USAARL REPORT NO. 76-13
VOLUME II

COMPUTER MODELING OF THE BODY-HEAD-HELMET SYSTEM

FINITE ELEMENT COORDINATES AND COMPUTER PROGRAM SUBROUTINES FOR A BODY-HEAD-HELMET SYSTEM

By

Wartan A. Jemian
Nan-Heng Lin

School of Engineering, Auburn University
Auburn, Alabama 36830

February 1976

Final Report

This document has been approved for public release and sale; its distribution is unlimited.

Prepared for:

Bioengineering and Evaluation Division
US Army Aeromedical Research Laboratory
Fort Rucker, Alabama 36362

ADA023786
Technical Report

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: USAARL 76-13
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:
4. TITLE (and Subtitle): Computer Modeling of the Body-Head-Helmet System, Finite Element Coordinates and Computer Program Subroutines for a Body-Head-Helmet System, Volume II
5. TYPE OF REPORT & PERIOD COVERED: Report for publication
6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): Wartan A. Jemian, Nan-Heng Lin
8. CONTRACT OR GRANT NUMBER(s): DABT01-74-C-0231
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Auburn University School of Engineering, Auburn, AL 36830
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: DD Form 1498
11. CONTROLLING OFFICE NAME AND ADDRESS: Bioengineering and Evaluation Division, US Army Aeromedical Research Laboratory, Fort Rucker, AL 36362
12. REPORT DATE: December 1975
13. NUMBER OF PAGES: 71
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): USA Medical Research and Development Command, Washington, DC 20314
15. SECURITY CLASS. (of this report): Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

This document has been approved for public release and sale; its distribution is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Crash Helmet
Computer Simulation
Finite Element
Structural Analysis
Inertial Properties
Severity Index
Stress Field
Displacement
Acceleration Profile
Three Dimensional Finite Element

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is a supplement to the basic report entitled, "Computer Modeling of the Body-Head-Helmet System". As such, it should be used with the basic report for maximum clarity. Nodal point coordinates and boundary conditions for a fixed Body-Head-Helmet configuration are listed. A 3X3X3 pseudosphere head-helment configuration is also listed. A listing of service in FORTRAN calls on the facilities and subprograms of the IBM operating system and the Calcomp Plotter. The service listed should perform all of the operations referred to in the basic report.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

NOTICE

Qualified requesters may obtain copies from the Defense Documentation Center (DDC), Cameron Station, Alexandria, Virginia. Orders will be expedited if placed through the librarian or other person designated to request documents from DDC (Formerly ASTIA).

Change of Address

Organization receiving reports from the US Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about laboratory reports.

Disposition

Destroy this report when it is no longer needed. Do not return it to the originator.

Disclaimer

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

SUMMARY

This report is a supplement to the basic report entitled, "Computer Modeling of the Body-Head-Helmet System". As such, it should be used with the basic report for maximum clarity.

Nodal point coordinates and boundary conditions for a fixed Body-Head-Helmet configuration are listed. A 3X3X3 pseudosphere head-helmet configuration is also listed. A listing of service in FORTRAN calls on the facilities and subprograms of the IBM operating system and the Calcomp Plotter. The service listed should perform all of the operations referred to in the basic report.

Approved:

ROBERT W. BAILEY
Colonel, MSC
Commander

TABLE OF CONTENTS
VOLUME 1

SUMMARY. . . . . .

I. INTRODUCTION 1

A. Objective 1

B. Human Tolerance 2

C. Helmet Design 3

D. Testing 4

E. Simulation 5

II. FINITE ELEMENT SIMULATION. 9

A. The Structural System 9

B. Stereographic Drawings 16

C. Inertial Properties. 16

1. Nodal Points 16
2. Elements 17
3. Centers of Gravity. 17
4. Element Volume. 20
5. Element Mass 21
6. Mass Moment of Inertia. 21
7. Element Group Properties. 21

D. Static Structural Analysis 22

1. Variables and Equations 23
2. Solution and Results. 24
3. Accuracy and Execution Time 25

E. Dynamic Structural Analysis 25

F. General Comments on Computer Operation 27

III. RESULTS: STATIC ANALYSIS. 30

A. System Mechanics 30

1. Linear Deformation 30
2. Relationship to Dynamic Loading 30

B. System Formation and Characteristics 31

1. Dimensions 31
2. Mass. 33
3. Inertial Moments 36
4. Stress Field 39

C. Effect of Inner Liner Modulus 40

1. Materials Properties 40
2. Displacements 43
3. Skull Deflection 46
4. Stresses 46
5. Work of Deformation 52

IV. RESULTS: DYNAMIC ANALYSIS 55

A. Drop Test Simulation 56

B. The Configuration 56

C. Inertial Properties 57

D. Boundary Conditions and Inertial Loading 62

1. Loading Points 62
2. Ground Acceleration 62
3. Displacement Time Trace 64
4. Rotational Acceleration 66

E. Effect of Inner Liner Modulus Variation 70

1. Aluminum Head Form 70
2. Humanoid Head Form 72
3. Severity Index 72

V. SUMMARY AND RECOMMENDATIONS FOR FURTHER WORK 76

A. Inertial Properties Analysis 76

B. Structural Analysis 77

C. Injury Parameters 78

D. Recommendations for Further Research 78

VI. CONCLUSIONS 82

BIBLIOGRAPHY 84

TABLE OF CONTENTS
VOLUME II

Section I - The Fixed Body-Head-Helmet Configuration 86
Identity of 382 Nodal Point Coordinates and
Boundary Conditions

Section II - The 3X3X3 Pseudosphere Head-Helmet Model, ... 105
Identity of 87 Nodal Point Coordinates and
Boundary Conditions

Section III - Computer Service Listing in FORTRAN, The 112
Facilities and Subprograms of the IBM
Operating System and Calcomp Plotter

SECTION I

THE FIXED BODY-HEAD-HELMET CONFIGURATION

1. NODAL POINT COORDINATES AND BOUNDARY CONDITIONS (SYMBOL 'F' DESIGNATES FIXED COORDINATE)

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
1			F	-5.4500	1.4500	0.0
2	F	F	F	-0.8167	0.0	0.0
3		F	F	3.8167	0.0	0.0
4			F	8.4500	1.4500	0.0
5			F	-5.4500	7.2500	0.0
6			F	-0.8167	7.2500	0.0
7			F	3.8167	7.2500	0.0
8			F	8.4500	7.2500	0.0
9			F	-5.4500	10.8750	0.0
10			F	-0.8167	13.0500	0.0
11			F	3.8167	13.0500	0.0
12			F	8.4500	10.8750	0.0
13				-7.0717	0.0	10.0953
14				-0.8167	-1.4500	10.0953
15				3.8167	-1.4500	10.0953
16				10.0717	0.0	10.0953
17				-7.0717	5.8000	10.0953
18				-0.8167	5.8000	10.0953
19				3.8167	5.8000	10.0953
20				10.0717	5.8000	10.0953
21				-7.0717	9.4250	10.0953
22				-1.3572	11.6000	10.0953
23				4.3572	11.6000	10.0953
24				10.0717	9.4250	10.0953
25				-9.3884	0.4887	20.1906
26				-0.8167	0.0	20.1906
27				3.8167	0.0	20.1906
28				12.3884	0.4887	20.1906
29				-9.3884	8.8522	20.1906

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
30				-0.8167	7.2500	20.1906
31				3.8167	7.2500	20.1906
32				12.3884	8.8522	20.1906
33				-9.3884	14.0795	20.1906
34				-2.1295	17.2158	20.1906
35				5.1295	17.2158	20.1906
36				12.3884	14.0795	20.1906
37				10.0834	1.3253	30.2858
38				-0.8167	1.4500	30.2858
39				3.8167	1.4500	30.2858
40				13.0834	1.3253	30.2858
41				10.0834	11.3245	30.2858
42				-0.8167	8.7000	30.2858
43				3.8167	8.7000	30.2858
44				13.0834	11.3245	30.2858
45				10.0834	17.5740	30.2858
46				-2.3611	21.3237	30.2858
47				5.3611	21.3237	30.2858
48				13.0834	17.5740	30.2858
49				10.0834	1.3775	40.3811
50				-0.8167	1.4500	40.3811
51				3.8167	1.4500	40.3811
52				13.0834	1.3775	40.3811
53				10.0834	11.2375	40.3811
54				-0.8167	8.7000	40.3811
55				3.8167	8.7000	40.3811
56				13.0834	11.2375	40.3811
57				10.0834	17.4000	40.3811
58				-2.3611	21.0975	40.3811
59				5.3611	21.0975	40.3811
60				13.0834	17.4000	40.3811
61				-1.6000	2.2471	50.4763
62				-0.0500	1.0154	50.4763
63				3.0500	1.0154	50.4763
64				4.6000	2.2471	50.4763
65				-1.6000	4.7575	50.4763
66				-0.0500	5.3616	50.4763
67				3.0500	5.3616	50.4763
68				4.6000	4.7575	50.4763
69				-1.6000	6.3264	50.4763
70				0.4667	7.2678	50.4763
71				2.5333	7.2678	50.4763
72				4.6000	6.3264	50.4763
73				-1.6000	1.8846	55.5240
74				-0.0500	0.5807	55.5240
75				3.0500	0.5807	55.5240
76				4.6000	1.8846	55.5240
77				-1.6000	4.2026	55.5240
78				-0.0500	4.9270	55.5240

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
79				3.0500	4.9270	55.5240
80				4.6000	4.2026	55.5240
81				-1.6000	5.6513	55.5240
82				0.4667	6.5206	55.5240
83				2.5333	6.5206	55.5240
84				4.6000	5.6513	55.5240
85				-1.6000	1.8846	57.0381
86				-0.0500	0.5807	57.0381
87				3.0500	0.5807	57.0381
88				4.6000	1.8846	57.0381
89				-1.6000	4.1881	58.0477
90				-0.0500	4.9270	58.0477
91				3.0500	4.9270	58.0477
92				4.6000	4.1881	58.0477
93				-2.5300	12.5329	59.5619
94				-0.0500	13.6194	58.5524
95				3.0500	13.6194	58.5524
96				5.5300	12.5329	59.5619
97				-3.1500	8.4039	62.5906
98				-0.0500	5.9701	61.2277
99				3.0500	5.9701	61.2277
100				6.1500	8.4039	62.5906
101				-2.2200	11.0986	62.9438
102				-0.0500	12.3155	62.7924
103				3.0500	12.3155	62.7924
104				5.2200	11.0986	62.9438
105				-3.1500	0.1461	59.2591
106				-0.0500	-0.2885	58.0477
107				3.0500	-0.2885	58.0477
108				6.1500	0.1461	59.2591
109				-4.7000	1.9281	61.5810
110				-3.1500	2.1019	60.3191
111				6.1500	2.1019	60.3191
112				7.7000	1.9281	61.5810
113				-4.7000	-1.5924	61.1772
114				-0.0500	-1.9401	60.1677
115				3.0500	-1.9401	60.1677
116				7.7000	-1.5924	61.1772
117				-4.7000	-0.2885	62.9944
118				-3.4600	-0.3754	62.0858
119				6.4600	-0.3754	62.0858
120				7.7000	-0.2885	62.9944
121				-3.1500	-5.2866	64.5591
122				-0.0500	-7.2424	63.6001
123				3.0500	-7.2424	63.6001
124				6.1500	-5.2866	64.5591
125				-4.7000	-3.3309	66.1239
126				-3.4600	-4.2436	65.1144
127				6.4600	-4.2436	65.1144

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
128				7.7000	-3.3309	66.1239
129				-3.1500	-5.5040	68.9001
130				-0.0500	-7.6771	68.6477
131				3.0500	-7.6771	68.6477
132				6.1500	-5.5040	68.9001
133				-4.7000	-3.3309	69.1525
134				-3.4600	-4.8955	68.7487
135				6.4600	-4.8955	68.7487
136				7.7000	-3.3309	69.1525
137				-3.1500	-4.2001	74.4525
138				-0.0500	-5.9386	75.7145
139				3.0500	-5.9386	75.7145
140				6.1500	-4.2001	74.4525
141				-4.7000	-2.0270	72.9382
142				-3.4600	-3.7655	73.9478
143				6.4600	-3.7655	73.9478
144				7.7000	-2.0270	72.9382
145				-3.1500	-1.5924	77.2287
146				-0.0500	-2.8962	79.7525
147				3.0500	-2.8962	79.7525
148				6.1500	-1.5924	77.2287
149				-4.7000	-0.3754	74.7049
150				-3.4600	-1.3751	76.8249
151				6.4600	-1.3751	76.8249
152				7.7000	-0.3754	74.7049
153				-3.1500	3.6231	76.9764
154				-0.0500	4.0577	79.2478
155				3.0500	4.0577	79.2478
156				6.1500	3.6231	76.9764
157				-4.7000	3.1885	74.7049
158				-3.4600	3.6231	76.7240
159				6.4600	3.6231	76.7240
160				7.7000	3.1885	74.7049
161				-3.1500	8.4039	75.7145
162				-0.0500	10.1424	77.7335
163				3.0500	10.1424	77.7335
164				6.1500	8.4039	75.7145
165				-4.7000	7.1001	74.2002
166				-3.4600	7.9693	75.2097
167				6.4600	7.9693	75.2097
168				7.7000	7.1001	74.2002
169				-3.1500	10.1424	73.1906
170				-0.0500	11.8809	73.6954
171				3.0500	11.8809	73.6954
172				6.1500	10.1424	73.1906
173				-4.7000	8.8386	71.9287
174				-3.4600	9.7078	72.1810
175				6.4600	9.7078	72.1810
176				7.7000	8.8386	71.9287

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
177				-6.2500	10.1424	71.1715
178				0.5700	11.4463	71.6763
179				2.4300	11.4463	71.6763
180				9.2500	10.1424	71.1715
181				-6.2500	9.2732	70.1620
182				0.5700	10.5771	70.5658
183				2.4300	10.5771	70.5658
184				9.2500	9.2732	70.1620
185				-6.2500	7.5347	68.1430
186				-3.4600	9.2732	68.6477
187				6.4600	9.2732	68.6477
188				9.2500	7.5347	68.1430
189				-6.2500	10.1424	63.6001
190				-0.0500	11.0117	63.7515
191				3.0500	11.0117	63.7515
192				9.2500	10.1424	63.6001
193				-6.2500	7.9693	63.6001
194				-0.0500	6.8828	63.6001
195				3.0500	6.8828	63.6001
196				9.2500	7.9693	63.6001
197				-6.2500	3.6231	63.0954
198				-3.4600	3.6231	63.0954
199				6.4600	3.6231	63.0954
200				9.2500	3.6231	63.0954
201				-6.2500	1.4500	64.6096
202				-3.4600	1.4500	64.6096
203				6.4600	1.4500	64.6096
204				9.2500	1.4500	64.6096
205				-6.2500	-1.3751	67.1334
206				-3.4600	-1.5924	67.1334
207				6.4600	-1.5924	67.1334
208				9.2500	-1.3751	67.1334
209				-6.2500	-1.5924	69.1525
210				-3.4600	-2.6789	69.1525
211				6.4600	-2.6789	69.1525
212				9.2500	-1.5924	69.1525
213				-6.2500	-0.5927	71.6763
214				-3.4600	-1.5924	72.6858
215				6.4600	-1.5924	72.6858
216				9.2500	-0.5927	71.6763
217				-6.2500	0.9284	72.6858
218				-3.4600	0.0157	74.2002
219				6.4600	0.0157	74.2002
220				9.2500	0.9284	72.6858
221				-6.2500	2.7539	72.6858
222				-3.4600	2.7539	74.2002
223				6.4600	2.7539	74.2002
224				9.2500	2.7539	72.6858
225				-6.2500	5.7962	72.1810

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
226				-3.4600	6.4481	73.1906
227				6.4600	6.4481	73.1906
228				9.2500	5.7962	72.1810
229				-6.2500	5.3616	66.9315
230				-3.4600	6.2308	66.1239
231				6.4600	6.2308	66.1239
232				9.2500	5.3616	66.9315
233				-6.2500	3.1885	68.6477
234				-3.4600	3.1885	68.6477
235				6.4600	3.1885	68.6477
236				9.2500	3.1885	68.6477
237				-6.2500	1.0154	70.6668
238				-3.4600	1.0154	70.6668
239				6.4600	1.0154	70.6668
240				9.2500	1.0154	70.6668
241				0.7250	14.0540	64.6096
242				2.2750	14.0540	64.6096
243				10.9707	4.1719	61.8505
244				12.1472	4.0425	61.8392
245				-9.8455	-1.1072	61.3887
246				10.9158	-1.7346	61.3338
247				-7.3518	-5.5842	60.9970
248				-8.1869	-6.6340	60.9052
249				-3.7905	-8.7190	60.7227
250				-4.2896	10.0645	60.6050
251				-0.6738	-9.9543	60.6147
252				-0.8789	11.4164	60.4867
253				3.6738	-9.9543	60.6147
254				3.8789	11.4164	60.4867
255				6.7905	-8.7190	60.7227
256				7.2896	10.0645	60.6050
257				10.3518	-5.5842	60.9970
258				11.1869	-6.6340	60.9052
259				12.8455	-1.1072	61.3887
260				13.9158	-1.7346	61.3338
261				13.9707	4.1719	61.8505
262				15.1472	4.0425	61.8392
263				10.9707	3.2048	66.3096
264				12.1472	3.0749	66.3096
265				-9.8455	-2.0945	66.3096
266				10.9158	-2.7244	66.3096
267				-7.3518	-6.5886	66.3096
268				-8.1869	-7.6424	66.3096
269				-3.7905	-9.7354	66.3096
270				-4.2896	11.0861	66.3096
271				-0.6738	10.9755	66.3096
272				-0.8789	12.4431	66.3096
273				3.6738	10.9755	66.3096
274				3.8789	12.4431	66.3096

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
275				6.7905	-9.7354	66.3096
276				7.2896	11.0861	66.3096
277				10.3518	-6.5886	66.3096
278				11.1869	-7.6424	66.3096
279				12.8455	-2.0945	66.3096
280				13.9158	-2.7244	66.3096
281				13.9707	3.2048	66.3096
282				15.1472	3.0749	66.3096
283				10.9707	3.3338	66.8914
284				12.1472	3.2161	66.9463
285				-9.8455	-1.4690	69.1310
286				10.9158	-2.0399	69.3972
287				-7.3518	-5.5421	71.0303
288				-8.1869	-6.4971	71.4756
289				-3.7905	-8.3940	72.3602
290				-4.2896	-9.6181	72.9310
291				-0.6738	-9.5179	72.8842
292				-0.8789	10.8480	73.5045
293				3.6738	-9.5179	72.8842
294				3.8789	10.8480	73.5045
295				6.7905	-8.3940	72.3602
296				7.2896	-9.6181	72.9310
297				10.3518	-5.5421	71.0303
298				11.1869	-6.4971	71.4756
299				12.8455	-1.4690	69.1310
300				13.9158	-2.0399	69.3972
301				13.9707	3.3338	66.8914
302				15.1472	3.2161	66.9463
303				10.9707	3.6966	67.3642
304				12.1472	3.6131	67.4637
305				-9.8455	0.2903	71.4238
306				10.9158	-0.1146	71.9062
307				-7.3518	-2.5985	74.8664
308				-8.1869	-3.2759	75.6737
309				-3.7905	-4.6212	77.2770
310				-4.2896	-5.4894	78.3116
311				-0.6738	-5.4183	78.2270
312				-0.8789	-6.3617	79.3512
313				3.6738	-5.4183	78.2270
314				3.8789	-6.3617	79.3512
315				6.7905	-4.6212	77.2770
316				7.2896	-5.4894	78.3116
317				10.3518	-2.5985	74.8664
318				11.1869	-3.2759	75.6737
319				12.8455	0.2903	71.4238
320				13.9158	-0.1146	71.9062
321				13.9707	3.6966	67.3642
322				15.1472	3.6131	67.4637
323				10.9707	4.2252	67.6395

