                               MEMSTF28
      EM(2,1) = EM(1,2)                                                     MEMSTF29
      EM(2,2) = TERM                                                        MEMSTF30
      EM(3,3) = ( 1.0 - POISSO ) * TERM / 2.0                               MEMSTF31
      AMNIN(1,1) = -1.0 / XL(LB)                                            MEMSTF32
      AMNIN(1,3) = - AMNIN(1,1)                                             MEMSTF33
      AMNIN(2,2) = AMNIN(1,1)                                               MEMSTF34
      AMNIN(2,4) = AMNIN(1,3)                                               MEMSTF35
      AMNIN(3,1) = ( XL(LC) - XL(LB) ) / XL(LB) / YL(LC)                    MEMSTF36
      AMNIN(3,3) = - XL(LC) / XL(LB) / YL(LC)                               MEMSTF37
      AMNIN(3,5) = 1.0 / YL(LC)                                             MEMSTF38
      AMNIN(4,2) = AMNIN(3,1)                                               MEMSTF39
      AMNIN(4,4) = AMNIN(3,3)                                               MEMSTF40
      AMNIN(4,6) = AMNIN(3,5)                                               MEMSTF41
      AMNIN(5,1) = 1.0                                                      MEMSTF42
      AMNIN(6,2) = 1.0                                                      MEMSTF43
      DO 10 I = 1,6                                                         MEMSTF44
      ZINT(1,I) = 0.0                                                       MEMSTF45
      DO 10 J = 1,6                                                         MEMSTF46
   10 AMNIT(I,J) = AMNIN(J,I)                                               MEMSTF47
      TN(1,1) = TH(LAA)                                                     MEMSTF48
      TN(3,1) = TH(LBB)                                                     MEMSTF49
      TN(5,1) = TH(LCC)                                                     MEMSTF50
      CALL ZINTI ( IE,ZINT )                                                MEMSTF51
      DO 15 J = 1,6                                                         MEMSTF52
      Z1(1,J) = 0.0                                                         MEMSTF53
      DO 15 K = 1,6                                                         MEMSTF54
   15 Z1(1,J) = Z1(1,J) + ZINT(1,K) * AMNIN(K,J)                            MEMSTF55
      Z2(1,1) = 0.0                                                         MEMSTF56
      DO 20 K = 1,6                                                         MEMSTF57
   20 Z2(1,1) = Z2(1,1) + Z1(1,K) * TN(K,1)                                 MEMSTF58
```

```
      THBAR(IE) = ( TH(LAA) + TH(LBB) + TH(LCC) ) / 3.0                  MEMSTF59
      DO 25 I = 1,6                                                      MEMSTF60
      DO 25 J = 1,3                                                      MEMSTF61
      Z1(I,J) = 0.0                                                      MEMSTF62
      DO 25 K = 1,3                                                      MEMSTF63
   25 Z1(I,J) = Z1(I,J) + Z2(1,1) * WMT(I,K) * EM(K,J)                   MEMSTF64
      DO 30 I = 1,6                                                      MEMSTF65
      DO 30 J = 1,6                                                      MEMSTF66
      Z2(I,J) = 0.0                                                      MEMSTF67
      DO 30 K = 1,3                                                      MEMSTF68
   30 Z2(I,J) = Z2(I,J) + Z1(I,K) * WM(K,J)                              MEMSTF69
      DO 35 I = 1,6                                                      MEMSTF70
      DO 35 J = 1,6                                                      MEMSTF71
      Z1(I,J) = 0.0                                                      MEMSTF72
      DO 35 K = 1,6                                                      MEMSTF73
   35 Z1(I,J) = Z1(I,J) + AMNIT(I,K) * Z2(K,J)                           MEMSTF74
      DO 40 I = 1,6                                                      MEMSTF75
      DO 40 J = 1,6                                                      MEMSTF76
      ELMSM(I,J) = 0.0                                                   MEMSTF77
      DO 40 K = 1,6                                                      MEMSTF78
   40 ELMSM(I,J) = ELMSM(I,J) + Z1(I,K) * AMNIN(K,J)                     MEMSTF79
      RETURN                                                             MEMSTF80
      END                                                                MEMSTF81
```

```
      SUBROUTINE ZINT1 ( IE,ZINT )                                          ZINT1001
C     USING GAUSSIAN QUADRATURE, INTEGRATE THE FOLLOWING FUNCTIONS OVER     ZINT1002
C     THE SURFACE OF THE TRIANGLE                                           ZINT1003
C                        F(XL,YL) = 1.0                                     ZINT1004
C                        F(XL,YL) =  XL                                     ZINT1005
C                        F(XL,YL) =  YL                                     ZINT1006
C                                                                           ZINT1007
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,ZINT1008
     1       PRESSE( 200) , XLL ( 200,3) , YLL ( 200,3) ,                   ZINT1009
     2       RAPANG( 100) , ZGL    ( 100) , RHUB  ( 100) , RTIP   ( 100) ,ZINT1010
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM  ( 3,3) ,ZINT1011
     4       RHO , OMEGA  , POISSO , YOUNGS , RADGEN ,                      ZINT1012
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,        ZINT1013
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,            ZINT1014
     7       PFLGN(9,1)                                                     ZINT1015
      DIMENSION ZINT(1,6) , A(10) , H(10) , YI(10) , XI(10) , AREA(10) ,ZINT1016
     1          XIL(10) , XIR(10)                                           ZINT1017
      DIMENSION YL(3) , XL(3)                                               ZINT1018
      DOUBLE PRECISION YO , HT , XO , ZINT , A , H , YI , XI , AREA ,       ZINT1019
     1                 XIL , XIR , XL , YL                                  ZINT1020
      DATA LA,LB,LC / 1 , 2 , 3 /                                           ZINT1021
      DATA A / -.97390652851717 , -.86506336668899 , -.67940956829902 ,     ZINT1022
     1         -.43339539412925 , -.14887433898163 ,  .14887433898163 ,     ZINT1023
     2          .43339539412925 ,  .67940956829902 ,  .86506336668899 ,     ZINT1024
     3          .97390652851717  /                                          ZINT1025
      DATA H /  .06667134430869 ,  .14945134915058 ,  .21908636251598 ,     ZINT1026
     1          .26926671930100 ,  .29552422471475 ,  .29552422471475 ,     ZINT1027
     2          .26926671930100 ,  .21908636251598 ,  .14945134915058 ,     ZINT1028
     3          .06667134430869  /                                          ZINT1029
      XL(LB) = XLL(IE,2)                                                    ZINT1030
      XL(LC) = XLL(IE,3)                                                    ZINT1031
      YL(LC) = YLL(IE,3)                                                    ZINT1032
      YO = 0.5 * YL(LC)                                                     ZINT1033
      DO 3 I = 1,10                                                         ZINT1034
      YI(I)  = YO + A(I) * YO                                               ZINT1035
      XIL(I) = XL(LC) * YI(I) / YL(LC)                                      ZINT1036
      XIR(I) = XL(LB) - ( XL(LB) - XL(LC) ) * YI(I) / YL(LC)                ZINT1037
      IF ( I .NE. 1 ) GO TO 2                                               ZINT1038
      HT     = 0.0                                                          ZINT1039
      DO 1 J = 1,10                                                         ZINT1040
    1 HT     = HT + H(J)                                                    ZINT1041
    2 AREA(I)= XL(LB) * ( 1.0 - A(I) ) * 0.25 * HT                          ZINT1042
      ZINT(1,5) = ZINT(1,5) +DABS(YL(LC)) * 0.5 * AREA(I) * H(I)            ZINT1043
    3 ZINT(1,3) = ZINT(1,3) +DABS(YL(LC)) * 0.5 *YI(I) * AREA(I) * H(I)     ZINT1044
      DO 5 I = 1,10                                                         ZINT1045
      XO     = XIL(I) + 0.5 * ( XIR(I) - XIL(I) )                           ZINT1046
      AREA(I)= 0.0                                                          ZINT1047
      DO 4 J = 1,10                                                         ZINT1048
      XI(J)  = XO + A(J) * ( XO - XIL(I) )                                  ZINT1049
    4 AREA(I)= AREA(I) + XL(LB) * ( 1.0 - A(I) ) * 0.25 * H(J) * XI(J)      ZINT1050
    5 ZINT(1,1) = ZINT(1,1) +DABS(YL(LC)) * 0.5 * AREA(I) * H(I)            ZINT1051
      RETURN                                                                ZINT1052
      END                                                                   ZINT1053
```

```
      SUBROUTINE BENSTF ( LAA,LBB,LCC,IE )                                  BENS0010
C     CALCULATE THE ELEMENTAL LOCAL BENDING STIFFNESS MATRIX (ELBSM) .      BENS0020
C                                                                           BENS0030
      COMMON X     ( 200) , Y     ( 200) , Z     ( 200) , TH    ( 200) ,BENS0040
     1       PRESSE( 200) , XLL ( 200,3) , YLL ( 200,3) ,                  BENS0050
     2       RAPANG( 100) , ZGL   ( 100) , RHUB  ( 100) , RTIP  ( 100) ,BENS0060
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM  ( 3,3) ,BENS0070
     4       RHO , OMEGA  , POISSO , YOUNGS , RADGEN ,                     BENS0080
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,       BENS0090
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,           BENS0100
     7       PFLGN(9,1)                                                    BENS0110
      DIMENSION ABNIT(9,9) , Z1(9,9) , ZINT(9,9)                            BENS0120
      DIMENSION YL(3) , XL(3)                                               BENS0130
      DOUBLE PRECISION ZJ1 , ZJ2 , ZJ3 , ZJ4 , ZJ5 , ZJ6 , ABNIT , Z1 ,    BENS0140
     1                 ZINT , XL , YL                                       BENS0150
      DATA LA,LB,LC / 1 , 2 , 3 /                                           BENS0160
      XL(LB) = XLL(IE,2)                                                    BENS0170
      XL(LC) = XLL(IE,3)                                                    BENS0180
      YL(LC) = YLL(IE,3)                                                    BENS0190
      ABNIN(1,1) = 1.0                                                      BENS0200
      ABNIN(2,3) = -1.0                                                     BENS0210
      ABNIN(3,2) = 1.0                                                      BENS0220
      ABNIN(4,1) = -3.0 / XL(LB) / XL(LB)                                   BENS0230
      ABNIN(4,3) = 2.0 / XL(LB)                                             BENS0240
      ABNIN(4,4) = - ABNIN(4,1)                                             BENS0250
      ABNIN(4,6) = 1.0 / XL(LB)                                             BENS0260
      ABNIN(5,1) = 3.0 * ( XL(LC)**2 - XL(LB)**2 ) / (XL(LB)*YL(LC))**2     BENS0270
      ABNIN(5,2) = -2.0 / YL(LC)                                            BENS0280
      ABNIN(5,3) = 2.0 * ( XL(LB) - XL(LC) ) * XL(LC) / XL(LB) / YL(LC)     BENS0290
     1             / YL(LC)                                                 BENS0300
      ABNIN(5,4) = -3.0 * ( XL(LC) / XL(LB) / YL(LC) )**2                   BENS0310
      ABNIN(5,6) = - ( XL(LC) / YL(LC) )**2 / XL(LB)                        BENS0320
      ABNIN(5,7) = 3.0 / YL(LC) / YL(LC)                                    BENS0330
      ABNIN(5,8) = - 1.0 / YL(LC)                                           BENS0340
      ABNIN(5,9) = XL(LC) / YL(LC) / YL(LC)                                 BENS0350
      ABNIN(6,1) = 2.0 / XL(LB)**3                                          BENS0360
      ABNIN(6,3) = - 1.0 / XL(LB) / XL(LB)                                  BENS0370
      ABNIN(6,4) = - ABNIN(6,1)                                             BENS0380
      ABNIN(6,6) = ABNIN(6,3)                                               BENS0390
      ABNIN(7,2) = ABNIN(6,3)                                               BENS0400
      ABNIN(7,5) = - ABNIN(6,3)                                             BENS0410
      ABNIN(8,1) = 6.0 * XL(LC) / XL(LB)**3 / YL(LC)**2 *(XL(LB)-XL(LC))    BENS0420
      ABNIN(8,2) = 2.0 * XL(LC) / XL(LB) / XL(LB) / YL(LC)                  BENS0430
      ABNIN(8,3) = ( XL(LB) - 3.0*XL(LC) ) * ( XL(LB) - XL(LC) ) /          BENS0440
     1            (XL(LB) * YL(LC))**2                                     BENS0450
      ABNIN(8,4) = 6.0 * XL(LC) * ( XL(LC) - XL(LB) ) / XL(LB)**3 /         BENS0460
     1             YL(LC)**2                                              BENS0470
      ABNIN(8,5) = -2.0 * XL(LC) / XL(LB) / XL(LB) / YL(LC)                 BENS0480
      ABNIN(8,6) = XL(LC) * ( 3.0*XL(LC) - 2.0*XL(LB) ) / ( XL(LB) *        BENS0490
     1             YL(LC) )**2                                            BENS0500
      ABNIN(8,9) = -1.0 / YL(LC) / YL(LC)                                   BENS0510
      ABNIN(9,1) = 2.0 * ( 2.0*XL(LC)**3 - XL(LB)*( 3.0*XL(LC)**2 -         BENS0520
     1             XL(LB)**2 ) ) / ( XL(LB) * YL(LC) )**3                   BENS0530
      ABNIN(9,2) = ( XL(LB)**2 - XL(LC)**2 ) / ( XL(LB) * YL(LC) )**2       BENS0540
      ABNIN(9,3) = -2.0 * XL(LC) * ( XL(LB) - XL(LC) )**2 / XL(LB)**2 /     BENS0550
     1             YL(LC)**3                                                BENS0560
      ABNIN(9,4) = 2.0 * XL(LC)**2 * ( 3.0*XL(LB) - 2.0*XL(LC) ) /          BENS0570
     1             ( XL(LB) * YL(LC) )**3                                   BENS0580
```

```
      ABNIN(9,5) = ( XL(LC) / XL(LB) / YL(LC) )**2                          BENS0590
      ABNIN(9,6) = 2.0 * XL(LC)**2 * ( XL(LB) - XL(LC) ) / XL(LB)**2 /      BENS0600
     1             YL(LC)**3                                                BENS0610
      ABNIN(9,7) = -2.0 / YL(LC)**3                                         BENS0620
      ABNIN(9,8) = 1.0 / YL(LC)**2                                          BENS0630
      DO 5  I = 1,9                                                         BENS0640
      DO 5  J = 1,9                                                         BENS0650
      ZINT(I,J) = 0.0                                                       BENS0660
    5 ABNIT(I,J) = ABNIN(J,I)                                               BENS0670
      CALL ZINT2 ( LAA,LBB,LCC,ZJ1,ZJ2,ZJ3,ZJ4,ZJ5,ZJ6,IE )                BENS0680
      ZINT(4,4) = 4.0 * ZJ1                                                 BENS0690
      ZINT(4,5) = POISSO * ZINT(4,4)                                        BENS0700
      ZINT(4,6) = 12.0 * ZJ2                                                BENS0710
      ZINT(4,7) = 4.0 * ZJ3                                                 BENS0720
      ZINT(4,8) = 4.0 * POISSO * ZJ2                                        BENS0730
      ZINT(4,9) = POISSO * ZINT(4,7) * 3.0                                  BENS0740
      ZINT(5,5) = ZINT(4,4)                                                 BENS0750
      ZINT(5,6) = POISSO * ZINT(4,6)                                        BENS0760
      ZINT(5,7) = POISSO * ZINT(4,7)                                        BENS0770
      ZINT(5,8) = ZINT(4,8) / POISSO                                        BENS0780
      ZINT(5,9) = ZINT(4,9) / POISSO                                        BENS0790
      ZINT(6,6) = 36.0 * ZJ4                                                BENS0800
      ZINT(6,7) = 12.0 * ZJ5                                                BENS0810
      ZINT(6,8) = 12.0 * POISSO * ZJ4                                       BENS0820
      ZINT(6,9) = ZINT(6,7) * POISSO * 3.0                                  BENS0830
      ZINT(7,7) = 4.0 * ZJ6 + 8.0 * ( 1.0 - POISSO ) * ZJ4                  BENS0840
      ZINT(7,8) = 4.0 * ( 2.0 - POISSO ) * ZJ5                              BENS0850
      ZINT(7,9) =12.0 * POISSO * ZJ6                                        BENS0860
      ZINT(8,8) = 8.0 * ( 1.0 - POISSO ) * ZJ6 + 4.0 * ZJ4                  BENS0870
      ZINT(8,9) =12.0 * ZJ5                                                 BENS0880
      ZINT(9,9) =36.0 * ZJ6                                                 BENS0890
      DO 10 I = 4,8                                                         BENS0900
      I1 = I + 1                                                            BENS0910
      DO 10 J = I1,9                                                        BENS0920
   10 ZINT(J,I) = ZINT(I,J)                                                 BENS0930
      ZJ1 = YOUNGS / ( 12.0 * ( 1.0 - POISSO**2 ) )                         BENS0940
      DO 15 I = 4,9                                                         BENS0950
      DO 15 J = 4,9                                                         BENS0960
   15 ZINT(I,J) = ZINT(I,J) * ZJ1                                           BENS0970
      DO 20 I = 1,9                                                         BENS0980
      DO 20 J = 1,9                                                         BENS0990
      Z1(I,J) = 0.0                                                         BENS1000
      DO 20 K = 1,9                                                         BENS1010
   20 Z1(I,J) = Z1(I,J) + ABNIT(I,K) * ZINT(K,J)                            BENS1020
      DO 25 I = 1,9                                                         BENS1030
      DO 25 J = 1,9                                                         BENS1040
      ELBSM(I,J) = 0.0                                                      BENS1050
      DO 25 K = 1,9                                                         BENS1060
   25 ELBSM(I,J) = ELBSM(I,J) + Z1(I,K) * ABNIN(K,J)                        BENS1070
      RETURN                                                                BENS1080
      END                                                                   BENS1090
```

```
      SUBROUTINE ZINT2 ( LAA,LBB,LCC,ZJ1,ZJ2,ZJ3,ZJ4,ZJ5,ZJ6,IE )       ZINT2010
C     USING GAUSSIAN QUADRATURE, INTEGRATE THE FOLLOWING FUNCTIONS OVER ZINT2020
C     THE SURFACE OF THE TRIANGLE                                       ZINT2030
C                    F(XL,YL) = TERM ** 3                               ZINT2040
C                    F(XL,YL) = TERM ** 3 * XL                          ZINT2050
C                    F(XL,YL) = TERM ** 3 * YL                          ZINT2060
C                    F(XL,YL) = TERM ** 3 * XL ** 2                     ZINT2070
C                    F(XL,YL) = TERM ** 3 * XL * YL                     ZINT2080
C                    F(XL,YL) = TERM ** 3 * YL ** 2                     ZINT2090
C     WHERE                                                             ZINT2100
C           TERM =((XL(LB)*YL(LC) + (XL(LC) - XL(LB))*YL - YL(LC)*XL)*  ZINT2110
C                  TH(LAA)+ (YL(LC)*XL - XL(LC)*YL)*TH(LBB)+ XL(LB)*    ZINT2120
C                  TH(LCC)*XL)/XL(LB)/YL(LC)                          ZINT2130
C                                                                       ZINT2140
      COMMON X     ( 200) , Y     ( 200) , Z     ( 200) , TH    ( 200) ,ZINT2150
     1       PRESSE( 200) , XLL ( 200,3) , YLL ( 200,3) ,               ZINT2160
     2       RAPANG( 100) , ZGL   ( 100) , RHUB  ( 100) , RTIP  ( 100) ,ZINT2170
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM  ( 3,3) ,ZINT2180
     4       RHO , OMEGA  , POISSO , YOUNGS , RADGEN ,                  ZINT2190
     5       NGENLI , LINEI , NPRES(100) , NEXT ( 200,3) , NP , NT ,    ZINT2200
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,        ZINT2210
     7       PFLGN(9,1)                                                 ZINT2220
      DIMENSION A(10) , H(10) , YI(10) , XI(10) , AREA(10,6) , XIL(10) ,ZINT2230
     1          XIR(10)                                                 ZINT2240
      DIMENSION YL(3) , XL(3)                                           ZINT2250
      DOUBLE PRECISION ZJ1 , ZJ2 , ZJ3 , ZJ4 , ZJ5 , ZJ6 , YO , XO ,   ZINT2260
     1                 TERM , A , H , XI , YI , AREA , XIL , XIR , XL , ZINT2270
     2                 YL                                               ZINT2280
      DATA LA,LB,LC / 1 , 2 , 3 /                                       ZINT2290
      DATA A / -.97390652851717 , -.86506336668899 , -.67940956829902 , ZINT2300
     1         -.43339539412925 , -.14887433898163 ,  .14887433898163 , ZINT2310
     2          .43339539412925 ,  .67940956829902 ,  .86506336668899 , ZINT2320
     3          .97390652851717  /                                      ZINT2330
      DATA H /  .06667134430869 ,  .14945134915058 ,  .21908636251598 , ZINT2340
     1          .26926671930100 ,  .29552422471475 ,  .29552422471475 , ZINT2350
     2          .26926671930100 ,  .21908636251598 ,  .14945134915058 , ZINT2360
     3          .06667134430869  /                                      ZINT2370
      XL(LB) = XLL(IE,2)                                                ZINT2380
      XL(LC) = XLL(IE,3)                                                ZINT2390
      YL(LC) = YLL(IE,3)                                                ZINT2400
      ZJ1 = 0.0                                                         ZINT2410
      ZJ2 = 0.0                                                         ZINT2420
      ZJ3 = 0.0                                                         ZINT2430
      ZJ4 = 0.0                                                         ZINT2440
      ZJ5 = 0.0                                                         ZINT2450
      ZJ6 = 0.0                                                         ZINT2460
      YO  = 0.5 * YL(LC)                                                ZINT2470
      DO 4 I = 1,10                                                     ZINT2480
      YI(I) = YO + A(I) * YO                                            ZINT2490
      XIL(I) = XL(LC) * YI(I) / YL(LC)                                  ZINT2500
      XIR(I) = XL(LB) - ( XL(LB) - XL(LC) ) * YI(I) / YL(LC)            ZINT2510
      XO = XIL(I) + 0.5 * ( XIR(I) - XIL(I) )                           ZINT2520
      DO 2 J = 1,10                                                     ZINT2530
      DO 1 K = 1,6                                                      ZINT2540
    1 AREA(J,K) = 0.0                                                   ZINT2550
    2 XI(J) = XO + A(J) * ( XO - XIL(I) )                               ZINT2560
      DO 3 J = 1,10                                                     ZINT2570
      TERM = ( ( XL(LB)*YL(LC) + ( XL(LC) - XL(LB) ) * YI(I) - YL(LC)*  ZINT2580
```

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     1       XI(J) ) * TH(LAA)- ( XL(LC)*YI(I) - YL(LC)*XI(J) ) *TH(LBB)ZINT2590
     2       + XL(LB)*TH(LCC)*YI(I))**3 * XL(LB)*( 1.0 - A(I) ) * 0.25  ZINT2600
     3       * H(J) / XL(LB)**3 / YL(LC)**3                             ZINT2610
      AREA(I,1) = AREA(I,1) + TERM                                      ZINT2620
      AREA(I,2) = AREA(I,2) + TERM * XI(J)                              ZINT2630
      AREA(I,3) = AREA(I,3) + TERM * YI(I)                              ZINT2640
      AREA(I,4) = AREA(I,4) + TERM * XI(J)**2                           ZINT2650
      AREA(I,5) = AREA(I,5) + TERM * XI(J) * YI(I)                      ZINT2660
   3  AREA(I,6) = AREA(I,6) + TERM * YI(I)**2                           ZINT2670
      ZJ1 = ZJ  +          0.5 * H(I) * AREA(I,1)*DABS(YL(LC))          ZINT2680
      ZJ2 = ZJ2 +          0.5 * H(I) * AREA(I,2)*DABS(YL(LC))          ZINT2690
      ZJ3 = ZJ3 +          0.5 * H(I) * AREA(I,3)*DABS(YL(LC))          ZINT2700
      ZJ4 = ZJ4 +          0.5 * H(I) * AREA(I,4) *DABS(YL(LC))         ZINT2710
      ZJ5 = ZJ5 +          0.5 * H(I) * AREA(I,5) *DABS(YL(LC))         ZINT2720
   4  ZJ6 = ZJ6 +          0.5 * H(I) * AREA(I,6) *DABS(YL(LC))         ZINT2730
      RETURN                                                            ZINT2740
      END                                                               ZINT2750
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```
      SUBROUTINE NPFORC ( I )                                                NPFOR010
C     CALCULATE THE LOCAL GENERALIZED NODAL PRESSURE FORCE (PFLGN) FOR       NPFOR020
C     A TRIANGULAR ELEMENT .                                                 NPFOR030
C                                                                            NPFOR040
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,NPFOR050
     1        PRESSE( 200) , XLL ( 200,3) , YLL ( 200,3) ,                   NPFOR060
     2        RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,NPFOR070
     3        THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,NPFOR080
     4        RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                     NPFOR090
     5        NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,        NPFOR100
     6        ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,            NPFOR120
     7        PFLGN(9,1)                                                     NPFOR130
      DIMENSION ABNIT(9,9) , ZINT(9,1)                                       NPFOR140
      DOUBLE PRECISION ABNIT , ZINT                                          NPFOR150
      DO 10 J = 1,9                                                          NPFOR160
      ZINT(J,1) = 0.0                                                        NPFOR170
      DO 10 K = 1,9                                                          NPFOR180
 10   ABNIT(J,K) = ABNIN(K,J)                                                NPFOR190
      CALL ZINT3 ( I,ZINT )                                                  NPFOR200
      DO 15 J = 1,9                                                          NPFOR210
      PFLGN(J,1) = 0.0                                                       NPFOR220
      DO 15 K = 1,9                                                          NPFOR230
 15   PFLGN(J,1) = PFLGN(J,1) + PRESSE(I) * ABNIT(J,K) * ZINT(K,1)           NPFOR240
      RETURN                                                                 NPFOR250
      END                                                                    NPFOR260
```

```
      SUBROUTINE ZINT3 ( IE,ZINT )                                          ZINT3010
C     USING GAUSSIAN QUADRATURE, INTEGRATE THE FOLLOWING FUNCTIONS OVER     ZINT3020
C     THE SURFACE OF THE TRIANGLE                                           ZINT3030
C                         F(XL,YL) = 1.0                                    ZINT3040
C                         F(XL,YL) = XL                                     ZINT3050
C                         F(XL,YL) = YL                                     ZINT3060
C                         F(XL,YL) = XL**2                                  ZINT3070
C                         F(XL,YL) = YL**2                                  ZINT3080
C                         F(XL,YL) = XL**3                                  ZINT3090
C                         F(XL,YL) = XL**2 * YL                             ZINT3100
C                         F(XL,YL) = YL**2 * XL                             ZINT3110
C                         F(XL,YL) = YL**3                                  ZINT3120
C                                                                           ZINT3130
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,ZINT3140
     1       PRESSE( 200) , XLL ( 200,3) , YLL ( 200,3) ,                   ZINT3150
     2       RAPANG( 100) , ZGL    ( 100) , RHUB  ( 100) , RTIP  ( 100) ,ZINT3160
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM  ( 3,3) ,ZINT3170
     4       RHO , OMEGA  , POISSO , YOUNGS , RADGEN ,                      ZINT3180
     5       NGENLI , LINEI , NPRES(100) , NEXT ( 200,3) , NP , NT ,        ZINT3190
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,            ZINT3200
     7       PFLGN(9,1)                                                     ZINT3210
      DIMENSION ZINT(9,1) , A(10) , H(10) , YI(10) , XI(10) , AREA(10,9)ZINT3220
     1         ,XIL(10) , XIR(10) , XL(3) , YL(3)                           ZINT3230
      DOUBLE PRECISION YI,XI, AREA , XIL , XIR , XL , YL , XO , YO ,        ZINT3240
     1                 TERM , ZINT , A , H                                  ZINT3250
      DATA LA,LB,LC / 1 , 2 , 3 /                                           ZINT3260
      DATA A / -.97390652851717 , -.86506336668899 , -.67940956829902 ,     ZINT3270
     1         -.43339539412925 , -.14887433898163 ,  .14887433898163 ,     ZINT3280
     2          .43339539412925 ,  .67940956829902 ,  .86506336668899 ,     ZINT3290
     3          .97390652851717  /                                          ZINT3300
      DATA H /  .06667134430869 ,  .14945134915058 ,  .21908636251598 ,     ZINT3310
     1          .26926671930100 ,  .29552422471475 ,  .29552422471475 ,     ZINT3320
     2          .26926671930100 ,  .21908636251598 ,  .14945134915058 ,     ZINT3330
     3          .06667134430869  /                                          ZINT3340
      XL(LB) = XLL(IE,2)                                                    ZINT3350
      XL(LC) = XLL(IE,3)                                                    ZINT3360
      YL(LC) = YLL(IE,3)                                                    ZINT3370
      YO = 0.5 * YL(LC)                                                     ZINT3380
      DO 5 I = 1,10                                                         ZINT3390
      YI(I) = YO + A(I) * YO                                                ZINT3400
      XIL(I) = XL(LC) * YI(I) / YL(LC)                                      ZINT3410
      XIR(I) = XL(LB) - ( XL(LB) - XL(LC) ) * YI(I) / YL(LC)                ZINT3420
      XO = XIL(I) + 0.5 * ( XIR(I) - XIL(I) )                               ZINT3430
      DO 2 J = 1,10                                                         ZINT3440
      DO 1 K = 1,9                                                          ZINT3450
    1 AREA(J,K) = 0.0                                                       ZINT3460
    2 XI(J) = XO + A(J) * ( XO - XIL(I) )                                   ZINT3470
      DO 3 J = 1,10                                                         ZINT3480
      TERM = XL(LB) * ( 1.0 - A(I) ) * 0.25 * H(J)                          ZINT3490
      AREA(I,1) = AREA(I,1) + TERM                                          ZINT3500
      AREA(I,2) = AREA(I,2) + TERM * XI(J)                                  ZINT3510
      AREA(I,3) = AREA(I,3) + TERM * YI(I)                                  ZINT3520
      AREA(I,4) = AREA(I,4) + TERM * XI(J)**2                               ZINT3530
      AREA(I,5) = AREA(I,5) + TERM * YI(I)**2                               ZINT3540
      AREA(I,6) = AREA(I,6) + TERM * XI(J)**3                               ZINT3550
      AREA(I,7) = AREA(I,7) + TERM * XI(J)**2 * YI(I)                       ZINT3560
      AREA(I,8) = AREA(I,8) + TERM * XI(J) * YI(I)**2                       ZINT3570
    3 AREA(I,9) = AREA(I,9) + TERM * YI(I)**3                               ZINT3580
```

```
      TERM = DABS( YL(LC) ) * 0.5 * H(I)                                ZINT3590
      DO 4 J = 1,9                                                      ZINT3600
4     ZINT(J,1) = ZINT(J,1) + TERM * AREA(I,J)                          ZINT3610
5     CONTINUE                                                          ZINT3620
      RETURN                                                            ZINT3630
      END                                                               ZINT3640
```

```
      SUBROUTINE NCFORC ( LAA,LBB,LCC,IE,NCF )                          NCF00010
C     CALCULATE THE COMMON GENERALIZED CENTRIFUGAL FORCE MATRIX (CFLGN) NCF00020
C     FOR A TRIANGULAR ELEMENT .                                        NCF00030
C                                                                       NCF00040
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,NCF00050
     1       PRESSE( 200) , XLL ( 200,3) , YLL ( 200,3) ,               NCF00060
     2       RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,NCF00070
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDGM  ( 3,3) ,NCF00080
     4       RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                 NCF00090
     5       NGENLI , LINEI , NPRES(100) , NEXT ( 200,3) , NP , NT ,    NCF00100
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,        NCF00110
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) , NCF00120
     8       PFCGN(18,1) , CFCGN(18,1), MEX(200,8), IMEX(200),          NCF00130
     9       FORCE(200,6)                                               NCF00140
      DIMENSION A(10) , H(10) , YI(10) , XI(10) , AREA(10,15) , XIL(10),NCF00150
     1        XIR(10) , TERM(9) , XL(3) , YL(3)                         NCF00160
      DOUBLE PRECISION AREE , TERN , YO , XO , TERM0 , TERM1 , TERM2 ,  NCF00170
     1                 TERM3 , TERM4 , TERM5 , A , H , YI , XI ,        NCF00180
     2                 AREA , XIL , XIR , TERM , XL , YL                NCF00190
      DATA A / -.97390652851717 , -.86506336668899 , -.67940956829902 , NCF00200
     1         -.43339539412925 , -.14887433898163 ,  .14887433898163 , NCF00210
     2          .43339539412925 ,  .67940956829902 ,  .86506336668899 , NCF00220
     3          .97390652851717  /                                      NCF00230
      DATA H /  .06667134430869 ,  .14945134915058 ,  .21908636251598 , NCF00240
     1          .26926671930100 ,  .29552422471475 ,  .29552422471475 , NCF00250
     2          .26926671930100 ,  .21908636251598 ,  .14945134915058 , NCF00260
     3          .06667134430869  /                                      NCF00270
      DATA LA,LB,LC / 1 , 2 , 3 /                                       NCF00280
      IF ( NCF .GT. 0 ) GO TO 9                                         NCF00290
      DO  8 J = 1,18                                                    NCF00300
    8 CFLGN(J,1) = 0.0                                                  NCF00310
      AREE = 0.5 * ABS( XLL(IE,2) * YLL(IE,3) )                         NCF00320
      TERN = RHO * OMEGA**2 * AREE / 3.0                                NCF00330
      CFLGN(1,1) = X(LAA)* TH(LAA)* TERN                                NCF00340
      CFLGN(2,1) = Y(LAA)* TH(LAA)* TERN                                NCF00350
      CFLGN(7,1) = X(LBB)* TH(LBB)* TERN                                NCF00360
      CFLGN(8,1) = Y(LBB)* TH(LBB)* TERN                                NCF00370
      CFLGN(13,1) = X(LCC)* TH(LCC)* TERN                               NCF00380
      CFLGN(14,1) = Y(LCC)* TH(LCC)* TERN                               NCF00390
      RETURN                                                            NCF00400
    9 XL(LB) = XLL(IE,2)                                                NCF00410
      XL(LC) = XLL(IE,3)                                                NCF00420
      YL(LC) = YLL(IE,3)                                                NCF00430
      DO 10 I = 1,18                                                    NCF00440
   10 CFLGN(I,1) = 0.0                                                  NCF00450
      YO = 0.50 * YL(LC)                                                NCF00460
      DO 6 I = 1,10                                                     NCF00470
      YI(I) = YO + A(I) * YO                                            NCF00480
      XIL(I) = XL(LC) * YI(I) / YL(LC)                                  NCF00490
      XIR(I) = XL(LB) - (XL(LB) - XL(LC) ) * YI(I) / YL(LC)             NCF00500
      XO = XIL(I) + 0.5 * ( XIR(I) - XIL(I) )                           NCF00510
      DO 2 J = 1,10                                                     NCF00520
      DO 1 K = 1,15                                                     NCF00530
    1 AREA(J,K) = 0.0                                                   NCF00540
    2 XI(J) = XO + A(J) * (XO - XIL(I))                                 NCF00550
      DO 4 J = 1,10                                                     NCF00560
      TERM0 = XL(LB)*(1.0 - A(I))*0.25*H(J)*((XL(LB)*YL(LC) + (XL(LC) - NCF00570
     1        XL(LB))*YI(I) - YL(LC)*XI(J))*TH(LAA) - (XL(LC)*YI(I) -   NCF00580
```

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     2         YL(LC)*XI(J))*TH(LBB) + XL(LB)*TH(LCC)*YI(I))                NCF00590
     3         / XL(LB) / YL(LC)                                            NCF00595
      TERM1 = (EDCM(1,1)*(EDCM(1,1))                    + EDCM(2,1)**2)NCF00600
     1*XI(J)+ (EDCM(1,1)*EDCM(1,2) + EDCM(2,1)*(      EDCM(2,2)))*YI(I) NCF00610
     2         + X(LAA) * EDCM(1,1) + Y(LAA) * EDCM(2,1)                    NCF00620
      TERM2 = (EDCM(1,2)*(      EDCM(1,1)) + EDCM(2,2)*EDCM(2,1))*XI(J) NCF00630
     1         + (EDCM(1,2)**2 + EDCM(2,2)*(      EDCM(2,2)))*YI(I)       NCF00640
     2         + X(LAA) * EDCM(1,2) + Y(LAA) * EDCM(2,2)                    NCF00650
      TERM3=(EDCM(1,3)*(EDCM(1,1))                     +EDCM(2,3)*EDCM(2,NCF00660
     11))*XI(J)+(EDCM(1,3)*EDCM(1,2) + EDCM(2,3)*(     EDCM(2,2)))*YI(I)NCF00670
     2         + X(LAA) * EDCM(1,3) + Y(LAA) * EDCM(2,3)                    NCF00680
      TERM4 = 1.0 - XI(J)/XL(LB) + (XL(LC) - XL(LB))/XL(LB)/YL(LC)*YI(I)NCF00690
      TERM5 = XI(J)/XL(LB) - XL(LC)*YI(I)/XL(LB)/YL(LC)                   NCF00700
      TERM(1) = ABNIN(1,1) + XI(J)**2*ABNIN(4,1) + YI(I)**2*ABNIN(5,1)    NCF00710
     1          + XI(J)**3*ABNIN(6,1) + XI(J)*YI(I)**2*ABNIN(8,1) +       NCF00720
     2          YI(I)**3*ABNIN(9,1)                                       NCF00730
      TERM(2) = YI(I)*ABNIN(3,2) + YI(I)**2*ABNIN(5,2) + XI(J)**2*YI(I)   NCF00740
     1          *ABNIN(7,2) + XI(J)*YI(I)**2*ABNIN(8,2) + YI(I)**3*       NCF00750
     2          ABNIN(9,2)                                                NCF00760
      TERM(3) = XI(J)*ABNIN(2,3) + XI(J)**2*ABNIN(4,3) + YI(I)**2*        NCF00770
     1          ABNIN(5,3) + XI(J)**3*ABNIN(6,3) + XI(J)*YI(I)**2*        NCF00780
     2          ABNIN(8,3) + YI(I)**3*ABNIN(9,3)                          NCF00790
      TERM(4) = XI(J)**2*ABNIN(4,4) + YI(I)**2*ABNIN(5,4) + XI(J)**3 *    NCF00800
     1          ABNIN(6,4) + XI(J)*YI(I)**2 * ABNIN(8,4) + YI(I)**3 *     NCF00810
     2          ABNIN(9,4)                                                NCF00820
      TERM(5) = XI(J)**2 *YI(I)*ABNIN(7,5) + XI(J)*YI(I)**2 * ABNIN(8,5)NCF00830
     1          + YI(I)**3 * ABNIN(9,5)                                   NCF00840
      TERM(6) = XI(J)**2 * ABNIN(4,6) + YI(I)**2 * ABNIN(5,6) + XI(J)**3NCF00850
     1          *ABNIN(6,6) + XI(J)*YI(I)**2 *ABNIN(8,6) + YI(I)**3 *     NCF00860
     2          ABNIN(9,6)                                                NCF00870
      TERM(7) = YI(I)**2 * ABNIN(5,7) + YI(I)**3 * ABNIN(9,7)             NCF00880
      TERM(8) = YI(I)**2 * ABNIN(5,8) + YI(I)**3 * ABNIN(9,8)             NCF00890
      TERM(9) = YI(I)**2 * ABNIN(5,9) + XI(J)*YI(I)**2 * ABNIN(8,9)       NCF00900
      AREA(I,1) = AREA(I,1) + TERM0 * TERM4 * TERM1                       NCF00910
      AREA(I,2) = AREA(I,2) + TERM0 * TERM4 * TERM2                       NCF00920
      AREA(I,3) = AREA(I,3) + TERM0 * TERM5 * TERM1                       NCF00930
      AREA(I,4) = AREA(I,4) + TERM0 * TERM5 * TERM2                       NCF00940
      AREA(I,5) = AREA(I,5) + TERM0 / YL(LC) * YI(I) * TERM1              NCF00950
      AREA(I,6) = AREA(I,6) + TERM0 / YL(LC) * YI(I) * TERM2              NCF00960
      DO 3 K = 1,9                                                        NCF00970
   3  AREA(I,K+6) = AREA(I,K+6) + TERM0 * TERM(K) * TERM3                 NCF00980
   4  CONTINUE                                                            NCF00990
      TERM0 =           0.5 * H(I) * RHO * OMEGA**2 *DABS(YL(LC))         NCF01000
      DO 5 J = 1,15                                                       NCF01010
   5  CFLGN(J,1) = CFLGN(J,1) + TERM0 * AREA(I,J)                         NCF01020
   6  CONTINUE                                                            NCF01030
      RETURN                                                              NCF01040
      END                                                                 NCF01050
```

```
      SUBROUTINE COMSTF ( IE , NCF )                                    COMST010
C     CALCULATE THE STIFFNESS MATRIX (ECSTIF), NODAL PRESSURE FORCE     COMST020
C     MATRIX (PFCGN), AND NODAL CENTRIFUGAL FORCE MATRIX (CFCGN) OF A   COMST030
C     TRIANGULAR ELEMENT IN THE COMMON COORDINATE SYSTEM (X,Y,Z) .      COMST040
C                                                                       COMST050
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,COMST060
     1       PRESSE( 200) , XL   ( 200,3) , YL   ( 200,3) ,             COMST070
     2       RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,COMST080
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,COMST090
     4       RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                 COMST100
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,    COMST110
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,        COMST120
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) , COMST130
     8       PFCGN(18,1) , CFCGN(18,1)                                  COMST140
      DIMENSION R6(18,18) , RESULT(18,18) , EPFLGN(18,1) , IND(18)      COMST150
      DOUBLE PRECISION RESULT , EPFLGN                                  COMST160
      DATA IND / 1,2,7,8,9,16, 3,4,10,11,12,17, 5,6,13,14,15,18 /       COMST170
      DO 5 I = 1,18                                                     COMST180
      DO 5 J = 1,18                                                     COMST190
    5 R6(I,J) = 0.0                                                     COMST200
      DO 10 I = 1,3                                                     COMST210
      DO 10 J = 1,3                                                     COMST220
      R6(I,J) = EDCM(I,J)                                               COMST230
      R6(I+3,J+3) = EDCM(I,J)                                           COMST240
      R6(I+6,J+6) = EDCM(I,J)                                           COMST250
      R6(I+9,J+9) = EDCM(I,J)                                           COMST260
      R6(I+12,J+12) = EDCM(I,J)                                         COMST270
   10 R6(I+15,J+15) = EDCM(I,J)                                         COMST280
      WRITE (4'IE) R6,AMNIN,ABNIN                                       COMST290
      DO 20 I = 1,18                                                    COMST300
      DO 20 J = 1,18                                                    COMST310
      RESULT(I,J) = 0.0                                                 COMST320
      DO 20 K = 1,18                                                    COMST330
   20 RESULT(I,J) = RESULT(I,J) + R6(I,K) * ELSTIF(K,J)                 COMST340
      DO 30 I = 1,18                                                    COMST350
      DO 30 J = 1,18                                                    COMST360
      ECSTIF(I,J) = 0.0                                                 COMST370
      DO 30 K = 1,18                                                    COMST380
   30 ECSTIF(I,J) = ECSTIF(I,J) + RESULT(I,K) * R6(J,K)                 COMST390
      DO 40 I = 1,18                                                    COMST400
   40 EPFLGN(I,1) = 0.0                                                 COMST410
      DO 50 I = 1,3                                                     COMST420
      EPFLGN(I+2,1) = PFLGN(I,1)                                        COMST430
      EPFLGN(I+8,1) = PFLGN(I+3,1)                                      COMST440
   50 EPFLGN(I+14,1) = PFLGN(I+6,1)                                     COMST450
      DO 60 I = 1,18                                                    COMST460
      PFCGN(I,1) = 0.0                                                  COMST470
      IF ( NCF .EQ. 0 ) GO TO 53                                        COMST480
      CFCGN(I,1) = CFLGN(IND(I),1)                                      COMST490
      GO TO 55                                                          COMST500
   53 CFCGN(I,1) = CFLGN(I,1)                                           COMST510
   55 DO 60 J = 1,18                                                    COMST520
   60 PFCGN(I,1) = PFCGN(I,1) + R6(I,J) * EPFLGN(J,1)                   COMST530
      IF ( NCF .EQ. 0 ) GO TO 75                                        COMST540
      DO 65 I = 1,18                                                    COMST550
      RESULT(I,1) = 0.0                                                 COMST560
      DO 65 J = 1,18                                                    COMST570
   65 RESULT(I,1) = RESULT(I,1) + R6(I,J) * CFCGN(J,1)                  COMST580
      DO 70 I = 1,18                                                    COMST590
   70 CFCGN(I,1) = RESULT(I,1)                                          COMST600
   75 RETURN                                                            COMST610
      END                                                               COMST620
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      SUBROUTINE ADDF ( I )                                                 ADDF0010
C     ADD VALUES OF COMMON NODAL PRESSURE FORCE (PFCGN) AND COMMON NODALADDF0020
C     CENTRIFUGAL FORCE (CFCGN) WHICH ARE COMMON TO A COMMON NODE .     ADDF0030
C                                                                       ADDF0040
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,ADDF0050
     1       PRESSF( 200) , XL   ( 200,3) , YL   ( 200,3) ,                 ADDF0060
     2       RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,ADDF0070
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,ADDF0080
     4       RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                     ADDF0090
     5       NGENLI , LINEI , NPRES(100) , NEXT ( 200,3) , NP , NT ,        ADDF0100
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,            ADDF0110
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) ,     ADDF0120
     8       PFCGN(18,1), CFCGN(18,1), MEX(200,8), IMEX(200), FORCE(        ADDF0130
     9       200,6)                                                         ADDF0140
  20  LA = NEXT(I,1)                                                        ADDF0150
      LB = NEXT(I,2)                                                        ADDF0160
      LC = NEXT(I,3)                                                        ADDF0170
      DO 30 J = 1,6                                                         ADDF0180
      FORCE(LA,J) = FORCE(LA,J) + PFCGN(J    ,1) + CFCGN(J    ,1)          ADDF0190
      FORCE(LB,J) = FORCE(LB,J) + PFCGN(J+6  ,1) + CFCGN(J+6  ,1)          ADDF0200
  30  FORCE(LC,J) = FORCE(LC,J) + PFCGN(J+12,1) + CFCGN(J+12,1)            ADDF0210
      RETURN                                                                ADDF0220
      END                                                                   ADDF0230
```