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
324				12.1472	4.1916	67.7649
325				-9.8455	2.8537	72.7582
326				10.9158	2.6907	73.3665
327				-7.3518	1.6905	77.0991
328				-8.1869	1.4178	78.1170
329				-3.7905	0.8761	80.1387
330				-4.2896	0.5265	81.4434
331				-0.6738	0.5551	81.3365
332				-0.8789	0.1753	82.7541
333				3.6738	0.5551	81.3365
334				3.8789	0.1753	82.7541
335				6.7905	0.8761	80.1387
336				7.2896	0.5265	81.4434
337				10.3518	1.6905	77.0991
338				11.1869	1.4178	78.1170
339				12.8455	2.8537	72.7582
340				13.9158	2.6907	73.3665
341				13.9707	4.2252	67.6395
342				15.1472	4.1916	67.7649
343				10.9707	4.8207	67.6654
344				12.1472	4.8432	67.7933
345				-9.8455	5.7409	72.8842
346				10.9158	5.8502	73.5045
347				-7.3518	6.5213	77.3100
348				-8.1869	6.7043	78.3478
349				-3.7905	7.0677	80.4090
350				-4.2896	7.3022	81.7392
351				-0.6738	7.2830	81.6303
352				-0.8789	7.5379	83.0756
353				3.6738	7.2830	81.6303
354				3.8789	7.5379	83.0756
355				6.7905	7.0677	80.4090
356				7.2896	7.3022	81.7392
357				10.3518	6.5213	77.3100
358				11.1869	6.7043	78.3478
359				12.8455	5.7409	72.8842
360				13.9158	5.8502	73.5045
361				13.9707	4.8207	67.6654
362				15.1472	4.8432	67.7933
363				10.9707	7.7557	62.9665
364				12.1472	7.8302	63.0729
365				-9.8455	10.7953	67.3074
366				10.9158	11.1566	67.8233
367				-7.3518	10.9886	75.4596
368				-8.1869	11.5930	76.3228
369				-3.7905	12.7935	78.0373
370				-4.2896	13.5682	79.1437
371				-0.6738	13.5047	79.0531
372				-0.8789	14.3465	80.2554

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
373				3.6738	13.5047	79.0531
374				3.8789	14.3465	80.2554
375				6.7905	12.7935	78.0373
376				7.2896	13.5682	79.1437
377				10.3518	10.9886	75.4596
378				11.1869	11.5930	76.3228
379				12.8455	10.7953	67.3074
380				13.9158	11.1566	67.8233
381				13.9707	7.7557	62.9665
382				15.1472	7.8302	63.0729

2. CONNECTION ARRAYS

ELEMENT NUMBER	NODAL POINT NUMBERS (ELEMENT POSITIONS, 1 TO 8)								MATERIAL TYPE
1	1	2	6	5	13	14	18	17	5
2	2	3	7	6	14	15	19	18	6
3	3	4	8	7	15	16	20	19	5
4	5	6	10	9	17	18	22	21	5
5	6	7	11	10	18	19	23	22	5
6	7	8	12	11	19	20	24	23	5
7	13	14	18	17	25	26	30	29	5
8	14	15	19	18	26	27	31	30	6
9	15	16	20	19	27	28	32	31	5
10	17	18	22	21	29	30	34	33	5
11	18	19	23	22	30	31	35	34	5
12	19	20	24	23	31	32	36	35	5
13	25	26	30	29	37	38	42	41	5
14	26	27	31	30	38	39	43	42	6
15	27	28	32	31	39	40	44	43	5
16	29	30	34	33	41	42	46	45	5
17	30	31	35	34	42	43	47	46	5
18	31	32	36	35	43	44	48	47	5
19	37	38	42	41	49	50	54	53	5
20	38	39	43	42	50	51	55	54	6
21	39	40	44	43	51	52	56	55	5
22	41	42	46	45	53	54	58	57	5
23	42	43	47	46	54	55	59	58	5
24	43	44	48	47	55	56	60	59	5
25	49	50	54	53	61	62	66	65	5
26	50	51	55	54	62	63	67	66	6
27	51	52	56	55	63	64	68	67	5
28	53	54	58	57	65	66	70	69	5
29	54	55	59	58	66	67	71	70	5
30	55	56	60	59	67	68	72	71	5
31	61	62	66	65	73	74	78	77	5
32	62	63	67	66	74	75	79	78	6
33	63	64	68	67	75	76	80	79	5
34	65	66	70	69	77	78	82	81	5
35	66	67	71	70	78	79	83	82	5
36	67	68	72	71	79	80	84	83	5
37	73	74	78	77	85	86	90	89	5
38	74	75	79	78	86	87	91	90	1
39	75	76	80	79	87	88	92	91	5
40	77	78	82	81	89	90	94	93	5

ELEMENT NUMBER	NODAL POINT NUMBERS (ELEMENT POSITIONS, 1 TO 8)								MATERIAL TYPE
41	78	79	83	82	90	91	95	94	5
42	79	80	84	83	91	92	96	95	5
43	89	90	94	93	97	98	102	101	1
44	90	91	95	94	98	99	103	102	1
45	91	92	96	95	99	100	104	103	1
46	85	86	90	89	105	106	110	109	1
47	86	87	91	90	106	107	111	110	1
48	87	88	92	91	107	108	112	111	1
49	105	106	110	109	113	114	118	117	1
50	106	107	111	110	114	115	119	118	1
51	107	108	112	111	115	116	120	119	1
52	113	114	118	117	121	122	126	125	1
53	114	115	119	118	122	123	127	126	1
54	115	116	120	119	123	124	128	127	1
55	121	122	126	125	129	130	134	133	1
56	122	123	127	126	130	131	135	134	1
57	123	124	128	127	131	132	136	135	1
58	129	130	134	133	137	138	142	141	1
59	130	131	135	134	138	139	143	142	1
60	131	132	136	135	139	140	144	143	1
61	137	138	142	141	145	146	150	149	1
62	138	139	143	142	146	147	151	150	1
63	139	140	144	143	147	148	152	151	1
64	145	146	150	149	153	154	158	157	1
65	146	147	151	150	154	155	159	158	1
66	147	148	152	151	155	156	160	159	1
67	153	154	158	157	161	162	166	165	1
68	154	155	159	158	162	163	167	166	1
69	155	156	160	159	163	164	168	167	1
70	161	162	166	165	169	170	174	173	1
71	162	163	167	166	170	171	175	174	1
72	163	164	168	167	171	172	176	175	1
73	169	170	174	173	177	178	182	181	1
74	170	171	175	174	178	179	183	182	1
75	171	172	176	175	179	180	184	183	1
76	181	182	174	173	189	190	186	185	1
77	182	183	175	174	190	191	187	186	1
78	183	184	176	175	191	192	188	187	1
79	89	90	98	97	109	110	198	197	1
80	90	91	99	98	110	111	199	198	1
81	91	92	100	99	111	112	200	199	1
82	109	110	198	197	117	118	202	201	1
83	110	111	199	198	118	119	203	202	2
84	111	112	200	199	119	120	204	203	1
85	117	118	202	201	125	126	206	205	1
86	118	119	203	202	126	127	207	206	2
87	119	120	204	203	127	128	208	207	1
88	125	126	206	205	133	134	210	209	1
89	126	127	207	206	134	135	211	210	2
90	127	128	208	207	135	136	212	211	1

ELEMENT NUMBER	NODAL POINT NUMBERS (ELEMENT POSITIONS, 1 TO 8)								MATERIAL TYPE
91	133	134	210	209	141	142	214	213	1
92	134	135	211	210	142	143	215	214	2
93	135	136	212	211	143	144	216	215	1
94	141	142	214	213	149	150	218	217	1
95	142	143	215	214	150	151	219	218	2
96	143	144	216	215	151	152	220	219	1
97	149	150	218	217	157	158	222	221	1
98	150	151	219	218	158	159	223	222	2
99	151	152	220	219	159	160	224	223	1
100	157	158	222	221	165	166	226	225	1
101	158	159	223	222	166	167	227	226	2
102	159	160	224	223	167	168	228	227	1
103	165	166	226	225	173	174	186	185	1
104	166	167	227	226	174	175	187	186	2
105	167	168	228	227	175	176	188	187	1
106	97	98	194	193	197	198	230	229	1
107	98	99	195	194	198	199	231	230	1
108	99	100	196	195	199	200	232	231	1
109	197	198	230	229	201	202	234	233	1
110	198	199	231	230	202	203	235	234	2
111	199	200	232	231	203	204	236	235	1
112	201	202	234	233	205	206	238	237	1
113	202	203	235	234	206	207	239	238	2
114	203	204	236	235	207	208	240	239	1
115	205	206	238	237	209	210	214	213	1
116	206	207	239	238	210	211	215	214	2
117	207	208	240	239	211	212	216	215	1
118	217	218	214	213	221	222	238	237	1
119	218	219	215	214	222	223	239	238	2
120	219	220	216	215	223	224	240	239	1
121	221	222	238	237	225	226	234	233	1
122	222	223	239	238	226	227	235	234	2
123	223	224	240	239	227	228	236	235	1
124	225	226	234	233	185	186	230	229	1
125	226	227	235	234	186	187	231	230	2
126	227	228	236	235	187	188	232	231	1
127	185	186	230	229	189	190	194	193	1
128	186	187	231	230	190	191	195	194	2
129	187	188	232	231	191	192	196	195	1
130	178	179	183	182	241	242	191	190	2
131	243	245	265	263	244	246	266	264	3
132	245	247	267	265	246	248	268	266	3
133	247	249	269	267	248	250	270	268	3
134	249	251	271	269	250	252	272	270	3
135	251	253	273	271	252	254	274	272	3
136	253	255	275	273	254	256	276	274	3
137	255	257	277	275	256	258	278	276	3
138	257	259	279	277	258	260	280	278	3
139	259	261	281	279	260	262	282	280	3
140	263	265	285	283	264	266	286	284	3

ELEMENT NUMBER	NODAL POINT NUMBERS (ELEMENT POSITIONS, 1 TO 8)								MATERIAL TYPE
141	265	267	287	285	266	268	288	286	3
142	267	269	289	287	268	270	290	288	3
143	269	271	291	289	270	272	292	290	3
144	271	273	293	291	272	274	294	292	3
145	273	275	295	293	274	276	296	294	3
146	275	277	297	295	276	278	298	296	3
147	277	279	299	297	278	280	300	298	3
148	279	281	301	299	280	282	302	300	3
149	283	285	305	303	284	286	306	304	3
150	285	287	307	305	286	288	308	306	3
151	287	289	309	307	288	290	310	308	3
152	289	291	311	309	290	292	312	310	3
153	291	293	313	311	292	294	314	312	3
154	293	295	315	313	294	296	316	314	3
155	295	297	317	315	296	298	318	316	3
156	297	299	319	317	298	300	320	318	3
157	299	301	321	319	300	302	322	320	3
158	303	305	325	323	304	306	326	324	3
159	305	307	327	325	306	308	328	326	3
160	307	309	329	327	308	310	330	328	3
161	309	311	331	329	310	312	332	330	3
162	311	313	333	331	312	314	334	332	3
163	313	315	335	333	314	316	336	334	3
164	315	317	337	335	316	318	338	336	3
165	317	319	339	337	318	320	340	338	3
166	319	321	341	339	320	322	342	340	3
167	323	325	345	343	324	326	346	344	3
168	325	327	347	345	326	328	348	346	3
169	327	329	349	347	328	330	350	348	3
170	329	331	351	349	330	332	352	350	3
171	331	333	353	351	332	334	354	352	3
172	333	335	355	353	334	336	356	354	3
173	335	337	357	355	336	338	358	356	3
174	337	339	359	357	338	340	360	358	3
175	339	341	361	359	340	342	362	360	3
176	343	345	365	363	344	346	366	364	3
177	345	347	367	365	346	348	368	366	3
178	347	349	369	367	348	350	370	368	3
179	349	351	371	369	350	352	372	370	3
180	351	353	373	371	352	354	374	372	3
181	353	355	375	373	354	356	376	374	3
182	355	357	377	375	356	358	378	376	3
183	357	359	379	377	358	360	380	378	3
184	359	361	381	379	360	362	382	380	3
185	243	263	343	363	244	264	344	364	3
186	381	361	281	261	382	362	282	262	3
187	169	161	162	170	369	349	351	371	4
188	161	153	154	162	349	329	331	351	4
189	153	145	146	154	329	309	311	331	4
190	145	137	138	146	309	289	291	311	4

ELEMENT NUMBER	NODAL POINT NUMBERS (ELEMENT POSITIONS, 1 TO 8)								MATERIAL TYPE
191	137	129	130	138	289	269	271	291	4
192	129	121	122	130	269	249	251	271	4
193	170	162	163	171	371	351	353	373	4
194	162	154	155	163	351	331	333	353	4
195	154	146	147	155	331	311	313	333	4
196	146	138	139	147	311	291	293	313	4
197	138	130	131	139	291	271	273	293	4
198	130	122	123	131	271	251	253	273	4
199	171	163	164	172	373	353	355	375	4
200	163	155	156	164	353	333	335	355	4
201	155	147	148	156	333	313	315	335	4
202	147	139	140	148	313	293	295	315	4
203	139	131	132	140	293	273	275	295	4
204	131	123	124	132	273	253	255	275	4

3. COMPUTED PARAMETERS FOR THE ELEMENTS

ELEMENT NUMBER	MATERIAL TYPE	VOLUME (CC)	MASS (GRAMS)	CENTROID COORDINATES X	Y	Z
1	5	0.359E 03	0.359E 03	-3.54	3.26	5.05
2	6	0.339E 03	0.104E 04	1.50	2.90	5.05
3	5	0.359E 03	0.359E 03	6.54	3.26	5.05
4	5	0.254E 03	0.254E 03	-3.61	8.88	5.05
5	5	0.287E 03	0.287E 03	1.50	9.42	5.05
6	5	0.254E 03	0.254E 03	6.61	8.88	5.05
7	5	0.539E 03	0.539E 03	-4.52	3.34	15.14
8	6	0.339E 03	0.104E 04	1.50	2.90	15.14
9	5	0.539E 03	0.539E 03	7.52	3.34	15.14
10	5	0.441E 03	0.441E 03	-4.76	10.00	15.14
11	5	0.445E 03	0.445E 03	1.50	10.47	15.14
12	5	0.441E 03	0.441E 03	7.76	10.00	15.14
13	5	0.740E 03	0.740E 03	-5.28	4.92	25.24
14	6	0.339E 03	0.104E 04	1.50	4.35	25.24
15	5	0.740E 03	0.740E 03	8.28	4.92	25.24
16	5	0.711E 03	0.711E 03	-5.63	13.29	25.24
17	5	0.692E 03	0.692E 03	1.50	13.62	25.24
18	5	0.711E 03	0.711E 03	8.63	13.29	25.24
19	5	0.804E 03	0.804E 03	-5.45	5.70	35.33
20	6	0.339E 03	0.104E 04	1.50	5.07	35.33
21	5	0.804E 03	0.804E 03	8.45	5.70	35.33
22	5	0.807E 03	0.807E 03	-5.84	14.67	35.33
23	5	0.780E 03	0.780E 03	1.50	14.96	35.33
24	5	0.807E 03	0.807E 03	8.84	14.67	35.33
25	5	0.360E 03	0.360E 03	-3.14	4.52	45.43
26	6	0.230E 03	0.705E 03	1.50	4.13	45.43
27	5	0.360E 03	0.360E 03	6.14	4.52	45.43
28	5	0.330E 03	0.330E 03	-3.27	10.27	45.43
29	5	0.348E 03	0.348E 03	1.50	10.61	45.43
30	5	0.330E 03	0.330E 03	6.27	10.27	45.43
31	5	0.264E 02	0.264E 02	-0.82	3.12	53.00
32	6	0.680E 02	0.209E 03	1.50	2.97	53.00
33	5	0.264E 02	0.264E 02	3.82	3.12	53.00
34	5	0.138E 02	0.138E 02	-0.70	5.63	53.00
35	5	0.228E 02	0.228E 02	1.50	6.02	53.00
36	5	0.138E 02	0.138E 02	3.70	5.63	53.00
37	5	0.104E 02	0.104E 02	-0.82	2.90	56.53
38	1	0.272E 02	0.400E 02	1.50	2.75	56.53
39	5	0.104E 02	0.104E 02	3.82	2.90	56.53
40	5	0.257E 02	0.257E 02	-0.88	7.07	57.04

ELEMENT NUMBER	MATERIAL TYPE	VOLUME (CC)	MASS (GRAMS)	CENTROID COORDINATES X	Y	Z
41	5	0.388E 02	0.388E 02	1.50	7.50	56.91
42	5	0.257E 02	0.257E 02	3.88	7.07	57.04
43	1	0.552E 02	0.811E 02	-1.21	9.13	60.47
44	1	0.869E 02	0.128E 03	1.50	9.21	60.16
45	1	0.552E 02	0.811E 02	4.21	9.13	60.47
46	1	0.125E 02	0.183E 02	-1.79	1.93	58.67
47	1	0.415E 02	0.610E 02	1.50	1.83	58.36
48	1	0.125E 02	0.183E 02	4.79	1.93	58.67
49	1	0.134E 02	0.197E 02	-2.99	-0.04	60.70
50	1	0.524E 02	0.770E 02	1.50	-0.13	60.16
51	1	0.134E 02	0.197E 02	5.99	-0.04	60.70
52	1	0.198E 02	0.291E 02	-3.03	-3.04	63.23
53	1	0.973E 02	0.143E 03	1.50	-3.45	62.74
54	1	0.198E 02	0.291E 02	6.03	-3.04	63.23
55	1	0.538E 01	0.791E 01	-2.84	-5.19	66.86
56	1	0.823E 02	0.121E 03	1.50	-6.01	66.53
57	1	0.538E 01	0.791E 01	5.84	-5.19	66.86
58	1	0.413E 01	0.607E 01	-2.84	-4.67	71.56
59	1	0.104E 03	0.153E 03	1.50	-5.57	71.76
60	1	0.413E 01	0.607E 01	5.84	-4.67	71.56
61	1	0.196E 01	0.288E 01	-2.84	-2.77	75.70
62	1	0.810E 02	0.119E 03	1.50	-3.49	76.56
63	1	0.196E 01	0.288E 01	5.84	-2.77	75.70
64	1	0.205E 00	0.301E 00	-2.84	1.03	77.02
65	1	0.102E 03	0.150E 03	1.50	0.85	78.14
66	1	0.205E 00	0.301E 00	5.84	1.03	77.02
67	1	0.158E 01	0.233E 01	-2.84	6.01	76.31
68	1	0.960E 02	0.141E 03	1.50	6.45	77.23
69	1	0.158E 01	0.232E 01	5.84	6.01	76.31
70	1	0.395E 01	0.581E 01	-2.84	9.27	74.23
71	1	0.716E 02	0.105E 03	1.50	9.93	74.70
72	1	0.394E 01	0.580E 01	5.84	9.27	74.23
73	1	0.830E 01	0.122E 02	-2.84	10.25	71.82
74	1	0.140E 02	0.206E 02	1.50	10.90	72.03
75	1	0.829E 01	0.122E 02	5.84	10.25	71.82
76	1	0.213E 02	0.313E 02	-3.73	9.54	68.62
77	1	0.412E 02	0.605E 02	1.50	10.14	68.79
78	1	0.213E 02	0.313E 02	6.73	9.54	68.62
79	1	0.279E 02	0.409E 02	-2.80	4.35	61.00
80	1	0.657E 02	0.966E 02	1.50	4.16	60.67
81	1	0.279E 02	0.409E 02	5.80	4.35	61.00
82	1	0.143E 02	0.210E 02	-4.43	1.69	62.80
83	2	0.869E 02	0.913E 02	1.50	1.70	62.53
84	1	0.143E 02	0.210E 02	7.43	1.69	62.80
85	1	0.210E 02	0.309E 02	-4.47	-1.04	64.98
86	2	0.139E 03	0.146E 03	1.50	-1.19	64.74
87	1	0.210E 02	0.309E 02	7.47	-1.04	64.98
88	1	0.101E 02	0.149E 02	-4.47	-2.88	67.71
89	2	0.787E 02	0.826E 02	1.50	-3.35	67.54
90	1	0.101E 02	0.149E 02	7.47	-2.88	67.71

ELEMENT NUMBER	MATERIAL TYPE	VOLUME (CC)	MASS (GRAMS)	CENTROID COORDINATES X	Y	Z
91	1	0.112E 02	0.164E 02	-4.47	-2.56	70.93
92	2	0.998E 02	0.105E 03	1.50	-3.23	71.13
93	1	0.112E 02	0.164E 02	7.47	-2.56	70.93
94	1	0.850E 01	0.125E 02	-4.47	-1.10	73.71
95	2	0.774E 02	0.812E 02	1.50	-1.68	74.41
96	1	0.850E 01	0.125E 02	7.47	-1.10	73.71
97	1	0.103E 02	0.152E 02	-4.47	1.44	74.59
98	2	0.986E 02	0.104E 03	1.50	1.25	75.49
99	1	0.103E 02	0.152E 02	7.47	1.44	74.59
100	1	0.136E 02	0.200E 02	-4.47	4.95	74.14
101	2	0.106E 03	0.111E 03	1.50	5.20	74.83
102	1	0.136E 02	0.200E 02	7.47	4.95	74.14
103	1	0.161E 02	0.237E 02	-4.47	7.83	71.96
104	2	0.996E 02	0.105E 03	1.50	8.35	72.31
105	1	0.161E 02	0.237E 02	7.47	7.83	71.96
106	1	0.315E 02	0.463E 02	-3.61	6.01	63.78
107	1	0.542E 02	0.797E 02	1.50	5.68	63.51
108	1	0.315E 02	0.463E 02	6.61	6.01	63.78
109	1	0.348E 02	0.512E 02	-4.85	3.51	65.72
110	2	0.135E 03	0.142E 03	1.50	3.62	65.62
111	1	0.348E 02	0.512E 02	7.85	3.51	65.72
112	1	0.404E 02	0.594E 02	-4.85	1.04	67.76
113	2	0.147E 03	0.154E 03	1.50	1.02	67.76
114	1	0.404E 02	0.594E 02	7.85	1.04	67.76
115	1	0.215E 02	0.316E 02	-4.85	-0.92	69.78
116	2	0.102E 03	0.107E 03	1.50	-1.21	69.91
117	1	0.215E 02	0.316E 02	7.85	-0.92	69.78
118	1	0.161E 02	0.236E 02	-4.85	0.79	72.43
119	2	0.837E 02	0.879E 02	1.50	0.55	72.94
120	1	0.161E 02	0.236E 02	7.85	0.79	72.43
121	1	0.355E 02	0.522E 02	-4.85	3.27	71.36
122	2	0.155E 03	0.163E 03	1.50	3.35	71.68
123	1	0.355E 02	0.522E 02	7.85	3.27	71.36
124	1	0.453E 02	0.666E 02	-4.85	5.88	69.06
125	2	0.213E 03	0.224E 03	1.50	6.29	69.15
126	1	0.453E 02	0.666E 02	7.85	5.88	69.06
127	1	0.553E 02	0.812E 02	-4.00	8.05	65.55
128	2	0.963E 02	0.101E 03	1.50	8.35	65.53
129	1	0.552E 02	0.812E 02	7.00	8.05	65.55
130	5	0.319E 02	0.319E 02	1.50	11.77	67.65
131	3	0.317E 02	0.307E 02	-10.97	0.85	63.96
132	3	0.347E 02	0.336E 02	-9.08	-4.26	63.73
133	3	0.370E 02	0.359E 02	-5.90	-8.26	63.56
134	3	0.290E 02	0.281E 02	-2.41	-10.55	63.46
135	3	0.387E 02	0.375E 02	1.50	-11.20	63.43
136	3	0.290E 02	0.281E 02	5.41	-10.55	63.46
137	3	0.370E 02	0.359E 02	8.90	-8.26	63.56
138	3	0.347E 02	0.336E 02	12.07	-4.26	63.73
139	3	0.317E 02	0.307E 02	13.97	0.85	63.96
140	3	0.119E 02	0.116E 02	-10.97	0.56	67.20

ELEMENT NUMBER	MATERIAL TYPE	VOLUME (CC)	MASS (GRAMS)	CENTROID COORDINATES X	Y	Z
141	3	0.264E 02	0.256E 02	-9.08	-4.32	68.28
142	3	0.377E 02	0.366E 02	-5.90	-8.14	69.13
143	3	0.334E 02	0.324E 02	-2.41	-10.33	69.61
144	3	0.460E 02	0.447E 02	1.50	-10.95	69.75
145	3	0.335E 02	0.324E 02	5.41	-10.33	69.61
146	3	0.377E 02	0.366E 02	8.90	-8.14	69.13
147	3	0.264E 02	0.256E 02	12.07	-4.32	68.28
148	3	0.119E 02	0.116E 02	13.97	0.56	67.20
149	3	0.119E 02	0.116E 02	-10.97	1.32	68.82
150	3	0.264E 02	0.256E 02	-9.08	-2.66	71.86
151	3	0.377E 02	0.366E 02	-5.90	-5.75	74.24
152	3	0.334E 02	0.324E 02	-2.41	-7.53	75.61
153	3	0.460E 02	0.447E 02	1.50	-8.04	75.99
154	3	0.335E 02	0.324E 02	5.41	-7.53	75.61
155	3	0.377E 02	0.366E 02	8.90	-5.75	74.24
156	3	0.264E 02	0.256E 02	12.07	-2.66	71.86
157	3	0.119E 02	0.116E 02	13.97	1.32	68.82
158	3	0.119E 02	0.116E 02	-10.97	2.68	69.96
159	3	0.264E 02	0.256E 02	-9.08	0.37	74.40
160	3	0.377E 02	0.366E 02	-5.90	-1.43	77.87
161	3	0.334E 02	0.324E 02	-2.41	-2.47	79.85
162	3	0.460E 02	0.447E 02	1.50	-2.76	80.42
163	3	0.334E 02	0.324E 02	5.41	-2.47	79.85
164	3	0.377E 02	0.366E 02	8.90	-1.43	77.87
165	3	0.264E 02	0.256E 02	12.07	0.37	74.40
166	3	0.119E 02	0.116E 02	13.97	2.68	69.96
167	3	0.119E 02	0.116E 02	-10.97	4.40	70.42
168	3	0.264E 02	0.256E 02	-9.08	4.18	75.42
169	3	0.377E 02	0.366E 02	-5.90	4.01	79.33
170	3	0.334E 02	0.324E 02	-2.41	3.92	81.57
171	3	0.460E 02	0.447E 02	1.50	3.89	82.20
172	3	0.334E 02	0.324E 02	5.41	3.92	81.57
173	3	0.377E 02	0.366E 02	8.90	4.01	79.33
174	3	0.264E 02	0.256E 02	12.07	4.18	75.42
175	3	0.119E 02	0.116E 02	13.97	4.40	70.42
176	3	0.374E 02	0.363E 02	-10.97	7.35	67.88
177	3	0.453E 02	0.439E 02	-9.08	8.67	73.62
178	3	0.377E 02	0.366E 02	-5.90	9.57	78.35
179	3	0.334E 02	0.324E 02	-2.41	10.43	80.42
180	3	0.460E 02	0.446E 02	1.50	10.67	81.00
181	3	0.334E 02	0.324E 02	5.41	10.43	80.42
182	3	0.377E 02	0.366E 02	8.90	9.57	78.35
183	3	0.453E 02	0.439E 02	12.07	8.67	73.62
184	3	0.374E 02	0.363E 02	13.97	7.35	67.88
185	3	0.175E 02	0.170E 02	-11.56	4.97	64.73
186	3	0.175E 02	0.170E 02	14.56	4.97	64.73
187	4	0.612E 02	0.367E 01	-1.92	10.15	77.43
188	4	0.658E 02	0.395E 01	-1.92	5.25	79.15
189	4	0.359E 02	0.215E 01	-1.92	[illegible]	78.77
190	4	0.332E 02	0.199E 01	-1.92	-5.32	75.99

ELEMENT NUMBER	MATERIAL TYPE	VOLUME (CC)	MASS (GRAMS)	CENTROID COORDINATES X	Y	Z
191	4	0.703E 02	0.422E 01	-1.92	-7.74	70.70
192	4	0.664E 02	0.399E 01	-1.92	-8.14	64.96
193	4	0.632E 02	0.379E 01	1.50	10.70	78.03
194	4	0.650E 02	0.390E 01	1.50	5.51	79.99
195	4	0.225E 02	0.135E 01	1.50	-0.93	79.64
196	4	0.245E 02	0.147E 01	1.50	-5.94	76.64
197	4	0.719E 02	0.431E 01	1.50	-8.53	70.89
198	4	0.677E 02	0.406E 01	1.50	-8.96	64.79
199	4	0.612E 02	0.367E 01	4.92	10.15	77.43
200	4	0.658E 02	0.395E 01	4.92	5.25	79.15
201	4	0.359E 02	0.215E 01	4.92	-0.68	78.77
202	4	0.332E 02	0.199E 01	4.92	-5.32	75.99
203	4	0.703E 02	0.422E 01	4.92	-7.74	70.70
204	4	0.664E 02	0.399E 01	4.92	-8.14	64.96
	GROUP	0.217E 05	0.253E 05	1.50	6.08	38.05

SECTION II

THE 3X3X3 PSEUDO SPHERE HEAD-HELMET MODEL

1. NODAL POINT COORDINATES AND BOUNDARY CONDITIONS (SYMBOL 'F' DESIGNATES FIXED COORDINATE)

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
1				-4.76891	-4.76891	-4.76891
2				0.0	-5.84070	-5.84070
3				4.76891	-4.76891	-4.76891
4				-5.84070	0.0	-5.84070
5				0.0	0.0	-8.26000
6				5.84070	0.0	-5.84070
7				-4.76891	4.76891	-4.76891
8				0.0	5.84070	-5.84070
9				4.76891	4.76891	-4.76891
10				-5.84070	-5.84070	0.0
11				0.0	-8.26000	0.0
12				5.84070	-5.84070	0.0
13				-8.26000	0.0	0.0
14				0.0	0.0	0.0
15				8.26000	0.0	0.0
16				-5.84070	5.84070	0.0
17				0.0	8.26000	0.0
18				5.84070	5.84070	0.0
19				-4.76891	-4.76891	4.76891
20				0.0	-5.84070	5.84070
21				4.76891	-4.76891	4.76891
22				-5.84070	0.0	5.84070
23				0.0	0.0	8.26000
24				5.84070	0.0	5.84070
25				-4.76891	4.76891	4.76891
26				0.0	5.84070	5.84070
27				4.76891	4.76891	4.76891
28				-5.11532	-5.11532	-5.11532
29				-5.69267	-5.69267	-5.69267

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
30				-5.89474	-5.89474	-5.89474
31				0.0	-6.26496	-6.26496
32				0.0	-6.97207	-6.97207
33			F	0.0	-7.21956	-7.21956
34				5.11532	-5.11532	-5.11532
35				5.69267	-5.69267	-5.69267
36				5.89474	-5.89474	-5.89474
37				-6.26496	0.0	-6.26496
38				-6.97207	0.0	-6.97207
39			F	-7.21956	0.0	-7.21956
40				0.0	0.0	-8.85999
41				0.0	0.0	-9.85999
42	F	F	F	0.0	0.0	-10.21000
43				6.26496	0.0	-6.26496
44				6.97207	0.0	-6.97207
45		F	F	7.21956	0.0	-7.21956
46				-5.11532	5.11532	-5.11532
47				-5.69267	5.69267	-5.69267
48				-5.89474	5.89474	-5.89474
49				0.0	6.26496	-6.26496
50				0.0	6.97207	-6.97207
51			F	0.0	7.21956	-7.21956
52				5.11532	5.11532	-5.11532
53				5.69267	5.69267	-5.69267
54				5.89474	5.89474	-5.89474
55				-6.26496	-6.26496	0.0
56				-6.97207	-6.97207	0.0
57				-7.21956	-7.21956	0.0
58				0.0	-8.85999	0.0
59				0.0	-9.85999	0.0
60				0.0	-10.21000	0.0
61				6.26496	-6.26496	0.0
62				6.97207	-6.97207	0.0
63				7.21956	-7.21956	0.0
64				-8.85999	0.0	0.0
65				-9.85999	0.0	0.0
66				-10.21000	0.0	0.0
67				8.85999	0.0	0.0
68				9.85999	0.0	0.0
69				10.21000	0.0	0.0
70				-6.26496	6.26496	0.0
71				-6.97207	6.97207	0.0
72				-7.21956	7.21956	0.0
73				0.0	8.85999	0.0
74				0.0	9.85999	0.0
75				0.0	10.21000	0.0
76				6.26496	6.26496	0.0
77				6.97207	6.97207	0.0
78				7.21956	7.21956	0.0

NODAL POINT	BOUNDARY CONDITIONS X	Y	Z	COORDINATES X	Y	Z
79				-5.11532	-5.11532	5.11532
80				0.0	-6.26496	6.26496
81				5.11532	-5.11532	5.11532
82				-6.26496	0.0	6.26496
83				0.0	0.0	8.85999
84				6.26496	0.0	6.26496
85				-5.11532	5.11532	5.11532
86				0.0	6.26496	6.26496
87				5.11532	5.11532	5.11532

2. CONNECTION ARRAYS

ELEMENT NUMBER	NODAL POINT NUMBERS (ELEMENT POSITIONS, 1 TO 8)								MATERIAL TYPE
1	1	2	5	4	10	11	14	13	1
2	2	3	6	5	11	12	15	14	1
3	4	5	8	7	13	14	17	16	1
4	5	6	9	8	14	15	18	17	1
5	10	11	14	13	19	20	23	22	1
6	11	12	15	14	20	21	24	23	1
7	13	14	17	16	22	23	26	25	1
8	14	15	18	17	23	24	27	26	1
9	2	1	4	5	31	28	37	40	2
10	3	2	5	6	34	31	40	43	2
11	5	4	7	8	40	37	46	49	2
12	6	5	8	9	43	40	49	52	2
13	11	10	1	2	58	55	28	31	2
14	12	11	2	3	61	58	31	34	2
15	15	12	3	6	67	61	34	43	2
16	18	15	6	9	76	67	43	52	2
17	17	18	9	8	73	76	52	49	2
18	16	17	8	7	70	73	49	46	2
19	13	16	7	4	64	70	46	37	2
20	10	13	4	1	55	64	37	28	2
21	20	19	10	11	80	79	55	58	2
22	21	20	11	12	81	80	58	61	2
23	24	21	12	15	84	81	61	67	2
24	27	24	15	18	87	84	67	76	2
25	26	27	18	17	86	87	76	73	2
26	25	26	17	16	85	86	73	70	2
27	22	25	16	13	82	85	70	64	2
28	19	22	13	10	79	82	64	55	2
29	19	20	23	22	79	80	83	82	2
30	20	21	24	23	80	81	84	83	2
31	22	23	26	25	82	83	86	85	2
32	23	24	27	26	83	84	87	86	2
33	31	28	37	40	32	29	38	41	3
34	34	31	40	43	35	32	41	44	3
35	40	37	46	49	41	38	47	50	3
36	43	40	49	52	44	41	50	53	3
37	58	55	28	31	59	56	29	32	3
38	61	58	31	34	62	59	32	35	3
39	67	61	34	43	68	62	35	44	3
40	76	67	43	52	77	68	44	53	3

ELEMENT NUMBER	NODAL POINT NUMBERS (ELEMENT POSITIONS, 1 TO 8)								MATERIAL TYPE
41	73	76	52	49	74	77	53	50	3
42	70	73	49	46	71	74	50	47	3
43	64	70	46	37	65	71	47	38	3
44	55	64	37	28	56	65	38	29	3
45	32	29	38	41	33	30	39	42	4
46	35	32	41	44	36	33	42	45	4
47	41	38	47	50	42	39	48	51	4
48	44	41	50	53	45	42	51	54	4
49	59	56	29	32	60	57	30	33	4
50	62	59	32	35	63	60	33	36	4
51	68	62	35	44	69	63	36	45	4
52	77	68	44	53	78	69	45	54	4
53	74	77	53	50	75	78	54	51	4
54	71	74	50	47	72	75	51	48	4
55	65	71	47	38	66	72	48	39	4
56	56	65	38	29	57	66	39	30	4