```
      SUBROUTINE PRINT1                                                 PRINT010
C     PRINT GEOMETRIC BREAK-UP AND ASSOCIATED PROPERTIES .              PRINT020
C                                                                       PRINT030
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,PRINT040
     1       PRESSE( 200) , XL   ( 200,3) , YL   ( 200,3) ,            PRINT050
     2       RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,PRINT060
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,PRINT070
     4       RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                 PRINT080
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT      PRINT090
      KOUNT = 0                                                         PRINT100
      WRITE (6,5)                                                       PRINT110
    5 FORMAT (1H1//38X,29HRESULTING TRIANGULAR ELEMENTS ///)            PRINT120
      DO 20 I = 1,NT                                                    PRINT130
      AREA = ABS( XL(I,2) * YL(I,3) ) / 2.0                             PRINT140
      PLOAD = AREA * PRESSE(I)                                          PRINT150
      WRITE (6,10) I , AREA , PRESSE(I) , PLOAD                         PRINT155
   10 FORMAT (45X 'ELEMENT NO. ' I3 / 14X 'AREA =' F10.6,10X 'PRESSURE =PRINT160
     1 ' E12.5,10X 'LOAD = ' E12.5 / 20X 'NODE NO.        X          Y   PRINT165
     2       Z         TH         XL         YL' )                     PRINT170
      LA = NEXT(I,1)                                                    PRINT180
      LB = NEXT(I,2)                                                    PRINT190
      LC = NEXT(I,3)                                                    PRINT200
      WRITE (6,15) LA,X(LA),Y(LA),Z(LA),TH(LA),XL(I,1),YL(I,1),LB,X(LB),PRINT210
     1             Y(LB),Z(LB),TH(LB),XL(I,2),YL(I,2),LC,X(LC),Y(LC),   PRINT220
     2             Z(LC),TH(LC),XL(I,3),YL(I,3)                         PRINT230
   15 FORMAT (17X,5HLA   ,I3,5X,3F10.3,3F10.4/ 17X,5HLB   ,I3,5X,3F10.3,PRINT240
     1       3F10.4 / 17X,5HLC   ,I3,5X,3F10.3,3F10.4// )               PRINT250
      KOUNT = KOUNT + 1                                                 PRINT260
      IF ((KOUNT .EQ. 7) .AND. (I .NE. NT)) WRITE (6,5)                 PRINT270
      IF ( KOUNT .EQ. 7 ) KOUNT = 0                                     PRINT280
   20 CONTINUE                                                          PRINT290
      RETURN                                                            PRINT300
      END                                                               PRINT310
```

```
      SUBROUTINE DEFL ( IPRINT )                                        DEFL0010
C     SOLVE FOR THE NODAL DEFLECTIONS (DISPL) IN THE COMMON COORDINATE  DEFL0020
C     SYSTEM .                                                          DEFL0030
C                                                                       DEFL0040
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,DEFL0050
     1       PRESSE( 200) , XL   ( 200,3) , YL   ( 200,3) ,             DEFL0060
     2       RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,DEFL0070
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,DEFL0080
     4       RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                 DEFL0090
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,    DEFL0100
     6       FLMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,        DEFL0110
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) , DEFL0120
     8       PFCGN(18,1), CFCGN(18,1), MEX(200,8), IMEX(200), FORCE(    DEFL0130
     9       200,6)                                                     DEFL0140
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10),  DEFL0150
     1    INTN(10)                                                      DEFL0160
      DIMENSION DISPLA(900) , COEFF(900) , EQUAT(6,900) , COEFR(900) ,  DEFL0170
     1     MEXT(8) , DISPL(18,200)                                      DEFL0180
      DATA DISPL / 3600*0.0 /                                           DEFL0190
      IEQ = 6 * ( NP - NGENLI )                                         DEFL0200
      I1 = IEQ + 1                                                      DEFL0210
      IF ( IPRINT .GT. 1 ) WRITE (6,5) I1,IEQ                           DEFL0220
5     FORMAT (1H1//10X,18HFOLLOWING ARE THE ,I4,30H COEFFICIENTS FOR EACDEFL0230
     1H OF THE ,I4,45H SIMULTANEOUS EQUATIONS FOR NODAL DEFLECTIONS //) DEFL0240
      KOUNT = 0                                                         DEFL0250
      DO 90 I = 1,NP                                                    DEFL0260
      IF ( IPOS(I) .LT. 0 ) GO TO 90                                    DEFL0270
      KOUNT = KOUNT + 1                                                 DEFL0280
      IMEXT = IMEX(I)                                                   DEFL0290
      DO 40 J = 1,IMEXT                                                 DEFL0300
   40 MEXT(J) = MEX(I,J)                                                DEFL0310
      DO 50 J = 1,I1                                                    DEFL0320
      DO 50 K = 1,6                                                     DEFL0330
50    EQUAT(K,J) = 0.0                                                  DEFL0340
      DO 80 J = 1,IMEXT                                                 DEFL0350
      K2 = MEXT(J)                                                      DEFL0360
      FIND (1'K2)                                                       DEFL0370
      LA = NEXT(K2,1)                                                   DEFL0380
      LB = NEXT(K2,2)                                                   DEFL0390
      LC = NEXT(K2,3)                                                   DEFL0400
      NA = 6 * IPOS(LA)                                                 DEFL0410
      NB = 6 * IPOS(LB)                                                 DEFL0420
      NC = 6 * IPOS(LC)                                                 DEFL0430
      READ (1'K2 ) ECSTIF                                               DEFL0440
      DO 75 K = 1,6                                                     DEFL0450
      IF ( LA .EQ. I ) IND1 = K                                         DEFL0460
      IF ( LB .EQ. I ) IND1 = K + 6                                     DEFL0470
      IF ( LC .EQ. I ) IND1 = K + 12                                    DEFL0480
      DO 70 L = 1,6                                                     DEFL0490
      KA = NA + L                                                       DEFL0500
      KB = NB + L                                                       DEFL0510
      KC = NC + L                                                       DEFL0520
      IF ( IPOS(LA) .LT. 0 ) GO TO 60                                   DEFL0530
      EQUAT(K,KA) = EQUAT(K,KA) + ECSTIF(IND1,L)                        DEFL0540
60    IF ( IPOS(LB) .LT. 0 ) GO TO 65                                   DEFL0550
      EQUAT(K,KB) = EQUAT(K,KB) + ECSTIF(IND1,L+6)                      DEFL0560
65    IF ( IPOS(LC) .LT. 0 ) GO TO 70                                   DEFL0570
      EQUAT(K,KC) = EQUAT(K,KC) + ECSTIF(IND1,L+12)                     DEFL0580
```

```
 70 CONTINUE                                                          DEFL0590
75   CONTINUE                                                         DEFL0600
80   CONTINUE                                                         DEFL0610
     DO 85 K = 1,6                                                    DEFL0620
     J1 = 6 * ( KOUNT - 1 ) + K                                       DEFL0630
     EQUAT(K,IEQ+1) = FORCE(I,K)                                      DEFL0640
     IF ( IPRINT .GT. 1 ) WRITE (6,86) (EQUAT(K,J),J=1,I1)            DEFL0650
85   WRITE (3'J1) (EQUAT(K,J),J=1,1201)                               DEFL0660
86   FORMAT (10E12.4)                                                 DEFL0670
90   CONTINUE                                                         DEFL0680
     K = 1                                                            DEFL0690
100  READ (3'K) COEFF                                                 DEFL0700
     I = K + 1                                                        DEFL0710
     IF (ABS( COEFF(K)) .GT. 1.0E-10 ) GO TO 120                      DEFL0720
     DO 105 J = I,IEQ                                                 DEFL0730
     READ (3'J) COEFR                                                 DEFL0740
     J1 = J                                                           DEFL0750
     IF ( ABS( COEFR(K)) .GT. 1.0E-10 ) GO TO 115                     DEFL0760
 105 CONTINUE                                                         DEFL0770
     WRITE (6,110)                                                    DEFL0780
 110 FORMAT (32H DISPLACEMENT MATRIX IS SINGULAR )                    DEFL0790
     NP = -NP                                                         DEFL0800
     RETURN                                                           DEFL0810
115  WRITE (3'J1) COEFF                                               DEFL0820
     WRITE (3'K) COEFR                                                DEFL0830
     DO 117 J = 1,I1                                                  DEFL0840
117  COEFF(J) = COEFR(J)                                              DEFL0850
120  READ (3'I) COEFR                                                 DEFL0860
     ZM = COEFR(K) / COEFF(K)                                         DEFL0870
     COEFR(K) = 0.0                                                   DEFL0880
     J = K + 1                                                        DEFL0890
130  COEFR(J) = COEFR(J) - ZM * COEFF(J)                              DEFL0900
     IF ( J .EQ. IEQ ) GO TO 140                                      DEFL0910
     J = J + 1                                                        DEFL0920
     GO TO 130                                                        DEFL0930
140  COEFR(J+1) = COEFR(J+1) - ZM * COEFF(J+1)                        DEFL0940
     WRITE (3'I) COEFR                                                DEFL0950
     IF,( I .EQ. IEQ ) GO TO 150                                      DEFL0960
     I = I + 1                                                        DEFL0970
     GO TO 120                                                        DEFL0980
150  IF ( K .EQ. IEQ - 1 ) GO TO 160                                  DEFL0990
     K = K + 1                                                        DEFL1000
     GO TO 100                                                        DEFL1010
160  CONTINUE                                                         DEFL1020
     READ (3'IEQ) COEFF                                               DEFL1030
     DISPLA(   IEQ    ) = COEFF(IEQ + 1) / COEFF(IEQ)                 DEFL1040
     I = IEQ - 1                                                      DEFL1050
210  READ (3'I)     COEFF                                             DEFL1060
     J = I + 1                                                        DEFL1070
     S = 0.0                                                          DEFL1080
220  S = S + COEFF(J) * DISPLA(   J                                   DEFL1090
     IF ( J .EQ. IEQ ) GO TO 230                                      DEFL1100
     J = J + 1                                                        DEFL1110
     GO TO 220                                                        DEFL1120
230  DISPLA(   I    ) = (COEFF(IEQ+1) - S) / COEFF(I)                DEFL1130
     IF ( I .EQ. 1 ) GO TO 240                                        DEFL1140
     I = I - 1                                                        DEFL1150
     GO TO 210                                                        DEFL1160
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240   CONTINUE                                                          DEFL1170
      FIND (3'1)                                                        DEFL1180
      DO 260 I = 1,NT                                                   DEFL1190
      LA = NEXT(I,1)                                                    DEFL1200
      LB = NEXT(I,2)                                                    DEFL1210
      LC = NEXT(I,3)                                                    DEFL1220
      NA = 6 * IPOS(LA)                                                 DEFL1230
      NB = 6 * IPOS(LB)                                                 DEFL1240
      NC = 6 * IPOS(LC)                                                 DEFL1250
      DO 250 J = 1,6                                                    DEFL1260
      IF ( IPOS(LA) .LT. 0 ) GO TO 243                                  DEFL1270
      DISPL(J,I) = DISPLA(NA + J)                                       DEFL1280
243   IF ( IPOS(LB) .LT. 0 ) GO TO 246                                  DEFL1290
      DISPL(J+6,I) = DISPLA(NB + J)                                     DEFL1300
246   IF ( IPOS(LC) .LT. 0 ) GO TO 250                                  DEFL1310
      DISPL(J+12,I) = DISPLA(NC + J)                                    DEFL1320
250   CONTINUE                                                          DEFL1330
 260  CONTINUE                                                          DEFL1340
      FIND (4'1)                                                        DEFL1350
      WRITE (6,270)                                                     DEFL1360
270   FORMAT (1H1/43X,14HCOMMON  SYSTEM /                               DEFL1370
     1              40X,20HDEFLECTION  PRINTOUT //8X,8HNODE NO.,6X,1HX,  DEFL1380
     1 9X,1HY,9X,1HZ,11X,1HU,14X,1HV,14X,1HW,10X,6HTHETAX,9X,6HTHETAY/)  DEFL1390
      J = 0                                                             DEFL1400
      DO 280 I = 1,NP                                                   DEFL1410
      LA = I                                                            DEFL1420
      K = 6 * IPOS(LA)                                                  DEFL1430
      D1 = 0.0                                                          DEFL1440
      D2 = 0.0                                                          DEFL1450
      D3 = 0.0                                                          DEFL1460
      D4 = 0.0                                                          DEFL1470
      D5 = 0.0                                                          DEFL1480
      IF ( IPOS(LA) .LT. 0 ) GO TO 275                                  DEFL1490
      D1 = DISPLA(K+1)                                                  DEFL1500
      D2 = DISPLA(K+2)                                                  DEFL1510
      D3 = DISPLA(K+3)                                                  DEFL1520
      D4 = DISPLA(K+4)                                                  DEFL1530
      D5 = DISPLA(K+5)                                                  DEFL1540
275   J = J + 1                                                         DEFL1550
      IF ( J .EQ. 50 ) WRITE (6,270)                                    DEFL1560
      IF ( J .EQ. 50 ) J = 0                                            DEFL1570
280   WRITE (6,290) I,X(I),Y(I),Z(I),D1,D2,D3,D4,D5                     DEFL1580
290   FORMAT (10X,I5,3F10.3,5E15.5)                                     DEFL1590
      K1 = -49                                                          DEFL1600
      K2 = 0                                                            DEFL1610
      DO 300 I = 1,4                                                    DEFL1620
      K1 = K1 + 50                                                      DEFL1630
      K2 = K2 + 50                                                      DEFL1640
300   WRITE(3'I) ((DISPL(J,K),J=1,18),K=K1,K2)                          DEFL1650
      RETURN                                                            DEFL1660
      END                                                               DEFL1670
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      SUBROUTINE ASSEM1                                                 ASM10010
C     ASSEMBLE THE KAA AND KAB PORTIONS OF THE COMMON STIFFNESS MATRIX  ASM10020
C     FOR EACH SUB-SYSTEM.                                              ASM10030
C                                                                       ASM10040
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,ASM10050
     1       PRESSE( 200) , XL   ( 200,3) , YL   ( 200,3) ,             ASM10060
     2       RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,ASM10070
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,ASM10080
     4       RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                 ASM10090
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,    ASM10100
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,        ASM10110
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) , ASM10120
     8       PFCGN(18,1), CFCGN(18,1), MEX(200,8), IMEX(200), FORCE(    ASM10130
     9       200,6)                                                     ASM10140
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10),  ASM10150
     1    INTN(10)                                                      ASM10160
      DIMENSION KAA(90,90), KAB(90,90) , MEXT(8)                        ASM10170
      REAL KAA, KAB                                                     ASM10180
      KREC = 0                                                          ASM10190
      DO 110 I = 1,NSUBS                                                ASM10200
      KAAM = 0                                                          ASM10210
      IEQ1 = 6 * NBN(I)                                                 ASM10220
      DO 5 J = 1,90                                                     ASM10230
      DO 5 K = 1,90                                                     ASM10240
      KAA(J,K) = 0.0                                                    ASM10250
    5 KAB(J,K) = 0.0                                                    ASM10260
      J1 = NBTS(I,1)                                                    ASM10270
      J2 = NBTS(I,NBN(I))                                               ASM10280
      DO 90 J = J1, J2                                                  ASM10290
      IF (J .NE. NBTS(I,KAAM+1)) GO TO 90                               ASM10300
      KAAM = KAAM + 1                                                   ASM10310
      IMEXT = IMEX(J)                                                   ASM10320
      DO 10 K = 1,IMEXT                                                 ASM10330
   10 MEXT(K) = MEX(J,K)                                                ASM10340
      DO 85 K = 1,IMEXT                                                 ASM10350
      K2 = MEXT(K)                                                      ASM10360
      FIND (1'K2)                                                       ASM10370
      LA = NEXT(K2,1)                                                   ASM10380
      LB = NEXT(K2,2)                                                   ASM10390
      LC = NEXT(K2,3)                                                   ASM10400
      IF (I .EQ. 1) GO TO 15                                            ASM10410
      IF (I .EQ. NSUBS) GO TO 20                                        ASM10420
      IF(((LA .LT. J1-1) .OR. (LA .GT. J2)) .OR.                        ASM10430
     1    ((LB .LT. J1-1) .OR. (LB .GT. J2)) .OR.                       ASM10440
     2    ((LC .LT. J1-1) .OR. (LC .GT. J2)))GO TO 85                   ASM10450
      GO TO 25                                                          ASM10460
   15 IF ((LA .GT. J2) .OR. (LB .GT. J2) .OR. (LC .GT. J2)) GO TO 85    ASM10470
      GO TO 25                                                          ASM10480
   20 IF ((LA .LT. J1-1) .OR. (LB .LT. J1-1) .OR. (LC .LT. J1-1)) GO TO ASM10490
     1 85                                                               ASM10500
   25 L2 = NBN(I)                                                       ASM10510
      NA = -1                                                           ASM10520
      NB = -1                                                           ASM10530
      NC = -1                                                           ASM10540
      DO 30 L = 1,L2                                                    ASM10550
      IF (LA .EQ. NBTS(I,L)) NA = 6* (L-1)                              ASM10560
      IF (LB .EQ. NBTS(I,L)) NB = 6* (L-1)                              ASM10570
      IF (LC .EQ. NBTS(I,L)) NC = 6* (L-1)                              ASM10580
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  30 CONTINUE                                                          ASM10590
     L2 = INTN(I)                                                      ASM10600
     DO 35 L = 1,L2                                                    ASM10610
     IF (LA .EQ. NITS(I,L)) NA = 6* (L+NBN(I)-1)                       ASM10620
     IF (LB .EQ. NITS(I,L)) NB = 6* (L+NBN(I)-1)                       ASM10630
     IF (LC .EQ. NITS(I,L)) NC = 6* (L+NBN(I)-1)                       ASM10640
  35 CONTINUE                                                          ASM10650
  45 READ (1'K2) ECSTIF                                                ASM10660
     DO 80 L = 1,6                                                     ASM10670
     IF (LA .EQ. J) IND1 = L                                           ASM10680
     IF (LB .EQ. J) IND1 = L + 6                                       ASM10690
     IF (LC .EQ. J) IND1 = L + 12                                      ASM10700
     M1 = 6*(KAAM-1) + L                                               ASM10710
     DO 80 M = 1,6                                                     ASM10720
     KA = NA + M                                                       ASM10730
     KB = NB + M                                                       ASM10740
     KC = NC + M                                                       ASM10750
     IF (NA .LT. 0) GO TO 55                                           ASM10760
     IF (NA .GT. 6*(NBN(I)-1)) GO TO 50                                ASM10770
     KAA(M1,KA) = KAA(M1,KA) + ECSTIF(IND1,M)                          ASM10780
     GO TO 55                                                          ASM10790
50   KA = M + NA - IEQ1                                                ASM10800
     KAB(M1,KA) = KAB(M1,KA) + ECSTIF(IND1,M)                          ASM10810
  55 IF (NB .GT. 6*(NBN(I)-1)) GO TO 60                                ASM10820
     KAA(M1,KB) = KAA(M1,KB) + ECSTIF(IND1,M+6)                        ASM10830
     GO TO 65                                                          ASM10840
60   KB = M + NB - IEQ1                                                ASM10850
     KAB(M1,KB) = KAB(M1,KB) + ECSTIF(IND1,M+6)                        ASM10860
  65 IF (NC .LT. 0) GO TO 75                                           ASM10870
     IF (NC .GT. 6*(NBN(I)-1)) GO TO 70                                ASM10880
     KAA(M1,KC) = KAA(M1,KC) + ECSTIF(IND1, M+12)                      ASM10890
     GO TO 75                                                          ASM10900
70   KC = M + NC - IEQ1                                                ASM10910
     KAB(M1,KC) = KAB(M1,KC) + ECSTIF(IND1, M+12)                      ASM10920
  75 CONTINUE                                                          ASM10930
  80 CONTINUE                                                          ASM10940
  85 CONTINUE                                                          ASM10950
  90 CONTINUE                                                          ASM10960
     K1 = -9                                                           ASM10970
     K2 = 0                                                            ASM10980
     DO 95 L = 1,9                                                     ASM10990
     KREC = KREC + 1                                                   ASM11000
     IF ( K2 .GE. IEQ1 ) GO TO 95                                      ASM11010
     K1 = K1 + 10                                                      ASM11020
     K2 = K2 + 10                                                      ASM11030
     WRITE (3'KREC) ((KAA(K,J),J=1,90),K=K1,K2)                        ASM11040
95   CONTINUE                                                          ASM11050
     K1 = -9                                                           ASM11060
     K2 = 0                                                            ASM11070
     DO 100 L = 1,9                                                    ASM11080
     KREC = KREC + 1                                                   ASM11090
     IF ( K2 .GE. IEQ1 ) GO TO 100                                     ASM11100
     K1 = K1 + 10                                                      ASM11110
     K2 = K2 + 10                                                      ASM11120
     WRITE (3'KREC) ((KAB(K,J),J=1,90),K=K1,K2)                        ASM11130
100  CONTINUE                                                          ASM11140
 110 CONTINUE                                                          ASM11150
     RETURN                                                            ASM11160


     END                                                               ASM11170
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      SUBROUTINE ASSEM2                                                 ASM20010
C     ASSEMBLE THE KBA AND KBB-1 PORTIONS OF THE COMMON STIFFNESS       ASM20020
C     MATRIX FOR EACH SUB-SYSTEM.                                       ASM20030
C                                                                       ASM20040
      COMMON X11    ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,ASM20050
     1       PRESSE( 200) , XL   ( 200,3) , YL   ( 200,3) ,            ASM20060
     2       RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,ASM20070
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,ASM20080
     4       RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                 ASM20090
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,    ASM20100
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,        ASM20110
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) , ASM20120
     8       PFCGN(18,1), CFCGN(18,1), MEX(200,8), IMEX(200), FORCE(    ASM20130
     9       200,6)                                                     ASM20140
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10),  ASM20150
     1    INTN(10)                                                      ASM20160
      DIMENSION KBA(90,90), KBB(90,90), MEXT(8)                         ASM20170
      REAL KBA, KBB                                                     ASM20180
      KREC = 18 * NSUBS                                                 ASM20190
      DO 135 I = 1,NSUBS                                                ASM20200
      KBAM = 0                                                          ASM20210
      IEQ1 = 6 * INTN(I)                                                ASM20220
      IEQ2 = 6 * NBN(I)                                                 ASM20230
      DO 5 J = 1,90                                                     ASM20240
      DO 5 K = 1,90                                                     ASM20250
      KBA(J,K) = 0.0                                                    ASM20260
    5 KBB(J,K) = 0.0                                                    ASM20270
      J1 = NITS(I,1)                                                    ASM20280
      J2 = NITS(I,INTN(I))                                              ASM20290
      DO 90 J = J1,J2                                                   ASM20300
      IF (J .NE. NITS(I,KBAM+1)) GO TO 90                               ASM20310
      KBAM = KBAM + 1                                                   ASM20320
      IMEXT = IMEX(J)                                                   ASM20330
      DO 15 K = 1,IMEXT                                                 ASM20340
   15 MEXT(K) = MEX(J,K)                                                ASM20350
      DO 85 K = 1,IMEXT                                                 ASM20360
      K2 = MEXT(K)                                                      ASM20370
      FIND (1*K2)                                                       ASM20380
      LA = NEXT(K2,1)                                                   ASM20390
      LB = NEXT(K2,2)                                                   ASM20400
      LC = NEXT(K2,3)                                                   ASM20410
      L2 = NBN(I)                                                       ASM20420
      NA = -1                                                           ASM20430
      NB = -1                                                           ASM20440
      NC = -1                                                           ASM20450
      DO 30 L = 1,L2                                                    ASM20460
      IF (LA .EQ. NBTS(I,L)) NA = 6*(L-1)                               ASM20470
      IF (LB .EQ. NBTS(I,L)) NB = 6*(L-1)                               ASM20480
      IF (LC .EQ. NBTS(I,L)) NC = 6*(L-1)                               ASM20490
   30 CONTINUE                                                          ASM20500
      L2 = INTN(I)                                                      ASM20510
      DO 35 L = 1,L2                                                    ASM20520
      IF (LA .EQ. NITS(I,L)) NA = 6* (L + NBN(I)-1)                     ASM20530
      IF (LB .EQ. NITS(I,L)) NB = 6* (L + NBN(I)-1)                     ASM20540
      IF (LC .EQ. NITS(I,L)) NC = 6* (L + NBN(I)-1)                     ASM20550
   35 CONTINUE                                                          ASM20560
   45 READ (1*K2) ECSTIF                                                ASM20570
      DO 80 L = 1,6                                                     ASM20580
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      IF (LA .EQ. J) IND1 = L                                          ASM20590
      IF (LB .EQ. J) IND1 = L + 6                                      ASM20600
      IF (LC .EQ. J) IND1 = L + 12                                     ASM20610
      M1 = 6 * (KBAM-1) + L                                            ASM20620
      DO 80 M = 1,6                                                    ASM20630
      KA = NA + M                                                      ASM20640
      KB = NB + M                                                      ASM20650
      KC = NC + M                                                      ASM20660
      IF (NA .LT. 0) GO TO 55                                          ASM20670
      IF (NA .GT. 6*(NBN(I)-1)) GO TO 50                               ASM20680
      KBA(M1,KA) = KBA(M1,KA) + ECSTIF(IND1,M)                         ASM20690
      GO TO 55                                                         ASM20700
50    KA = M + NA - IEQ2                                               ASM20710
      KBB(M1,KA) = KBB(M1,KA) + ECSTIF(IND1,M)                         ASM20720
  55  IF (NB .GT. 6*(NBN(I)-1)) GO TO 60                               ASM20730
      KBA(M1,KB) = KBA(M1,KB) + ECSTIF(IND1,M+6)                       ASM20740
      GO TO 65                                                         ASM20750
60    KB = M + NB - IEQ2                                               ASM20760
      KBB(M1,KB) = KBB(M1,KB) + ECSTIF(IND1,M+6)                       ASM20770
  65  IF (NC .LT. 0) GO TO 75                                          ASM20780
      IF (NC .GT. 6*(NBN(I)-1)) GO TO 70                               ASM20790
      KBA(M1,KC) = KBA(M1,KC) + ECSTIF(IND1,M+12)                      ASM20800
      GO TO 75                                                         ASM20810
70    KC = M + NC - IEQ2                                               ASM20820
      KBB(M1,KC) = KBB(M1,KC) + ECSTIF(IND1,M+12)                      ASM20830
  75  CONTINUE                                                         ASM20840
  80  CONTINUE                                                         ASM20850
  85  CONTINUE                                                         ASM20860
  90  CONTINUE                                                         ASM20870
      K2 = INTN(I) * 6                                                 ASM20880
      DO 120 K = 1,K2                                                  ASM20890
      IF (KBB(K,K)) 105,95,105                                         ASM20900
  95  WRITE (6,100) I                                                  ASM20910
 100  FORMAT (22H KBB OF SUB-SYSTEM NO., I3, 13H  IS SINGULAR)         ASM20920
      NSUBS = -NSUBS                                                   ASM20930
      RETURN                                                           ASM20940
 105  X = 1.0 / KBB(K,K)                                               ASM20950
      KBB(K,K) = 1.0                                                   ASM20960
      DO 110 J = 1,K2                                                  ASM20970
 110  KBB(K,J) = KBB(K,J) * X                                          ASM20980
      IF (K-K2) 115,125,115                                            ASM20990
 115  M = K + 1                                                        ASM21000
      DO 120 N = M,K2                                                  ASM21010
      X = KBB(N,K)                                                     ASM21020
      KBB(N,K) = 0.0                                                   ASM21030
      DO 120 J = 1,K2                                                  ASM21040
 120  KBB(N,J) = KBB(N,J) - X * KBB(K,J)                               ASM21050
 125  LL = K2 - 1                                                      ASM21060
      DO 130 J = 1,LL                                                  ASM21070
      M = J + 1                                                        ASM21080
      DO 130 K = M,K2                                                  ASM21090
      X = KBB(J,K)                                                     ASM21100
      KBB(J,K) = 0.0                                                   ASM21110
      DO 130 L = 1,K2                                                  ASM21120
 130  KBB(J,L) = KBB(J,L) - KBB(K,L) * X                               ASM21130
      K1 = -9                                                          ASM21140
      K2 = 0                                                           ASM21150
      DO 131 L = 1,9                                                   ASM21160
```

```
      KREC = KREC + 1                                                   ASM21170
      IF ( K2 .GE. IEQ1 ) GO TO 131                                     ASM21180
      K1 = K1 + 10                                                      ASM21190
      K2 = K2 + 10                                                      ASM21200
      WRITE (3'KREC) ((KBA(K,J),J=1,90),K=K1,K2)                        ASM21210
  131 CONTINUE                                                          ASM21220
      K1 = -9                                                           ASM21230
      K2 = 0                                                            ASM21240
      DO 132 L = 1,9                                                    ASM21250
      KREC = KREC + 1                                                   ASM21260
      IF ( K2 .GE. IEQ1 ) GO TO 132                                     ASM21270
      K1 = K1 + 10                                                      ASM21280
      K2 = K2 + 10                                                      ASM21290
      WRITE (3'KREC) ((KBB(K,J),J=1,90),K=K1,K2)                        ASM21300
  132 CONTINUE                                                          ASM21310
  135 CONTINUE                                                          ASM21320
      RETURN                                                            ASM21330
      END                                                               ASM21340
```

```
      SUBROUTINE CALC                                                   CALC0010
C     CALCULATE THE SUB-SYSTEM PORTION OF THE SYSTEM STIFFNESS          CALC0020
C     MATRIX AND SYSTEM BOUNDARY FORCE COEFFICIENT MATRIX.              CALC0030
C                                                                       CALC0040
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10),  CALC0050
     1    INTN(10)                                                      CALC0060
      REAL KSS                                                          CALC0070
      DIMENSION B(90,90), KSS(50,90), A(90,90)                          CALC0080
      J3 = 36 * NSUBS                                                   CALC0090
      J4 = 45 * NSUBS                                                   CALC0100
      DO 20 I = 1,NSUBS                                                 CALC0110
      IEQ1 = 6 * NBN(I)                                                 CALC0120
      IEQ2 = 6 * INTN(I)                                                CALC0130
      KA = 18 * I - 9                                                   CALC0140
      K1 = -9                                                           CALC0150
      K2 = 0                                                            CALC0160
      DO 1 L = 1,9                                                      CALC0170
      KA = KA + 1                                                       CALC0180
      IF ( K2 .GE. IEQ1 ) GO TO 1                                       CALC0190
      K1 = K1 + 10                                                      CALC0200
      K2 = K2 + 10                                                      CALC0210
      READ (3'KA) ((A(K,J),J=1,90),K=K1,K2)                             CALC0220
1     CONTINUE                                                          CALC0230
      KB = 18 * (NSUBS + I) - 9                                         CALC0240
      K1 = -9                                                           CALC0250
      K2 = 0                                                            CALC0260
      DO 2 L = 1,9                                                      CALC0270
      KB = KB + 1                                                       CALC0280
      IF ( K2 .GE. IEQ2 ) GO TO 2                                       CALC0290
      K1 = K1 + 10                                                      CALC0300
      K2 = K2 + 10                                                      CALC0310
      READ (3'KB) ((B(K,J),J=1,90),K=K1,K2)                             CALC0320
2     CONTINUE                                                          CALC0330
      J1 = IEQ1                                                         CALC0340
      J2 = IEQ2                                                         CALC0350
      IF ( J1 .GT. 50 ) J1 = 50                                         CALC0360
      DO 3 J = 1,J1                                                     CALC0370
      DO 3 K = 1,J2                                                     CALC0380
      KSS(J,K) = 0.0                                                    CALC0390
      DO 3 L = 1,J2                                                     CALC0400
3     KSS(J,K) = KSS(J,K) + A(J,L) * B(L,K)                             CALC0410
      K1 = -9                                                           CALC0420
      K2 = 0                                                            CALC0430
      DO 4 L = 1,5                                                      CALC0440
      J3 = J3 + 1                                                       CALC0450
      IF ( K2 .GE. IEQ1 ) GO TO 4                                       CALC0460
      K1 = K1 + 10                                                      CALC0470
      K2 = K2 + 10                                                      CALC0480
      WRITE (3'J3) ((KSS(K,J),J=1,90),K=K1,K2)                          CALC0490
4     CONTINUE                                                          CALC0500
      IF ( IEQ1 .LE. 50 ) J3 = J3 + 4                                   CALC0510
      IF ( IEQ1 .LE. 50 ) GO TO 7                                       CALC0520
      J1 = IEQ1 - 50                                                    CALC0530
      DO 5 J = 1,J1                                                     CALC0540
      DO 5 K = 1,J2                                                     CALC0550
      KSS(J,K) = 0.0                                                    CALC0560
      DO 5 L = 1,J2                                                     CALC0570
5     KSS(J,K) = KSS(J,K) + A(J+50,L) * B(L,K)                          CALC0580
```

```
      K1 = -9                                                          CALC0590
      K2 = 0                                                           CALC0600
      DO 6 L = 1,4                                                     CALC0610
      J3 = J3 + 1                                                      CALC0620
      IF ( K2 .GE. IEQ1-50 ) GO TO 6                                   CALC0630
      K1 = K1 + 10                                                     CALC0640
      K2 = K2 + 10                                                     CALC0650
      WRITE (3'J3) ((KSS(K,J),J=1,90),K=K1,K2)                         CALC0660
    6 CONTINUE                                                         CALC0670
    7 KB = KB - 18                                                     CALC0680
      K1 = -9                                                          CALC0690
      K2 = 0                                                           CALC0700
      DO 8 L = 1,9                                                     CALC0710
      KB = KB + 1                                                      CALC0720
      IF ( K2 .GE. IEQ2 ) GO TO 8                                      CALC0730
      K1 = K1 + 10                                                     CALC0740
      K2 = K2 + 10                                                     CALC0750
      READ (3'KB) ((B(K,J),J=1,90),K=K1,K2)                            CALC0760
    8 CONTINUE                                                         CALC0770
      J11 = IEQ1                                                       CALC0780
      J1 = IEQ1                                                        CALC0790
      IF ( J11 .LE. 50 ) GO TO 11                                      CALC0800
      J11 = J11 - 50                                                   CALC0810
      DO 9 J = 1,J11                                                   CALC0820
      DO 9 K = 1,J1                                                    CALC0830
      A(J+50,K) = 0.0                                                  CALC0840
      DO 9 L = 1,J2                                                    CALC0850
    9 A(J+50,K) = A(J+50,K) + KSS(J,L) * B(L,K)                        CALC0860
      J3 = J3 - 9                                                      CALC0870
      K1 = -9                                                          CALC0880
      K2 = 0                                                           CALC0890
      DO 10 L = 1,5                                                    CALC0900
      J3 = J3 + 1                                                      CALC0910
      IF ( K2 .GE. IEQ1 ) GO TO 10                                     CALC0920
      K1 = K1 + 10                                                     CALC0930
      K2 = K2 + 10                                                     CALC0940
      READ (3'J3) ((KSS(K,J),J=1,90),K=K1,K2)                          CALC0950
   10 CONTINUE                                                         CALC0960
      J3 = J3 + 4                                                      CALC0970
   11 J11 = IEQ1                                                       CALC0980
      IF ( J11 .GT. 50 ) J11 = 50                                      CALC0990
      DO 12 J = 1,J11                                                  CALC1000
      DO 12 K = 1,J1                                                   CALC1010
      A(J,K) = 0.0                                                     CALC1020
      DO 12 L = 1,J2                                                   CALC1030
   12 A(J,K) = A(J,K) + KSS(J,L) * B(L,K)                              CALC1040
      KA = KA - 18                                                     CALC1050
      K1 = -9                                                          CALC1060
      K2 = 0                                                           CALC1070
      DO 14 L = 1,9                                                    CALC1080
      KA = KA + 1                                                      CALC1090
      IF ( K2 .GE. IEQ1 ) GO TO 14                                     CALC1100
      K1 = K1 + 10                                                     CALC1110
      K2 = K2 + 10                                                     CALC1120
      READ (3'KA) ((B(K,J),J=1,90),K=K1,K2)                            CALC1130
   14 CONTINUE                                                         CALC1140
      DO 15 J = 1,J1                                                   CALC1150
      DO 15 K = 1,J1                                                   CALC1160
```

```
   15 B  (J,K) = B(J,K) - A(J,K)                                        CALC1170
      K1 = -9                                                           CALC1180
      K2 = 0                                                            CALC1190
      DO 16 L = 1,9                                                     CALC1200
      J4 = J4 + 1                                                       CALC1210
      IF ( K2 .GE. IEQ1 ) GO TO 16                                      CALC1220
      K1 = K1 + 10                                                      CALC1230
      K2 = K2 + 10                                                      CALC1240
      WRITE (3'J4) ((B  (K,J),J=1,90),K=K1,K2)                          CALC1250
16    CONTINUE                                                          CALC1260
   20 CONTINUE                                                          CALC1270
      RETURN                                                            CALC1280
      END                                                               CALC1290
```

```
      SUBROUTINE ASSEM3 ( NBNODE )                                          ASEM3010
C     ASSEMBLE THE SUB-SYSTEM MATRICES INTO THE SYSTEM MATRIX.              ASEM3020
C                                                                           ASEM3030
      REAL KSS                                                              ASEM3040
      COMMON X      ( 200) , Y      ( 200) , Z      ( 200) , TH     ( 200) ,ASEM3050
     1        PRESSE( 200) , XL   ( 200,3) , YL   ( 200,3) ,               ASEM3060
     2        RAPANG( 100) , ZGL    ( 100) , RHUB   ( 100) , RTIP   ( 100) ,ASEM3070
     3        THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM   ( 3,3) ,ASEM3080
     4        RHO , OMEGA   , POISSO , YOUNGS , RADGEN ,                   ASEM3090
     5        NGENLI , LINEI , NPRES(100) , NEXT ( 200,3) , NP , NT ,      ASEM3100
     6        ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,          ASEM3110
     7        PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) ,   ASEM3120
     8        PFCGN(18,1), CFCGN(18,1), MEX(200,8), IMEX(200), FORCE(      ASEM3130
     9        200,6)                                                       ASEM3140
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10),      ASEM3150
     1    INTN(10)                                                         ASEM3160
      DOUBLE PRECISION COEFF                                                ASEM3170
      DIMENSION COEFF(301), F(90), KSS(90,90) , NBNEW(10)                   ASEM3180
      NBNEW(1) = NBN(1)                                                     ASEM3190
      DO 2 I = 2,NSUBS                                                      ASEM3200
    2 NBNEW(I) = NBN(I) - NBNEW(I-1)                                        ASEM3210
      NBNODE = NBN(1)                                                       ASEM3220
      J2 = NBTS(1,NBNODE)                                                   ASEM3230
      J1 = IPOS(J2)                                                         ASEM3240
      NSUB = NSUBS -1                                                       ASEM3250
      DO 4 I = 2,NSUB                                                       ASEM3260
      J = NBN(I)                                                            ASEM3270
      DO 3 K = 1,J                                                          ASEM3280
      J2 = NBTS(I,K)                                                        ASEM3290
      IF ( IPOS(J2) .LE. J1 ) GO TO 3                                       ASEM3300
      J1 = IPOS(J2)                                                         ASEM3310
      NBNODE = NBNODE + 1                                                   ASEM3320
    3 CONTINUE                                                              ASEM3330
    4 CONTINUE                                                              ASEM3340
      I1 = 6 * NBNODE + 1                                                   ASEM3350
      DO 40 I = 1,NSUBS                                                     ASEM3360
      K1 = 36 * NSUBS + 9 * (I-1)                                           ASEM3370
      IEQ1 = 6 * NBN(I)                                                     ASEM3380
      J2 = -9                                                               ASEM3390
      J3 = 0                                                                ASEM3400
      DO 5 L = 1,9                                                          ASEM3410
      K1 = K1 + 1                                                           ASEM3420
      IF ( J3 .GE. IEQ1 ) GO TO 5                                           ASEM3430
      J2 = J2 + 10                                                          ASEM3440
      J3 = J3 + 10                                                          ASEM3450
      READ (3'K1) ((KSS(K,J),J=1,90),K=J2,J3)                               ASEM3460
    5 CONTINUE                                                              ASEM3470
      J2 = NBN(I)                                                           ASEM3480
      J3 = INTN(I)                                                          ASEM3490
      DO 10 J = 1,J2                                                        ASEM3500
      DO 10 K = 1,6                                                         ASEM3510
      J1 = 6* (J-1) + K                                                     ASEM3520
      F(J1) = 0.0                                                           ASEM3530
      DO 10 L = 1,J3                                                        ASEM3540
      DO 10 M = 1,6                                                         ASEM3550
      M1 = 6 * (L-1) + M                                                    ASEM3560
   10 F(J1) = F(J1) + KSS(J1,M1) * FORCE(NITS(I,L),M )                      ASEM3570
      K1 = 45 * NSUBS + 9 * (I-1)                                           ASEM3580
```

```
      L1 = -9                                                          ASEM3590
      L2 = 0                                                           ASEM3600
      DO 11 L = 1,9                                                    ASEM3610
      K1 = K1 + 1                                                      ASEM3620
      IF ( L2 .GE. IEQ1 ) GO TO 11                                     ASEM3630
      L1 = L1 + 10                                                     ASEM3640
      L2 = L2 + 10                                                     ASEM3650
      READ (3'K1) ((KSS(K,J),J=1,90),K=L1,L2)                          ASEM3660
11    CONTINUE                                                         ASEM3670
      J1 = I - 2                                                       ASEM3680
      ICOL1 = 1                                                        ASEM3690
      IF ( I .LE. 2 ) GO TO 13                                         ASEM3700
      DO 12 J = 1,J1                                                   ASEM3710
12    ICOL1 = ICOL1 + 6 * NBNEW(J)                                     ASEM3720
13    ICOL2 = ICOL1 + 6 * NBN(I) - 1                                   ASEM3730
      K3 = ICOL1 -1                                                    ASEM3740
      DO 40 J = 1,J2                                                   ASEM3750
      DO 40 K = 1,6                                                    ASEM3760
      DO 15 L = 1,301                                                  ASEM3770
   15 COEFF(L) = 0.0                                                   ASEM3780
      K1 = 6 * (J-1) + K                                               ASEM3790
      K2 = K1 + K3                                                     ASEM3800
      IF ( I .EQ. 1 ) GO TO 20                                         ASEM3810
      IF ( J .GT. NBNEW(I-1) ) GO TO 20                                ASEM3820
      READ (4'K2+200) COEFF                                            ASEM3830
20    DO 25 L = ICOL1, ICOL2                                           ASEM3840
   25 COEFF(L) = COEFF(L) + KSS(K1, L-ICOL1+1)                         ASEM3850
      COEFF(I1) = COEFF(I1) - F(K1)                                    ASEM3860
      IF ( I .EQ. 1 ) GO TO 27                                         ASEM3870
      IF ( J .LE. NBNEW(I-1) ) GO TO 30                                ASEM3880
27    COEFF(I1) = COEFF(I1) + FORCE(NBTS(I,J),K)                       ASEM3890
30    WRITE (4'K2+200) COEFF                                           ASEM3900
   40 CONTINUE                                                         ASEM3910
      RETURN                                                           ASEM3920
      END                                                              ASEM3930
```