3. COMPUTED PARAMETERS FOR THE ELEMENTS

ELEMENT NUMBER	MATERIAL TYPE	VOLUME (CC)	MASS (GRAMS)	CENTROID COORDINATES X	Y	Z
1	1	0.226E 03	0.475E 03	-3.09	-3.09	-3.09
2	1	0.226E 03	0.475E 03	3.09	-3.09	-3.09
3	1	0.226E 03	0.475E 03	-3.09	3.09	-3.09
4	1	0.226E 03	0.475E 03	3.09	3.09	-3.09
5	1	0.226E 03	0.475E 03	-3.09	-3.09	3.09
6	1	0.226E 03	0.475E 03	3.09	-3.09	3.09
7	1	0.226E 03	0.475E 03	-3.09	3.09	3.09
8	1	0.226E 03	0.475E 03	3.09	3.09	3.09
9	2	0.176E 02	0.535E 02	-2.75	-2.75	-6.40
10	2	0.176E 02	0.535E 02	2.75	-2.75	-6.40
11	2	0.176E 02	0.535E 02	-2.75	2.75	-6.40
12	2	0.176E 02	0.535E 02	2.75	2.75	-6.40
13	2	0.176E 02	0.535E 02	-2.75	-6.40	-2.75
14	2	0.176E 02	0.535E 02	2.75	-6.40	-2.75
15	2	0.176E 02	0.535E 02	6.40	-2.75	-2.75
16	2	0.176E 02	0.535E 02	6.40	2.75	-2.75
17	2	0.176E 02	0.535E 02	2.75	6.40	-2.75
18	2	0.176E 02	0.535E 02	-2.75	6.40	-2.75
19	2	0.176E 02	0.535E 02	-6.40	2.75	-2.75
20	2	0.176E 02	0.535E 02	-6.40	-2.75	-2.75
21	2	0.176E 02	0.535E 02	-2.75	-6.40	2.75
22	2	0.176E 02	0.535E 02	2.75	-6.40	2.75
23	2	0.176E 02	0.535E 02	6.40	-2.75	2.75
24	2	0.176E 02	0.535E 02	6.40	2.75	2.75
25	2	0.176E 02	0.535E 02	2.75	6.40	2.75
26	2	0.176E 02	0.535E 02	-2.75	6.40	2.75
27	2	0.176E 02	0.535E 02	-6.40	2.75	2.75
28	2	0.176E 02	0.535E 02	-6.40	-2.75	2.75
29	2	0.176E 02	0.535E 02	-2.75	-2.75	6.40
30	2	0.176E 02	0.535E 02	2.75	-2.75	6.40
31	2	0.176E 02	0.535E 02	-2.75	2.75	6.40
32	2	0.176E 02	0.535E 02	2.75	2.75	6.40
33	3	0.351E 02	0.432E 02	-3.00	-3.00	-7.00
34	3	0.351E 02	0.432E 02	3.00	-3.00	-7.00
35	3	0.351E 02	0.432E 02	-3.00	3.00	-7.00
36	3	0.351E 02	0.432E 02	3.00	3.00	-7.00
37	3	0.351E 02	0.432E 02	-3.00	-7.00	-3.00
38	3	0.351E 02	0.432E 02	3.00	7.00	-3.00
39	3	0.351E 02	0.432E 02	7.00	-3.00	-3.00
40	3	0.351E 02	0.432E 02	7.00	3.00	-3.00

ELEMENT NUMBER	MATERIAL TYPE	VOLUME (CC)	MASS (GRAMS)	CENTROID COORDINATES X	Y	Z
41	3	0.351E 02	0.432E 02	3.00	7.00	-3.00
42	3	0.351E 02	0.432E 02	-3.00	7.00	-3.00
43	3	0.351E 02	0.432E 02	-7.00	3.00	-3.00
44	3	0.351E 02	0.432E 02	-7.00	-3.00	-3.00
45	4	0.141E 02	0.844E 02	-3.22	-3.22	-7.50
46	4	0.141E 02	0.844E 02	3.22	-3.22	-7.50
47	4	0.141E 02	0.844E 02	-3.22	3.22	-7.50
48	4	0.141E 02	0.844E 02	3.22	3.22	-7.50
49	4	0.141E 02	0.844E 02	-3.22	-7.50	-3.22
50	4	0.141E 02	0.844E 02	3.22	-7.50	-3.22
51	4	0.141E 02	0.844E 02	7.50	-3.22	-3.22
52	4	0.141E 02	0.844E 02	7.50	3.22	-3.22
53	4	0.141E 02	0.844E 02	3.22	7.50	-3.22
54	4	0.141E 02	0.844E 02	-3.22	7.50	-3.22
55	4	0.141E 02	0.844E 02	-7.50	3.22	-3.22
56	4	0.141E 02	0.844E 02	-7.50	-3.22	-3.22
	GROUP	0.282E 04	0.661E 04	0.0	0.0	-1.05

SECTION III

COMPUTER SERVICE LISTING IN FORTRAN

LISTING OF SERVICE, WHICH IS WRITTEN IN FORTRAN AND CALLS UPON FACILITIES AND SUBPROGRAMS OF THE IBM OPERATING SYSTEM AND THE CALCOMP PLOTTER. SERVICE SUCCESSFULLY PERFORMS ALL OF THE OPERATIONS REFERRED TO IN THIS REPORT BUT SOME CHANGES MAY BE REQUIRED IN THE STATEMENTS IN ORDER TO USE OTHER FEATURES OF THIS PROGRAM.

```
C
C     DIMENSIONING AND INITIALLIZATION
C
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      REAL MIN1, MIN2, MAX1, MAX2
      READ (5, 10) U, V, NW, IBUG
   10 FORMAT (2F5.0, 2I5)
      WRITE (6, 20) U, V, NW, IBUG
   20 FORMAT (10X, 2F10.2, 2I10)
      CALL GSIZE (U, V, NW)
C
C     INPUT DATA ON SAMPLE
C
      READ (8, 30) NEL, NNP
   30 FORMAT (16I5)
      WRITE (6, 30) NEL, NNP
      READ (8, 40) ((X(I,J), J=1,3), I=1,NNP)
   40 FORMAT (T25, 3G10.0)
      READ (8, 40) ((X(I,J), J=4,6), I=1,NNP)
      WRITE (6, 50) ((X(I,J), J=1,6), I = 1,NNP)
   50 FORMAT (20X, 6F15.3)
   55 FORMAT (I15, 10X, 6F15.3)
      READ (8, 60) ((IC(I,J), J=1,8), I=1,NEL)
```

```
      WRITE (6, 182)
      WRITE(6, 65) (I, (IC(I,J), J=1,8), I=1,NEL)
   60 FORMAT (T1, 8I5)
   65 FORMAT (T5, I5, 10X, 8I5)
      DO 70 I = 1, NNP
      DO 70 J = 1, 3
   70 X(I,J+3) = X(I,J+3) - X(I,J)
      WRITE (6, 183)
      WRITE (6, 55) (I, (X(I,J), J=1,6), I=1,NNP)
  125 FORMAT (20A4)
  130 FORMAT (20X, 20A4/)
  182 FORMAT (//)
  183 FORMAT (///)
C
C     TASK MANAGEMENT
C
  300 READ (5, 80, END=9999) ZZ, TASK, NUM, A
   80 FORMAT (20A4, T1, 2I5, 14G5.0)
      WRITE (6, 85) ZZ
   85 FORMAT (//' TASK, NUM, SPECIFICATIONS ** ', 20A4//)
      IF (TASK .EQ. 380) IBUG = NUM
      IF (TASK .EQ. 395) GO TO 395
      IF (TASK .EQ. 400) CALL S400
      IF (TASK .EQ. 450) CALL S400
      IF (TASK .EQ. 500) CALL S500
      IF (TASK .EQ. 600) CALL S600
      IF (TASK .EQ. 700) CALL S700
      IF (TASK .EQ. 730) CALL S700
      IF (TASK .EQ. 800) CALL S800(V)
      IF (TASK .EQ. 820) CALL S820
      IF (TASK .EQ. 900) CALL S900
      IF (TASK .EQ. 901) CALL S900
      IF (TASK .EQ. 925) CALL S925
      IF (TASK .EQ. 950) CALL S950
      IF (TASK .EQ. 951) CALL S950
      IF (TASK .EQ. 960) CALL S960
      IF (TASK .EQ. 975) CALL S975
      IF (TASK .EQ. 980) CALL S975
      IF (TASK .EQ. 1000) CALL S1000
      IF (TASK .EQ. 1020) CALL S1000
      IF (TASK .EQ. 1200) CALL S1200
      IF (TASK .EQ. 1400) CALL S1400
      IF (TASK .EQ. 1500) CALL S1500
      IF (TASK .EQ. 1600) CALL S1600
      IF (TASK .EQ. 1800) CALL S1800
      IF (TASK .EQ. 1900) CALL S1900
      IF (TASK .EQ. 2000) CALL S2000
      X820 = 0.0
      Y820 = 0.0
      IF (TASK .EQ. 9999) GO TO 9999
      GO TO 300
C
C     PRINTOUT MESSAGE
```

```
C
  395 WRITE (6, 183)
      IF  (NUM .EQ. 0) NUM = 1
      DO 398 I = 1, NUM
      READ (5, 125) BB
  398 WRITE (6, 130) BB
      GO TO 300
 9999 CONTINUE
      CALL PLOT (U, V, 999)
      STOP
      END
      SUBROUTINE NUMB (I,HE)
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      IF(IBUG .GE. 15) WRITE(6,1) I,P(I,1),P(I,2),HE
    1 FORMAT(T5,G15.5)
      CALL NUMBER (P(I,1),P(I,2),HE,FLOAT(I),0,-1)
      RETURN
       END




      SUBROUTINE S400
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      IF (TASK .EQ. 450) GO TO 450
      NUME1=NUM+1
      GO TO (400,5,50,100,200), NUME1
C
C     LOAD ORIGINAL INTO WORKING ARRAY
C
  400 DO 410 I = 1, 3
```

```
  410 A(I) = 1.0
      DO 420 I = 4, 14
  420 A(I) = 0.0
      IF (IBUG .GT. 10) WRITE (6,440) ((W(I,J), J = 1, 3), I = 1,NNP)
      IF (IBUG .GT. 10) WRITE (6, 60) ((IA(I,J), J = 1, 8), I = 1,NEL)
  440 FORMAT (T20, 3G15.4)
C
C     LOAD WORKING ARRAY, ALLOWS EXAGGERATION
C
  450 DO 460 I = 1, NNP
      W(I,4) = 1.0
      DO 460 J = 1, 3
  460 W(I,J) = A(J) * X(I,J)  +  A(J+3) * X(I,J+3)
      DO 470 I = 1, NEL
      NI(I) = I
      DO 470 J = 1, 8
  470 IA(I,J) = IC(I,J)
      NP = NNP
      NL = NEL
      IF (IBUG .GT. 10) WRITE (6,440) ((W(I,J), J = 1, 3), I = 1, NP)
      IF (IBUG .GT. 10) WRITE (6, 60) ((IA(I,J), J = 1, 8), I = 1, NL)
   60 FORMAT (T1, 8I5)
      RETURN
C     EXPANSION & INVERSION
    5 IS=A(4)
      IF=A(5)
      DO 10 I=IS,IF
      DO 10 J=1,3
      W(I,J)=A(J)*(W(I,J)-W(J+5,J))+W(J+5,J)
   10 IF(IBUG.GE.15) WRITE(6,20) I,J,A(J),A(J+5),W(I,J),W(J+5,J)
   20 FORMAT(/,T10,6G15.5)
      RETURN
C     TRANSLATION
   50 IS=A(4)
      IF=A(5)
      DO 61 I=IS,IF
      DO 61 J=1,3
      W(I,J)=W(I,J)+A(J)
   61 IF(IBUG.GE.15) WRITE(6,20) J,J,W(I,J),A(J)
      RETURN
C
C     TO INSERT THE COORDINATE AXES
C
  100 DO 110 I=1,3
      DO 110 J=1,7
  110 W(NP+J,I) = 0.0
      DO 120 I=1,3
      IF(A(I) .EQ. 0.0) A(I)=1.0
      W(NP+I+1,I)=A(I)
  120 W(NP+I+4,I) = W(NP+I+1,I)+A(6)
      ZMIN=W(1,3)
      DO 125 I=2,NP
  125 IF(W(I,3) .LT. ZMIN) ZMIN=W(I,3)
```

```
      IF (A(5) .LT. 0.0) ZMIN = 0.0
      DO 130 I=1,7
  130 W(NP+I,3)=W(NP+I,3)+ZMIN+A(4)
      DO 140 I=1,8
      IA(NL+1,I)=NP+1
  140 IA(NL+2,I)=NP+1
      IA(NL+1,1)=NP+3
      IA(NL+1,5)=NP+3
      IA(NL+1,3)=NP+2
      IA(NL+1,7)=NP+2
      DO 150 I=5,8
  150 IA(NL+2,I)=NP+4
C     TRY IF THE CONNECTION ARRAY IS CORRECT
      DO 151 I=1,8
      WRITE(6,152) IA(NL+1,I)
      WRITE(6,152) IA(NL+2,I)
  151 CONTINUE
  152 FORMAT(//8I5)
C
      DO 155 I=1,2
  155 NI(NL+I)=NL+I
      NP=NP+7
      NL=NL+2
      RETURN
C     TO REMOVE THE COORDINATE AXES.
  200 NL=NL-2
      NP=NP-7
C     TEST OF THE RETURN OF THE NP AND NL
      WRITE(6,201) NL,NP,ZMIN
  201 FORMAT(//2I10,10X,F10.3)
C
      RETURN
      END
```

```
      SUBROUTINE S500
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
C
```

```
C     PROJECT POINTS
C
  500 DV = A(1)
      DO 510 I = 1, NP
  510 IF (DV .LT. W(I,3)) DW = W(I,3) + DV
      IF (DV .NE. A(1)) WRITE (6, 530) DV, A(1)
  530 FORMAT (2E20.5)
      DO 520 I = 1, NP
      D = DV / (DV - W(I,3))
      IF (IBUG .GE. 10) WRITE (6, 1223) D, DV, W(I,3)
      P(I,1) = D * W(I,1)
  520 P(I,2) = D * W(I,2)
      IF (IBUG .GT. 10) WRITE (6, 525) ((P(I,J),J=1,2), I=1,NP)
  525 FORMAT (T15, 2F20.3)
      DO 536 I = 1, NP
      P(I,3) = W(I,3)
  536 P(I,4) = SQRT((DV-W(I,3)) ** 2  +  W(I,2) ** 2  +  W(I,1) ** 2)
      IF (IBUG .GE. 25) WRITE (6, 526) ((P(I,J),J=1,4),I=1,NP), DV
  526 FORMAT (T15, 4E15.4)
 1223 FORMAT (//6E20.6)
      RETURN
      END
```

```
      SUBROUTINE S600
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
C
C     ROTATE
C
  600 A(1) = A(1) * 1.74533E-2
      A(2) = A(2) * 1.74533E-2
      A(3) = A(3) * 1.74533E-2
  605 FORMAT (///3E20.5//3E20.5//3E20.5//)
      DO 610 I = 1, 3
      DO 610 J = 1, 3
      DO 610 K = 1, 3
  610 AA(I,J,K) = 0
      DO 620 K = 1,3
```

```
      DO 620 I = 1,3
  620 AA(I,I,K) = 1
      AA(2,2,1) = COS(A(1))
      AA(3,3,1) = AA(2,2,1)
      AA(1,1,2) = COS(A(2))
      AA(3,3,2) = AA(1,1,2)
      AA(1,1,3) = COS(A(3))
      AA(2,2,3) = AA(1,1,3)
      AA(3,2,1) = -SIN(A(1))
      AA(2,3,1) = -AA(3,2,1)
      AA(3,1,2) = SIN(A(2))
      AA(1,3,2) = -AA(3,1,2)
      AA(2,1,3) = -SIN(A(3))
      AA(1,2,3) = -AA(2,1,3)
      IF (IBUG .GE. 5) WRITE (6, 180)
      IF (IBUG .GE. 5) WRITE (6, 605) AA
      L = 2
  630 DO 640 I = 1, 3
      DO 640 J = 1, 3
      C(J,I) = 0.0
      DO 640 K = 1, 3
  640 C(J,I) = C(J,I)  +  AA(K,I,L-1) * AA(J,K,L)
      IF (L .EQ. 3) GO TO 660
      DO 650 I = 1, 3
      DO 650 J = 1, 3
  650 AA(I,J,2) = C(I,J)
      L = 3
      GO TO 630
  660 CONTINUE
      IF (IBUG .GE. 5) WRITE (6, 605) C
      DO 690 L = 1, NP
      DO 670 I = 1, 3
      T(I) = 0.0
      DO 670 J = 1, 3
  670 T(I) = T(I)  +  C(J,I) * W(L,J)
      DO 680 I = 1, 3
  680 W(L,I) = T(I)
  690 CONTINUE
      IF (IBUG .GT. 10) WRITE (6,440) ((W(I,J), J = 1, 3), I = 1, NP)
  180 FORMAT ('1')
  440 FORMAT (T20, 3G15.4)
      RETURN
      END
```

```
      SUBROUTINE S700
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
```

```
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      IF (TASK .EQ. 730) GO TO 730
C
C     CENTERING
C
  700 MAX1 = -1.0E75
      MAX2 = MAX1
      MIN1 = -MAX1
      MIN2 = MIN1
      DO 710 I = 1, NP
      IF (W(I,1) .GT. MAX1) MAX1 = W(I,1)
      IF (W(I,2) .GT. MAX2) MAX2 = W(I,2)
      IF (W(I,1) .LT. MIN1) MIN1 = W(I,1)
  710 IF (W(I,2) .LT. MIN2) MIN2 = W(I,2)
      C1 = (MAX1  +  MIN1) / 2.0
      C2 = (MAX2  +  MIN2) / 2.0
      IF (IBUG .GT. 10) WRITE (6, 525)  C1, C2, MAX1, MIN1, MAX2, MIN2
      DO 720 I = 1, NP
      W(I,1) = W(I,1) - C1
  720 W(I,2) = W(I,2) - C2
      IF (IBUG .GT. 10) WRITE (6,440) ((W(I,J), J = 1, 3), I = 1, NP)
      RETURN
C
C     SHIFT LEFT AND/OR LOWER THE PROJECTION POINT
C
  730 DO 740 I = 1, NP
      W(I,1) = W(I,1) + A(1)
  740 W(I,2) = W(I,2) + A(2)
      IF (IBUG .GT. 10) WRITE (6,440) ((W(I,J), J = 1, 3), I = 1, NP)
  440 FORMAT (T20, 3G15.4)
  525 FORMAT (T15, 2F20.3)
      RETURN
      END
```

```
      SUBROUTINE S800 (V)
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
```

```
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      COMMON /FRAME/ AH,AW,XB,YB,XX,YY,WW,X820,Y820,XMAX,YMAX,XMIN,YMIN
C
C     SCALE
C
  800 AW = A(1)
      AH = A(2)
      AB = A(3)
      SR = A(4)
      XX = A(5)
      IF(IBUG.GE.15) WRITE(6,1223) A
      IF (AW .LE. 3.0 * AB) AB = 0.0
      IF (AH .LE. 3.0 * AB) AB = 0.0
      IF (SR .EQ. 0.0) SR = 1.0
      YY = (V - AH) / 2.0
      IF (A(6) .GT. 0.0) YY = A(6)
      XB = XX
      YB = YY
      XMAX = -1.0E75
      YMAX = XMAX
      XMIN = -XMAX
      YMIN = XMIN
      DO 810 I = 1, NP
      IF(IBUG.GE.25) WRITE(6,1223) P(I,1),P(I,2)
      IF (P(I,1) .LT. XMIN) XMIN = P(I,1)
      IF (P(I,2) .LT. YMIN) YMIN = P(I,2)
      IF (P(I,1) .GT. XMAX) XMAX = P(I,1)
  810 IF (P(I,2) .GT. YMAX) YMAX = P(I,2)
      XD = XMAX - XMIN
      YD = YMAX - YMIN
      XW = XD / (AW  -  2.0 * AB)
      YH = YD / (AH  -  2.0 * AB)
      WW = 1.0 / YH
      IF (XW .GT. YH) WW = 1.0 / XW
      WW = SR * WW
      XX = XX  + (AW - XD * WW) / 2.0
      YY = YY + (AH - YD * WW) / 2.0
      IF(IBUG.GE.15) WRITE(6,815) XX,XD,XMAX,XMIN,
     *  YY,YD,YMAX,YMIN,WW,SR
  815 FORMAT (//4F15.4//4F15.4, 30X, 2F15.4)
 1223 FORMAT (/6E20.6)
      RETURN
      END
```

```
      SUBROUTINE S820
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      COMMON /FRAME/ AH,AW,XB,YB,XX,YY,WW,X820,Y820,XMAX,YMAX,XMIN,YMIN
C
C     SHIFT OFFSET FACTORS
C
  820 XX = XX + A(1)
      YY = YY + A(2)
      X820 = A(1)
      Y820 = A(2)
      RETURN
      END
```

```
      SUBROUTINE S900
      DIMENSION IP(12,2)
C*********************************************************************
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      COMMON /FRAME/ AH,AW,XB,YB,XX,YY,WW,X820,Y820,XMAX,YMAX,XMIN,YMIN
      DATA IP /1, 2, 3, 4, 5, 6, 7, 8, 1, 2, 3, 4,
     *         2, 3, 4, 1, 6, 7, 8, 5, 5, 6, 7, 8/
C
C     PLOT FIGURE
C
  900 CALL PLOT (XX, YY, -3)
      IF(IBUG.GE.15) WRITE(6,525) XX,YY
  905 FORMAT (// I10, 2F15.3//I10, 2F15.3)
      DO 910 I = 1, NP
```

```
      P(I,1) = (P(I,1) - XMIN) * WW
  910 P(I,2) = (P(I,2) - YMIN) * WW
  915 FORMAT (////' ELEMENT ', I10)
      IF (IBUG .GE. 10) WRITE (6, 525) ((P(I,J),J=1,2), I=1,NP)
      IF (TASK .EQ. 901) GO TO 921
      DO 920 JJ=1,NL
      J=NI(JJ)
      IF (IBUG .GE. 18) WRITE (6, 915) J
      DO 920 I = 1, 12
      I1 = IA(J,IP(I,1))
      I2 = IA(J,IP(I,2))
      IF (IBUG .GE. 18) WRITE (6, 905) I1,P(I1,1),P(I1,2),
     *  I2,P(I2,1),P(I2,2)
      CALL PLOT (P(I1,1), P(I1,2), 3)
  920 CALL PLOT (P(I2,1), P(I2,2), 2)
  921 CALL PLOT (-XX, -YY, -3)
  525 FORMAT (T15, 2F20.3)
      RETURN
      END
```

```
      SUBROUTINE S925
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      COMMON /FRAME/ AH,AW,XB,YB,XX,YY,WW,X820,Y820,XMAX,YMAX,XMIN,YMIN
C
C     ELEMENT NUMBERING SEQUENCE
C
  925 CALL PLOT (XX, YY, -3)
      HE = 0.35
      IF (A(1) .GT. 0.0) HE = A(1)
      DO 940 I = 1, NL
      AB = FLOAT (NI(I))
      XC = 0.0
      YC = 0.0
      DO 930 J = 1, 8
      IF (IBUG.GE. 15)WRITE(6,905)IA(I,J),P(IA(I,J),1),P(IA(I,J),2)
      XC = XC + P(IA(I,J),1)
  930 YC = YC + P(IA(I,J),2)
```

```
      XC = XC / 8.0
      YC = YC / 8.0
      IF (IBUG .GE. 15) WRITE (6, 905) I, XC, YC
      XC = XC + HE / 2.0
      YC = YC - HE / 1.8
      IF (I .GE. 10) XC = XC - HE / 2.0
      IF (I .GE. 100) XC = XC - HE / 2.0
      IF (I .GE. 1000) XC = XC - HE / 2.0
  940 CALL NUMBER (XC, YC, HE, AB, 0, -1)
      CALL PLOT (-XX, -YY, -3)
  905 FORMAT (// I10, 2F15.3//I10, 2F15.3)
      RETURN
      END
```

```
      SUBROUTINE S950
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NMP, NP, NUM
      COMMON /FRAME/ AH,AW,XB,YB,XX,YY,WW,X820,Y820,XMAX,YMAX,XMIN,YMIN
C
C     NODAL POINT NUMBERING SEQUENCE
C
  950 CALL PLOT (XX, YY, -3)
      HE = 0.035
      IF (A(1) .GT. 0.0) HE = A(1)
      NPK = NP
      IF (TASK .EQ. 951) NPK = P(1,3)
      IF (NUM .EQ. 0) GO TO 960
      LIMO = 8 * NL
      NPK = LIMO
      LIML1 = LIMO - 1
      DO 951 I = 1, NL
      J = (I-1) * 8
      DO 951 K = 1, 8
  951 NK(J+K) = IA(I, K)
      DO 954 I = 1, LIML1
      IP1 = I + 1
      DO 954 J = IP1, LIMO
      IF (NK(I) .LE. NK(J)) GO TO 954
```

```
      ITEMP = NK(I)
      NK(I) = NK(J)
      NK(J) = ITEMP
954   CONTINUE
      LIMB = 1
956   DO 957 I = LIMB, LIML1
      IP1 = I + 1
      DO 957 J = IP1, LIMO
      JJ = J
      IF (NK(I) .EQ. NK(J)) GO TO 958
957   CONTINUE
      GO TO 965
958   DO 959 I = JJ, LIML1
959   NK(I) = NK(I+1)
      NPK = NPK - 1
      LIMO = NPK
      LIML1 = LIMO - 1
      LIMB = JJ
      IF (LIML1-LIMB .GE. 0) GO TO 956
      GO TO 965
960   DO 961 I = 1, NPK
961   NK(I) = I
965   DO 970 I = 1, NPK
      XC = P(NK(I), 1)
      YC = P(NK(I), 2)
      XC = XC + HE / 2.0
      YC = YC + HE / 2.0
      AB = FLOAT (NK(I))
970   CALL NUMBER (XC, YC, HE, AB, 0, -1)
      CALL PLOT (-XX, -YY, -3)
      RETURN
      END
```

```
      SUBROUTINE S960
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      COMMON /FRAME/ AH,AW,XB,YB,XX,YY,WW,X820,Y820,XMAX,YMAX,XMIN,YMI
      CALL PLOT (XX, YY, -3)
```

```
      HE = 0.035
      IF (A(1) .GT. 0.0) HE = A(1)
C
C     NUM = 1      INDIVIDUAL NODAL POINTS
C     NUM = 2      SELECT NODAL POINTS BY 3 DO-LOOP PARAMETERS
C     NUM = 3      SELECT SPECIFIC NODAL POINTS OR CONTIGUOUS NODAL
C                  POINT STRINGS
C     NUM = 4      SELECT SPECIFIC NODAL POINTS AND PLOT THE CHARACTERS