```
      SUBROUTINE BDEFL ( NBNODE )                                       BDEFL010
      IMPLICIT REAL*8 (A-H, O-Z)                                        BDEFL020
C     SOLVE FOR THE BOUNDARY NODE DEFLECTIONS IN THE COMMON             BDEFL030
C     COORDINATE SYSTEM                                                 BDEFL040
C                                                                       BDEFL050
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10),  BDEFL060
     1    INTN(10)                                                      BDEFL070
      DIMENSION COEFF(301) , DISPLA(1200) , COEFR(301) , IDIS(300)      BDEFL080
      DIMENSION NBNEW(10)                                               BDEFL090
      DATA IDIS / 300 * 0 /                                             BDEFL100
      IEQ = 6 * NBNODE                                                  BDEFL110
      NBNEW(1) = NBN(1)                                                 BDEFL120
      DO 5 I = 2,NSUBS                                                  BDEFL130
 5    NBNEW(I) = NBN(I) - NBNEW(I-1)                                    BDEFL140
      I1 = IEQ + 1                                                      BDEFL150
      K = 1                                                             BDEFL160
 10   READ (4'K+200) COEFF                                              BDEFL170
      I = K + 1                                                         BDEFL180
      IF(DABS(COEFF(K)).GT. 1.0D-10) GO TO 35                           BDEFL190
      DO 15 J = I, IEQ                                                  BDEFL200
      J1 = J                                                            BDEFL210
      READ (4'J+200) COEFR                                              BDEFL220
      IF(DABS(COEFR(K)) .GT. 1.0D-10) GO TO 25                          BDEFL230
   15 CONTINUE                                                          BDEFL240
      WRITE (6,20)                                                      BDEFL250
   20 FORMAT (32H DISPLACEMENT MATRIX IS SINGULAR )                     BDEFL260
      NSUBS = -NSUBS                                                    BDEFL270
      RETURN                                                            BDEFL280
 25   WRITE (4'J1+200) COEFF                                            BDEFL290
      WRITE (4'K+200) COEFR                                             BDEFL300
      DO 30 J = 1,I1                                                    BDEFL310
   30 COEFF(J) = COEFR(J)                                               BDEFL320
 35   READ (4'I+200) COEFR                                              BDEFL330
      ZM = COEFR(K) / COEFF(K)                                          BDEFL340
      COEFR(K) = 0.0                                                    BDEFL350
      J = K + 1                                                         BDEFL360
   40 COEFR(J) = COEFR(J) - ZM * COEFF(J)                               BDEFL370
      IF (J .EQ. IEQ) GO TO 45                                          BDEFL380
      J = J + 1                                                         BDEFL390
      GO TO 40                                                          BDEFL400
   45 COEFR(J+1) = COEFR(J+1) - ZM * COEFF(J+1)                         BDEFL410
      WRITE (4'I+200) COEFR                                             BDEFL420
      IF (I .EQ. IEQ) GO TO 50                                          BDEFL430
      I = I + 1                                                         BDEFL440
      GO TO 35                                                          BDEFL450
   50 IF (K .EQ. IEQ - 1) GO TO 55                                      BDEFL460
      K = K + 1                                                         BDEFL470
      GO TO 10                                                          BDEFL480
 55   K = K + 1                                                         BDEFL490
      READ (4'K+200) COEFF                                              BDEFL500
      K2 = 0                                                            BDEFL510
      DO 60 I = 2,NSUBS                                                 BDEFL520
      K1 = K2 + 1                                                       BDEFL530
      K2 = K1 + NBNEW(I-1) - 1                                          BDEFL540
      J12 = 0                                                           BDEFL550
      DO 60 J = K1,K2                                                   BDEFL560
      J12 = J12 + 1                                                     BDEFL570
      J11 = NBTS(I,J12)                                                 BDEFL580
```

```
      DO 60 K = 1,6                                                    BDEFL590
      L = 6 * (J-1) + K                                                BDEFL600
 60   IDIS(L) = 6 * IPOS(J11) + K                                      BDEFL610
 62   DISPLA(IDIS(IEQ)) = COEFF(IEQ+1) / COEFF(IEQ)                    BDEFL620
      I = IEQ - 1                                                      BDEFL630
 65   READ (4'I+200) COEFF                                             BDEFL640
      J = I + 1                                                        BDEFL650
      S = 0.0                                                          BDEFL660
   70 S = S + COEFF(J) * DISPLA(IDIS(J))                               BDEFL670
      IF (J .EQ. IEQ) GO TO 75                                         BDEFL680
      J = J + 1                                                        BDEFL690
      GO TO 70                                                         BDEFL700
   75 DISPLA(IDIS(I)) = (COEFF(  IEQ + 1  ) - S) / COEFF(I)            BDEFL710
      IF (I .EQ. 1) GO TO 80                                           BDEFL720
      I = I - 1                                                        BDEFL730
      GO TO 65                                                         BDEFL740
   80 CONTINUE                                                         BDEFL750
      WRITE (3'1) (DISPLA(I),I=1,300)                                  BDEFL760
      WRITE (3'2) (DISPLA(I),I=301,600)                                BDEFL770
      WRITE (3'3) (DISPLA(I),I=601,900)                                BDEFL780
      WRITE (3'4) (DISPLA(I),I=901,1200)                               BDEFL790
      RETURN                                                           BDEFL800
      END                                                              BDEFL810
```

```
      SUBROUTINE IDEFL                                                  IDFL0010
C     SOLVE FOR THE INTERNAL NODE DEFLECTION OF EACH SUB-SYSTEM.        IDFL0020
C                                                                       IDFL0030
      COMMON X     ( 200) , Y     ( 200) , Z     ( 200) , TH    ( 200) ,IDFL0040
     1       PRESSE( 200) , XL  ( 200,3) , YL  ( 200,3) ,               IDFL0050
     2       RAPANG( 100) , ZGL   ( 100) , RHUB  ( 100) , RTIP  ( 100) ,IDFL0060
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM  ( 3,3) ,IDFL0070
     4       RHO , OMEGA  , POISSO , YOUNGS , RADGEN ,                  IDFL0080
     5       NGENLI , LINEI , NPRES(100) , NEXT ( 200,3) , NP , NT ,    IDFL0090
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,        IDFL0100
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) , IDFL0110
     8       PFCGN(18,1), CFCGN(18,1), MEX(200,8), IMEX(200), FORCE(    IDFL0120
     9       200,6)                                                     IDFL0130
      COMMON / MANE / NSUBS,IPOS(200),NBTS(10,15),NITS(10,15),NBN(10),  IDFL0140
     1    INTN(10)                                                      IDFL0150
      DOUBLE PRECISION DISPLA                                           IDFL0160
      DIMENSION DISPLA(1200) , A(90,90) , B(90) , DISPL(18,200)         IDFL0170
      DATA DISPL / 3600*0.0 /                                           IDFL0180
      READ  (3'1) (DISPLA(I),I=1,300)                                   IDFL0190
      READ  (3'2) (DISPLA(I),I=301,600)                                 IDFL0200
      READ  (3'3) (DISPLA(I),I=601,900)                                 IDFL0210
      READ  (3'4) (DISPLA(I),I=901,1200)                                IDFL0220
      DO 25 I = 1,NSUBS                                                 IDFL0230
      KBA = 18 * NSUBS + 18 * (I-1)                                     IDFL0240
      IEQ1 = 6 * INTN(I)                                                IDFL0250
      K1 = -9                                                           IDFL0260
      K2 = 0                                                            IDFL0270
      DO 5 L = 1,9                                                      IDFL0280
      KBA = KBA + 1                                                     IDFL0290
      IF ( K2 .GE. IEQ1 ) GO TO 5                                       IDFL0300
      K1 = K1 + 10                                                      IDFL0310
      K2 = K2 + 10                                                      IDFL0320
      READ (3'KBA) ((A(K,J),J=1,90),K=K1,K2)                            IDFL0330
 5    CONTINUE                                                          IDFL0340
      J1 = INTN(I)                                                      IDFL0350
      L1 = NBN(I)                                                       IDFL0360
      DO 15 J = 1,J1                                                    IDFL0370
      DO 15 K = 1,6                                                     IDFL0380
      K1 = 6 * (J-1) + K                                                IDFL0390
      B(K1) = 0.0                                                       IDFL0400
      DO 10 L = 1,L1                                                    IDFL0410
      L3 = NBTS(I,L)                                                    IDFL0420
      L2 = 6 * IPOS(L3)                                                 IDFL0430
      DO 10 M = 1,6                                                     IDFL0440
      M1 = L2 + M                                                       IDFL0450
      N = 6 * (L-1) + M                                                 IDFL0460
 10   B(K1) = B(K1) + A(K1,N) * DISPLA(M1)                              IDFL0470
 15   B(K1) = FORCE(NITS(I,J),K) - B(K1)                                IDFL0480
      K1 = -9                                                           IDFL0490
      K2 = 0                                                            IDFL0500
      DO 17 L = 1,9                                                     IDFL0510
      KBA = KBA + 1                                                     IDFL0520
      IF ( K2 .GE. IEQ1 ) GO TO 17                                      IDFL0530
      K1 = K1 + 10                                                      IDFL0540
      K2 = K2 + 10                                                      IDFL0550
      READ (3'KBA) ((A(K,J),J=1,90),K=K1,K2)                            IDFL0560
 17   CONTINUE                                                          IDFL0570
      J1 = INTN(I)                                                      IDFL0580
```

```
      L1 = 6 * J1                                                       IDFL0590
      DO 20 J = 1,J1                                                    IDFL0600
      K3 = NITS(I,J)                                                    IDFL0610
      DO 20 K = 1,6                                                     IDFL0620
      K1 = 6 * IPOS(K3) + K                                             IDFL0630
      K2 = 6 * ( J - 1 ) + K                                            IDFL0640
      DISPLA(K1) = 0.0                                                  IDFL0650
      DO 20 L = 1,L1                                                    IDFL0660
   20 DISPLA(K1) = DISPLA(K1) + A(K2,L) * B(L)                          IDFL0670
   25 CONTINUE                                                          IDFL0680
      DO 50 I = 1,NT                                                    IDFL0690
      LA = NEXT(I,1)                                                    IDFL0700
      LB = NEXT(I,2)                                                    IDFL0710
      LC = NEXT(I,3)                                                    IDFL0720
      NA = 6 * IPOS(LA)                                                 IDFL0730
      NB = 6 * IPOS(LB)                                                 IDFL0740
      NC = 6 * IPOS(LC)                                                 IDFL0750
      DO 40 J = 1,6                                                     IDFL0760
      IF (IPOS(LA) .LT. 0) GO TO 30                                     IDFL0770
      DISPL(J,I) = DISPLA(NA + J)                                       IDFL0780
   30 IF (IPOS(LB) .LT. 0) GO TO 35                                     IDFL0790
      DISPL(J+6,I) = DISPLA(NB+J)                                       IDFL0800
   35 IF (IPOS(LC) .LT. 0) GO TO 40                                     IDFL0810
      DISPL(J+12,I) = DISPLA(NC+J)                                      IDFL0820
   40 CONTINUE                                                          IDFL0830
   50 CONTINUE                                                          IDFL0840
      K1 = -49                                                          IDFL0850
      K2 = 0                                                            IDFL0860
      DO 52 I = 1,4                                                     IDFL0870
      K1 = K1 + 50                                                      IDFL0880
      K2 = K2 + 50                                                      IDFL0890
   52 WRITE (3'I) ((DISPL(J,K),J=1,18),K=K1,K2)                         IDFL0900
      WRITE (6,55)                                                      IDFL0910
   55 FORMAT (1H1/ 43X, 14HCOMMON  SYSTEM / 40X, 20HDEFLECTION  PRINTOUTIDFL0920
     1 // 8X, 8HNODE NO., 6X, 1HX, 9X, 1HY, 9X, 1HZ, 11X, 1HU, 14X, 1HV,IDFL0930
     2 14X, 1HW, 10X, 6HTHETAX, 9X, 6HTHETAY /)                         IDFL0940
      J = 0                                                             IDFL0950
      DO 70 I = 1,NP                                                    IDFL0960
      LA = I                                                            IDFL0970
      K = 6 * IPOS(LA)                                                  IDFL0980
      D1 = 0.0                                                          IDFL0990
      D2 = 0.0                                                          IDFL1000
      D3 = 0.0                                                          IDFL1010
      D4 = 0.0                                                          IDFL1020
      D5 = 0.0                                                          IDFL1030
      IF (IPOS(LA) .LT. 0) GO TO 60                                     IDFL1040
      D1 = DISPLA(K+1)                                                  IDFL1050
      D2 = DISPLA(K+2)                                                  IDFL1060
      D3 = DISPLA(K+3)                                                  IDFL1070
      D4 = DISPLA(K+4)                                                  IDFL1080
      D5 = DISPLA(K+5)                                                  IDFL1090
   60 J = J + 1                                                         IDFL1100
      IF (J .EQ. 50) WRITE (6,55)                                       IDFL1110
      IF (J .EQ. 50) J = 0                                              IDFL1120
   70 WRITE (6,80) I, X(I), Y(I), Z(I), D1, D2, D3, D4, D5              IDFL1130
   80 FORMAT (10X, I5, 3F10.3, 5E15.5)                                  IDFL1140
      RETURN                                                            IDFL1150
      END                                                               IDFL1160
```

```
      SUBROUTINE STRESS ( IPUNCH )                                      STRS0010
C     CALCULATE THE LOCAL NODAL DISPLACEMENT MATRIX (DISPLL), THE LOCAL STRS0020
C     MEMBRANE STRESS MATRIX (STRSLM), AND THE LOCAL BENDING STRESS     STRS0030
C     MATRIX (STRSLB) .                                                 STRS0040
C                                                                       STRS0050
      COMMON X     ( 200) , Y     ( 200) , Z     ( 200) , TH    ( 200) ,STRS0060
     1       PRESSE( 200) , XL  ( 200,3) , YL  ( 200,3) ,              STRS0070
     2       RAPANG( 100) , ZGL   ( 100) , RHUB  ( 100) , RTIP  ( 100) ,STRS0080
     3       THHUB ( 100) , THTIP ( 100) , PRESSL(100,15),EDCM  ( 3,3) ,STRS0090
     4       RHO , OMEGA  , POISSO , YOUNGS , RADGEN ,                  STRS0100
     5       NGENLI , LINE1 , NPRES(100) , NEXT ( 200,3) , NP , NT ,    STRS0110
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,        STRS0120
     7       PFLGN(9,1) , CFLGN(18,1) , ELSTIF(18,18) , ECSTIF(18,18) , STRS0130
     8       PFCGN(18,1), CFCGN(18,1), MEX(200,8), IMEX(200J, FORCE(    STRS0140
     9       200,6)                                                     STRS0150
      COMMON / TBAR / THBAR(200)                                        STRS0160
      DIMENSION EM(3,3) , WM(3,6) , PRST(15) ,   DISPLL(18,1) ,         STRS0170
     1          R6(18,18) , Z1(3,9) , Z2(3,9) , IND(6) , BST(3) , TST(3)STRS0180
     2        , VB(3,3) , STRSLM(3) , STRSLB(3) , EB(3,9),A(3) , B(3) , STRS0190
     3          C(3),DISPL(18,200)                                      STRS0200
      DATA WM / 1.0,4*0.0,1.0,2*0.0,1.0,0.0,1.0, 7*0.0 /                STRS0210
      DATA IND/ 1 , 2 , 7 , 8 , 13 , 14  /                              STRS0220
      K1 = -49                                                          STRS0230
      K2 = 0                                                            STRS0240
      DO 1  I = 1,4                                                     STRS0250
      K1 = K1 + 50                                                      STRS0260
      K2 = K2 + 50                                                      STRS0270
    1 READ (3'I) ((DISPL(J,K),J=1,18),K=K1,K2)                          STRS0280
      TERM = YOUNGS / ( 1.0 - POISSO**2  )                              STRS0290
      EM(1,1) = TERM                                                    STRS0300
      EM(1,2) = TERM * POISSO                                           STRS0310
      EM(1,3) = 0.0                                                     STRS0320
      EM(2,1) = EM(1,2)                                                 STRS0330
      EM(2,2) = EM(1,1)                                                 STRS0340
      EM(2,3) = 0.0                                                     STRS0350
      EM(3,1) = 0.0                                                     STRS0360
      EM(3,2) = 0.0                                                     STRS0370
      EM(3,3) = TERM * ( 1.0 - POISSO ) / 2.0                           STRS0380
      WRITE (6,5)                                                       STRS0390
    5 FORMAT (1H1 / 44X,13HLOCAL  SYSTEM / 35X,30HDEFLECTION AND STRESS STRS0400
     1PRINTOUT )                                                        STRS0410
      KOUNT = -1                                                        STRS0420
      DO 65 I = 1,NT                                                    STRS0430
      IPASS = 0                                                         STRS0431
      SIGNSS = 1.0                                                      STRS0432
      READ (4'I) R6 , AMNIN , ABNIN                                     STRS0440
      DO 10 J = 1,18                                                    STRS0450
      DISPLL (J,1) = 0.0                                                STRS0460
      DO 10 K = 1,18                                                    STRS0470
   10 DISPLL(J,1) = DISPLL(J,1) + R6(K,J) * DISPL(K,I)                  STRS0480
      KOUNT = KOUNT + 1                                                 STRS0490
      IF ( KOUNT .EQ. 2 ) WRITE (6,5)                                   STRS0500
      IF ( KOUNT .EQ. 2 ) KOUNT = 0                                     STRS0510
      LA = NEXT(I,1)                                                    STRS0520
      LB = NEXT(I,2)                                                    STRS0530
      LC = NEXT(I,3)                                                    STRS0540
      WRITE (6,15) I,LA,X(LA),Y(LA),Z(LA),DISPLL(1,1),DISPLL(2,1),      STRS0550
     1  DISPLL(3,1), LB,X(LB),Y(LB),Z(LB),DISPLL(7,1),DISPLL(8,1),      STRS0560
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     2 DISPLL( 9,1), LC,X(LC),Y(LC),Z(LC),DISPLL(13,1),DISPLL(14,1),     STRS0570
     3 DISPLL(15,1)                                                      STRS0580
  15   FORMAT (// 43X,12HELEMENT NO. I4 /11X,72HNODE        X          Y   STRS0590
     1      Z          U               V               W / 12X,73HNO.    COSTRS0600
     2MMON     COMMON     COMMON      LOCAL           LOCAL          LOCAL /STRS0610
     38X,2HLA,I5,3F10.3,3E15.5 / 8X,2HLB,I5,3F10.3,3E15.5 / 8X,2HLC,I5, STRS0620
     43F10.3,3E15.5 )                                                    STRS0630
      DO 20 J = 1,3                                                      STRS0640
      DO 20 K = 1,6                                                      STRS0650
      Z1(J,K) = 0.0                                                      STRS0660
      DO 20 L = 1,3                                                      STRS0670
  20  Z1(J,K) = Z1(J,K) + EM(J,L) * WM(L,K)                              STRS0680
      DO 30 J = 1,3                                                      STRS0690
      DO 30 K = 1,6                                                      STRS0700
      Z2(J,K) = 0.0                                                      STRS0710
      DO 30 L = 1,6                                                      STRS0720
  30  Z2(J,K) = Z2(J,K) + Z1(J,L) * AMNIN(L,K)                           STRS0730
      DO 40 J = 1,3                                                      STRS0740
      STRSLM(J) = 0.0                                                    STRS0750
      DO 40 K = 1,6                                                      STRS0760
  40  STRSLM(J) = STRSLM(J) + Z2(J,K) * DISPLL(IND(K),1)                 STRS0770
C                                                                        STRS0780
C                                                                        STRS0790
C                                                                        STRS0800
      TERM1= YOUNGS * THBAR(I) / 2.0 / ( 1.0 - POISSO**2 )               STRS0810
      A(1) = -2.0 * TERM1 * (( 3.0 * ABNIN(6,1) + POISSO * ABNIN(8,1) ) STRS0820
     1       * DISPLL(3,1) + POISSO * ABNIN(8,2) * DISPLL(4,1) + ( 3.0 *STRS0830
     2       ABNIN(6,3) + POISSO * ABNIN(8,3) ) * DISPLL(5,1) + ( 3.0 * STRS0840
     3       ABNIN(6,4) + POISSO * ABNIN(8,4) ) * DISPLL(9,1) + POISSO *STRS0850
     4       ABNIN(8,5) * DISPLL(10,1) + ( 3.0 * ABNIN(6,6) + POISSO *  STRS0860
     5       ABNIN(8,6) ) * DISPLL(11,1) + POISSO * ABNIN(8,9) *        STRS0870
     6       DISPLL(17,1))                                              STRS0880
      A(2) = -2.0 * TERM1 * (( 3.0 * POISSO * ABNIN(6,1) + ABNIN(8,1) ) STRS0890
     1       * DISPLL(3,1) + ABNIN(8,2) * DISPLL(4,1) + ( 3.0 * POISSO *STRS0900
     2       ABNIN(6,3) + ABNIN(8,3) ) * DISPLL(5,1) + ( 3.0 * POISSO * STRS0910
     3       ABNIN(6,4) + ABNIN(8,4) ) * DISPLL(9,1) + ABNIN(8,5) *     STRS0920
     4       DISPLL(10,1) + ( 3.0 * POISSO * ABNIN(6,6) + ABNIN(8,6) ) *STRS0930
     5       DISPLL(11,1) + ABNIN(8,9) * DISPLL(17,1))                  STRS0940
      A(3) = 2.0 * TERM1* ( ABNIN(7,2) * DISPLL(4,1) + ABNIN(7,5) *      STRS0950
     1       DISPLL(10,1) ) * ( 1.0 - POISSO )                          STRS0960
      B(1) = -2.0 * TERM1 * ( 3.0 * POISSO * ABNIN(9,1) * DISPLL(3,1) + STRS0970
     1       ( ABNIN(7,2) + 3.0 * POISSO * ABNIN(9,2) ) * DISPLL(4,1) + STRS0980
     2       3.0 * POISSO * ABNIN(9,3) * DISPLL(5,1) + 3.0 * POISSO *   STRS0990
     3       ABNIN(9,4) * DISPLL(9,1) + ( ABNIN(7,5) + 3.0 * POISSO *   STRS1000
     4       ABNIN(9,5) ) * DISPLL(10,1) + 3.0 * POISSO * ABNIN(9,6) *  STRS1010
     5       DISPLL(11,1) + 3.0 * POISSO * ABNIN(9,7) * DISPLL(15,1) +  STRS1020
     6       3.0 * POISSO * ABNIN(9,8) * DISPLL(16,1) )                 STRS1030
      B(2) = -2.0 * TERM1* ( 3.0 * ABNIN(9,1) * DISPLL(3,1) + ( POISSO *STRS1040
     1       ABNIN(7,2) + 3.0 * ABNIN(9,2) ) * DISPLL(4,1) + 3.0 *      STRS1050
     2       ABNIN(9,3) * DISPLL(5,1) + 3.0 * ABNIN(9,4) * DISPLL(9,1)  STRS1060
     3       + ( POISSO * ABNIN(7,5) + 3.0 * ABNIN(9,5) ) * DISPLL(10,1)STRS1070
     4       + 3.0 * ABNIN(9,6) * DISPLL(11,1) + 3.0 * ABNIN(9,7) *     STRS1080
     5       DISPLL(15,1) + 3.0 * ABNIN(9,8) * DISPLL(16,1) )           STRS1090
      B(3) = 2.0 * TERM1 * ( ABNIN(8,1) * DISPLL(3,1) + ABNIN(8,2) *    STRS1100
     1       DISPLL(4,1) + ABNIN(8,3) * DISPLL(5,1) + ABNIN(8,4) *      STRS1110
     2       DISPLL(9,1) + ABNIN(8,5) * DISPLL(10,1)+ ABNIN(8,6) *      STRS1120
     3       DISPLL(11,1)+ ABNIN(8,9) * DISPLL(17,1) ) * ( 1.0 - POISSO)STRS1130
      C(1) = -2.0 * TERM1 * (( ABNIN(4,1) + POISSO * ABNIN(5,1) ) *     STRS1140
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     1       DISPLL(3,1) + POISSO * ABNIN(5,2) * DISPLL(4,1) +          STRS1150
     2       ( ABNIN(4,3) + POISSO * ABNIN(5,3) ) * DISPLL(5,1) +       STRS1160
     3       ( ABNIN(4,4) + POISSO * ABNIN(5,4) ) * DISPLL(9,1) +       STRS1170
     4       ( ABNIN(4,6) + POISSO * ABNIN(5,6) ) * DISPLL(11,1) +      STRS1180
     5       POISSO * ABNIN(5,7) * DISPLL(15,1) + POISSO * ABNIN(5,8) * STRS1190
     6       DISPLL(16,1) + POISSO * ABNIN(5,9) * DISPLL(17,1))         STRS1200
      C(2) = -2.0 * TERM1 *(( POISSO * ABNIN(4,1) + ABNIN(5,1) ) *      STRS1210
     1       DISPLL(3,1) + ABNIN(5,2) * DISPLL(4,1) + ( POISSO *        STRS1220
     2       ABNIN(4,3) + ABNIN(5,3) ) * DISPLL(5,1) + ( POISSO *       STRS1230
     3       ABNIN(4,4) + ABNIN(5,4) ) * DISPLL(9,1) + ( POISSO *       STRS1240
     4       ABNIN(4,6) + ABNIN(5,6) ) * DISPLL(11,1) + ABNIN(5,7) *    STRS1250
     5       DISPLL(15,1) + ABNIN(5,8) * DISPLL(16,1) + ABNIN(5,9) *    STRS1260
     6       DISPLL(17,1))                                              STRS1270
      C(3) = 0.0                                                        STRS1280
      XG = ( XL(I,1) + XL(I,2) + XL(I,3) ) / 3.0                        STRS1290
      YG = ( YL(I,1) + YL(I,2) + YL(I,3) ) / 3.0                        STRS1300
 45   DO 50 K = 1,3                                                     STRS1310
      BST(K) = ( A(K)*XG + B(K)*YG + C(K) ) * SIGNSS                    STRS1320
C                                                                       STRS1330
C                                                                       STRS1340
C                                                                       STRS1350
C                                                                       STRS1360
C                                                                       STRS1370
 50   TST(K) = BST(K) + STRSLM(K)                                       STRS1380
      TERM1 = ( TST(1) + TST(2) ) / 2.0                                 STRS1390
      TERM2 = SQRT( ( TST(1) - TST(2) )**2 / 4.0 + TST(3)**2 )          STRS1400
      SIGNS = 1.0                                                       STRS1410
      IF ( TST(2) .GT. TST(1) ) SIGNS = -1.0                            STRS1420
      PRST(1) = TERM1 + SIGNS * TERM2                                   STRS1430
      PRST(2) = TERM1 - SIGNS * TERM2                                   STRS1440
      PRST(3) = 0.5 * ATAN( 2.0 * TST(3) / ( TST(1) - TST(2) ) ) *      STRS1450
     1          57.29578                                               STRS1460
      PRST(4) = ( PRST(1) - PRST(2) ) / 2.0                             STRS1470
      PRST(5) = SQRT( PRST(1)**2 - PRST(1) * PRST(2) + PRST(2)**2 )     STRS1480
      IF ( IPASS .EQ. 0 ) WRITE (6,55) (A(K),B(K),C(K),BST(K),K=1,3)    STRS1490
 55   FORMAT (/20X,74HBENDING STRESSES  =  A * ( LOCAL X VALUE )  +  B *STRS1500
     1 ( LOCAL Y VALUE )  +  C // 42X,1HA,14X,1HB,14X,1HC,7X,17HVALUE ATSTRS1510
     2 CENTROID / 26X,9HSIGMAXBAR , 4E15.5 / 26X,9HSIGMAYBAR ,4E15.5 /  STRS1520
     3 26X,9HSHEAR    ,4E15.5)                                         STRS1530
      TERM1 = ( BST(1) + BST(2) ) / 2.0                                 STRS1540
      TERM2 = SQRT( ( BST(1) - BST(2) )**2 / 4.0 + BST(3)**2 )          STRS1550
      SIGNS = 1.0                                                       STRS1560
      IF ( BST(2) .GT. BST(1) ) SIGNS = -1.0                            STRS1570
      PRST(6) = TERM1 + SIGNS * TERM2                                   STRS1580
      PRST(7) = TERM1 - SIGNS * TERM2                                   STRS1590
      PRST(8) = 0.5 * ATAN( 2.0 * BST(3) / ( BST(1) - BST(2) ) ) *      STRS1600
     1          57.29578                                               STRS1610
      PRST(9) = ( PRST(6) - PRST(7) ) / 2.0                             STRS1620
      PRST(10) = SQRT( PRST(6)**2 - PRST(6) * PRST(7) + PRST(7)**2 )    STRS1630
      TERM1 = ( STRSLM(1) + STRSLM(2) ) / 2.0                           STRS1640
      TERM2 = SQRT( ( STRSLM(1) - STRSLM(2) )**2 / 4.0 + STRSLM(3)**2 ) STRS1650
      SIGNS = 1.0                                                       STRS1660
      IF ( STRSLM(2) .GT. STRSLM(1) ) SIGNS = -1.0                      STRS1670
      PRST(11) = TERM1 + SIGNS * TERM2                                  STRS1680
      PRST(12) = TERM1 - SIGNS * TERM2                                  STRS1690
      PRST(13) = 0.5 * ATAN( 2.0 * STRSLM(3) / ( STRSLM(1) - STRSLM(2) )STRS1700
     1           ) * 57.29578                                           STRS1710
      PRST(14) = ( PRST(11) - PRST(12) ) / 2.0                          STRS1720
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      PRST(15) = SQRT( PRST(11)**2 - PRST(11) * PRST(12) + PRST(12)**2 )STRS1730
      IF ( IPASS .EQ. 0 ) WRITE (6,60) (STRSLM(J),J=1,3) , (PRST(J),J=11STRS1740
     1 ,15) , (BST(J),J=1,3) , (PRST(J),J=6,10) , (TST(J),J=1,3) ,      STRS1750
     2        (PRST(J),J=1,5)                                          STRS1755
   60 FORMAT (/ 61X,3( 'PRINCIPAL' 6X ), ' MAXIMUM       EFFECTIVE' /   STRS1760
     1 16X 'SIGMAXBAR     SIGMAYBAR       SHEAR       SIGMAXBAR      STRS1770
     2SIGMAYBAR     THETA (DEG)        SHEAR        STRESS' / ' MEMBRANESTRS1780
     3  ' 8E15.5 / ' BEND.(TOP)' 8E15.5 / ' TOT. (TOP)' 8E15.5       )  STRS1790
      IF ( IPASS .EQ. 1 ) WRITE (6,61) (BST(J),J=1,3) , (PRST(J),J=6,10 STRS1791
     1   ) , (TST(J),J=1,3) , (PRST(J),J=1,5)                          STRS1792
   61 FORMAT ( ' BEND.(BOT)' 8E15.5 / ' TOT. (BOT)' 8E15.5 //// )      STRS1793
      IPASS = IPASS + 1                                                STRS1794
      SIGNSS = -1.0                                                    STRS1795
      IF ( IPASS .NE. 1 ) GO TO 65                                     STRS1796
      XG = ( XL(I,2) + XL(I,3) ) / 3.0                                 STRS1797
      IF ( IPUNCH .NE. 0 ) WRITE (7,62) XL(I,2), XG, PRST(4), TST(1),  STRS1798
     1   PRST(5), PRST(10), PRST(15)                                   STRS1799
   62 FORMAT ( 2F10.6, 1P5E10.3 )                                      STRS179A
      GO TO 45                                                         STRS179B
   65 CONTINUE                                                         STRS1800
      RETURN                                                           STRS1810
      END                                                              STRS1820
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CLOCK   START 0                                                        CLOK0000
BR0     EQU   0                                                        CLOK0010
BR1     EQU   1                                                        CLOK0021
BR2     EQU   2                                                        CLOK0022
BR3     EQU   3                                                        CLOK0023
BR4     EQU   4                                                        CLOK0024
BR5     EQU   5                                                        CLOK0025
BR6     EQU   6                                                        CLOK0026
BR7     EQU   7                                                        CLOK0027
BR8     EQU   8                                                        CLOK0028
BR9     EQU   9                                                        CLOK0029
BR10    EQU   10                                                       CLOK0030
BR11    EQU   11                                                       CLOK0031
BR12    EQU   12                                                       CLOK0032
BR13    EQU   13                                                       CLOK0033
BR14    EQU   14                                                       CLOK0034
BR15    EQU   15                                                       CLOK0035
        ENTRY HCLOCK,ICLOCK,SCLOCK,DATE
        USING *,BR15
HCLOCK  SAVE  (14,5),,*                                                CLOK0100
        LR    BR1,BR13                                                 CLOK0103
        LA    BR13,SAVE                                                CLOK0105
        ST    BR13,8(0,BR1)                                            CLOK0107
        ST    BR1,4(0,BR13)                                            CLOK0109
        TIME                                                           CLOK0110
        L     BR13,4(0,BR13)                                           CLOK0112
        L     BR15,16(0,BR13)     RESTORE BASE REGISTER                CLOK0115
        O     BR0,ZFBYT           INSURE PROPER SIGN FOR PACKED DIGIT. CLOK0120
        ST    BR0,PTIME           TEMP STORAGE FOR PACKED TIME.        CLOK0130
        UNPK  ZTIME(7),PTIME(4)   UNPACK TIME TO ZONED DECIMAL.        CLOK0140
        L     BR3,ZTIME           HOURS AND MINUTES.                   CLOK0150
        SLDL  BR2,16              SHIFT IN                             CLOK0160
        SLL   BR2,16              HOURS WITH                           CLOK0170
        O     BR2,BLNK2           TRAILING BLANKS.                     CLOK0180
        L     BR1,24(0,BR13)                                           CLOK0190
        L     BR5,0(0,BR1)        ADDRESS OF FIRST PARAMETER.          CLOK0200
        ST    BR2,0(0,BR5)        SAVE TIME.                           CLOK0210
        SLDL  BR2,16              SHIFT IN                             CLOK0220
        SLL   BR2,16              MINUTES WITH                         CLOK0230
        O     BR2,BLNK2           TRAILING BLANKS.                     CLOK0240
        L     BR5,4(0,BR1)                                             CLOK0245
        ST    BR2,0(0,BR5)        SAVE MINUTES.                        CLOK0250
        L     BR3,ZTIME+4         MINUTE AND TENTHS                    CLOK0260
        SLDL  BR2,16              SHIFT IN                             CLOK0270
        SLL   BR2,16              SECONDS WITH                         CLOK0280
        O     BR2,BLNK2           TRAILING BLANKS.                     CLOK0290
        L     BR5,8(0,BR1)                                             CLOK0295
        ST     BR2,0(0,BR5)       SAVE SECONDS.                        CLOK0300
        RETURN (14,5),T                                                CLOKK310
        USING *,BR15
ICLOCK  SAVE  (14,5),,*                                                CLOK0100
        LR    BR1,BR13                                                 CLOKO
        LA    BR13,SAVE                                                CLOKO
        ST    BR13,8(0,BR1)                                            CLOKO
        ST    BR1,4(0,BR13)                                            CLOKO
        TIME  BIN                                                      CLOK0330
        L     BR13,4(0,BR13)                                           CLOK0333
        L     BR15,16(0,BR13)     RESTORE BASE REGISTER                CLOK0335
```

```
                LR    BR1,BR0                                                  CLOK0337
                SR    BR0,BR0                                                  CLOK0339
                D     BR0,F100          CHANGE TO SECONDS FROM HUNDREDTHS      CLOK0340
                LR    BR0,BR1                                                  CLOK0350
                L     BR1,24(0,BR13)    RELOAD ADDRESS OF PARAMETER LIST.      CLOK0360
                L     BR5,0(0,BR1)                                             CLOK0370
                ST    BR0,0(0,BR5)      STORE TIME                             CLOK0380
                RETURN (14,5),T                                                CLOK0390
                USING *,BR15
SCLOCK          SAVE  (14,5),,*                                                CLOK0100
                LR    BR1,BR13                                                 CLOK0
                LA    BR13,SAVE                                                CLOK0
                ST    BR13,8(0,BR1)                                            CLOK0
                ST    BR1,4(0,BR13)                                            CLOK0
                TIME  BIN                                                      CLOK0410
                L     BR13,4(0,BR13)                                           CLOK0420
                L     BR1,24(0,BR13)                                           CLOK0430
                L     BR5,0(0,BR1)                                             CLOK0440
                ST    BR0,0(0,BR5)      STORE TIME                             CLOK0450
                RETURN (14,5),T                                                CLOK0460
                USING *,BR15
DATE            SAVE  (14,5),,*                                                CLOK0100
                LR    BR1,BR13                                                 CLOK0
                LA    BR13,SAVE                                                CLOK0
                ST    BR13,8(0,BR1)                                            CLOK0
                ST    BR1,4(0,BR13)                                            CLOK0
                TIME  DEC                                                      CLOK0480
                L     BR13,4(0,BR13)                                           CLOK0483
                L     BR15,16(0,BR13)   RESTORE BASE REGISTER                  CLOK0485
                LR    BR4,BR1         LOAD DATE INTO EVEN REGISTER.            CLOK0490
                SRDL  BR4,16          SHIFT DAY OF YEAR TO ODD REGISTER.       CLOK0500
                SRL   BR5,16          RIGHT JUSTIFY IT WITH LEADING ZEROES.    CLOK0510
                SLL   BR4,4           SET-UP YEAR TO ACCEPT A SIGN             CLOK0520
                O     BR5,ZFBYT       INSURE PROPER SIGN FOR DAY OF YEAR.      CLOK0530
                O     BR4,ZFBYT       INSURE PROPER SIGN FOR YEAR.             CLOK0540
                ST    BR4,PYEAR       STORE YEAR.                              CLOK0550
                ST    BR4,LYEAR       STORE YEAR                               CLOK0555
                ST    BR5,PDOFY       STORE DAY OF YEAR.                       CLOK0560
*               IS THIS LEAP YEAR.                                             CLOK0570
                DP    LYEAR(4),PFOUR(1)                                        CLOK0580
                CP    LYEAR+3(1),ZFBYT+3(1) REMAINDER = 0 - MEANS LEAP YEAR    CLOK0590
                BE    LPYER           BRANCH IF LEAP YEAR.                     CLOK0600
*               IS IT DECEMBER                                                 CLOK0610
FINDT           L     BR4,DEC12                                                CLOK0620
                CP    PDOFY(4),PK334(4)  IS IT DECEMBER.                       CLOK0630
                BH    DECSI           YES.                                     CLOK0640
*               IS IT NOVEMBER                                                 CLOK0650
                L     BR4,NOV11                                                CLOK0660
                CP    PDOFY(4),PK304(4)  IS IT NOVEMBER.                       CLOK0670
                BH    NOVSI           YES                                      CLOK0680
*               IS IT OCTOBER                                                  CLOK0690
                L     BR4,OCT10                                                CLOK0700
                CP    PDOFY(4),PK273(4)                                        CLOK0710
                BH    OCTSI                                                    CLOK0720
*               IS IT SEPTEMBER                                                CLOK0730
                L     BR4,SEP09                                                CLOK0740
                CP    PDOFY(4),PK243(4)  IS IT SEPTEMBER.                      CLOK0750
                BH    SEPSI           YES                                      CLOK0760
```

```
*               IS IT AUGUEST                                          CLOK0770
          L     BR4,AUG08                                              CLOK0780
          CP    PDOFY(4),PK212(4)     IS IT AUGUEST                    CLOK0790
          BH    AUGSI                 YES                              CLOK0800
*               IS IT JULY                                             CLOK0810
          L     BR4,JUL07                                              CLOK0820
          CP    PDOFY(4),PK181(4)     IS IT JULY                       CLOK0830
          BH    JULSI                 YES                              CLOK0840
*               IS IT JUNE                                             CLOK0850
          L     BR4,JUN06                                              CLOK0860
          CP    PDOFY(4),PK151(4)     IS IT JUNE                       CLOK0870
          BH    JUNSI                 YES                              CLOK0880
*               IS IT MAY                                              CLOK0890
          L     BR4,MAY05                                              CLOK0900
          CP    PDOFY(4),PK120(4)     IS IT MAY                        CLOK0910
          BH    MAYSI                 YES                              CLOK0920
*               IS IT APRIL                                            CLOK0930
          L     BR4,APR04                                              CLOK0940
          CP    PDOFY(4),PK090(4)     IS IT APRIL                      CLOK0950
          BH    APRSI                 YES                              CLOK0960
*               IS IT MARCH                                            CLOK0970
          L     BR4,MAR03                                              CLOK0980
          CP    PDOFY(4),PK059(4)     IS IT MARCH                      CLOK0990
          BH    MARSI                 YES                              CLOK1000
*               IS IT FEBRUARY                                         CLOK1010
FERJA     L     BR4,FEB02                                              CLOK1020
          CP    PDOFY(4),PK031(4)     IS IT FEBRUARY                   CLOK1030
          BH    FEBSI                 YES                              CLOK1040
*               IT MUST BE JANUARY                                     CLOK1050
          L     BR4,JAN01                                              CLOK1060
STOAT     L     BR1,24(0,BR13)                                         CLOK1070
          L     BR5,0(0,BR1)                                           CLOK1080
          ST    BR4,0(0,BR5)          STORE MONTH - MM  .              CLOK1090
          UNPK  ZTIME+2(2),PDOFY+2(2) UNPACK DAY OF MONTH.             CLOK1100
          L     BR4,ZTIME                                              CLOK1110
          SLL   BR4,16                LEFT JUSTIFY.                    CLOK1120
          O     BR4,BLNK2             PUT IN TRAILING BLANKS.          CLOK1130
          L     BR5,4(0,BR1)                                           CLOK1140
          ST    BR4,0(0,BR5)          STORE DAY - DD  .                CLOK1150
          UNPK  ZTIME+2(2),PYEAR+2(2)                                  CLOK1160
          L     BR4,ZTIME                                              CLOK1170
          SLL   BR4,16                                                 CLOK1180
          O     BR4,BLNK2                                              CLOK1190
          L     BR5,8(0,BR1)                                           CLOK1200
          ST    BR4,0(0,BR5)          STORE YEAR - YY  .               CLOK1210
          RETURN (14,5),T                                              CLOK1220
*               ITS LEAP YEAR                                          CLOK1230
LPYER     CP    PDOFY(4),PK060(4)     IS IT JANUARY OR FEBRUARY        CLOK1240
          BNH   FERJA                 YES                              CLOK1250
          SP    PDOFY(4),PK001(4)     REDUCE DAYS BY ONE.              CLOK1260
          B     FINDT                 GO FIND DATE.                    CLOK1270
*               CALCULATE DAY OF MONTH.                                CLOK1280
DECSI     SP    PDOFY(4),PK334(4)                                      CLOK1290
          B     STOAT                                                  CLOK1300
NOVSI     SP    PDOFY(4),PK304(4)                                      CLOK1310
          B     STOAT                                                  CLOK1320
OCTSI     SP    PDOFY(4),PK273(4)                                      CLOK1330
          B     STOAT                                                  CLOK1340
```

```
SEPSI   SP    PDOFY(4),PK243(4)                                  CLOK1350
        B     STOAT                                              CLOK1360
AUGSI   SP    PDOFY(4),PK212(4)                                  CLOK1370
        B     STOAT                                              CLOK1380
JULSI   SP    PDOFY(4),PK181(4)                                  CLOK1390
        B     STOAT                                              CLOK1400
JUNSI   SP    PDOFY(4),PK151(4)                                  CLOK1410
        B     STOAT                                              CLOK1420
MAYSI   SP    PDOFY(4),PK120(4)                                  CLOK1430
        B     STOAT                                              CLOK1440
APRSI   SP    PDOFY(4),PK090(4)                                  CLOK1450
        B     STOAT                                              CLOK1460
MARSI   SP    PDOFY(4),PK059(4)                                  CLOK1470
        B     STOAT                                              CLOK1480
FEBSI   SP    PDOFY(4),PK031(4)                                  CLOK1490
        B     STOAT                                              CLOK1500
JAN01   DC    C' 1  '                                            CLOK1600
FEB02   DC    C' 2  '                                            CLOK1610
MAR03   DC    C' 3  '                                            CLOK1620
APR04   DC    C' 4  '                                            CLOK1630
MAY05   DC    C' 5  '                                            CLOK1640
JUN06   DC    C' 6  '                                            CLOK1650
JUL07   DC    C' 7  '                                            CLOK1660
AUG08   DC    C' 8  '                                            CLOK1670
SEP09   DC    C' 9  '                                            CLOK1680
OCT10   DC    C'10  '                                            CLOK1690
NOV11   DC    C'11  '                                            CLOK1700
DEC12   DC    C'12  '                                            CLOK1710
BLNK2   DC    C'00  '                                            CLOK1720
ZFBYT   DC    PL4'0'                                             CLOK1730
PYEAR   DC    PL4'0'                                             CLOK1740
LYEAR   DC    PL4'0'                                             CLOK1750
PDOFY   DC    PL4'0'                                             CLOK1760
PK334   DC    PL4'334'                                           CLOK1770
PK304   DC    PL4'304'                                           CLOK1780
PK273   DC    PL4'273'                                           CLOK1790
PK243   DC    PL4'243'                                           CLOK1800
PK212   DC    PL4'212'                                           CLOK1810
PK181   DC    PL4'181'                                           CLOK1820
PK151   DC    PL4'151'                                           CLOK1830
PK120   DC    PL4'120'                                           CLOK1840
PK090   DC    PL4'090'                                           CLOK1850
PK059   DC    PL4'059'                                           CLOK1860
PK031   DC    PL4'031'                                           CLOK1870
PK060   DC    PL4'060'                                           CLOK1880
PK001   DC    PL4'001'                                           CLOK1890
PFOUR   DC    P'4'                                               CLOK1900
ZTIME   DS    2F                                                 CLOK1910
PTIME   DS    1F                                                 CLOK1920
F100    DC    F'6000'                                            CLOK1930
SAVE    DS    18F          SAVE AREA FOR THIS PROGRAM.           CLOK0705
        END                                                      CLOK0720
```