C     NUM = 5      TERMINATE
C     NUM = 6      SELECT AND PLOT ELEMENT NUMBER INDIVIDUALLY
C
      GO TO 1610
 1640 READ(5,1604) ZZ,TASK,NUM,A
 1604 FORMAT(20A4,T1,2I5,14G5.0)
      WRITE(6,1603) ZZ
      IF(NUM .EQ. 0) GO TO 300
 1610 GO TO (1620, 100, 1660, 50, 300, 400), NUM
C
 1620 READ(5,1602) ZZ,A
      WRITE(6,1603) ZZ
      DO 1625 I=1, 14
      IF (IBUG .GE. 15) WRITE (6,1601) I,A(I)
 1625 CALL NUMB (IFIX(A(I)),HE)
      GO TO 1640
  100 READ(5,1602) ZZ,A
      WRITE(6,1603) ZZ
      NA1 = A(1)
      NA2 = A(2)
      NA3 = A(3)
      DO 110 I = NA1, NA2, NA3
      IF (IBUG .GE. 15) WRITE (6,1601) I,A(I)
  110 CALL NUMB (IFIX(A(I)),HE)
      GO TO 1640
 1660 READ(5,1602) ZZ ,A
      WRITE(6,1603) ZZ
      DO 1645 I=1, 14
      IF (A(I)) 1645,1640,1641
 1641 IF (I .EQ. 14) GO TO 1642
      IF (A(I+1) .GE. 0.0) GO TO 1642
      NA1= A(I)
      NA2 = -A(I+1)
      IF (NA2 .LT. NA1) GO TO 1645
      DO 1644 J= NA1, NA2
      IF (IBUG .GE. 15) WRITE (6,1601) J,A(J)
 1644 CALL NUMB (IFIX(A(J)),HE)
 1642 IF (IBUG .GE. 15) WRITE (6,1601) I,A(I)
      CALL NUMB (IFIX(A(I)),HE)
 1645 CONTINUE
      GO TO 1640
   50 READ(5,51) ZZ,(A(I),I=1,14)
   51 FORMAT(20A4,T1,7(F6.0,A4))
      WRITE(6,1603) ZZ
      DO 52 I=1,14,2
```

```
      IF (A(I) .EQ. 0.0) GO TO 1640
      IF (IBUG .GE. 15) WRITE (6,1601) I,A(I)
   52 CALL SYMBOL (P(IFIX(A(I)),1),P(IFIX(A(I)),2),HE,A(I+1),0,4)
      GO TO 1640
C
C
C     SELECT ELEMENT NUMBER
C
  400 READ (5,1602) ZZ,A
      WRITE(6,1603) ZZ
      NEL=A(1)
      IF (NEL .LE. 0) GO TO 1640
      IAN=IA(NEL,1)
      SUMX=P(IAN,1)
      SUMY=P(IAN,2)
      DO 410 I=2,8
      IAN=IA(NEL,I)
      SUMX=SUMX+P(IAN,1)
  410 SUMY=SUMY+P(IAN,2)
      SUMX=SUMX/8.0
      SUMY=SUMY/8.0
      IF (IBUG .GE. 15) WRITE (6,1605) SUMX, SUMY, HE, IAN, NEL
 1605 FORMAT(10X,3F20.5,2I10)
      CALL NUMBER(SUMX,SUMY,HE,FLOAT(NEL),0,-1)
      GO TO 400
 1601 FORMAT(/I10,20X,F20.5)
 1602 FORMAT(20A4,T1,14G5.0)
 1603 FORMAT(T10,20A4)
  300 CALL PLOT (-XX,-YY,-3)
      RETURN
      END
```

```
      SUBROUTINE S975
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      COMMON /FRAME/ AH,AW,XB,YB,XX,YY,WW,X820,Y820,XMAX,YMAX,XMIN,YMIN
      IF (TASK .EQ. 980) GO TO 980
C
```

```
C     BORDER DRAWING SEQUENCE
C
  975 CALL PLOT (XB, YB, -3)
      CALL PLOT(0.0, 0.0, 3)
      CALL PLOT(AW, 0.0, 2)
      CALL PLOT(AW, AH, 2)
      CALL PLOT(0.0, AH, 2)
      CALL PLOT(0.0, 0.0, 2)
      CALL PLOT(-XB, -YB, -3)
      RETURN
C
C     BORDER TO ENCLOSE STEREO PAIR (CALL AFTER 820 COMMAND)
C
  980 CALL PLOT(XB, YB, -3)
      AW = AW + X820
      AH = AH+Y820
      CALL PLOT(0.0, Y820, 3)
      CALL PLOT(AW, Y820, 2)
      CALL PLOT(AW, AH, 2)
      CALL PLOT(0.0, AH, 2)
      CALL PLOT(0.0, Y820, 2)
      CALL PLOT(-XB, -YB, -3)
      RETURN
      END





      SUBROUTINE S1000
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      IF (TASK .EQ. 1020) GO TO 1020
C
C     DIRECT SPECIFICATION OF REGION FOR AMPLIFICATION
C
 1000 CONTINUE
      DO 1010 I = 1, 6
 1010 BOR(I) = A(I)
      IF (IBUG .GE. 10) WRITE (6, 1223) BOR
      GO TO 1100
C
```

```
C     SELECTION FOR AMPLIFICATION ABOUT NODAL POINT
C
 1020 DO 1030 I = 1, 3
      IF (A(2*I-1) .EQ. 0.0) A(2*I-1) = A(1)
      IF (A(2*I) .EQ. 0.0) A(2*I) = A(2)
      BOR(2*I-1) = W(NUM,I) - A(2*I-1)
 1030 BOR(2*I) = W(NUM,I) + A(2*I)
      IF (IBUG .GE. 10) WRITE (6, 1223) BOR
      GO TO 1100
C
C     SELECTION FOR AMPLIFICATION
C
 1100 NC = 0
      DO 1101 I=1,NNP
      W(I,4) = 1.0
 1101 IF (IBUG .GE. 10) WRITE (6, 1223)  (W(I,J), J=1,4)
      IF (IBUG .GE. 10) WRITE (6, 1223) EXT
      DO 1150 I = 1, NEL
      DO 1130 J = 1, 8
      DO 1163 K = 1, 3
      XI = I
      XJ = J
      XK = K
      IF (IBUG .GE. 10) WRITE (6,1223)W(IA(I,J),K), BOR(2*K-1),BOR(2*K),
     *  XI, XJ, XK
 1162 CONTINUE
      IF (W(IA(I,J),K) .LT. BOR(2*K-1)) GO TO 1130
      IF (W(IA(I,J),K) .GT. BOR(2*K)) GO TO 1130
 1163 CONTINUE
      GO TO 1135
 1130 CONTINUE
      IF (IBUG .GE. 10) WRITE (6, 40) I
      GO TO 1150
 1135 NC = NC + 1
      NI(NC) = I
      IF (IBUG .GE. 10) WRITE (6, 40) NC, I
C
C
      DO 1140 J = 1, 8
      IA(NC,J) = IA(I,J)
      DO 1140 K = 1, 3
 1140 W(IA(I,J),4) = -1.0
      IF (IBUG .GE. 10) WRITE (6, 1223) EXT
 1150 CONTINUE
      IF (NC .EQ. 0) GO TO 300
      DO 1155 I = 1, 3
 1155 EXT(I) = W(IA(1,1),I)
      IF (IBUG .GE. 10) WRITE (6, 1223) ((W(I,J), J=1,3),I=1,NNP)
      NL = NC
      DO 1165 I = 1, NP
      IF (W(I,4) .LT. 0.0) GO TO 1165
      DO 1160 J = 1, 3
 1160 W(I,J) = EXT(J)
```

```
 1165 CONTINUE
      DO 1170 I=1,NNP
 1170 IF (IBUG .GE. 10) WRITE (6, 1223) (W(I,J), J=1,4)
      IF (IBUG .GE. 10) WRITE (6, 40) (NI(I),(IA(I,J),J=1,2),I=1,NL)
   40 FORMAT (T25, 3G10.0)
 1223 FORMAT (//6E20.6)
  300 RETURN
      END
```

```
      SUBROUTINE S1200
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      DATA IP /1, 2, 3, 4, 5, 6, 7, 8, 1, 2, 3, 4,
     *         2, 3, 4, 1, 6, 7, 8, 5, 5, 6, 7, 8/
C
C     SORT EDGES (AFTER 500 TASK)
C
 1200 LIMO = 12 * NL
      LIMB = 1
      LIML1 = LIMO - 1
      DO 1210 I = 1, NP
 1210 P(I,3) = FLOAT(NP)
      DO 1201 I = 1, NL
      J = (I-1) * 12
      DO 1201 K = 1, 12
      JK = J + K
      IE (J+K, 1) = IA (I, IP(K,1))
      IE (J+K, 2) = IA (I, IP(K,2))
      IF (P(IE(J+K,1),4) .LT. P(IE(J+K,2),4)) GO TO 1201
      ITEMP = IE(J+K, 1)
      IE (J+K, 1) = IE (J+K,2)
      IE (J+K, 2) = ITEMP
 1201 IF (IBUG .GE. 25) WRITE (6, 1202) I, K, JK,
     *  IE (J+K, 1), IE (J+K, 2), P(IE(J+K,1),4), P(IE(J+K,2),4)
 1202 FORMAT (/5I5, 2E20.6)
C     IDENTIFICATION OF DUPLICATE EDGES
 1203 DO 1212 I = LIMB, LIML1
      IP1 = I + 1
```

```
      DO 1212 J = IP1, LIMO
      IF (IE(I,1) - IE(J,1)) 1205, 1204, 1205
 1204 IF (IE(I,2) - IE (J,2)) 1205, 1213, 1205
 1205 DO 1208 M = 1, 2
      DO 1208 L = 1, 3
      IF (W(IE(I,M),L) .NE. W(IE(J,M),L)) GO TO 1209
 1208 CONTINUE
      GO TO 1213
 1209 IF (P(IE(J,1),4) - P(IE(I,1),4)) 1207, 1206, 1212
 1206 IF (P(IE(J,2),4) - P(IE(I,2),4)) 1207, 1212, 1212
 1207 DO 1211 K = 1, 2
      ITEMP = IE (I, K)
      IE (I, K) = IE (J, K)
 1211 IE (J, K) = ITEMP
 1212 IF (IBUG .GE. 55) WRITE (6, 1202) I, J, LIMB
      GO TO 1215
C     ELIMINATION ROUTINE
 1213 LIMB = I
      IF (IBUG .GE. 45) WRITE (6, 1202) LIMB, LIMO, LIML1,
     *  IE(I,1), IE(J,1), P(IE(I,1),4), P(IE(J,1),4),
     *  LIMB, LIMO, LIML1,
     *  IE(I,2), IE(J,2), P(IE(I,2),4), P(IE(J,2),4)
      LIMO = LIMO - 1
      LIML1 = LIMO - 1
      DO 1214 I = J, LIMO
      IE (I, 1) = IE (I+1, 1)
 1214 IE (I, 2) = IE (I+1, 2)
      IF (LIML1 - LIMB .GE. 0) GO TO 1203
 1215 IF (IBUG .GE. 5) WRITE (6, 1202) LIMO
      IF (IBUG .GE. 15) WRITE (6, 40) (I, (IE(I,J),J=1,2),I=1,LIMO)
C
C     PRINCIPAL OVERLAP SEQUENCE
C
      IF (IBUG .GE. 35) WRITE (6, 526) ((P(K,L),L=1,4),K=1,NP)
      DEL = 0.1
      IF (A(1) .GT. 0.0) DEL = A(1)
      IRES = 0
      LIMB = 1
 1216 DO 1275 I = LIMB, LIML1
      IF (IBUG .EQ.  4) WRITE (6, 1733)
     *  (M, (IE(M,K), (P(IE(M,K),L), L = 1,2), K = 1,2), M=1,LIMO)
      IF (IBUG .GE. 5) WRITE (6, 1266) I, LIMO, NP
      IF (LIMB .GT. LIML1) GO TO 300
 1266 FORMAT ('1NEAR SEGMENT IS NUMBER', I5,
     *    '            TOTAL NUMBER OF SEGMENTS IN LIST =', I5,
     *    '            NUMBER OF NODAL POINTS =', I5////)
      IP1 = I + 1
      IF (IRES .GT. 0) IP1 = IRES
      DO 1275 J = IP1, LIMO
      IRES = 0
      IF (IBUG .GE. 35) WRITE (6, 1267) J
      IF (IBUG .GE. 35) WRITE (6, 526) ((P(K,L),L=1,4),K=1,NP)
      IF (IBUG .GE. 5) WRITE (6, 1267) J
```

```
 1267 FORMAT (//' FAR SEGMENT IS', I5//)
C     TEST FOR CONTACT (SEGMENTS MAY TOUCH)
      DO 1700 K = 1, 2
      DO 1700 L = 1, 2
      IF (IE(I,K) .EQ. IE(J,L)) GO TO 1275
 1700 CONTINUE
      DC = 0.0
      DD = 0.0
      DC1 = 0.0
      DD1 = 0.0
C     CALCULATE SLOPES ON PROJECTION PLANE FOR THE PURPOSE OF ROTATION
      SAY = P(IE(I,2),2) - P(IE(I,1),2)
      SAX = P(IE(I,2),1) - P(IE(I,1),1)
      SBY = P(IE(J,2),2) - P(IE(J,1),2)
      SBX = P(IE(J,2),1) - P(IE(J,1),1)
      IF (ABS(SAX) .LE. 1.0E-5) GO TO 1217
      SA = SAY / SAX
      GO TO 1218
 1217 SA = 1.0E75 * SAY / ABS(SAY)
 1218 IF (ABS(SBX) .LE. 1.0E-5) GO TO 1219
      SB = SBY / SBX
      GO TO 1220
 1219 SB = 1.0E75 * SBY / ABS(SBY)
 1220 IF (IBUG .GE. 25) WRITE (6, 1223) SAY,SAX,SBY,SBX,SA,SB
      DA = SQRT (SAX * SAX  +  SAY * SAY)
      DB = SQRT (SBX * SBX  +  SBY * SBY)
      IF (IBUG .GE. 35) WRITE (6, 1223) SAX, DA
      IF (IBUG .GE. 35) WRITE (6, 1223) SAY, DA
      IF (IBUG .GE. 35) WRITE (6, 1223) SBX, DB
      IF (IBUG .GE. 35) WRITE (6, 1223) SBY, DB
C     ROTATE FAR INTO ALIGNMENT WITH THE X-AXIS
C     USE TEMPORARY ARRAY (THE ORIGINAL IS NOT ALTERED HERE)
      SAX = SAX / DA
      SAY = SAY / DA
      SBX = SBX / DB
      SBY = SBY / DB
      DO 1221 K = 1, 2
      TE(K,1) = SBX * P(IE(I,K),1)  +  SBY * P(IE(I,K),2)
      TE(K+2,1) = SBX * P(IE(J,K),1)  +  SBY * P(IE(J,K),2)
      TE(K,2) = -SBY * P(IE(I,K),1)  +  SBX * P(IE(I,K),2)
 1221 TE(K+2,2) = -SBY * P(IE(J,K),1)  +  SBX * P(IE(J,K),2)
      IF (IBUG .GE.  5) WRITE (6, 1223) ((TE(K,L),L=1,2),K=1,4)
      TE3 = TE(3,1)
      TE4 = TE(4,1)
      SAA = ABS(SA)
      SDD = SAA
      SBB = ABS(SB)
      IF (SBB .GT. SDD) SDD = SBB
      IF (SDD .LT. 1.0E-5) SDD = 1.0
      IF (ABS(SBB-SAA)/SDD .GT. 1.0E-2) GO TO 1234
C     PARALLEL SEGMENT SEQUENCE
      SEP = ABS (TE(1,2) - TE(3,2))
      IF (IBUG .GE. 25) WRITE (6, 1223) ((TE(K,L),L=1,2),K=1,4), SEP
```

```
      IF (SEP .GE. DEL) GO TO 1275
C     SEQUENCE ALIGNMENT TEST  -  CORRECT NEAR IF NECESSARY
      IF ((TE(4,1)-TE(3,1))/(TE(2,1)-TE(1,1)) .GT. 0.0) GO TO 1222
      TEMP = TE(2,1)
      TE(2,1) = TE(1,1)
      TE(1,1) = TEMP
      IF (IBUG .GE. 25) WRITE (6, 1223) ((TE(K,L),L=1,2),K=1,4)
 1222 CONTINUE
C     CALCULATE BASIC ADJUSTMENT LENGTH (CUT)
C     ADJUST NEAR
      CUT = SQRT(DEL*DEL  -  SEP*SEP)
      IF (TE(1,1) .GT. TE(2,1)) CUT = -CUT
      TE(1,1) = TE(1,1) - CUT * 1.1
      TE(2,1) = TE(2,1) + CUT * 1.1
 1236 IF (IBUG .GE. 15) WRITE (6, 1223) (TE(K,1), K = 1, 4), CUT
C     TEST NATURE OF OVERLAP
      IF (CUT*TE(2,1) .LE. CUT*TE(3,1)) GO TO 1275
      IF (CUT*TE(1,1) .GE. CUT*TE(4,1)) GO TO 1275
      IF (CUT*TE(1,1) .LE. CUT*TE(3,1)) GO TO 1226
      IF (CUT*TE(2,1) .LT. CUT*TE(4,1)) GO TO 1228
      INCR = 0
      TE(4,1) = TE(1,1)
      MISS = 4
      GO TO 1233
 1224 INCR = -1
      MISS = J
      IF (IBUG .EQ.  4) WRITE (6, 1266) I, LIMO, NP
      IF (IBUG .EQ.  4) WRITE (6, 1267) J
      IF (IBUG .EQ.   4) WRITE (6, 1733)
     *  (M, (IE(M,K), (P(IE(M,K), L), L = 1,2), K=1,2), M=1,LIMO)
      IF (IBUG .EQ.  4) WRITE (6, 1223) ((TE(K,L),L=1,2),K=1,4),SBX, SBY
      IF (IBUG .EQ.  4) WRITE (6, 1223) TE3, TE4, SAA, SBB, SDD, SEP
      IF (IBUG .EQ.  4) WRITE (6, 1223) DA, DB, DC, DD, CR,T1,T2,T3,T4
      IF (IBUG .EQ.  4) WRITE (6, 1223) (TE(K,1),K=1,4),CUT,DC1,DD1,DC
      IF (IBUG .EQ.  4)
     *WRITE (6, 1223) CR,((P(IE(I,K),L),L=1,2),K=1,2),
     *                    ((P(IE(J,K),L),L=1,2),K=1,2)
      IF (IBUG .EQ.  4) WRITE (6, 40) INCR, MISS, J
      GO TO 1233
 1226 IF (CUT*TE(2,1) .GE. CUT*TE(4,1)) GO TO 1224
      INCR = 0
      TE(3,1) = TE(2,1)
      MISS = 3
      GO TO 1233
 1228 INCR = 1
      MISS = J
      TE(6,1) = TE(2,1)
      TE(5,1) = TE(1,1)
      TE(6,2) = TE(2,2)
      TE(5,2) = TE(1,2)
 1233 IF (IBUG .GE. 15) WRITE (6, 40) INCR, MISS, J
      IF (INCR) 1360, 1272, 1360
 1223 FORMAT (//6E20.6)
```

```
C
C     X-T-L SEQUENCE FOLLOWS
C     IMPLEMENTED BY AN EQUIVELANT PARALLEL SEGMENT ROUTINE
C
 1234 T1 = TE(1,1)
      T2 = TE(2,1)
      T3 = TE(3,1)
      T4 = TE(4,1)
      IF (T2 .GE. T1) GO TO 1240
      TEMP = T1
      T1 = T2
      T2 = TEMP
 1240 IF (T4 .GE. T3) GO TO 1241
      TEMP = T3
      T3 = T4
      T4 = TEMP
 1241 IF (T2 .LT. T3-DEL/4.0) GO TO 1275
      IF (T4 .LT. T1-DEL/4.0) GO TO 1275
      IF (ABS(TE(2,2) - TE(1,2)) .LE. 1.0E-5) GO TO 1237
      CR=TE(1,1)+(TE(3,2)-TE(1,2))*(TE(2,1)-TE(1,1))/(TE(2,2)-TE(1,2))
      GO TO 1238
 1237 CR = TE(1,1)
 1238 IF (IBUG .GE. 15) WRITE (6, 1223) ((TE(K,L),L=1,2),K=1,2),
     *  (TE(K,1),K=3,4), TE(3,2), CR
      DC = SQRT((CR-TE(1,1))**2 + (TE(3,2)-TE(1,2))**2)
      DD = SQRT((CR-TE(2,1))**2 + (TE(3,2)-TE(2,2))**2)
      DC1 = DC
      DD1 = DD
      IF (ABS(DC+DD-DA) .LE. 1.0E-5) GO TO 1235
 1715 IF (IBUG .GE. 15) WRITE (6, 1223) DA, DB, DC, DD
      DC = ABS(TE(1,2) - TE(3,2))
      DD = ABS (TE(2,2) - TE(3,2))
      IF (DC .GT. DD) DC = DD
      IF (DC .GT. DEL) GO TO 1275
C     T-L APPROXIMATION OF THE EQUIVELANT SEGMENT
 1720 CUT = SQRT (DEL*DEL - DC*DC)
      CR = TE(1,1)
      IF (DC .EQ. DD) CR = TE(2,1)
      GO TO 1730
C     THE X COMPUTATION OF THE EQUIVELANT SEGMENT
 1235 TEX = TE(2,1)  -  TE(1,1)
      TEY = TE(2,2)  -  TE(1,2)
      TEH = SQRT (TEX * TEX  +  TEY * TEY)
      CUT = DEL * TEH / TEY
      CUT = ABS(CUT)
      TE(1,2) = TE(3,2)
      TE(2,2) = TE(3,2)
 1730 TE(1,1) = CR - CUT * 1.1
      TE(2,1) = CR + CUT * 1.1
      IF (IBUG .GE. 15) WRITE (6, 1223) ((TE(K,L),L=1,2),K=1,2), CUT,
     *  DC, DD, DA, CR, CUT
      GO TO 1236
C
```

```
C     SCALE PROJECTION DISTANCE
 1272 NP = NP + 1
      MISSL2 = MISS - 2
      TEMP = P(IE(J,1),4)
      PIE4 = P(IE(J,2),4) - P(IE(J,1),4)
      P(NP,4) = TEMP + (TE(MISS,1)-TE3) * PIE4 / (TE4-TE3)
C     ROTATE BACK (INCR = 0)
      P(NP,1) = SBX * TE(MISS,1) - SBY * TE(MISS,2)
      P(NP,2) = SBY * TE(MISS,1) + SBX * TE(MISS,2)
C     STORE COORDINATES
      P(NP,3) = 0.0
      IE(J,MISSL2) = NP
      DO 1250 K = 1, LIMO
      IF (P(IE(J,1),4) - P(IE(K,1),4)) 1251, 1251, 1250
 1251 IF (P(IE(J,2),4) - P(IE(K,2),4)) 1252, 1252, 1250
 1250 CONTINUE
      GO TO 1275
 1252 DO 1253 L = 1, 2
      ITEMP = IE(J,L)
      IE(J,L) = IE(K,L)
 1253 IE(K,L) = ITEMP
      IF (IBUG .GE. 10) WRITE (6, 440) (IE(J,K),K=1,2), MISS, MISSL2,
     *  NP, ((P(IE(J,K),L),L=1,4),K=1,2)
 1275 CONTINUE
      RETURN
C
C     SEQUENCE TO ADJUST LIST
C
 1360 LIMB = I
      IRES = J + 1
      LIMO = LIMO + INCR
      LIML1 = LIMO - 1
      IF (INCR) 1370, 1216, 1380
 1370 IRES = IRES - 1
      DO 1371 K = MISS, LIMO
      IF (IRES .LE. LIMO) GO TO 1372
      IRES = 0
      LIMB = LIMB + 1
 1372 CONTINUE
      DO 1371 L = 1, 2
 1371 IE(K, L) = IE(K+1, L)
      IF (IBUG .NE.  4) GO TO 1385
      WRITE (6, 40) LIMB, IRES, LIMO, LIML1, INCR, NP, MISS
      WRITE (6,40) (I, (IE(I,J),J=1,2),I=1,LIMO)
      WRITE (6,526) ((P(K,L),L=1,4),K=1,NP)
 1385 CONTINUE
      IF (MISS .LT. LIMO) GO TO 1216
      RETURN
 1380 NP = NP + 2
C     SCALE PROJECTION DISTANCE
      TEMP = P(IE(MISS, 1), 4)
      PIE4 = P(IE(MISS, 2), 4) - TEMP
      DO 1381 K = 1, 2
```

```
      P(NP-2+K,3) = 0.0
 1381 P(NP-2+K,4) = TEMP + (TE(K+4,1)-TE3) * PIE4 / (TE4-TE3)
C     IDENTIFY NEW SEGMENT IN EDGE ARRAY
      IE(LIMO,1) = NP
      IE(LIMO,2) = IE(MISS,2)
      IE(MISS,2) = NP - 1
      IF (P(IE(LIMO,1),4) .LT. P(IE(LIMO,2),4)) GO TO 1395
      ITEMP = IE(LIMO,1)
      IE(LIMO,1) = IE(LIMO,2)
      IE(LIMO,2) = ITEMP
 1395 IF (P(IE(MISS,1),4) .LT. P(IE(MISS,2),4)) GO TO 1796
      ITEMP = IE(MISS,1)
      IE(MISS,1) = IE(MISS,2)
      IE(MISS,2) = ITEMP
 1796 CONTINUE
C     ROTATE BACK
      DO 1383 K = 5, 6
      J = K - 4
      TE(J,1) = SBX * TE(K,1)  -  SBY * TE(K-2,2)
 138   E(J,2) = SBY * TE(K,1)  +  SBX * TE(K-2,2)
      DO 1382 K = 1, 2
      P(IE(MISS,2),K) = TE(1,K)
 1382 P(IE(LIMO,1),K) = TE(2,K)
      IF (IBUG .GE. 20) WRITE (6, 1223) ((TE(K,L),L=1,2),K=1,2),
     *  (P(IE(MISS,2),K),K=1,2), (P(IE(LIMO,1),K),K=1,2)
C     STORE COORDINATES
C     RELOCATE SECOND SEGMENT
      MISS = MISS + 1
      DO 1386 I = 1, LIML1
      IF (P(IE(LIMO,1),4) - P(IE(I,1),4)) 1388, 1388, 1386
 1388 IF (P(IE(LIMO,2),4) - P(IE(I,2),4)) 1387, 1387, 1386
 1386 CONTINUE
      GO TO 1390
 1387 IE(LIMO+1,1) = IE(LIMO,1)
      IE(LIMO+1,2) = IE(LIMO,2)
      DO 1389 JJ = I, LIML1
      J = LIML1 + I - JJ
      DO 1389 K = 1, 2
 1389 IE(J+1,K) = IE(J,K)
      IE(I,1) = IE(LIMO+1,1)
      IE(I,2) = IE(LIMO+1,2)
      GO TO 1390
 1390 CONTINUE
      IF (IBUG .GE. 15) WRITE (6, 1391)  LIMB, MISS
 1391 FORMAT (//' END OF ADJUSTMENT ROUTINE,   LIMB = ',I5,
     *  '              MISS = ', I5/)
      IF (IBUG .GE. 10) WRITE (6, 1733)
     *  (I, (IE(I,K), (P(IE(I,K), J), J = 1,2), K=1,2), I=1,LIMO)
 1733 FORMAT (/I10, I15, 2F7.3, I15, 2F7.3)
      IF (IBUG .GE. 15) WRITE (6, 40) (I, (IE(I,J),J=1,2),I=1,LIMO)
      IF (IBUG .GE. 25) WRITE (6, 1223) ((TE(I,J),J=1,2),I=1,6)
      IF (IBUG .GE. 35) WRITE (6, 526) ((P(K,L),L=1,4),K=1,NP)
      IF (LIMB .LT. LIML1) GO TO 1216
```

```
      IF (IBUG .GE. 10) WRITE (6, 440) (IE(J,K),K=1,2), MISS, MISSL2,
     *  ((P(IE(J,K),L),L=1,4),K=1,2)
   40 FORMAT (T25, 3G10.0)
  440 FORMAT (T20, 3G15.4)
  526 FORMAT (T15, 4E15.4)
  300 RETURN
      END
```

```
      SUBROUTINE S1400
C     TO PRODUCE A SET OF POLYGONS THAT COINCIDE WITH A SPECIFIED PLANE
C     (ORIENTATION AND POSITION) THROUGH A THREE DIMENSIONAL FINITE
C     ELEMENT STRUCTURE.  THE SET WILL BE RETAINED IN THE ORIGINAL
C     ORIENTATION AND POSITION.
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      DIMENSION EC(6, 4, 3), FC(4, 3), IW(6,4), JF(4, 2)
      DATA IW /1, 1, 2, 3, 4, 5,
     *         2, 2, 3, 4, 1, 6,
     *         3, 6, 7, 8, 5, 7,
     *         4, 5, 6, 7, 8, 8/
      DATA JF /1, 2, 3, 4,
     *         2, 3, 4, 1/
C
C     TRANSLATIONS
C
      NUMP1 = NUM + 1
      GO TO (190, 10, 100, 150, 170), NUMP1
C
C     SECTION PASSES THROUGH NODAL POINT
C
   10 NUM = A(1)
      SET = W(NUM, 3)
      GO TO 190
C
C     SECTION PASSES THROUGH CENTER OF ELEMENT
C
  100 NUM = A(1)
      SET = W(IA(NUM, I), 3)
```

```
      DO 110 I = 2, 8
  110 SET = SUM + W(IA(NUM, I), 3)
      SET = SET / 8.0
       GO TO 190
C
C     SECTION PASSES THROUGH SPECIFIED POINT ON Z-AXIS
C
  150 SET = A(1)
      GO TO 190
C
C     SECTION PASSES BETWEEN TWO NODAL POINTS
C
  170 IF (A(3) .EQ. 0.0) A(3) = 0.5
      SET = A(3) * W(IFIX(A(1)), 3) + (1.0 - A(3)) * W(IFIX(A(2)), 3)
      GO TO 190
  190 DO 200 I = 1, NP
  200 W(I, 3) = W(I, 3) - SET
      INDEX = 0
      DO 500 II = 1, NL
      I = NI(I)
      IF (IBUG .GE. 15) WRITE (6, 1000) II, I
 1000 FORMAT ('1SELECTION ', I3, ' IS ELEMENT NUMBER ', I3//)
      TOUCH = 0.0
      IF (W(IA(I,1),3)) 210, 250, 220
  210 TOUCH = -1.0
      GO TO 230
  220 TOUCH = 1.0
  230 DO 240 J = 2, 8
      IF (TOUCH * W(IA(I,J),3)) 250, 250, 240
  240 CONTINUE
      GO TO 500
 1010 FORMAT (/F5.1, ' SYSTEM POINTS ', 2I15/)
  250 IF (IBUG .GE. 15) WRITE (6, 1010) TOUCH, IA(2,1), IA(I,J)
      DO 410 J = 1, 6
      IF (IBUG .GE. 15) WRITE (6, 1020) J
 1020 FORMAT (/' SIDE ', I3)
      DO 280 K = 1, 4
      DO 260 L = 1, 3
  260 EC(J, K, L) = 0.0
      INP = IA(I, IW(J, K))
      DO 280 L = 1, 3
  280 FC(K,L) = W(INP, L)
      NB = 0
      DO 330 L = 1, 4
      IF (FC(JF(L,1),3) * FC(JF(L,2),3)) 290, 310, 330
  290 NB = NB + 1
      FAC = FC(JF(L,1),3) / (FC(JF(L,1),3) - FC(JF(L,2),3))
      DO 300 M = 1, 2
  300 EC(J, NB, M) = FC(JF(L,1),M) + FAC * (FC(JF(L,2),M)-FC(JF(L,1),M))
      EC(J, NB, 3) = 2.0
      GO TO 330
  310 NB = NB + 1
      JFL = 1
```

```
      IF (FC(JF(L,2),3) .EQ. 0.0) JFL = 2
      DO 320 M = 1, 2
  320 EC(J, NB, M) = FC(JF(L,JFL),M)
      EC(J, NB, 3) = 2.0
  330 IF (IBUG .GE. 15) WRITE (6, 1030) I, NB, JFL, L, J, FAC,FC
 1030 FORMAT (T5, 6G20.6)
      NBP1 = NB + 1
      GO TO (410, 340, 360, 360, 360), NBP1
  340 DO 350 K = 1, 3
  350 EC(J, 1, K) = 0.0
      GO TO 410
  360 NBL1 = NB - 1
      DO 400 K = 1, NBL1
      KP1 = K + 1
      DO 400 KB = KP1, NB
      DO 370 L = 1, 2
      IF (EC(J, K, L) - EC(J, KB, L)) 400, 370, 400
  370 IF (IBUG .GE. 15) WRITE (6, 1030) I, NB, J, KB, K, L
      DO 380 L = KB, NBL1
      DO 380 M = 1, 3
  380 EC(J, L, M) = EC(J, L+1, M)
      DO 390 L = 1, 3
  390 EC(J, NB, L) = 0.0
  400 IF (IBUG .GE. 15) WRITE (6, 1030) EC, J, KB
  410 CONTINUE
      DO 430 J = 1, 6
      IF (EC(J, 2, 3) .NE. 0.0) GO TO 416
      DO 415 K = 1, 3
  415 EC(J, 1, K) = 0.0
  416 DO 420 K = 1, 3
  420 EC(J, 3, K) = EC(J, 1, K)
  430 CONTINUE
      IF (IBUG .GE. 15) WRITE (6, 1030) EC
      INDEX = INDEX + 1
      DO 445 LF = 1, 6
      IF (EC(1, 1, 3) .EQ. 0.0) GO TO 445
      DO 440 L = 1, 3
      W(1000, L) = EC(1, 2, L)
  440 W(INDEX, L) = EC(1, 1, L)
      GO TO 446
  445 CONTINUE
  446 LP1 = LF + 1
      W(INDEX, 3) = 3.0
      DO 480 J = LP1, 6
      DO 470 K = 1, 2
      IF (EC(J, K, L) - W(1000, L)) 470, 450, 470
  450 CONTINUE
      INDEX = INDEX + 1
      DO 460 L = 1, 3
      W(INDEX, L) = EC(J, K, L)
  460 W(1000, L) = EC(J, K+1, L)
      EC(J, K, 3) = 0.0
      EC(J, K+1, 3) = 0.0
```

```
      GO TO 480
  470 IF (IBUG .GE. 25) WRITE (6, 1030) EC, INDEX
  480 IF (IBUG .GE. 15) WRITE (6, 1030) EC, I, INDEX
  500 CONTINUE
      DO 510 I = 1, INDEX
      W(I, 4) = W (I, 3)
  510 W(I, 3) = 0.0
      NL = INDEX
      RETURN
      END
```

```
      SUBROUTINE S1500
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      COMMON /FRAME/ AH,AW,XB,YB,XX,YY,WW,X820,Y820,XMAX,YMAX,XMIN,YMIN
C
C     PLOT EDGES
C
 1500 CALL PLOT (XX, YY, -3)
 1505 XNP = NP
      XLIMO = LIMO
      IF (IBUG .GE. 15) WRITE (6, 1223) XX, YY, XMIN, YMIN, WW,
     *  XNP, XLIMO
      DO 1510 I = 1, NP
      XI = I
      P(I,1) = (P(I,1) - XMIN) * WW
 1510 P(I,2) = (P(I,2) - YMIN) * WW
      DO 1520 I = 1, LIMO
      XI = I
      IF (IBUG .GE. 15) WRITE (6, 1223) ((P(IE(I,J),K),K=1,2),J=1,2), XI
      CALL PLOT (P(IE(I,1),1), P(IE(I,1),2), 3)
 1520 CALL PLOT (P(IE(I,2),1), P(IE(I,2),2), 2)
      CALL PLOT (-XX, -YY, -3)
 1223 FORMAT (//6E20.6)
      RETURN
      END
```

```
      SUBROUTINE S1600
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      GO TO 1610
 1605 READ(5,80) ZZ, TASK, NUM, A
      WRITE(6, 85) ZZ
C
C     NUM = 1      READ IN ELEMENT SPECIFIC GRAVITIES TO TYPES
C     NUM = 2      ASSIGN TYPES TO STRINGS BY 3 DO-LOOP PARAMETERS
C     NUM = 3      ASSIGN TYPES TO SPECIFIC ELEMENTS OR TO CONTIGUOUS
C                  ELEMENT STRINGS
C     NUM = 4      TERMINATE
C
 1610 GO TO (1620, 100, 1640, 300), NUM
 1620 DO 1625 I=1, 14
 1625 SGT(I)= A(I)
      GO TO 1605
  100 NA1 = A(1)
      NA2 = A(2)
      NA3 = A(3)
      DO 110 I = NA1, NA2, NA3
      SG(I) = SGT (TASK)
  110 NT(I) = TASK
      GO TO 1605
 1640 DO 1645 I=1, 14
      IF (A(I)) 1645,1605,1641
 1641 IF (I .EQ. 14) GO TO 1644
      IF (A(I+1) .GE. 0.0) GO TO 1644
      NA1= A(I)
      NA2 = -A(I+1)
      IF (NA2 .LT. NA1) GO TO 1645
      DO 1642 J= NA1, NA2
      NT(J) = TASK
 1642 SG(J) = SGT(TASK)
      GO TO 1645
 1644 SG(IFIX(A(I))) = SGT(TASK)
      NT(IFIX(A(I))) = TASK
 1645 CONTINUE
      GO TO 1605
   80 FORMAT (20A4, T1, 2I5, 14G5.0)
   85 FORMAT (/'       INTERNAL                    ', 20A4//)
  300 RETURN
      END
```

```
      SUBROUTINE S1800
      DIMENSION TCE(500,3),CCE(500,3),SUM6(500,10),ETEH(500,3)
      DIMENSION EMOI(500,3)
      DIMENSION GMOI(3),TMOI(3),TEH(10,3),TCG(10,3)
      DIMENSION ND(4,3), NS(10,4)
C     ***************************************************************
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      DATA ND / 2,  4,  1,  3,
     *          3,  3,  2,  2,
     *          4,  1,  4,  1/
      DATA NS / 1,  3,  8,  6,  5,   2,  4,  5,  7,  6,
     *          3,  1,  1,  3,  2,   4,  2,  2,  4,  3,
     *          2,  4,  5,  7,  7,   3,  1,  6,  8,  8,
     *          6,  8,  6,  8,  4,   7,  5,  7,  5,  1/
      DO 1804 I= 1, 3
 1804 CG(I) = 0.0
      NL = NL
      WG = 0.0
      EVOL = 0.0
      GVOL = 0.0
      TWT = 0.0
      WRITE(6, 1805)
      DO 1870 I =1, NL
      DO 1810 J = 1, 8
      DO 1810 K = 1, 3
 1810 AC(J,K) = W(IA(I,J),K)
      EVOL = 0.0
      DO 1850 J = 1, 10
      TVOL = 0.0
      DO 1840 K = 1,4
      SD(1,1) = AC(NS(J,ND(K,2)),3)
      SD(2,2) = AC(NS(J,ND(K,2)),2)
      SD(3,3) = AC(NS(J,ND(K,2)),1)
      SD(1,2) = AC(NS(J,ND(K,1)),1)
      SD(3,1) = AC(NS(J,ND(K,1)),2)
      SD(2,3) = AC(NS(J,ND(K,1)),3)
      SD(2,1) = AC(NS(J,ND(K,3)),1)
      SD(1,3) = AC(NS(J,ND(K,3)),2)
      SD(3,2) = AC(NS(J,ND(K,3)),3)
      SUM = 0.0
      DO 1835 L = 1, 3
 1835 SUM = SUM + SD(L,1)*SD(L,2)*SD(L,3) - SD(1,L)*SD(2,L)*SD(3,L)
 1840 TVOL = TVOL + SUM/6.
```

```
C     ******************************************************************
      SUM6(I,J)=TVOL
C     ******************************************************************
      IF(IBUG .GE. 15) WRITE(6,1807) TVOL,(IA(I,NS(J,L)),L=1,4)
 1850 EVOL = EVOL + TVOL/2.
      VE(I) = EVOL
      WT(I) = EVOL * SG(NI(I))
      WG = WG + WT(I)
      DO 1865 J = 1, 3
      CE(J) = 0.0
      DO 1860 K = 1, 8
 1860 CE(J) = CE(J) + 0.125*AC(K,J)
      CG(J) = CG(J) + WT(I)*CE(J)
 1865 CCE(I,J)=CE(J)
      GVOL = GVOL + EVOL
C
C     IN CASE THE FORMAT NEED TO BE CHANGED, USE NUM=1
C
      IF (NUM .EQ. 1) WRITE(7,1886) NI(I),NT(I),VE(I),WT(I),CE
 1886 FORMAT (I5,7X,I1,2X,2E12.3,2X,3F7.2)
C
 1870 WRITE(6, 1806) NI(I), NT(I), VE(I), WT(I), CE
      DO 1880 I = 1, 3
 1880 CG(I) = CG(I)/WG
C
C     USING NUM=1 TO PUNCH OUT THE GROUP VOLUME AND CENTROID.
C
      IF(NUM .EQ. 1) WRITE(7,1884) GVOL,WG,CG
 1884 FORMAT(T10,'GROUP',T16,5E13.5)
C
      WRITE(6, 1885) GVOL, WG, CG
 1805 FORMAT('1',T40,'E L E M E N T      M A S S      T A B L E'///,T21,
     *'ELEMENT',T41,'VOLUME',T61,'WEIGHT',T80,'CENTROID COORDINATES (CM)
     *'/,T22,'NUMBER',T42,'(CC)',T60,'(GRAMS)',T86,'X',T94,'Y',T102,'Z'/
     */)
 1806 FORMAT(T15,I4,T25,I4,T35,E12.5,T55,E12.5,T75,3F8.3)
 1807 FORMAT(T35,E12.5,T60,4I5)
 1885 FORMAT(T22,'GROUP',T35,E12.5,T55,E12.5,T75,3F8.3//)
C
C*******************************************************************
C
C     THE CALCULATION OF THE MOMENT OF INERTIA
C
      WRITE(6,1809)
      DO 1820 N=1,NL
      DO 1821 J=1,8
      DO 1821 K=1,3
 1821 AC(J,K)=W(IA(N,J),K)
      DO 1822 J=1,10
C
C     FIND THE CENTROID OF THE TETRAHEDRON AND MAKE TRANSLATION
C
      DO 1841 L=1,3
```

```
      TCG(J,L)=0.0
      DO 1842 K=1,4
 1842 TCG(J,L)=TCG(J,L)+AC(NS(J,K),L)
 1841 TCG(J,L)=TCG(J,L)/4.0
      DO 1823 L=1,3
      TEH(J,L)=0.0
      DO 1824 K=1,4
      AC(NS(J,K),L)=AC(NS(J,K),L)-TCG(J,L)
      TEH(J,L)=TEH(J,L)+AC(NS(J,K),L)**2
 1824 AC(NS(J,K),L)=AC(NS(J,K),L)+TCG(J,L)
      TEH(J,L)=TEH(J,L)*SUM6(N,J)/20.0
 1823 TEH(J,L)=TEH(J,L)+SG(NI(N))*SUM6(N,J)*(CCE(N,L)-TCG(J,L))**2
 1822 CONTINUE
      DO 1825 L=1,3
      ETEH(N,L)=0.0
      DO 1826 J=1,10
 1826 ETEH(N,L)=ETEH(N,L)+TEH(J,L)
 1825 ETEH(N,L)=ETEH(N,L)/2.0
      DO 1827 I=1,3
      I1 = I + 1
      I2 = I + 2
      IF (I1 .GT. 3) I1 = I1 - 3
      IF (I2 .GT. 3 ) I2 = I2 -3
 1827 EMOI(N,I)=SG(NI(N))*(ETEH(N,I1)+ETEH(N,I2))
C
C     TRANSLATE ELEMENT MOMENT OF INERTIA TO GROUP CENTER OF GRAVITY
C
      DO 1844 L=1,3
 1844 TCE(N,L)=CCE(N,L)-CG(L)
      DO 1845 L=1,3
      L1=L+1
      L2=L+2
      IF(L1 .GT. 3) L1=L1-3
      IF(L2 .GT. 3) L2=L2-3
      TMOI(L)=WT(N)*(TCE(N,L1)**2+TCE(N,L2)**2)
 1845 EMOI(N,L)=EMOI(N,L)+TMOI(L)
 1820 WRITE(6,1808) NI(N),(EMOI(N,I),I=1,3)
      DO 1829 L=1,3
      GMOI(L)=0.0
      DO 1828 N=1,NL
 1828 GMOI(L)=GMOI(L)+EMOI(N,L)
 1829 CONTINUE
      WRITE(6,1811) GMOI
 1808 FORMAT(T25,I4,T40,3E20.5)
 1809 FORMAT(///,T40,'M A S S    M O M E N T    O F    I N E R T I A'//,
     *T21,'ELEMENT NO.',T51,'I(X)',T71,'I(Y)',T91,'I(Z)'/)
 1811 FORMAT(/T12,'GROUP MOMENT OF INERTIA',T40,3E20.5)
C
C*********************************************************************
C
      RETURN
      END
```

```
      SUBROUTINE S1900
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
      COMMON IBUG, NEL, NL, NNP, NP, NUM
C
C     SELECTION BY ELEMENT NUMBER
C
C        S E L E C T I O N    T A B L E
C
C   NUM        ELEMENT STRING DESCRIPTION
C
C    1      DISCONNECTED ELEMENTS  (1 TO 14)
C    2      REGULAR SEQUENCE BY DO-LOOP SPECIFICATION
C    3      HETEROGENEOUS SET OF ELEMENTS SPECIFIED
C           BY DO/LOOPS AND SINGLE ELEMENT NUMBERS
C    4      TERMINATE LIST
C
      NC=0
      GO TO 1908
 1904 READ(5,80) ZZ, TASK, NUM, A
      WRITE(6,85) ZZ
 1908 GO TO (1910, 1930, 1640, 1970), NUM
 1910 DO 1920 I=1,14
      IF (A(I) .EQ. 0.0) GO TO 1904
      NC= NC + 1
      NI(NC) =IFIX(A(I))
      NT(NC) = NT(NI(NC))
      DO 1920 J=1,8
 1920 IA(NC,J) = IC(NI(NC),J)
      GO TO 1904
 1930 NA1 =IFIX(A(1))
      NA2 =IFIX(A(2))
      NA3 =IFIX(A(3))
      IF(A(3) .EQ. 0.0) NA3 = 1
      DO 1940 I= NA1, NA2, NA3
      NC= NC + 1
      NI(NC) = I
      NT(NC) = NT(NI(NC))
      DO 1940 J=1, 8
 1940 IA(NC,J) = IC(I,J)
      GO TO 1904
 1640 DO 1645 I=1, 14
      IF (A(I)) 1645,1904,1641
 1641 IF (I .EQ. 14) GO TO 1644
      IF (A(I+1) .GE. 0.0) GO TO 1644