```
*            ZEROC - FILL DESIGNATED AREA OF CORE WITH ZERO OR WITH      ZER00000
*                    A CONSTANT SUPPLIED IN THE CALLING SEQUENCE.        ZER00010
*                                                                        ZER00020
*                         CALLING SEQUENCE                               ZER00030
*                           CALL ZEROC (FROM,TO)                         ZER00040
*                                 OR                                     ZER00050
*                           CALL ZEROC (FROM,TO,CONST)                   ZER00060
*                                                                        ZER00070
*                           WHERE-FROM-IS THE STARTING ADDRESS           ZER00080
*                                 TO-FINAL ADDRESS TO BE CLEARED         ZER00090
*                                 CONST-THE CONSTANT CORE IS TO BE       ZER00100
*                                       FILLED WITH. IF NOT SUPPLIED     ZER00110
*                                       IN CALLING SEQUENCE, CORE        ZER00120
*                                       WILL BE FILLED WITH ZEROES.      ZER00130
*                                                                        ZER00140
PWZERO  START 0                                                          ZER00150
BR0     EQU   0                    BASE REGISTER 0                       ZER00160
BR1     EQU   1                                                          ZER00170
BR2     EQU   2                                                          ZER00180
BR3     EQU   3                                                          ZER00190
BR4     EQU   4                                                          ZER00200
BR5     EQU   5                                                          ZER00210
BR6     EQU   6                                                          ZER00220
BR7     EQU   7                                                          ZER00230
BR8     EQU   8                                                          ZER00240
BR9     EQU   9                                                          ZER00250
BR10    EQU   10                                                         ZER00260
BR11    EQU   11                                                         ZER00270
BR12    EQU   12                                                         ZER00280
BR13    EQU   13                                                         ZER00290
BR14    EQU   14                                                         ZER00300
BR15    EQU   15                                                         ZER00310
*                                                                        ZER00320
        ENTRY ZERO                                                       ZER00325
        USING *,BR15                                                     ZER00340
ZERO    SAVE  (14,12),,*                                                 ZER00330
        ST    BR13,SAVE+4                                                ZER00350
        LA    BR10,SAVE                                                  ZER00360
        ST    BR10,8(0,BR13)                                             ZER00370
        L     BR3,0(0,BR1)                                               ZER00390
        L     BR4,4(0,BR1)                                               ZER00400
        N     BR3,BIGAD            INSURE ADDRESS ONLY.                  ZER00410
        N     BR4,BIGAD            INSURE ADDRESS ONLY.                  ZER00420
        CLR   BR3,BR4              1ST ARG. LESS THAN 2ND ARG.           ZER00430
        BNL   SWITCH               NO, THEN SWITCH REGISTERS.            ZER00440
MODE1   TM    4(BR1),X'80'                                               ZER00470
        BZ    NTZRO                MORE ARGUMENTS.                       ZER00480
MODE    A     BR4,FORBT            YES,CALCULATE BYTES TO BE CLEARED.    ZER00450
        SR    BR4,BR3              BR4 EQUAL NO. OF BYTES.               ZER00460
MORE    C     BR4,TWO56            OVER 255 BYTES TO CLEAR               ZER00500
        BL    LESTN                YES                                   ZER00510
        S     BR4,TWO56            REDUCE BY 256                         ZER00520
        L     BR5,TWO56                                                  ZER00530
MONE    S     BR5,TWO                                                    ZER00540
        STC   BR5,MOVE+1                                                 ZER00550
MOVE    XC    0(0,BR3),0(BR3)                                            ZER00560
        A     BR3,TWO56                                                  ZER00570
        LTR   BR4,BR4                                                    ZER00580
```

```
         BC    2,MORE                                          ZERO0590
RETRN    RETURN (14,12),T          RESTORE AND RETURN        ZERO0600
LESTN    LR    BR5,BR4                                         ZERO0610
         LA    BR4,0                                           ZERO0620
         B     MONE                                            ZERO0630
SWITCH   LR    BR5,BR3                                         ZERO0640
         LR    BR3,BR4                                         ZERO0650
         LR    BR4,BR5                                         ZERO0660
         B     MODE1                                           ZERO0670
NTZRO    L     BR6,8(0,BR1)                                    ZERO0680
         L     BR6,0(0,BR6)                                    ZERO0685
NTZR1    ST    BR6,0(0,BR3)                                    ZERO0690
         CR    BR3,BR4                                         ZERO0700
         BE    RETRN                                           ZERO0710
         A     BR3,FORBT                                       ZERO0720
         B     NTZR1                                           ZERO0730
SAVE     DS    18F                                             ZERO1000
BIGAD    DC    X'00FFFFFF'                                     ZERO1010
FORBT    DC    F'4'                                            ZERO1020
TWO56    DC    F'256'                                          ZERO1030
TWO      DC    F'1'                                            ZERO1050
         END                                                   ZERO9990
```

SECTION IV
VIBRATION COMPUTER PROGRAM (PWA 6140)

A. GENERAL

The vibration computer program is a finite element analysis which uses many of the same subroutines as the stress program. This program calculates natural frequencies and the distribution of relative displacement and stress for each resonant frequency. The resonant frequencies which satisfy the eigen-value equation: are obtained by reducing the term

$$[A] = [M]_T^{*-1} [K]_T^*$$

to an almost triangular Hessenburg form $[H]$ by elementary similarity transformation. The eigen-values are then determined by an extension of Hyman's method followed by iterations using a modification of Laguerre's method.

The size of the eigen-value subroutine limits the number of free finite element nodes to 50 (100 total nodes). The program requires 210,000 bytes of core on the IBM System 360, Model 75 computer. Computer time for the full 50 nodes is approximately 3 minutes. Single precision with 4 bytes/word and 8 bits/byte is used. Fortran IV-G, Level 1, Mod. 3 compilations were used.

B. INPUT DESCRIPTION

The input to the vibration computer program generally consists of: a physical description of the inducer, a description of the finite element breakup to be used, and a specification of the number of vibratory nodes required.

The finite element breakup should be sketched to aid in preparing the program input. An example is shown in figure 1. The program is limited to 50 free nodes (all nodes at the hub are fixed), 100 total nodes, and 100 triangular elements.

The program will reproduce the required finite element breakup properly if the following rules are observed when preparing the input.

1. If generator line "i" has "ii" points and generator line "i+1" has "ii$\pm$1" points, then the lines forming the edges of the finite elements start at the first point of the generator with the least number of points and zig zag between the generator lines. The areas between generators A and B, B and C, D and E, etc., of figure 1 are examples.

2. The area between the first two generator lines with the same number of points will be broken up as shown between generators F and G and G and H of figure 1.

3. The procedure of (2) will be followed for all generators with the same number of points until symmetry about a generator is requested, as was done about generator H in figure 1.

4. The altered breakup will continue for sections between generators with the same number of points, until symmetry is again requested, as was done about generator J in figure 1. After symmetry is again requested, the breakup will revert to the original pattern.

5. If two generators "i" and "j" have "m" and "n" points respectively such that

$$m = 2n-1 \quad \text{and } n > 2$$

or

$$n = 2m-1 \quad \text{and } m > 2$$

then the breakup will be as in the sections between L and M, and M and N of figure 1.

6. Notice that generator A of figure 1 has only one point. In this case

RHUB = RTIP and THHUB = THTIP

7. Elements are identified as shown in figure 1 and nodes are identified as shown in figure 2.

Unless otherwise specified, data may be input in any consistent set of units. The same units must be used for force and mass. Output will correspond to the input units used. Several examples are listed below:

Input			Output	
Force	Mass	Length	Displacement	Stress
lb	lb	ft	ft	lb/ft^2
lb	lb	in.	in.	$lb/in.^2$
gram	gram	meter	meter	$gram/meter^2$

Input data to be written on each card is described below. "F" format data should be left adjusted in the column field and should contain a decimal point. "E" format data (.300E08) must be right adjusted. "I" format data should not contain a decimal point and should be right adjusted.

Card 1 Title Card

As many title cards as required may be input. With a 1 in column 1 the machine will read in another title card. Omit the 1 in column 1 on the last title card to stop the machine from reading title cards.

Column		Variable	Format
Card 2			
1-10	RHO	Density of the inducer blade (MASS= RHO/G)	F10.0
11-20	POISSO	Poisson's ratio for the material of the inducer blade.	F10.0
21-30	YOUNGS	Youngs modulus of elasticity for the material of the inducer blade.	F10.0
31-40	RADGEN	Generator line offset radius. R_G in figure 3.	F10.0
41-50	NGL	Total number of input generator lines. Maximum of 50.	I10
51-60	NGS	Number of generator lines about which geometric break-up symmetry is desired.	I10
61-65	MODE	Total number of vibratory modes requested. Maximum is the number of free nodes.	I5
66-70	IPRINT	Intermediate print option which should be used for check-out of the program Leave blank for no intermediate print. Input as 1 (right adjusted with no decimal point) for the following intermediate print: a. Elemental local membrane stiffness matrices. b. Elemental local bending stiffness matrices. c. Elemental local membrane inertia matrices. d. Elemental local bending inertia matrices. e. Elemental local assembled stiffness matrices. f. Elemental local assembled inertia matrices.	I5
71-80	G	Gravitational constant in the appropriate units. If left blank or input as 0.0, a value of 386.4 is used. MASS = RHO/G.	F10.0
Card 3	Symmetry Requests (Optional)		
1-5 6-10 etc.	NCHB(1) NCHB (NGS)	Generator line numbers of the generator lines about which geometric break-up symmetry is desired. The only condition allowing this request for break-up symmetry is that the previous generator line and the next generator line must each have the same number of points as does the generator line about which symmetry is requested.	I5

Column	Variable	Format
	That is $NUP_{I-1} = NUP_I = NUP_{I+1}$ Sixteen values per card, as many cards as needed. If NGS on line 3 was input as zero or left blank, omit this card(s).	
Card 4	Generator Lines (NGL Cards)	
1-10	RAPANG(I)	Wrap angle in degrees of the Ith generator line (θ_1 , and θ_2 in figure 4). No two adjacent wrap angles may be equal. All wrap angles must be either continually increasing or continually decreasing in size.	F10.0
11-20	ZGL(I)	z value at the hub of the Ith generator line. (z_1 and z_2 in figure 4). No two adjacent generator lines may have the same z value unless one of the two lean angles is non-zero.	F10.0
21-30	RHUB(I)	If RADGEN $\neq$ 0, then RHUB(I) is the horizontal (x-y plane) distance from the point where the generator line is tangent to a cylinder with a radius of RADGEN to the hub of the Ith generator. If RADGEN = 0, then RHUB(I) is the radial distance from the z-axis to the hub of the Ith generator.	F10.0
31-40	RTIP(I)	Measured the same as RHUB(I) except that it is the distance to the tip instead of the hub of the Ith generator.	F10.0
41-50	THHUB(I)	Thickness of the inducer blade at the hub of the Ith generator line.	F10.0
51-60	THTIP(I)	Thickness of the inducer blade at the tip of the Ith generator line. Thickness is varied linearly from the hub to the tip of a generator line.	F10.0

Column		Variable	Format
61-65	NUP(I)	Number of points on the Ith generator line which are used for the division of the inducer blade into triangular elements. These points are evenly spaced between and including the hub and the tip.	I5
71-80	ALEAN(I)	The lean angle in degrees of the Ith generator line measured positive upward from the horizontal (x-y plane). These are illustrated by λ in figure 3.	F10.0

C. OUTPUT DESCRIPTION

X, Y, Z	Common coordinates of vertices or nodes of triangular elements.
XL, YL	Local coordinates of vertices or nodes of triangular elements.
TH	Nodal thickness of vertices of triangular elements.
FREQUENCY	Natural frequency.
AMPLITUDE	Relative amplitude ratio of node.
SIGMA X BAR, SIGMA Y BAR SHEAR	Relative bending stress of centroid of triangular element.
PRINCIPAL SIGMA X BAR, PRINCIPAL SIGMA Y BAR	Relative principle bending stresses at centroid of triangular element.
MAX SHEAR	Relative maximum shear stress at centroid of triangular element
EFFECTIVE STRESS	Effective combined stress at centroid of triangular element.
KM	Triangular element local membrane stiffness matrix.
KB	Triangular element local bending stiffness matrix.
MM	Triangular element local mass matrix.
MB	Triangular element reduced mass matrix.

D. VIBRATION COMPUTER PROGRAM

Sample Case (Simulated Cantilevered Flat Plate)

LISTING OF INPUT CARDS

```
0.283       0.3000      0.30C00E08C.C                       5         3    10
    2       3     4
0.00000     0.C00       100.C0C     102.C00     0.100       0.100          9      0.000
0.01255     0.250       10C.C0C     102.CC0     0.10C       0.100          9      0.000
0.02510     0.500       1CC.C0C     102.C00     0.10C       0.100          9      0.000
0.03764     0.750       100.C0C     102.C00     0.10C       0.100          9      0.000
0.05013     1.C00       100.C0C     102.C00     C.100       0.100          9      0.000
```

OUTPUT

INDUCER VIBRATION PROGRAM - DECK 6140

DATE 6/30/70

VIBRATION STUDY OF A SIMULATED CANTILEVERED FLAT PLATE

J. A. SCHEURENBRAND DESIGN STA. A DEPT. 712 EXT. 395

DENSITY = 0.2830 G = 0.3864E 03 POISSON'S RATIO = 0.300 YOUNG'S MODULUS = 0.3000E 08

NO. OF GENERATING LINES = 5 NO. OF SYMMETRY CHANGES REQUESTED = 3

GENERATOR LINE OFFSET RADIUS = 0.0

NO. OF MODES REQUESTED = 10

SYMMETRY CHANGE ABOUT GENERATOR LINES 2 3 4

INDUCER VIBRATION PROGRAM - DECK 6140

GENERATOR LINE NUMBER 1 (ANGLES IN DEG.)

WRAP ANGLE = 0.0 ZHUB = 0.0 HUB RADIUS = 100.0000 TIP RADIUS = 102.0000
HUB THICKNESS = 0.1000 TIP THICKNESS = 0.1000 LEAN ANGLE = 0.0 NO. OF POINTS = 9

GENERATOR LINE NUMBER 2 (ANGLES IN DEG.)

WRAP ANGLE = 0.012550 ZHUB = 0.2500 HUB RADIUS = 100.0000 TIP RADIUS = 102.0000
HUB THICKNESS = 0.1000 TIP THICKNESS = 0.1000 LEAN ANGLE = 0.0 NO. OF POINTS = 9

GENERATOR LINE NUMBER 3 (ANGLES IN DEG.)

WRAP ANGLE = 0.025100 ZHUB = 0.5000 HUB RADIUS = 100.0000 TIP RADIUS = 102.0000
HUB THICKNESS = 0.1000 TIP THICKNESS = 0.1000 LEAN ANGLE = 0.0 NO. OF POINTS = 9

GENERATOR LINE NUMBER 4 (ANGLES IN DEG.)

WRAP ANGLE = 0.037640 ZHUB = 0.7500 HUB RADIUS = 100.0000 TIP RADIUS = 102.0000
HUB THICKNESS = 0.1000 TIP THICKNESS = 0.1000 LEAN ANGLE = 0.0 NO. OF POINTS = 9

GENERATOR LINE NUMBER 5 (ANGLES IN DEG.)

WRAP ANGLE = 0.050130 ZHUB = 1.0000 HUB RADIUS = 100.0000 TIP RADIUS = 102.0000
HUB THICKNESS = 0.1000 TIP THICKNESS = 0.1000 LEAN ANGLE = 0.0 NO. OF POINTS = 9

RESULTING TRIANGULAR ELEMENTS

ELEMENT NO. 1

	NODE NO.	X	Y	Z	TH	XL	YL
LA	10	-0.022	100.000	0.250	0.1000	0.0	0.0
LB	11	-0.022	100.250	0.250	0.1000	0.2500	0.0
LC	1	-0.0	100.000	0.0	0.1000	-0.0000	-0.2510

ELEMENT NO. 2

	NODE NO.	X	Y	Z	TH	XL	YL
LA	1	-0.0	100.000	0.0	0.1000	0.0	0.0
LB	2	-0.0	100.250	0.0	0.1000	0.2500	0.0
LC	11	-0.022	100.250	0.250	0.1000	0.2500	0.2510

ELEMENT NO. 3

	NODE NO.	X	Y	Z	TH	XL	YL
LA	11	-0.022	100.250	0.250	0.1000	0.0	0.0
LB	12	-0.022	100.500	0.250	0.1000	0.2500	0.0
LC	2	-0.0	100.250	0.0	0.1000	-0.0000	-0.2510

ELEMENT NO. 4

	NODE NO.	X	Y	Z	TH	XL	YL
LA	2	-0.0	100.250	0.0	0.1000	0.0	0.0
LB	3	-0.0	100.500	0.0	0.1000	0.2500	0.0
LC	12	-0.022	100.500	0.250	0.1000	0.2500	0.2510

ELEMENT NO. 5

	NODE NO.	X	Y	Z	TH	XL	YL
LA	12	-0.022	100.500	0.250	0.1000	0.0	0.0
LB	13	-0.022	100.750	0.250	0.1000	0.2500	0.0
LC	3	-0.0	100.500	0.0	0.1000	-0.0000	-0.2510

ELEMENT NO. 6

	NODE NO.	X	Y	Z	TH	XL	YL
LA	3	-0.0	100.500	0.0	0.1000	0.0	0.0
LB	4	-0.0	100.750	0.0	0.1000	0.2500	0.0
LC	13	-0.022	100.750	0.250	0.1000	0.2500	0.2510

ELEMENT NO. 7

	NODE NO.	X	Y	Z	TH	XL	YL
LA	13	-0.022	100.750	0.250	0.1000	0.0	0.0
LB	14	-0.022	101.000	0.250	0.1000	0.2500	0.0
LC	4	-0.0	100.750	0.0	0.1000	-0.0000	-0.2510

(CONTINUING TO ELEMENT NO. 64)

AMPLITUDES FOR MODE 1

FREQUENCY = 0.71916E 03

NODE	AMPLITUDE
2	0.23737E-01
3	0.92537E-01
4	0.19944E 00
5	0.33480E 00
6	0.48952E 00
7	0.65566E 00
8	0.82709E 00
9	0.10000E 01
11	0.21975E-01
12	0.90760E-01
13	0.19742E 00
14	0.33259E 00
15	0.48726E 00
16	0.65351E 00
17	0.82513E 00
18	0.99815E 00
20	0.22868E-01
21	0.90887E-01
22	0.19732E 00
23	0.33233E 00
24	0.48684E 00
25	0.65292E 00
26	0.82433E 00
27	0.99721E 00
29	0.21921E-01
30	0.90588E-01
31	0.19712E 00
32	0.33216E 00
33	0.48667E 00
34	0.65275E 00
35	0.82416E 00
36	0.99693E 00
38	0.23600E-01
39	0.92175E-01
40	0.19883E 00
41	0.33392E 00
42	0.48833E 00
43	0.65414E 00
44	0.82518E 00
45	0.99748E 00

RELATIVE VIBRATORY BENDING STRESSES
EVALUATED AT CENTROIDS

ELEMENT	SIGMAY3AR	SIGMAXBAR	SHEAR	PRIN SIGMA1BAR	PRIN SIGMA2BAR	MAX SHEAR	EFF. STRESS
1	0.10000E 01	0.10000E 01	0.30532E-01	0.10000E 01	0.10000E 01	0.93768E 00	0.10000E 01
2	-0.71152E-01	0.66038E 00	-0.89250E 00	-0.15109E 00	0.68434E 00	0.97738E 00	0.79666E 00
3	0.30774E 00	0.68855E 00	-0.86959E 00	0.22170E 00	0.71435E 00	0.86777E 00	0.76902E 00
4	0.18552E 00	0.65409E 00	-0.71705E 00	0.12645E 00	0.67179E 00	0.84904E 00	0.73541E 00
5	0.21514E 00	0.52961E 00	-0.70057E 00	0.14373E 00	0.55102E 00	0.68034E 00	0.59717E 00
6	0.16572E 00	0.50605E 00	-0.53293E 00	0.12288E 00	0.51889E 00	0.64567E 00	0.55420E 00
7	0.18140E 00	0.38120E 00	-0.52326E 00	0.12501E 00	0.39811E 00	0.48303E 00	0.42837E 00
8	0.14394E 00	0.36030E 00	-0.37071E 00	0.11411E 00	0.36924E 00	0.44875E 00	0.39757E 00
9	0.15162E 00	0.24637E 00	-0.36625E 00	0.10729E 00	0.25966E 00	0.30470E 00	0.27582E 00
10	0.12448E 00	0.23029E 00	-0.23272E 00	0.10520E 00	0.23608E 00	0.27395E 00	0.24975E 00
11	0.11823E 00	0.13302E 00	-0.23175E 00	0.83066E-01	0.14356E 00	0.15892E 00	0.14949E 00
12	0.10224E 00	0.12344E 00	-0.12371E 00	0.90977E-01	0.12682E 00	0.13332E 00	0.13008E 00
13	0.82802E-01	0.49799E-01	-0.12384E 00	0.51265E-01	0.59260E-01	0.58780E-01	0.59925E-01
14	0.77515E-01	0.45828E-01	-0.49216E-01	0.70568E-01	0.47913E-01	0.35824E-01	0.46789E-01
15	0.56156E-01	0.72098E-02	-0.49152E-01	0.11319E-01	0.20661E-01	0.23127E-01	0.21590E-01
16	0.50802E-01	0.88168E-02	-0.20070E-01	0.25617E-01	0.16373E-01	0.11638E-01	0.15963E-01
17	0.98725E 00	0.98723E 00	0.30458E-01	0.98725E 00	0.98723E 00	0.92569E 00	0.98723E 00
18	-0.67994E-01	0.66974E 00	0.97598E 00	-0.16207E 00	0.69794E 00	0.10000E 01	0.81397E 00
19	0.24019E 00	0.67371E 00	0.10000E 01	0.12873E 00	0.70713E 00	0.89546E 00	0.77477E 00
20	0.17166E 00	0.66963E 00	0.75238E 00	0.10876E 00	0.68849E 00	0.87852E 00	0.75592E 00
21	0.16895E 00	0.51919E 00	0.76885E 00	0.84234E-01	0.54459E 00	0.69563E 00	0.59900E 00
22	0.15705E 00	0.51362E 00	0.56156E 00	0.11058E 00	0.52755E 00	0.66221E 00	0.57578E 00
23	0.14920E 00	0.37463E 00	0.57130E 00	0.83129E-01	0.39444E 00	0.49495E 00	0.43044E 00
24	0.12988E 00	0.36609E 00	0.39081E 00	0.97782E-01	0.37571E 00	0.46397E 00	0.40721E 00
25	0.12495E 00	0.24227E 00	0.39524E 00	0.74664E-01	0.25736E 00	0.31472E 00	0.27781E 00
26	0.10304E 00	0.23335E 00	0.24108E 00	0.83298E-01	0.23927E 00	0.28702E 00	0.25530E 00
27	0.99680E-01	0.13096E 00	0.24211E 00	0.62687E-01	0.14206E 00	0.16510E 00	0.15037E 00
28	0.79776E-01	0.12350E 00	0.12315E 00	0.69328E-01	0.12663E 00	0.14176E 00	0.13233E 00
29	0.75198E-01	0.49170E-01	0.12302E 00	0.45133E-01	0.58189E-01	0.59809E-01	0.59336E-01
30	0.62048E-01	0.43764E-01	0.47334E-01	0.56161E-01	0.45530E-01	0.38421E-01	0.44859E-01
31	0.57794E-01	0.73109E-02	0.47440E-01	0.12616E-01	0.20864E-01	0.22879E-01	0.21661E-01
32	0.47690E-01	0.82715E-02	0.20558E-01	0.23458E-01	0.15542E-01	0.11392E-01	0.15155E-01
33	0.98614E 00	0.98617E 00	-0.24091E-01	0.98618E 00	0.98616E 00	0.92469E 00	0.98616E 00
34	-0.68251E-01	0.66896E 00	-0.96906E 00	-0.16096E 00	0.69674E 00	0.99795E 00	0.81242E 00
35	0.23752E 00	0.67436E 00	-0.98574E 00	0.12930E 00	0.70681E 00	0.89480E 00	0.77432E 00
36	0.16694E 00	0.66799E 00	-0.74316E 00	0.10551E 00	0.68641E 00	0.87704E 00	0.75509E 00
37	0.16571E 00	0.52002E 00	-0.75355E 00	0.84436E-01	0.54439E 00	0.69528E 00	0.59874E 00
38	0.15238E 00	0.51206E 00	-0.55210E 00	0.10742E 00	0.52554E 00	0.66079E 00	0.57401E 00
39	0.14445E 00	0.37519E 00	-0.55595E 00	0.82046E-01	0.39391E 00	0.49466E 00	0.43000E 00
40	0.12605E 00	0.36457E 00	-0.38042E 00	0.95568E-01	0.37381E 00	0.46231E 00	0.40540E 00
41	0.11910E 00	0.24272E 00	-0.37861E 00	0.73138E-01	0.25650E 00	0.31419E 00	0.27707E 00
42	0.99063E-01	0.23180E 00	-0.22923E 00	0.81140E-01	0.23717E 00	0.28509E 00	0.25426E 00
43	0.93540E-01	0.13139E 00	-0.22329E 00	0.62233E-01	0.14078E 00	0.16356E 00	0.14900E 00
44	0.75704E-01	0.12159E 00	-0.10953E 00	0.67334E-01	0.12410E 00	0.13917E 00	0.12976E 00
45	0.70355E-01	0.49514E-01	-0.10201E 00	0.49167E-01	0.55870E-01	0.55082E-01	0.56422E-01
46	0.59471E-01	0.41444E-01	-0.30534E-01	0.56756E-01	0.42259E-01	0.33801E-01	0.41433E-01
47	0.58108E-01	0.71837E-02	-0.25954E-01	0.19795E-01	0.18678E-01	0.17065E-01	0.18597E-01
48	0.43512E-01	0.54619E-02	0.10294E-02	0.18198E-01	0.13057E-01	0.10177E-01	0.12779E-01
49	0.99649E 00	0.99651E 00	-0.25412E-01	0.99652E 00	0.99650E 00	0.93439E 00	0.99550E 00
50	-0.68739E-01	0.65960E 00	0.89352E 00	-0.14989E 00	0.68393E 00	0.97634E 00	0.79597E 00

51	0.30366E 00	0.68686E 00	0.88035E 00	0.21541E 00	0.71332E 00	0.86893E 00	0.75878E 00
52	0.18820E 00	0.65501E 00	0.72435E 00	0.12789E 00	0.67309E 00	0.85020E 00	0.73554E 00
53	0.21114E 00	0.52824E 00	0.71356E 00	0.13715E 00	0.55043E 00	0.68218E 00	0.59748E 00
54	0.16851E 00	0.50710E 00	0.54178E 00	0.12429E 00	0.52036E 00	0.64707E 00	0.55554E 00
55	0.17750E 00	0.37974E 00	0.53737E 00	0.11814E 00	0.39755E 00	0.48504E 00	0.42873E 00
56	0.14694E 00	0.36129E 00	0.38052E 00	0.11557E 00	0.37069E 00	0.45010E 00	0.39899E 00
57	0.14718E 00	0.24460E 00	0.38198E 00	0.99118E-01	0.25901E 00	0.30712E 00	0.27621E 00
58	0.12736E 00	0.23127E 00	0.24353E 00	0.10631E 00	0.23753E 00	0.27545E 00	0.25123E 00
59	0.11303E 00	0.13092E 00	0.24931E 00	0.72706E-01	0.14301E 00	0.16235E 00	0.15015E 00
60	0.10553E 00	0.12446E 00	0.13543E 00	0.92131E-01	0.12848E 00	0.13508E 00	0.13178E 00
61	0.77073E-01	0.47278E-01	0.14288E 00	0.37095E-01	0.59271E-01	0.64487E-01	0.61390E-01
62	0.79730E-01	0.46575E-01	0.53098E-01	0.68861E-01	0.49836E-01	0.39086E-01	0.48794E-01
63	0.47536E-01	0.44568E-02	0.57774E-01	-0.55597E-02	0.20385E-01	0.29539E-01	0.23928E-01
64	0.50470E-01	0.78168E-02	0.51993E-01	0.10212E-01	0.19894E-01	0.22545E-01	0.20874E-01

1	-0.34997E 06						
1		-0.11665E 07					
19			-0.17000E 06				
1				-0.34994E 06			
1					-0.11666E 07		
18						0.43545E 06	
1							0.13369E 07

(PROGRAM CONTINUES ON THRU NUMBER OF MODE SELECTED AT INPUT.)

E. VIBRATION COMPUTER PROGRAM LISTING

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C     THIS IS THE MAIN PROGRAM FOR THE INDUCER VIBRATIONS PROGRAM        MAIN0001
C     DECK 6140                                                          MAIN0002
C                                                                        MAIN0003
      COMMON X     ( 100) , Y     ( 100) , Z     ( 100) , TH    ( 100) ,MAIN0004
     1                     XL  ( 100,3) , YL  ( 100,3) ,                MAIN0005
     2       RAPANG(  50) , ZGL   (  50) , RHUB  (  50) , RTIP  (  50) ,MAIN0006
     3       THHUB (  50) , THTIP (  50) ,                EDCM  ( 3,3) ,MAIN0007
     4       RHO ,          POISSO , YOUNGS , RADGEN ,                    MAIN0008
     5       NGENLI , LINEI ,              NEXT ( 100,3) , NP , NT ,      MAIN0009
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,          MAIN0010
     7      SIGMAX(100) , SIGMAY(100) , ELSTIF(18,18) ,                   MAIN0011
     8         TAUXY(100),  ELSSM(9,9), MEX(100,8), IMEX(100),            MAIN0012
     9         ELINR(18,18) , ELMIM(6,6) , ELBIM(9,9) , ALEAN(50)         MAIN0013
      DIMENSION ICOL(15) , ZCOS(100) , NUP(100) , NCHB(50) , IPOS(100)   MAIN0014
      DIMENSION OMEGA(50) , IGEN(100)                                    MAIN0015
      DATA ICOL / 1 , 2 , 7 , 8 , 13 , 14 , 3 , 4 , 5 , 9 , 10 , 11 ,   MAIN0016
     1          15 , 16 , 17 /                                           MAIN0017
      DEFINE FILE 1(100,657,U,IR1),2(48,900,U,IR2),3(100,324,U,IR3)      MAIN0018
   5  CALL ZERO(X,ELBIM(9,9))                                            MAIN0019
C     READ AND PRINT ALL INPUT                                           MAIN0020
  10  CALL INPUT ( IPRINT,NUP,NCHB,MODE )                                MAIN0021
C     TRIANGULATION OF INDUCER BLADE AND DETERMINATION OF THICKNESS AT   MAIN0022
C     EACH VERTEX .                                                      MAIN0023
      CALL GEOM ( NUP,NCHB,IPOS,IGEN )                                   MAIN0024
      IF ( ( NP .GT. 100 ) .OR. ( NT .GT. 100 ) ) GO TO 5                MAIN0025
      DO 30  I = 1,NT                                                    MAIN0026
      LA = NEXT(I,1)                                                     MAIN0027
      LB = NEXT(I,2)                                                     MAIN0028
      LC = NEXT(I,3)                                                     MAIN0029
      IMEX(LA) = IMEX(LA) + 1                                            MAIN0030
      IMEX(LB) = IMEX(LB) + 1                                            MAIN0031
      IMEX (LC) = IMEX(LC) + 1                                           MAIN0032
      MEX(LA,IMEX(LA)) = I                                               MAIN0033
      MEX(LB,IMEX(LB)) = I                                               MAIN0034
      MEX(LC,IMEX(LC)) = I                                               MAIN0035
C     CALCULATE THE DIRECTION COSINE MATRIX (EDCM) FOR A TRIANGULAR ELEMMAIN0036
      CALL DIRCOS (LA,LB,LC,I)                                           MAIN0037
      ZCOS(I) = EDCM(3,3)                                                MAIN0038
C     CALCULATE THE LOCAL COORDINATES (XL,YL,ZL) FOR A TRIANGULAR ELEMENMAIN0039
      CALL LCOORD (LA,LB,LC,I)                                           MAIN0040
C     CALCULATE THE MEMBRANE STIFFNESS MATRIX (ELMSM) FOR A TRIANGULAR   MAIN0041
C     ELEMENT IN THE LOCAL COORDINATE SYSTEM (XL,YL,ZL)                  MAIN0042
      CALL MEMSTF ( LA,LB,LC,I )                                         MAIN0043
C     CALCULATE THE BENDING STIFFNESS MATRIX (ELBSM) FOR A TRIANGULAR    MAIN0044
C     ELEMENT IN THE LOCAL COORDINATE SYSTEM (XL,YL,ZL)                  MAIN0045
      CALL BENSTF ( LA,LB,LC,I )                                         MAIN0046
      IF ( IPRINT .GE. 1 )                                               MAIN0047
     1WRITE (6,14) ((ELMSM(J,K),K=1,6),J=1,6),((ELBSM(J,K),K=1,9),J=1,9)MAIN0048
  14  FORMAT(1H1/45X,2HKM / 6(10X,6E14.6/) //65X,2HKB/9( 1X,9E14.6/))    MAIN0049
C     CALCULATE THE LOCAL MEMBRANE INERTIA                               MAIN0050
C     MATRIX (ELMIM) FOR A TRIANGULAR                                    MAIN0051
C     ELEMENT.                                                           MAIN0052
      CALL MEMINR (LA,LB,LC,I)                                           MAIN0053
C     CALCULATE THE LOCAL BENDING INERTIA MATRIX (ELBIM) FOR A           MAIN0054
C     TRIANGULAR ELEMENT.                                                MAIN0055
      CALL BENINR (LA,LB,LC,I)                                           MAIN0056
      IF ( IPRINT .GE. 1 ) WRITE (6,15) ((ELMIM(J,K),K=1,6),J=1,6),      MAIN0057
     1        ((ELBIM(J,K),K=1,9),J=1,9)                                 MAIN0058
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 15   FORMAT (//45X,2HMM/6(10X,6E14.6/)//65X,2HMB/9(1X,9E14.6/))          MAIN0059
C     ASSEMBLE LOCAL STIFFNESS MATRIX (ELSTIF) AND LOCAL INERTIA MATRIX MAIN0060
C     (ELINR) FOR A TRIANGULAR ELEMENT .                                 MAIN0061
      DO 20 J = 1,6                                                      MAIN0062
      DO 20 K = 1,6                                                      MAIN0063
      ELINR(ICOL(J),ICOL(K)) = ELMIM(J,K)                                MAIN0064
 20   ELSTIF(ICOL(J),ICOL(K)) = ELMSM(J,K)                               MAIN0065
      DO 24 J = 1,9                                                      MAIN0066
      DO 24 K = 1,9                                                      MAIN0067
      ELINR(ICOL(J+6),ICOL(K+6)) = ELBIM(J,K)                            MAIN0068
 24   ELSTIF(ICOL(J+6),ICOL(K+6)) = ELBSM(J,K)                           MAIN0069
      WRITE (1'I) ELSTIF,ELINR,EDCM                                      MAIN0070
      IF ( IPRINT .GE. 1 ) WRITE (6,25)                                  MAIN0071
 25   FORMAT (1H  //25X,55H LOCAL COORDINATE SYSTEM TRIANGULAR STIFFNESSMAIN0072
     1 MATRIX   )                                                        MAIN0073
      IF ( IPRINT .GE. 1 ) WRITE (6,26) ((ELSTIF(J,K),K=1,18),J=1,18)   MAIN0074
 26   FORMAT (//18(10E12.4/8E12.4/))                                     MAIN0075
      IF ( IPRINT .GE. 1 ) WRITE (6,27)                                  MAIN0076
 27   FORMAT (1H //25X,52H LOCAL COORDINATE SYSTEM TRIANGULAR INERTIA MAMAIN0077
     1TRIX  )                                                            MAIN0078
      IF ( IPRINT .GE. 1 ) WRITE (6,26) ((ELINR(J,K),K=1,18),J=1,18)    MAIN0079
 30   CONTINUE                                                           MAIN0080
C     PRINT GEOMETRIC BREAK-UP AND ASSOCIATED PROPERTIES .               MAIN0081
      CALL PRINT1                                                        MAIN0082
C     CALCULATE NORMAL DIRECTION COSINE MATRIX AT EACH NODE .            MAIN0083
      CALL NORM ( ZCOS,IGEN )                                            MAIN0084
C     TRANSFORM STIFFNESS MATRICES TO NORMAL SYSTEMS AND ASSEMBLE        MAIN0085
C     INTO A (3N X 3N) MATRIX .                                          MAIN0086
      CALL ASSEMK ( ZCOS , IPOS )                                        MAIN0087
C     TRANSFORM INERTIA MATRICES TO NORMAL SYSTEMS AND ASSEMBLE          MAIN0088
C     INTO A (3N X 3N) MATRIX .                                          MAIN0089
      CALL ASSEMM ( ZCOS , IPOS )                                        MAIN0090
C     REDUCE THE ASSEMBLED STIFFNESS MATRIX TO AN (N X N) MATRIX .       MAIN0091
      N = NP - NGENLI                                                    MAIN0092
      CALL REDUCK ( N )                                                  MAIN0093
      IF ( N .LE. 0 ) GO TO 5                                            MAIN0094
C     REDUCE THE ASSEMBLED INERTIA MATRIX TO AN (N X N) MATRIX .         MAIN0095
      CALL REDUCM ( N )                                                  MAIN0096
      IF ( N .LE. 0 ) GO TO 5                                            MAIN0097
C     SOLVE FOR THE NATURAL FREQUENCIES .                                MAIN0098
      CALL EIGEN ( N,OMEGA )                                             MAIN0099
C     SOLVE FOR THE AMPLITUDES FOR EACH REQUESTED FREQUENCY .            MAIN0100
      DO 35 I = 1,MODE                                                   MAIN0101
      IF ( I .GT. N ) GO TO 5                                            MAIN0102
      WRITE (6,32) I                                                     MAIN0103
 32   FORMAT (1H1,//50X,22HAMPLITUDES  FOR  MODE  I3 )                   MAIN0104
      M = NP - NGENLI                                                    MAIN0105
      I1 = N + 1 - I                                                     MAIN0106
      CALL AMPL (M , OMEGA(I1) , IPOS)                                   MAIN0107
 35   CALL STRESS ( ZCOS, IPOS )                                         MAIN0108
      GO TO 5                                                            MAIN0109
 40   STOP                                                               MAIN0110
      END                                                                MAIN0111
```

```
      SUBROUTINE INPUT ( IPRINT,NUP,NCHB,MODE )                          INPUT001
C     READ AND PRINT ALL INPUT                                           INPUT002
C                                                                        INPUT003
      COMMON X      ( 100) , Y      ( 100) , Z      ( 100) , TH     ( 100) ,INPUT004
     1                       XL   ( 100,3) , YL   ( 100,3) ,             INPUT005
     2        RAPANG(   50) , ZGL    (  50) , RHUB  (  50) , RTIP  (  50) ,INPUT006
     3        THHUB (   50) , THTIP (  50) ,                 EDCM  ( 3,3) ,INPUT007
     4        RHO ,           POISSO , YOUNGS , RADGEN ,                  INPUT008
     5        NGENLI , LINE1 ,                NEXT ( 100,3) , NP , NT ,   INPUT009
     6        ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,         INPUT010
     7       SIGMAX(100) , SIGMAY(100) , ELSTIF(18,18) ,                  INPUT011
     8          TAUXY(100),  ELSSM(9,9), MEX(100,8), IMEX(100),           INPUT012
     9          ELINR(18,18) , ELMIM(6,6) , ELBIM(9,9) , ALEAN(50)        INPUT013
      DIMENSION NUP(100) , NCHB(50)                                      INPUT014
      REAL TITLE (18)                                                    INPUT015
    1 WRITE (6,5)                                                        INPUT016
    5 FORMAT (1H1/38HOINDUCER VIBRATION PROGRAM - DECK 6140 //)          INPUT017
      CALL DATE (BMONTH,DAY,YEAR)                                        INPUT018
      WRITE (6,7) BMONTH,DAY,YEAR                                        INPUT019
    7 FORMAT (6H DATE ,A2,1H/,A2,1H/,A2//)                               INPUT020
   10 READ (5,15,END=50) NT,TITLE                                        INPUT021
   15 FORMAT (I1,18A4)                                                   INPUT022
      WRITE (6,20) TITLE                                                 INPUT023
   20 FORMAT (5X,18A4 /)                                                 INPUT024
      IF ( NT .GT. 0 ) GO TO 10                                          INPUT025
      READ (5,25) RHO,POISSO,YOUNGS,RADGEN,NGENLI,LINE1,MODE,IPRINT,G    INPUT026
   25 FORMAT (2F10.0, E10.0,F10.0,2I10,2I5,F10.0)                        INPUT027
      IF ( G .EQ. 0.0 ) G = 386.4                                        INPUT028
      IF ( LINE1 .GT. 0 ) READ (5,26) (NCHB(I),I=1,LINE1)                INPUT029
   26 FORMAT (16I5)                                                      INPUT030
      DO 29 I = 1,50                                                     INPUT031
      IF ( NCHB(I) .GT. 0 ) GO TO 29                                     INPUT032
      NCHB(I) = NGENLI + 1                                               INPUT033
   29 CONTINUE                                                           INPUT034
      WRITE (6,30)RHO,G,    POISSO,YOUNGS,NGENLI,LINE1,RADGEN,MODE       INPUT035
   30 FORMAT (//10X,10HDENSITY = F6.4,5X,4HG = ,E12.4,5X,                INPUT036
     1 18HPOISSON'S RATIO = F5.3,5X,18HYOUNG'S MODULUS = E12.4 //10X,    INPUT037
     2 26HNO. OF GENERATING LINES = I4,5X,40HNO. OF SYMMETRY CHANGES REQINPUT038
     3UESTED     = I3 //10X,31HGENERATOR LINE OFFSET RADIUS = F9.3 //    INPUT039
     4  10X,24HNO. OF MODES REQUESTED = I4//)                            INPUT040
      IF ( LINE1 .EQ. 0 ) GO TO 32                                       INPUT041
      WRITE (6,31) (NCHB(I),I=1,LINE1)                                   INPUT042
   31 FORMAT (10X,38HSYMMETRY CHANGE ABOUT GENERATOR LINES 15I5/)        INPUT043
      KOUNT = 0                                                          INPUT044
   32 RHO = RHO / G                                                      INPUT045
      WRITE (6,5)                                                        INPUT046
      DO 45 I = 1,NGENLI                                                 INPUT047
      READ (5,35) RAPANG(I),ZGL(I),RHUB(I),RTIP(I),THHUB(I),THTIP(I),    INPUT048
     1            NUP(I) , ALEAN(I)                                      INPUT049
   35 FORMAT (6F10.0,I5,5X,F10.0)                                        INPUT050
      WRITE (6,39) I                                                     INPUT051
   39 FORMAT (30X,22HGENERATOR LINE NUMBER I3,5X,16H(ANGLES IN DEG.) /)  INPUT052
      WRITE (6,40)   RAPANG(I),ZGL(I),RHUB(I),RTIP(I),THHUB(I),THTIP(I),INPUT053
     1    ALEAN(I) , NUP(I)                                              INPUT054
   40 FORMAT (                                . 10X,13HWRAP ANGLE = F12.6INPUT055
     1,5X,       7HZHUB = F8.4,5X,13HHUB RADIUS = F8.4,5X,13HTIP RADIUS INPUT056
     2= F8.4/ 5X,16HHUB THICKNESS = F7.4,5X,16HTIP THICKNESS = F7.4,5X,  INPUT057
     3 12HLEAN ANGLE = F12.6,       5X,16HNO. OF POINTS = I2/)            INPUT058
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```
      KOUNT = KOUNT + 1                                              INPUT058
      IF (KOUNT .EQ.11) WRITE (6,5)                                  INPUT059
      IF (KOUNT .EQ.11) KOUNT = 0                                    INPUT060
      ALEAN(I) = ALEAN(I) * 0.0174533                                INPUT061
45    RAPANG(I) = RAPANG(I) * 0.0174533                              INPUT062
      GO TO 55                                                       INPUT063
50    STOP                                                           INPUT064
55    RETURN                                                         INPUT065
      END                                                            INPUT066
```

```
      SUBROUTINE GEOM ( NUP,NCHB,IPOS,IGEN )                                GEOM0010
C     TRIANGULATION OF INDUCER BLADE AND DETERMINATION OF THICKNESS AT      GEOM0020
C     EACH VERTEX AND PRESSURE ON EACH TRIANGLE .                           GEOM0030
C                                                                           GEOM0040
      COMMON X      ( 100) , Y      ( 100) , Z      ( 100) , TH     ( 100) ,GEOM0050
     1                       XL   ( 100,3) , YL   ( 100,3) ,                GEOM0060
     2        RAPANG(  50) , ZGL    (  50) , RHUB   (  50) , RTIP   (  50) ,GEOM0070
     3        THHUB (  50) , THTIP (  50) ,                  EDCM   ( 3,3) ,GEOM0080
     4        RHO ,          POISSO , YOUNGS , RADGEN ,                     GEOM0090
     5        NGENLI , LINEL ,                NEXT ( 100,3) , NP , NT ,      GEOM0100
     6        ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,            GEOM0110
     7       SIGMAX(100) , SIGMAY(100) , ELSTIF(18,18) ,                     GEOM0120
     8          TAUXY(100),  ELSSM(9,9), MEX(100,8), IMEX(100),              GEOM0130
     9          ELINR(18,18) , ELMIM(6,6) , ELBIM(9,9) , ALEAN(50)           GEOM0140
      DIMENSION NUP(100) , NCHB(50) , IPOS(100) , IGEN(100)                 GEOM0150
      ICHB = 1                                                              GEOM0160
      KOUNT = -1                                                            GEOM0170
      IPOS(1) = -1                                                          GEOM0180
      NP1 = 1                                                               GEOM0190
      NT  = 0                                                               GEOM0200
      NP  = NUP(1)                                                          GEOM0210
      NS  = NGENLI - 1                                                      GEOM0220
      DO 90 I = 1,NS                                                        GEOM0230
      NT1 = NUP(I) + NUP(I+1) -2                                            GEOM0240
      IF ( I .NE. 1 ) GO TO 15                                              GEOM0250
      LINE = NUP(I)                                                         GEOM0260
      DR = 1.0                                                              GEOM0261
      IF ( LINE .EQ. 1 ) GO TO 1                                            GEOM0262
      DR = ( RTIP(I) - RHUB(I) ) / FLOAT( LINE  - 1 )                       GEOM0270
    1 RADIUS = RHUB(I) - DR                                                 GEOM0280
      SINA = SIN( RAPANG(I) )                                               GEOM0290
      COSA = COS( RAPANG(I) )                                               GEOM0300
      TANL = TAN ( ALEAN(I) )                                               GEOM0310
C                                                                           GEOM0320
      DO 10 J = 1,LINE                                                      GEOM0330
      IF ( J .EQ. 1 ) GO TO 5                                               GEOM0340
      KOUNT = KOUNT + 1                                                     GEOM0350
      IPOS(J) = KOUNT                                                       GEOM0360
    5 RADIUS = RADIUS + DR                                                  GEOM0370
      Z(J)   = ZGL(I) + ( RADIUS - RHUB(I) ) * TANL                         GEOM0380
      X(J)   = RADGEN * COSA - RADIUS * SINA                                GEOM0390
      Y(J)   = RADGEN * SINA + RADIUS * COSA                                GEOM0400
      TH(J)  = THHUB(I) + ( THTIP(I) - THHUB(I) ) * ( RADIUS - RHUB(I) )GEOM0410
     1         / ( RTIP(I) - RHUB(I) )                                      GEOM0420
      IGEN(J) = I                                                           GEOM0421
      IF ( TH(J) .LT. 0.0 ) TH(J) = 0.0                                     GEOM0430
   10 CONTINUE                                                              GEOM0440
   15 LINE = NUP(I+1)                                                       GEOM0441
      DR = 1.0                                                              GEOM0442
      IF ( LINE .EQ. 1 ) GO TO 16                                           GEOM0443
      DR = ( RTIP(I+1) - RHUB(I+1) ) / FLOAT( LINE  - 1 )                   GEOM0450
   16 RADIUS = RHUB(I+1) - DR                                               GEOM0460
      J2  = NP + 1                                                          GEOM0470
      J3  = NP + NUP(I+1)                                                   GEOM0480
      IPOS(J2) = -1                                                         GEOM0490
      SINA = SIN( RAPANG(I+1) )                                             GEOM0500
      COSA = COS( RAPANG(I+1) )                                             GEOM0510
      TANL = TAN( ALEAN(I+1) )                                              GEOM0520
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      DO 25  J = J2,J3                                                  GEOM0530
      IF ( J .EQ. J2 ) GO TO 20                                         GEOM0540
      KOUNT = KOUNT + 1                                                 GEOM0550
      IPOS(J) = KOUNT                                                   GEOM0560
 20   RADIUS = RADIUS + DR                                              GEOM0570
      Z(J) = ZGL(I+1) + ( RADIUS - RHUB(I+1) ) * TANL                   GEOM0580
      X(J) = RADGEN * COSA - RADIUS * SINA                              GEOM0590
      Y(J) = RADGEN * SINA + RADIUS * COSA                              GEOM0600
      TH(J)= THHUB(I+1) + ( THTIP(I+1) - THHUB(I+1) ) * ( RADIUS -      GEOM0610
     1       RHUB(I+1) ) / ( RTIP(I+1) - RHUB(I+1) )                    GEOM0620
      IGEN(J) = I + 1                                                   GEOM0621
      IF ( TH(J) .LT. 0.0 ) TH(J) = 0.0                                 GEOM0630
 25   CONTINUE                                                          GEOM0640
      J1 = NT + 1                                                       GEOM0650
      J2 = NT + NT1                                                     GEOM0660
      NB = 0                                                            GEOM0670
      K = 0                                                             GEOM0671
      NB1 = -2                                                          GEOM0672
      NPT1 = NUP(I)                                                     GEOM0673
      NPT2 = NUP(I+1)                                                   GEOM0674
      IF (NPT1 .EQ. NPT2) GO TO 27                                      GEOM0675
      IF (NPT2 - NPT1 .EQ. 1) GO TO 275                                 GEOM0676
      IF (NPT1 - NPT2 .EQ. 1) GO TO 270                                 GEOM0677
      IF (NPT2 - NPT1 .GT. 1) GO TO 265                                 GEOM0678
C     BOTTOM GENERATOR HAS AT LEAST TWO MORE NODES THAN THE TOP         GEOM0679
C     GENERATOR.                                                        GEOM0680
      DO 264 J = J1,J2                                                  GEOM0681
      K = K + 1                                                         GEOM0682
      L = MOD(K,3)                                                      GEOM0683
      IF (L .EQ. 0) L =                                                 GEOM0684
      GO TO (261, 262, 263), L                                          GEOM0685
  261 NB1 = NB1 + 2                                                     GEOM0686
      NEXT(J,1) = NP1 + NB1                                             GEOM0687
      NEXT(J,2) = NP1 + NB1 + 1                                         GEOM0688
      NEXT(J,3) = NP + NB1 / 2 + 1                                      GEOM0689
      GO TO 264                                                         GEOM0690
  262 NEXT(J,1) = NEXT(J-1,3)                                           GEOM0691
      NEXT(J,2) = NEXT(J,1) + 1                                         GEOM0692
      NEXT(J,3) = NEXT(J-1,2)                                           GEOM0693
      GO TO 264                                                         GEOM0694
  263 NEXT(J,1) = NEXT(J-1,3)                                           GEOM0695
      NEXT(J,2) = NEXT(J,1) + 1                                         GEOM0696
      NEXT(J,3) = NEXT(J-1,2)                                           GEOM0697
  264 CONTINUE                                                          GEOM0698
      GO TO 85                                                          GEOM0699
C     TOP GENERATOR HAS AT LEAST TWO MORE NODES THAN                    GEOM0700
C     THE BOTTOM GENERATOR.                                             GEOM0701
  265 DO 269 J = J1, J2                                                 GEOM0702
      K = K + 1                                                         GEOM0703
      L = MOD(K,3)                                                      GEOM0704
      IF (L .EQ. 0) L = 3                                               GEOM0705
      GO TO (266,267,268), L                                            GEOM0706
  266 NB1 = NB1 + 2                                                     GEOM0707
      NEXT(J,1) = NP + NB1 + 1                                          GEOM0708
      NEXT(J,2) = NP + NB1 + 2                                          GEOM0709
      NEXT(J,3) = NP1 + NB1 / 2                                         GEOM0710
      GO TO 269                                                         GEOM0711
  267 NEXT(J,1) = NEXT(J-1,3)                                           GEOM0712
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      NEXT(J,2) = NEXT(J,1) + 1                                          GEOM0713
      NEXT(J,3) = NEXT(J-1,2)                                            GEOM0714
      GO TO 269                                                          GEOM0715
  268 NEXT(J,1) = NEXT(J-1,3)                                            GEOM0716
      NEXT(J,2) = NEXT(J,1) + 1                                          GEOM0717
      NEXT(J,3) = NEXT(J-1,2)                                            GEOM0718
  269 CONTINUE                                                           GEOM0719
      GO TO 85                                                           GEOM0720
C     BOTTOM GENERATOR HAS ONE MORE NODE THAN THE TOP GENERATOR.         GEOM0721
  270 NEXT(J1,1) = NP1                                                   GEOM0722
      NEXT(J1,2) = NP1 + 1                                               GEOM0723
      NEXT(J1,3) = NP + 1                                                GEOM0724
      IF (J1 .EQ. J2) GO TO 85                                           GEOM0725
      J11 = J1 + 1                                                       GEOM0726
      DO 271 J = J11,J2                                                  GEOM0727
      NEXT(J,1) = NEXT(J-1,3)                                            GEOM0728
      NEXT(J,2) = NEXT(J,1)+1                                            GEOM0729
  271 NEXT(J,3) = NEXT(J-1,2)                                            GEOM0730
      GO TO 85                                                           GEOM0731
C     TOP GENERATOR HAS ONE MORE NODE THAN THE BOTTOM GENERATOR.         GEOM0732
  275 NEXT(J1,1) = NP + 1                                                GEOM0733
      NEXT(J1,2) = NP + 2                                                GEOM0734
      NEXT(J1,3) = NP1                                                   GEOM0735
      IF (J1 .EQ. J2) GO TO 85                                           GEOM0736
      J11 = J1 + 1                                                       GEOM0737
      DO 276 J = J11, J2                                                 GEOM0738
      NEXT(J,1) = NEXT(J-1,3)                                            GEOM0739
      NEXT(J,2) = NEXT(J,1)+1                                            GEOM0740
  276 NEXT(J,3) = NEXT(J-1,2)                                            GEOM0741
      GO TO 85                                                           GEOM0742
C     SAME NUMBER OF NODES ON TOP AND BOTTOM GENERATORS .                GEOM0743
   27 IF ( RADGEN .NE. 0.0 ) GO TO 55                                    GEOM0744
      IF ( NCHB(ICHB) .EQ. 1 ) GO TO 40                                  GEOM0745
      IF ( ICHB .GE. 2 ) GO TO 42                                        GEOM0746
   28 DO 35 J = J1,J2                                                    GEOM0747
      K = J - J1 + 1                                                     GEOM0748
      IF ( MOD(K,2) .EQ. 0 ) GO TO 30                                    GEOM0749
      NB = NB + 1                                                        GEOM0750
      NEXT(J,1) = NP + NB                                                GEOM0751
      NEXT(J,2) = NP + NB + 1                                            GEOM0760
      NEXT(J,3) = NP1 + NB - 1                                           GEOM0770
      GO TO 35                                                           GEOM0780
   30 NEXT(J,1) = NP1 + NB - 1                                           GEOM0790
      NEXT(J,2) = NP1 + NB                                               GEOM0800
      NEXT(J,3) = NP + NB + 1                                            GEOM0810
   35 CONTINUE                                                           GEOM0820
      GO TO 85                                                           GEOM0830
   40 ICHB = ICHB + 1                                                    GEOM0840
   42 IF ( MOD(ICHB,2) .EQ. 1 ) GO TO 28                                 GEOM0850
      DO 50 J = J1,J2                                                    GEOM0860
      K = J - J1 + 1                                                     GEOM0870
      IF ( MOD(K,2) .EQ. 0 ) GO TO 45                                    GEOM0880
      NB = NB + 1                                                        GEOM0890
      NEXT(J,1) = NP1 + NB - 1                                           GEOM0900
      NEXT(J,2) = NP1 + NB                                               GEOM0910
      NEXT(J,3) = NP + NB                                                GEOM0920
      GO TO 50                                                           GEOM0930
   45 NEXT(J,1) = NP + NB                                                GEOM0940
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      NEXT(J,2) = NP + NB + 1                                          GEOM0950
      NEXT(J,3) = NP1 + NB                                             GEOM0960
50    CONTINUE                                                         GEOM0970
      GO TO 85                                                         GEOM0980
55    IF ( NCHB(ICHB) .EQ. 1 ) GO TO 70                                GEOM0990
      IF ( ICHB .GE. 2 ) GO TO 72                                      GEOM1010
58    DO 65 J = J1,J2                                                  GEOM1020
      K = J - J1 + 1                                                   GEOM1030
      IF ( MOD(K,2) .EQ. 0 ) GO TO 60                                  GEOM1040
      NB = NB + 1                                                      GEOM1050
      NEXT(J,1) = NP1 + NB - 1                                         GEOM1060
      NEXT(J,2) = NP1 + NB                                             GEOM1070
      NEXT(J,3) = NP + NB                                              GEOM1080
      GO TO 65                                                         GEOM1090
60    NEXT(J,1) = NP + NB                                              GEOM1100
      NEXT(J,2) = NP + NB + 1                                          GEOM1110
      NEXT(J,3) = NP1 + NB                                             GEOM1120
65    CONTINUE                                                         GEOM1130
      GO TO 85                                                         GEOM1140
70    ICHB = ICHB + 1                                                  GEOM1150
72    IF ( MOD(ICHB,2) .EQ. 1 ) GO TO 58                               GEOM1160
      DO 80 J = J1,J2                                                  GEOM1170
      K = J - J1 + 1                                                   GEOM1180
      IF ( MOD(K,2) .EQ. 0 ) GO TO 75                                  GEOM1190
      NB = NB + 1                                                      GEOM1200
      NEXT(J,1) = NP + NB                                              GEOM1210
      NEXT(J,2) = NP + NB + 1                                          GEOM1220
      NEXT(J,3) = NP1 + NB - 1                                         GEOM1230
      GO TO 80                                                         GEOM1240
75    NEXT(J,1) = NP1 + NB - 1                                         GEOM1250
      NEXT(J,2) = NP1 + NB                                             GEOM1260
      NEXT(J,3) = NP + NB + 1                                          GEOM1270
80    CONTINUE                                                         GEOM1280
85    CONTINUE                                                         GEOM1290
      NP1 = NP + 1                                                     GEOM1300
      NP  = NP + NUP(I+1)                                              GEOM1310
      NT  = NT + NT1                                                   GEOM1320
      IF ( NP .LE. 100 ) GO TO 87                                      GEOM1330
      WRITE (6,86)                                                     GEOM1340
86    FORMAT (//20X,35HMORE THAN 100 POINTS WERE GENERATED )           GEOM1350
      RETURN                                                           GEOM1360
87    IF ( NT .LE. 100 ) GO TO 90                                      GEOM1370
      WRITE (6,88)                                                     GEOM1380
88    FORMAT (//20X,37HMORE THAN 100 ELEMENTS WERE GENERATED )         GEOM1390
      RETURN                                                           GEOM1400
90    CONTINUE                                                         GEOM1410
      NP1 = NP - NGENLI                                                GEOM1411
      IF ( NP1 .LE. 50 ) GO TO 100                                     GEOM1412
      NP = 150                                                         GEOM1413
      WRITE (6,95)                                                     GEOM1414
95    FORMAT (//20X,38HMORE THAN 50 FREE NODES WERE GENERATED )        GEOM1415
100   RETURN                                                           GEOM1420
      END                                                              GEOM1430
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      SUBROUTINE DIRCOS (LA,LB,LC,I)                                    DIRCOS01
C     CALCULATE THE DIRECTION COSINE MATRIX (EDCM) OF ELEMENT LOCAL AXESDIRCOS02
C     (XL,YL,ZL) RELATIVE TO COMMON AXES (X,Y,Z) .                      DIRCOS03
C                                                                       DIRCOS04
      COMMON X     ( 100) , Y     ( 100) , Z     ( 100)   TH    ( 100) ,DIRCOS05
     1                     XL  ( 100,3) , YL  ( 100,3)                  DIRCOS06
     2       RAPANG(  50) , ZGL   (  50) , RHUB  (  50) , RTIP  (  50) ,DIRCOS07
     3       THHUB (  50) , THTIP (  50) ,                EDCM  ( 3,3) ,DIRCOS08
     4       RHO ,          POISSO , YOUNGS , RADGEN ,                   DIRCOS09
     5       NGENLI , LINE1 ,              NEXT ( 100,3) , NP , NT      DIRCOS10
      DOUBLE PRECISION L12 , S1X , S1Y , S1Z , S1 , S2X , S2Y , S2Z ,   DIRCOS11
     1                 S2                                               DIRCOS12
      L12 = SQRT( (X(LB)-X(LA))**2 + (Y(LB)-Y(LA))**2 +(Z(LB)-Z(LA))**2)DIRCOS13
      S1X = (Y(LB)-Y(LA)) * (Z(LC)-Z(LA)) - (Y(LC)-Y(LA))*(Z(LB)-Z(LA)) DIRCOS14
      S1Y = (Z(LB)-Z(LA))*(X(LC)-X(LA)) - (Z(LC)-Z(LA))*(X(LB)-X(LA))   DIRCOS15
      S1Z = (X(LB) - X(LA)) * (Y(LC) - Y(LA)) - (X(LC) - X(LA)) *       DIRCOS16
     1      (Y(LB) - Y(LA))                                             DIRCOS17
      SIGN = 1.0                                                        DIRCOS18
      IF ( LC .LT. LB ) SIGN = -1.0                                     DIRCOS19
 5    S1X = S1X * SIGN                                                  DIRCOS20
      S1Y = S1Y * SIGN                                                  DIRCOS21
      S1Z = S1Z * SIGN                                                  DIRCOS22
 10   S1  =DSQRT( S1X**2 + S1Y**2 + S1Z**2 )                           DIRCOS23
      S2X = S1Y * (Z(LB) - Z(LA)) - S1Z * (Y(LB) - Y(LA))               DIRCOS24
      S2Y = S1Z * (X(LB) - X(LA)) - S1X * (Z(LB) - Z(LA))               DIRCOS25
      S2Z = S1X * (Y(LB) - Y(LA)) - S1Y * (X(LB) - X(LA))               DIRCOS26
      S2  =DSQRT( S2X**2 + S2Y**2 + S2Z**2 )                            DIRCOS27
      EDCM(1,1) = (X(LB) - X(LA)) / L12                                 DIRCOS28
      EDCM(2,1) = (Y(LB) - Y(LA)) / L12                                 DIRCOS29
      EDCM(3,1) = ( Z(LB) - Z(LA) ) / L12                               DIRCOS30
      EDCM(1,2) = S2X / S2                                              DIRCOS31
      EDCM(2,2) = S2Y / S2                                              DIRCOS32
      EDCM(3,2) = S2Z / S2                                              DIRCOS33
      EDCM(1,3) = S1X / S1                                              DIRCOS34
      EDCM(2,3) = S1Y / S1                                              DIRCOS35
      EDCM(3,3) = S1Z / S1                                              DIRCOS36
      RETURN                                                            DIRCOS37
      END                                                               DIRCOS38
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      SUBROUTINE LCOORD (LA,LB,LC,I)                                    LCOORD01
C     DETERMINE LOCAL NODAL COORDINATES (XL,YL,ZL) OF TRIANGULAR ELEMENTLCOORD02
C     FROM COMMON NODAL COORDINATES (X,Y,Z) .                           LCOORD03
C                                                                       LCOORD04
      COMMON X      ( 100) , Y      ( 100) , Z      ( 100) , TH     ( 100) ,LCOORD05
     1                       XL   ( 100,3) , YL   ( 100,3) ,            LCOORD06
     2        RAPANG(   50) , ZGL    (  50) , RHUB   (  50) , RTIP   (  50) ,LCOORD07
     3        THHUB (   50) , THTIP (   50) ,                  EDCM   ( 3,3) ,LCOORD08
     4        RHO ,           POISSO , YOUNGS , RADCEN ,                 LCOORD09
     5        NGENLI , LINE1 ,                 NEXT ( 100,3) , NP , NT   LCOORD10
      XL(I,2)= EDCM(1,1) * (X(LB) - X(LA)) + EDCM(2,1) * (Y(LB) - Y(LA))LCOORD11
     1         +EDCM(3,1) * (Z(LB) - Z(LA))                             LCOORD12
      XL(I,3)= EDCM(1,1) * (X(LC) - X(LA)) + EDCM(2,1) * (Y(LC) - Y(LA))LCOORD13
     1         +EDCM(3,1) * (Z(LC) - Z(LA))                             LCOORD14
      YL(I,3)= EDCM(1,2) * (X(LC) - X(LA)) + EDCM(2,2) * (Y(LC) - Y(LA))LCOORD15
     1         +EDCM(3,2) * (Z(LC) - Z(LA))                             LCOORD16
      RETURN                                                            LCOORD17
      END                                                               LCOORD18
```

```
      SUBROUTINE MEMSTF ( LAA,LBB,LCC,IE )                                  MEMSTI01
C     CALCULATE THE LOCAL MEMBRANE STIFFNESS MATRIX (ELMSM) FOR A           MEMSTI02
C     TRIANGULAR ELEMENT .                                                  MEMSTI03
C                                                                           MEMSTI04
      COMMON X      ( 100) , Y      ( 100) , Z      ( 100) , TH     ( 100) ,MEMSTI05
     1                       XLL ( 100,3) , YLL ( 100,3) ,                  MEMSTI06
     2        RAPANG(  50) , ZGL   (  50) , RHUB  (  50) , RTIP   (  50) ,MEMSTI07
     3        THHUB (  50) , THTIP (  50) ,                 EDCM   ( 3,3) ,MEMSTI08
     4        RHO ,          POISSO , YOUNGS , RADGEN ,                     MEMSTI09
     5        NGENLI , LINE1 ,                NEXT ( 100,3) , NP , NT ,     MEMSTI10
     6        ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9)             MEMSTI11
      DIMENSION             AMNIT(6,6) , WM(3,6) , WMT(6,3) , EM(3,3) ,     MEMSTI12
     1             TN(6,1) , ZINT (1,6) , Z1(6,6) , Z2 (6,6)                MEMSTI13
      DIMENSION YL(3) , XL(3)                                               MEMSTI14
      DOUBLE PRECISION ZINT , XL , YL , TERM , AMNIT , WM , WMT , EM ,      MEMSTI15
     1                 TN , Z1 , Z2                                         MEMSTI16
      DATA LA,LB,LC / 1 , 2 , 3 /                                           MEMSTI17
      DATA WM / 1.0D0,4*0.0D0,1.0D0,2*0.0D0,1.0D0,0.0D0,1.0D0,7*0.0D0 /     MEMSTI18
      DATA WMT / 1.0D0,8*0.0D0,1.0D0,3*0.0D0,2*1.0D0,3*0.0D0 /              MEMSTI19
      DATA      AMNIT,EM,TN / 51*0.0D0 /                                    MEMSTI20
      XL(LB) = XLL(IE,2)                                                    MEMSTI21
      XL(LC) = XLL(IE,3)                                                    MEMSTI22
      YL(LC) = YLL(IE,3)                                                    MEMSTI23
      TERM = YOUNGS / ( 1.0 - POISSO**2 )                                   MEMSTI24
      EM(1,1) = TERM                                                        MEMSTI25
      EM(1,2) = TERM * POISSO                                               MEMSTI26
      EM(2,1) = EM(1,2)                                                     MEMSTI27
      EM(2,2) = TERM                                                        MEMSTI28
      EM(3,3) = ( 1.0 - POISSO ) * TERM / 2.0                               MEMSTI29
      AMNIN(1,1) = -1.0 / XL(LB)                                            MEMSTI30
      AMNIN(1,3) = - AMNIN(1,1)                                             MEMSTI31
      AMNIN(2,2) = AMNIN(1,1)                                               MEMSTI32
      AMNIN(2,4) = AMNIN(1,3)                                               MEMSTI33
      AMNIN(3,1) = ( XL(LC) - XL(LB) ) / XL(LB) / YL(LC)                    MEMSTI34
      AMNIN(3,3) = - XL(LC) / XL(LB) / YL(LC)                               MEMSTI35
      AMNIN(3,5) = 1.0 / YL(LC)                                             MEMSTI36
      AMNIN(4,2) = AMNIN(3,1)                                               MEMSTI37
      AMNIN(4,4) = AMNIN(3,3)                                               MEMSTI38
      AMNIN(4,6) = AMNIN(3,5)                                               MEMSTI39
      AMNIN(5,1) = 1.0                                                      MEMSTI40
      AMNIN(6,2) = 1.0                                                      MEMSTI41
      DO 10 I = 1,6                                                         MEMSTI42
      ZINT(1,I) = 0.0                                                       MEMSTI43
      DO 10 J = 1,6                                                         MEMSTI44
   10 AMNIT(I,J) = AMNIN(J,I)                                               MEMSTI45
      TN(1,1) = TH(LAA)                                                     MEMSTI46
      TN(3,1) = TH(LBB)                                                     MEMSTI47
      TN(5,1) = TH(LCC)                                                     MEMSTI48
      CALL ZINT1 ( IE,ZINT )                                                MEMSTI49
      DO 15 J = 1,6                                                         MEMSTI50
      Z1(1,J) = 0.0                                                         MEMSTI51
      DO 15 K = 1,6                                                         MEMSTI52
   15 Z1(1,J) = Z1(1,J) + ZINT(1,K) * AMNIN(K,J)                            MEMSTI53
      Z2(1,1) = 0.0                                                         MEMSTI54
      DO 20 K = 1,6                                                         MEMSTI55
   20 Z2(1,1) = Z2(1,1) + Z1(1,K) * TN(K,1)                                 MEMSTI56
      DO 25 I = 1,6                                                         MEMSTI57
      DO 25 J = 1,3                                                         MEMSTI58
```

```
      Z1(I,J) = 0.0                                                    MEMSTI59
      DO 25 K = 1,3                                                    MEMSTI60
25    Z1(I,J) = Z1(I,J) + Z2(1,1) * WMT(I,K) * EM(K,J)                 MEMSTI61
      DO 30 I = 1,6                                                    MEMSTI62
      DO 30 J = 1,6                                                    MEMSTI63
      Z2(I,J) = 0.0                                                    MEMSTI64
      DO 30 K = 1,3                                                    MEMSTI65
30    Z2(I,J) = Z2(I,J) + Z1(I,K) * WM(K,J)                            MEMSTI66
      DO 35 I = 1,6                                                    MEMSTI67
      DO 35 J = 1,6                                                    MEMSTI68
      Z1(I,J) = 0.0                                                    MEMSTI69
      DO 35 K = 1,6                                                    MEMSTI70
35    Z1(I,J) = Z1(I,J) + AMNIT(I,K) * Z2(K,J)                         MEMSTI71
      DO 40 I = 1,6                                                    MEMSTI72
      DO 40 J = 1,6                                                    MEMSTI73
      ELMSM(I,J) = 0.0                                                 MEMSTI74
      DO 40 K = 1,6                                                    MEMSTI75
40    ELMSM(I,J) = ELMSM(I,J) + Z1(I,K) * AMNIN(K,J)                   MEMSTI76
      RETURN                                                           MEMSTI77
      END                                                              MEMSTI78
```

```
      SUBROUTINE ZINT1 ( IE,ZINT )                                          ZINT1001
C     USING GAUSSIAN QUADRATURE, INTEGRATE THE FOLLOWING FUNCTIONS OVER     ZINT1002
C     THE SURFACE OF THE TRIANGLE                                           ZINT1003
C                        F(XL,YL) = 1.0                                     ZINT1004
C                        F(XL,YL) =  XL                                     ZINT1005
C                        F(XL,YL) =  YL                                     ZINT1006
C                                                                           ZINT1007
      COMMON X     ( 100) , Y     ( 100) , Z     ( 100) , TH    ( 100) ,ZINT1008
     1                      XLL ( 100,3) , YLL ( 100,3) ,                  ZINT1009
     2       RAPANG(  50) , ZGL   (  50) , RHUB  (  50) , RTIP  (  50) ,ZINT1010
     3       THHUB (  50) , THTIP (  50) ,                EDCM  ( 3,3) ,ZINT1011
     4       RHO ,          POISSO , YOUNGS , RADGEN ,                     ZINT1012
     5       NGENLI , LINEI ,              NEXT ( 100,3) , NP , NT ,       ZINT1013
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9)            ZINT1014
      DIMENSION ZINT(1,6) , A(10) , H(10) , YI(10) , XI(10) , AREA(10) ,ZINT1015
     1          XIL(10) , XIR(10)                                          ZINT1016
      DIMENSION YL(3) , XL(3)                                             ZINT1017
      DOUBLE PRECISION YO , HT , XO , ZINT , A , H , YI , XI , AREA ,     ZINT1018
     1                 XIL , XIR , XL , YL                                ZINT1019
      DATA LA,LB,LC / 1 , 2 , 3 /                                         ZINT1020
      DATA A / -.97390652851717 , -.86506336668899 , -.67940956829902 , ZINT1021
     1         -.43339539412925 , -.14887433898163 ,  .14887433898163 , ZINT1022
     2          .43339539412925 ,  .67940956829902 ,  .86506336668899 , ZINT1023
     3          .97390652851717  /                                        ZINT1024
      DATA H /  .06667134430869 ,  .14945134915058 ,  .21908636251598 , ZINT1025
     1          .26926671930100 ,  .29552422471475 ,  .29552422471475 , ZINT1026
     2          .26926671930100 ,  .21908636251598 ,  .14945134915058 , ZINT1027
     3          .06667134430869  /                                        ZINT1028
      XL(LB) = XLL(IE,2)                                                  ZINT1029
      XL(LC) = XLL(IE,3)                                                  ZINT1030
      YL(LC) = YLL(IE,3)                                                  ZINT1031
      YO = 0.5 * YL(LC)                                                   ZINT1032
      DO 3 I = 1,10                                                       ZINT1033
      YI(I)  = YO + A(I) * YO                                             ZINT1034
      XIL(I) = XL(LC) * YI(I) / YL(LC)                                    ZINT1035
      XIR(I) = XL(LB) - ( XL(LB) - XL(LC) ) * YI(I) / YL(LC)              ZINT1036
      IF ( I .NE. 1 ) GO TO 2                                             ZINT1037
      HT     = 0.0                                                        ZINT1038
      DO 1 J = 1,10                                                       ZINT1039
    1 HT     = HT + H(J)                                                  ZINT1040
    2 AREA(I)= XL(LB) * ( 1.0 - A(I) ) * 0.25 * HT                        ZINT1041
      ZINT(1,5) = ZINT(1,5) +DABS(YL(LC)) * 0.5 * AREA(I) * H(I)          ZINT1042
    3 ZINT(1,3) = ZINT(1,3) +DABS(YL(LC)) * 0.5 *YI(I) * AREA(I) * H(I) ZINT1043
      DO 5 I = 1,10                                                       ZINT1044
      XO     = XIL(I) + 0.5 * ( XIR(I) - XIL(I) )                         ZINT1045
      AREA(I)= 0.0                                                        ZINT1046
      DO 4 J = 1,10                                                       ZINT1047
      XI(J)  = XO + A(J) * ( XO - XIL(I) )                                ZINT1048
    4 AREA(I)= AREA(I) + XL(LB) * ( 1.0 - A(I) ) * 0.25 * H(J) * XI(J)  ZINT1049
    5 ZINT(1,1) = ZINT(1,1) +DABS(YL(LC)) * 0.5 * AREA(I) * H(I)          ZINT1050
      RETURN                                                              ZINT1051
      END                                                                 ZINT1052
```

```
      SUBROUTINE BENSTF ( LAA,LBB,LCC,IE )                                  BENST001
C     CALCULATE THE ELEMENTAL LOCAL BENDING STIFFNESS MATRIX (ELBSM) .      BENST002
C                                                                           BENST003
      COMMON X      ( 100) , Y      ( 100) , Z      ( 100) , TH     ( 100) ,BENST004
     1                       XLL ( 100,3) , YLL ( 100,3) ,                  BENST005
     2       RAPANG(  50) , ZGL    (  50) , RHUB   (  50) , RTIP   (  50) ,BENST006
     3       THHUB (  50) , THTIP (  50) ,                  EDCM   ( 3,3) ,BENST007
     4       RHO ,          POISSO , YOUNGS , RADGEN ,                      BENST008
     5       NGENLI , LINE1 ,                NEXT ( 100,3) , NP , NT ,      BENST009
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9)              BENST010
      DIMENSION ABNIT(9,9) , Z1(9,9) , ZINT(9,9)                            BENST011
      DIMENSION YL(3) , XL(3)                                               BENST012
      DOUBLE PRECISION ZJ1 , ZJ2 , ZJ3 , ZJ4 , ZJ5 , ZJ6 , ABNIT , Z1 ,     BENST013
     1                 ZINT , XL , YL                                       BENST014
      DATA LA,LB,LC / 1 , 2 , 3 /                                           BENST015
      XL(LB) = XLL(IE,2)                                                    BENST016
      XL(LC) = XLL(IE,3)                                                    BENST017
      YL(LC) = YLL(IE,3)                                                    BENST018
      ABNIN(1,1) = 1.0                                                      BENST019
      ABNIN(2,3) = -1.0                                                     BENST020
      ABNIN(3,2) = 1.0                                                      BENST021
      ABNIN(4,1) = -3.0 / XL(LB) / XL(LB)                                   BENST022
      ABNIN(4,3) = 2.0 / XL(LB)                                             BENST023
      ABNIN(4,4) = - ABNIN(4,1)                                             BENST024
      ABNIN(4,6) = 1.0 / XL(LB)                                             BENST025
      ABNIN(5,1) = 3.0 * ( XL(LC)**2 - XL(LB)**2 ) / (XL(LB)*YL(LC))**2     BENST026
      ABNIN(5,2) = -2.0 / YL(LC)                                            BENST027
      ABNIN(5,3) = 2.0 * ( XL(LB) - XL(LC) ) * XL(LC) / XL(LB) / YL(LC)     BENST028
     1           / YL(LC)                                                   BENST029
      ABNIN(5,4) = -3.0 * ( XL(LC) / XL(LB) / YL(LC) )**2                   BENST030
      ABNIN(5,6) = - ( XL(LC) / YL(LC) )**2 / XL(LB)                        BENST031
      ABNIN(5,7) = 3.0 / YL(LC) / YL(LC)                                    BENST032
      ABNIN(5,8) = - 1.0 / YL(LC)                                           BENST033
      ABNIN(5,9) = XL(LC) / YL(LC) / YL(LC)                                 BENST034
      ABNIN(6,1) = 2.0 / XL(LB)**3                                          BENST035
      ABNIN(6,3) = - 1.0 / XL(LB) / XL(LB)                                  BENST036
      ABNIN(6,4) = - ABNIN(6,1)                                             BENST037
      ABNIN(6,6) = ABNIN(6,3)                                               BENST038
      ABNIN(7,2) = ABNIN(6,3)                                               BENST039
      ABNIN(7,5) = - ABNIN(6,3)                                             BENST040
      ABNIN(8,1) = 6.0 * XL(LC) / XL(LB)**3 / YL(LC)**2 *(XL(LB)-XL(LC))    BENST041
      ABNIN(8,2) = 2.0 * XL(LC) / XL(LB) / XL(LB) / YL(LC)                  BENST042
      ABNIN(8,3) = ( XL(LB) - 3.0*XL(LC) ) * ( XL(LB) - XL(LC) ) /          BENST043
     1           (XL(LB) * YL(LC))**2                                       BENST044
      ABNIN(8,4) = 6.0 * XL(LC) * ( XL(LC) - XL(LB) ) / XL(LB)**3 /         BENST045
     1           YL(LC)**2                                                  BENST046
      ABNIN(8,5) = -2.0 * XL(LC) / XL(LB) / XL(LB) / YL(LC)                 BENST047
      ABNIN(8,6) = XL(LC) * ( 3.0*XL(LC) - 2.0*XL(LB) ) / ( XL(LB) *        BENST048
     1           YL(LC) )**2                                                BENST049
      ABNIN(8,9) = -1.0 / YL(LC) / YL(LC)                                   BENST050
      ABNIN(9,1) = 2.0 * ( 2.0*XL(LC)**3 - XL(LB)*( 3.0*XL(LC)**2 -         BENST051
     1           XL(LB)**2 ) ) / ( XL(LB) * YL(LC) )**3                     BENST052
      ABNIN(9,2) = ( XL(LB)**2 - XL(LC)**2 ) / ( XL(LB) * YL(LC) )**2       BENST053
      ABNIN(9,3) = -2.0 * XL(LC) * ( XL(LB) - XL(LC) )**2 / XL(LB)**2 /     BENST054
     1           YL(LC)**3                                                  BENST055
      ABNIN(9,4) = 2.0 * XL(LC)**2 * ( 3.0*XL(LB) - 2.0*XL(LC) ) /          BENST056
     1           ( XL(LB) * YL(LC) )**3                                     BENST057
      ABNIN(9,5) = ( XL(LC) / XL(LB) / YL(LC) )**2                          BENST058
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      ABNIN(9,6) = 2.0 * XL(LC)**2 * ( XL(LB) - XL(LC) ) / XL(LB)**2 /  BENST059
     1             YL(LC)**3                                            BENST060
      ABNIN(9,7) = -2.0 / YL(LC)**3                                     BENST061
      ABNIN(9,8) = 1.0 / YL(LC)**2                                      BENST062
      DO 5  I = 1,9                                                     BENST063
      DO 5  J = 1,9                                                     BENST064
      ZINT(I,J) = 0.0                                                   BENST065
    5 ABNIT(I,J) = ABNIN(J,I)                                           BENST066
      CALL ZINT2 ( LAA,LBB,LCC,ZJ1,ZJ2,ZJ3,ZJ4,ZJ5,ZJ6,IE )            BENST067
      ZINT(4,4) = 4.0 * ZJ1                                             BENST068
      ZINT(4,5) = POISSO * ZINT(4,4)                                    BENST069
      ZINT(4,6) = 12.0 * ZJ2                                            BENST070
      ZINT(4,7) = 4.0 * ZJ3                                             BENST071
      ZINT(4,8) = 4.0 * POISSO * ZJ2                                    BENST072
      ZINT(4,9) = POISSO * ZINT(4,7) * 3.0                              BENST073
      ZINT(5,5) = ZINT(4,4)                                             BENST074
      ZINT(5,6) = POISSO * ZINT(4,6)                                    BENST075
      ZINT(5,7) = POISSO * ZINT(4,7)                                    BENST076
      ZINT(5,8) = ZINT(4,8) / POISSO                                    BENST077
      ZINT(5,9) = ZINT(4,9) / POISSO                                    BENST078
      ZINT(6,6) = 36.0 * ZJ4                                            BENST079
      ZINT(6,7) = 12.0 * ZJ5                                            BENST080
      ZINT(6,8) = 12.0 * POISSO * ZJ4                                   BENST081
      ZINT(6,9) = ZINT(6,7) * POISSO * 3.0                              BENST082
      ZINT(7,7) = 4.0 * ZJ6 + 8.0 * ( 1.0 - POISSO ) * ZJ4              BENST083
      ZINT(7,8) = 4.0 * ( 2.0 - POISSO ) * ZJ5                          BENST084
      ZINT(7,9) =12.0 * POISSO * ZJ6                                    BENST085
      ZINT(8,8) = 8.0 * ( 1.0 - POISSO ) * ZJ6 + 4.0 * ZJ4              BENST086
      ZINT(8,9) =12.0 * ZJ5                                             BENST087
      ZINT(9,9) =36.0 * ZJ6                                             BENST088
      DO 10 I = 4,8                                                     BENST089
      I1 = I + 1                                                        BENST090
      DO 10 J = I1,9                                                    BENST091
   10 ZINT(J,I) = ZINT(I,J)                                             BENST092
      ZJ1 = YOUNGS / ( 12.0 * ( 1.0 - POISSO**2 ) )                     BENST093
      DO 15 I = 4,9                                                     BENST094
      DO 15 J = 4,9                                                     BENST095
   15 ZINT(I,J) = ZINT(I,J) * ZJ1                                       BENST096
      DO 20 I = 1,9                                                     BENST097
      DO 20 J = 1,9                                                     BENST098
      Z1(I,J) = 0.0                                                     BENST099
      DO 20 K = 1,9                                                     BENST100
   20 Z1(I,J) = Z1(I,J) + ABNIT(I,K) * ZINT(K,J)                        BENST101
      DO 25 I = 1,9                                                     BENST102
      DO 25 J = 1,9                                                     BENST103
      ELBSM(I,J) = 0.0                                                  BENST104
      DO 25 K = 1,9                                                     BENST105
   25 ELBSM(I,J) = ELBSM(I,J) + Z1(I,K) * ABNIN(K,J)                    BENST106
      RETURN                                                            BENST107
      END                                                               BENST108
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     2       + XL(LB)*TH(LCC)*YI(I))**3 * XL(LB)*( 1.0 - A(I) ) * 0.25  ZINT2059
     3       * H(J) / XL(LB)**3 / YL(LC)**3                             ZINT2060
      AREA(I,1) = AREA(I,1) + TERM                                      ZINT2061
      AREA(I,2) = AREA(I,2) + TERM * XI(J)                              ZINT2062
      AREA(I,3) = AREA(I,3) + TERM * YI(I)                              ZINT2063
      AREA(I,4) = AREA(I,4) + TERM * XI(J)**2                           ZINT2064
      AREA(I,5) = AREA(I,5) + TERM * XI(J) * YI(I)                      ZINT2065
  3   AREA(I,6) = AREA(I,6) + TERM * YI(I)**2                           ZINT2066
      ZJ1 = ZJ1 +           0.5 * H(I) * AREA(I,1)*DABS(YL(LC))         ZINT2067
      ZJ2 = ZJ2 +           0.5 * H(I) * AREA(I,2)*DABS(YL(LC))         ZINT2068
      ZJ3 = ZJ3 +           0.5 * H(I) * AREA(I,3)*DABS(YL(LC))         ZINT2069
      ZJ4 = ZJ4 +           0.5 * H(I) * AREA(I,4) *DABS(YL(LC))        ZINT2070
      ZJ5 = ZJ5 +           0.5 * H(I) * AREA(I,5) *DABS(YL(LC))        ZINT2071
  4   ZJ6 = ZJ6 +           0.5 * H(I) * AREA(I,6) *DABS(YL(LC))        ZINT2072
      RETURN                                                            ZINT2073
      END                                                               ZINT2074
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```
      SUBROUTINE MEMINR (LAA,LBB,LCC,IE)                                    MEMIN001
C     CALCULATE THE LOCAL MEMBRANE INERTIA                                  MEMIN002
C     MATRIX (ELMIM) FOR A TRIANGULAR                                       MEMIN003
C     ELEMENT.                                                              MEMIN004
C                                                                           MEMIN005
      COMMON X      ( 100) , Y      ( 100) , Z      ( 100) ,       ( 100) ,MEMIN006
     1                       XLL ( 100,3) , YLL ( 100,3) ,                  MEMIN007
     2       RAPANG(  50) , ZGL    (  50) , RHUB  (  50) , RTIP  (  50) ,MEMIN008
     3       THHUB (  50) , THTIP (  50) ,                 EDCM  ( 3,3) ,MEMIN009
     4       RHO ,          POISSO , YOUNGS , RADGEN ,                     MEMIN010
     5       NGENLI , LINEI ,              NEXT ( 100,3) , NP , NT ,       MEMIN011
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,            MEMIN012
     7      SIGMAX(100) , SIGMAY(100) , ELSTIF(18,18) ,                     MEMIN013
     8         TAUXY(100),  ELSSM(9,9), MEX(100,8), IMEX(100),              MEMIN014
     9         ELINR(18,18) ,                ELMIM(6,6) , ELBIM(9,9)       MEMIN015
      DIMENSION AMNIT(6,6) , R1(6,6) , A(10) , H(10) , YI(10) ,             MEMIN016
     1XI(10) , AREA(10,6) , XIL(10) , XIR(10) , XL(3) , YL(3) ,             MEMIN017
     2ZINT(6) , R2(6,6)                                                     MEMIN018
      DOUBLE PRECISION YO , XO , TERM1 , AMNIT , R1 , A , H , YI ,         MEMIN019
     1             XL , YL , ZINT , R2                                      MEMIN020
      DATA LA,LB,LC / 1,2,3 /                                               MEMIN021
      DATA A / -.97390652851717 , -.86506336668899 , -.67940956829902 ,     MEMIN022
     1         -.43339539412925 , -.14887433898163 ,  .14887433898163 ,     MEMIN023
     2          .43339539412925 ,  .67940956829902 ,  .86506336668899 ,     MEMIN024
     3          .97390652851717  /                                          MEMIN025
      DATA H /  .06667134430869 ,  .14945134915058 ,  .21908636251598 ,     MEMIN026
     1          .26926671930100 ,  .29552422471475 ,  .29552422471475 ,     MEMIN027
     2          .26926671930100 ,  .21908636251598 ,  .14945134915058 ,     MEMIN028
     3          .06667134430869  /                                          MEMIN029
      XL(LB) = XLL(IE,2)                                                    MEMIN030
      XL(LC) = XLL(IE,3)                                                    MEMIN031
      YL(LC) = YLL(IE,3)                                                    MEMIN032
      DO  10  I = 1,6                                                       MEMIN033
      ZINT(I) = 0.0                                                         MEMIN034
      DO  10  J = 1,6                                                       MEMIN035
      R1(I,J) = 0.0                                                         MEMIN036
      R2(I,J) = 0.0                                                         MEMIN037
      ELMIM(I,J) = 0.0                                                      MEMIN038
 10   AMNIT(I,J) = AMNIN(J,I)                                               MEMIN039
C     USING GAUSIAN QUADRATURE,INTEGRATE THE FOLLOWING FUNCTIONS OVER       MEMIN040
C     THE SURFACE OF THE TRIANGLE                                           MEMIN041
C                          F(XL,YL) = TERM                                  MEMIN042
C                          F(XL,YL) = TERM * XL                             MEMIN043
C                          F(XL,YL) = TERM * YL                             MEMIN044
C                          F(XL,YL) = TERM * XL*YL                          MEMIN045
C                          F(XL,YL) = TERM * XL**2                          MEMIN046
C                          F(XL,YL) = TERM * YL**2                          MEMIN047
C     WHERE                                                                 MEMIN048
C      TERM =((XL(LB)*YL(LC) + (XL(LC)-XL(LB))*YL - YL(LC)*XL*TH(LAA) -     MEMIN049
C            (XL(LC)*YL - YL(LC)*XL)*TH(LBB) + XL(LB)*TH(LCC)*YL)/XL(LBMEMIN050
      YO = 0.50 * YL(LC)                                                    MEMIN051
      DO  35  I = 1,10                                                      MEMIN052
      YI(I) = YO + A(I)*YO                                                  MEMIN053
      XIL(I) = XL(LC)*YI(I) / YL(LC)                                        MEMIN054
      XIR(I) = XL(LB) - (XL(LB) - XL(LC))*YI(I) / YL(LC)                    MEMIN055
      XO = XIL(I) + 0.5*(XIR(I)-XIL(I))                                     MEMIN056
      DO  20  J = 1,10                                                      MEMIN057
      DO  15  K = 1,6                                                       MEMIN058
```

```
 15   AREA(J,K) = 0.0                                                    MEMIN056
 20   XI(J) = XO + A(J)*(XO-XIL(I))                                      MEMIN060
      DO  25  J = 1,10                                                   MEMIN061
      TERM1 = XL(LB)*(1.0-A(I))*0.25*H(J)*((XL(LB)*YL(LC)                MEMIN062
     1         +(XL(LC)-XL(LB))*YI(I)-YL(LC)*XI(J))*TH(LAA)              MEMIN063
     2         + (YL(LC)*XI(J)-XL(LC)*YI(I))*TH(LBB)+XL(LB)*TH(LCC)      MEMIN064
     3         *YI(I))/XL(LB)/YL(LC)                                     MEMIN065
      AREA(I,1) = AREA(I,1) + TERM1                                      MEMIN066
      AREA(I,2) = AREA(I,2) + TERM1*XI(J)                                MEMIN067
      AREA(I,3) = AREA(I,3) + TERM1*YI(I)                                MEMIN068
      AREA(I,4) = AREA(I,4) + TERM1*XI(J)*YI(I)                          MEMIN069
      AREA(I,5) = AREA(I,5) + TERM1*XI(J)**2                             MEMIN070
      AREA(I,6) = AREA(I,6) + TERM1*YI(I)**2                             MEMIN071
 25   CONTINUE                                                           MEMIN072
      TERM1 =DABS( YL(LC) ) * 0.5 * H(I)                                 MEMIN073
      DO  30  J =1,6                                                     MEMIN074
 30   ZINT(J) = ZINT(J) + TERM1*AREA(I,J)                                MEMIN075
 35   CONTINUE                                                           MEMIN076
C     END OF INTEGRATION                                                 MEMIN077
      R2(1,1) = ZINT(5)*RHO                                              MEMIN078
      R2(1,3) = ZINT(4)*RHO                                              MEMIN079
      R2(1,5) = ZINT(2)*RHO                                              MEMIN080
      R2(2,2) = R2(1,1)                                                  MEMIN081
      R2(2,4) = R2(1,3)                                                  MEMIN082
      R2(2,6) = R2(1,5)                                                  MEMIN083
      R2(3,3) = ZINT(6)*RHO                                              MEMIN084
      R2(3,5) = ZINT(3)*RHO                                              MEMIN085
      R2(4,4) = R2(3,3)                                                  MEMIN086
      R2(4,6) = R2(3,5)                                                  MEMIN087
      R2(5,5) = ZINT(1)*RHO                                              MEMIN088
      R2(6,6) = R2(5,5)                                                  MEMIN089
      DO  40  I = 1,5                                                    MEMIN090
      I1 = I+1                                                           MEMIN091
      DO  40  J = I1,6                                                   MEMIN092
 40   R2(J,I) = R2(I,J)                                                  MEMIN093
      DO  45  I = 1,6                                                    MEMIN094
      DO  45  J = 1,6                                                    MEMIN095
      DO  45  K = 1,6                                                    MEMIN096
 45   R1(I,J) = R1(I,J) + AMNIT(I,K)*R2(K,J)                             MEMIN097
      DO  50  I = 1,6                                                    MEMIN098
      DO  50  J = 1,6                                                    MEMIN099
      DO  50  K = 1,6                                                    MEMIN100
 50   ELMIM(I,J) = ELMIM(I,J) + R1(I,K)*AMNIN(K,J)                       MEMIN101
      RETURN                                                             MEMIN102
      END                                                                MEMIN103
```

```
      SUBROUTINE BENINR (LAA, LBB, LCC, IE)                                 BENIN001
C     CALCULATE THE LOCAL BENDING INERTIA MATRIX (ELBIM) FOR A              BENIN002
C     TRIANGULAR ELEMENT.                                                   BENIN003
C                                                                           BENIN004
      COMMON X      ( 100) , Y      ( 100) , Z      ( 100) , TH     ( 100) ,BENIN005
     1                      XLL ( 100,3) , YLL ( 100,3) ,                  BENIN006
     2       RAPANG(  50) , ZGL    (  50) , RHUB   (  50) , RTIP   (  50) ,BENIN007
     3       THHUB (  50) , THTIP (  50) ,                   EDCM   ( 3,3) ,BENIN008
     4       RHO ,          POISSO , YOUNGS , RADGEN ,                     BENIN009
     5       NGENLI , LINEI ,                NEXT ( 100,3) , NP , NT ,      BENIN010
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,            BENIN011
     7      SIGMAX(100) , SIGMAY(100) , ELSTIF(18,18) ,                     BENIN012
     8         TAUXY(100),  ELSSM(9,9), MEX(100,8), IMEX(100),              BENIN013
     9         ELINR(18,18) ,                 ELMIM(6,6) , ELBIM(9,9)       BENIN014
      DIMENSION ABNIT(9,9), R1(9,9), R2(9,9), A(10), H(10), YI(10),         BENIN015
     1          XI(10), AREA(10,28), XIL(10), XIR(10), XL(3), YL(3),        BENIN016
     2          ZINT(28)                                                    BENIN017
      DOUBLE PRECISION YO , XO , TERM1 , ABNIT , R1 , R2 , A , H ,         BENIN018
     1                 YI , XI , AREA , XIL , XIR , XL , YL , ZINT        BENIN019
      DATA LA, LB, LC / 1,2,3 /                                             BENIN020
      DATA A / -.97390652851717 , -.86506336668899 , -.67940956829902 , BENIN021
     1         -.43339539412925 , -.14887433898163 ,  .14887433898163 , BENIN022
     2          .43339539412925 ,  .67940956829902 ,  .86506336668899 , BENIN023
     3          .97390652851717  /                                         BENIN024
      DATA H /  .06667134430869 ,  .14945134915058 ,  .21908636251598 , BENIN025
     1          .26926671930100 ,  .29552422471475 ,  .29552422471475 , BENIN026
     2          .26926671930100 ,  .21908636251598 ,  .14945134915058 , BENIN027
     3          .06667134430869  /                                         BENIN028
      XL(LB) = XLL(IE,2)                                                    BENIN029
      XL(LC) = XLL(IE,3)                                                    BENIN030
      YL(LC) = YLL(IE,3)                                                    BENIN031
      DO 10 I = 1,9                                                         BENIN032
      DO 10 J = 1,9                                                         BENIN033
      R1(I,J) = 0.0                                                         BENIN034
      R2(I,J) = 0.0                                                         BENIN035
      ELBIM(I,J) = 0.0                                                      BENIN036
   10 ABNIT(I,J) = ABNIN(J,I)                                               BENIN037
      DO 15 I = 1,28                                                        BENIN038
   15 ZINT(I) = 0.0                                                         BENIN039
C     USING GAUSSIAN QUADRATURE, INTEGRATE THE FOLLOWING FUNCTIONS          BENIN040
C     OVER THE SURFACE OF THE TRIANGLE.                                     BENIN041
C                   F(XL,YL) = TERM                                         BENIN042
C                   F(XL,YL) = TERM * YL                                    BENIN043
C                   F(XL,YL) = TERM * YL**2                                 BENIN044
C                   F(XL,YL) = TERM * YL**3                                 BENIN045
C                   F(XL,YL) = TERM * YL**4                                 BENIN046
C                   F(XL,YL) = TERM * YL**5                                 BENIN047
C                   F(XL,YL) = TERM * YL**6                                 BENIN048
C                   F(XL,YL) = TERM * XL                                    BENIN049
C                   F(XL,YL) = TERM * XL**2                                 BENIN050
C                   F(XL,YL) = TERM * XL**3                                 BENIN051
C                   F(XL,YL) = TERM * XL**4                                 BENIN052
C                   F(XL,YL) = TERM * XL**5                                 BENIN053
C                   F(XL,YL) = TERM * XL**6                                 BENIN054
C                   F(XL,YL) = TERM * XL * YL                               BENIN055
C                   F(XL,YL) = TERM * XL * YL**2                            BENIN056
C                   F(XL,YL) = TERM * XL * YL**3                            BENIN057
C                   F(XL,YL) = TERM * XL * YL**4                            BENIN058
```

```
C                 F(XL,YL) = TERM * XL * YL**5                                  BENIN059
C                 F(XL,YL) = TERM * XL**2 * YL                                  BENIN060
C                 F(XL,YL) = TERM * XL**2 * YL**2                               BENIN061
C                 F(XL,YL) = TERM * XL**2 * YL**3                               BENIN062
C                 F(XL,YL) = TERM * XL**2 * YL**4                               BENIN063
C                 F(XL,YL) = TERM * XL**3 * YL                                  BENIN064
C                 F(XL,YL) = TERM * XL**3 * YL**2                               BENIN065
C                 F(XL,YL) = TERM * XL**3 * YL**3                               BENIN066
C                 F(XL,YL) = TERM * XL**4 * YL                                  BENIN067
C                 F(XL,YL) = TERM * XL**4 * YL**2                               BENIN068
C                 F(XL,YL) = TERM * XL**5 * YL                                  BENIN069
C     WHERE                                                                     BENIN070
C      TERM =((XL(LB)*YL(LC) + (XL(LC)-XL(LB))*YL - YL(LC)*XL*TH(LAA) -         BENIN071
C             (XL(LC)*YL - YL(LC)*XL)*TH(LBB) + XL(LB)*TH(LCC)*YL)/XL(LBBENIN072
      YO = 0.50 * YL(LC)                                                        BENIN073
      DO 40 I = 1,10                                                            BENIN074
      YI(I) = YO + A(I) * YO                                                    BENIN075
      XIL(I) = XL(LC) * YI(I) / YL(LC)                                          BENIN076
      XIR(I) = XL(LB) - (XL(LB) - XL(LC)) * YI(I) / YL(LC)                      BENIN077
      XO = XIL(I) + 0.5 * (XIR(I) - XIL(I))                                     BENIN078
      DO 25 J = 1,10                                                            BENIN079
      DO 20 K = 1,28                                                            BENIN080
 20   AREA(J,K) = 0.0                                                           BENIN081
 25   XI(J) = XO + A(J) * (XO - XIL(I))                                         BENIN082
      DO 30 J = 1,10                                                            BENIN083
      TERM1 = XL(LB) * (1.0 - A(I)) * 0.25 * H(J) * ((XL(LB) * YL(LC) +         BENIN084
     1        (XL(LC) - XL(LB)) * YI(I) - YL(LC) * XI(J)) * TH(LAA) +           BENIN085
     2        (YL(LC) * XI(J) - XL(LC) * YI(I)) * TH(LBB) + XL(LB) *            BENIN086
     3        TH(LCC) * YI(I))/XL(LB)/YL(LC)                                    BENIN087
      AREA(I,1) = AREA(I,1) + TERM1                                             BENIN088
      AREA(I,2) = AREA(I,2) + TERM1*YI(I)                                       BENIN089
      AREA(I,3) = AREA(I,3) + TERM1*YI(I)**2                                    BENIN090
      AREA(I,4) = AREA(I,4) + TERM1*YI(I)**3                                    BENIN091
      AREA(I,5) = AREA(I,5) + TERM1*YI(I)**4                                    BENIN092
      AREA(I,6) = AREA(I,6) + TERM1*YI(I)**5                                    BENIN093
      AREA(I,7) = AREA(I,7) + TERM1*YI(I)**6                                    BENIN094
      AREA(I,8) = AREA(I,8) + TERM1*XI(J)                                       BENIN095
      AREA(I,9) = AREA(I,9) + TERM1*XI(J)**2                                    BENIN096
      AREA(I,10)= AREA(I,10)+ TERM1*XI(J)**3                                    BENIN097
      AREA(I,11)= AREA(I,11)+ TERM1*XI(J)**4                                    BENIN098
      AREA(I,12)= AREA(I,12)+ TERM1*XI(J)**5                                    BENIN099
      AREA(I,13)= AREA(I,13)+ TERM1*XI(J)**6                                    BENIN100
      AREA(I,14)= AREA(I,14)+ TERM1*XI(J)*YI(I)                                 BENIN101
      AREA(I,15)= AREA(I,15)+ TERM1*XI(J)*YI(I)**2                              BENIN102
      AREA(I,16)= AREA(I,16)+ TERM1*XI(J)*YI(I)**3                              BENIN103
      AREA(I,17)= AREA(I,17)+ TERM1*XI(J)*YI(I)**4                              BENIN104
      AREA(I,18)= AREA(I,18)+ TERM1*XI(J)*YI(I)**5                              BENIN105
      AREA(I,19)= AREA(I,19)+ TERM1*XI(J)**2*YI(I)                              BENIN106
      AREA(I,20)= AREA(I,20)+ TERM1*XI(J)**2*YI(I)**2                           BENIN107
      AREA(I,21)= AREA(I,21)+ TERM1*XI(J)**2*YI(I)**3                           BENIN108
      AREA(I,22)= AREA(I,22)+ TERM1*XI(J)**2*YI(I)**4                           BENIN109
      AREA(I,23)= AREA(I,23)+ TERM1*XI(J)**3*YI(I)                              BENIN110
      AREA(I,24)= AREA(I,24)+ TERM1*XI(J)**3*YI(I)**2                           BENIN111
      AREA(I,25)= AREA(I,25)+ TERM1*XI(J)**3*YI(I)**3                           BENIN112
      AREA(I,26)= AREA(I,26)+ TERM1*XI(J)**4*YI(I)                              BENIN113
      AREA(I,27)= AREA(I,27)+ TERM1*XI(J)**4*YI(I)**2                           BENIN114
      AREA(I,28)= AREA(I,28)+ TERM1*XI(J)**5*YI(I)                              BENIN115
 30   CONTINUE                                                                  BENIN116
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      TERM1 =DABS( YL(LC) ) * 0.5 * H(I)                                BENIN117
      DO 35 J = 1,28                                                    BENIN118
35    ZINT(J) = ZINT(J) + TERM1 * AREA(I,J)                             BENIN119
40    CONTINUE                                                          BENIN120
      R1(1,1) = ZINT(1) * RHO                                           BENIN121
      R1(1,2) = ZINT(8) * RHO                                           BENIN122
      R1(1,3) = ZINT(2) * RHO                                           BENIN123
      R1(1,4) = ZINT(9) * RHO                                           BENIN124
      R1(1,5) = ZINT(3) * RHO                                           BENIN125
      R1(1,6) = ZINT(10)* RHO                                           BENIN126
      R1(1,7) = ZINT(19)* RHO                                           BENIN127
      R1(1,8) = ZINT(15)* RHO                                           BENIN128
      R1(1,9) = ZINT(4) * RHO                                           BENIN129
      R1(2,2) = R1(1,4)                                                 BENIN130
      R1(2,3) = ZINT(14)* RHO                                           BENIN131
      R1(2,4) = R1(1,6)                                                 BENIN132
      R1(2,5) = R1(1,8)                                                 BENIN133
      R1(2,6) = ZINT(11)* RHO                                           BENIN134
      R1(2,7) = ZINT(23)* RHO                                           BENIN135
      R1(2,8) = ZINT(20)* RHO                                           BENIN136
      R1(2,9) = ZINT(16)* RHO                                           BENIN137
      R1(3,3) = R1(1,5)                                                 BENIN138
      R1(3,4) = R1(1,7)                                                 BENIN139
      R1(3,5) = R1(1,9)                                                 BENIN140
      R1(3,6) = R1(2,7)                                                 BENIN141
      R1(3,7) = R1(2,8)                                                 BENIN142
      R1(3,8) = R1(2,9)                                                 BENIN143
      R1(3,9) = ZINT(5) * RHO                                           BENIN144
      R1(4,4) = R1(2,6)                                                 BENIN145
      R1(4,5) = R1(2,8)                                                 BENIN146
      R1(4,6) = ZINT(12) * RHO                                          BENIN147
      R1(4,7) = ZINT(26) * RHO                                          BENIN148
      R1(4,8) = ZINT(24) * RHO                                          BENIN149
      R1(4,9) = ZINT(21) * RHO                                          BENIN150
      R1(5,5) = R1(3,9)                                                 BENIN151
      R1(5,6) = R1(4,8)                                                 BENIN152
      R1(5,7) = R1(4,9)                                                 BENIN153
      R1(5,8) = ZINT(17) * RHO                                          BENIN154
      R1(5,9) = ZINT(6) * RHO                                           BENIN155
      R1(6,6) = ZINT(13) * RHO                                          BENIN156
      R1(6,7) = ZINT(28) * RHO                                          BENIN157
      R1(6,8) = ZINT(27) * RHO                                          BENIN158
      R1(6,9) = ZINT(25) * RHO                                          BENIN159
      R1(7,7) = R1(6,8)                                                 BENIN160
      R1(7,8) = R1(6,9)                                                 BENIN161
      R1(7,9) = ZINT(22) * RHO                                          BENIN162
      R1(8,8) = R1(7,9)                                                 BENIN163
      R1(8,9) = ZINT(18) * RHO                                          BENIN164
      R1(9,9) = ZINT(7) * RHO                                           BENIN165
      DO 45 I = 1,8                                                     BENIN166
      I1 = I + 1                                                        BENIN167
      DO 45 J =I1,9                                                     BENIN168
45    R1(J,I) = R1(I,J)                                                 BENIN169
      DO 50 I = 1,9                                                     BENIN170
      DO 50 J = 1,9                                                     BENIN171
      DO 50 K = 1,9                                                     BENIN172
50    R2(I,J) = R2(I,J) + ABNIT(I,K) * R1(K,J)                          BENIN173
      DO 55 I = 1,9                                                     BENIN174
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      DO 55 J = 1,9                                                    BENIN175
      DO 55 K = 1,9                                                    BENIN176
55    ELBIM(I,J) = ELBIM(I,J) + R2(I,K) * ABNIN(K,J)                   BENIN177
      RETURN                                                           BENIN178
      END                                                              BENIN179
```

```
      SUBROUTINE PRINT1                                                 PRINT101
C     PRINT GEOMETRIC BREAK-UP AND ASSOCIATED PROPERTIES .              PRINT102
C                                                                       PRINT103
      COMMON X      ( 100) , Y      ( 100) , Z      ( 100) , TH     ( 100) ,PRINT104
     1                       XL   ( 100,3) , YL   ( 100,3) ,            PRINT105
     2        RAPANG(   50) , ZGL    (  50) , RHUB  (  50) , RTIP   (  50) ,PRINT106
     3        THHUB (   50) , THTIP (  50) ,                 EDCM   ( 3,3) ,PRINT107
     4        RHO ,           POISSO , YOUNGS , RADGEN ,                 PRINT108
     5        NGENLI , LINE1 ,               NEXT ( 100,3) , NP , NT     PRINT109
      KOUNT = 0                                                         PRINT110
      WRITE (6,5)                                                       PRINT111
   5  FORMAT (1H1//30X,29HRESULTING TRIANGULAR ELEMENTS ///)            PRINT112
      DO 20 I = 1,NT                                                    PRINT113
      WRITE (6,10) I                                                    PRINT114
  10  FORMAT (35X,12HELEMENT NO. ,I3,//                                 PRINT115
     1 20X,67HNODE NO.        X          Y          Z         TH         XL PRINT116
     2        YL   )                                                    PRINT117
      LA = NEXT(I,1)                                                    PRINT118
      LB = NEXT(I,2)                                                    PRINT119
      LC = NEXT(I,3)                                                    PRINT120
      WRITE (6,15) LA,X(LA),Y(LA),Z(LA),TH(LA),XL(I,1),YL(I,1),LB,X(LB),PRINT121
     1             Y(LB),Z(LB),TH(LB),XL(I,2),YL(I,2),LC,X(LC),Y(LC),   PRINT122
     2             Z(LC),TH(LC),XL(I,3),YL(I,3)                         PRINT123
  15  FORMAT (17X,5HLA   ,I3,5X,3F10.3,3F10.4/ 17X,5HLB   ,I3,5X,3F10.3,PRINT124
     1        3F10.4 / 17X,5HLC   ,I3,5X,3F10.3,3F10.4// )              PRINT125
      KOUNT = KOUNT + 1                                                 PRINT126
      IF ((KOUNT .EQ. 7) .AND. (I .NE. NT)) WRITE (6,5)                 PRINT127
      IF ( KOUNT .EQ. 7 ) KOUNT = 0                                     PRINT128
  20  CONTINUE                                                          PRINT129
      RETURN                                                            PRINT130
      END                                                               PRINT131
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```
      SUBROUTINE NORM ( ZCOS,IGEN )                                      NORM0001
C     CALCULATE NORM DIRECTION COSINE MATRIX AT EACH NODE.               NORM0002
C                                                                        NORM0003
      COMMON X     ( 100) , Y     ( 100) , Z     ( 100) , TH    ( 100) ,NORM0004
     1                     XL  ( 100,3) , YL  ( 100,3) ,                 NORM0005
     2       RAPANG(  50) , ZGL   (  50) , RHUB  (  50) , RTIP  (  50) ,NORM0006
     3       THHUB (  50) , THTIP (  50) ,                EDCM  ( 3,3) ,NORM0007
     4       RHO ,          POISSO , YOUNGS , RADGEN ,                    NORM0008
     5       NGENLI , LINE1 ,              NEXT ( 100,3) , NP , NT ,     NORM0009
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,         NORM0010
     7      SIGMAX(100) , SIGMAY(100) , ELSTIF(18,18) ,                   NORM0011
     8         TAUXY(100),  ELSSM(9,9), MEX(100,8), IMEX(100),           NORM0012
     9       ELINR(18,18) , ELMIM(6,6) , ELBIM(9,9) , ALEAN(50)          NORM0013
      DIMENSION ZCOS(100) , IT(4) , IGEN(100)                            NORM0014
      DIMENSION R6(18,18)
      DATA R6 / 324*0.0 /
      EDCM(1,1) = 1.0
      EDCM(2,1) = 0.0
      EDCM(3,1) = 0.0
      EDCM(1,2) = 0.0
      EDCM(1,3) = 0.0
      DO 40 I = 1,NP
      IF ( IMEX(I) .NE. 1 ) GO TO 15
C     POINT I IS COMMON TO ONLY ONE TRIANGLE .
      DO 10  J = 1,18
      DO 5 K = 1,18
 5    R6(J,K) = 0.0
 10   R6(J,J) = 1.0
      WRITE (3'I) R6
      GO TO 40
C     POINT I IS COMMON TO MORE THAN 1 TRIANGLE .
 15   ITS = IMEX(I)
      KOUNT = 0
      DO 20 J = 1,ITS
      J1 = MEX(I,J)
      IF ( NEXT(J1,3) .EQ. I ) GO TO 20
      KOUNT = KOUNT + 1
      IT(KOUNT) = MEX(I,J)
 20   CONTINUE
      ZNO = KOUNT
      EDCM (2,2) = 0.0
      EDCM (2,3) = 0.0
      DO 25 J = 1,KOUNT
      J1 = IT(J)
 25   EDCM(2,2) = EDCM(2,2) + ARCOS( ZCOS(J1) )
      EDCM(2,2) = EDCM(2,2) / ZNO
      EDCM(3,3) = EDCM(2,2)
      DO 30 J = 1,3
      DO 30 K = 1,3
      R6(J   ,K   ) = EDCM(J,K)
      R6(J+3 ,K+3 ) = EDCM(J,K)
      R6(J+6 ,K+6 ) = EDCM(J,K)
      R6(J+9 ,K+9 ) = EDCM(J,K)
      R6(J+12,K+12) = EDCM(J,K)
 30   R6(J+15,K+15) = EDCM(J,K)
      WRITE (3'I) R6
 40   CONTINUE
      RETURN
```