```

```
      NA1= A(I)
      NA2 = -A(I+1)
      IF (NA2 .LT. NA1) GO TO 1645
      DO 1642 J= NA1, NA2
      NC=NC+1
      NI(NC)=J
      NT(NC)=NT(NI(NC))
      DO 1642 K=1,8
 1642 IA(NC,K)=IC(J,K)
      GO TO 1645
 1644 NC=NC+1
      NI(NC)=A(I)
      NT(NC)=NT(NI(NC))
 1645 CONTINUE
      GO TO 1904
 1970 NL= NC
      DO 1980 I= 1, NL
      DO 1980 J= 1, 8
 1980 W(IA(NI(I),J),4)=-1.0
      DO 1985 I= 1, 3
 1985 EXT(I)=W(IA(NI(1),1),I)
      DO 1995 I=1,NP
      IF (W(I,4) .LT. 0.0) GO TO 1995
      DO 1990 J= 1, 3
 1990 X(I,J) = EXT(J)
 1995 CONTINUE
   80 FORMAT (20A4, T1, 2I5, 14G5.0)
   85 FORMAT (//' TASK, NUM, SPECIFICATIONS ** ', 20A4//)
      RETURN
      END
```

```
      SUBROUTINE S2000
C
C     CONFORMAL MAPPING OF ELEMENTS
C
      DIMENSION IP (12,2)
C*********************************************************************
      DIMENSION IA(500,8), IC(500,8), NI(500), NK(500)
      DIMENSION IE(1000,2), X(1000,6), P(1000,4), W(1000,4)
      DIMENSION A(14), AA(3,3,3), BB(20), BOR(6), C(3,3), EXT(6)
      DIMENSION T(3), TE(6,2), ZZ(20)
      DIMENSION SG(500), NT(1000),AC(8,3), SD(3,3)
      DIMENSION VE(500), WT(500), CE(3), CG(3),SGT(14)
      INTEGER TASK
      COMMON A,AA,AC,BB,BOR,C,CE,CG,EXT,P,SD,SG,SGT,T,TE,VE,W,WT,X
      COMMON IA,IC,IE,NI,NK,NT,TASK
```

```
      COMMON IBUG, NEL, NL, NNP, NP, NUM
      DIMENSION NSL(14)
C
C     CALCULATE ORIGINAL NODAL POINT COORDINATES
C
      IF(NUM .LT. 0) GO TO 449
      NX = A(1)
      NY = A(2)
      IF (NY .EQ. 0) NY = NX
      NZ = A(3)
      IF (NZ .EQ. 0) NZ = NY
      DX = A(4)
      IF (DX .EQ. 0.0) DX = 1.0
      DY = A(5)
      IF (DY .EQ. 0.0) DY = 1.0
      DZ = A(6)
      IF (DZ .EQ. 0.0) DZ = 1.0
      R = A(7)
C
C     NBC IS THE NUMBER OF BOUNDARY CONDITION CARDS TO BE LATER ENTERED.
C
      NBC = A(8)
      CX = FLOAT(NX-1)*DX/2.0
      CY = FLOAT(NY-1)*DY/2.0
      CZ = FLOAT(NZ-1)*DZ/2.0
      XL1 = NX - 1
      YL1 = NY - 1
      ZL1 = NZ - 1
      IF (IBUG .GE. 15) WRITE (6, 20) CX, CY, CZ, XL1, YL1, ZL1, R
      IF (NUM .EQ. 0) GO TO 150
      READ (5,60) ZZ, IPR, NUM1, A
      WRITE (6, 70) ZZ
      NUM2 = A(1)
      NUM3 = A(2)
      NUM4 = NUM1 + NUM2
C     IF (NUM2 .EQ. 0) GO TO 150
      DO 205 I = 1, NUM4
  205 A(I) = A(I+2)
      IF (IBUG .GE. 15) WRITE(6,11) A
      A(1) = A(1) + R
      DO 210 I = 2, NUM4
  210 A(I) = A(I) + A(I-1)
      IF (IBUG .GE. 15) WRITE (6, 20) NUM1, NUM2, NUM3, NUM4, A
      NXY = NX * NY
      NXL1 = NX - 1
      NYL1 = NY - 1
      NZL1 = NZ - 1
      NXYZ = NX * NY * NZ
      IND = NXYZ
      NXYZL1 = NXL1 * NYL1 * NZL1
      NP = NXYZ + NXY*(NUM4+NUM1)
      NP = NP + 2*(NXL1+NYL1)*((NUM3-1)*NUM4 + (NZ-NUM3-1)*NUM1)
      NL = NXYZL1
```

```
      LAYER = 2*(NXL1+NYL1)
      DO 157 I=1,NL
  157 NI(I)=I
      DO 159 I = 1, 14
  159 NSL(I) = 0
      DO 160 I = 1, NUM4
      NSL(I) = NXL1*NYL1 + 2*(NXL1+NYL1)*(NUM3-1)
      IF (I .LE. NUM1) NSL(I) = 2*NXL1*NYL1 + 2*(NXL1+NYL1)*NZL1
  160 NL = NL + NSL(I)
      IF (IBUG .GE. 15) WRITE (6, 20) NXYZ, NP, NXYZL1, NL, NSL, LAYER
      IF (NP .GT. 999) WRITE (6, 90)  NP
C     NUM1            NUMBER OF COMPLETE SHELLS
C     NUM2            NUMBER OF PARTIAL SHELLS
C     NUM3            EXTENT OF PARTIAL SHELLS IN Z-DIRECTION
C     NUM4            TOTAL NUMBER OF SHELLS
C     NX, NY, NZ      NUMBERS OF NODAL POINTS ALONG AXES IN CENTRAL BLOCK
C     NXYZ            NUMBER OF NODAL POINTS IN CENTRAL BLOCK
C     NSL(I)          NUMBER OF ELEMENTS IN THE ITH SHELL
C     NXYZL1          NUMBER OF ELEMENTS IN THE CENTRAL BLOCK
C     IND             REFERENCE NODAL POINT NUMBER FOR STORING IN SHELLS
  150 INDEX = 0
      DO 300 K = 1, NZ
      DO 300 J = 1, NY
      DO 300 I = 1, NX
      INDEX = INDEX + 1
C     ORIGINAL COORDINATES IN BLOCK    (AX, AY, AZ)
      AX = 2 * (I- 1) - NX + 1
      AY = 2 * (J- 1) - NY + 1
      AZ = 2 * (K- 1) - NZ + 1
      IF (AX .EQ. 0.0 .AND. AY .EQ. 0.0 .AND. AZ .EQ. 0.0) GO TO 8
      AX = AX * DX / 2.0
      AY = AY * DY / 2.0
      AZ = AZ * DZ / 2.0
      BX = AX
      BY = AY
      BZ = AZ
      IF (IBUG .GE. 55) WRITE (6, 20) I, J, K,    AX, AY, AZ,
     *BX, BY, BZ
C     PROJECTION RATIOS
      RX = ABS (AX / XL1)
      RY = ABS (AY / YL1)
      RZ = ABS (AZ / ZL1)
      IF (IBUG .GE. 55) WRITE (6, 20) RX, RY, RZ
      IF (RY - RX) 1, 1, 2
    1 IF (RZ - RX) 3, 2, 5
    2 IF (RZ - RY) 4, 5, 5
    3 RF = ABS (CX / AX)
      GO TO 6
    4 RF = ABS (CY / AY)
      GO TO 6
    5 RF = ABS (CZ / AZ)
C     COORDINATES ON SURFACE OF BLOCK  (BX, BY, BZ)
    6 BX = BX * RF
```

```
      BY = BY * RF
      BZ = BZ * RF
      DQ = SQRT (BX*BX  +  BY*BY  +  BZ*BZ)
      IF (DQ .EQ. 0) GO TO 8
      IF (DQ .LT. 0.0) GO TO 423
      DQ = R / DQ
      IF (IBUG .GE. 55) WRITE (6, 20) BX, BY, BZ, DQ
C     PROJECTED POINT
      AX = DQ * AX
      AY = DQ * AY
      AZ = DQ * AZ
    8 W(INDEX, 1) = AX
      W(INDEX, 2) = AY
      W(INDEX, 3) = AZ
      W(INDEX, 4) = 0.0
      IF (IBUG .GE. 55) WRITE (6, 20) RF,    AX, AY, AZ,    INDEX,
     *DQ,    BX, BY, BZ
      WRITE(6,30) INDEX
      DQ = SQRT (AX*AX + AY*AY + AZ*AZ)
      IF (DQ .LT. R-1.0E-4) GO TO 300
C
C     COORDINATES FOR NODAL POINTS IN SHELLS
C
      DO 290 L = 1, NUM4
      IF (K .GT. NUM3 .AND. L .GT. NUM1) GO TO 300
      IND = IND + 1
      ARB = A(L) / R
      W(IND, 1) = ARB * AX
      W(IND, 2) = ARB * AY
      W(IND, 3) = ARB * AZ
      W(IND, 4) = 0.0
      WRITE(6,10) IND
  290 IF (IBUG .GT. 55) WRITE (6, 20) IND, I, J, K, L, (W(IND,M),M=1,3)
  300 CONTINUE
      IF (IBUG .GE. 55) WRITE (6, 40) (I, (W(I,J), J = 1, 3), I = 1, NP)
C
C     GENERATE THE CONNECTION ARRAY
C
C     RECORD MATERIAL TYPE NUMBERS
      INDEX = 0
      DO 440 I = 1, NXYZL1
      INDEX = INDEX + 1
  440 NT (INDEX) = 1
      N2 = NXYZL1
      DO 448 J = 1, NUM4
      N1 = NXYZL1 + 1
      IF (J .GT. 1) N1 = N1 + NSL(J - 1)
      N2 = N2 + NSL(J)
      DO 448 I = N1, N2
      INDEX = INDEX + 1
  448 NT (INDEX) = J + 1
C
C
```

```
C     ELEMENTS IN CENTRAL BLOCK
C
      JNDEX = 0
      DO 400 K = 1, NZL1
      DO 400 J = 1, NYL1
      DO 400 I = 1, NXL1
      JNDEX = JNDEX + 1
      N1 = I + (J-1) * NX + ( K-1 ) * NXY
      N2 = N1 + 1
      N3 = N2 + NX
      N4 = N3 - 1
      N5 = N1 + NXY
      N6 = N2 + NXY
      N7 = N3 + NXY
      N8 = N4 + NXY
      IA(JNDEX, 1) = N1
      IA(JNDEX, 2) = N2
      IA(JNDEX, 3) = N3
      IA(JNDEX, 4) = N4
      IA(JNDEX, 5) = N5
      IA(JNDEX, 6) = N6
      IA(JNDEX, 7) = N7
      IA(JNDEX, 8) = N8
  400 IF (IBUG .GE. 15) WRITE (6, 30) N1, N2, N3, N4, N5, N6, N7, N8,
     *JNDEX
      IF (NUM .EQ. 0) GO TO 1005
C
C     SHELL ELEMENTS
C
      IND = NXYZL1
      DO 1000 L = 1, NUM4
      INB = IND
      IF (L .GT. 1) IND = IND + NSL(L-1)
C
C     BASE
      DO 510 J = 1, NYL1
      DO 510 I = 1, NXL1
      ID = IND + I + (J-1) * NXL1
      IB = ID - IND + INB
      IF (L .GT. 1) GO TO 504
      IA (ID, 2)= I + (J-1) * NX
      IA (ID, 1)= IA (ID, 2) + 1
      IA (ID, 4)= IA (ID, 1) + NX
      IA (ID, 3)= IA (ID, 4) - 1
      IA (ID, 6)= NXYZ + 1 + (I-1) * NUM4 + (J-1) * NX * NUM4
      IA (ID, 5)= IA (ID, 6) + NUM4
      IA (ID, 8)= IA (ID, 5) + NX * NUM4
      IA (ID, 7)= IA (ID, 8) - NUM4
      GO TO 510
  504 DO 506 M = 1, 4
      IA (ID, M) = IA (IB, M+4)
  506 IA (ID, M+4) = IA (ID, M) + 1
  510 IF (IBUG .GE. 15) WRITE (6, 10) I, J, L, IND, INB, ID, IB,
```

```
     *(IA (ID, M), M = 1, 8)
C
C     LAYERS
      DO 590 K = 1, NZL1
      IF (K .GE. NUM3 .AND. L .GT. NUM1) GO TO 600
      N5 = NUM4
      IF (K .GT. NUM3) N5 = NUM1
      N4 = NUM4
      IF (K .GE. NUM3) N4 = NUM1
C
C     FRONT SIDE
      DO 560 I = 1, NXL1
      ID=IND+NXL1*NYL1+I
      ID = ID + (K-1)*2*(NXL1+NYL1)
      IB = ID - IND + INB
      IF (L .GT. 1) GO TO 554
      IA (ID, 3) = I + (K-1) * NXY
      IA (ID, 4) = IA (ID, 3) + 1
      IA (ID, 1) = IA (ID, 4) + NXY
      IA (ID, 2) = IA (ID, 1) - 1
      N7 = NXYZ + 1 + (I-1)*N5
      IF (K .GT. 1) N7 = N7 + NXY*NUM4 + (K-2)*2*(NXL1+NYL1)*NUM4
      IF (K .GT. NUM3 .AND. NUM3 .GT. 0) N7 = NXY*NUM4+(NUM3-1)*LAYER
     *  *NUM4 + (K-NUM3-1)*LAYER*NUM1 + NXYZ + 1 + (I-1)*N5
      IA (ID, 7) = N7
      LINC = 2*(NXL1+NYL1)*NUM4 - (I-1)*(N5-N4)
      IF (K .EQ. 1) LINC = NXY*NUM4
      IF (K .GT. NUM3 .AND. NUM3 .GT. 0) LINC = 2*(NXL1+NYL1) * NUM1
      NINCL = NUM4
      IF (K .GT. NUM3) NINCL = NUM1
      NINCU = NUM4
      IF (K .GE. NUM3) NINCU = NUM1
      IA (ID, 8) = IA (ID, 7) + NINCL
      IA (ID, 6) = IA (ID, 7) + LINC
      IA (ID, 5) = IA (ID, 6) + NINCU
      GO TO 560
  554 DO 556 M = 1, 4
      IA (ID, M) = IA (IB, M+4)
  556 IA (ID, M+4) = IA (ID, M) + 1
  560 IF (IBUG .GE. 15) WRITE (6, 10) I, J, L, IND, INB, ID, IB,
     *(IA (ID, M), M = 1, 8), L, NINCL, LINC, NINCU
C
C     FRONT END
      DO 610 J = 1, NYL1
      ID=IND+NXL1*NYL1+NXL1+J
      ID = ID + (K-1)*2*(NXL1+NYL1)
      IB = ID - IND + INB
      IF (L .GT. 1) GO TO 604
      IA (ID, 3) = J * NX + (K-1) * NXY
      IA (ID, 4) = IA (ID, 3) + NX
      IA (ID, 1) = IA (ID, 4) + NXY
      IA (ID, 2) = IA (ID, 1) - NX
      NINCL = 2*N5
```

```
      IF (K .EQ. 1 .OR. J .EQ. NYL1) NINCL = NX*N5
      NINCU = 2*N4
      IF (K .EQ. NZL1 .OR. J .EQ. NYL1) NINCU = NX*N4
      IA (ID, 7) = IA(ID-1,8)
      IA (ID, 8) = IA (ID, 7) + NINCL
      IA (ID, 6) = IA (ID-1,5)
      IA (ID, 5) = IA (ID, 6) + NINCU
      GO TO 610
  604 DO 606 M = 1, 4
      IA (ID, M) = IA (IB, M+4)
  606 IA (ID, M+4) = IA (ID, M) + 1
  610 IF (IBUG .GE. 15) WRITE (6, 10) I, J, L, IND, INB, ID, IB,
     *(IA (ID, M), M = 1, 8), L, NINCL, LINC, NINCU
C
C     BACK SIDE
      DO 660 I = 1, NXL1
      ID=IND+NXL1*NYL1+NXL1+NYL1+I
      ID = ID + (K-1)*2*(NXL1+NYL1)
      IB = ID - IND + INB
      IF (L .GT. 1) GO TO 654
      IA (ID, 4) = NXY * K - I
      IA (ID, 3) = IA (ID, 4) + 1
      IA (ID, 2) = IA (ID, 3) + NXY
      IA (ID, 1) = IA (ID, 2) - 1
      NINCL = NUM4
      IF (K .GT. NUM3) NINCL = NUM1
      NINCU = NUM4
      IF (K .GE. NUM3) NINCU = NUM1
      IA(ID,7) = IA(ID-1,8)
      IA (ID, 8) = IA (ID, 7) - NINCL
      IA (ID, 6) = IA (ID-1,5)
      IA (ID, 5) = IA (ID, 6) - NINCU
      GO TO 660
  654 DO 656 M = 1, 4
      IA (ID, M) = IA (IB, M+4)
  656 IA (ID, M+4) = IA (ID, M) + 1
  660 IF (IBUG .GE. 15) WRITE (6, 10) I, J, L, IND, INB, ID, IB,
     *(IA (ID, M), M = 1, 8), L, NINCL, LINC, NINCU
C
C     BACK END
      DO 710 J = 1, NYL1
      ID=IND+NXL1*NYL1+NXL1+NYL1+NXL1+J
      ID = ID + (K-1)*2*(NXL1+NYL1)
      IB = ID - IND + INB
      IF (L .GT. 1) GO TO 704
      IA (ID, 3) = K*NXY - J*NX + 1
      IA (ID, 4) = IA (ID, 3) - NX
      IA (ID, 2) = IA (ID, 3) + NXY
      IA (ID, 1) = IA (ID, 2) - NX
      NINCL = 2*N5
      IF (K .EQ. 1 .OR. J .EQ. NYL1) NINCL = NX*N5
      NINCU = 2*N4
      IF (K .EQ. NZL1 .OR. J .EQ. NYL1) NINCU = NX*N4
```

```
      IA (ID, 7) = IA(ID-1,8)
      IA (ID, 8) = IA (ID, 7) - NINCL
      IA (ID, 6) = IA (ID-1,5)
      IA (ID, 5) = IA (ID, 6) - NINCU
      GO TO 710
  704 DO 706 M = 1, 4
      IA (ID, M) = IA (IB, M+4)
  706 IA (ID, M+4) = IA (ID, M) + 1
  710 IF (IBUG .GE. 15) WRITE (6, 10) I, J, L, IND, INB, ID, IB,
     *(IA (ID, M), M = 1, 8), L, NINCL, LINC, NINCU
  590 CONTINUE
C
C     TOP
      DO 760 J = 1, NYL1
      DO 760 I = 1, NXL1
      ID = IND + NXL1*NYL1 + NZL1*2*(NXL1+NYL1) + I + (J-1)*NXL1
      IB = ID - IND + INB
      IF (L .GT. 1) GO TO 754
      IA (ID, 1) = NXYZ - NXY + I + (J - 1) * NX
      IA (ID, 2) = IA (ID, 1) + 1
      IA (ID, 3) = IA (ID, 2) + NX
      IA (ID, 4) = IA (ID, 3) - 1
      IA (ID, 5) = NXYZ+NXY*NUM4+(NUM3-1)*2*(NXL1+NYL1)*NUM4+
     *(NZL1-NUM3)*2*
     *(NXL1+NYL1)*NUM1+1+(I-1)*NUM1+(J-1)*NX*NUM1
      IA (ID, 6) = IA (ID, 5) + NUM1
      IA (ID, 7) = IA (ID, 6) + NX * NUM1
      IA (ID, 8) = IA (ID, 7) - NUM1
      GO TO 760
  754 DO 756 M = 1, 4
      IA (ID, M) = IA (IB, M+4)
  756 IA (ID, M+4) = IA (ID, M) + 1
  760 IF (IBUG .GE. 15) WRITE (6, 10) I, J, L, IND, INB, ID, IB,
     *(IA (ID, M), M = 1, 8)
  600 CONTINUE
 1000 CONTINUE
 1005 CONTINUE
C
C     PREPARE NODAL POINT COORDINATE AND CONNECTION ARRAY CARDS
C
C     NOTE THAT NBC=A(8) MUST HAVE BEEN SPECIFIED
C
      IF (IPR .GT. 0) WRITE (6, 92)
      N7=1
      N8=1
      N6=3
      N5=2
      NUM4=NUM4+1
      XL1=980.0
      IF(IPR .GT. 0) WRITE(7,10)NP,N7,N8,N6,N5
      WRITE(6,10) NP,N7,N8,N6,N5
      NBCC = 1
      READ (5, 60) ZZ, N4, N1, N2, N3
```

```
      IF (IBUG .GE. 45) WRITE (6, 60) ZZ
      DO 1001 I = 1, NP
      IF (NBC .EQ. 0) GO TO 1003
      IF (NBCC .GT. NBC) GO TO 1003
      IF (N4 .GE. I) GO TO 1004
      IF (NBCC .GE. NBC) GO TO 1003
      READ (5, 60) ZZ, N4, N1, N2, N3
      IF (IBUG .GE. 45) WRITE (6, 60) ZZ
      NBCC = NBCC + 1
 1004 CONTINUE
      IF (N4 .GT. I) GO TO 1003
      WRITE (6, 82) N4, N1, N2, N3, (W(I, M), M = 1, 3)
      IF (IPR .GT. 0) WRITE (7, 82) N4, N1, N2, N3, (W(I, M), M = 1, 3)
      GO TO 1001
 1003 WRITE (6, 84) I, (W(I, M), M = 1, 3)
      IF (IPR .GT. 0) WRITE (7, 84) I, (W(I, M), M = 1, 3)
 1001 CONTINUE
      N4=5
      IF(IPR.GT.0) WRITE(7,10)N4,NL,NUM4
      WRITE(6,10)N4,NL,NUM4
      DO 1010 I=1,NUM4
      READ(5,95)J,CX,CY,CZ
   95 FORMAT(I5,E10.3,2F10.3)
      IF(IPR.GT.0) WRITE(7,95)I,CX,CY,CZ
 1010 WRITE(6,95)I,CX,CY,CZ
      IF(IPR.GT.0)WRITE(7,96)XL1
      WRITE(6,96)XL1
   96 FORMAT(8F10.2)
      DO 1020 I=1,4
      WRITE(6,96)
 1020 IF(IPR.GT.0)WRITE(7,96)
      X7 = 1.00
      IF(IPR.GT.0)WRITE(7,96)X7,X7,X7,X7
      WRITE(6,96)X7,X7,X7,X7
      DO 1002 I = 1, NL
      NI(I) = I
      IF(IPR .GT. 0) WRITE (7, 85) I, (IA(I, M), M = 1, 8), NT(I)
 1002 WRITE (6, 85) I, (IA(I, M), M = 1, 8), NT(I)
C
      GO TO 450
  423 WRITE (6, 50)
  449 CONTINUE
  450 RETURN
   10 FORMAT (16G5.0)
   11 FORMAT (/T10,14F5.2)
   20 FORMAT (//T10,6G15.6/)
   30 FORMAT (//T5, 20G5.2/)
   40 FORMAT (T30, I5, 3F12.3)
   50 FORMAT ('      ERROR  ***  DQ .LT. 0.0      ')
   60 FORMAT (20A4, T1, 2I5, 14G5.0)
   70 FORMAT(/' SHELL PARAMETERS', T30, 20A4)
   82 FORMAT (T1, 4I5, T25, '1', T30, '1', T35, '1', 3F10.5)
   84 FORMAT (T1, I5, T25, '1', T30, '1', T35, '1', 3F10.5)
```

```
85 FORMAT (T1, 9I5, T50, '2', I5, T80, '0')
90 FORMAT (///' *****************   NP .GT.  999   *****************
  ******',T99, 'NP = ',I5///)
92 FORMAT ('1')
   END
```