END

NORM0420

```
      SUBROUTINE ASSEMK ( ZCOS , IPOS )                                  ASSEK001
C     TRANSFORM STIFFNESS MATRICES TO NORMAL SYSTEMS AND ASSEMBLE        ASSEK002
C     INTO A (3N X 3N) MATRIX .                                          ASSEK003
C                                                                        ASSEK004
      COMMON X      ( 100) , Y      ( 100) , Z      ( 100) , TH     ( 100) ,ASSEK005
     1                       XL   ( 100,3) , YL   ( 100,3) ,             ASSEK006
     2        RAPANG(  50) , ZGL    (  50) , RHUB   (  50) , RTIP   (  50) ,ASSEK007
     3        THHUB (  50) , THTIP (  50) ,                  EDCM   ( 3,3) ,ASSEK008
     4        RHO ,          POISSO , YOUNGS , RADGEN ,                   ASSEK009
     5        NGENLI , LINE1 ,                NEXT ( 100,3) , NP , NT ,   ASSEK010
     6        ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,         ASSEK011
     7       SIGMAX(100) , SIGMAY(100) , ELSTIF(18,18) ,                  ASSEK012
     8          TAUXY(100),  ELSSM(9,9), MEX(100,8), IMEX(100),           ASSEK013
     9          ELINR(18,18) ,                ELMIM(6,6) , ELBIM(9,9)     ASSEK014
      DIMENSION ENSTIF(9,9) ,               R6(18,18) , AK(50,50) ,       ASSEK015
     1          BK(100,100) , CK(100,50) , IPOS(100) , MEXT(8) , IND(9),ASSEK016
     2          R1(18,18) , ZCOS(100)                                    ASSEK017
      DATA IN / 3, 9, 15, 4, 10, 16, 5, 11, 17 /                         ASSEK018
      DO 1 I = 1,50                                                      ASSEK019
      DO 1 J = 1,50                                                      ASSEK020
      AK(I,J) = 0.0                                                      ASSEK021
      CK(I,J) = 0.0                                                      ASSEK022
    1 CK(I+50,J) = 0.0                                                   ASSEK023
      DO 2 I = 1,18
      DO 2 J = 1,18
    2 R6(I,J) = 0.0
      DO 5 I = 1,100
      DO 5 J = 1,100
    5 BK(I,J) = 0.0
      N = NP - NGENLI
      KOUNT = 0
      DO 55 I = 1,NP
      IF ( IPOS(I) .LT. 0 ) GO TO 55
      KOUNT = KOUNT + 1                                                  ASSEK024
      IMEXT = IMEX(I)                                                    ASSEK025
      DO 10 J = 1,IMEXT                                                  ASSEK026
   10 MEXT(J) = MEX(I,J)                                                 ASSEK027
      DO 50  J = 1,IMEXT                                                 ASSEK028
      K2 = MEXT(J)                                                       ASSEK029
      FIND (1'K2)                                                        ASSEK030
      LA = NEXT(K2,1)                                                    ASSEK031
      LB = NEXT(K2,2)                                                    ASSEK032
      LC = NEXT(K2,3)                                                    ASSEK033
      NA =     IPOS(LA)                                                  ASSEK034
      NB =     IPOS(LB)                                                  ASSEK035
      NC =     IPOS(LC)                                                  ASSEK036
      READ (1'K2) ELSTIF,ELINR,EDCM                                      ASSEK037
      FIND (3'I)
      IF ( LA .EQ. I ) IND1 = 1                                          ASSEK038
      IF ( LB .EQ. I ) IND1 = 2                                          ASSEK039
      IF ( LC .EQ. I ) IND1 = 3                                          ASSEK040
      READ (3'I) R6
      IF ( IMEXT .EQ. 1 ) GO TO 17
      J1 = MEXT(J)
      R6(3,2) = SIN( R6(3,3) - ARCOS( ZCOS(J1) ) )
      R6(3,3) = COS( R6(3,3) - ARCOS( ZCOS(J1) ) )
      R6(2,2) = R6(3,3)
      R6(2,3) = -R6(3,2)
```

```
      DO 15 K = 1,3                                                          ASSEK048
      DO 15 L = 1,3                                                          ASSEK049
      R6(K+3,L+3)   = R6(K,L)                                                ASSEK050
      R6(K+6,L+6)   = R6(K,L)                                                ASSEK051
      R6(K+9,L+9)   = R6(K,L)                                                ASSEK052
      R6(K+12,L+12) = R6(K,L)                                                ASSEK053
   15 R6(K+15,L+15) = R6(K,L)                                                ASSEK054
17    DO 20 K = 1,18                                                         ASSEK055
      DO 20 L = 1,18                                                         ASSEK056
      R1(K,L) = 0.0                                                          ASSEK057
      DO 20 M = 1,18                                                         ASSEK058
   20 R1(K,L) = R1(K,L) + R6(K,M) * ELSTIF(M,L)                              ASSEK059
      DO 25 K = 1,9                                                          ASSEK060
      DO 25 L = 1,9                                                          ASSEK061
      ENSTIF(K,L) = 0.0                                                      ASSEK062
      DO 25 M = 1,18                                                         ASSEK063
   25 ENSTIF(K,L) = ENSTIF(K,L) + R1(IND(K),M) * R6(IND(L),M)                ASSEK064
      IF ( IPOS(LA) .LT. 0 ) GO TO 40                                        ASSEK065
      AK(KOUNT,NA+1)     = AK(KOUNT,NA+1)     + ENSTIF(IND1,1)               ASSEK066
      CK(KOUNT,NA+1)     = CK(KOUNT,NA+1)     + ENSTIF(IND1+3,1)             ASSEK067
      CK(KOUNT+N,NA+1)   = CK(KOUNT+N,NA+1)   + ENSTIF(IND1+6,1)             ASSEK068
      BK(KOUNT,NA+1)     = BK(KOUNT,NA+1)     + ENSTIF(IND1+3,4)             ASSEK069
      BK(KOUNT,N+NA+1)   = BK(KOUNT,N+NA+1)   + ENSTIF(IND1+3,7)             ASSEK070
      BK(KOUNT+N,NA+1)   = BK(KOUNT+N,NA+1)   + ENSTIF(IND1+6,4)             ASSEK071
      BK(KOUNT+N,N+NA+1) = BK(KOUNT+N,N+NA+1) + ENSTIF(IND1+6,7)             ASSEK072
40    IF ( IPOS(LB) .LT. 0 ) GO TO 45                                        ASSEK073
      AK(KOUNT,NB+1)     = AK(KOUNT,NB+1)     + ENSTIF(IND1,2)               ASSEK074
      CK(KOUNT,NB+1)     = CK(KOUNT,NB+1)     + ENSTIF(IND1+3,2)             ASSEK075
      CK(KOUNT+N,NB+1)   = CK(KOUNT+N,NB+1)   + ENSTIF(IND1+6,2)             ASSEK076
      BK(KOUNT,NB+1)     = BK(KOUNT,NB+1)     + ENSTIF(IND1+3,5)             ASSEK077
      BK(KOUNT,N+NB+1)   = BK(KOUNT,N+NB+1)   + ENSTIF(IND1+3,8)             ASSEK078
      BK(KOUNT+N,NB+1)   = BK(KOUNT+N,NB+1)   + ENSTIF(IND1+6,5)             ASSEK079
      BK(KOUNT+N,N+NB+1) = BK(KOUNT+N,N+NB+1) + ENSTIF(IND1+6,8)             ASSEK080
45    IF ( IPOS(LC) .LT. 0 ) GO TO 50                                        ASSEK081
      AK(KOUNT,NC+1)     = AK(KOUNT,NC+1)     + ENSTIF(IND1,3)               ASSEK082
      CK(KOUNT,NC+1)     = CK(KOUNT,NC+1)     + ENSTIF(IND1+3,3)             ASSEK083
      CK(KOUNT+N,NC+1)   = CK(KOUNT+N,NC+1)   + ENSTIF(IND1+6,3)             ASSEK084
      BK(KOUNT,NC+1)     = BK(KOUNT,NC+1)     + ENSTIF(IND1+3,6)             ASSEK085
      BK(KOUNT,N+NC+1)   = BK(KOUNT,N+NC+1)   + ENSTIF(IND1+3,9)             ASSEK086
      BK(KOUNT+N,NC+1)   = BK(KOUNT+N,NC+1)   + ENSTIF(IND1+6,6)             ASSEK087
      BK(KOUNT+N,N+NC+1) = BK(KOUNT+N,N+NC+1) + ENSTIF(IND1+6,9)             ASSEK088
   50 CONTINUE                                                               ASSEK089
   55 CONTINUE                                                               ASSEK090
      WRITE (2'1) ((AK(I,J),J=1,50),I=1,17)                                  ASSEK091
      WRITE (2'2) ((AK(I,J),J=1,50),I=18,34)                                 ASSEK092
      WRITE (2'3) ((AK(I,J),J=1,50),I=35,50)                                 ASSEK093
      K1 = -8                                                                ASSEK094
      K2 = 0                                                                 ASSEK095
      DO 60 K = 1,11                                                         ASSEK096
      K1 = K1 + 9                                                            ASSEK097
      K2 = K2 + 9                                                            ASSEK098
      L = K + 3                                                              ASSEK099
60    WRITE (2'L) ((BK(I,J),J=1,100),I=K1,K2)                                ASSEK100
      WRITE (2'15) (BK(100,J),J=1,100)                                       ASSEK101
      K1 = -8                                                                ASSEK102
      K2 = 0                                                                 ASSEK103
      DO 65 K = 1,5                                                          ASSEK104
      K1 = K1 + 9                                                            ASSEK105
```

```
      K2 = K2 + 9                                                       ASSEK106
      L = K + 15                                                        ASSEK107
65    WRITE (2'L) ((CK(I,J),I=1,100),J=K1,K2)                           ASSEK108
      WRITE (2'21) ((CK(I,J),I=1,100),J=46,50)                          ASSEK109
      RETURN                                                            ASSEK110
      END                                                               ASSEK111
```

```
      SUBROUTINE ASSEMM ( ZCOS , IPOS )                                 ASSEM001
C     TRANSFORM INERTIA MATRICES TO NORMAL SYSTEMS AND ASSEMBLE         ASSEM002
C     INTO A (3N X 3N) MATRIX .                                         ASSEM003
C                                                                       ASSEM004
      COMMON X     ( 100) , Y     ( 100) , Z     ( 100) , TH    ( 100) ,ASSEM005
     1                    XL  ( 100,3) , YL  ( 100,3) ,                ASSEM006
     2       RAPANG(  50) , ZGL   (  50) , RHUB  (  50) , RTIP  (  50) ,ASSEM007
     3       THHUB (  50) , THTIP (  50) ,                EDCM  ( 3,3) ,ASSEM008
     4       RHO ,          POISSO , YOUNGS , RADGEN ,                   ASSEM009
     5       NGENLI , LINE1 ,                NEXT ( 100,3) , NP , NT ,    ASSEM010
     6       ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,          ASSEM011
     7      SIGMAX(100) , SIGMAY(100) , ELSTIF(18,18) ,                   ASSEM012
     8        TAUXY(100),  ELSSM(9,9), MEX(100,8), IMEX(100),             ASSEM013
     9       ELINR(18,18) ,                ELMIM(6,6) , ELBIM(9,9)       ASSEM014
      DIMENSION              ENINR(9,9) , R6(18,18) , AM(50,50) ,         ASSEM015
     1        BM(100,100) , CM(100,50) , IPOS(100) , MEXT(8) ,            ASSEM016
     2        IND(9) , R1(18,18) , ZCOS(100)                              ASSEM017
      DATA IND / 3, 9, 15, 4, 10, 16, 5, 11, 17 /                       ASSEM018
      DO 1 I = 1,50                                                     ASSEM019
      DO 1 J = 1,50                                                     ASSEM020
      AM(I,J) = 0.0                                                     ASSEM021
      CM(I,J) = 0.0                                                     ASSEM022
    1 CM(I+50,J) = 0.0                                                  ASSEM023
      DO 2 I = 1,18
      DO 2 J = 1,18
    2 R6(I,J) = 0.0
      DO 5 I = 1,100
      DO 5 J = 1,100
    5 BM(I,J) = 0.0
      N = NP - NGENLI
      KOUNT = 0
      DO 55 I = 1,NP
      IF ( IPOS(I) .LT. 0 ) GO TO 55
      KOUNT = KOUNT + 1                                                 ASSEM024
      IMEXT = IMEX(I)                                                   ASSEM025
      DO 10 J = 1,IMEXT                                                 ASSEM026
   10 MEXT(J) = MEX(I,J)                                                ASSEM027
      DO 50  J = 1,IMEXT                                                ASSEM028
      K2 = MEXT(J)                                                      ASSEM029
      FIND (1'K2)                                                       ASSEM030
      LA = NEXT(K2,1)                                                   ASSEM031
      LB = NEXT(K2,2)                                                   ASSEM032
      LC = NEXT(K2,3)                                                   ASSEM033
      NA =    IPOS(LA)                                                  ASSEM034
      NB =    IPOS(LB)                                                  ASSEM035
      NC =    IPOS(LC)                                                  ASSEM036
      READ (1'K2) ELSTIF,ELINR,EDCM                                     ASSEM037
      FIND (3'I)
      IF ( LA .EQ. I ) IND1 = 1                                         ASSEM038
      IF ( LB .EQ. I ) IND1 = 2                                         ASSEM039
      IF ( LC .EQ. I ) IND1 = 3                                         ASSEM040
      READ (3'I) R6
      IF ( IMEXT .EQ. 1 ) GO TO 20
      J1 = MEXT(J)
      R6(3,2) = SIN( R6(3,3) - ARCOS( ZCOS(J1) ) )
      R6(3,3) = COS( R6(3,3) - ARCOS( ZCOS(J1) ) )
      R6(2,2) = R6(3,3)
      R6(2,3) = -R6(3,2)
```

```
      DO 15 K = 1,3                                                          ASSEM048
      DO 15 L = 1,3                                                          ASSEM049
      R6(K+3,L+3)   = R6(K,L)                                                ASSEM050
      R6(K+6,L+6)   = R6(K,L)                                                ASSEM051
      R6(K+9,L+9)   = R6(K,L)                                                ASSEM052
      R6(K+12,L+12) = R6(K,L)                                                ASSEM053
   15 R6(K+15,L+15) = R6(K,L)                                                ASSEM054
20    DO 30 K = 1,18                                                         ASSEM055
      DO 30 L = 1,18                                                         ASSEM056
      R1(K,L) = 0.0                                                          ASSEM057
      DO 30 M = 1,18                                                         ASSEM058
   30 R1(K,L) = R1(K,L) + R6(K,M) * ELINR(M,L)                               ASSEM059
      DO 35 K = 1,9                                                          ASSEM060
      DO 35 L = 1,9                                                          ASSEM061
      ENINR(K,L) = 0.0                                                       ASSEM062
      DO 35 M = 1,18                                                         ASSEM063
   35 ENINR(K,L) = ENINR(K,L) + R1(IND(K),M) * R6(IND(L),M)                  ASSEM064
      IF ( IPOS(LA) .LT. 0 ) GO TO 40                                        ASSEM065
      AM(KOUNT,NA+1)      = AM(KOUNT,NA+1)      +  ENINR(IND1,1)             ASSEM066
      CM(KOUNT,NA+1)      = CM(KOUNT,NA+1)      +  ENINR(IND1+3,1)           ASSEM067
      CM(KOUNT+N,NA+1)    = CM(KOUNT+N,NA+1)    +  ENINR(IND1+6,1)           ASSEM068
      BM(KOUNT,NA+1)      = BM(KOUNT,NA+1)      +  ENINR(IND1+3,4)           ASSEM069
      BM(KOUNT,N+NA+1)    = BM(KOUNT,N+NA+1)    +  ENINR(IND1+3,7)           ASSEM070
      BM(KOUNT+N,NA+1)    = BM(KOUNT+N,NA+1)    +  ENINR(IND1+6,4)           ASSEM071
      BM(KOUNT+N,N+NA+1) = BM(KOUNT+N,N+NA+1) +  ENINR(IND1+6,7)           ASSEM072
40    IF ( IPOS(LB) .LT. 0 ) GO TO 45                                        ASSEM073
      AM(KOUNT,NB+1)      = AM(KOUNT,NB+1)      + ENINR(IND1,2)              ASSEM074
      CM(KOUNT,NB+1)      = CM(KOUNT,NB+1)      +  ENINR(IND1+3,2)           ASSEM075
      CM(KOUNT+N,NB+1)    = CM(KOUNT+N,NB+1)    +  ENINR(IND1+6,2)           ASSEM076
      BM(KOUNT,NB+1)      = BM(KOUNT,NB+1)      +  ENINR(IND1+3,5)           ASSEM077
      BM(KOUNT,N+NB+1)    = BM(KOUNT,N+NB+1)    +  ENINR(IND1+3,8)           ASSEM078
      BM(KOUNT+N,NB+1)    = BM(KOUNT+N,NB+1)    +  ENINR(IND1+6,5)           ASSEM079
      BM(KOUNT+N,N+NB+1) = BM(KOUNT+N,N+NB+1) +  ENINR(IND1+6,8)           ASSEM080
45    IF ( IPOS(LC) .LT. 0 ) GO TO 50                                        ASSEM081
      AM(KOUNT,NC+1)      = AM(KOUNT,NC+1)      +  ENINR(IND1,3)             ASSEM082
      CM(KOUNT,NC+1)      = CM(KOUNT,NC+1)      +  ENINR(IND1+3,3)           ASSEM083
      CM(KOUNT+N,NC+1)    = CM(KOUNT+N,NC+1)    +  ENINR(IND1+6,3)           ASSEM084
      BM(KOUNT,NC+1)      = BM(KOUNT,NC+1)      +  ENINR(IND1+3,6)           ASSEM085
      BM(KOUNT,N+NC+1)    = BM(KOUNT,N+NC+1)    +  ENINR(IND1+3,9)           ASSEM086
      BM(KOUNT+N,NC+1)    = BM(KOUNT+N,NC+1)    +  ENINR(IND1+6,6)           ASSEM087
      BM(KOUNT+N,N+NC+1) = BM(KOUNT+N,N+NC+1) +  ENINR(IND1+6,9)           ASSEM088
   50 CONTINUE                                                               ASSEM089
   55 CONTINUE                                                               ASSEM090
      WRITE (2'22)((AM(I,J),J=1,50),I=1,17)                                  ASSEM091
      WRITE (2'23)((AM(I,J),J=1,50),I=18,34)                                 ASSEM092
      WRITE (2'24)((AM(I,J),J=1,50),I=35,50)                                 ASSEM093
      K1 = -8                                                                ASSEM094
      K2 = 0                                                                 ASSEM095
      DO 60 K = 1,11                                                         ASSEM096
      K1 = K1 + 9                                                            ASSEM097
      K2 = K2 + 9                                                            ASSEM098
      L = K + 24                                                             ASSEM099
60    WRITE (2'L) ((BM(I,J),J=1,100),I=K1,K2)                                ASSEM100
      WRITE (2'36) (BM(100,J),J=1,100)                                       ASSEM101
      K1 = -8                                                                ASSEM102
      K2 = 0                                                                 ASSEM103
      DO 65 K = 1,5                                                          ASSEM104
      K1 = K1 + 9                                                            ASSEM105
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      K2 = K2 + 9                                                       ASSEM106
      L = K + 36                                                        ASSEM107
65    WRITE (2*L) ((CM(I,J),I=1,100),J=K1,K2)                           ASSEM108
      WRITE (2*42) ((CM(I,J),I=1,100),J=46,50)                          ASSEM109
      RETURN                                                            ASSEM110
      END                                                               ASSEM111
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      SUBROUTINE REDUCK(N)                                                  REDUCK01
C     REDUCE THE ASSEMBLED STIFFNESS MATRIX TO AN (N X N) MATRIX.           REDUCK02
C                                                                           REDUCK03
      DIMENSION AK(50,50), BK(100,100), CK(100,50), SK(50,50), R1(50,100REDUCK04
     1)                                                                     REDUCK05
      EQUIVALENCE (AK(1,1), SK(1,1))                                        REDUCK06
      DATA R1 / 5000 * 0.0 /                                                REDUCK07
      READ  (2'1) ((AK(I,J),J=1,50),I=1,17)                                 REDUCK08
      READ  (2'2) ((AK(I,J),J=1,50),I=18,34)                                REDUCK09
      READ  (2'3) ((AK(I,J),J=1,50),I=35,50)                                REDUCK10
      K1 = -8                                                               REDUCK11
      K2 = 0                                                                REDUCK12
      DO  1 K = 1,11                                                        REDUCK13
      K1 = K1 + 9                                                           REDUCK14
      K2 = K2 + 9                                                           REDUCK15
      L = K + 3                                                             REDUCK16
 1    READ  (2'L) ((BK(I,J),J=1,100),I=K1,K2)                               REDUCK17
      READ  (2'15) (BK(100,J),J=1,100)                                      REDUCK18
      K1 = -8                                                               REDUCK19
      K2 = 0                                                                REDUCK20
      DO  2 K = 1,5                                                         REDUCK21
      K1 = K1 + 9                                                           REDUCK22
      K2 = K2 + 9                                                           REDUCK23
      L = K + 15                                                            REDUCK24
 2    READ  (2'L) ((CK(I,J),I=1,100),J=K1,K2)                               REDUCK25
      READ  (2'21) ((CK(I,J),I=1,100),J=46,50)                              REDUCK26
      N2 = 2 * N                                                            REDUCK27
      DO 30 K = 1,N2                                                        REDUCK28
      IF (BK(K,K))15,5,15                                                   REDUCK29
    5 WRITE (6,10)                                                          REDUCK30
   10 FORMAT (52H B PORTION OF ASSEMBLED STIFFNESS MATRIX IS SINGULAR )     REDUCK31
      WRITE (6,12) ((BK(I,J),J=1,N2),I=1,N2)                                REDUCK32
 12   FORMAT (10E12.4)                                                      REDUCK33
      N = -N                                                                REDUCK34
      RETURN                                                                REDUCK35
   15 X = 1.0 / BK(K,K)                                                     REDUCK36
      BK(K,K) = 1.0                                                         REDUCK37
      DO 20 J = 1,N2                                                        REDUCK38
   20 BK(K,J) = BK(K,J) * X                                                 REDUCK39
      IF (K - N2) 25, 35, 25                                                REDUCK40
   25 M = K + 1                                                             REDUCK41
      DO 30 I = M, N2                                                       REDUCK42
      X = BK(I,K)                                                           REDUCK43
      BK(I,K) = 0.0                                                         REDUCK44
      DO 30 J = 1,N2                                                        REDUCK45
   30 BK(I,J) = BK(I,J) - X * BK(K,J)                                       REDUCK46
   35 LL = N2 - 1                                                           REDUCK47
      DO 40 I = 1, LL                                                       REDUCK48
      M = I + 1                                                             REDUCK49
      DO 40 K = M, N2                                                       REDUCK50
      X = BK(I,K)                                                           REDUCK51
      BK(I,K) = 0.0                                                         REDUCK52
      DO 40 J = 1, N2                                                       REDUCK53
   40 BK(I,J) = BK(I,J) - BK(K,J) * X                                       REDUCK54
      DO 45 I = 1,N                                                         REDUCK55
      DO 45 J = 1,N2                                                        REDUCK56
      DO 45 K = 1,N2                                                        REDUCK57
   45 R1(I,J) = R1(I,J) + CK(K,I) * BK(K,J)                                 REDUCK58
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      DO 50 I = 1,N                                                    REDUCK59
      DO 50 J = 1,N                                                    REDUCK60
      DO 50 K = 1,N2                                                   REDUCK61
   50 SK(I,J) = SK(I,J) - R1(I,K) * CK(K,J)                            REDUCK62
      WRITE (2'1) ((SK(I,J),J=1,50),I=1,17)                            REDUCK63
      WRITE (2'2) ((SK(I,J),J=1,50),I=18,34)                           REDUCK64
      WRITE (2'3) ((SK(I,J),J=1,50),I=35,50)                           REDUCK65
      DO 55 I = 1,N2                                                   REDUCK66
      DO 55 J = 1,N                                                    REDUCK67
      R1(J,I) = 0.0                                                    REDUCK68
      DO 55 K = 1,N2                                                   REDUCK69
   55 R1(J,I) = R1(J,I) + BK(I,K) * CK(K,J)                            REDUCK70
      K1 = -8                                                          REDUCK71
      K2 = 0                                                           REDUCK72
      DO 60 K = 1,5                                                    REDUCK73
      K1 = K1 + 9                                                      REDUCK74
      K2 = K2 + 9                                                      REDUCK75
      L = K + 42                                                       REDUCK76
   60 WRITE (2'L) ((R1(I,J),J=1,100),I=K1,K2)                          REDUCK77
      WRITE (2'48)((R1(I,J),J=1,100),I=46,50)                          REDUCK78
      RETURN                                                           REDUCK79
      END                                                              REDUCK80
```

```
      SUBROUTINE REDUCM(N)                                              REDUCM01
C     REDUCE THE INERTIA MATRIX TO AN (N X N) MATRIX.                   REDUCM02
C                                                                       REDUCM03
      DIMENSION AM(50,50), BM(100,100), CM(100,50), SM(50,50), R1(100,50REDUCM04
     1)                                                                 REDUCM05
      EQUIVALENCE (AM(1,1),SM(1,1))                                     REDUCM06
      DATA R1 / 5000 * 0.0 /                                            REDUCM07
      READ  (2'22)((AM(I,J),J=1,50),I=1,17)                             REDUCM08
      READ  (2'23)((AM(I,J),J=1,50),I=18,34)                            REDUCM09
      READ  (2'24)((AM(I,J),J=1,50),I=35,50)                            REDUCM10
      K1 = -8                                                           REDUCM11
      K2 = 0                                                            REDUCM12
      DO  1 K = 1,11                                                    REDUCM13
      K1 = K1 + 9                                                       REDUCM14
      K2 = K2 + 9                                                       REDUCM15
      L = K + 24                                                        REDUCM16
    1 READ  (2'L) ((BM(I,J),J=1,100),I=K1,K2)                           REDUCM17
      READ  (2'36) (BM(100,J),J=1,100)                                  REDUCM18
      K1 = -8                                                           REDUCM19
      K2 = 0                                                            REDUCM20
      DO  2 K = 1,5                                                     REDUCM21
      K1 = K1 + 9                                                       REDUCM22
      K2 = K2 + 9                                                       REDUCM23
      L = K + 36                                                        REDUCM24
    2 READ  (2'L) ((CM(I,J),I=1,100),J=K1,K2)                           REDUCM25
      READ  (2'42) ((CM(I,J),I=1,100),J=46,50)                          REDUCM26
      K1 = -8                                                           REDUCM27
      K2 = 0                                                            REDUCM28
      DO 3 K = 1,5                                                      REDUCM29
      K1 = K1 + 9                                                       REDUCM30
      K2 = K2 + 9                                                       REDUCM31
      L = K + 42                                                        REDUCM32
    3 READ (2'L) ((R1(J,I),J=1,100),I=K1,K2)                            REDUCM33
      READ (2'48)((R1(J,I),J=1,100),I=46,50)                            REDUCM34
      N2 = 2 * N                                                        REDUCM35
      DO 4 I = 1,N2                                                     REDUCM36
      DO 4 J = 1,N                                                      REDUCM37
      DO 4 K = 1,N2                                                     REDUCM38
    4 CM(I,J) = CM(I,J) - BM(I,K) * R1(K,J)                             REDUCM39
      DO 5 I = 1,N                                                      REDUCM40
      DO 5 J = 1,N                                                      REDUCM41
      DO 5 K = 1,N2                                                     REDUCM42
    5 SM(I,J) = SM(I,J) - R1(K,I) * CM(K,J)                             REDUCM43
      K1 = -8                                                           REDUCM44
      K2 = 0                                                            REDUCM45
      DO 6 K = 1,5                                                      REDUCM46
      K1 = K1 + 9                                                       REDUCM47
      K2 = K2 + 9                                                       REDUCM48
      L = K + 36                                                        REDUCM49
    6 READ (2'L) ((CM(I,J),I=1,100),J=K1,K2)                            REDUCM50
      READ (2'42) ((CM(I,J),I=1,100),J=46,50)                           REDUCM51
      DO 7 I = 1,N                                                      REDUCM52
      DO 7 J = 1,N                                                      REDUCM53
      DO 7 K = 1,N2                                                     REDUCM54
    7 SM(I,J) = SM(I,J) - CM(K,I) * R1(K,J)                             REDUCM55
      WRITE (2'43)((SM(I,J),J=1,50),I=1,17)                             REDUCM56
      WRITE (2'44)((SM(I,J),J=1,50),I=18,34)                            REDUCM57
      WRITE (2'45)((SM(I,J),J=1,50),I=35,50)                            REDUCM58
```

```
      RETURN                                                    REDUCM59
      END                                                       REDUCM60
```

```
      SUBROUTINE EIGEN (N,OMEGA)                                        EIGEN000
C                                                                       EIGEN001
C     SOLVE FOR THE NATURAL FREQUENCIES.                                EIGEN002
      DOUBLE PRECISION COEF, EIGVR, EIGVI                               EIGEN003
      DIMENSION SK(50,50), SM(50,50), OMEGA(50), COEF(50,50), EIGVR(50),EIGEN004
     1EIGVI(50),FREQ(50)                                                EIGEN005
      DATA COEF , EIGVI , EIGVR / 2600 * 0.0D0 /                        EIGEN006
      READ  (2'1) ((SK(I,J),J=1,50),I=1,17)                             EIGEN007
      READ  (2'2) ((SK(I,J),J=1,50),I=18,34)                            EIGEN008
      READ  (2'3) ((SK(I,J),J=1,50),I=35,50)                            EIGEN009
      READ  (2'43)((SM(I,J),J=1,50),I=1,17)                             EIGEN010
      READ  (2'44)((SM(I,J),J=1,50),I=18,34)                            EIGEN011
      READ  (2'45)((SM(I,J),J=1,50),I=35,50)                            EIGEN012
      DO 30 K = 1,N                                                     EIGEN013
      IF (SM(K,K))15, 5, 15                                             EIGEN014
    5 WRITE (6,10)                                                      EIGEN015
   10 FORMAT (35H REDUCED INERTIA MATRIX IS SINGULAR )                  EIGEN016
      N = -N                                                            EIGEN017
      RETURN                                                            EIGEN018
   15 X = 1.0 / SM(K,K)                                                 EIGEN019
      SM(K,K) = 1.0                                                     EIGEN020
      DO 20 J = 1,N                                                     EIGEN021
   20 SM(K,J) = SM(K,J) * X                                             EIGEN022
      IF (K - N) 25, 35, 25                                             EIGEN023
   25 M = K + 1                                                         EIGEN024
      DO 30 I = M,N                                                     EIGEN025
      X = SM(I,K)                                                       EIGEN026
      SM(I,K) = 0.0                                                     EIGEN027
      DO 30 J = 1,N                                                     EIGEN028
   30 SM(I,J) = SM(I,J) - X * SM(K,J)                                   EIGEN029
   35 LL = N - 1                                                        EIGEN030
      DO 40 I = 1,LL                                                    EIGEN031
      M = I + 1                                                         EIGEN032
      DO 40 K = M,N                                                     EIGEN033
      X = SM(I,K)                                                       EIGEN034
      SM(I,K) = 0.0                                                     EIGEN035
      DO 40 J = 1,N                                                     EIGEN036
   40 SM(I,J) = SM(I,J) - SM(K,J) * X                                   EIGEN037
      DO 45 I = 1,N                                                     EIGEN038
      DO 45 J = 1,N                                                     EIGEN039
      DO 45 K = 1,N                                                     EIGEN040
   45 COEF(I,J) = COEF(I,J) + SK(I,K) * SM(K,J)                         EIGEN041
      M = N                                                             EIGEN042
      CALL EIG3 (COEF, N, M, EIGVR, EIGVI)                              EIGEN043
      KOUNT = 0                                                         EIGEN044
      DO 50 I = 1,N                                                     EIGEN045
      IF (SNGL(EIGVI(I)) .NE. 0.0) GO TO 50                             EIGEN046
      IF ( EIGVR(I) .LT. 0.0D0 ) GO TO 50                               EIGEN047
      KOUNT = KOUNT + 1                                                 EIGEN048
      SIGNS = 1.0                                                       EIGEN049
      OMEGA(KOUNT) = SIGNS * DSQRT(       DABS(EIGVR(I)))               EIGEN050
      FREQ(KOUNT) = OMEGA(KOUNT) / 6.283185                             EIGEN051
   50 CONTINUE                                                          EIGEN052
      IF (KOUNT .GT. 0) GO TO 60                                        EIGEN053
      N = - N                                                           EIGEN054
      WRITE (6,55)                                                      EIGEN055
   55 FORMAT (49H ALL CALCULATED FREQUENCIES ARE IMAGINARY NUMBERS )    EIGEN056
      RETURN                                                            EIGEN057
```

```
60 WRITE (6,65) ( FREQ(KOUNT+1-I),I=1,KOUNT)                          EIGEN058
65 FORMAT (1H1,// 40X, 19HNATURAL FREQUENCIES //(43X, E12.5  ))       EIGEN059
   N = KOUNT                                                          EIGEN060
   RETURN                                                             EIGEN061
   END                                                                EIGEN062
```

```
      SUBROUTINE LAGER(A,EPS,N1,NU,N,RTR,RTI)                          LAGR0010
      IMPLICIT REAL*8 (A-H, O-Z)                                       LAGR0020
      DIMENSION  A(50,50),P(6,101)                                     LAGR0030
      DIMENSION  RTR(50),RTI(50),B(6)                                  LAGR0040
      REAL SSSSSS                                                      LAGR0050
C          ****    DOUBLE PRECISION LAGER    ****                    LAGR0060
      ONCE=0.0                                                         LAGR0070
      DATA X /0.0D0 /                                                  LAGR0080
      DATA Z /1.0D0/                                                   LAGR0090
      BL1=1.0                                                          LAGR0100
      NUQ=NU-1                                                         LAGR0110
      LLY=0                                                            LAGR0120
      DELOLD=1.0                                                       LAGR0130
      ROLD=1.0                                                         LAGR0140
      EGSUM1=0.0                                                       LAGR0150
      EGSUM2=0.0                                                       LAGR0160
      DO 10 L=1,6                                                      LAGR0170
      DO 10 LLX=1,101                                                  LAGR0180
 10   P(L,LLX)=0.0                                                     LAGR0190
      NU1=NU+1                                                         LAGR0200
      CUP=0.0                                                          LAGR0210
      DO 11 J=NU1,N                                                    LAGR0220
 11   CUP=CUP+DABS(A(J-1,J))                                           LAGR0230
      IF (N .NE. NU)  GO TO  200                                       LAGR0240
      CUP = 0.                                                         LAGR0250
      GO TO 201                                                        LAGR0260
 200  CUP=CUP/DFLOAT(N-NU)                                             LAGR0270
 201  CAP=0.                                                           LAGR0280
      P(1,NU)=1.0                                                      LAGR0290
C                                                                      LAGR0300
C     FIND TRACE OF H AND H SQUARED                                    LAGR0310
C                                                                      LAGR0320
      SPUR1=A(NU,NU)                                                   LAGR0330
      SPUR2=A(NU,NU)**2                                                LAGR0340
      DO 13 J=NU1,N                                                    LAGR0350
      SPUR1=SPUR1+A(J,J)                                               LAGR0360
   13 SPUR2=SPUR2+A(J,J)**2+2.0D0*A(J-1,J)*A(J,J-1)                    LAGR0370
C                                                                      LAGR0380
C     INITIAL ITERATE FROM INFINITY                                    LAGR0390
C                                                                      LAGR0400
   14 S1R=EGSUM1-SPUR1                                                 LAGR0410
      S2R=SPUR2-EGSUM2                                                 LAGR0420
      F1=N-NUQ                                                         LAGR0430
      IF(DABS (S1R) + DABS(S2R) -1.D-7*CAP) 15,15,16                   LAGR0440
   15 XBAR=CUP                                                         LAGR0450
      YBAR=0.0                                                         LAGR0460
      GO TO 23                                                         LAGR0470
 16   F2=F1-1.0D0                                                      LAGR0480
      DR=F2*(F1*S2R-S1R**2)                                            LAGR0490
      ER=DSQRT (DABS(DR))                                              LAGR0500
      IF(DR)17,18,18                                                   LAGR0510
 17   IF(F1 .NE. 0.0D0) GO TO 202                                      LAGR0520
      XBAR=0.                                                          LAGR0530
      YBAR=0.                                                          LAGR0540
      GO TO 23                                                         LAGR0550
 202  XBAR=-2.0D0*S1R/F1                                               LAGR0560
      YBAR=2.0D0*ER/F1                                                 LAGR0570
      GO TO 23                                                         LAGR0580
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   18 YBAR=0.0                                                          LAGR0590
      S1RX=S1R                                                          LAGR0600
      F2 = DSIGN( 1.0D0, S1RX )                                         LAGR0610
      IF(S1R)22,20,22                                                   LAGR0620
   20 F2=0.0                                                            LAGR0630
 22   IF(F1.NE. 0.0D0) GO TO 203                                        LAGR0640
      XBAR=0.                                                           LAGR0650
      GO TO 23                                                          LAGR0660
 203  XBAR= -(S1R+F2*ER)/F1                                             LAGR0670
C                                                                       LAGR0680
C     EVALUATE POLYNOMIAL AND DERIVATIVES                               LAGR0690
C                                                                       LAGR0700
 23   IF (DABS(YBAR)-DABS(XBAR) *1.D-6 )24,25,25                        LAGR0710
   24 YBAR=0.0                                                          LAGR0720
   25 M=6                                                               LAGR0730
      IF(YBAR)27,26,27                                                  LAGR0740
   26 M=3                                                               LAGR0750
 27   DO 207 K=NU,N                                                     LAGR0760
      T=-A(K,K+1)                                                       LAGR0770
      DO 207 L=1,M                                                      LAGR0780
      S = DSIGN( 1.0D0, 3.5D0-DFLOAT(L) )                               LAGR0790
      SSSSSS = S                                                        LAGR0800
      M1=L+3*IFIX(SSSSSS)                                               LAGR0810
      R=-XBAR*P(L,K)+YBAR*S*P(M1,K)-DFLOAT(MOD(L-1,3))*P(L-1,K)         LAGR0820
      DO 28 J=NU,K                                                      LAGR0830
 28   R=R+P(L,J)*A(K,J)                                                 LAGR0840
      IF(Z)29,32,29                                                     LAGR0850
 29   Z=0.0                                                             LAGR0860
      P(1,NU)=1.D-10*P(1,NU)                                            LAGR0870
      IF(P(1,NU))30,30,27                                               LAGR0880
 30   IF(N-NU+1) 204,305,204                                            LAGR0890
 305  F=0.                                                              LAGR0900
      GO TO 205                                                         LAGR0910
 204  F=DFLOAT(K-NU)/DFLOAT(N-NU+1)                                     LAGR0920
 205  CONTINUE                                                          LAGR0930
      XBAR=XBAR*F                                                       LAGR0940
      YBAR=YBAR*F                                                       LAGR0950
      P(1,NU)=1.0                                                       LAGR0960
      GO TO 27                                                          LAGR0970
 32   IF(N-K)33,33,34                                                   LAGR0980
 33   T=1.0                                                             LAGR0990
 34   IF (T.NE. 0.0D0) GO TO 206                                        LAGR1000
      P(L,K+1)=0.                                                       LAGR1010
      GO TO 207                                                         LAGR1020
 206  P(L,K+1)=R/T                                                      LAGR1030
C                                                                       LAGR1040
 207  CONTINUE                                                          LAGR1050
C     SCALE DOWN                                                        LAGR1060
C                                                                       LAGR1070
      DO 39 K=1,6                                                       LAGR1080
   39 B(K)=0.0                                                          LAGR1090
      DO 35 J=1,M                                                       LAGR1100
   35 B(J)=P(J,N+1)                                                     LAGR1110
      G1= DABS(B(1))+DABS(B(4))                                         LAGR1120
      G2= DABS(B(2))+DABS(B(5))                                         LAGR1130
      G3= DABS(B(3))+DABS(B(6))                                         LAGR1140
      G=DABS(B(1))                                                      LAGR1150
      DO 36 K=2,M                                                       LAGR1160
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 36   D= DMAX1(D,DABS(B(K)))                                          LAGR1170
      CALL SCALE(D,B,M)                                               LAGR1180
      IF (G1) 41,41,43                                                LAGR1190
C                                                                     LAGR1200
C     REMOVE KNOWN ROOTS                                              LAGR1210
C                                                                     LAGR1220
   43 Q1R=0.0                                                         LAGR1230
      Q1I=0.0                                                         LAGR1240
      Q2R=0.0                                                         LAGR1250
      Q2I=0.0                                                         LAGR1260
      IF(NUQ-NU)19,21,21                                              LAGR1270
   21 DO 44 J=NU,NUQ                                                  LAGR1280
      D1=RTR(J)-XBAR                                                  LAGR1290
      D2=RTI(J)-YBAR                                                  LAGR1300
      D=D1**2+D2**2                                                   LAGR1310
      IF (D.NE. 0.0D0) GO TO 208                                      LAGR1320
      D1=0.                                                           LAGR1330
      D2=0.                                                           LAGR1340
      GO TO 209                                                       LAGR1350
 208  D1=D1/D                                                         LAGR1360
      D2=-D2/D                                                        LAGR1370
 209  Q1R=Q1R+D1                                                      LAGR1380
      Q1I=Q1I+D2                                                      LAGR1390
      Q2R=Q2R+D1**2-D2**2                                             LAGR1400
   44 Q2I=Q2I+2.0D0*D1*D2                                             LAGR1410
C                                                                     LAGR1420
C     FIND S1 AND S2                                                  LAGR1430
C                                                                     LAGR1440
 19   IF (B(1) .NE. 0.0D0) GO TO 210                                  LAGR1450
      T1R = 0.                                                        LAGR1460
      GO TO 211                                                       LAGR1470
 210  T1R= B(2)/B(1)                                                  LAGR1480
 211  T1I= 0.                                                         LAGR1490
      IF(B(2) .NE. 0.0D0) GO TO 212                                   LAGR1500
      T2R = 0.                                                        LAGR1510
      GO TO 213                                                       LAGR1520
 212  T2R = B(3)/B(2)                                                 LAGR1530
 213  T2I = 0.                                                        LAGR1540
      IF(YBAR)45,46,45                                                LAGR1550
   45 D1=B(1)**2+B(4)**2                                              LAGR1560
      D2=B(2)**2+B(5)**2                                              LAGR1570
      IF (D1 .NE. 0.0D0) GO TO 214                                    LAGR1580
      T1R = 0.                                                        LAGR1590
      T1I = 0.                                                        LAGR1600
      GO TO 215                                                       LAGR1610
 214  T1R=(B(2)*B(1)+B(5)*B(4))/D1                                    LAGR1620
      T1I=(B(5)*B(1)-B(4)*B(2))/D1                                    LAGR1630
 215  IF (D2 .NE. 0.0D0) GO TO 315                                    LAGR1640
      T2R = 0.                                                        LAGR1650
      T2I = 0.                                                        LAGR1660
      GO TO 46                                                        LAGR1670
 315  T2R=(B(3)*B(2)+B(6)*B(5))/D2                                    LAGR1680
      T2I=(B(6)*B(2)-B(5)*B(3))/D2                                    LAGR1690
   46 S1R=T1R+Q1R                                                     LAGR1700
      S1I=T1I+Q1I                                                     LAGR1710
      S2R=T1R*(T1R-T2R)-T1I*(T1I-T2I)-Q2R                             LAGR1720
      S2I=T1R*(T1I-T2I)+T1I*(T1R-T2R)-Q2I                             LAGR1730
C                                                                     LAGR1740
```

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C      FIND THE NEXT ITERATE                                          LAGR1750
C                                                                     LAGR1760
       LLY=LLY+1                                                      LAGR1770
       D= DABS(XBAR)+DABS(YBAR )                                      LAGR1780
       IF (1.D+7 -D *(DABS(S1R)+DABS(S1I))) 41,41,42                  LAGR1790
   41  MARK=1                                                         LAGR1800
       GO TO 100                                                      LAGR1810
   42  G=N-NUQ                                                        LAGR1820
 48    IF (YBAR-DABS(X))50,50,491                                     LAGR1830
 491   IF (YBAR .NE. 0.0D0) GO TO 49                                  LAGR1840
       GO TO 216                                                      LAGR1850
   49  S1I=S1I+1.0D0 / ( 2.0D0 * YBAR )                               LAGR1860
       S2R=S2R+1.0D0 / ( 4.0D0 * YBAR**2 )                            LAGR1870
 216   G=G-1.0D0                                                      LAGR1880
 50    IF(BL1)65,65,66                                                LAGR1890
 65    H = 0.5D0 * ( G - 2.0D0 )                                      LAGR1900
       GO TO 67                                                       LAGR1910
 66    H=G-1.0D0                                                      LAGR1920
 67    DR=H*(G*S2R-S1R**2+S1I**2)                                     LAGR1930
       DI=H*(G*S2I-2.0D0*S1R*S1I)                                     LAGR1940
       IF(DI)53,51,53                                                 LAGR1950
   51  EI=0.0                                                         LAGR1960
       ER=DSQRT(DABS(DR))                                             LAGR1970
       IF(DR)52,54,54                                                 LAGR1980
   52  EI=ER                                                          LAGR1990
       ER=0.0                                                         LAGR2000
       GO TO 54                                                       LAGR2010
   53  CALL CXSQRT(DR,DI,ER,EI)                                       LAGR2020
   54  IF(S1R*ER+S1I*EI)55,56,56                                      LAGR2030
   55  ER=-ER                                                         LAGR2040
       EI=-EI                                                         LAGR2050
   56  D1=S1R+ER                                                      LAGR2060
       D2=S1I+EI                                                      LAGR2070
       D=D1**2+D2**2                                                  LAGR2080
       IF (D .NE. 0.0D0) GO TO 217                                    LAGR2090
       X=0.                                                           LAGR2100
       Y=0.                                                           LAGR2110
       GO TO 218                                                      LAGR2120
 217   X=-G*D1/D                                                      LAGR2130
       Y=G*D2/D                                                       LAGR2140
 218   XBAR=XBAR+X                                                    LAGR2150
       YBAR=YBAR+Y                                                    LAGR2160
       DELNEW =DABS(X)+DABS(Y)                                        LAGR2170
       IF (DELOLD .NE. 0.0D0) GO TO 219                               LAGR2180
       RNEW = 0.                                                      LAGR2190
       GO TO 220                                                      LAGR2200
 219   RNEW =DELNEW/DELOLD                                            LAGR2210
 220   D= DABS(XBAR)+DABS(YBAR)                                       LAGR2220
C                                                                     LAGR2230
C      TEST FOR LINEAR CONVERGENCE                                    LAGR2240
C                                                                     LAGR2250
       IF(LLY-3)62,62,57                                              LAGR2260
 57    IF (DELNEW-DMAX1(3.0D0*DELOLD,.5D0*D))571,571,570              LAGR2270
 570   IF (BL1) 571,571,572                                           LAGR2280
 572   DELOLD=CAP                                                     LAGR2290
       ROLD=3.0                                                       LAGR2300
       IF (LLY-15) 14,14,100                                          LAGR2310
 571   IF(RNEW-.7D0*ROLD) 62,58,58                                    LAGR2320
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```
   58 MARK=3                                                          LAGR2330
      IF(DELNEW-.001D0*EPS*CAP) 70,59,59                              LAGR2340
 59   IF(BL1)61,61,60                                                 LAGR2350
 60   XBAR=XBAR-X                                                     LAGR2360
      YBAR=YBAR-Y                                                     LAGR2370
      BL1=0.0                                                         LAGR2380
      GO TO 48                                                        LAGR2390
 61   BL1=1.0                                                         LAGR2400
      GO TO 63                                                        LAGR2410
C                                                                     LAGR2420
C     TEST FOR AN EIGENVALUE                                          LAGR2430
C                                                                     LAGR2440
 62   IF (DELNEW-EPS*DMAX1 (D,.001D0*CAP))64,64,63                    LAGR2450
 63   DELOLD=DELNEW                                                   LAGR2460
      ROLD=RNEW                                                       LAGR2470
      IF (LLY-15) 23,23,100                                           LAGR2480
C                                                                     LAGR2490
C     DO WE HAVE A COMPLEX APPROACH TO A REAL ROOT                    LAGR2500
C                                                                     LAGR2510
   64 MARK=2                                                          LAGR2520
   70 BL1=1                                                           LAGR2530
      IF(YBAR)71,100,71                                               LAGR2540
 71   IF(G2 *DABS(YBAR)-G1) 72,100,100                                LAGR2550
   72 IF(ONCE)73,73,100                                               LAGR2560
   73 X=0.0                                                           LAGR2570
      ONCE=1.0                                                        LAGR2580
      YBAR=0.0                                                        LAGR2590
      GO TO 63                                                        LAGR2600
C                                                                     LAGR2610
C     WE ACCEPT (XBAR,YBAR) AS A ROOT                                 LAGR2620
C                                                                     LAGR2630
  100 NUQ=NUQ+1                                                       LAGR2640
      RTR(NUQ)=XBAR                                                   LAGR2650
      IF(DABS(YBAR)-.001D0*DABS(XBAR))74,74,75                        LAGR2660
   74 YBAR=0.0                                                        LAGR2670
   75 IF(NUQ-NU) 9,76, 9                                              LAGR2680
    9 IF(RTI(NUQ-1))76,76,77                                          LAGR2690
 76   YBAR=DABS(YBAR)                                                 LAGR2700
      RTI(NUQ)=YBAR                                                   LAGR2710
      GO TO 78                                                        LAGR2720
 77   RTI(NUQ)=-DABS(YBAR)                                            LAGR2730
 78   CONTINUE                                                        LAGR2740
      LLY=0                                                           LAGR2750
      CAP=DMAX1(D,CAP)                                                LAGR2760
      DELOLD=1.0                                                      LAGR2770
      ROLD=1.0                                                        LAGR2780
      EGSUM1=EGSUM1+RTR(NUQ)                                          LAGR2790
      EGSUM2=EGSUM2+RTR(NUQ)**2-RTI(NUQ)**2                           LAGR2800
      IF(NUQ-NU)80,101,101                                            LAGR2810
   80 IF(YBAR)83,84,81                                                LAGR2820
   81 YBAR=-YBAR                                                      LAGR2830
      GO TO 23                                                        LAGR2840
   83 IF(NUQ-NU)31,84,31                                              LAGR2850
   31 RTI(NUQ-1)=.5D0*(RTI(NUQ-1)-RTI(NUQ))                           LAGR2860
      RTI(NUQ)=-RTI(NUQ-1)                                            LAGR2870
C                                                                     LAGR2880
C     A NEWTON ITERATE TOWARDS NEXT ROOT                              LAGR2890
C                                                                     LAGR2900
```

```
   84 ONCE=0.0                                                                  LAGR2910
      Z=0.0                                                                     LAGR2920
      IF(( DABS(Q1R)+DABS(Q1I))*D-10000.D0)85,85,14                             LAGR2930
   85 IF (DABS (EGSUM1-SPUR1)+ DABS(EGSUM2-SPUR2)-1.D-5 *CAP)15,15,86           LAGR2940
   86 DR=B(3)+2.0D0*(B(2)*Q1R-B(5)*Q1I)                                         LAGR2950
      DI=B(6)+2.0D0*(B(2)*Q1I+B(5)*Q1R)                                         LAGR2960
      D2=DR**2+DI**2                                                            LAGR2970
      IF (D2 .NE. 0.0D0) GO TO 221                                              LAGR2980
      YBAR= DABS(YBAR)                                                          LAGR2990
      GO TO 23                                                                  LAGR3000
  221 CONTINUE                                                                  LAGR3010
      XBAR=XBAR-2.0D0*(DR*B(2)+DI*B(5))/D2                                      LAGR3020
      YBAR= DABS(YBAR-2.0D0*(DR*B(5)-DI*B(2))/D2)                               LAGR3030
      GO TO 23                                                                  LAGR3040
  101 RETURN                                                                    LAGR3050
      END                                                                       LAGR3060
```

```
      SUBROUTINE EIG3(A,N,M,RTR,RTI)                                    EIG30010
      IMPLICIT REAL*8 (A-H, O-Z)                                        EIG30020
C      EIGENVALUES OF NON-SYMMETRIC MATRICES                            EIG30030
      DIMENSION  A(50,50)                                               EIG30040
      DIMENSION  NC(50),RTR(50),RTI(50)                                 EIG30050
C          ****    DOUBLE PRECISION EIG3     ****                     EIG30060
      TRACE=A(1,1)                                                      EIG30070
      DO 10 I=2,N                                                       EIG30080
   10 TRACE=TRACE+A(I,I)                                                EIG30090
      B= 1.E-7                                                          EIG30100
      CALL TRING (A,B,N,NC )                                            EIG30110
      TRACE=A(1,1)                                                      EIG30120
      DO 11 I=2,N                                                       EIG30130
   11 TRACE=TRACE+A(I,I)                                                EIG30140
      NU=0                                                              EIG30150
      NV=0                                                              EIG30160
   13 IF (N7-N)14,12,14                                                 EIG30170
   14 NV=NV+1                                                           EIG30180
      NU=NV                                                             EIG30190
   16 IF (NC(NV))15,17,15                                               EIG30200
   15 NV=NV+1                                                           EIG30210
      GO TO 16                                                          EIG30220
   17 IF (NV-NU)19,18,19                                                EIG30230
   18 RTR(NU)=A(NU,NU)                                                  EIG30240
      RTI(NU)=0.0                                                       EIG30250
      GO TO 13                                                          EIG30260
   19 IF (NV-NU-1)20,21,20                                              EIG30270
   20 NP=MINO(M,NV)                                                     EIG30280
      CALL LAGER(A,1.D-4,NP,NU,NV,RTR,RTI)                              EIG30290
      GO TO 13                                                          EIG30300
   21 RR=.5D0*(A(NU,NU)+A(NV,NV))                                       EIG30310
      E1=RR**2-A(NU,NU)*A(NV,NV)+A(NU,NV)*A(NV,NU)                      EIG30320
      S=DSQRT(DABS(E1))                                                 EIG30330
      IF(E1)22,23,23                                                    EIG30340
   23 RTR(NU)=RR+S                                                      EIG30350
      RTI(NU)=0.0                                                       EIG30360
      RTR(NV)=RR-S                                                      EIG30370
      RTI(NV)=0.0                                                       EIG30380
   25 CONTINUE                                                          EIG30390
      GO TO 13                                                          EIG30400
   22 RTR(NU)=RR                                                        EIG30410
      RTI(NU)=S                                                         EIG30420
      RTR(NV)=RR                                                        EIG30430
      RTI(NV)=-S                                                        EIG30440
      GO TO 25                                                          EIG30450
   12 X=0.0                                                             EIG30460
      DO 24 J=1,M                                                       EIG30470
   24 X=X+RTR(J)                                                        EIG30480
      RETURN                                                            EIG30490
      END                                                               EIG30500
```

```
      SUBROUTINE TRING(A,EPS,N,KOOOFX)                                  TRIN0010
      IMPLICIT REAL*8 (A-H, O-Z)                                        TRIN0020
C     ALMOST TRIANGULAR (HESSENBERG) SUBROUTINE                         TRIN0030
      DIMENSION  A(50,50)                                               TRIN0040
      DIMENSION  KOOOFX(50)                                             TRIN0050
C          ****    DOUBLE PRECISION TRING    ****                     TRIN0060
      N1=N-1                                                            TRIN0070
      N2=N-2                                                            TRIN0080
      DO 21 J=1,N1                                                      TRIN0090
      S=DABS (A(J,J+1))                                                 TRIN0100
      J1=J+1                                                            TRIN0110
      J2=J+2                                                            TRIN0120
      L=J1                                                              TRIN0130
      NJ1=N-J1                                                          TRIN0140
      IF (NJ1) 15,15,6                                                  TRIN0150
 6    DO 12 K=J2,N                                                      TRIN0160
      T=DABS (A(J,K))                                                   TRIN0170
      IF(T-S)12,12,11                                                   TRIN0180
 11   L=K                                                               TRIN0190
      S=T                                                               TRIN0200
 12   CONTINUE                                                          TRIN0210
      IF(L-J1)13,15,13                                                  TRIN0220
13    DO 131 K=1,N                                                      TRIN0230
      T=A(K,J+1)                                                        TRIN0240
      A(K,J+1)=A(K,L)                                                   TRIN0250
131   A(K,L)=T                                                          TRIN0260
14    DO 141 K=1,N                                                      TRIN0270
      T=A(J+1,K)                                                        TRIN0280
      A(J+1,K)=A(L,K)                                                   TRIN0290
141   A(L,K)=T                                                          TRIN0300
 15   IF(S-EPS*  DMIN1(DABS(A(J,J)),DABS(A(J+1,J+1)))) 16,16,17         TRIN0310
 16   L=0                                                               TRIN0320
      NJ1=0                                                             TRIN0330
      GO TO 181                                                         TRIN0340
 17   T=A(J,J+1)                                                        TRIN0350
      DO 18 K=J2,N                                                      TRIN0360
      IF(T) 30,31,30                                                    TRIN0370
 31   A(J,K)=0.                                                         TRIN0380
      GO TO 18                                                          TRIN0390
 30   A(J,K)=A(J,K)/T                                                   TRIN0400
 18   CONTINUE                                                          TRIN0410
 181  DO 20 I=1,N                                                       TRIN0420
      M= MINO(J,I-2)                                                    TRIN0430
      U=0.0                                                             TRIN0440
      IF (NJ1) 19,19,7                                                  TRIN0450
7     DO 8 K=J2,N                                                       TRIN0460
 8    U=U+A(K,I)*A(J,K)                                                 TRIN0470
19    IF (M) 20,20,9                                                    TRIN0480
 9    DO 10 K=1,M                                                       TRIN0490
 10   U=U-A(K,I)*A(J+1,K+1)                                             TRIN0500
 20   A(J+1,I)=A(J+1,I)+U                                               TRIN0510
 21   KOOOFX(J)=L                                                       TRIN0520
 22   KOOOFX(N)=0                                                       TRIN0530
      RETURN                                                            TRIN0540
      END                                                               TRIN0550
```

```
      SUBROUTINE SCALE (D,B,M)                                          SCAL0010
C        SUBROUTINE SCALE - FOR USE WITH DECK NO. 6140   FORTRAN IV     SCAL0020
      DIMENSION B(6)                                                    SCAL0030
      EQUIVALENCE (G,IG),(E,IE),(E1,IE1),(GP,IGP),(Q,IQ)                SCAL0040
      DOUBLE PRECISION   D,B,DP                                         SCAL0050
      FMASK =  SWL(127,24)                                              SCAL0060
      FMASK1=  SWL(7,21)                                                SCAL0070
      Q = SWL(1,30)                                                     SCAL0080
      DP = SNGL (DABS(D))                                               SCAL0090
      E = ANDA(DP,FMASK)                                                SCAL0100
      IE = IE-IQ                                                        SCAL0110
      G = ANDA(DP,FMASK1)                                               SCAL0120
      G = SWR(IG,21)                                                    SCAL0130
      IG1= IG/2                                                         SCAL0140
      IF (IG1 - 1)21,10,23                                              SCAL0150
   23 IG1 = 0                                                           SCAL0160
      GO TO 10                                                          SCAL0170
   21 IF (IG EQ.0)IG1=1                                                 SCAL0180
      IG1 = IG1+2                                                       SCAL0190
   10 E1 = SWR(IABS(IE),22)                                             SCAL0200
      IE1 = IE1 - IG1                                                   SCAL0210
      IF(E.LT.0.)IE1=-IE1                                               SCAL0220
      DO 5 I = 1,M                                                      SCAL0230
    5 B(I) = B(I)/2.0D0**IE1                                            SCAL0240
      RETURN                                                            SCAL0250
      END                                                               SCAL0260
```

```
      SUBROUTINE CXSQRT(A,B,X,Y)                                    CXSQ0010
      IMPLICIT REAL*8 (A-H, O-Z)                                    CXSQ0020
C     COMPLEX SQUARE ROOT                                           CXSQ0030
      F=DMAX1(DABS(A),DABS(B))                                      CXSQ0040
      IF(F) 5,7,5                                                   CXSQ0050
 5    F=F*DSQRT((A/F)**2 + (B/F)**2)                                CXSQ0060
 7    IF(A) 1,1,2                                                   CXSQ0070
 1    Y=DSQRT((F-A)*.5D0)                                           CXSQ0080
      IF(Y) 8,9,8                                                   CXSQ0090
 9    X=0.                                                          CXSQ0100
      GO TO 3                                                       CXSQ0110
 8    X=.5D0 * B / Y                                                CXSQ0120
      IF(X)4,3,3                                                    CXSQ0130
    4 X=-X                                                          CXSQ0140
      Y=-Y                                                          CXSQ0150
      GO TO 3                                                       CXSQ0160
 2    X=DSQRT ((F+A)*.5D0)                                          CXSQ0170
      IF(X) 10,11,10                                                CXSQ0180
 11   Y=0.                                                          CXSQ0190
      GO TO 3                                                       CXSQ0200
 10   Y=.5D0 * B / X                                                CXSQ0210
    3 RETURN                                                        CXSQ0220
      END                                                           CXSQ0230
```

```
      SUBROUTINE AMPL (M, OMEGA, IPOS)                                  AMPL0001
C     SOLVE FOR THE AMPLITUDES AT EACH REQUESTED FREQUENCY.             AMPL0002
C                                                                       AMPL0003
      COMMON X      ( 100) , Y      ( 100) , Z      ( 100) , TH     ( 100) ,AMPL0004
     1                       XL   ( 100,3) , YL   ( 100,3) ,            AMPL0005
     2        RAPANG(  50) , ZGL    (  50) , RHUB   (  50) , RTIP   (  50) ,AMPL0006
     3        THHUB (  50) , THTIP (  50) ,                  EDCM   ( 3,3) ,AMPL0007
     4        RHO ,          POISSO , YOUNGS , RADGEN ,                  AMPL0008
     5        NGENLI , LINE1 ,                NEXT ( 100,3) , NP , NT ,   AMPL0009
     6        ELMSM(6,6) , AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) ,         AMPL0010
     7       SIGMAX(100) , SIGMAY(100) , ELSTIF(18,18) ,                  AMPL0011
     8          TAUXY(100),  ELSSM(9,9), MEX(100,8), IMEX(100) , AMP(100)AMPL0012
      DIMENSION SM(50,50),SK(50,50),ROW(50),IPOS(100)                   AMPL0013
      DO 1 I = 1,100                                                    AMPL0014
    1 AMP(I) = 0.0
      FREQ = OMEGA / 6.283185                                           AMPL0015
      N = M - 1                                                         AMPL0016
      READ (2'1) ((SK(I,J), J=1,50), I=1,17)                            AMPL0017
      READ (2'2) ((SK(I,J), J=1,50), I=18,34)                           AMPL0018
      READ (2'3) ((SK(I,J), J=1,50), I=35,50)                           AMPL0019
      READ (2'43)((SM(I,J), J=1,50), I=1,17)                            AMPL0020
      READ (2'44)((SM(I,J), J=1,50), I=18,34)                           AMPL0021
      READ (2'45)((SM(I,J), J=1,50), I=35,50)                           AMPL0022
      DO 7 I = 1,N                                                      AMPL0023
      DO 5 J = 1,M                                                      AMPL0024
    5 SM(I,J) = -OMEGA ** 2 * SM(I,J) + SK(I,J)                         AMPL0025
    7 SM(I,M) = - SM(I,M)                                               AMPL0026
      K = 1                                                             AMPL0027
   10 I = K + 1                                                         AMPL0028
      IF (ABS(SM(K,K)) .GT. 1.0E-10) GO TO 30                           AMPL0029
      DO 15 J = I,N                                                     AMPL0030
      J1 = J                                                            AMPL0031
      IF (ABS(SM(J,K)) .GT. 1.0E-10) GO TO 20                           AMPL0032
   15 CONTINUE                                                          AMPL0033
      WRITE (6,16)                                                      AMPL0034
   16 FORMAT (// 29H AMPLITUDE MATRIX IS SINGULAR)                      AMPL0035
      N = -N                                                            AMPL0036
      RETURN                                                            AMPL0037
   20 DO 25 J = 1,M                                                     AMPL0038
      ROW(J) = SM(J1,J)                                                 AMPL0039
      SM(J1,J) = SM(K,J)                                                AMPL0040
   25 SM(K,J) = ROW(J)                                                  AMPL0041
   30 ZM = SM(I,K) / SM(K,K)                                            AMPL0042
      SM(I,K) = 0.0                                                     AMPL0043
      J = K + 1                                                         AMPL0044
   35 SM(I,J) = SM(I,J) - ZM * SM(K,J)                                  AMPL0045
      IF (J .EQ. N) GO TO 40                                            AMPL0046
      J = J + 1                                                         AMPL0047
      GO TO 35                                                          AMPL0048
   40 SM(I,M) = SM(I,M) - ZM * SM(K,M)                                  AMPL0049
      IF (I .EQ. N) GO TO 45                                            AMPL0050
      I = I + 1                                                         AMPL0051
      GO TO 30                                                          AMPL0052
   45 IF (K .EQ. N-1) GO TO 50                                          AMPL0053
      K = K + 1                                                         AMPL0054
      GO TO 10                                                          AMPL0055
   50 ROW(M) = 1.0                                                      AMPL0056
      ROW(N) = SM(N,M) / SM(N,N)                                        AMPL0057
```

```
      I = N-1                                                          AMPL0058
   55 J = I+1                                                          AMPL0059
      S = 0.0                                                          AMPL0060
   60 S = S + SM(I,J) * ROW(J)                                         AMPL0061
      IF (J .EQ. N) GO TO 65                                           AMPL0062
      J = J + 1                                                        AMPL0063
      GO TO 60                                                         AMPL0064
   65 ROW(I) =(SM(I,M) - S) / SM(I,I)                                  AMPL0065
      IF (I .EQ. 1) GO TO 70                                           AMPL0066
      I = I - 1                                                        AMPL0067
      GO TO 55                                                         AMPL0068
   70 CONTINUE                                                         AMPL0069
      K = 0                                                            AMPL0070
      DO 75 I = 2,NP                                                   AMPL0071
      IF (IPOS(I) .LT. 0) GO TO 75                                     AMPL0072
      K = K + 1                                                        AMPL0073
      AMP(I) = ROW(K)                                                  AMPL0074
   75 CONTINUE                                                         AMPL0075
      WRITE (6,80) FREQ                                                AMPL0076
   80 FORMAT (//50X,12HFREQUENCY = E12.5//48X,4HNODE,16X,9HAMPLITUDE /) AMPL0077
      AMX = 0.0                                                        AMPL0078
      DO 82 I = 2,NP                                                   AMPL0079
      IF ( IPOS(I) .LT. 0 ) GO TO 82                                   AMPL0080
      IF ( ABS(AMP(I)) .LE. AMX ) GO TO 82                             AMPL0081
      AMX = ABS( AMP(I) )                                              AMPL0082
   82 CONTINUE                                                         AMPL0083
      DO 90 I = 1,NP                                                   AMPL0084
      IF (IPOS(I) .LT. 0) GO TO 90                                     AMPL0085
      AMP(I) = AMP(I) / AMX                                            AMPL0086
      WRITE (6,85) I, AMP(I)                                           AMPL0087
   85 FORMAT (47X, I5, 10X, E15.5)                                     AMPL0088
   90 CONTINUE                                                         AMPL0089
      RETURN                                                           AMPL0090
      END                                                              AMPL0091
```

```
      SUBROUTINE STRESS ( ZCOS, IPOS )                                  STRS0010
C     SOLVE FOR THE RELATIVE VIBRATORY BENDING STRESSES AT THE CENTROID STRS0020
C     OF EACH ELEMENT .                                                 STRS0030
C                                                                       STRS0040
      COMMON X(100) , Y(100) , Z(100) , TH(100) , XL(100,3) , YL(100,3),STRS0050
     1       RAPANG(50) , ZGL(50) , RHUB(50) , RTIP(50) , THHUB(50) ,   STRS0060
     2       THTIP(50) , EDCM(3,3) , RHO , PCISSC , YOUNGS , RADGEN ,   STRS0070
     3       NGENLI , LINE1 , NEXT(100,3) , NP , NT , ELMSM(6,6) ,      STRS0080
     4       AMNIN(6,6) , ELBSM(9,9) , ABNIN(9,9) , SIGMAX(100) ,       STRS0090
     5       SIGMAY(100) , ELSTIF(18,18) , TAUXY(100) , ELSSM(9,9) ,    STRS0100
     6       MEX(100,8) , IMEX(100) , AMP(150)                          STRS0110
      DIMENSION IPOS(100) , ZCOS(100) , BK(100,100) , CK(100,50) ,      STRS0120
     1          BC(100,50) , R6(18,18) , WL(9) , SIG1(100) , SIG2(100) ,STRS0130
     2          TAUMAX(100) , SIGEFF(100)                               STRS0135
      EQUIVALENCE ( R6(1,1) , ELSTIF(1,1) )                             STRS0140
      J = 0                                                             STRS0150
      DO 5 I = 1,NP                                                     STRS0160
      IF ( IPOS(I) .LT. 0 ) GO TO 5                                     STRS0170
      J = J + 1                                                         STRS0180
      AMP(J) = AMP(I)                                                   STRS0190
 5    CONTINUE                                                          STRS0200
      K1 = -8                                                           STRS0210
      K2 =  0                                                           STRS0220
      DO 10 K = 1,11                                                    STRS0230
      K1 = K1 + 9                                                       STRS0240
      K2 = K2 + 9                                                       STRS0250
      L = K + 3                                                         STRS0260
 10   READ (2'L) ((BK(I,J),J=1,100),I=K1,K2)                            STRS0270
      READ (2'15) (BK(100,J),J=1,100)                                   STRS0280
      K1 = -8                                                           STRS0290
      K2 = 0                                                            STRS0300
      DO 15 K = 1,5                                                     STRS0310
      K1 = K1 + 9                                                       STRS0320
      K2 = K2 + 9                                                       STRS0330
      L  = K  + 15                                                      STRS0340
 15   READ (2'L) ((CK(I,J),I=1,100),J=K1,K2)                            STRS0350
      READ (2'21) ((CK(I,J),I=1,100),J=46,50)                           STRS0360
      M = NP - NGENLI                                                   STRS0370
      M2 = 2 * M                                                        STRS0380
      DO 30 K = 1,M2                                                    STRS0390
      XX= 1.0 / BK(K,K)                                                 STRS0400
      BK(K,K) = 1.0                                                     STRS0410
      DO 20 J = 1,M2                                                    STRS0420
 20   BK(K,J) = BK(K,J) * XX                                            STRS0430
      IF ( K - M2 ) 25,35,25                                            STRS0440
 25   M = K + 1                                                         STRS0450
      DO 30 I = M,M2                                                    STRS0460
      XX= BK(I,K)                                                       STRS0470
      BK(I,K) = 0.0                                                     STRS0480
      DO 30 J = 1,M2                                                    STRS0490
 30   BK(I,J) = BK(I,J) - XX* BK(K,J)                                   STRS0500
 35   LL = M2 - 1                                                       STRS0510
      DO 40 I = 1,LL                                                    STRS0520
      M = I + 1                                                         STRS0530
      DO 40 K = M,M2                                                    STRS0540
      XX= BK(I,K)                                                       STRS0550
      BK(I,K) = 0.0                                                     STRS0560
      DO 40 J = 1,M2                                                    STRS0570
```

```
40    BK(I,J) = BK(I,J) - BK(K,J) * XX                                  STRS0580
      M = NP - NCENLI                                                   STRS0590
      DO 45 I = 1,M2                                                    STRS0600
      DO 45 J = 1,M                                                     STRS0610
      BC(I,J) = 0.0                                                     STRS0620
      DO 45 K = 1,M2                                                    STRS0630
45    BC(I,J) = BC(I,J) - BK(I,K) * CK(K,J)                             STRS0640
      DO 50 I = 1,M2                                                    STRS0650
      AMP(M+I) = 0.0                                                    STRS0660
      DO 50 J = 1,M                                                     STRS0670
50    AMP(M+I) = AMP(M+I) + BC(I,J) * AMP(J)                            STRS0680
      COEF1 = YOUNGS / 2.0 / ( 1.0 - POISSO**2 )                        STRS0690
      DO 120 I = 1,NT                                                   STRS0700
      LA = NEXT(I,1)                                                    STRS0710
      LB = NEXT(I,2)                                                    STRS0720
      LC = NEXT(I,3)                                                    STRS0730
      NA = IPOS(LA) + 1                                                 STRS0740
      NB = IPOS(LB) + 1                                                 STRS0750
      NC = IPOS(LC) + 1                                                 STRS0760
      XLC = ( XL(I,1) + XL(I,2) + XL(I,3) ) / 3.0                       STRS0770
      YLC = ( YL(I,1) + YL(I,2) + YL(I,3) ) / 3.0                       STRS0780
      TBAR = ( XL(I,2) * YL(I,3) + ( XL(I,3) - XL(I,2) ) * YLC -        STRS0790
     1       YL(I,3) * XLC ) * TH(LA) + ( - XL(I,3) * YLC + YL(I,3) *   STRS0800
     2       XLC ) * TH(LB) + ( XL(I,2) * YLC ) * TH(LC)                STRS0810
      COEF = COEF1 * ABS( TBAR / XL(I,2) / YL(I,3) )                    STRS0820
      DO  55 J = 1,9                                                    STRS0830
      DO  55 K = 1,9                                                    STRS0840
55    ABNIN(J,K) = 0.0                                                  STRS0850
      ABNIN(1,1) = 1.0                                                  STRS0860
      ABNIN(2,3) = -1.0                                                 STRS0870
      ABNIN(3,2) = 1.0                                                  STRS0880
      ABNIN(4,1) = -3.0 / XL(I,2)/ XL(I,2)                              STRS0890
      ABNIN(4,3) = 2.0 / XL(I,2)                                        STRS0900
      ABNIN(4,4) = - ABNIN(4,1)                                         STRS0910
      ABNIN(4,6) = 1.0 / XL(I,2)                                        STRS0920
      ABNIN(5,1) = 3.0 * (XL(I,3)**2 - XL(I,2)**2)/(XL(I,2)*YL(I,3))**2 STRS0930
      ABNIN(5,2) = -2.0 / YL(I,3)                                       STRS0940
      ABNIN(5,3) = 2.0 * (XL(I,2) - XL(I,3)) * XL(I,3)/XL(I,2)/YL(I,3)  STRS0950
     1             / YL(I,3)                                          STRS0960
      ABNIN(5,4) = -3.0 * ( XL(I,3)/ XL(I,2)/ YL(I,3))**2               STRS0970
      ABNIN(5,6) = - ( XL(I,3)/ YL(I,3))**2 / XL(I,2)                   STRS0980
      ABNIN(5,7) = 3.0 / YL(I,3)/ YL(I,3)                               STRS0990
      ABNIN(5,8) = - 1.0 / YL(I,3)                                      STRS1000
      ABNIN(5,9) = XL(I,3)/ YL(I,3)/ YL(I,3)                            STRS1010
      ABNIN(6,1) = 2.0 / XL(I,2)**3                                     STRS1020
      ABNIN(6,3) = - 1.0 / XL(I,2)/ XL(I,2)                             STRS1030
      ABNIN(6,4) = - ABNIN(6,1)                                         STRS1040
      ABNIN(6,6) = ABNIN(6,3)                                           STRS1050
      ABNIN(7,2) = ABNIN(6,3)                                           STRS1060
      ABNIN(7,5) = - ABNIN(6,3)                                         STRS1070
      ABNIN(8,1) = 6.0*XL(I,3)/XL(I,2)**3/YL(I,3)**2*(XL(I,2)-XL(I,3))  STRS1080
      ABNIN(8,2) = 2.0 * XL(I,3)/ XL(I,2)/ XL(I,2)/ YL(I,3)             STRS1090
      ABNIN(8,3) = (XL(I,2) - 3.0 * XL(I,3)) * (XL(I,2) - XL(I,3)) /    STRS1100
     1             ( XL(I,2)* YL(I,3))**2                             STRS1110
      ABNIN(8,4) = 6.0 * XL(I,3) * (XL(I,3) - XL(I,2)) / XL(I,2)**3 /   STRS1120
     1             YL(I,3)**2                                         STRS1130
      ABNIN(8,5) = - 2.0 * XL(I,3)/ XL(I,2)/ XL(I,2)/ YL(I,3)           STRS1140
      ABNIN(8,6) = XL(I,3)* ( 3.0 * XL(I,3)- 2.0 * XL(I,2)) / ( XL(I,2)*STRS1150
```

```
1               YL(I,3))**2                                                    STRS1160
 ABNIN(8,9) = -1.0 / YL(I,3)/ YL(I,3)                                          STRS1170
 ABNIN(9,1) = 2.0 * ( 2.0 *XL(I,3)**3 - XL(I,2)* ( 3.0 *XL(I,3)**2 STRS1180
1               - XL(I,2)**2) ) / ( XL(I,2)* YL(I,3))**3                      STRS1190
 ABNIN(9,2) = (XL(I,2)**2 - XL(I,3)**2) / (XL(I,2) * YL(I,3))**2   STRS1200
 ABNIN(9,3) = -2.0 *XL(I,3) * (XL(I,2) - XL(I,3))**2 /XL(I,2)**2 / STRS1210
1               YL(I,3)**3                                                     STRS1220
 ABNIN(9,4) = 2.0 * XL(I,3)**2* ( 3.0 * XL(I,2)- 2.0 * XL(I,3)) /  STRS1230
1               ( XL(I,2)* YL(I,3))**3                                         STRS1240
 ABNIN(9,5) = ( XL(I,3)/ XL(I,2)/ YL(I,3))**2                                  STRS1250
 ABNIN(9,6) = 2.0 * XL(I,3)**2* ( XL(I,2)- XL(I,3)) / XL(I,2)**2/  STRS1260
1               YL(I,3)**3                                                     STRS1270
 ABNIN(9,7) = -2.0 / YL(I,3)**3                                                STRS1280
 ABNIN(9,8) = 1.0 / YL(I,3)**2                                                 STRS1290
 ELBSM(1,1) = -2.0 * POISSO * ABNIN(4,1) - 2.0 * ABNIN(5,1) - ( 6.0STRS1300
1               * POISSO * ABNIN(6,1) + 2.0 * ABNIN(8,1) ) * XLC -   STRS1310
2               6.0 * ABNIN(9,1) * YLC                                         STRS1320
 ELBSM(1,2) = -2.0 * ABNIN(5,2) - 2.0 * ABNIN(8,2) * XLC - ( 2.0 * STRS1330
1               POISSO * ABNIN(7,2) + 6.0 * ABNIN(9,2) ) * YLC         STRS1340
 ELBSM(1,3) = -2.0 * ( POISSO * ABNIN(4,3) + ABNIN(5,3) ) - 2.0 *  STRS1350
1               ( 3.0 * POISSO * ABNIN(6,3) + ABNIN(8,3) ) * XLC -   STRS1360
2               6.0 * ABNIN(9,3) * YLC                                         STRS1370
 ELBSM(1,4) = -2.0 * ( POISSO * ABNIN(4,4) + ABNIN(5,4) ) - 2.0 *  STRS1380
1               ( 3.0 * POISSO * ABNIN(6,4) + ABNIN(8,4) ) * XLC     STRS1390
2               - 6.0 * ABNIN(9,4) * YLC                                       STRS1400
 ELBSM(1,5) = -2.0 * ABNIN(8,5) * XLC - 2.0 * ( POISSO * ABNIN(7,5)STRS1410
1               + 3.0 * ABNIN(9,5) ) * YLC                             STRS1420
 ELBSM(1,6) = -2.0 * ( POISSO * ABNIN(4,6) + ABNIN(5,6) ) - 2.0 *  STRS1430
1               ( 3.0 * POISSO * ABNIN(6,6) + ABNIN(8,6) ) * XLC -   STRS1440
2               6.0 * ABNIN(9,6) * YLC                                         STRS1450
 ELBSM(1,7) = -2.0 * ABNIN(5,7) - 6.0 * ABNIN(9,7) * YLC                       STRS1460
 ELBSM(1,8) = -2.0 * ABNIN(5,8) - 6.0 * ABNIN(9,8) * YLC                       STRS1470
 ELBSM(1,9) = -2.0 * ABNIN(5,9) - 2.0 * ABNIN(8,9) * XLC                       STRS1480
 ELBSM(2,1) = -2.0 * ( ABNIN(4,1) + POISSO * ABNIN(5,1) ) - 2.0 *  STRS1490
1               ( 3.0 * ABNIN(6,1) + POISSO * ABNIN(8,1) ) * XLC -   STRS1500
2               6.0 * POISSO * ABNIN(9,1) * YLC                                STRS1510
 ELBSM(2,2) = -2.0 * POISSO * ABNIN(5,2) - 2.0 * POISSO * ABNIN(8, STRS1520
1               2) * XLC - 2.0 * ( ABNIN(7,2) + 3.0 * POISSO *         STRS1530
2               ABNIN(9,2) ) * YLC                                             STRS1540
 ELBSM(2,3) = -2.0 * ( ABNIN(4,3) + POISSO * ABNIN(5,3) ) - 2.0 *  STRS1550
1               ( 3.0 * ABNIN(6,3) + POISSO * ABNIN(8,3) ) * XLC -   STRS1560
2               6.0 * POISSO * ABNIN(9,3) * YLC                                STRS1570
 ELBSM(2,4) = -2.0 * ( ABNIN(4,4) + POISSO * ABNIN(5,4) ) - 2.0 *  STRS1580
1               ( 3.0 * ABNIN(6,4) + POISSO * ABNIN(8,4) ) * XLC -   STRS1590
2               6.0 * POISSO * ABNIN(9,4) * YLC                                STRS1600
 ELBSM(2,5) = -2.0 * POISSO * ABNIN(8,5) * XLC - 2.0 * ( ABNIN(7,5)STRS1610
1               + 3.0 * POISSO * ABNIN(9,5) ) * YLC                    STRS1620
 ELBSM(2,6) = -2.0 * ( ABNIN(4,6) + POISSO * ABNIN(5,6) ) - 2.0 *  STRS1630
1               ( 3.0 * ABNIN(6,6) + POISSO * ABNIN(8,6) ) * XLC -   STRS1640
2               6.0 * POISSO * ABNIN(9,6) * YLC                                STRS1650
 ELBSM(2,7) = -2.0 * POISSO * ( ABNIN(5,7) + 3.0*ABNIN(9,7)*YLC )  STRS1660
 ELBSM(2,8) = -2.0 * POISSO * ( ABNIN(5,8) + 3.0*ABNIN(9,8)*YLC )  STRS1670
 ELBSM(2,9) = -2.0 * POISSO * ( ABNIN(5,9) + ABNIN(8,9) * XLC )    STRS1680
 ELBSM(3,1) = 2.0 * ABNIN(8,1) * ( 1.0 - POISSO ) * YLC                        STRS1690
 ELBSM(3,2) = 2.0 * ( 1.0 - POISSO ) * ( ABNIN(7,2) * XLC +        STRS1700
1               ABNIN(8,2) * YLC )                                             STRS1710
 ELBSM(3,3) = 2.0 * ABNIN(8,3) * ( 1.0 - POISSO ) * YLC                        STRS1720
 ELBSM(3,4) = 2.0 * ABNIN(8,4) * ( 1.0 - POISSO ) * YLC                        STRS1730
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      ELBSM(3,5) = 2.0 * ( 1.0 - POISSO ) * ( ABNIN(7,5) * XLC +          STRS1740
     1             ABNIN(8,5) * YLC )                                     STRS1750
      ELBSM(3,6) = 2.0 * ABNIN(8,6) * ( 1.0 - POISSO ) * YLC             STRS1760
      ELBSM(3,7) = 0.0                                                   STRS1770
      ELBSM(3,8) = 0.0                                                   STRS1780
      ELBSM(3,9) = 2.0 * ABNIN(8,9) * ( 1.0 - POISSO ) * YLC             STRS1790
      DO  60 J = 1,3                                                     STRS1800
      DO  60 K = 1,9                                                     STRS1810
60    ELBSM(J,K) = ELBSM(J,K) * COEF                                     STRS1820
      DO  65 J = 1,9                                                     STRS1830
65    WL(J) = 0.0                                                        STRS1840
      IF ( NA .LE. 0 ) GO TO 80                                          STRS1850
      READ (3'LA) R6                                                     STRS1860
      IF ( IMEX(LA) .EQ. 1 ) GO TO 70                                    STRS1870
      R6(3,2) = SIN( R6(3,3) - ARCOS( ZCOS(I) ) )                        STRS1880
      R6(3,3) = COS( R6(3,3) - ARCOS( ZCOS(I) ) )                        STRS1890
      R6(2,2) = R6(3,3)                                                  STRS1900
      R6(2,3) = -R6(3,2)                                                 STRS1910
70    DO 75 J = 1,3                                                      STRS1920
75    WL(J) = AMP(NA) * R6(1,J) + AMP(M+NA) * R6(2,J) + AMP(M+M+NA) *    STRS1930
     1        R6(3,J)                                                    STRS1940
80    IF ( NB .LE. 0 ) GO TO 95                                          STRS1950
      READ (3'LB) R6                                                     STRS1960
      IF ( IMEX(LB) .EQ. 1 ) GO TO 85                                    STRS1970
      R6(3,2) = SIN( R6(3,3) - ARCOS( ZCOS(I) ) )                        STRS1980
      R6(3,3) = COS( R6(3,3) - ARCOS( ZCOS(I) ) )                        STRS1990
      R6(2,2) = R6(3,3)                                                  STRS2000
      R6(2,3) = -R6(3,2)                                                 STRS2010
85    DO 90 J = 1,3                                                      STRS2020
90    WL(J+3) = AMP(NB) * R6(1,J) + AMP(M+NB) * R6(2,J) + AMP(M+M+NB) *  STRS2030
     1          R6(3,J)                                                  STRS2040
95    IF ( NC .LE. 0 ) GO TO 110                                         STRS2050
      READ (3'LC) R6                                                     STRS2060
      IF ( IMEX(LC) .EQ. 1 ) GO TO 100                                   STRS2070
      R6(3,2) = SIN( R6(3,3) - ARCOS( ZCOS(I) ) )                        STRS2080
      R6(3,3) = COS( R6(3,3) - ARCOS( ZCOS(I) ) )                        STRS2090
      R6(2,2) = R6(3,3)                                                  STRS2100
      R6(2,3) = -R6(3,2)                                                 STRS2110
100   DO 105 J = 1,3                                                     STRS2120
105   WL(J+6) = AMP(NC) * R6(1,J) + AMP(M+NC) * R6(2,J) + AMP(M+M+NC) *  STRS2130
     1          R6(3,J)                                                  STRS2140
110   DO 115 K = 1,9                                                     STRS2150
      SIGMAX(I) = SIGMAX(I) + ELBSM(2,K) * WL(K)                         STRS2160
      SIGMAY(I) = SIGMAY(I) + ELBSM(1,K) * WL(K)                         STRS2170
115   TAUXY (I) = TAUXY (I) + ELBSM(3,K) * WL(K)                         STRS2180
120   CONTINUE                                                           STRS2190
      DO 125 I = 1,NT                                                    STRS2200
      TERM1 = ( SIGMAX(I) + SIGMAY(I) ) / 2.0                            STRS2210
      TERM2 = SQRT( ( SIGMAX(I) - SIGMAY(I) )**2 / 4.0 + TAUXY(I)**2 )   STRS2220
      SIG1(I) = TERM1 + TERM2                                            STRS2230
      SIG2(I) = TERM1 - TERM2                                            STRS2240
      TAUMAX(I) = ( SIG1(I) - SIG2(I) ) / 2.0                            STRS2250
125   SIGEFF(I) = SQRT( SIG1(I)**2 + SIG2(I)**2 - SIG1(I) * SIG2(I) )    STRS2260
      J0 = 1                                                             STRS2270
      J1 = 1                                                             STRS2280
      J2 = 1                                                             STRS2290
      J3 = 1                                                             STRS2300
      J4 = 1                                                             STRS2310
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      J5 = 1                                                            STRS2320
      J6 = 1                                                            STRS2330
      AMX = C.C                                                         STRS2340
      BMX = C.C                                                         STRS2350
      CMX = C.C                                                         STRS2360
      DMX = C.C                                                         STRS2370
      EMX = C.C                                                         STRS2380
      FMX = C.C                                                         STRS2390
      GMX = C.C                                                         STRS2400
      DO 160 J = 1,NT                                                   STRS2410
      IF ( ABS( SIGMAX(J) ) .LE. BMX ) GO TO 130                        STRS2420
      J1 = J                                                            STRS2430
      BMX = ABS( SIGMAX(J) )                                            STRS2440
  130 IF ( ABS( SIGMAY(J) ) .LE. AMX ) GO TO 135                        STRS2450
      J0 = J                                                            STRS2460
      AMX = ABS( SIGMAY(J) )                                            STRS2470
  135 IF ( ABS( TAUXY(J) ) .LE. CMX ) GO TO 140                         STRS2480
      J2 = J                                                            STRS2490
      CMX = ABS( TAUXY(J) )                                             STRS2500
  140 IF ( ABS( SIG1(J) ) .LE. DMX ) GO TO 145                          STRS2510
      J3 = J                                                            STRS2520
      DMX = ABS( SIG1(J) )                                              STRS2530
  145 IF ( ABS( SIG2(J) ) .LE. EMX ) GO TO 150                          STRS2540
      J4 = J                                                            STRS2550
      EMX = ABS( SIG2(J) )                                              STRS2560
  150 IF ( ABS( TAUMAX(J) ) .LE. FMX )  GO TO 155                       STRS2570
      J5 = J                                                            STRS2580
      FMX = ABS( TAUMAX(J) )                                            STRS2590
  155 IF ( ABS( SIGEFF(J) ) .LE. GMX ) GO TO 160                        STRS2600
      J6 = J                                                            STRS2610
      GMX = ABS( SIGEFF(J) )                                            STRS2620
  160 CONTINUE                                                          STRS2630
      AMX = SIGMAY(J0)                                                  STRS2640
      BMX = SIGMAX(J1)                                                  STRS2650
      CMX = TAUXY(J2)                                                   STRS2660
      DMX = SIG1(J3)                                                    STRS2670
      EMX = SIG2(J4)                                                    STRS2680
      FMX = TAUMAX(J5)                                                  STRS2690
      GMX = SIGEFF(J6)                                                  STRS2700
      DO 165 J = 1,NT                                                   STRS2710
      SIGMAY(J) = SIGMAY(J) / AMX                                       STRS2720
      SIGMAX(J) = SIGMAX(J) / BMX                                       STRS2730
      TAUXY (J) = TAUXY (J) / CMX                                       STRS2740
      SIG1  (J) = SIG1  (J) / DMX                                       STRS2750
      SIG2  (J) = SIG2  (J) / EMX                                       STRS2760
      TAUMAX(J) = TAUMAX(J) / FMX                                       STRS2770
  165 SIGEFF(J) = SIGEFF(J) / GMX                                       STRS2780
      WRITE (6,170) (I,SIGMAY(I),SIGMAX(I),TAUXY(I),SIG1(I),SIG2(I),   STRS2790
     1               TAUMAX(I),SIGEFF(I) , I = 1,NT )                   STRS2800
  170 FORMAT ( '1' //40X 'RELATIVE VIBRATORY BENDING STRESSES' / 45X     STRS2810
     1  'EVALUATED AT CENTROIDS' // '  ELEMENT    SIGMAYBAR       SIGMAXSTRS2820
     2BAR          SHEAR       PRIN SIGMA1BAR  PRIN SIGMA2BAR     MAX SHEASTRS2830
     3R       EFF. STRESS' / 50(4X,I3,7E16.5 /),'1' //// 50(4X,I3,7E16.5 STRS2840
     4 /) )                                                             STRS2850
      WRITE (6,175) J0,AMX,J1,BMX,J2,CMX,J3,DMX,J4,EMX,J5,FMX,J6,GMX    STRS2860
  175 FORMAT ( / 4X,I3,E16.5 / 4X,I3,16X,E16.5 / 4X,I3,32X,E16.5 /      STRS2870
     1           4X,I3,48X,E16.5 / 4X,I3,64X,E16.5 / 4X,I3,80X,E16.5 /  STRS2880
     2           4X,I3,96X,E16.5 )                                      STRS2890
      RETURN                                                            STRS2900
      END                                                               STRS2910
```

```
LOGIC   START 0
        ENTRY ANDA
        ENTRY ORA
        ENTRY XOR
        ENTRY COM
        ENTRY SWR
        ENTRY SWL
        ENTRY IANDA
        ENTRY IORA
        ENTRY IXOR
        ENTRY ICOM
        ENTRY ISWR
        ENTRY ISWL
        DC    C'AND'
        DC    X'03'
        USING ANDA,15
ANDA    STM   2,3,28(13)
        LM    2,3,0(1)
        L     2,0(2)
        L     3,0(3)
        NR    2,3
        ST    2,X0
        LE    0,X0
        L     0,X0
        LM    2,3,28(13)
        BCR   15,14
        DC    C'OR '
        DC    X'03'
        USING ORA,15
ORA     STM   2,3,28(13)
        LM    2,3,0(1)
        L     2,0(2)
        L     3,0(3)
        OR    2,3
        ST    2,X0
        LE    0,X0
        L     0,X0
        LM    2,3,28(13)
        BCR   15,14
        DC    C'XOR'
        DC    X'03'
        USING XOR,15
XOR     STM   2,3,28(13)
        LM    2,3,0(1)
        L     2,0(2)
        L     3,0(3)
        XR    2,3
        ST    2,X0
        LE    0,X0
        L     0,X0
        LM    2,3,28(13)
        BCR   15,14
        DC    C'COM'
        DC    X'03'
        USING COM,15
COM     STM   2,3,28(13)
        LM    2,3,0(1)
        L     2,0(2)
```

```
         LCR   2,2
         ST    2,X0
         LE    0,X0
         L     0,X0
         LM    2,3,28(13)
         BCR   15,14
         DC    C'SWR'
         DC    X'03'
         USING SWR,15
SWR      STM   2,3,28(13)
         LM    2,3,0(1)
         L     2,0(2)
         L     3,0(3)
         SRL   2,0(3)
         ST    2,X0
         LE    0,X0
         L     0,X0
         LM    2,3,28(13)
         BCR   15,14
         DC    C'SWL'
         DC    X'03'
         USING SWL,15
SWL      STM   2,3,28(13)
         LM    2,3,0(1)
         L     2,0(2)
         L     3,0(3)
         SLL   2,0(3)
         ST    2,X0
         LE    0,X0
         L     0,X0
         LM    2,3,28(13)
         BCR   15,14
X0       DS    1F
IANDA    EQU   ANDA
IORA     EQU   ORA
IXOR     EQU   XOR
ICOM     EQU   COM
ISWR     EQU   SWR
ISWL     EQU   SWL
         END
```

```
CLOCK   START 0                                                         CLOK0000
BR0     EQU   0                                                         CLOK0010
BR1     EQU   1                                                         CLOK0021
BR2     EQU   2                                                         CLOK0022
BR3     EQU   3                                                         CLOK0023
BR4     EQU   4                                                         CLOK0024
BR5     EQU   5                                                         CLOK0025
BR6     EQU   6                                                         CLOK0026
BR7     EQU   7                                                         CLOK0027
BR8     EQU   8                                                         CLOK0028
BR9     EQU   9                                                         CLOK0029
BR10    EQU   10                                                        CLOK0030
BR11    EQU   11                                                        CLOK0031
BR12    EQU   12                                                        CLOK0032
BR13    EQU   13                                                        CLOK0033
BR14    EQU   14                                                        CLOK0034
BR15    EQU   15                                                        CLOK0035
        ENTRY HCLOCK,ICLOCK,SCLOCK,DATE
        USING *,BR15
HCLOCK  SAVE  (14,5),,*                                                 CLOK0100
        LR    BR1,BR13                                                  CLOK0103
        LA    BR13,SAVE                                                 CLOK0105
        ST    BR13,8(0,BR1)                                             CLOK0107
        ST    BR1,4(0,BR13)                                             CLOK0109
        TIME                                                            CLOK0110
        L     BR13,4(0,BR13)                                            CLOK0112
        L     BR15,16(0,BR13)     RESTORE BASE REGISTER                 CLOK0115
        O     BR0,ZFBYT           INSURE PROPER SIGN FOR PACKED DIGIT.  CLOK0120
        ST    BR0,PTIME           TEMP STORAGE FOR PACKED TIME.         CLOK0130
        UNPK  ZTIME(7),PTIME(4)   UNPACK TIME TO ZONED DECIMAL.         CLOK0140
        L     BR3,ZTIME           HOURS AND MINUTES.                    CLOK0150
        SLDL  BR2,16              SHIFT IN                              CLOK0160
        SLL   BR2,16              HOURS WITH                            CLOK0170
        O     BR2,BLNK2           TRAILING BLANKS.                      CLOK0180
        L     BR1,24(0,BR13)                                            CLOK0190
        L     BR5,0(0,BR1)        ADDRESS OF FIRST PARAMETER.           CLOK0200
        ST    BR2,0(0,BR5)        SAVE TIME.                            CLOK0210
        SLDL  BR2,16              SHIFT IN                              CLOK0220
        SLL   BR2,16              MINUTES WITH                          CLOK0230
        O     BR2,BLNK2           TRAILING BLANKS.                      CLOK0240
        L     BR5,4(0,BR1)                                              CLOK0245
        ST    BR2,0(0,BR5)        SAVE MINUTES.                         CLOK0250
        L     BR3,ZTIME+4         MINUTE AND TENTHS                     CLOK0260
        SLDL  BR2,16              SHIFT IN                              CLOK0270
        SLL   BR2,16              SECONDS WITH                          CLOK0280
        O     BR2,BLNK2           TRAILING BLANKS.                      CLOK0290
        L     BR5,8(0,BR1)                                              CLOK0295
        ST    BR2,0(0,BR5)        SAVE SECONDS.                         CLOK0300
        RETURN (14,5),T                                                 CLOKK310
        USING *,BR15
ICLOCK  SAVE  (14,5),,*                                                 CLOK0100
        LR    BR1,BR13                                                  CLOK0
        LA    BR13,SAVE                                                 CLOK0
        ST    BR13,8(0,BR1)                                             CLOK0
        ST    BR1,4(0,BR13)                                             CLOK0
        TIME  BIN                                                       CLOK0330
        L     BR13,4(0,BR13)                                            CLOK0333
        L     BR15,16(0,BR13)     RESTORE BASE REGISTER                 CLOK0335
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         LR    BR1,BR0                                                CLOK0337
         SR    BR0,BR0                                                CLOK0339
         D     BR0,F100          CHANGE TO SECONDS FROM HUNDREDTHS    CLOK0340
         LR    BR0,BR1                                                CLOK0350
         L     BR1,24(0,BR13)    RELOAD ADDRESS OF PARAMETER LIST.    CLOK0360
         L     BR5,0(0,BR1)                                           CLOK0370
         ST    BR0,0(0,BR5)      STORE TIME                           CLOK0380
         RETURN (14,5),T                                            CLOK0390
         USING *,BR15
SCLOCK   SAVE  (14,5),,*                                            CLOK0100
         LR    BR1,BR13                                             CLOK0
         LA    BR13,SAVE                                            CLOK0
         ST    BR13,8(0,BR1)                                        CLOK0
         ST    BR1,4(0,BR13)                                        CLOK0
         TIME  BIN                                                  CLOK0410
         L     BR13,4(0,BR13)                                       CLOK0420
         L     BR1,24(0,BR13)                                       CLOK0430
         L     BR5,0(0,BR1)                                         CLOK0440
         ST    BR0,0(0,BR5)      STORE TIME                         CLOK0450
         RETURN (14,5),T                                            CLOK0460
         USING *,BR15
DATE     SAVE  (14,5),,*                                            CLOK0100
         LR    BR1,BR13                                             CLOK0
         LA    BR13,SAVE                                            CLOK0
         ST    BR13,8(0,BR1)                                        CLOK0
         ST    BR1,4(0,BR13)                                        CLOK0
         TIME  DEC                                                  CLOK0480
         L     BR13,4(0,BR13)                                       CLOK0483
         L     BR15,16(0,BR13)     RESTORE BASE REGISTER            CLOK0485
         LR    BR4,BR1          LOAD DATE INTO EVEN REGISTER.       CLOK0490
         SRDL  BR4,16           SHIFT DAY OF YEAR TO ODD REGISTER.  CLOK0500
         SRL   BR5,16           RIGHT JUSTIFY IT WITH LEADING ZEROES. CLOK0510
         SLL   BR4,4            SET-UP YEAR TO ACCEPT A SIGN        CLOK0520
         O     BR5,ZFBYT        INSURE PROPER SIGN FOR DAY OF YEAR. CLOK0530
         O     BR4,ZFBYT        INSURE PROPER SIGN FOR YEAR.        CLOK0540
         ST    BR4,PYEAR        STORE YEAR.                         CLOK0550
         ST    BR4,LYEAR        STORE YEAR                          CLOK0555
         ST    BR5,PDOFY        STORE DAY OF YEAR.                  CLOK0560
*        IS THIS LEAP YEAR.                                         CLOK0570
         DP    LYEAR(4),PFOUR(1)                                    CLOK0580
         CP    LYEAR+3(1),ZFBYT+3(1) REMAINDER = 0 - MEANS LEAP YEAR CLOK0590
         BE    LPYER              BRANCH IF LEAP YEAR.              CLOK0600
*        IS IT DECEMBER                                             CLOK0610
FINDT    L     BR4,DEC12                                            CLOK0620
         CP    PDOFY(4),PK334(4)  IS IT DECEMBER.                   CLOK0630
         BH    DECSI              YES.                              CLOK0640
*        IS IT NOVEMBER                                             CLOK0650
         L     BR4,NOV11                                            CLOK0660
         CP    PDOFY(4),PK304(4)  IS IT NOVEMBER.                   CLOK0670
         BH    NOVSI              YES                               CLOK0680
*        IS IT OCTOBER                                              CLOK0690
         L     BR4,OCT10                                            CLOK0700
         CP    PDOFY(4),PK273(4)                                    CLOK0710
         BH    OCTSI                                                CLOK0720
*        IS IT SEPTEMBER                                            CLOK0730
         L     BR4,SEP09                                            CLOK0740
         CP    PDOFY(4),PK243(4)  IS IT SEPTEMBER.                  CLOK0750
         BH    SEPSI              YES                               CLOK0760
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*               IS IT AUGUEST                                          CLOK0770
          L     BR4,AUG08                                              CLOK0780
          CP    PDOFY(4),PK212(4)     IS IT AUGUEST                    CLOK0790
          BH    AUGSI                 YES                              CLOK0800
*               IS IT JULY                                             CLOK0810
          L     BR4,JUL07                                              CLOK0820
          CP    PDOFY(4),PK181(4)     IS IT JULY                       CLOK0830
          BH    JULSI                 YES                              CLOK0840
*               IS IT JUNE                                             CLOK0850
          L     BR4,JUN06                                              CLOK0860
          CP    PDOFY(4),PK151(4)     IS IT JUNE                       CLOK0870
          BH    JUNSI                 YES                              CLOK0880
*               IS IT MAY                                              CLOK0890
          L     BR4,MAY05                                              CLOK0900
          CP    PDOFY(4),PK120(4)     IS IT MAY                        CLOK0910
          BH    MAYSI                 YES                              CLOK0920
*               IS IT APRIL                                            CLOK0930
          L     BR4,APR04                                              CLOK0940
          CP    PDOFY(4),PK090(4)     IS IT APRIL                      CLOK0950
          BH    APRSI                 YES                              CLOK0960
*               IS IT MARCH                                            CLOK0970
          L     BR4,MAR03                                              CLOK0980
          CP    PDOFY(4),PK059(4)     IS IT MARCH                      CLOK0990
          BH    MARSI                 YES                              CLOK1000
*               IS IT FEBRUARY                                         CLOK1010
FERJA     L     BR4,FEB02                                              CLOK1020
          CP    PDOFY(4),PK031(4)     IS IT FEBRUARY                   CLOK1030
          BH    FEBSI                 YES                              CLOK1040
*               IT MUST BE JANUARY                                     CLOK1050
          L     BR4,JAN01                                              CLOK1060
STDAT     L     BR1,24(0,BR13)                                         CLOK1070
          L     BR5,0(0,BR1)                                           CLOK1080
          ST    BR4,0(0,BR5)          STORE MONTH - MM  .              CLOK1090
          UNPK  ZTIME+2(2),PDOFY+2(2) UNPACK DAY OF MONTH.             CLOK1100
          L     BR4,ZTIME                                              CLOK1110
          SLL   BR4,16                LEFT JUSTIFY.                    CLOK1120
          O     BR4,BLNK2             PUT IN TRAILING BLANKS.          CLOK1130
          L     BR5,4(0,BR1)                                           CLOK1140
          ST    BR4,0(0,BR5)          STORE DAY - DD  .                CLOK1150
          UNPK  ZTIME+2(2),PYEAR+2(2)                                  CLOK1160
          L     BR4,ZTIME                                              CLOK1170
          SLL   BR4,16                                                 CLOK1180
          O     BR4,BLNK2                                              CLOK1190
          L     BR5,8(0,BR1)                                           CLOK1200
          ST    BR4,0(0,BR5)          STORE YEAR - YY  .               CLOK1210
          RETURN (14,5),T                                              CLOK1220
*               ITS LEAP YEAR         -                                CLOK1230
LPYER     CP    PDOFY(4),PK060(4)     IS IT JANUARY OR FEBRUARY        CLOK1240
          BNH   FERJA                 YES                              CLOK1250
          SP    PDOFY(4),PK001(4)     REDUCE DAYS BY ONE.              CLOK1260
          B     FINDT                 GO FIND DATE.                    CLOK1270
*               CALCULATE DAY OF MONTH.                                CLOK1280
DECSI     SP    PDOFY(4),PK334(4)                                      CLOK1290
          B     STDAT                                                  CLOK1300
NOVSI     SP    PDOFY(4),PK304(4)                                      CLOK1310
          B     STDAT                                                  CLOK1320
OCTSI     SP    PDOFY(4),PK273(4)                                      CLOK1330
          B     STDAT                                                  CLOK1340
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SEPSI    SP    PDOFY(4),PK243(4)                                  CLOK1350
         B     STDAT                                              CLOK1360
AUGSI    SP    PDOFY(4),PK212(4)                                  CLOK1370
         B     STDAT                                              CLOK1380
JULSI    SP    PDOFY(4),PK181(4)                                  CLOK1390
         B     STDAT                                              CLOK1400
JUNSI    SP    PDOFY(4),PK151(4)                                  CLOK1410
         B     STDAT                                              CLOK1420
MAYSI    SP    PDOFY(4),PK120(4)                                  CLOK1430
         B     STDAT                                              CLOK1440
APRSI    SP    PDOFY(4),PK090(4)                                  CLOK1450
         B     STDAT                                              CLOK1460
MARSI    SP    PDOFY(4),PK059(4)                                  CLOK1470
         B     STDAT                                              CLOK1480
FEBSI    SP    PDOFY(4),PK031(4)                                  CLOK1490
         B     STDAT                                              CLOK1500
JAN01    DC    C' 1  '                                            CLOK1600
FEB02    DC    C' 2  '                                            CLOK1610
MAR03    DC    C' 3  '                                            CLOK1620
APR04    DC    C' 4  '                                            CLOK1630
MAY05    DC    C' 5  '                                            CLOK1640
JUN06    DC    C' 6  '                                            CLOK1650
JUL07    DC    C' 7  '                                            CLOK1660
AUG08    DC    C' 8  '                                            CLOK1670
SEP09    DC    C' 9  '                                            CLOK1680
OCT10    DC    C'10  '                                            CLOK1690
NOV11    DC    C'11  '                                            CLOK1700
DEC12    DC    C'12  '                                            CLOK1710
BLNK2    DC    C'00  '                                            CLOK1720
ZFBYT    DC    PL4'0'                                             CLOK1730
PYEAR    DC    PL4'0'                                             CLOK1740
LYEAR    DC    PL4'0'                                             CLOK1750
PDOFY    DC    PL4'0'                                             CLOK1760
PK334    DC    PL4'334'                                           CLOK1770
PK304    DC    PL4'304'                                           CLOK1780
PK273    DC    PL4'273'                                           CLOK1790
PK243    DC    PL4'243'                                           CLOK1800
PK212    DC    PL4'212'                                           CLOK1810
PK181    DC    PL4'181'                                           CLOK1820
PK151    DC    PL4'151'                                           CLOK1830
PK120    DC    PL4'120'                                           CLOK1840
PK090    DC    PL4'090'                                           CLOK1850
PK059    DC    PL4'059'                                           CLOK1860
PK031    DC    PL4'031'                                           CLOK1870
PK060    DC    PL4'060'                                           CLOK1880
PK001    DC    PL4'001'                                           CLOK1890
PFOUR    DC    P'4'                                               CLOK1900
ZTIME    DS    2F                                                 CLOK1910
PTIME    DS    1F                                                 CLOK1920
F100     DC    F'6000'                                            CLOK1930
SAVE     DS    18F        SAVE AREA FOR THIS PROGRAM.             CLOK0705
         END                                                      CLOK0720
```

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*          ZEROC - FILL DESIGNATED AREA OF CORE WITH ZERO OR WITH      ZER00000
*                  A CONSTANT SUPPLIED IN THE CALLING SEQUENCE.        ZER00010
*                                                                      ZER00020
*                        CALLING SEQUENCE                              ZER00030
*                          CALL ZEROC (FROM,TO)                        ZER00040
*                                OR                                    ZER00050
*                          CALL ZEROC (FROM,TO,CONST)                  ZER00060
*                                                                      ZER00070
*                        WHERE-FROM-IS THE STARTING ADDRESS            ZER00080
*                              TO-FINAL ADDRESS TO BE CLEARED          ZER00090
*                              CONST-THE CONSTANT CORE IS TO BE        ZER00100
*                                    FILLED WITH. IF NOT SUPPLIED      ZER00110
*                                    IN CALLING SEQUENCE, CORE         ZER00120
*                                    WILL BE FILLED WITH ZEROES.       ZER00130
*                                                                      ZER00140
PWZERO  START 0                                                        ZER00150
BR0     EQU   0          BASE REGISTER 0                               ZER00160
BR1     EQU   1                                                        ZER00170
BR2     EQU   2                                                        ZER00180
BR3     EQU   3                                                        ZER00190
BR4     EQU   4                                                        ZER00200
BR5     EQU   5                                                        ZER00210
BR6     EQU   6                                                        ZER00220
BR7     EQU   7                                                        ZER00230
BR8     EQU   8                                                        ZER00240
BR9     EQU   9                                                        ZER00250
BR10    EQU   10                                                       ZER00260
BR11    EQU   11                                                       ZER00270
BR12    EQU   12                                                       ZER00280
BR13    EQU   13                                                       ZER00290
BR14    EQU   14                                                       ZER00300
BR15    EQU   15                                                       ZER00310
*                                                                      ZER00320
        ENTRY ZERO                                                     ZER00325
        USING *,BR15                                                   ZER00340
ZERO    SAVE  (14,12),,*                                               ZER00330
        ST    BR13,SAVE+4                                              ZER00350
        LA    BR10,SAVE                                                ZER00360
        ST    BR10,8(0,BR13)                                           ZER00370
        L     BR3,0(0,BR1)                                             ZER00390
        L     BR4,4(0,BR1)                                             ZER00400
        N     BR3,BIGAD    INSURE ADDRESS ONLY.                        ZER00410
        N     BR4,BIGAD    INSURE ADDRESS ONLY.                        ZER00420
        CLR   BR3,BR4      1ST ARG. LESS THAN 2ND ARG.                 ZER00430
        BNL   SWITCH       NO, THEN SWITCH REGISTERS.                  ZER00440
MODE1   TM    4(BR1),X'80'                                             ZER00470
        BZ    NTZRO        MORE ARGUMENTS.                             ZER00480
MODE    A     BR4,FORBT    YES,CALCULATE BYTES TO BE CLEARED.          ZER00450
        SR    BR4,BR3      BR4 EQUAL NO. OF BYTES.                     ZER00460
MORE    C     BR4,TWO56    OVER 255 BYTES TO CLEAR                     ZER00500
        BL    LESTN        YES                                         ZER00510
        S     BR4,TWO56    REDUCE BY 256                               ZER00520
        L     BR5,TWO56                                                ZER00530
MONE    S     BR5,TWO                                                  ZER00540
        STC   BR5,MOVE+1                                               ZER00550
MOVE    XC    0(0,BR3),0(BR3)                                          ZER00560
        A     BR3,TWO56                                                ZER00570
        LTR   BR4,BR4                                                  ZER00580
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         BC     2,MORE                                          ZERO0590
RETRN    RETURN (14,12),T          RESTORE AND RETURN            ZERO0600
LESTN    LR     BR5,BR4                                         ZERO0610
         LA     BR4,0                                           ZERO0620
         B      MONE                                            ZERO0630
SWITCH   LR     BR5,BR3                                         ZERO0640
         LR     BR3,BR4                                         ZERO0650
         LR     BR4,BR5                                         ZERO0660
         B      MODE1                                           ZERO0670
NTZRO    L      BR6,8(0,BR1)                                    ZERO0680
         L      BR6,0(0,BR6)                                    ZERO0685
NTZR1    ST     BR6,0(0,BR3)                                    ZERO0690
         CR     BR3,BR4                                         ZERO0700
         BE     RETRN                                           ZERO0710
         A      BR3,FORBT                                       ZERO0720
         B      NTZR1                                           ZERO0730
SAVE     DS     18F                                             ZERO1000
BIGAD    DC     X'00FFFFFF'                                     ZERO1010
FORBT    DC     F'4'                                            ZERO1020
TWO56    DC     F'256'                                          ZERO1030
TWO      DC     F'1'                                            ZERO1050
         END                                                    ZERO9990
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